

# Energy Efficiency in China's Buildings Sector

Policy opportunities



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# Aim of the report

This report outlines opportunities for actions, targets and timelines that could improve energy efficiency in the buildings sector of the People's Republic of China, hereafter referred to as China. It includes an analysis of the country's current buildings energy efficiency policies and the data which tracks progress in achieving them.

The opportunities to improve energy performance, lower levels of embodied carbon, reduce fuel costs and improve thermal comfort fall into the following broad categories:

Promote the ongoing development of retrofit standards and policy frameworks that drive energy performance in existing buildings

Build a policy package that encourages energy efficiency through regulation, information and incentives

Facilitate financial mechanisms that will incentivise energy efficiency upgrades in buildings

Develop policies that support the ability of buildings to interact with power grids and benefit from digital tools and techniques.

While considering the policy opportunities presented in this report, it is important to keep in mind several overarching principles:

**Adaptability:** the suggestions in this report are based on a review of international best practice as well as workshops and discussions with China's buildings expert community. China's government, with its decades of experience and in-depth knowledge of the differing local contexts across the country, has an opportunity to develop and drive an effective implementation plan.

**Holistic approach:** globally and in China, the buildings sector is complex and fragmented. This report suggests that an integrated approach, taking into account broad socio-economic considerations, will yield stronger results.

**Strategic planning:** proposed actions outlined in this report are likely to have a higher impact if they are integrated into existing policy processes and strategic plans.

**Multi-stakeholder collaboration:** effective communication channels and co-ordination mechanisms between national, subnational and local governments, along with the involvement of various other stakeholder groups, are important for the effective implementation of this report's suggested policy actions.

# 1. Overview of energy efficiency in China's buildings sector

In 2023, nearly 200 governments meeting at COP28 in Dubai committed to work together to collectively double the global annual average rate of energy efficiency improvements and to triple the world's installed renewable energy generation capacity by 2030 as part of an orderly transition away from fossil fuels. While progress on renewables is close to being on track, efficiency progress, measured through primary energy intensity, is still far from the 4% needed to achieve the doubling goal. Although global primary energy intensity is estimated to have improved by [about 1.8% in 2025](#), up from just over 1% in 2024, governments still need to take strong policy action to meet global energy efficiency commitments and capture the multiple benefits of energy efficiency.

Energy-efficiency measures [deliver a wide range](#) of benefits beyond simply reducing energy consumption: they lower household energy bills, particularly helping lower-income households; enhance industrial competitiveness by reducing costs and boosting productivity; cut grid investment and generation costs by avoiding additional infrastructure; improve energy security by reducing reliance on imported fossil fuels and mitigating peak-demand risks; reduce carbon- and air-pollution emissions, thereby improving human health; support job creation across multiple sectors; raise property values; and underpin broader economic growth. End-use electrification, digitalisation and decarbonisation in buildings are important means through which to increase [energy efficiency](#).

