Existing Building Energy Efficiency Renovation

International Review of Regulatory Policies

IPEEC Building Energy Efficiency Taskgroup

ipeec International Partnership for Energy Efficiency Cooperation

Contents

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Executive Summary

There has been significant progress in recent years in improving the energy efficiency of new buildings, driven by technological improvements and various regulatory requirements and policy initiatives, and there is beginning to be a critical mass of very low energy buildings or even zero energy buildings in various regions of the world. However, a large percentage of existing buildings are significantly less efficient than most newly constructed buildings, and have major opportunities for improvement. Energy consumption from buildings that had been constructed prior to the implementation of recent improved energy performance regulations will continue to consume significant amounts of energy long into the future. Determining the most effective set of policies to significantly improve the existing building stock is a key challenge for energy policy makers around the world.

A variety of regulatory policy instruments have been used around the world to drive energy performance improvements in existing buildings. The major policy instruments can be broken into four categories:

Table 1. Major Policy Instruments

Type of Policy	Benefits	Challenges
Targets: Performance based renovation targets and requirements	Very broad driver that sets high ambitions and goals	Complex to administer generally and challenging to determine and impose penalties for non-compliance
Energy Codes: Building energy codes/standards applied to existing buildings	Relatively simple to develop and administer	Applies only at time of substantial renovation, so does not drive widespread market change rapidly
Disclosure/Improvement: Mandatory energy performance disclosure, sometimes linked to upgrade requirements	Simple rating and disclosure of performance is not controversial, and allows market forces to operate	Without mandatory upgrade requirements, may not result in significant performance improvement
Financing/Incentives: Voluntary standards that become mandatory with financing from certain sources	Can be most creative and ambitious, as these initiatives are voluntary and therefore require less political consensus	Cost for implementation—needs to come from some source, either government funds, or energy price surcharges

Key findings

Building energy codes can be applied to existing building renovations, but without other policies or programs, are not likely to result in the deep energy savings sought by many governments. Instead, energy codes as one part of a more comprehensive policy package are key to driving more significant energy savings from the existing building stock.

While development of building regulations is conceptually and technically relatively simple, in the reality of implementation, there are significant challenges that arise from varying perspectives and goals of different stakeholders. This can lead to big differences about what is considered feasible and cost-effective, and can be realistically applied widely to all existing buildings. The uniqueness of most buildings—due to both their physical variations and their different uses - leads to significant complexities of policy administration. Beyond these practical challenges, real world implementation is difficult for administrators that have varying jurisdictions, responsibilities, and priorities for different parts of code implementation, enforcement and compliance.

There are best practices emerging in many countries around the world, both in the development of comprehensive policy targets, but also in the implementation of specific building performance regulations, that can be more widely adopted to result in more efficient existing buildings. This review identified some of those opportunities, though deeper research might be able to recommend specific suggestions for countries at different levels of development and ambition toward building energy policy.

Among the policies that appear to deliver the most significant activity in building energy renovation are the following:

- **Comprehensive improvement targets**, supported by underlying policies and initiatives including regulations, financing, and information campaigns aimed toward various stakeholders, can set high, longer-term ambitions while continuously upgrading energy performance requirements.
- **Disclosure of energy performance**, with mandates tied to improving the performance of the poor performers, has the potential for major energy reductions, though the mandated improvements may be politically challenging to implement and enforce; periodic disclosure of measured energy performance provides a feedback loop to understand the effectiveness of other policies.
- **Linking financing and other supportive policies to deeper savings**, through tiered incentives where very deep renovations are rewarded, can transform markets and drive greater impacts.
- **Some role for a "renovation facilitator"** to navigate different policies and stakeholder groups needed for implementation of deep renovations seems to be useful; important larger scale initiatives are getting underway that hold promise.

There appears to be the most certainty of delivering large scale market changes when legally binding measures can be tied to demonstrated improvement in building performance. The most advanced example of this type of policy is the UK Energy Act of 2011, which prescribes minimum energy performance standards, tied to a building's Energy Performance Certificate rating, that will make it unlawful beginning in 2018 for the worst performing buildings to be rented to new tenants without some required energy upgrades.

The French mandate requiring individual buildings to prepare a "plan for renovation" that will result in energy consumption reduction within a set period of time is also very promising, though the "legally binding" enforcement of that mandate may be more challenging. The Tokyo emissions trading Cap-and-Trade policy applied to very large buildings is another policy mechanism that has driven significant reductions in a relatively short period of time, using the market mechanism of cap and trade to allow the most cost-effective renovations to take place among the targeted stock of buildings.

More research is needed to understand the real impacts of more comprehensive policy packages that begin with ambitious targets, relative to other comprehensive policy packages. Additional research is also needed to understand how to accelerate getting the most innovative and successful city/subnational policy packages adopted and implemented at regional or national levels, and assessing the impacts of mandated minimum energy performance standards and upgrades over time and the possible impacts these mandates may have on affordability and availability of buildings covered by the policies.

Existing buildings are ripe opportunities for improved energy efficiency, and the increased interest in tapping this potential is resulting in a range of new policy activities addressing this sector. Much more will be known in a few years about the impacts and effectiveness of these newer policies.

2 Introduction

This report, commissioned as part of the International Partnership for Energy Efficiency's (IPEEC's) Building Energy Efficiency Taskgroup (BEET), aims to provide an overview of key regulatory policies which have been used internationally to require improvements to existing commercial and residential buildings at the point of renovation, refurbishment, retrofit, alterations, or additions.

Buildings consumed over 30% of global final energy consumption in 2014, and 55% of final electricity demand[1]. Building energy consumption globally has been steadily growing, with building-related CO_2 emissions rising by nearly 1% per year since 2010. Consumption is forecast to continue to grow through 2060 without substantial new policy implementation.[2] Despite this trend, over the last decade several leading countries have managed to decouple their average energy consumption from economic growth and to reduce the economy wide energy consumed by buildings. An earlier IPEEC BEET report on Building Energy Performance Metrics showed that from 2000 to 2012, the United Kingdom (UK), Germany, Canada, Japan and France all had cut their total building energy use over that period, despite economic growth.[3]

There has been significant progress in recent years in improving the energy efficiency of new buildings, driven by technological improvements and various regulatory structures, and there is beginning to be a critical mass of very low energy buildings or even zero energy buildings in various regions of the world.

However, there are a large percentage of existing buildings that are significantly less efficient than new construction, and have major opportunities for improvement. Determining the most effective set of policies to significantly improve the existing building stock is a key challenge for energy policy makers around the world.

Energy consumption from buildings that had been constructed prior to the implementation of recent improved energy performance regulations will continue to consume significant amounts of energy long into the future. European research has found that residential buildings constructed between 1945 and 1980 are the major culprits of building energy waste.[4] Other research in the United States (US) and other countries has found that commercial buildings built in the 1960s through early 2000s have higher energy consumption than buildings built before or after that period, and offer significant opportunities for increased efficiency.[5] Compre-

1. IEA Energy Technology Perspectives 2017.
2. IEA Energy Technology Perspectives 2017.
3. Building Energy Performance Metrics: Supporting Energy Efficiency Progress in Major Economies, IPEEC and International Energy Agency, 2015. (IPEEC 2015a).
4. European Commission, Good practice in energy efficiency, 2016.
5. US Energy Information Administration Commercial Buildings Energy Consumption Survey (CBECS), at https://www.eia.gov/consumption/commercial/data/2012/index.php?view=consumption#c1-c12

hensive energy renovations or refurbishments of these buildings have been shown to reduce consumption cost-effectively by 20-50%, or even more.

Building energy codes (also sometimes called standards or regulations)[6] are the principal policy instrument used to realize the energy savings potential in the building sector and ensure satisfactory thermal and indoor air quality comfort levels. While this policy lever is widely used to drive improved energy performance in new construction, applying energy codes to existing buildings is more challenging for a variety of reasons—a critical one being the difficulty in determining how to distinguish between maintenance or small improvements, and substantial changes to the building, which then are generally subject to more rigorous oversight and usually are required to comply with the current code.

