BUILDING ENERGY CODES
WORKING GROUP

EBC

Energy in Building and
Communities Programme

Building Energy Codes and Other Mandatory Policies Applied to Existing Buildings

June 2021

Technology Collaboration Programme
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Preface

The International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme. A basic aim of the IEA is to foster international co-operation among the 30 IEA participating countries and to increase energy security through energy research, development and demonstration in the fields of technologies for energy efficiency and renewable energy sources.

The IEA Energy in Buildings and Communities Programme

The IEA co-ordinates international energy research and development (R&D) activities through a comprehensive portfolio of Technology Collaboration Programmes (TCPs). The mission of the IEA Energy in Buildings and Communities (IEA EBC) TCP is to support the acceleration of the transformation of the built environment towards more energy efficient and sustainable buildings and communities, by the development and dissemination of knowledge, technologies and processes and other solutions through international collaborative research and open innovation. (Until 2013, the IEA EBC Programme was known as the IEA Energy Conservation in Buildings and Community Systems Programme, ECBCS.)
The high priority research themes in the EBC Strategic Plan 2019–2024 are based on research drivers, national programmes within the EBC participating countries, the Future Buildings Forum (FBF) Think Tank Workshop held in Singapore in October 2017 and a Strategy Planning Workshop held at the EBC Executive Committee Meeting in November 2017. The research themes represent a collective input of the Executive Committee members and Operating Agents to exploit technological and other opportunities to save energy in the buildings sector, and to remove technical obstacles to market penetration of new energy technologies, systems and processes. Future EBC collaborative research and innovation work should have its focus on these themes.
At the Strategy Planning Workshop in 2017, some 40 research themes were developed. From those 40 themes, 10 themes of special high priority have been extracted, taking into consideration a score that was given to each theme at the workshop. The 10 high priority themes can be separated in two types namely ‘Objectives’ and ‘Means’. These two groups are distinguished for a better understanding of the different themes.

Objectives: The strategic objectives of the EBC TCP are as follows:
– reinforcing the technical and economic basis for refurbishment of existing buildings, including financing, engagement of stakeholders and promotion of co-benefits;
– improvement of planning, construction and management processes to reduce the performance gap between design stage assessments and real-world operation;
– the creation of ‘low tech’, robust and affordable technologies;
– the further development of energy efficient cooling in hot and humid, or dry climates, avoiding mechanical cooling if possible;
– the creation of holistic solution sets for district level systems taking into account energy grids, overall performance, business models, engagement of stakeholders, and transport energy system implications.

Means: The strategic objectives of the EBC TCP will be achieved by the means listed below:
– the creation of tools for supporting design and construction through to operations and maintenance, including building energy standards and life cycle analysis (LCA);
– benefitting from ‘living labs’ to provide experience of and overcome barriers to adoption of energy efficiency measures;
– improving smart control of building services technical installations, including occupant and operator interfaces;
– addressing data issues in buildings, including non-intrusive and secure data collection;
– the development of building information modelling (BIM) as a game changer, from design and construction through to operations and maintenance.

The themes in both groups can be the subject for new Annexes, but what distinguishes them is that the ‘objectives’ themes are final goals or solutions (or part of) for an energy efficient built environment, while the ‘means’ themes are instruments or enablers to reach such a goal. These themes are explained in more detail in the EBC Strategic Plan 2019–2024.

The Executive Committee

Overall control of the IEA EBC Programme is maintained by an Executive Committee, which not only monitors existing projects, but also identifies new strategic areas in which collaborative efforts may be beneficial. As the Programme is based on a contract with the IEA, the projects are legally established as Annexes to the IEA EBC Implementing Agreement. At the present time, the following projects have been initiated by the IEA EBC Executive Committee, with completed projects identified by (*) and joint projects with the IEA Solar Heating and Cooling Technology Collaboration Programme by (☼):

Annex 1: Load Energy Determination of Buildings (*)
Annex 2: Ekistics and Advanced Community Energy Systems (*)
Annex 3: Energy Conservation in Residential Buildings (*)
Annex 4: Glasgow Commercial Building Monitoring (*)
Annex 5: Air Infiltration and Ventilation Centre
Annex 6: Energy Systems and Design of Communities (*)
Annex 7: Local Government Energy Planning (*)
Annex 8: Inhabitants Behaviour with Regard to Ventilation (*)
Annex 9: Minimum Ventilation Rates (*)
Annex 10: Building HVAC System Simulation (*)
Annex 11: Energy Auditing (*)
Annex 12: Windows and Fenestration (*)
Annex 13: Energy Management in Hospitals (*)
Annex 14: Condensation and Energy (*)
Annex 15: Energy Efficiency in Schools (*)
Annex 16: BEMS 1- User Interfaces and System Integration (*)
Annex 17: BEMS 2- Evaluation and Emulation Techniques (*)
Annex 18: Demand Controlled Ventilation Systems (*)
Annex 19: Low Slope Roof Systems (*)
Annex 20: Air Flow Patterns within Buildings (*)
Annex 21: Thermal Modelling (*)
Annex 22: Energy Efficient Communities (*)
Annex 23: Multi Zone Air Flow Modelling (COMIS) (*)
Annex 24: Heat, Air and Moisture Transfer in Envelopes (*)
Annex 25: Real time HVAC Simulation (*)
Annex 26: Energy Efficient Ventilation of Large Enclosures (*)
Annex 27: Evaluation and Demonstration of Domestic Ventilation Systems (*)
Annex 28: Low Energy Cooling Systems (*)
Annex 29: ☼ Daylight in Buildings (*)
Annex 30: Bringing Simulation to Application (*)
Annex 31: Energy-Related Environmental Impact of Buildings (*)
Annex 32: Integral Building Envelope Performance Assessment (*)
Annex 33: Advanced Local Energy Planning (*)
Annex 34: Computer-Aided Evaluation of HVAC System Performance (*)
Annex 35: Design of Energy Efficient Hybrid Ventilation (HYBVENT) (*)
Annex 36: Retrofitting of Educational Buildings (*)
Annex 37: Low Exergy Systems for Heating and Cooling of Buildings (LowEx) (*)
Annex 38: ☼ Solar Sustainable Housing (*)
Annex 39: High Performance Insulation Systems (*)
Annex 40: Building Commissioning to Improve Energy Performance (*)
Annex 41: Whole Building Heat, Air and Moisture Response (MOIST-ENG) (*)
Annex 42: The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems (FC+COGEN-SIM) (*)
Annex 43: ☼ Testing and Validation of Building Energy Simulation Tools (*)
Annex 44: Integrating Environmentally Responsive Elements in Buildings (*)
Annex 45: Energy Efficient Electric Lighting for Buildings (*)
Annex 46: Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo) (*)
Annex 47: Cost-Effective Commissioning for Existing and Low Energy Buildings (*)
Annex 48: Heat Pumping and Reversible Air Conditioning (*)
Annex 49: Low Exergy Systems for High Performance Buildings and Communities (*)
Annex 50: Prefabricated Systems for Low Energy Renovation of Residential Buildings (*)
Annex 51: Energy Efficient Communities (*)
Annex 52: ☼ Towards Net Zero Energy Solar Buildings (*)
Annex 53: Total Energy Use in Buildings: Analysis and Evaluation Methods (*)
Annex 54: Integration of Micro-Generation and Related Energy Technologies in Buildings (*)
Annex 55: Reliability of Energy Efficient Building Retrofitting–Probability Assessment of Performance and Cost (RAP-RETRO) (*)

Annex 56: Cost Effective Energy and CO_2 Emissions Optimization in Building Renovation (*)
Annex 57: Evaluation of Embodied Energy and CO_2 Equivalent Emissions for Building Construction (*)
Annex 58: Reliable Building Energy Performance Characterisation Based on Full Scale Dynamic Measurements (*)
Annex 59: High Temperature Cooling and Low Temperature Heating in Buildings (*)
Annex 60: New Generation Computational Tools for Building and Community Energy Systems (*)
Annex 61: Business and Technical Concepts for Deep Energy Retrofit of Public Buildings (*)
Annex 62: Ventilative Cooling (*)
Annex 63: Implementation of Energy Strategies in Communities (*)
Annex 64: LowEx Communities–Optimised Performance of Energy Supply Systems with Exergy Principles (*)
Annex 65: Long-Term Performance of Super-Insulating Materials in Building Components and Systems (*)
Annex 66: Definition and Simulation of Occupant Behavior in Buildings (*)
Annex 67: Energy Flexible Buildings (*)
Annex 68: Indoor Air Quality Design and Control in Low Energy Residential Buildings (*)
Annex 69: Strategy and Practice of Adaptive Thermal Comfort in Low Energy Buildings
Annex 70: Energy Epidemiology: Analysis of Real Building Energy Use at Scale
Annex 71: Building Energy Performance Assessment Based on In-situ Measurements
Annex 72: Assessing Life Cycle Related Environmental Impacts Caused by Buildings
Annex 73: Towards Net Zero Energy Resilient Public Communities
Annex 74: Competition and Living Lab Platform
Annex 75: Cost-effective Building Renovation at District Level Combining Energy Efficiency and Renewables
Annex 76: ☼ Deep Renovation of Historic Buildings Towards Lowest Possible Energy Demand and CO_2 Emissions
Annex 77: ☼ Integrated Solutions for Daylight and Electric Lighting
Annex 78: Supplementing Ventilation with Gas-phase Air Cleaning, Implementation and Energy Implications
Annex 79: Occupant-Centric Building Design and Operation
Annex 80: Resilient Cooling
Annex 81: Data-Driven Smart Buildings
Annex 82: Energy Flexible Buildings Towards Resilient Low Carbon Energy Systems
Annex 83: Positive Energy Districts
Annex 84: Demand Management of Buildings in Thermal Networks
Annex 85: Indirect Evaporative Cooling
Annex 86: Energy Efficient Indoor Air Quality Management in Residential Buildings

Working Group–Energy Efficiency in Educational Buildings (*)
Working Group–Indicators of Energy Efficiency in Cold Climate Buildings (*)
Working Group–Annex 36 Extension: The Energy Concept Adviser (*)
Working Group–HVAC Energy Calculation Methodologies for Non-residential Buildings (*)
Working Group–Cities and Communities
Working Group–Building Energy Codes

Table of contents

Executive Summary

Many countries and subnational jurisdictions are exploring potential new or expanded mandatory policies to improve existing building energy performance in response to the challenge of limiting climate change.