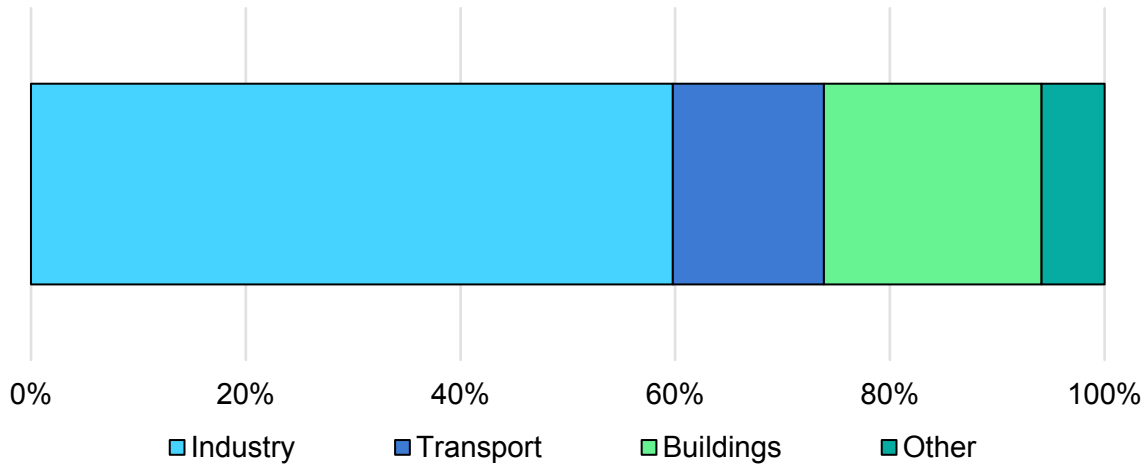
In the past two decades, China has made significant strides in energy efficiency. According to [IEA analysis](#), between 2010 and 2019, China achieved an average annual reduction in primary energy intensity of just under 4%. This rate was nearly double the global average for the period of around 2%. Between 2020 and 2025,<sup>1</sup> China's average annual reduction in primary energy intensity stood at an estimated 2.4%, reflecting the impacts of the Covid-19 health pandemic and the associated economic recovery. To date, much of China's improvement has come from [energy efficiency upgrades](#) in industry and overall economic structural shifts. Though improvements in the buildings sector have occurred at a slower rate, there has been an increase in the provision of energy services across households. As this report demonstrates, there is potential for further energy savings through technical efficiency initiatives in buildings, which could significantly contribute to

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<sup>1</sup> IEA (2025), [World Energy Balances](#) for 2020-2023 values; IEA (2025), [World Energy Outlook](#), for 2024 value; IEA (2025) [Energy Efficiency](#) for 2025 value (estimate).

China's dual goals of peaking carbon emissions before 2030 and achieving net zero emissions before 2060, while also delivering broad socio-economic benefits.

### Total final energy consumption by end use in China, 2024



IEA. CC BY 4.0.

Source: IEA (2025), [World Energy Outlook](#).

According to IEA estimates, China's buildings sector accounts for approximately 20% of its total final energy consumption, just under 23 000 petajoules (PJ). Between 2010 and 2023, energy demand in the sector grew at an average rate of almost 3% per annum. Demographic and societal shifts have played a major role in shaping the energy demand of buildings and continue to influence the efficiency policies pertaining to buildings. In 1980, roughly 80% of China's population lived in rural areas, residing in work unit-owned apartments and relying on biomass or coal for cooking and heating. A construction boom in urban areas after 2000 led to urban residential floor space [doubling](#) by 2015. The level of urbanisation grew from 37.7% in 2001 to 66.2% in 2023.<sup>2</sup> This transformation has accelerated the need to address energy efficiency in residential urban environments.

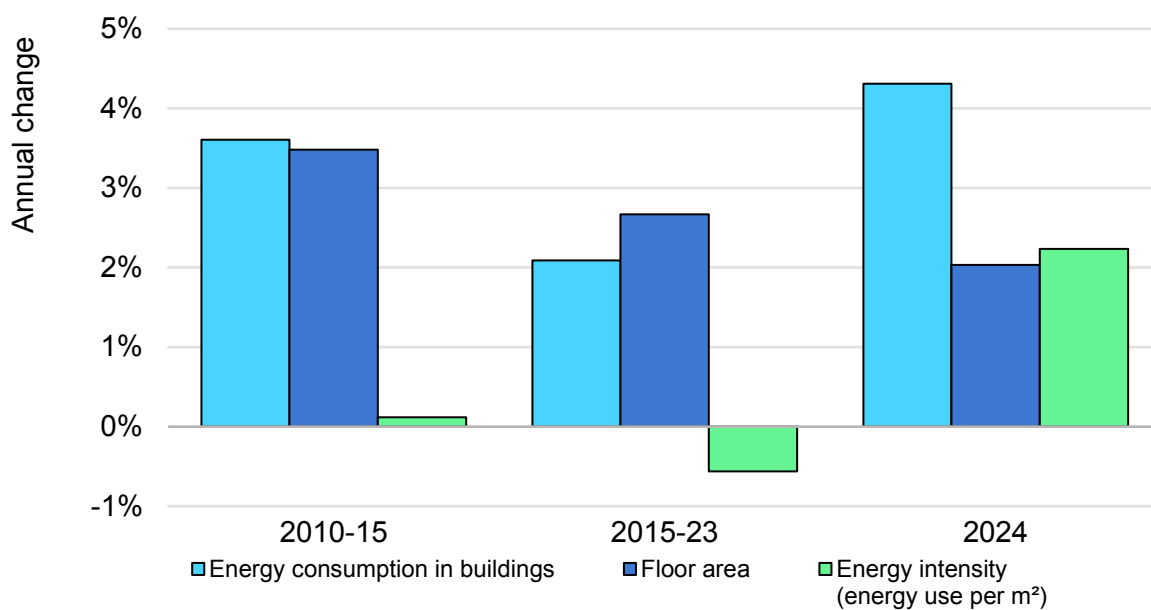
## Stable long-term improvements in energy intensity impacted by growing electricity demand for cooling

