Driving existing building energy improvement: building codes and performance standards – a tale of two regulatory routes

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Abstract

In many parts of the world, building energy codes (or regulations) have been the policy instrument of choice to drive improvements in building energy efficiency. Originally conceived to raise the minimum standard for new buildings, codes have been extended to existing buildings, particularly when a building is undergoing a substantial extension or renovation. However, there is increasing need to improve existing building energy performance much more rapidly than seems possible through this means, so a new policy lever, building performance standards, or minimum energy performance standards, is being adopted in a number of jurisdictions. These policies require existing buildings to meet a performance benchmark, generally an energy performance rating, or a level of energy or carbon intensity, often giving building owners multiple years to meet them.

There are a variety of implementation issues and challenges with both codes and performance standards, and different approaches are being tested in various national and sub-national jurisdictions around the world. This paper reviews the state of play with these, compares the issues and benefits of different policy approaches, and summarizes where different approaches may fit best.

Introduction

Buildings consume about 30 % of global final energy, which grows to 35 % when the building construction industry 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 with new buildings in getting to very low and even zero energy and emissions buildings, there is a tremendous stock of existing buildings where there are very large opportunities for the energy performance to be dramatically improved. The United Nations Environment and International Energy Agency (UN Environment and IEA 2017) 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. 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 these buildings were built to lower (or no) energy codes they tend to have poorer thermal performance. The inherent low energy efficiency may be exacerbated by older equipment and appliances which may not be well maintained. The advantage to this is that there is vast scope for energy savings in existing buildings. The IEA (2017) found that the energy savings potential from improved building envelope performance improvements was huge: globally, high-performance buildings construction and deep energy renovations of existing building envelopes represented a savings potential more than all the final energy consumed by the G20 countries in 2015, or around 330 EJ in cumulative energy savings to 2060.

But this requires a step change to the number and depth of energy efficient renovations. The Global Alliance for Buildings

and Construction Roadmap for Buildings and Construction (IEA 2020) identified key steps to achieving these as including enabling 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. 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 paper focuses on mandatory requirements driving existing building energy performance improvement. Beyond mandatory policies there are other policy instruments, including voluntary and information programs, aimed toward improving existing buildings, or which are mandatory for a selection of buildings (such as Government owned or occupied buildings), but we look only at mandatory policies that must be met by broad groups of buildings. The paper summarizes an ongoing 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), as an input from Australia to the BECWG workplan. The results will be published in a forthcoming report to the BECWG, expected to be finalized later in 2021. Inputs to the paper include responses from BECWG members to a survey on information on the mandatory codes for existing buildings which operate in their countries.

KEY TERMINOLOGY IN THIS PAPER

Before exploring an overview of the key policies, we provide a brief glossary of key terms for better understanding of how those terms are used in this paper. 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.

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

"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).

"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.

"**Renovation**" is the broad improvement of buildings, generally synonymous with refurbishment, though potentially more comprehensive than refurbishment. In the European context, "renovation" has been extended for use with major deep energy renovation policies.

"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.

"**Target**" is a goal to be achieved. Where policies set a target, this may be more of an aspirational goal as opposed to a binding requirement that has severe consequences for non-compliance. In some cases, targets also create a mechanism and market climate where certain parties may suffer commercial consequences for non-compliance, even if there are no legal infringements.

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

Overview of regulatory policies

As noted earlier, this paper is concentrated on mandatory policies aimed at existing building energy performance. For this paper, we have broken the policies reviewed into 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 also applied to an existing building when some form of change to the building structure or major infrastructure takes place. The requirements of energy efficiency in these codes can be 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.

A key issue about when different types of codes or other regulations force energy performance improvements are "triggers" for when the policy applies, often some portion of the building being renovated or altered, and thresholds for the type and

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

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 offer of loans or grants. Then 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 were mentioned by survey respondents or in the literature.

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 then 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.

Most codes are a choice between or a combination of "prescriptive" requirements, with specific rules on building components such as allowable transmittance of heat through wall insulation and windows, and equipment efficiency levels, or "performance" approaches that demonstrate 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).

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 the paper under "Implementation of building regulatory policies."

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, such as an energy performance rating, or energy or carbon intensity, 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. A summary of some leading performance standards is shown in Table 1.

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. Many of these issues are highlighted in the report "Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals" (Nadel and Hinge 2020), as well as "Filling the Policy Gap: Minimum Energy Performance Standards for European Buildings" (Sunderland and Santini 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 have energy performance improvement done in any given year, improving the prospects for much broader renovation rate improvement and better progress toward greenhouse gas reduction targets.

COMPARING CODES WITH PERFORMANCE STANDARDS

While this paper focuses on energy codes and performance standards, the two key policies have different basis of requirements as well as triggers for when they take effect, as summarized in Table 2.

IMPLEMENTATION OF BUILDING REGULATORY POLICIES

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 implementation at local jurisdiction level, such as through a state or province, or even down to a city. Even when an energy code or other regulation is adopted by a subnational jurisdiction like a state or province, the implementation or enforcement of all of the building policies 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 more rural 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.