The IEA Energy in Buildings and Communities (EBC) Programme Building Energy Codes Working Group (BECWG) commissioned a review of building energy codes and other mandatory regulatory instruments applied to existing buildings in member economies.

This report synthesizes the experience to date with two major types of policies based on information from Building Energy Code Working Group members and the literature. The two key policy types are:

Building energy codes

Generally developed as requirements for new building construction but often applied to existing buildings when renovations or substantial additions or other changes are made, building energy codes are a mature regulatory policy lever in wide use in most BECWG economies. They deliver significant energy savings for new buildings and major renovations, but their effectiveness in driving performance improvement in existing buildings is less clear. There is significant variation both among countries, but also within countries, regarding the thresholds or triggers that require existing building compliance with an energy code.

Building energy performance standards

A newer policy tool, just in early implementation in some leading jurisdictions, performance standards bring the opportunity to drive energy performance improvement in a much larger portion of the existing building stock. Thus, they have the potential to accelerate energy use and greenhouse gas reduction each year, though it is still relatively early days to understand the actual effectiveness of this policy.

Table ES1 distills the project findings on the key characteristics of both type of policies, and Table ES2 shows some of the key benefits and challenges of these two major mandatory policy levers.

Both energy codes and performance standards are important policies for driving energy performance improvements in existing buildings and can be applied differently or together to achieve significant savings in the substantial existing buildings stock. While there is more to be learned as new performance standards come into effect and results are better understood, there is strong potential that well designed codes and standards implemented together will be able to accomplish what neither would be able to accomplish on their own.

Table ES1
Key characteristics of energy codes relative to performance standards

	Energy Codes	Performance Standards
Basis of requirements	Codes are generally developed for new construction, though some new construction requirements are applied to substantial renovation or alteration projects	Based on some threshold of building energy or carbon performance linked to a performance rating (either calculated or measured), or a measured energy or carbon intensity
Basic trigger for requirement	A "one-time" requirement to meet prescribed energy efficiency levels or performance when renovating, refurbishing or remodeling an existing building, generally when the level of renovation exceeds a stated portion of the building floor area or value, or some specified construction value	Meet a prescribed energy performance level by a given date, and/or on change of tenancy or ownership, often with the performance level ratcheted up over time sending longer term signal for more stringent requirements in the future
Implementation issues	– With some other building renovation as the trigger, only a very small percentage of existing buildings face requirements in any given year – Thresholds for trigger are sometimes a given percent of existing building floor area to be modified or renovated. These may be manipulated to keep below the threshold	– New type of regulation: many potentially regulated buildings not currently subject to ongoing maintenance or other compliance checking requirements such as an initial "occupancy certificate" – Falls beyond traditional building control/ department regulatory functions and will likely require significant new administrative resources
Enforcement and compliance issues	– Authority responsible for building control may not be notified by building owner or contractor that renovation work that meets the requirement for the code to apply is taking place	– All properties in the qualifying class are required to meet the standard so in principle it is easy to identify properties which need to comply – Many properties required to meet performance at same time so possible resource issue (for supply chain, e.g., building raters, as well as regulators)
Enabling or financial issues	– Because renovation is already planned, presumably with financing in place, meeting the code requirements should generally not place a substantial additional financial burden on the owner/developer	– Requires a mature energy rating system, or data for a "fleet standard" that can be the basis for performance measurement – Potential financial hardship for some without special financing/ incentives in place—or risk that lack of finance means many exemptions

Table ES2
Benefits and Challenges of energy codes relative to performance standards

	Energy Codes	Performance Standards
Benefits	– Development and implementation process already in place for new construction and some renovation in most jurisdictions – Construction stakeholders largely familiar with energy codes – Most jurisdictions have some building control department in place, dealing with variety of building codes	– Can trigger major energy improvement activity without other construction (renovation/ remodelling) being a trigger – Should drive much more significant volume of building energy improvement in existing building stock than solely buildings being otherwise renovated – Potential longer-term glide to more stringent standards, with regular ratcheting up of requirements; a clear signal about requirements several years ahead allows consideration in normal building capital planning
Challenges	– Most code processes are focused on a construction process trigger, which means large portion of existing building stock not addressed – Code implementation/ enforcement is focused on health and life safety issues; energy performance lower priority	– Relatively new policy lever — not many mature policies in place which creates some uncertainty and potential risk regarding policy effectiveness – Relative lack of familiarity by many industry stakeholders, and potential lack of technical knowledge of ways to meet the standards

1. Introduction

Buildings consume about 30% of global final energy, which grows to 35% when the building construction industry energy use is added, and buildings (including the construction industry) were responsible for 38% of total global greenhouse gas emissions in 2019 (UNEP 2020). Policies to reduce energy use in buildings, with resulting emissions reductions, have been identified by most countries as a significant low-cost opportunity for greenhouse gas reduction.

While there is significant progress in getting new buildings to very low, and even zero, energy and emissions, there is a tremendous stock of existing buildings where there are significant opportunities for the energy performance to be dramatically improved. The United Nations Environment and International Energy Agency (IEA) estimated that roughly 65% of the 2060 building stock in Organization for Economic Cooperation and Development (OECD) countries will be buildings that already exist today (UN Environment & IEA 2017). This reflects the fact that most buildings last many decades, and, in the OECD, are being replaced by new buildings at a very slow rate.

As most of these existing buildings were built to lower (or no) energy codes, they tend to have poorer energy performance. The inherent low energy efficiency may be exacerbated by older equipment and appliances which may not be well maintained. This means there is major energy savings potential in existing buildings. The IEA found that the energy savings potential from improved building envelope performance improvements is huge: globally, high-performance buildings construction and deep energy renovations of existing building envelopes represents a savings potential that is more than all the final energy consumed by the G20 countries in 2015, or around 330 EJ in cumulative energy savings to 2060 (IEA 2017).

But this requires a step change in the number and depth of energy efficient renovations being implemented. The Global Alliance for Buildings and Construction Roadmap for Buildings and Construction (Global ABC/UNEP/IEA 2020) identified key steps to achieving these, including increasing deep energy renovations that reduce energy consumption of existing buildings by 50% or more in developed economies and 30% or more in developing economies and increasing annual renovation rates globally to 4% by 2050 from a current rate of less than 1%.

The Roadmap recognizes codes for existing buildings as a crucial part of this process. It recommends that codes for existing buildings become mandatory for all buildings, recommending that most countries adopt “near-zero” mandatory codes for existing buildings by 2040, and that all countries and jurisdictions have “near-zero” codes for existing buildings in 2050.

This report is focused on mandatory requirements driving existing building energy performance improvement. While there are other policy instruments including voluntary and information programs aimed toward improving existing buildings’ energy performance, or mandatory policies that apply to a selection of buildings (such as Government owned or occupied buildings[1]), we focus here only on mandatory policies that must be met by broad groups of buildings.

This report provides a review of building energy codes and other mandatory regulatory instruments applied to existing buildings in economies that are part of the IEA Energy in Buildings and Communities (EBC) Programme Building Energy Codes Working Group (BECWG). Members of the Working Group are listed in Annex 1.

To gather input for the report, a simple survey was developed and distributed to BECWG members and other leading experts. Fourteen countries responded to the survey, and email follow up was conducted with most to clarify certain points about codes or other policies in place in those countries. Desk research was also conducted to survey available literature regarding energy codes and other mandatory policies applied to existing buildings in those countries.

1.1 Key terminology in this report

Before exploring these key policies, we provide a brief glossary of key terms for better understanding of how those terms are used in this report. There is much to learn about effective policy design and market impact by comparing how different policies and strategies have been implemented globally. However, key discrepancies in terminology, priorities, and scopes of local initiatives make this comparison difficult. While many policies are aimed toward the same goals, and share characteristics, there are often subtle but important differences in terminology and use of similar terms that may confuse policy makers from different regions.