While the framework for energy efficiency measures for new buildings is in place within many national construction codes,[7] and in some regions is also applied to building refurbishments over a certain established area threshold, there is clearly an opportunity for new or improved regulatory instruments targeting the energy consumption of existing buildings. The best opportunity to improve the energy use of the existing building stock is while they are undergoing broad renovation or refurbishment.

In some regions, particularly Europe, a more comprehensive policy approach to renovation of existing buildings has been pursued. The approach goes beyond energy codes to the establishment of long-term national comprehensive building energy renovation strategies, targets for renovating public buildings, along with policies and supporting initiatives targeting the private sector. At the EU level, the Energy Efficiency Directive establishes the obligation for Member States to annually renovate 3% of the total floor area of the central governmental buildings (Article 5). However, the implementation of this Article is relatively recent and it is therefore early to quantify its impacts. In addition, mandatory renovation obligations are being applied in some Member States, e.g. in England and Wales for private rented accommodation, in Greece for public buildings, and in Scotland for publicly owned social housing. These measures are expected to have significant impacts on increasing renovation rates, by directly mandating investments from building owners.

The information in this report is based on desk research of relevant reports prepared on the subject of existing building renovation policies, as well as interviews with a variety of both governmental and non-governmental building energy efficiency experts.

6. For simplicity, in this report the term "energy codes" is used, recognizing that other countries or regions may use different terminology. In many countries the term "code" applies broadly to policies that affect the performance of new and existing buildings. A glossary of key terms used in report is provided in the next section.

7. According to the Global Alliance for Building and Construction's Global Status Report 2016, 62 countries have building energy codes, while 84 countries have building energy certification requirements.

2.1 Key terminology in this report

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 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.

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.

"Refurbishment" is the general improvement of a building at some periodic interval, with dictionaries generally 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, as further explained at the end of this section.

"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 refurbishment or renovation project.

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

"Building energy codes" (or "energy codes") 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).

"Mandatory" energy codes or standards 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.

The building 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 IPEEC BEET report on "Building Energy Rating Schemes: Assessing Issues and Impacts" (IPEEC 2014a).

As noted above, in the European Union (EU) context, "renovation" has been extended for use with major deep energy renovation. A key European policy, the Energy Efficiency Directive (EED), includes the following requirements:

- EU countries make energy efficient renovations to at least 3% annually by floor area of buildings owned and occupied by central government (art. 5)
- EU countries must regularly draw-up long-term national building renovation strategies which can be included in their National Energy Efficiency Action Plans[8] (art. 4)

Article 4 (Building Renovation) of the EED requires that "Member States shall establish a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private." However, there is no formal definition of renovation or deep renovation in the EED, and each Member State has flexibility with how the terms are used. In the recast of the European Energy Performance of Buildings Directive ("EPBD," Directive 2010/31/EU) **"major renovation"** is defined as when the total cost of the renovation relating to the building envelope or the technical building systems is higher than 25% of the building value, or more than 25% of the surface of the building envelope undergoes renovation. In reality, in the implementation and transposition of these Directives into national regulations, the "major-" and "deep-renovation" definitions are quite different between different member states.

8. European Commission Directive 2012/27/EU (Energy Efficiency Directive).

3 Overview of Regulatory Policies for Renovation of Existing Buildings

A variety of regulatory policy instruments have been used around the world to drive energy performance improvements in existing buildings. An overview of the major policy mechanisms aimed toward existing buildings is summarized below, and further discussed in the subsections below.

3.1 Renovation targets

Renovation targets set an aspirational goal for reduction of building energy consumption over a period of time, usually for a full population of buildings or specific

Table 2. Summary of Key Renovation Policy Types

Type of Energy Renovation Policy	Summary
Targets: Performance based renovation targets and requirements	Targets established for certain categories or sectors of buildings, and depth of energy savings to be met; usually a specified amount of savings targeted, and policy dictates number or categories of buildings included
Energy Codes: Building energy codes/standards applied to existing buildings	Application of some or all provisions of building energy codes developed for new construction to building renovation or refurbishment; generally, only covering the systems/equipment being replaced and not remaining parts of the building. Requirements may be based on performance or prescriptive methods, or both. Nearly always include some threshold as trigger for coverage, such as percent of value of system or percent of system/subsystem being replaced
Disclosure/Improvement: Mandatory energy performance disclosure, sometimes linked to upgrade requirements	Periodic reporting and/or public disclosure of building energy performance or consumption, often at time of sale and/or lease; sometimes with mandatory upgrade/performance improvement requirements if identified as a poor performer or fine for non-compliance; most extreme case prohibiting lease or sale until performance is improved
Financing/Incentives: Voluntary standards that become mandatory with financing from certain sources	Buildings that participate in certain government funded programs are required to meet certain performance targets or minimum efficiency levels as a condition of accessing the available financing, such as project subsidies/incentives, or preferential loans. Often part of energy efficiency obligation/energy supplier incentive programs

sectors of buildings (i.e., government owned, institutional, etc.), that then becomes the over-arching rationale for other policies to help meet that target. In some regions policies have been established requiring a certain portion of buildings each year to be upgraded to an improved performance level.

Actions by the European Commission to mobilize investment in deep renovations are mandated in accordance with article 4 of the Energy Efficiency Directive, which states that "*Member States shall establish a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private*." A number of requirements established in the directive, such as energy savings obligations, renovation strategies and dedicated financing mechanisms that drive renovation, combine to support the renovation requirements. The Directive states that such deep renovations could also be carried out in stages.

Research in the EU has found that to reach the objectives of transforming the existing building sector by 2050, the rate of renovation of existing buildings needs to increase dramatically, from a recent rate of around 1% of floor area renovated annually, to a rate of around 3% per annum by 2020. The European policies are aimed toward significantly increasing both the rate of renovation, and the depth of energy savings in the renovated buildings.

The EU member states' long-term strategies for mobilizing investment in the renovation of the national building stock (Article 4 of the 2012 Energy Efficiency Directive) must encompass policies and measures to stimulate cost-effective deep renovations of buildings, including staged deep renovations.

In parallel with the incentive to stimulate investments in deep renovation, the European Energy Performance of Buildings Directive ("EPBD," Directive 2010/31/EU) provides a definition for major renovation. Member states must set minimum energy performance requirements for buildings that undergo a major renovation with the view to achieving cost-optimal levels. Member states must take all necessary measures to ensure that when a building undergoes a major renovation, these minimum energy performance requirements are met.

A recent report by the European Commission Joint Research Center found that twenty-three out of the thirty-one submitted member-state national building renovation strategies satisfactorily addressed the main elements of the Energy Efficiency Directive, with only ten of the strategies "fully compliant". It is less clear how many member states are on track to meet the renovation rates and targets established in these strategies; some experts have recently expressed concerns that there are some significant gaps in the strategies, and the renovation targets may be quite challenging to meet.

While most targets are established for a sector or sub-sector of the building stock, an innovative policy approach is being used in France, where individual buildings are required to develop plans for significant reductions, with the plans implemented within a specified period. France has mandated renovation for commercial buildings, requiring individual buildings to develop a "plan for renovation"

that will result in reduction of energy consumption by at least 25% relative to the 2010 performance level. These renovation plans need to be submitted in 2017, with the improvement work done within five years. France is also exploring mandating renovation for private residential buildings whose primary energy consumption exceeds 330 kWh/m^2, essentially those buildings with the lowest Energy Performance Certificate ratings of F or G. These buildings should be renovated before 2025, though there is not yet a binding legal requirement for this.

3.2 Energy codes applied 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 are 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 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, but with 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 the 2015 IPEEC BEET report: "Delivering Energy Savings in Buildings: International Collaboration on Building Energy Code Implementation" (IPEEC 2014b).

Some discussions of energy codes applied to existing buildings would seem to intend to modify the "prescriptive" application of the code to include mandatory replacement of particular pieces of equipment. An example in application would be the requirement in much of the world to replace mechanical equipment using banned refrigerants.

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 in the section on Implementation of Building Regulations.