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 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 the citizens. There can also be construction industry ambivalence to learning about energy 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 effectively enforce energy codes when deficiencies are identified. Is a building removed from the market (rental or sale) when energy code violations are identified? In many cases, there are real challenges by local building officials in understanding how to best enforce codes, particularly when applied to existing buildings which may be occupied through the construction/renovation period.

Building performance standards are a relatively recent development and few of the standards have reached their first target date so there is little experience of implementation to date. The evidence so far is discussed below in the section "Opportunities and challenges with different approaches."

Table 1. Summary of building performance standards in leading jurisdictions.

Country/ jurisdiction	Applies to: Res	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 plus applies to 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 whose area is >1000 m^2	Staged requirements for 2030, 2040 and 2050. Alternatively, the building can comply with minimum operational energy performance standards.
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.
New York City (USA)	✓	✓	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 significantly more stringent requirements starting in 2030.
Scotland	✓		Initially applied when change or extension in tenancy; later to all properties	Private rented residential properties. was due to apply at change of tenancy from April 2020 but delayed due to Covid pandemic. Applies to all 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 kilolitres 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.
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 takes effective in 2021, mandatory first takes effect in 2026. Levels to be updated in 2029 and updated every five years thereafter.

Table 2. Energy codes applied to existing buildings compared with performance standards.

	Energy Codes	Performance Standards
Basis of requirements	Codes are generally developed for new construction, although some new construction requirements are often 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 remodelling 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 requirement(s) in the future.

Lessons learned in leading countries/regions

As noted earlier, this paper includes early findings from an ongoing survey of countries participating in the IEA Building Energy Codes Working Group, which will publish findings of the survey later in 2021. The experience from the policies reviewed in leading countries and regions has helped to identify some key lessons that are relevant to other jurisdictions considering new policies aimed toward existing buildings.

A COMPREHENSIVE APPROACH IS REQUIRED

Several countries have long term strategies or targets for the energy use or carbon emissions from their building stock that require energy renovation of existing buildings. The European Energy Performance of Buildings Directive (EPBD) requires all EU Member State to develop, periodically update and administer long-term renovation strategies, including policy measures and actions to promote cost-effective deep renovation of buildings. These high-level targets can be helpful in setting the country's ambition and goals, indicating the direction of travel to all stakeholders. 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, modernisation, 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 in the more efficient installation within its lifetime and it is recognised 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[1]) by 2030 (rented) and 2035 (owner occupied) total capital investment averaging UK£5.2 billion every year to 2035 would be required. Similarly, it has been estimated that meeting the New York City 2030 building performance standard emissions intensity limits will cost US$17–24 billion (Urban Green Council 2019).

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 TuREEFF in Turkey[2] and from the KfW Bank in Germany[3]. Others have subsidies or grants for products with high energy performance, for example for heat pumps in Portugal, or tax rebates, the Netherlands have reduced Value Added Tax (VAT) rate for home improvements. Some buildings in rural China must meet a minimum code to access retrofit subsidies in specific 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 programmes (such as Energy Efficiency Obligations in the EU).

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, in their response to the BECWG survey a representative for Portugal was able to state "9,061 residential and 1,257 commercial buildings have been renovated."

The responses to survey and follow up email interviews listed a further barrier: that energy related renovations have a large number 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 and reducing training costs; developing suitable specialist qualifications and/or making them more widely recognised. 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.

Another issue identified, that large, more complex energy renovations can take a long time to complete, highlights 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 and minimize the chances of lock-in through shallow renovations that might just meet a first, early tier of the performance standard.

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.

OPPORTUNITIES AND CHALLENGES WITH DIFFERENT APPROACHES

The evidence suggests that building codes are 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

1. This is a relatively modest level of energy performance.

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.

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.

Performance standards can potentially drive much more energy improvement, both to a larger number of buildings, and potentially deeper savings, and can less easily be manipulated. Given the urgency of the requirement to reduce energy use in buildings these are significant attractions, which explains the growing interest in their adoption. However, the different features of both approaches have different advantages and disadvantages.

As noted above funding required for energy improvements is 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 should 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 minimising both the cost and disruption. In some cases, the performance standard is triggered when there is a change of tenancy or ownership – this can help to minimise 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 requirement still places a financial burden on the building owner which may mean that, in the absence of dedicated funding support, 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.

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 and Hinge 2020). In some countries mandatory energy performance rating systems are already well established, (for example this is one of the requirements that the EPBD places on European Member States). 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.

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 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. Similarly, building performance standards may be set nationally, regionally or at a city level.

Codes for existing buildings are established and therefore familiar to most stakeholders and systems are in place to enforce them. (Although stakeholders may not 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. In jurisdictions with both codes and performance standards if one administrative entity does not administer both regulations then there is potential for market confusion.

Another aspect of implementation is that for building codes the authority responsible for building control or inspection may not be notified that renovation work that meets the requirement for the code to apply is taking place. 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 rates, 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 these procedures.