IEA data suggests a slowing rate of construction in China over the past decade. The annual increase in floor area averaged 3.5% between 2010 and 2015 and dropped to 2% by 2024. While there has been a slowdown in the rate of *growth* in construction, new floor area is still being built in high volumes. Energy consumption in the buildings sector saw mixed growth rates over the same period. From 2010 to

<sup>2</sup> 中国建筑节能年度发展研究报告 2025, 清华大学建筑节能研究中心 (China Energy Conservation Annual Report, Tsinghua Building Energy Research Centre).

2015, it grew at a rate of 3.6%, similar to that of floor area, meaning that energy intensity (energy usage per square metre per year [kWh/m<sup>2</sup>/year]) remained stable. From 2015 to 2023, the rate of energy consumption growth slowed to just over 2% per annum, resulting in an average sustained improvement in energy intensity of just over 0.5%. However, in 2024, a spike in energy consumption to over 4%, likely due to [increased cooling-related energy demand](#), with record-breaking temperatures as a contributing factor, resulted in greater energy use per square metre of floor space (shown as a deceleration of the rate of energy intensity improvement in the figure). [Weather effects](#) have impacted energy consumption patterns globally; in 2024, extreme weather contributed [0.3 percentage points](#) to the overall 2.2% growth in global energy demand. In addition, the increase in total building energy consumption in 2024 in China was driven by the electrification of heating in some regions and the growth in electric vehicle (EV) charging demand, some of which cannot be clearly separated from building energy consumption statistics.

**Annual average change in energy consumption, floor area and energy intensity in China's buildings sector, 2010-2024**



IEA. CC BY 4.0.

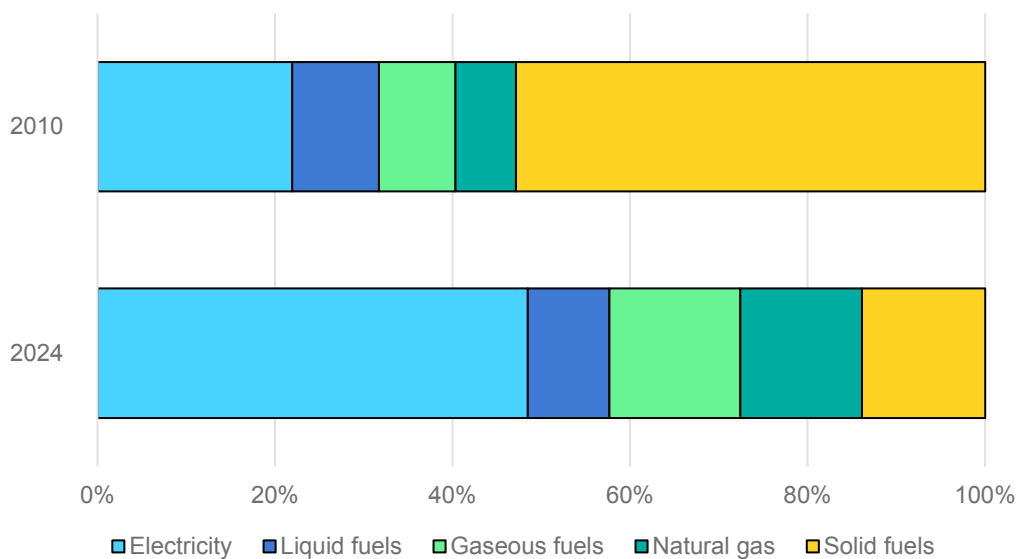
Source: IEA (2025), [World Energy Outlook](#).