1 For example, EU Member States are obliged by Article 5 of the Energy Efficiency Directive to make energy efficient renovations to at least 3% per year of buildings owned and occupied by central governments

Because of the different interpretations of some key terms, for the purposes of this report, we have explicitly defined the terms below as we use them in this report.

"Building energy codes" (or "energy codes" and "regulations") are regulations that are intended to impact the energy performance of buildings by regulating the efficiency of the building envelope (insulation, windows and materials), and building systems (lighting, heating, cooling, ventilation, hot water equipment technologies or a combination of them). Codes are generally triggered by a decision by the building owner to make some sort of capital improvement to the building.

"Building performance standards" (or "minimum energy performance standards") are regulations or policies that require building owners to meet some performance benchmark or target, generally an energy performance rating, or energy or carbon intensity, often giving building owners multiple years to bring buildings into compliance, sometimes with staged requirements increasing in stringency over time. Performance standards can require action from all building owners covered by the standard.

"Refurbishment" is the general improvement of a building at some periodic interval, with common dictionaries defining the term as work such as painting, repairing, and cleaning that is done to make a building look new again, but without necessarily improving its energy performance.

"Renovation" is the broad improvement of buildings, generally synonymous with refurbishment, though potentially more comprehensive than refurbishment. In the European context, **"major renovation"** has been specifically defined as part of deep energy renovation policies, as explained in the box below.

"Retrofit" is to re-fit some particular systems or subsystems for a specific purpose, or to add a component or accessory to something that did not have it when manufactured. Energy retrofits of existing buildings are generally done solely for the purpose of upgrading the energy performance of that building, generally not as part of any broader renovation or refurbishment project.

"Additions or alterations" (or **"consequential improvements"**) are terms used in some building codes to determine eligibility of code application for existing buildings. Often, the code may specifically define what is included as an addition or alteration for triggering the code requirements.

"Mandatory" energy codes or standards (or other policies) have provisions that are legally required to be followed with risk of liability and financial penalties for non-compliance.

"Building energy performance" is the efficiency of a building and may be expressed in energy intensity (usually energy per unit of floor area, expressed in kWh/m^2 per year) or in the performance of specific building elements or systems.

The **building energy performance** can be stated using an **"asset rating,"** or design or calculated rating, of performance based on the theoretical or simulated energy use in a building or building element as calculated under a set of defined conditions. The building performance can also be stated using an **"operational rating"** or measured rating based on the actual energy use of a building in operation based on energy bills and consumption. There can be significant discrepancies between how the same building's performance would be rated between the different methods; more information is available in the report "Building Energy Rating Schemes: Assessing Issues and Impacts" (IPEEC 2014).

European Definition

"Major Renovation"–European Union (EU) Member States have a common definition of "major renovation" which then requires building codes to apply. The Energy Performance of Buildings Directive[a] Article 2: defines "major renovation" as the renovation of a building where:

1. the total cost of the renovation relating to the building envelope or the technical building systems is higher than 25% of the value of the building, excluding the value of the land upon which the building is situated; or,

2. more than 25% of the surface of the building envelope undergoes renovation.

a https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en?

2. Overview of regulatory policies

This report concentrates on mandatory policies aimed at existing building energy performance. This includes two categories: energy codes/regulations and building energy performance standards. Energy codes/regulations are the more established policy, which have historically been additions to earlier building health or life safety codes initially developed for new buildings (such as fire codes, structural codes, etc.). These codes are often also applied to an existing building when a major change to the building occurs. The requirements of energy efficiency in these codes can be the same as for new buildings or may be less rigorous, to accommodate practical or cost constraints. Building energy performance standards are a more recent approach; they set energy related performance standards for all existing buildings of a group or type. These two types of policies can operate alongside one another, or in some cases, might even be part of the same broad regulatory package.

Other types of policies, which may be mandatory or voluntary, can support these policies and encourage the uptake of energy efficiency improvements. They include energy rating systems, requirements for energy audits, and the availability of financial support schemes offering loans or grants. In addition, there are other policies, such as product and equipment minimum performance standards and requirements for regular servicing of equipment. These policies are included as examples where mentioned by survey respondents or in the literature.

2.1 Application of building energy codes/regulations to renovations and refurbishment

Most building energy codes have been developed to impact the energy efficiency and performance of newly constructed buildings, but in many cases, they are also extended to apply to the renovation or refurbishment of existing buildings. Understanding how and when energy code provisions apply to existing buildings can, however, be a challenge for building and energy regulators, as well as for building owners.

In many cases, when the code is applied to an existing building, only the portion of the building that is being renovated (or a new addition) is covered by the code provisions. There are generally no requirements to upgrade the entire building.[1]

Most codes are a choice between or a combination of "prescriptive" requirements and "performance" requirements. "Prescriptive" requirements set specific rules on building components such as allowable transmittance of heat through wall insulation and windows, and equipment efficiency levels. In contrast, "performance" approaches require that the building as designed meets the intent of the prescriptive requirements, with the flexibility to trade off among different systems.

In most cases, the performance approach is a pathway that allows designers greater flexibility to demonstrate that the building as designed is "deemed to satisfy" the more simplified prescriptive requirements. A more comprehensive description of the different code compliance approaches can be found in "Delivering Energy Savings in Buildings: International Collaboration on Building Energy Code Implementation" (IPEEC 2015). A summary of energy code requirements as they apply to existing buildings in selected BECWG member countries is provided later in this report.

Energy codes, like all regulations, are only as impactful as their enforcement, and it is easier to develop and promulgate a code than to ensure that the requirements are enforced. More on this issue is presented later in this report in the section on Implementation of Building Regulatory Policies.

2.2 Building energy performance standards

Building energy performance standards (in Europe and some other regions referred to as "Minimum Energy Performance Standards", or MEPS, for buildings) require buildings to meet some performance benchmark or target, such as an energy performance rating, or energy or carbon intensity level, with building owners having advance notice to bring the buildings into compliance. Performance standards require buildings to be improved to meet a specified standard at a chosen trigger point or date and can include standards that tighten over time.

There are a variety of different policy design decisions that have substantial impact on how many buildings are impacted by performance standards, and the level of savings that can result. For example, whether to cover all building

1 This may be in recognition of the fact that if the requirements are too stringent, they can become too costly, and they risk becoming an obstacle to renovation. Cost and cost effectiveness and how they relate to building code requirements are discussed below.

stock or a certain portion of it, or only rented property or properties above a certain size. Many of these issues are highlighted in the report “Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals” (Nadel & Hinge 2020).

Performance standards are a newer policy approach than energy codes but have been identified as a key policy that has the potential to dramatically increase the number of buildings that implement energy performance improvements in any given year. They can improve the prospects for faster renovation rate increases and better progress toward greenhouse gas reduction targets.

2.3 Comparing codes with performance standards

While this report focuses on energy codes and performance standards, the two key policies have different bases of requirements as well as triggers for when they take effect, as summarized in Table 1.

Key issues about when different types of codes or other regulations force energy performance improvements are:

– The **“trigger”** for when the policy applies. This is often some portion of the building being renovated or altered,

– The **threshold** for the type and size of buildings that the regulation covers. While energy codes have traditionally covered nearly all construction in most regions where they are developed and implemented, application of the codes to existing buildings is not as comprehensive.

2.4 Implementation of building regulatory policies

Building performance standards are a relatively recent development and few of the standards have reached the first date for compliance, so there is little experience of implementation at this point. (The experience to date is discussed below in the section “Opportunities and challenges with different approaches”). Consequently, the findings in the section describe the experience with energy codes.

In most cases, model building energy codes and regulations (as well as other building codes including health and life safety codes) are written at a national level, with most adoption and implementation at the local jurisdiction level, such as through a state or province, or even at the city level. Even when an energy code or other regulation is adopted by a subnational jurisdiction like a state or province, the implementation and enforcement of all building policy is generally administered at the city or local level by a designated building control office or department. These offices employ “building inspectors” that are responsible for code and other related policy administration and enforcement. In some areas where the local government does not have the resources for implementation and enforcement, those functions are provided by other levels of government or contracted out to third parties such as private building control inspectors, or sometimes excluded or just not enforced.

There can be a mismatch between ambitious national (or in Europe, supra-national) policies and the realities of capacity in local jurisdictions to implement codes and

Table 1
Energy codes applied to existing buildings compared with performance standards

	Energy Codes	Performance Standards
Basis of requirements	Codes are generally developed for new construction, though some new construction requirements are applied to substantial renovation or alteration projects	Based on some threshold of building energy or carbon performance linked to a performance rating (either calculated or measured), or a measured energy or carbon intensity
Basic trigger for requirement	A “one-time” requirement to meet prescribed energy efficiency levels or performance when renovating, refurbishing or remodeling an existing building, generally when the level of renovation exceeds a stated portion of the building floor area or value, or some specified construction value	Meet a prescribed energy performance level by a given date, and/or on change of tenancy or ownership, often with the performance level ratcheted up over time sending longer term signal for more stringent requirements in the future

standards, and enforce good quality construction. In reality, in most local jurisdictions, the higher priorities for local code enforcement are health and life safety issues. In smaller cities and rural areas, building control officials are not as familiar with energy codes and regulations as those other aspects of the codes that may impact the immediate safety of building occupants or citizens. There can also be construction industry ambivalence to learning about energy code requirements. Significant outreach and training about efficient construction practices and skills development may be needed to increase the number of qualified contractors who are knowledgeable about energy efficiency and the related regulatory requirements.