Another point is that as most performance standards are relatively new and have set targets some years after adoption, so most of these are largely untested. 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 in the 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,

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

Table 3. 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 building requirements beyond 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 rates, 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 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.

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.

Most performance standards have been applied to a particular segment of the buildings market: e.g., office buildings (the Netherlands), social rented residential (Scotland) 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.

A summary of some key issues differentiating energy codes from performance standards is presented in Table 3. 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, labour, and compliance costs, and second, such a rigorous requirement could stifle the improvement of existing buildings rather than encourage it (Evans et. al. 2020).

Conclusions

Building energy codes are a very mature regulatory policy lever in wide use in most OECD economies, delivering significant energy savings. Codes are generally developed as requirements for new building construction but have been successfully applied to existing buildings.

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, and just in early implementation in some leading jurisdictions. Performance standards bring the opportunity to drive energy performance improvement in a much larger fraction of the existing building stock every year, potentially accelerating energy use and greenhouse gas reduction each year, though these are still relatively early days for understanding realistic policy effectiveness.

Table 4 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.

References

BEIS (Department of Business, Energy and Industrial Strategy, UK) 2021, Review of the Private Rented Sector Energy Efficiency Regulations. https://www.legislation.gov.uk/uksi/2015/962/pdfs/uksiod_20150962_en.pdf

Canadian Commission on Building and Fire Codes (CCBFC). 2019. Final Report: Alterations to Existing Buildings. Available at https://cdn.ymaws.com/cafc.ca/resource/resmgr/latest_news/alterations_to_existing_buil.pdf.

Evans, M., Delgado A., Halverson M., Charles M., Yu S., Mayernik J., and Williams J. 2020. Codes around the Globe: A Cross-national Comparison of Building Energy Codes. Proceedings of the 2020 ACEEE Summer Study.

Evans, M., Yu S., Song B, Deng Q., Liu J., and Delgado A.. (2014). Building energy efficiency in rural China. Energy Policy 64, 243–251.

Table 4. 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 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 regular ratcheting up of requirements, with signal about requirements several years to be considered as part of 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 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 risk regarding policy effectiveness. Relative lack of familiarity by many industry stakeholders.

Frontier Economics (2017) Affordable Warmth, Clean Growth: Action Plan for a comprehensive Buildings Energy Infrastructure Programme, Energy Efficiency Infrastructure Group. https://www.theeeig.co.uk/media/1026/fe-energy-efficiency-final-clean-250917.pdf

IEA (2017) Energy Technology Perspectives 2017. https://www.iea.org/reports/energy-technology-perspectives-2017

IEA (2020) Global Alliance for Buildings and Construction Roadmap for Buildings and Construction. https://webstore.iea.org/globalabc-roadmap-for-buildings-and-construction-2020-2050

International Partnerships for Energy Efficiency Cooperation (IPEEC) 2017. Existing Building Energy Efficiency Renovation: International Review of Regulatory Policies. IPEEC Buildings Energy Efficiency Taskgroup, Paris. https://ipeec.org/upload/publication_related_language/pdf/651.pdf

IPEEC (International Partnership for Energy Efficiency Cooperation) Building Energy Efficiency Taskgroup. 2015. Delivering Energy Savings in Buildings: International Collaboration on Building Energy Code Implementation. Paris: IPEEC. https://www.gbpn.org/sites/default/files/1448013016IPEEC_BEET3_Final_Report.pdf

Nadel, S and Hinge A. 2020. Mandatory Building Performance Standards: A Key Policy for Achieving Climate Goals. American Council for an Energy Efficient Economy White Paper. June 2020. https://www.aceee.org/sites/default/files/pdfs/buildings_standards_6.22.2020_0.pdf

Newgate Research. 2020. Energy Efficient Renovations. Prepared for the Victoria (Australia) State Department of Environment, Land, Water and Planning. 16 July 2020.

Sunderland, L. and Jahn, A., 2021, Considering minimum energy performance standards for Germany, Regulatory Assistance Project. https://www.raponline.org/knowledge-center/considering-minimum-energy-performance-standards-for-germany/

Sunderland, L., and Santini M.. 2020. Filling the Policy Gap: Minimum Energy Performance Standards for European Buildings. Berlin: Regulatory Assistance Project. June 2020. https://www.raponline.org/wp-content/uploads/2020/06/rap-sunderland-santini-mini-6mum-energy-performance-standards-june-2020-final.pdf

United Nations Environment Programme (UNEP). 2020. 2020 Global Status Report for Buildings and Construction: Towards a Zero-emission, Efficient and Resilient Buildings and Construction Sector. Nairobi. https://globalabc.org/our-work/tracking-progress-global-status-report

UN Environment and International Energy Agency (UN Environment and IEA) 2017. "Towards a Zero-Emission, Efficient, and Resilient Buildings and Construction Sector." Global Status Report 2017. https://globalabc.org/resources/publications/2017-global-status-report-buildings-and-construction

Urban Green Council 2019. Retrofit Market Analysis. June 18, 2019. https://www.urbangreencouncil.org/sites/default/files/urban_green_retrofit_market_analysis.pdf

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