A summary of energy code requirements as they apply to existing buildings in selected IPEEC member countries is provided in the Appendix to this report.

3.2.1 Performance based requirements/Outcome-based codes

With measured, in-use building performance sometimes not delivering the expected savings from better building components or performance modelling approaches (often termed "the performance gap"), there is a new type of energy regulation being examined in some jurisdictions, most

notably Seattle in the US, and Sweden, known as "outcome-based" codes. In the case of these outcome-based energy codes, compliance is determined by actual measurement of all the energy being used by the occupied building and the energy using elements associated with the building site.

Compliance for buildings and their sites to be designed on an outcome basis is determined by measurement of the energy being used once the building is in full operation. A "Target Energy Use Intensity (EUI)" is established for the building based on the planned building use and characteristics, and then the building must demonstrate a measured EUI less than or equal to the energy target.

One challenge with prescribing a target "outcome" is that in many cases, while a group or cohort of buildings may at first glance be similar (e.g., offices, apartment blocks, detached dwellings, etc.), in reality these similar buildings may be used quite differently, and a simple energy intensity target based on measured energy per floor area may not be the most appropriate baseline for measuring performance. Normalizing for different use and operational factors has the potential to solve this issue, though balancing simple metrics like EUI with complexities of variations in building use and operation can be difficult.

Outcome-based codes are just beginning implementation in some jurisdictions in the US, and a key barrier to the codes is understanding what penalties can be applied if the target EUI is not met. While this approach can be applied to major building renovations, it is less clear how it would work for less comprehensive refurbishments of individual building systems.

Probably the most advanced version of an outcome, measured performance based regulation is the City of Tokyo's "Cap-and-Trade" program that was implemented by the Tokyo Metropolitan Government by Ordinance in 2008. The target of the program is to "reduce greenhouse gas emissions to 25% below the 2000 levels by 2020," with two compliance periods (2010-2014, and 2015-2019) where facilities impacted by the ordinance (including approximately 1,000 of the largest commercial buildings in the City) are required to either reduce emissions from the 2000 baseline levels, or purchase credits from other covered facilities that have reduced their emissions below their established target levels and have "credits" available for sale to others.[1]

A hybrid approach is being piloted in China through the "Standard for Building Energy Consumption in Civil Buildings," where a target EUI is established for either a new or existing building.[2] The standard has two

Cap & Trade driving existing building performance outcomes

Since Tokyo's "Cap-and-Trade" program was implemented by the Tokyo Metropolitan Government by Ordinance in 2008, the large commercial buildings impacted by the ordinance have reduced building emissions by 25% for the policy's first compliance period (2010 through 2014), with many facilities already reaching their second compliance period targets that were not required to be met until 2019.

Source: http://www.kankyo.metro.tokyo.jp/en/climate/cap_and_trade.html

1. See http://www.kankyo.metro.tokyo.jp/en/climate/cap_and_trade.html

2. See "Establishing target-oriented energy consumption quotas for buildings," Le Yang, Jianjun Xia, and Qi Shen, Utilities Policy, Volume 41, August 2016, and China National Standard GB/T51161-2016.

defined levels of performance. One is called "restrictive value", which is the minimum requirement, and could be used as quota for the penalties. Another is called "guidance value or advanced value", which means it could demonstrate better performance in the same type of buildings. While the Standard is currently only being applied for certain building types, in a small number of cities if that target, or quota, is exceeded, then a punitive energy tariff adjustment can be applied, essentially imparting a fiscal penalty to buildings that exceed the established energy consumption quota.

Whether this approach can be extended to existing buildings in other economies has not yet been tested, though some US cities are studying the Chinese approach.

3.2.2 Building equipment minimum energy performance standards

While not specifically aimed toward time of building renovation, another key regulatory lever that impacts the energy performance of existing buildings is implementation and ongoing improvements to building equipment minimum energy performance standards (MEPS). Product standards for energy consuming equipment such as heating and air-conditioning systems, household appliances, lighting, and other devices that periodically need to be replaced at the end of their useful life, can have a significant impact on the overall energy consumption in any building. MEPS are often combined with product labeling schemes to communicate the efficiency of the product to both consumers and regulators.

However, these product standards and regulations do not affect the much longer life building envelope systems, such as the walls, roofs and windows, or overall building energy systems, that can be subject to other more comprehensive building codes and policies. Historic preservation/heritage regulations may in fact forbid the improvement of certain envelope components deemed to have architectural value. These regulations vary regionally, and implementation is often locally determined.

3.3 Mandatory performance disclosure and/or improvement

There is a growing trend around the world to mandate transparency in building energy performance, starting in Europe with the Energy Performance of Buildings Directive requiring Energy Performance Certificates, and growing efforts in the United States, Australia and other regions to use benchmarking to allow better information on energy performance for decision makers.[3]

Traditionally, building energy codes and benchmarking and disclosure policies had been viewed as separate types of policy instruments, without any strong

3. See for example, Building Energy Rating Schemes: Assessing Issues and Impacts; IPEEC 2014a, and Building energy rating & benchmarking: understanding similarities and differences, Burt, Burr and Hinge, Proceedings of 2015 eceee Summer Study.

linkage.[4] However, some policy makers have looked to understand what is sometimes termed a performance gap when more efficient building designs, with the advanced efficient systems and equipment included, are consuming more energy than was calculated and anticipated at the design stage. Periodic measurement and reporting of measured energy performance can be a constructive way to understand how buildings are performing, and introduce policies requiring measurement of performance at different points in a building's life cycle.[5]

The European EPBD mandates that all Member States have policies for the issuing and displaying Energy Performance Certificates when a building is constructed, sold or rented, as well as for buildings occupied by public authorities over 250m^2 frequently visited by the public. Display of Energy Performance in a prominent place is mandatory for the above mentioned public buildings and frequently visited by the public buildings over 500m^2 for which an Energy Performance Certificate has been issued, to help consumers understand the relative performance of buildings, and provide information on potential improvements.[6] The EPBD expands the disclosure to market participants, through expanded information provided to prospective buyers or tenants in buildings. The EPBD (along with the Energy Efficiency Directive) is currently under review again, and additional changes to the Directive will likely be issued in 2018.

4. Linking Building Energy Codes with Benchmarking and Disclosure Policies: Key synergies that drive building energy performance, Institute for Market Transformation (IMT), 2014.

5. See for example, Linking Building Energy Codes with Benchmarking and Disclosure Policies: Key synergies that drive building energy performance, Institute for Market Transformation (IMT), 2014.

6. European Commission 2016, Commission Staff Working Document: Evaluation of Directive 2010/31/EU on the energy performance of buildings, SWD (2016) 408, 30 November 2016. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016SC0408&from=EN

3.3.1 Prohibition of sale or lease below certain performance threshold

With more jurisdictions requiring performance disclosure through energy benchmarking or energy performance certificates, a small number of regulators have begun to drive improvements to better performing buildings by prohibiting sale or lease of buildings that are shown to have the lowest energy performance scores.

The most advanced use of this policy instrument is in the United Kingdom, where The Energy Act of 2011 commits the government to bring into force by April 2018 regulations making it unlawful to let (lease) properties in England and Wales which do not meet a prescribed minimum energy performance standard (MEPS). All rental properties, both residential and commercial, which require an Energy Performance Certificate (EPC) in accordance with the Energy Performance of Buildings Regulations 2012 are within the scope of this regulation. The Energy Efficiency (Private Rented Property) (England and Wales) Regulations 2015 require that from April 2018 all rented premises within scope will be expected to meet a minimum energy standard of an EPC rating of 'E', meaning that any properties with a rating of "F" or "G" will not be allowed to be re-leased from April 2018 without some required energy upgrades.[7]

The City of Boulder, Colorado in the US has adopted "SmartRegs," that requires all licensed rental housing to meet a basic energy efficiency standard by the end of 2018.[8]

3.4 Financing/Incentives tied to performance improvement

In any comprehensive policy package, beyond minimum energy performance levels required by energy codes or other regulations, there are usually voluntary financing or incentive programs to help building owners identify savings opportunities and improve the financial return on performance improvement investments.