There are also challenges with how to enforce energy codes effectively when construction quality or specific energy efficiency provision deficiencies are identified. Is a building removed from the market (rental or sale) when energy code violations are identified, or are penalty payments required? In many cases, there are real challenges for local building officials in understanding how to best enforce energy codes, particularly when applied to existing buildings which may be occupied through part or all of the construction/renovation period.

European Directives

In Europe, there is another level beyond national and subnational policies: "supra-national" high-level "Directives" from the European Commission to European Member States, such as the Energy Performance of Buildings Directive[a] (abbreviated as the "EPBD") and the Energy Efficiency Directive[b] (abbreviated as the "EED"). Under the EPBD, Member States are required to develop, periodically update and administer long-term renovation strategies,[c] including policy measures and actions to promote cost-effective deep renovation of buildings. Article 7 of the EPBD also requires to Member States ensure that when buildings undergo major renovation the energy performance is upgraded to meet minimum requirements.[d] Separately the EED requires Member States to make energy efficient renovations to at least 3% of the total floor area of buildings owned and occupied by central governments annually.[e]

To date the effects of these directives have been limited so in October 2020 the Commission announced the "Renovation Wave,"[f] a key initiative in the framework of the EU Green Deal to invigorate activity. This presents a strategy with the aim of at least doubling the annual energy renovation rate of buildings by 2030 and to foster deep energy renovations. It aims to renovate 35 million inefficient buildings by 2030, as 85–95% of buildings in the EU are expected to still be standing in 2050. It is supported by funds from the EU budget to unlock investment into building renovation.[g] The Renovation Wave has already provided an indication of specific aspects and measures to be considered, including the phased introduction of Mandatory Minimum Energy Performance Standards for buildings of all types (public and private), addressing the worst performing stock.

a https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en?
b https://ec.europa.eu/energy/topics/energy-efficiency/targets-directive-and-rules/energy-efficiency-directive_en
c Most recent national Renovation Strategies are posted at https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/long-term-renovation-strategies_en
d https://ec.europa.eu/energy/content/minimum-energy-performance-requirements-all-buildings-undergo-major-renovation_en
e http://eedguidebook.energycoalition.eu/public-renovation.html
f https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/renovation-wave_en
g https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1603122391413&uri=CELEX:52020SC0550

3. Policies in place in BECWG countries

3.1 Energy codes applied to existing buildings

Selected data on codes as applied to existing building for BECWG countries, collated from a combination of survey responses and literature sources, are shown in Table 2. Further details are provided in Annex 2.

Codes for existing buildings are generally incorporated in codes for new buildings, rather than being separate, stand alone, regulations, such that in some cases, information on the existing building requirements can be hard to find. This is not just a challenge for researchers trying to understand different codes. It also has a practical effect: building owners or contractors may not be aware of the requirements and therefore may not focus on complying with them.

As has been noted above, in codes for new buildings the requirements may set prescriptive standards for a building component (e.g., “U” values for thermal transmittance in windows and walls) or overall performance (for example a maximum energy use expressed in kWh/m^2) or a combination of the two (performance standards backed up with prescriptive standards). As with new buildings, the requirements are often different for residential and non-residential buildings.

The coverage of building codes also varies, in several cases requirements for existing buildings only apply to larger buildings. For example, in Japan only buildings with a floor area greater than 300 m^2 need to comply. Also, in some countries, different thresholds and different levels for requirements apply for residential and commercial buildings.

- The trigger for the regulations to apply is generally a renovation or a change or replacement of equipment. But how the trigger is expressed varies widely by jurisdiction. It may be value of renovation–for example, in Portugal, a percentage of the building value, or, in New South Wales, Australia, above a fixed financial value. (A further variation on this is that several of the regulations for States in Australia set a threshold for renovation which looks at the value or scale of work undertaken over three years to try to avoid evasion by building owners/developers who make changes by increments so that they don’t meet the threshold).

- An alternative is the percentage of the building changed, expressed by floor area or volume; or some fraction of the building envelope, as in the Netherlands, Italy and other European Union (EU) countries. Another possibility is if a substantive component of the building is changed, for example the building façade in England and Wales, or if part of the ‘energy system’ of the building is changed, such as the HVAC system, lighting, or installing renewable energy, in Turkey. Change of use of the building may also mean that the code applies, for example in Ireland. Another case is where the decision is at the discretion of the building certifier, such as in Queensland, Australia.

Once the building change/renovation triggers the requirement to meet the code the stringency of the requirements in the code also vary. In some countries the energy performance of the renovated building (or part of building) has to meet that of a new building. In others, for example Germany, the renovated portion of the building is given an extra energy allowance compared to a new building (energy consumption can be 140% that of a new building).

The degree of renovation required may depend on the cost. Within the European Union, the Energy Performance of Buildings Directive (EPBD) requires renovations to be “cost optimal.” There is guidance to help Member States interpret this, but the guidance leaves a large degree of flexibility for Member States in implementation.[1] For example, in Ireland, the building code requires only “cost optimal” upgrades, and in England & Wales the payback period must not exceed 15 years. In other cases, for example Italy, the requirements depend on the scale of the renovation: existing buildings that undergo a major renovation (“1st level major renovation,” as defined in Annex 2) have to comply with Near Zero Energy Building (NZEB) requirements like new buildings. The scope of the requirements can also differ; in some countries, for example for major renovations in Italy, the whole building has to meet the new code standard. In others, such as Sweden, only the renovated part of the building is in scope.

There are a range of conditions which mean that certain types of buildings are not obliged to meet the code. Many countries, including England and Wales, Portugal and the US have exemptions for heritage (historic) buildings. Buildings with low occupancy may be exempt, as is the case in Turkey, or unheated buildings in Sweden. An alternative approach is smaller renovations which are certified as meeting a requirement for a given energy performance for the renovated building are excused from applying for a building permit.

1 https://ec.europa.eu/energy/content/cost-optimality-level_en

Table 2
Mandatory building energy code requirements for existing buildings

Country/jurisdiction	Triggers and thresholds for code to apply
Australia	Requirements vary by jurisdiction
England and Wales	Triggers include replacement of a whole facade, some changes of use, complete renovation of the building, some of which result in the application of the new-build standard.
Finland	Buildings undergoing renovations and/or retrofitting that is subject to a building permit, when the use of a building is altered, or technical systems are repaired.
Germany	Whenever relevant refurbishment is done, the minimum requirements given by the Energy Saving Ordinance have to be met.
Ireland	Building Regulations apply to material alterations to existing buildings and where a material change of use takes place.
Italy	Minimum requirements are differentiated according to the extent of the renovation intervention split between major and minor renovations, up to the 1st level major renovations (definition in Annex 2), when the same standards as for new buildings apply (for the whole building).
Japan	For non-residential buildings, compliance is mandatory for additions and renovation > 300 m^2. (floor area)
The Netherlands	If there is a major renovation, where a major renovation is if more than 25% of the surface of the building envelope is renewed, changed or enlarged.
Portugal	Major renovations (if the cost of the renovation work is greater than 25% of the cost of the whole building)
Sweden	Requirements come into force when the building is altered (no matter how small the alteration). When a building is renovated or refurbished, the altered part of the building should comply with the regulations for new buildings.
Turkey	Renovation of building envelope, renewing heating system, or any applications for renewable energy systems
USA	Any system or component renovated or altered typically needs to be brought up to the same level of efficiency as new construction (though specific requirements vary by jurisdiction).

Note: All country's energy code requirements apply to both residential and commercial buildings.

Sources: responses to 2020–21 BECWG survey, and European EPBD Concerted Action Reports (CA EPBD 2018 for Finland, Germany, Ireland and Italy)

In most countries the incentive to comply, and to demonstrate compliance with the code requirements is that a new building cannot be occupied without certification by a building inspector, such as a "certificate of occupancy," which includes meeting the energy requirements of the building code. This form of enforcement is more of a challenge with existing buildings, which may already be occupied.

3.2 Building performance standards

Building performance standards are a newer policy lever aimed toward improving building energy and emissions performance, but are growing quickly in popularity, particularly in Europe and the US.

As noted earlier, performance standards generally focus on targeting the worst performing buildings under some metric of performance and require that these buildings be brought up to a higher level by a certain date or penalties will apply. The earliest national application to a very wide group of buildings was England & Wales, where requirements began in 2018, though the Tokyo Cap-and-Trade program set requirements on the largest facilities in that city starting in 2010.

Related policies highlighted by BECWG survey respondents

Responses to the Codes Survey from three BECWG countries covered other policies for existing building which weren't strictly current building codes:

- **Brazil** has a 'Normative Instruction' which applies to major renovations of Federal buildings (mostly offices and universities) that have a floor area of greater than 500 m^2. Renovated buildings have to meet energy class A of the Brazilian building energy classification. National heritage buildings are exempt.

- **Canada** is in the process of developing a national energy code for Alterations to Existing Buildings, though some provinces or cities already have codes that apply to existing buildings.

