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How to set energy efficiency requirements for new buildings

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Author(s): C40 Cities Climate Leadership Group, C40 Knowledge Hub

The average lifespan of a new building is 50 years; cities must adopt ambitious minimum energy performance standards in order to avoid locking in decades of inefficient building performance. Cities should set mandatory standards coupled with effective enforcement to maximise and accelerate the pace of uptake. However, voluntary standards and incentives are also valuable tools.

This article sets out the most effective options for cities to ensure that new buildings meet minimum energy performance requirements. It includes options for cities without the regulatory powers to set their own building energy codes.

Lead by example: set performance standards for public buildings

City governments can lead by example by setting higher standards for their own new buildings.¹ In particular, cities can:

- Establish energy-savings and renewable energy generation targets for public buildings.
- Set minimum energy performance standards for public buildings.
- Eliminate or significantly reduce fossil fuel usage in public buildings through building electrification requirements for heating, hot water and cooking.
- Require rooftop solar PV panels on public buildings, such as schools and hospitals.



English

Cities with the most ambitious policies on the energy efficiency standards of new buildings have set commitments for all building assets owned, managed and developed by municipalities to be net zero by 2030. For example, in Toronto, Canada all new planning applications must meet Tier 1 on the four-tier Toronto Green Standard. Public non-residential buildings are required to meet the more ambitious Tier 2 standard. Financial incentives are offered for (public and private) planning applications to meet the voluntary Tier 2–4 standards.

Set ambitious building energy codes and strengthen them over time

Building energy codes set buildings' energy performance requirements. They are usually mandatory, but can be voluntary. Codes are often issued at national or state level. However, cities with the power to do so should issue stricter codes and strengthen them over time to achieve more ambitious energy performance goals (see box).

Global cities setting ambitious building energy codes

The [2018 Seattle Energy Code](#), a commercial building energy code approved by the city of Seattle in 2021 has stricter restrictions on fossil fuel use in new commercial buildings than the Washington State code. It is one of the most stringent building energy codes in the United States. The code contains measures that eliminate the use of fossil fuels for heating and hot water systems for all commercial and multi-family residential buildings taller than three stories, alongside measures to increase energy efficiency and the generation of clean electricity from on-site solar photovoltaics. Other cities, such as Beijing, [London](#) and [Johannesburg](#) have set requirements for energy efficiency and building decarbonisation that are stricter than national requirements or set the cities on an accelerated pathway to net zero carbon buildings.

Building energy codes are powerful tools for reducing emissions and the cost of powering a building. For example, codes in the United States saved more than US \$44 billion in energy costs and 300 million tons of carbon emissions between 1992 and 2014.² In Chicago, United States, net zero energy homes are almost at cost-parity with regular homes due to strong local codes coupled with a range of incentives for both efficiency and onsite renewables.³

Typically, building energy codes (or standards, as they are known in some countries) set different energy performance and compliance requirements for residential and non-residential buildings. They are tailored to the local climate, as well as locally available resources and technologies.⁴ Building energy codes usually focus on new buildings, but they also can be applied to [existing buildings](#).

The main types of building energy codes in use around the world are:⁵



English

- **Prescriptive codes.** These set performance requirements for specific building components.
- **Performance-based codes.** These set a maximum level of energy consumption or intensity for the whole building, and can allow trade-offs (for example, less insulation but more efficient windows).
- **Outcome-based codes.** These require a specified performance to be achieved and verified over a period of at least 12 months (these are less common).

These approaches can be combined. For example, ideally, a performance-based code for the whole building would incorporate prescriptive code elements to target the worst performing building components. These codes can also include requirements for measurement and verification of the operational performance of buildings, such as measuring energy use after construction, to ensure predicted performance in the design is delivered.

Building energy codes should be tightened over time to reflect technology developments and to gradually raise performance standards toward a zero-carbon buildings goal. Cities can establish regular upgrade cycles, such as every three years. Set long term targets through ‘stretch codes’ (see below) and zero carbon buildings pathways to help smooth this process.

Codes should also be combined with incentives, capacity building and financing programmes, to encourage actors to meet the minimum performance requirements and maximise their effectiveness.

The following resources offer more information about building codes and how to develop them:

- World Resources Institute’s report *Accelerating Building Efficiency: Eight Actions for Urban Leaders*.
- Global Building Performance Network’s comparison tool for building energy efficiency policies.
- Global Building Performance Network’s report *Linking Building Energy Codes With Benchmarking and Disclosure Policies: Key Synergies that Drive Building Energy Performance*.
- Institute for Market Transformation’s building code resource library.
- New Building Institute’s *Implementing an Outcome-Based Compliance Path in Energy Codes: Guidance for Cities*, which focuses on the United States context.