One of the most successful examples of this policy instrument is the German KfW Bank incentive program that assists homeowners and other energy consumers with energy performance improvements through financial incentives, offered as either grants or loans for either comprehensive renovations to meet a specified performance level, or if that is not practical, for individual measures.[9]

The program defines performance levels based on the calculated performance (e.g., a "KfW Efficiency House 55" only uses 55% of standard energy code level performance through 2015, though minimum requirements were strengthened in 2016), with graduated incentive tiers for different performance levels. For an individual, detached house, the current incentive structure in the form of grants is shown in Table 3.

7. Further information at https://www.gov.uk/government/publications/the-non-domestic-private-rented-property-minimum-standard-landlord-guidance
8. More information at: https://bouldercolorado.gov/plan-develop/smartregs
9. Further information at https://www.kfw.de/inlandsfoerderung/Privatpersonen/Bestandsimmobilie/

Table 3. Grants for Single Family Homes Through KfW Bank Incentive Program

KfW Efficiency House "Level"	% of project cost subsidized	Maximum Grant Amount (Euros)
Efficiency House 55	30%	30,000
Efficiency House 70	25%	25,000
Efficiency House 85	20%	20,000
Efficiency House 100	17.5%	17,500
Efficiency House 115	15%	15,000
Heating or Ventilating Package	15%	7,500
Individual Measures	10%	5,000

Source: https://www.kfw.de/inlandsfoerderung/Privatpersonen/Bestandsimmobilie/

In addition to the grants for improvement, a homeowner can also receive funding to support construction supervision by a technical expert, and for other services or technologies. As an alternative to the grant incentive, KfW also offers comprehensive loan offerings. In addition, the Federal Office for Economic Affairs and Export Control in Germany provides grants for the installation of heating systems with renewable resources, solar thermal energy, heat pumps and optimisation of heating systems.

There are other examples of subsidized financing, or preferential terms, available through a variety of both commercial banks and/or regional development banks, that rely on government policies to help establish the performance tiers, or provide incentives to the banks or other financial intermediaries for implementation of the program.

Other examples of this type of policy include energy efficiency obligations, or utility or other energy supplier incentives provided to building owners or occupiers to make improvements, with a variety of different types of performance metrics used to qualify for the incentive.

4 Implementation of Building Regulations

While development of building regulations is conceptually and technically relatively simple, in the reality of implementation, there are significant challenges that arise from varying perspectives and goals of different stakeholders. This can lead to big differences about what is feasible and cost-effective, and can be realistically applied widely to all existing buildings. The uniqueness of most buildings—due to both their physical variations and their different uses - leads to significant complexities of policy administration. Beyond these practical challenges, real world implementation is difficult for administrators that have varying jurisdictions, responsibilities, and priorities for different parts of code implementation, enforcement and compliance.

4.1 National governments establish policies and model codes/regulations

In most cases, many of the overarching policies for building energy codes and other energy regulations are developed as model codes at the national level, but administered by local governments. As an example, in the US, national consensus bodies develop and promulgate model codes, that then allow states and local governments the flexibility in adopting the model code or different code requirements.

In the US, some states choose to develop their own energy codes, with California's Title 24 state-wide energy code being the most prominent example. The primary national model energy codes in the US, developed through the International Code Council, state that the provisions of the code apply to "additions, alterations, or repairs," though there is a list of exceptions and different states or localities may change the applicability of code provisions to existing buildings.

In Australia, the National Construction Code (NCC), developed by the Australian Building Codes Board, includes comprehensive energy provisions that apply to "new building work," whether carried out on new or existing buildings.[1] The states and territories establish thresholds above which new building work is required to be approved as compliant with the NCC.

In China, the national government's Ministry of Housing and Urban-Rural Development (MOHURD) convenes experts to develop standards that are then implemented by the relevant provincial and municipal government departments. There are a variety of energy codes that have been written and periodically strengthened. China has developed a National Standard[2] specifically for building renovation,

1. Australian Building Codes Board (ABCB) 2016, Upgrading Existing Buildings Handbook.
2. Technical Specification for Energy Efficiency Renovation of Public Building Energy Conservation,

which applies to buildings that are part of local government energy renovation programs that are established to meet renovation targets established for different provinces.[3]

In Europe, national governments are further influenced by "supra-national" requirements imposed by the European Union (EU), most specifically through Directives like the EPBD and the EED. Many European experts find the role of the EU very important, in that it can speed up implementation throughout nearly all of the Member States, and pull the underperforming countries up closer to the leaders. This is facilitated through a committed network of experts (called Concerted Action) from each country to help share experience during implementation. This is probably unique to Europe, and less applicable to the rest of the world, but perhaps there can be more lessons to be learned from the European experience for national, state or provincial, and local government coordination in other regions.

There is also a notable role played by professional societies in the US and Europe as these groups convene expert volunteers to create standards that serve as seminal documents for the establishment of mandatory codes. These documents serve as source material for other code-making entities in other countries, and a great deal of structural and technical similarities can be found, such as the "prescriptive" and "performance" pathways as described in Section 3.2, and the establishment of baseline systems and specific detailed provisions to clarify requirements of the different compliance pathways.

International collaboration such as through the International Energy Agency Technical Collaboration Programmes, as well as the International Organization for Standardization, also lead to agreed standards documents which are then called up in mandatory codes.

4.2 Implementation and compliance/enforcement challenges

While energy codes are defined and often adopted at the federal level, implementation occurs at the local level, which brings a different set of challenges. Local government building departments (sometimes known as building control agencies) are generally stretched extremely thin, as there are rarely adequate resources for comprehensive construction supervision and enforcement of various standards and directives.

International experts interviewed for this report who have studied energy code implementation and enforcement have regularly noted that energy codes are often among the lowest priorities for over-stretched local building officials. Code enforcement officials often perceive their higher priorities to be safety, fire protection, and protection of citizens, and local government staff is just focused on ensuring overall safety and general compliance at the lowest implementation cost.

Chinese National Standard JG/T176-2009

3. Synthesis Report on the Implementation of Building Energy Codes in China, Pacific Northwest National Laboratory, March 2011.

Local code enforcement bodies may be challenged by the changes in the demand for their services and by changes in the content of the codes they are tasked with enforcing. Moreover, local enforcement offices are regularly understaffed. Even in places where there has been strong progress toward enforcing stringent energy codes for new construction, much less attention is usually paid to existing buildings.

Finding the appropriate role for different levels of government in building regulation enforcement, relative to other compliance models can be complex. In some cases, there may be funding provided by a national or state/provincial government to local jurisdictions to have more enforcement and implementation capacity. Whether enforcement costs are borne by the cost of the construction project, or through other policies is a choice that needs careful consideration. as it impacts jobs, the creation of an energy efficiency market and public budgets. More ambitious national renovation policies might be expanded to include some funding mechanism to ensure adequate resources for implementation of the established regulations.