- **India** has a voluntary Energy Conservation Building Code which applies to major retrofits as well as new buildings. This applies to commercial buildings with connected loads of 110kW or greater. The residential code applies to buildings which have a plot area of 500 m^2 or greater.

Performance standards have the potential to have the stringency of requirements ratcheted up during successive performance compliance periods. For example, the Tokyo Cap-and-Trade program sets five-year compliance periods, with successive periods requiring additional emissions reductions from the previous compliance period. The New York City performance standard sets an initial compliance period of 2024–2029, where only around 20% of buildings are required to make improvements, but in the second (2030–2034) compliance period about 75% of covered buildings will need to make improvements, in some cases cutting their emissions by 50% or even more from their 2018 levels.

With growing interest in performance standards in the US, the US Environmental Protection Agency's ENERGY STAR Program has recently developed a guidance document on these policies for policymakers (US EPA 2021).

Summary information about performance standards in BECWG economies is shown in Table 3 below. More details on these policies can be found in Nadel & Hinge 2020, Sunderland & Santini 2020a and Sunderland & Santini 2020b.

Energy Performance Ratings as a Trigger for Performance Standards

For performance standards, building ratings/benchmarks are generally an important precursor to these standards. Such benchmarking provides data that can be used to help set performance standards, and often the performance standards use the metrics established with benchmarking. Several years of benchmarking and reporting to develop capacity and stakeholder confidence are helpful.

There are a number of well-established building energy rating schemes internationally (IPEEC 2014). In the EU the EPBD requires Member States to have in place mandatory building energy ratings– termed Energy Performance Certificates (EPCs). These are required to include the energy performance of a building.[a] Member States can choose the format of the Certificate and how to present the rating with most Member States have chosen to adapt the scale and graphics of the EU mandatory energy label use for consumer energy-using appliances and lighting[b] to EPCs. This has seven energy grades, A to G, with A being the best energy performance and G the worst. Each Member State sets their own metrics[c] and thresholds for the energy grades, so the energy performance of an 'A' grade house in the Netherlands will not be equivalent to that of one in Portugal. However, the rating does give some indication of a building's energy performance within the range in that country.

a https://ec.europa.eu/energy/eu-buildings-factsheets-topics-tree/energy-performance-certificates_en
b https://europa.eu/youreurope/business/product-requirements/labels-markings/energy-labels/index_en.htm
c Although kWh/m^2 is often used

Table 3
Summary of Building Performance Standards in BECWG Countries

Country/jurisdiction	Applies to Res	Applies to Com	Size threshold/ typical trigger	Summary of requirements
England and Wales (Private Rented Property Regulations)	●	●	Initially applied when change or extension in tenancy; later to all properties	Regulations adopted 2015. Residential: applied at change of tenancy from 2018 and to all from 2020. Commercial at change of tenancy from 2018 and to all 2023. Energy rating of "E" or better required or property cannot be let unless installing measures up to a cost cap does not meet this.
France	●	●	Residential, and commercial buildings < 1,000 m^2	Measures required are different depending on the size of the building but also its year of construction or the cost of the renovation. Staged requirements, up to 2028.
France		●	Commercial buildings > 1000 m^2	Staged requirements for 2030, 2040 and 2050. Alternatively, the building can comply with minimum operational energy performance standards.
New York City (USA)	●	●	Buildings >25,000 square feet (approx. 2,320 m^2)	Establishes maximum GHG intensity limits (CO2e per floor area) for different building types, with 1st compliance period in 2024, then more stringent requirements starting in 2030.
The Netherlands		●	All office buildings by a given date	Require minimum Energy Performance Certificate (EPC) rating of "C", takes effect from 2023. Includes a cost threshold: measures to meet the standard should pay back within 10 years. A landlord is required to install measures up to this payback threshold but not exceeding it, even if required efficiency is not reached.
Scotland	●		Initially applied when change or extension in tenancy; later to all properties	Applies to all private rented residential properties from April 2022. Must meet an energy rating E, or register an exemption, initially. The requirement increased to a D rating from 2025.
Scotland	●		By a given date	Social housing only (Energy Efficiency Standard for Social Housing Scotland (EESSH). Dwellings are required to meet required EE rating. Some funding is available.
Tokyo (Japan)		●	Very large "facilities" consuming more than 1,500 kiloliters of annual crude oil equivalent energy	Covered facilities must reduce a specified percentage below the allotted baseline GHG emissions for different compliance periods (2010–14, 2015–19, 2020–24). If they do not meet the allotted emissions, credits can be purchased from others.
Washington State (USA)		●	Commercial buildings over 50,000 square feet (approx. 4,650 m^2)	Establishes site Energy Use Intensity ("EUI") limits, such that any buildings' EUI must be no greater than the average EUI for that building's occupancy type with some adjustments. Voluntary participation with financial aid effective in 2021, mandatory first takes effect in 2026. Levels to be updated in 2029, and updated every five years thereafter.

4. Lessons learned in leading countries/ regions

The experience from the policies identified in the previous section has helped to identify some key lessons that are relevant to other jurisdictions considering new or expanded policies aimed toward existing buildings.

4.1 A comprehensive approach is required

Several countries have long term strategies or targets for the energy use or carbon emissions in their building stock that require energy renovation of existing buildings. For example, Turkey has a target of 1.5 million buildings that are classified as C class or worse on their Energy Performance Certificate scale. The European Energy Performance of Buildings Directive (EPBD) requires all EU Member States to develop, periodically update and administer long-term renovation strategies,[1] including policy measures and actions to promote cost-effective deep renovation of buildings. The aim of these strategies is to create a highly energy efficient and decarbonized building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings. These high-level targets can be helpful in setting a country's ambition and goals, indicating the direction of travel to all stakeholders. However, they need to be supported by more concrete measures in order to have effect.

Mandatory policies can provide the "stick" to drive building owners to consider energy efficiency, but it is clear, not least from the widespread low rate of renovation, that these need to be used in conjunction with other, supporting, policies to overcome the barriers to energy efficient renovation. This is true whether the energy efficiency renovation is an activity in its own right or as a component of renovation or refurbishment taking place for other reasons (building extension, modernization, change of use and so on).

A significant challenge is the up-front cost of energy efficient renovation. Performance levels are generally set such that the resulting energy savings pay back the investment within its lifetime and it is recognized that there are a number of additional benefits, such as improved health or higher worker productivity. Nevertheless, the investment capital needs to be found and across an economy the sums involved are significant. For example, Frontier Economics (on behalf of the Energy Efficiency Infrastructure Group, 2017) estimated that to bring all residential UK buildings to the Government target's level (EPC Band C) by 2030 (rented) and 2035 (owner occupied), total capital investment averaging UK£5.2 billion every year to 2035 would be required. Similarly, the Urban Green Council (2019) has estimated that meeting the New York City 2030 building performance standard emissions intensity limits will cost US$17–24 billion in total.

The cost of renovating to the required standard was quoted by a number of survey respondents as a barrier to implementation of codes for existing buildings. To address this some countries have systems of loans in place to help, for example from TuREEFF in Turkey[2] and from the KfW Bank in Germany[3]. Some have subsidies or grants for products with better energy performance, for example for heat pumps in Portugal. Others have tax rebates, such as the Netherlands which has reduced the Value Added Tax (VAT) rate for home improvements. Some buildings must meet a minimum code to access retrofit subsidies in specific rural parts of China (Evans et. al. 2014). Many other countries have finance mechanisms in place which can operate via commercial banks (for example green mortgages) or through utility funded energy efficiency programs (such as Energy Efficiency Obligations in the EU), as well as significant loan programs in other regions.

A mandatory certification/rating system (for example in the EU the Energy Performance Certificate) can assist in a number of ways — by making the energy performance visible it allows market forces to operate (for a more detailed discussion of this and other supporting policies for energy efficiency renovation see IPEEC 2017). If the rating system is combined with a registry of these certificates, this can allow Governments to track progress in energy performance from renovation, and in some cases, better understand compliance with applicable standards. For example,

1 https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/long-term-renovation-strategies_en

2 TuREEFF (Turkish Residential Energy Efficiency Financing Facility) is a programme developed by the EBRD (European Bank of Reconstruction and Development) and supported by CTF (Clean Technology Fund) and the EU (European Union) that aims to provide finance to residential consumers who wish to invest in Energy Efficiency projects in their homes.

3 The KfW, is a German state-owned development bank. One of its roles is to offer households finance for energy efficient renovation.

in their response to the BECWG survey, a representative from Turkey was able to state "170,000 buildings have been renovated" (though it is unclear about the extent of those renovations), and a representative for Portugal noted "9,061 residential and 1,257 commercial buildings have been renovated."

Other 'softer' policy approaches can help to address other barriers to renovation.

For example, another barrier to energy related renovation is the potential for large numbers of different experts involved, which complicates the work. A number of policy or programmatic responses are being both considered and tested to address this, including making training more easily available, reducing training costs, and developing suitable specialist qualifications and/or making them more widely recognized. Adequate capacity in all of the required contractor trades, including both supply of installers and other necessary workers, as well as training resources are critical to the effectiveness of any of the policies.