The passive house standard

Passive house is an established building standard requiring very high energy efficiency, which cities can adopt in a code or bylaw. The latest versions of the voluntary standard also include building-scale renewable standards for energy generated to operate the building or produce more than is required.

Passive House Explained in 90 Seconds



Brussels' passive house standards spark development of domestic zero-carbon buildings industry

The European Union (EU) mandates nearly zero energy buildings standards for all new public buildings from 2018 onwards, and for *all* new buildings from 2020. As of early 2024, the EU requirements are currently going through the process of being updated, and if approved a new Zero Emission (ZEB) Standard will be in operation from 2030 for all new buildings.

Brussels, Belgium has set the nearly zero energy building standard considerably lower than the EU requirement. And from January 2015, the city made 'passive house' construction mandatory in the building code.

To achieve this, the city first had to overcome scepticism about the achievability of this standard in the local market. Brussels ran three trial rounds of a voluntary Exemplary Buildings programme, beginning in 2007. During the trials hundreds of passive houses were built, thanks to the programme's financial incentives, technical support and workforce development assistance. It also sparked the development of a domestic passive house supply industry, creating hundreds of jobs.

The city studied the construction of these buildings and shared the lessons learnt. The trials generated support for a mandatory standard by demonstrating that passive house standards are affordable, achievable, and provide many benefits.^{6, 7}

The passive house standard is now integrated into city policies in a number of cities, including Vancouver and Chicago, where some building types can use passive house certification to demonstrate compliance with

Explore cities' energy efficiency policies for new buildings in our policy explorer

The [Building Energy Efficiency Policy Explorer](#) is an interactive dashboard showcasing a range of city policies that improve building energy performance. Filter for new buildings to understand what other cities are doing, and the policies and programmes they have in place. It includes, among others, policies from:

- **London, which requires all new residential buildings to achieve a zero-carbon standard.** The [Mayor of London's Zero Carbon London: A 1.5°C Compatible Plan](#) (2018), requires all new residential buildings to achieve a (modelled) zero carbon standard, excluding plug loads (energy for appliances). London's standard is stronger than United Kingdom national regulation, and must be achieved through a minimum of 35% reduction in regulated carbon dioxide emissions. Remaining emissions can be offset through a financial contribution to the borough, and the proceeds are ring-fenced for other local energy efficiency projects.^{8, 9}
- **eThekwini, where all new buildings will be net-zero in construction and operation by 2030.** The eThekwini (Durban) Municipality Council adopted the [eThekwini New Buildings Green Policy](#) in April 2021. This policy puts in place regulations which will see all new buildings being built according to net zero carbon requirements from 2030. This was made possible through collaboration between multiple departments, with a strong commitment to taking climate action.

Leading cities are banning fossil gas in new buildings

[Fossil gas](#) is often promoted by the fossil fuel industry as a ‘clean’ transition fuel, but it largely consists of [methane – an extremely potent greenhouse gas](#). [Fossil gas usage will need to reduce by 30%](#) by 2035 to remain on track for the 1.5°C goal of the Paris Agreement. This being the case, cities in the US such as [Seattle](#), [San Francisco](#), [Los Angeles](#) and [New York City](#) have used building energy codes to enact bans on the use of fossil gas in new buildings. As part of the European Union’s [Decarb City Pipes 2050 project](#), European cities such as [Bilbao](#), [Bratislava](#), [Dublin](#), [Rotterdam](#), [Munich](#), [Winterthur](#) and [Vienna](#) have developed roadmaps to decarbonise heating and cooling in all buildings by 2050.

Set ‘stretch’ codes to work towards zero-carbon building goals

Set a zero-carbon building end goal for your city’s new building stock and gradually strengthen local codes and standards towards this goal. These components taken together are often called ‘stretch’ codes, and are increasingly being adopted by cities.

A stretch code introduces a more ambitious, voluntary code in addition to any mandatory English. It can be followed by early adopters and gradually becomes standard practice, at which point the next stretch code is introduced. Updated stretch codes are usually introduced every three years, as steps toward a final zero carbon building goal.