There are many aspects of code/regulation compliance to be considered, and a recent evaluation of the compliance with the European EPBD requirements among EU member states reinforced that compliance rates, as reported by building control experts, were significantly lower for both existing buildings that undergo major renovation, and retrofitted building elements, than that for new construction, as shown in figure 1.[4]

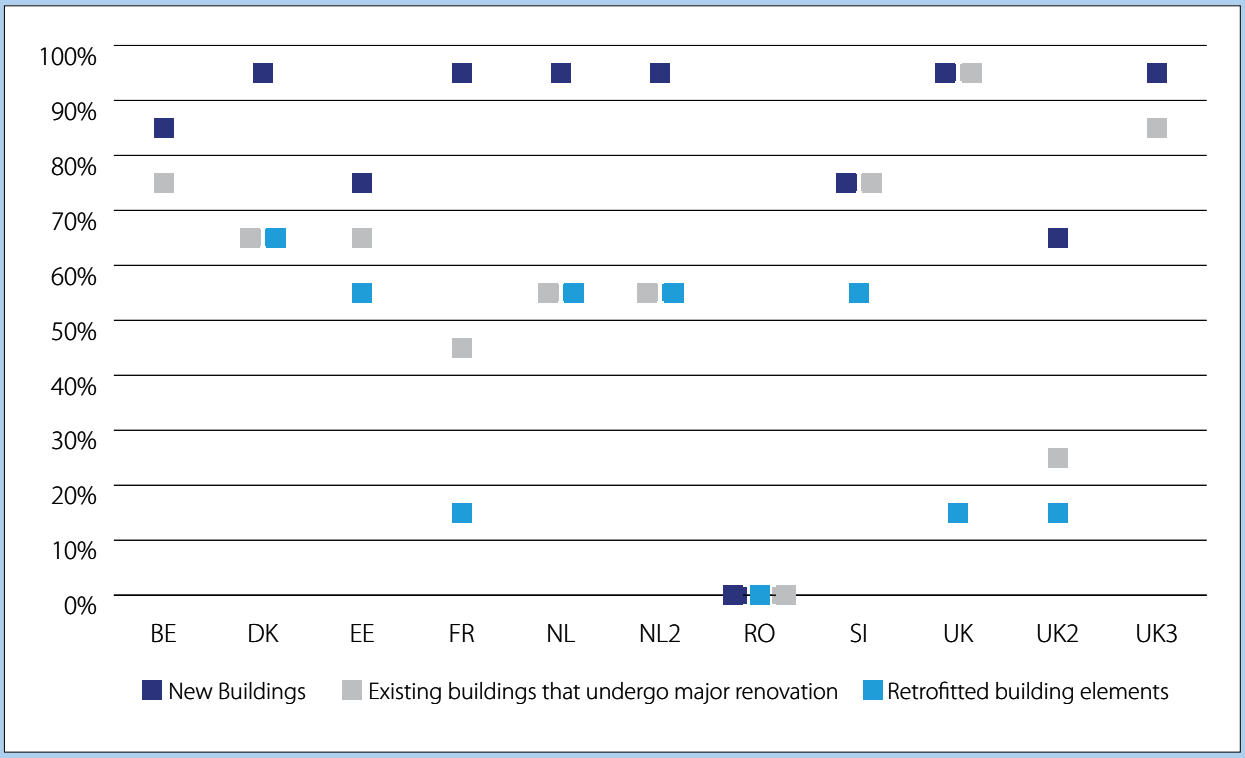
There are also many options for code/regulation compliance tracking; in some cases government employees are nearly all of the inspectors and compliance officers, while in other places most of the compliance inspections are done by third-party assessors/surveyors hired by the building owner. There does not seem to be any typical compliance model used globally, though in general, the costs for implementation and compliance are a local government expenditure, whether covered by building permit fees or other local government taxes.

Compounding the challenge of understanding levels of "compliance" with energy codes and other renovation policies is the reality that there are many different ways of measuring and reporting compliance. In some cases, compliance may mean that at the time of design, all of the required elements to meet a code or other regulation were included as part of that design. Other compliance reporting may include post-construction/renovation field inspections that would uncover issues that may have been intended to be included as part of the design, but then not in the actual renovation project. There is an opportunity for better international comparability of different definitions of compliance.

In many jurisdictions, there are also concerns in the building departments about graft and corruption, where construction market actors often pay bribes to avoid costly measures required by some codes. This is the most common cause for

4. Energy Performance of Buildings Directive (EPBD) Compliance Study, prepared by ICF Consulting for the European Commission, December 2015; https://ec.europa.eu/energy/sites/ener/files/documents/MJ-04-15-968-EN-N.pdf

Figure 1. Compliance Rates for European Member States for Different Renovation/Retrofit vs. New Construction, as Reported by Building Control Experts[a]



[a] Energy Performance of Buildings Directive (EPBD) Compliance Study, 2015.

replacement of local building officials—corruption is often identified when there are major safety violations that lead to building structural failure or deadly fires, though can be widespread in many economies.

4.3 Disconnect between national policies and local government capacity/priorities

There can often be very strong support for energy efficiency policy at either a national or local level, but given the different levers and responsibilities for action with the development and implementation of building control policies as noted above, progress implementing energy efficiency policies can sometimes be stalled.

Many large cities throughout the world have set very ambitious targets for energy or greenhouse gas emission reductions, and even for renewable energy penetration. However, in many cases they do not have the authority for regulating energy suppliers and local energy prices. In some cases these are limited by national or state/provincial laws as to the breadth and depth of their policies toward buildings. In some places, where the local government may have limitations on how it can regulate privately owned buildings, there is more flexibility and authority to lead by example to demonstrate how energy performance of existing public/municipal buildings can be improved, and then over time the practices of these demonstrations can be extended to the broader private sector building stock.

At the same time, these different levels of responsibility and authority can also balance one another out. This is currently being seen in the US, where state and local action are stepping up in the absence of federal support with the recent change of administration.

4.4 Understanding thresholds that "trigger" regulation

In many cases, the application of energy codes (and other building codes/regulations) to existing buildings are usually triggered by some threshold of change to the building, often expressed as a "percentage change" in the value or other metric of some building systems or subsystems. Typical language in some regions is often something like "requirements must be met for any system or subsystem that is replacing more than X% of its value".

As an example, a recent review as part of the International Energy Agency Technology Collaboration Programme on Energy in Buildings & Community Annex 56 project on Cost-Effective Energy and Carbon Emissions Optimization in Building Renovation examined renovation policies in a number of European member states, and found that typically, triggers for what is considered a "major renovation" in European building regulations are "25%" of either building envelope, building value, or some other term.[5]

In the case of the European major renovation targets, different member states have established their renovation plans aimed toward certain building types, often with certain types of funding programs with specific requirements for performance levels, or prescriptive requirements that would qualify a building for different tiers of incentives.

A quite innovative trigger has recently been established in Singapore. Since 2014, building owners of all buildings over 5,000 square meters, excluding industrial and residential buildings, are required to comply with Singapore's minimum environmental sustainability standard (Green Mark Certified equivalent) for existing buildings when replacing or installing building cooling systems, and submit periodic energy efficiency audits of building cooling systems.[6] The requirements apply whenever the building owner installs any water- or air-cooled chiller, or replaces an existing chiller with another chiller or unitary cooling system.

Other trigger points for regulations might include the sale, rental, or change of use of a building, such that the building must be brought up to a certain performance level at the time of one of those events.

4.5 Other building regulations aimed toward existing buildings

There are many other types of non-energy regulations and policy instruments

5. IEA ECS Annex 56 (Cost-Effective Energy and Carbon Emissions Optimization in Building Renovation), Terminology and Definitions, March 2017.

6. See details at https://www.bca.gov.sg/EnvSusLegislation/Existing_Building_Legislation.html#

aimed at modifications and improvements in existing buildings that can serve as models for understanding how to drive modernization of those buildings.

Building codes and regulations can be used in different ways to drive overall improvement of both new construction and the existing building stock, not just energy performance. In the United Kingdom, the energy provisions that apply to both new and existing buildings are contained in "Part L: Conservation of fuel and power" among the list of approved documents to meet building regulations. Parts A and B, respectively, are "structure" and "fire safety;" arguably, the first sections of the regulations, which were developed at earlier stages of building regulation evolution, are perceived as significantly higher priority than Part L.

Similarly, in the Australian National Construction Code, energy efficiency standards for commercial buildings are set out in Section J, not the most important or critical from the Building Code Board's perspective. The stated priority of the NCC is "health and safety" first, then "amenity and sustainability" (including energy efficiency).

There are regulations around the world that require older, existing buildings to retrofit fire safety and egress improvements, often starting with buildings of public assembly (such as government buildings, auditoriums, hotels and conference centers, where large groups of the public assemble). How these requirements are

implemented could serve as a model for stronger, and potentially more ambitious, implementation of building energy regulations.