A further issue identified was that large, more complex energy renovations can take a long time to complete, highlighting the need to take into account the life cycle and remaining life of major equipment and systems in a building. In many cases, when a building heating system fails, the equipment is just replaced with "like-for-like" equipment, without considering that there might be opportunities for a more holistic, significantly higher efficiency total system retrofit. In such a case, a more comprehensive deep retrofit may allow for a smaller, lower cost boiler or system than the like-for-like alternative, opening an opportunity for more attractive economics through a comprehensive plan for the end of major systems' useful life. Integration of capital planning for major equipment, including a performance improvement roadmap or "renovation passport," can deliver much deeper energy savings (EC 2020).

Finally, beyond requirements to meet a code or performance standard, there is a need for ongoing vigilance to make sure that better performance is maintained. Setting and enforcing building and HVAC commissioning and maintenance requirements, along with compulsory sub-metering, can go a long way towards meeting these needs.

4.2 Opportunities and challenges with different approaches

Implementation issues

Building codes. The evidence suggests that building codes can be very effective for new construction but may have mixed effectiveness with existing buildings. The triggers and thresholds for energy codes applied to existing buildings are varied but most only apply to the area or element of the building that is being renovated, not the whole building and in any case, they will only apply to a limited number of buildings in any given period. Further, thresholds for the need to meet the code are often for a given percent of existing building floor area to be modified or renovated–these may be manipulated to keep below the threshold. That said, codes can move some portion of the existing building market, particularly for countries that may not be ready to adopt a performance standard.

Experience in BECWG countries shows that for building codes in many countries (including Australia, Canada, India, and the US), codes are adopted and enforced at the state, province or regional level. This means that codes can be adapted to local conditions (climate, prevalent building types) but also that there can be a range of approaches and levels of stringency. This is particularly the case for the application of codes to existing buildings where the trigger and threshold for code application, type or scale of building change, can vary by state or province, as well as the required level of performance.

As an example of how the triggers and thresholds can vary within a country, a recent project in Australia (Newgate Research 2020) examined the triggers and thresholds for energy codes and other building regulations among different Australian states. Australian states have a wide range of climatic conditions and building types and this variation is reflected in the codes for existing buildings. Findings from this review were that: the thresholds for the building code to apply varied widely –for example 'substantial alterations'[4] in the Australian Capital Territory, to "new building work" in Queensland and South Australia. The requirements of the codes also differ, from meeting all requirements for new buildings in Tasmania, to changes which are "practical and appropriate" in the Northern Territory. A summary of the triggers and thresholds for the Australian states is included as Annex 3.

Performance standards. Performance standards can potentially drive much more energy improvement, both to a larger number of buildings, and potentially deeper savings, and may be less easily manipulated than building codes. For example, the substantial lead time for Tokyo buildings to meet the established carbon cap, as well as a very comprehensive stakeholder consultation and education process, has resulted in quite significant energy and carbon reductions in the buildings covered by the regulation. Given the urgency of the requirement to reduce energy

4 For example, changes to 50% of the floor area

use in buildings these are significant attractions, which explains the growing interest in their adoption.

Most performance standards have been applied to a particular segment of the buildings market: e.g., office buildings (the Netherlands), or private rented property (England and Wales), though in other cases (like New York City), the standards apply to all buildings over a certain size. Performance standards may be set nationally, regionally or at a city level.

For performance standards, building ratings/benchmarks are generally an important precursor to standards. Such benchmarking provides data that can be used to help set performance standards, and often the performance standards use the metrics established with benchmarking (Nadel & Hinge 2020). In some countries, mandatory energy performance rating or certification systems are already well established. In countries where there is not a mandatory rating system, only voluntary, such as most US states and India, this could be an additional step on the path to adopting performance standards. That said, there are performance standards in North America not specifically tied to a mandatory rating system, such as Boulder, New York City and Washington State, where standards are set on the basis of building code or other procedures complemented with studies needed to translate these codes and procedures into appropriate standards.

Energy codes, somewhat by definition, aim to improve energy performance of the buildings that are subject to their requirements. In nearly all cases, energy codes have energy as the metric of performance, while in some cases with performance standards, the metric is carbon (greenhouse gas emissions) performance.

Even when the metric is the same, there are different ways (or expressions) of the performance under that metric. With energy performance, which is often the basis for an energy code, there may be a significant disconnect between the predicted, or modelled, energy performance, and the measured, actual performance once the building is in operation. There are a variety of valid reasons for this disconnect that have been summarized in Building Energy Performance Gap Issues: An International Review (IPEEC 2019), but a performance standard based on measured performance is a way to drive actual performance improvement.

Enforcement and compliance issues

Codes for existing buildings are established and therefore more familiar than performance standards to most building regulatory stakeholders, and systems are in place to enforce them (although stakeholders may not always check that they are up to date with the current requirements and therefore not fully comply.) Performance standards, as a relatively new policy, will require new structures to be put in place, or existing systems to be adapted. Also, there needs to be additional effort to educate and inform everyone in the supply chain on how to comply. This is particularly the case as the regulations may apply to buildings that were not previously subject to ongoing maintenance or other compliance checking requirements.

In jurisdictions with both codes and performance standards if one administrative entity does not administer both regulations then there is potential for market confusion.

Where energy codes and performance standards will potentially apply to some of the same buildings, there is a need for careful regulatory design and harmonization. While most jurisdictions have energy codes that dictate requirements for new construction, once that building is occupied it may be subject to performance standards, and there is potential for a disconnect between the different sets of requirements. As an example, in Washington, DC in the US, some analysis of the performance standard requirements has shown that multifamily buildings built to the current energy code may not meet the performance standard in the first compliance cycle that will take effect in 2026.[5]

Another aspect of enforcement for building codes is that the authority responsible for building control or inspection may not be notified that renovation work that meets the requirement for the energy related code to apply is taking place. This is especially so if the renovation work being done may not require inspection for health or life safety reasons. In principle the situation is simpler for performance standards as all properties in the covered class of buildings are required to meet the standard by a given date, so it is easy to identify properties which need to comply. However, many properties would be required to meet the performance standard at the same time so this may cause resource issues, for the supply chain, e.g., building raters, as well as regulators. If the change of ownership/tenancy approach is taken, then the need to check compliance against the performance standard needs to be made part of any procedures for approval of a new owner or lease; there may be an opportunity to link this to other building sales or rental regulations.

Another point is that most performance standards are largely untested since the standards are relatively new

5 https://buildinginnovationhub.org/resource/regulation-basics/where-dcs-building-code-meets-beps/

and have set targets some years after adoption. Some early results have been reported; so far these are mixed. The first target date for residential property under the England and Wales Energy Efficiency Private Rented Property Regulations, was 2018. An interim evaluation for a Post Implementation Review of the regulations (BEIS 2021) found that domestic (residential) sector, landlords' awareness of and compliance with the regulations had increased and that there was some evidence that the regulations had increased energy efficiency. They found that the level of awareness in the non-domestic (commercial) sector was more varied. On the other hand, Sunderland and Jahn (2021) found that the experience to date from the performance standard for office buildings in the Netherlands is positive, where legislation was adopted in 2018 setting an energy performance which has to be met in 2023. This early announcement triggered major banks to adapt their finance offers to support owners and investors to comply early.

Enabling or financial issues

As noted earlier, the funding required for energy improvements can be a substantial constraint; the financing of required changes needs to be made as easy as possible and each approach does this in different ways. For codes for existing buildings, as renovation is already planned, presumably with financing in place, meeting the code requirements generally would not place a substantial additional financial burden on the owner/developer. For performance standards the target dates are set out several years in advance so that owners/developers can plan efficiency renovations together with other work, thus minimizing both the cost and disruption. In some cases, the requirement of the performance standard is triggered when there is a change of tenancy or ownership — this can help to minimize the disruption to the occupants so the work can be scheduled to take place in their absence.

While these features may reduce the cost, the requirements still place a financial burden on the building owner which may mean that, in the absence of dedicated funding support, that exemptions are granted which may severely reduce the scope to achieve the necessary energy savings. On the other hand, the evidence from codes for existing buildings is that the need not to place an undue financial burden on renovation has in many cases reduced the stringency of codes to considerably less than that for new buildings, along with concerns about code requirements potentially disturbing tenants who live in multifamily residential buildings.

Regarding equity and social justice issues, building codes may not help tenants of buildings with poor energy efficiency and less engaged owners, as there is no requirement to bring buildings up to a higher standard, too often leaving tenants with unhealthy, expensive to occupy buildings.

Performance standards may have an advantage here and this may explain why some of the policies adopted to date target rented buildings. But in the case of either policy type the improvements to energy efficiency in rented buildings may lead to higher rents (to recover renovation costs or to reflect increased property values) or possible displacement of disadvantaged communities. Policy design needs to consider this; any policies that may lead to reduced availability of affordable housing need extremely careful consideration.

4.3 Challenges for more stringent policies

As various jurisdictions look to introduce more stringent codes or other policies related to existing buildings, they will need to look for innovative ways to address common hurdles, particularly the challenge of evaluating and enforcing regulations after a building has been built. As an example, Canada, which has begun taking steps to develop its first national model energy code for existing buildings, is trying to anticipate possible challenges and provide guidance to address those challenges for local jurisdictions that will later adopt the code (CCBFC 2019).