Stretch codes send a strong signal to the buildings and renewable energy sectors about standards and requirements they can expect in the future. For example, a zero-carbon building goal coupled with a stretch-code requirement for solar-ready roofing connections helps builders to anticipate further rooftop solar energy requirements, and indicates increasing demand for this technology to the renewable energy sector. Incentives such as fast-tracked permitting processes can be offered for those meeting stretch codes.

Stretch codes can be set at national, state or city level. For example, the state of Massachusetts in the United States developed the opt-In Specialized Stretch Energy Code (Specialized Code), which was finalised in 2022, by the Massachusetts Department of Energy Resources (DOER). A number of municipalities in Massachusetts have adopted the stretch code including the City of Boston, which voted to opt-in in 2023 with the new code becoming effective from January 2024.

Add a voluntary zero-carbon appendix to the mandatory building code

Introducing a voluntary zero carbon appendix to a mandatory code is another way to prepare your market for a move to zero carbon. It gives local building developers insight into what a zero code may look like. Unlike stretch codes, which provide steps to reach a longer-term zero carbon goal, a zero carbon appendix is an option to meet zero carbon now. You can also use it to encourage and recognise early zero-carbon adopters. Cities that don't have the regulatory power to issue their own codes can link a voluntary appendix to state or national codes.

Washington D.C.'s net zero energy code appendix

Washington, D.C. in the United States is adding a voluntary net-zero energy buildings appendix to its building energy code, called Appendix Z. The appendix highlights the need for:

- reduced building energy demand for heating and cooling;
- reduced total building energy demand through higher efficiency technologies; and
- shifting the remaining building energy needs to renewable sources.

The city is introducing measures to encourage developers to follow the appendix. For example, providing financial incentives for setting and achieving net zero energy goals, technical assistance, expedited permitting or reduced fees.¹⁰

The Washington, D.C. government, driven by the Sustainable DC plan, is aiming to cut greenhouse gas emissions in half by 2032 and become carbon neutral by 2050.



'We already know what net-zero code looks like. Appendix Z describes the code, gets it out into the world, and helps people see where we're going to be in 10 years.'

David Epley, Green Building Manager at Washington, D.C. Department of Consumer and Regulatory Affairs.

British Columbia's voluntary Energy Step Code

The province of British Columbia in Canada has introduced the voluntary [BC Energy Step Code](#), which sets an incremental path towards net-zero energy 'ready' buildings by 2032. The city of Vancouver, British Columbia is supporting this through a comprehensive set of measures to build local capacity and remove adoption barriers. For example, the city recently launched the [Zero Emissions Buildings exchange \(ZEBx\) centre](#).¹¹

Use bylaws to mandate better building energy performance

Bylaws, or ordinances, are a useful option for cities that do not have the regulatory power to develop their own codes, or to strengthen codes set by higher levels of government. Bylaws can be narrow in scope, such as the Green Roof Bylaws in Toronto, Canada (see box below), or incorporate a broader range of mandatory and voluntary standards, such as in Tshwane, South Africa (see box below).



Roof bylaws around the world

In 2009, Toronto City Council became the first city in North America to require large new buildings to install green roofs under the [Toronto Green Roof Bylaw](#). The bylaw sets out a graduated green roof requirement from 20%– 60% of available roof space for new development or additions with a gross floor area greater than 2,000 square metres.¹² Green roofs must conform to the Toronto Green Roof Construction Standard as set out in the Green Roof Bylaw.

In 2016, San Francisco in the United States passed the [Better Roofs Ordinance](#), requiring new developments to include green roofs and/or solar roofs. [Cordoba](#), Argentina passed a bylaw requiring all buildings – new or existing – with rooftop space of 400 square metres or more to be turned into green roofs.¹³

Other cities with green roof bylaws include [Copenhagen](#), Denmark and Recife, Brazil. Philadelphia in the United States has passed a [Cool Roof bylaw](#), requiring reflective roofing for all new commercial and residential buildings with low roof angles.

Vancouver's Building By-law (VBBL)

The [Vancouver Building By-Law](#) was introduced in 2019 is based on the [British Columbia Building Code 2018](#). The by-law includes specific provision for Vancouver that regulate design and construction of buildings include and includes the unique to Vancouver By-law provisions regulating the design and construction including requirements for energy conservation and greenhouse gas emission reduction.

Use green building rating and certification schemes to set minimum performance standards

Rating and certification schemes measure and grade a range of sustainability features, including energy. They are a good way to set standards and provide recognition for a building's energy performance.

There are many well regarded national and international green building rating and certification schemes, many of which are non-governmental. Cities can also develop their own schemes. Read [How to use reporting and disclosure to drive building energy efficiency](#) for more information about how cities can establish schemes.