In 2017, a tragic fire in the high-rise Grenfell Tower block of housing flats in London caused at least 80 deaths and many more injuries, and the growth and rapid spread of the fire is believed to have been accelerated by the building's recently added exterior cladding, which included a flammable insulation material. The public outcry over this incident has resulted in rapid mobilization of inspections of similar towers and retrofit projects, resulting in massive investment being made very quickly to add fire suppression sprinkler systems, additional fire escape routes, and replacement of flammable materials.

This shows that if the priority is perceived to be high enough (many lives at stake, with the need for urgent action), then investment and political will to amend, implement, and enforce more strict regulations quickly can happen. To date, that is not the experience for building energy regulations; it is not clear how current ambition for reducing building energy use and resulting emissions can motivate that political will to drive change and investment at a similar rapid pace as happens following a tragic life safety event.

Two other examples of areas where there has been very significant investment over recent decades toward modernizing existing buildings are in the areas of disability access, and seismic, earthquake protection through strengthening or reinforcing building structures.

In the US, the passage of the "Americans with Disabilities Act" in 1990, intended to prohibit discrimination and ensure equal opportunity for persons with disabilities, mandated that many types of buildings, especially those intended for public assembly, be retrofitted to have appropriate handicap access routes, including ramps and elevators, as well as wider doorways and other parts of building passageways to allow better access for people needing wheelchairs. While not all existing buildings have had to meet these requirements, there has been relatively rapid improvement to allow better access for handicapped persons. Other countries and jurisdictions have implemented similar regulations.

In areas where there have been serious earthquakes, or concerns about seismic activity that may threaten buildings and lives, there are often combinations of mandatory and voluntary building modernization initiatives to minimize potential loss of life. Even for some safety codes, which are generally considered higher priority than energy codes, there can be small nuances to regulations that allow flexibility, and in some cases less comprehensive implementation of regulations. With seismic/earthquake regulations in California in the US, "strengthening" buildings is considered to be a less comprehensive or expensive "over the counter" simpler building permit process with no inspection, while a seismic "retrofit" requires a final inspection and costs more.

It could be argued that some of these other types of improvements have less economic return than energy efficiency improvements, but it was considered a political imperative, and a strong constituency has led to strong enforcement of

the regulations in many jurisdictions. There are likely additional lessons that can be learned by the energy policy community.

Beyond official regulations, there are often market norms and expectations that form "invisible" regulations in many jurisdictions. For example, in some places it can be impossible to get mortgage financing for residences without certain types of basic amenities, or if health hazards such as lead-based paint or other indoor air pollutants are identified. Leasing standards in place in a jurisdiction can essentially set expectations that all buildings will gradually need to follow.

5 Key Findings

5.1 Benefits and challenges with different approaches

Each of the policy types described earlier has a variety of different key benefits and challenges, which are summarized below.

In reviewing policies in place in different regions, there are quite different perspectives on the merits of the European directive approach with targets and

Table 4. Benefits and Challenges

Type of Policy	Benefits	Challenges
Targets: Performance based renovation targets and requirements	Very broad driver - sets high ambitions and goals, as overarching framework for suite of regulatory and financing policies, as well as justification for supporting activities; can be important to maintain political will and ambition for other policy levers	Can be difficult to articulate and administer penalties for non-compliance; best as high-level strategy with other supporting mandatory policies initiated to support the target; can be complex to administer; applies to population rather than individual buildings
Energy Codes: Building energy codes/standards applied to existing buildings	Relatively simple to develop and administer; most construction industry practitioners familiar with energy codes as used in new construction, so easier to adopt and update for renovation	Defining appropriate measurement tools and metrics; assessment processes to measure compliance; relevance of new construction building codes to complexities of the wide range of existing buildings; applies only at time of major renovation, so does not drive widespread market change rapidly; resourcing for enforcement.
Disclosure/ Improvement: Mandatory energy performance disclosure, sometimes linked to upgrade requirements	Simple rating and disclosure of performance is not controversial, so politically relatively easy; flexibility for how upgrade requirements might be implemented or phased in; allow market forces to operate	Without mandatory upgrade requirements, may not result in significant performance improvement; potential for confusion depending on metrics used; variety of different types of ratings or ways of defining the performance improvements needed if the current performance is deemed unacceptable
Financing/Incentives: Voluntary standards that become mandatory with financing from certain sources	Can be most creative and ambitious, as these initiatives are voluntary and therefore require less political consensus; offer opportunities to develop highest value incentives to spur deep energy reductions, and enable innovation in technology and implementation models	Cost for implementation—needs to come from some source, either government funds, or energy price surcharges; due to voluntary nature unlikely to expand to entirety of existing buildings

less comprehensive national policies in other regions. However, leading subnational policies in other countries are often similarly comprehensive.

5.2 Need for comprehensive packages of policies for best results

Energy codes by themselves are not enough to drive substantial reductions in energy use, as policies that are developed as "silos" do not have the maximum impact. In reality, application of energy codes is limited to the existing rate of renovation, often only 1% of the building stock per year, and compliance is an issue without incentives. What is needed instead for major progress toward improving the energy efficiency of existing buildings is a comprehensive package of complementary policies that, together, address the various barriers to improving the efficiency of buildings.

An earlier IPEEC BEET project, "Building Energy Efficiency: Opportunities for International Collaboration", found that:

> *"In order to realize the full potential of a more energy efficient building sector, it is necessary for national and regional governments to establish ambitious, concrete, and effective policies and programmes. Effective policy requires an integrated, holistic approach to design, development and implementation. Therefore, governments should pursue packages of regulations, incentives, labels and voluntary schemes based on their individual national circumstances that best accelerate market transformation and reap efficiency benefits at minimal cost."*

Other international best practice reviews have shown that comprehensive policy packages, including regulation, but also financing, information and other policies, have had the most significant impact to date. Many of the more innovative approaches are happening at subnational and local levels, where policy innovation can often be implemented with more ambition than might be possible at a national level. Some best practice policy package examples, at the national level and local level, that have been identified through earlier best practice reviews include:

- At the national level, in Germany, the KfW Bank, founded in 1948 to help with rebuilding Germany following the Second World War, has in recent years had environmental and climate protection as one of their key business lines. As detailed earlier in the section on financing/incentive policies, their energy efficient refurbishment program provides either tiered grants of up to EUR 30,000, or comprehensive financing as well as other packaging services, for homes to meet different levels of prescribed performance. The different performance levels are defined by the percentage of maximum primary energy requirement required by the German building energy code, with the most efficient refurbishments getting the most generous grants or financing terms. These different packages of measures have been shown to drive both higher renovation rates as well as depth of savings. The financing program, along with other supporting initiatives, is a major driver of renovation

projects that supports the regular updating of other regulations including the energy codes.

- At the subnational level, New York City's Greener, Greater Buildings Laws and the supporting programs are often held up as an example of a comprehensive approach. The laws, mostly addressed to the 2% of the City's largest buildings that together account for about half of the City's building energy consumption, include mandatory annual energy and water benchmarking with public disclosure, periodic mandatory energy audits, as well as "retro-commissioning", a form of building tune-up that requires bringing buildings up to intended controls and operating practice. The City also adopted a new energy code, with specific provisions to expand the coverage for existing building renovations and additions, and also has several financing support programs as well as information campaigns.

There are a growing number of comprehensive approaches to "Nearly Zero-Energy Building (NZEB) Renovation" being considered and tested in Europe, as different European Member States work toward their Energy Renovation Strategies as required by the 2012 Energy Efficiency Directive. Some best practices have been identified through the "Promotion of smart and integrated NZEB renovation measures" project in the European renovation market, funded by European Union's Intelligent Energy Europe Programme. These might provide examples for how to extend such approaches to the existing building segment.

Building energy regulations combined with financing provided through energy provider retrofit programs, under energy efficiency obligations in Europe and utility or public benefits providers in the US or other regions, can be a strong complement to energy codes. Improved energy performance thresholds, or energy reductions levels, often can be established as an initial voluntary standard level for accessing the incentives, which can then be extended to a mandatory requirement after a certain level of market saturation.

In China, government incentives for building retrofits and performance contracting, tied to the national renovation standard, have driven substantial investment in existing building renovation.