Some of the initial Canadian guidance includes urging that careful attention be given to building science and cost-effectiveness to avoid unintended consequences (such as undertaking changes to interior walls without considering asbestos remediation) and closing the performance gap between the current code and the existing building stock. The latter recommendation recognizes that requiring all existing buildings to meet the current codes will not be a realistic goal. For one, it would be far too expensive in terms of material, labor, and compliance costs, and second, such a rigorous requirement could stifle the improvement of existing buildings rather than encourage it (Evans et. al. 2020).

A summary of some key issues differentiating energy codes from performance standards is presented in Table 4.

Table 4
Key issues distinguishing codes from performance standards

	Energy Codes	Performance Standards
Implementation issues	– With some other building renovation as the trigger, only a very small percentage of existing buildings face requirements in any given year – Thresholds for trigger are sometimes a given percent of existing building floor area to be modified or renovated. These may be manipulated to keep below the threshold	– New type of regulation: many potentially regulated buildings not currently subject to ongoing maintenance or other compliance checking requirements such as an initial "occupancy certificate" – Falls beyond traditional building control/department regulatory functions and will likely require significant new administrative resources
Enforcement and compliance issues	– Authority responsible for building control may not be notified that renovation work that meets the requirement for the code to apply is taking place	– All properties in the qualifying class are required to meet the standard so in principle it is easy to identify properties which need to comply. But many properties required to meet performance at same time so possible resource issue (for supply chain, e.g., building raters, as well as regulators).
Enabling or financial issues	– Because renovation is already planned presumably with financing in place, meeting the code requirements should generally not place a substantial additional financial burden on the owner/developer	– Requires a mature energy rating system, or data for a "fleet standard" that can be the basis for performance measurement – Potential financial hardship for some without special financing/incentives in place — or risk that lack of finance means many exemptions

5. Conclusions

Building energy codes are a very mature regulatory policy lever in wide use in most BECWG economies, delivering significant energy savings. Codes are generally developed as requirements for new building construction but are often applied to existing buildings when renovations or substantial additions or other changes are made.

There is significant variation both among countries, but also within countries, regarding the thresholds or triggers that require existing building compliance with an energy code.

Building energy performance standards are a newer policy tool, just in early implementation in some leading jurisdictions. Performance standards bring the opportunity to drive energy performance improvement in a much larger portion of the existing building stock. Thus, they have the potential to accelerate energy use and greenhouse gas reduction each year, though they are still in relatively early days for understanding realistic policy effectiveness.

Table 5 shows some of the key benefits and challenges of these two major mandatory policy levers aimed to reducing energy consumption in existing buildings.

Both energy codes and performance standards are important policies for driving energy performance improvements in existing buildings and can be applied differently or together to achieve significant savings in the substantial existing buildings stock. While there is more to be learned as new performance standards come into effect and results are better understood, there is strong potential that well designed codes and standards implemented together will be able to accomplish what neither would be able to accomplish on their own.

Table 5
Benefits and Challenges of energy codes relative to performance standards

	Energy Codes	Performance Standards
Benefits	– Development and implementation process already in place for new construction and some renovation in most jurisdictions – Construction stakeholders largely familiar with energy codes – Most jurisdictions have some building control department in place, dealing with variety of building codes	– Can trigger major energy improvement activity without other construction (renovation/ remodelling) being a trigger – Should definitely drive much more significant volume of building energy improvement in existing building stock than solely buildings being otherwise renovated – Potential longer-term glide to more stringent standards, with regular ratcheting up of requirements; a clear signal about requirements several years ahead allows consideration in normal building capital planning
Challenges	– Most code processes are focused on a construction process trigger, which means large portion of existing building stock not addressed – Code implementation/ enforcement is focused on health and life safety issues; energy performance lower priority	– Relatively new policy lever — not many mature policies in place which creates some uncertainty and potential risk regarding policy effectiveness – Relative lack of familiarity by many industry stakeholders, and potential lack of technical knowledge of ways to meet the standards

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Annex 2. Details on policies/regulations

Codes applied to existing buildings

Country/ jurisdiction	Applies to Res	Com	Size threshold/typical trigger	Comments and link to further information
Australia	●	●		Requirements vary by jurisdiction — see Annex 3
England and Wales (Building regulations)	●	●	Example triggers are: replacement of a whole facade; some changes of use; complete renovation of the building. These triggers would typically result in the application of the new-build standard. (This only applies to residential buildings with a floor area of 1000 m^2.)	Grade I and Grade II listed (heritage) buildings, buildings in conservation areas, places of worship and other non-typical buildings have differing levels of exemption. https://www.gov.uk/government/publications/conservation-of-fuel-and-power-approved-document-l
Finland	●	●	Buildings undergoing renovations and/or retrofitting that are subject to a building permit, when the use of a building is altered, or technical systems are repaired. The 2017 amendment required renovations to meet the same nearly zero energy levels as for new buildings.	Compliance can be via 3 alternative routes: 1. energy efficiency requirements for each building element; 2. energy consumption requirements for a building-by-building type 3.taking into account renewable energy https://www.ymparisto.fi/fi-FI/Rakentaminen
Germany	●	●	Whenever relevant refurbishment is done, the minimum requirements given by the Energy Saving Ordinance have to be met.	The requirements of the ordinance can be fulfilled in two ways: – either by meeting specific energy performance requirements for building elements and installations, – or by attaining 140% of the performance requirements for a new building (calculated using the reference building status 2014). https://www.bbsr-energieeinsparung.de/EnEVPortal/EN/Home/home_node.html
Ireland	●	●	Building Regulations apply to material alterations to existing buildings and where a material change of use takes place.	Buildings undergoing major renovation are required to be upgraded to the cost-optimal level of energy performance in so far as this is technically, functionally and economically feasible. The following improvements are normally considered to be cost-optimal and will typically be economically feasible when more than 25% of the surface area of a building is being upgraded: upgrading heating, cooling, ventilation and lighting systems. https://www.gov.ie/en/organisation/department-of-housing-local-government-and-heritage/

Codes applied to existing buildings

Country/ jurisdiction	Applies to Res	Applies to Com	Size threshold/typical trigger	Comments and link to further information
Italy	●	●	Minimum requirements are differentiated according to the extent of the renovation intervention: – Major renovations — first level ("refurbishment of at least 50% of the envelope and renovation of the heating and/or cooling plant of the entire building"). Standards for new buildings apply to the whole building, limited to the considered energy service(s). For building enlargements (new volume >15% of the existing volume or >500 m3) these standards apply to the new volume. – Major renovations — second level (defined as "refurbishment of at least 25% of the external surfaces of the building"). Less demanding U-values and the mean efficiencies of renovated technical building systems are higher than the reference values. – Minor renovations — The performance of single components or of the technical building systems has to comply with mandatory limit values.	Italian regions and autonomous provinces (a total of 21 authorities) have final jurisdiction in energy topics. https://www.mise.gov.it/index.php/it/energia/efficienza-energetica/edifici
Japan	●	●	For non-residential buildings, compliance is mandatory for additions and renovation > 300 m^2 (floor area). For non-residential buildings smaller than 300 m^2 and residential buildings, it is mandatory for designers to explain building owners the evaluation results (predicted primary energy consumption compared with the standard value for the buildings). For renovation of existing buildings, the compliance and the explanation to the owners are mandatory if the renovation is for more than a certain percentage of the existing buildings.	Construction plans have to be certified to meet requirements. Completed buildings are inspected and if they do not meet requirements they cannot be occupied until they do. https://www.mlit.go.jp/jutakukentiku/jutakukentiku_house_tk4_000103.html
The Netherlands	●	●	If there is a major renovation, where a major renovation is if more than 25% of the surface of the building envelope is renewed, changed or enlarged.	Exemptions for industrial buildings where the environment is determined by the production process. https://www.nen.nl/media/wysiwyg/nta_8800_A1_2020.PDF

Codes applied to existing buildings

Country/ jurisdiction	Applies to Res	Applies to Com	Size threshold/typical trigger	Comments and link to further information
Portugal	●	●	Major renovations (if the cost of the renovation work is greater than 25% of the cost of the whole building)	Different regulations for residential and non-residential. Religious and agricultural buildings are exempt. For buildings with floor area > 1000 m^2 (or 500 m^2 in some cases), Energetic Rationalization Plan is mandatory if energy class is less than class C. Since July 1, 2008, all major renovations must have a minimum energy class B. A new regulation was adopted in December 2020: https://dre.pt/web/guest/home/-/dre/150570704/details/maximized
Sweden	●	●	Requirements come into force when the building is altered (no matter how small the alteration). When a building is renovated or refurbished, the altered part of the building should comply with the regulations for new buildings.	The requirements are basically the same as for new buildings, but are adaptable to specific circumstances such as economic feasibility, cultural values, technical conditions etc. All buildings with floor area heated to above 10 degrees Celsius are included, independent of usage. The building code for new and existing buildings is currently under an extensive review. https://www.boverket.se/en/start/building-in-sweden/swedish-market/laws-and-regulations/national-regulations/building-regulations/
Turkey	●	●	Renovation of building envelope, renewing heating system, or any applications for renewable energy systems	Exemptions are: buildings where production activities are carried out in industrial areas, buildings with a planned usage period of less than two years, buildings with a total usage area of less than 50 m^2, greenhouses, workshops and individually built warehouses, arsenals, warehouses, barns that do not need to be heated and cooled. http://www.bep.gov.tr/default.aspx#.YBASnBahk2w
USA	●	●	Any system or component renovated or altered typically needs to be brought up to the same level of efficiency as new construction.	Different codes for a) commercial and high rise residential, ASHRAE 90.1 or the International Energy Conservation Code (IECC), and b) low rise residential (3 stories and less), IECC. Buildings with significant historical significance are typically exempted. https://www.iccsafe.org/advocacy/international-energy-conservation-code-resource-page/