Cities can require new buildings and major retrofits of existing buildings to achieve a certain certification level under a relevant local or international green building scheme.¹⁴ For example, many cities in the United States require a specified [LEED](#) certification level for new public buildings.

These schemes can be used in addition to, or as a replacement for, building energy codes. They can have a transformative impact on the local market. They are especially useful for cities with limited regulatory powers to issue their own building energy codes. The minimum required certification level can be strengthened over time to further improve building performance.

Cities can use these schemes as voluntary standards, or compliance can be required in order to qualify for financial or non-financial incentives. For example, in India many states and cities provide extra floor area ratio to developers for meeting a certain performance level under the [India Green Building Council rating scheme](#).

Singapore's Green Mark platinum level certification

In Singapore, the city government has committed to obtaining the highest (platinum) level certification under the local [Green Mark](#) scheme for new public buildings and existing public sector buildings undergoing major retrofitting.¹⁵ The commitment applies to buildings over a certain size of air-conditioned floor area. The city also provides financial incentives for all buildings rated gold or higher under the scheme.

Tokyo's Green Building programme

In Japan, the national building energy code is not strictly enforced. However, the Tokyo Metropolitan Government mandates compliance for priority buildings with its [Green Building](#) programme, which incorporates both energy efficiency and renewable energy.

It is important to note that energy is often just one of many performance measures under building rating and certification schemes. They also assess water efficiency, materials and resources, siting considerations, among other factors. Developers can make trade-offs as they earn points to meet the scheme's performance levels. This means that a building with a high certification level may not have high energy performance. Therefore, cities using building rating and certification schemes should consider combining it with other measures to ensure high-energy performance standards are met.

Incorporate zero carbon building requirements into affordable housing programmes

Cities that oversee affordable or low-income housing stock can incorporate zero carbon requirements for building developers, or for the managing bodies of affordable housing programmes.

To incorporate energy standards without affecting affordability, cities can promote a combination of pay-as-you-save low-tech energy efficiency options, and small-scale renewable energy measures. However, if energy bills are heavily subsidised, pay as you save options will be less financially attractive.



Mexico's Green Mortgage programme

Infonavit, Mexico's federally owned social housing institute and the primary provider of mortgages in the country, runs a Green Mortgage programme. The programme enables those seeking credit to buy, build, enlarge or remodel a house to finance energy- and water-efficient features and technologies. The increased mortgage cost is balanced by the estimated reduction in energy and water bills.¹⁶

An alternative approach is to target developers through a combination of requirements and incentives. For example, the ECOCASA programme in Mexico provides housing developers with attractive loans for building affordable homes that deliver at least 20% or 40% carbon emission reductions compared to a determined baseline. The programme is also trialing passive homes.¹⁷

Introduce requirements to monitor energy use post-construction

It is widely accepted that a gap exists between the estimated performance of a building at design stage and the actual building performance post-construction. There is growing concern that buildings currently could be using as much as two to ten times the amount of energy they were originally estimated to.¹⁸

To truly achieve net zero-carbon buildings cities need to have a better understanding of their actual operational energy performance – measured through Post Occupational Evaluation (POE). Measuring the energy performance of building when in use is a first step towards bridging the ‘performance gap’ between design theory and measured reality. This requires monitoring and reporting of the actual operational energy performance of buildings for a number of years after construction. Energy performance data collected also provides an evidence base which could help inform future industry-wide benchmarks or performance ratings.

London's 'Be Seen' framework

In London, developers and owners of new major developments are required monitor and report actual operational energy performance for five years after construction to comply with The New London Plan – a spatial development strategy for greater London developed in 2021. The 'Be seen' energy monitoring guidance requires the reporting of energy performance data as a scheme is planned, built out and in use. A monitoring portal has been developed to house all data submissions, which breaks up the process into three

reporting stages during which information needs to be submitted – planning stage, as-built start and in-use English stage. The responsibility for providing the data at each reporting stage lies with the legal owner of the development at that reporting stage.

More information, case studies and examples of the policies discussed in this article can be found in:

- [Accelerating Building Efficiency: Eight Actions for Urban Leaders.](#)
- [Urban Efficiency: A Global Survey of Building Energy Efficiency Policies in Cities.](#)
- [Urban Efficiency II - Seven Innovative City Programmes for Existing Building Energy Efficiency.](#)
- [Building Energy Efficiency Policies Database.](#)



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