A recent European Commission Joint Research Centre report highlighted best practice policy measures among EU member states in their implementation of the Energy Efficiency Directive building renovation strategies, identifying innovative regulatory, financial and fiscal, and other policy approaches among

Key elements indentified to promote implementation of Nearly Zero-Energy Renovation include:

- Demonstrating the feasibility and best practices of NZEB renovation
- Developing concrete city action plans
- Overcoming barriers with stakeholder roadmaps
- Innovating with design competitions
- Effectively disseminating results

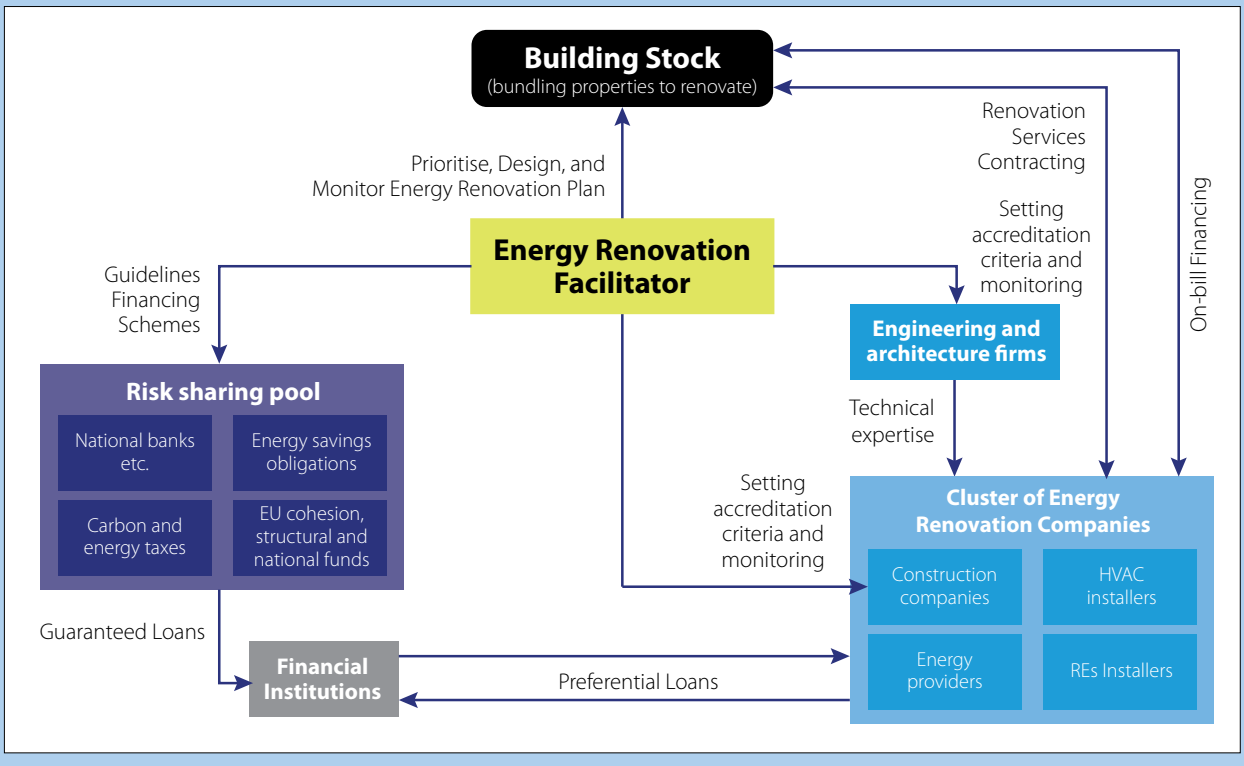
Source: Promoting implementation of Nearly Zero-Energy Building Renovation, Result Oriented Report of IEE NeZeR project, 2017; http://www.nezer-project.eu

member states that should be considered by other countries to deliver deeper energy reductions in existing building renovations.

Many of the more successful comprehensive renovation models include some sort of "energy renovation facilitator" that serves as project coordinator to bring together engineering and architecture firms, renovation contractors, and financing. A European Commission Joint Research Centre paper in 2015 identified the potential role for an "energy renovation facilitator," a role that could coordinate various stakeholders and market actors that are needed for comprehensive renovation initaitives and services, as shown in Figure 2.

One of the best-known comprehensive deep energy retrofit/renovation initiatives involving such a facilitation role, is the "EnergieSprong" (Dutch for "energy leap") model. The EnergieSprong model, which is growing quite strongly in terms of participation both in Europe, and in some jurisdictions in the US, was first offered in the Netherlands in 2011, and more recently launched in France, the UK, and New York State in the US, while a study is currently underway in Germany to examine the applicability there. It is a new, whole house refurbishment process and funding approach, begun as part of a Dutch government funded innovation program for the social housing sector. The approach delivers fully integrated refurbishment packages with long-term performance guarantees that make the solution commercially financeable and scalable. In the Netherlands, as of early 2016, 1,170 homes

Figure 2. "Energy Renovation Facilitator" Concept, as Proposed by the European Commission Joint Research Centre



had been contracted, with a significant portion already upgraded; the goal there is to upgrade 111,000 homes in the coming years to nearly zero energy performance.

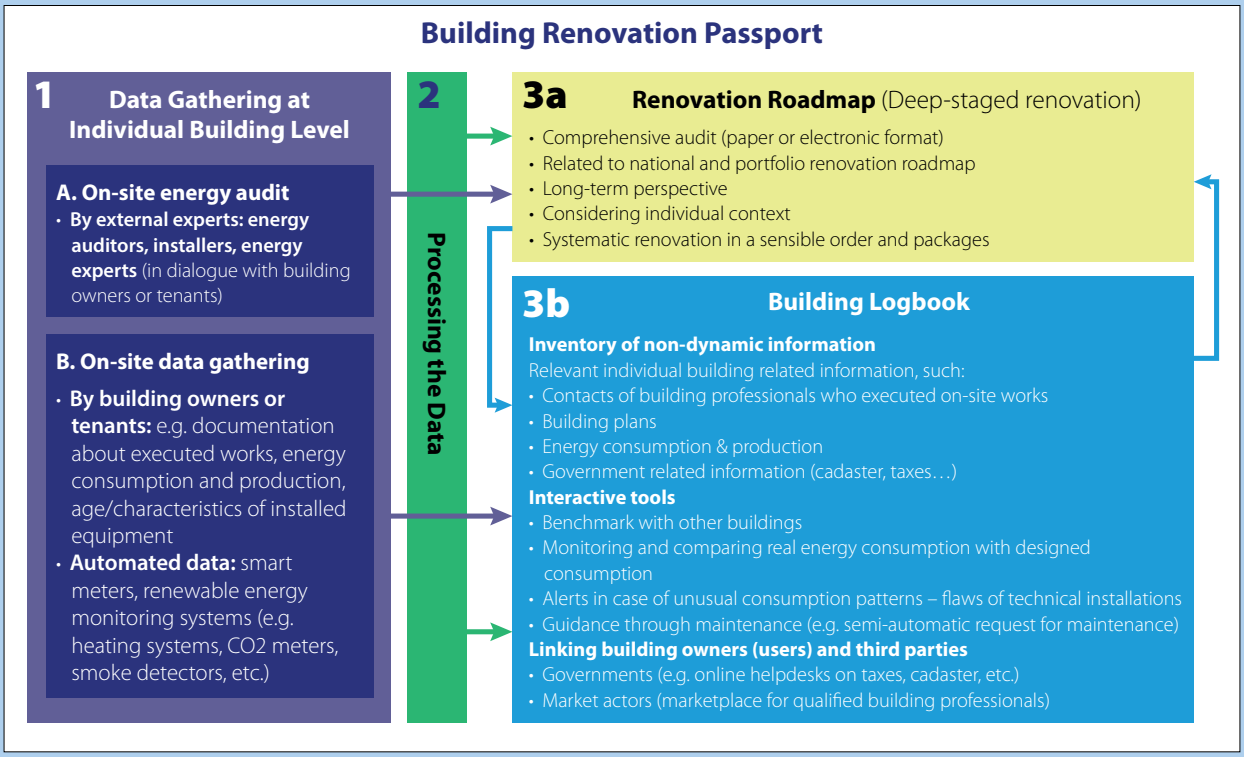
Beyond these examples, with cities doing much of the most ambitious energy and climate policy leadership, there are likely to be additional examples of innovative, comprehensive policy approaches that will emerge in the coming years. Two recent compilations of what leading large cities are doing toward building energy improvement policies have been prepared by the C40 Cities Climate Leadership Group;[1] these have examples of comprehensive approaches being implemented by leading large cities all around the world.