These trends reflect several developments in China's buildings sector. First, rising energy consumption is a corollary of improved energy services in homes and businesses, including greater access to appliances, clean cooking, heating and cooling. Meeting energy efficiency goals in the context of increasing living standards is essential. Second, longer-term trends from 2015 to 2023 suggest that China is moving towards greater decoupling of floor-area growth and energy-consumption growth. Third, as the expansion of floor area slows, further reductions in energy intensity will increasingly depend on retrofitting existing buildings.

## A world leader in building electrification

Electrification of the buildings sector, particularly with the replacement of traditional coal heating with heat pumps, is a major driver of energy efficiency progress and a key step towards [decarbonising the energy system](#). China's buildings sector has maintained a strong increase in its electrification rate. In 2024, electricity accounted for 47% of energy consumption in buildings, up from 22% in 2010. The electrification rate in China's buildings sector over this period was around five times the global average. Gas use also saw a small increase of more than 6% over the same period.

Energy consumption in buildings by fuel share in China, 2010 and 2024



IEA. CC BY 4.0.

Source: IEA (2025), [World Energy Outlook](#).

The share of solid fuels in the total amount of energy consumed in buildings across the country dropped from 52% in 2010 to 13% in 2024. This significant decrease in the use of coal in buildings is good news for emissions and pollution reduction efforts in China. While building electrification increases overall electricity demand, in practice, the decarbonisation of the grid and end use is occurring in parallel, contributing collectively to the development of a long-term green energy system. If countries wait for power generation to be fully decarbonised before electrifying and decarbonising the buildings sector, they risk falling short of [their carbon goals](#).

## China's buildings policy framework

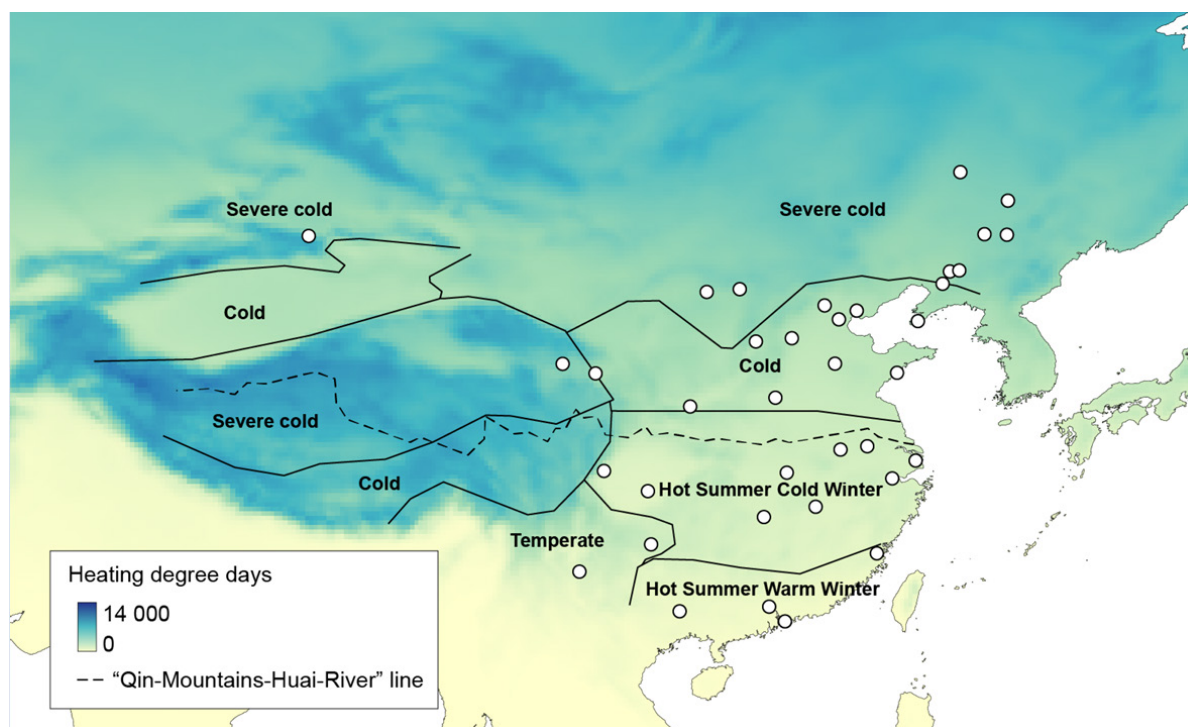
Though China has decades of experience in implementing energy efficiency policies for buildings, a key milestone was reached when they were enshrined in the [2007 revision of the Energy Conservation Law](#) and reinforced through successive work plans in the 11<sup>th</sup> through 13<sup>th</sup> Five-Year Plans (FYP), spanning 2006 to 2020. These plans include specific targets for energy use per square metre of floor area as well as strategic guidance to policy makers across the country by identifying tangible goals. The following is a selection of key measures that China has taken to improve the energy efficiency of buildings.