Sources: Responses to 2020–21 BECWG survey, and European EPBD Concerted Action Reports (CA EPBD 2018 for Finland, Germany, Ireland and Italy)

Energy performance standards

Country/ jurisdiction	Applies to Res	Applies to Com	Size threshold/typical trigger	Comments and link to further information
England and Wales	●	●	Initially applied when change or extension in tenancy; from 2020 to all properties.	Residential: seven-year lead time from introduction to compliance in 2018. Commercial from 2023. Energy rating E required or property cannot be let unless installing measures up to a cost cap does not meet this. Protected, historically significant buildings, places of worship, temporary buildings and low-energy-use industrial and agricultural buildings are exempt. https://www.legislation.gov.uk/ukdsi/2015/9780111128350/contents
France	●	●	Residential plus applies to commercial buildings < 1000 m^2. Required by a given date.	The measures required are different depending on the size of the building but also its year of construction or the cost of the renovation. There are staged requirements, up to 2028. http://www.rt-batiment.fr/
France		●	Every commercial building whose area is > 1000 m^2 is in scope. Required by a given date.	There are staged requirements for 2030, 2040 and 2050. Alternatively, the building can comply with minimum operational energy performance standards. http://www.rt-batiment.fr/
New York City	●	●	All buildings >25,000 square feet (approx. 2,320 m^2)	Establishes maximum GHG intensity limits (CO_2e per floor area) for different building types, with 1st compliance period in 2024, then more stringent requirements starting in 2030. https://www1.nyc.gov/assets/buildings/local_laws/ll97of2019.pdf
The Netherlands		●	All office buildings by a given date	Introduced in 2018, take effect from 2023. Includes a cost threshold: measures to meet the standard should pay back within 10 years. A landlord is required to install measures up to this payback threshold but not exceeding it, even if required efficiency is not reached. Excludes buildings where < 50% or in which < 100 m^2 is used for offices. There are exemptions for historic and listed buildings. https://www.rvo.nl/onderwerpen/duurzaam-ondernemen/gebouwen/wetten-en-regels/bestaande-bouw/energielabel-c-kantoren/veelgestelde-vragen

Energy performance standards

Country/ jurisdiction	Applies to Res	Applies to Com	Size threshold/typical trigger	Comments and link to further information
Scotland	●		All social housing by a given date	Energy Efficiency Standard for Social Housing Scotland (EESSH). Dwellings are required to meet required EE rating. Some funding is available. https://www.gov.scot/policies/home-energy-and-fuel-poverty/energy-efficiency-in-social-housing/
Tokyo (Japan)		●	Facilities consuming more than 1,500 kiloliters of annual crude oil equivalent energy	Covered facilities must reduce a specified percentage below the allotted baseline emissions for different compliance periods (2010–14, 2015–19, 2020–24). If they do not meet the allotted emissions, credits can be purchased from others. https://www.kankyo.metro.tokyo.lg.jp/en/climate/cap_and_trade/index.html
Washington State (USA)		●	Commercial buildings over 50,000 square feet (approx. 4,650 m^2)	Begins as a voluntary efficiency incentive program from 2021 to 2026, then phases in as a mandatory performance standard over time, starting with the largest buildings beginning in 2026. https://www.commerce.wa.gov/energy-blog/clean-buildings-e3shb-1257/

Sources: Responses to 2020–21 BECWG survey, Sunderland and Santini. 2020b and Nadel and Hinge 2020.

Annex 3. Australian State implementation of energy codes for existing buildings

Adapted from Newgate Research, 2020

Country/ jurisdiction	Applies to Res	Applies to Com	Size threshold/typical trigger	Comments
Australia Capital Territory	●		“Substantial alterations” which are ≥ 50% of floor area during the 3 years immediately before the day the application for building approval for the alteration is made and: a. not including any internal alterations for Class 1; b. including any other alterations for Class 2	If substantial alterations are made to the existing building, then the whole building must comply with NCC energy efficiency requirements.
New South Wales	●		Any alteration or addition valued ≥ $50,000 and/or involve the installation of a pool and/or spa with a total volume greater than 40,000 litres	Compliance via BASIX Certificate (generated using online application) submitted with Development Application
Northern Territory	●		No modifications are required for the existing part of a dwelling unless changing from a Class 10 to a Class 1, in which case compliance is required with all energy efficiency provisions.	NCC energy efficiency provisions should be applied to alterations where practical and appropriate.
Queensland	●		New building work associated with a renovation to an existing dwelling (alteration, addition or relocation) where it is subject to “Building Application.”	The renovation must comply as much as practical with the relevant energy efficiency requirements of the Queensland Development Code MP 4.1 Sustainable buildings (QDC 4.1). Where the proposed building work represents more than 50 percent of the existing dwelling’s volume, the building certifier has discretion to apply current building assessment provisions as much as practical (as per the Building Act 1975, section 81).
South Australia	●		New building work, as defined under the Development Act 1993 or Planning, Development and Infrastructure Act 2016. No requirement to upgrade existing building that is not subject to the new building work.	Upgrade in relation to energy efficiency to be undertake in accordance with NCC, with reference to ABCB non-mandatory documents
Tasmania	●		Proposed new building work, together with previous building work approved or carried out on the building in the past 3 years, comprises more than 50% of the volume of the original building. If the threshold is met, the entire existing building needs to be upgraded.	

Country/ jurisdiction	Applies to Res	Com	Size threshold/typical trigger	Comments
Victoria	●		Volume of all additions and alteration in the past 3 year ≥ 50% of building's relevant volume. If this the case, then existing building should be upgraded to current NCC standards.	
Western Australia	●		NCC provisions to be applied to all new building work, whether a whole house or new work to an existing house.	Any compliance pathway available under the NCC can be used, as for new buildings. The WA Government also supports the use of the "Alterations and Additions Protocol" as an alternative solution.
Australia Capital Territory		●	"Substantial alterations" which are ≥ 50% of the volume of the building during the 3 years immediately before the day the application for building approval for the alteration is made and the volume of a building is measured by reference to roof and outer walls, but excludes internal alterations made to a Class 1 building, and alterations to Class 10 buildings or structures. If substantial alterations are made to the existing building then the whole building must comply with NCC energy efficiency requirements.	
Queensland		●	Provision applies depending on whether the alterations within the Building Development Application represent more than half the total volume of the existing building, and the decisions of the Building Certifier. The building development approval may include a condition that all or part of the existing building or structure must comply with all or part of the building assessment provisions as if it were a new building or structure.	The exercise of discretion by a building certifier in relation to the existing part of a building should recognize the extent of work being undertaken to the building and the potential benefits derived from the requirements of the NCC. Certifier discretion may allow all or some of the current code requirements of the NCC or other relevant codes to be applied to the existing fabric of buildings being altered, provided that the certifier has a suitable basis for applying the requirement.
South Australia		●	Both Acts have provisions for enabling the upgrading an existing building constructed before 1 January 2002 when an application is made for an alteration to that building. However, it first has to be determined that the building is unsafe, structurally unsound, in an unhealthy condition or has inadequate access for people with disabilities. The upgrading can only be required to the extent reasonably necessary to ensure that the building is safe, conforms to proper structural and health standards, and provides adequate access.	The Development Act 1993 and Development Regulations 2008 reference the NCC and adopt it as part of the Building Rules for the purposes of obtaining a Building Consent. The Development Act and Development Regulations are currently being phased out and replaced with the Planning, Development and Infrastructure Act 2016 and its associated regulations.

Country/ jurisdiction	Applies to		Size threshold/typical trigger	Comments
	Res	Com		
Tasmania		●	Section 53 of the Building Act 2016: If the proposed new building work, together with previous building work approved or carried out on the building in the past 3 years, comprises more than 50% of the volume of the original building. If the threshold is met, the entire existing building needs to be upgraded. This includes but is not limited to the original building; all parts of the original building where prior building work has been carried out in the previous 3 years or earlier including any alterations or additions made; and parts of the building separated by fire compartments.	
Victoria		●	All building work that alters an existing building must comply with the Building Regulations 2018 (see Regulation 233) Note that under Item 4 of Schedule 3 to the Building Regulations, alterations to a building do not require a building permit if the building work will (among other things) not adversely affect the structural soundness of the building and does not include an increase or decrease in the floor area or height of the building. If the volume of all addition/alteration in the past 3 years ≥ 50% of relevant volume, then the entire building must be brought into conformity with the Building Regulations	

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