There are also an increasing number of large scale retrofit financing and operational models to facilitate renovations, including energy performance contracting, third-party financing, revolving funds, cooperatives, and others. Many leading European examples have been compiled through the CITYnvest project, which

1. See C40 Urban Efficiency: A global survey of building energy efficiency policies in cities, 2014; and, Urban Efficiency II: Seven innovative city programmes for Existing Building Energy Efficiency, 2017

Building Renovation Passports

A more advanced concept has been advanced by the Building Performance Institute Europe, based on work being done in Germany, Flanders (Belgium), and France, to develop longer term, step by step customized roadmaps towards deep renovation. In those three regions, renovation initiatives are approaching implementation, and BPIE analyzed the commonalities among those activities, summarized below.



Source: Building Renovation Passports, Building Performance Institute Europe, November 2016

summarized the various initiatives in a 2015 report "Increasing capacities in Cities for innovating financing in energy efficiency: a review of local authority innovative large scale retrofit financing and operational model."[2]

It is indisputable that the more comprehensive targets and directives approach in Europe is leading to more comprehensive policy packages, including funding and financing, providing incentives as well as information to overcome knowledge barriers.[3]

5.3 Conclusions

There are a number of policy tools in use around the world addressing existing building renovation. Some appear to be more successful than others, and some need more evaluation to understand impacts and effectiveness as countries move forward.

Building energy codes can be applied to existing building renovation, but without other policies or programs, are not likely to result in the deep energy savings sought by many governments. Instead, energy codes as one part of a more comprehensive policy package are key to driving more significant energy savings from the existing building stock.

There are best practices emerging in many countries around the world, both in development of comprehensive policy targets, but also in the implementation of specific building performance regulations, that can be more widely adopted and will result in more efficient existing buildings. This review identified some of those opportunities, though deeper research might be able to recommend specific suggestions for countries in different levels of development and ambition toward building energy policy.

Among the policies that appear to deliver the most significant activity in building energy renovation are the following:

- **Comprehensive improvement targets**, supported by underlying policies and initiatives including regulations, financing, and information campaigns aimed toward various stakeholders, can set high, longer-term ambitions while continuously upgrading energy performance requirements.
- **Disclosure of energy performance**, with mandates tied to improving the performance of the poor performers, has the potential for major energy reductions, though the mandated improvements may be politically challenging to implement and enforce; periodic disclosure of measured energy performance provides a feedback loop to understand the effectivenss of other policies.
- **Linking financing and other supportive policies to deeper savings**, through tiered incentives where very deep renovations get rewarded, can transform markets and drive greater impacts.

2. CITYnvest, Increasing capacities in Cities for innovating financing in energy efficiency: a review of local authority innovative large scale retrofit financing and operational model, 2015. http://citynvest.eu
3. Scaling up deep energy renovation: unleashing the potential through innovation & industrialization, Building Performance Institute Europe 2016. http://bpie.eu/publication/scaling-up-deep-energy-renovation/

- **Some role for a "renovation facilitator"** to navigate different policies and stakeholder groups needed for implementation of deep renovations seems to be useful; important larger scale initiatives are getting underway that hold promise.

There appears to be the most certainty of delivering large scale market changes when legally binding measures can be tied to demonstrated improvement in building performance. The most advanced example of this type of policy is the UK Energy Act of 2011, which prescribes minimum energy performance standards, tied to a building's Energy Performance Certificate rating, that will make it unlawful beginning in 2018 for the worst performing buildings to be re-leased without some required energy upgrades.

The French mandate requiring individual buildings to prepare a "plan for renovation" that will result in energy consumption reduction within a set period of time is also very promising, though the "legally binding" enforcement of that mandate may be more challenging. The Tokyo Cap-and-Trade policy is another policy mechanism that has driven significant reductions in a relatively short period of time, using the market mechanism of cap and trade to allow the most cost-effective renovations to take place among the targeted stock of buildings.

More research is needed to understand the real impacts of more comprehensive policy packages that begin with ambitious targets. Some experts have questioned the effectiveness of the target approach, and a closer review of the linkage between established targets, and measured reductions in existing building energy consumption, is needed.

Some areas for further study to understand the most impactful policies include:

- Evaluate relative impacts and effectiveness of the different types of policy instruments aimed toward existing building energy improvement to determine savings, impact and timeframe.
- Research the effectiveness of establishing targets by assessing whether targets are being reached, and whether there are more demonstrated savings from the existing building policies in regimes with those targets than elsewhere.
- Assess the level of change in energy renovation rates in different countries that have been subject to renovation mandates or targets, and how the building sector energy performance is changing as a result of the renovation targets.
- Assess how to accelerate getting the most innovative and successful city/subnational policy packages adopted and implemented at regional or national levels.
- Assess the impacts of minimum energy performance standards mandating upgrades to lower performers over time and determine what impact such programs may have on affordability and availability of buildings covered by these standards.

- Research on how other types of building retrofit/modernization requirements (fire safety/suppression, seismic strengthening) have been implemented, and what types of lessons can be learned and whether there are opportunities to create synergies between energy efficiency and safety regulations.
- Develop an international framework for defining the meaning of "compliance" with different regulations.

Existing buildings are ripe opportunities for improved energy efficiency, and the increased interest in tapping this potential is resulting in a range of new policy activities addressing this sector. Much more will be known in a few years about the impacts and effectiveness of these newer policies.

6

Appendix: IPEEC Countries' Energy Codes for Existing Buildings

A comprehensive survey of all IPEEC member economies and the coverage of their building energy codes for both new and existing buildings was conducted as part of the BEET 3 Implementing Building Energy Codes project, and much more detailed information beyond the report is available online at the project Energy Codes portal.[1] A summary of the application of energy codes in place regulating existing buildings in selected IPEEC countries is shown at right.

1. See Global Buildings Performance Network Energy Codes Portal: www.gbpn.org/laboratory/building-energy-codes-portal

Country	Application to Existing Buildings?		Size Threshold/ Typical Trigger	Comments
	Res*	Comm**		
Australia	●	●		Requirements vary by jurisdiction
Canada	●	●		
China	●	●		Separate code for renovations
France	●	●	Non-Res: extensive to buildings > 1000 m^2	Establishes EUI limits
Germany	●	●	Larger refurbishments except for res. Buildings used less than 4 months/year; certain equipment replacement	Comprehensive requirements
India		●	Greater than 1000 m^2	When voluntarily adopted in state or locality, for large additions
Italy	●	●		To meet European EPBD
Japan	●	●	Greater than 300 m^2	Applies to extensive modifications and major retrofits
Russia	●	●	Buildings heated at least 5 days/ week, or 3 months/year	Applies to "large renovations"
South Africa	●	●	Buildings that require building plan approval	
South Korea	●	●	Floor area thresholds; vary by building type	Apply to larger buildings, with higher expected energy consumption
United Kingdom	●	●	Floor area thresholds and other triggers; vary by building type	Slightly different requirements between codes in Scotland and Northern Ireland, and require-ments in England & Wales
United States	●	●	Varies by state/locality	

*Residential **Commercial

Source: Global Buildings Performance Network Energy Codes Portal: www.gbpn.org/laboratory/building-energy-codes-portal (based on information collected in 2014/15 for IPEEC BEET 3: Delivering Energy Savings in Buildings: International Cooperation on Building Energy Code Implementation

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