### Building codes

China's first residential building codes were established in 1986. They initially focused on residential buildings connected to district heat in the northern cold and severe cold regions and were eventually expanded to all climatic regions (including the hot-summer cold-winter central region and the hot-summer warm-winter southern region). Mandatory building energy codes were introduced nationally in 2005 for all building types (including commercial and public), with thermal insulation standards and performance-based design requirements. These promoted resource efficiency and integrated principles such as passive solar design, energy-saving equipment and sustainable construction materials. The efficiency improvements seen in China's building sector over the past decade are, in large part, thanks to these codes and the subsequent construction of new, highly efficient buildings.

The [latest code \(GB 55015-2021\)](#) was disseminated in 2022. Compared with previous codes, it puts more emphasis on post-construction building operational management (not only the materials and construction process), requires more comprehensive measurement as well as disclosure of energy consumption and carbon emissions, and increases ambition for energy savings through energy efficiency.

### Map of Chinese climate zones, heating degree days and distribution of selected Chinese cities with more than 1 million inhabitants



Notes: Heating degree days are derived from the [IEA Weather for Energy Tracker](#), calculated with base temperature 20°C. Source: IEA (2024), [The Future of Heat Pumps in China](#) and Ministry of Housing and Urban-Rural Development China (2016).

### Shenzhen model of low-carbon city

Shenzhen has become one of China's most advanced cities in establishing regulations that support [system-wide energy efficiency improvements and decarbonisation](#). The [government work report from 2025](#) announced that in 2024, 179 residential districts were retrofitted and 157 smart grid upgrade projects were carried out in urban villages. The city has also replaced the entirety of its public bus and taxi fleets with new energy vehicles. These results have been driven by comprehensive policy over the past fifteen years.

In 2010, Shenzhen was one of eight Chinese cities chosen for a pilot programme to develop ["low carbon provinces and cities"](#). It was also a pilot city for an emissions trading [scheme in 2013](#), ahead of the national rollout in 2021. In 2023, it was [the first city in China](#) to announce a city-level goal of controls on both energy efficiency and overall consumption. It aims to increase energy efficiency by 14.5% in 2025 compared with 2020, and reach a carbon peak before 2030, exceeding the national target of 13.5%, as outlined in the [14<sup>th</sup> Five-Year Plan](#).

## Implementation and enforcement

An energy savings review system is in place to evaluate both carbon output and energy consumption. Additionally, Shenzhen has developed green financing mechanisms to support the plan, including a city-level emissions trading scheme and [“green government bonds”](#).

The Shenzhen model has had significant early success in establishing a low-carbon and energy efficiency economic ecosystem. Yet, it is important to note the specific characteristics of the city that have been conducive to this; its economy has a low proportion of carbon-intensive heavy industry, its infrastructure is relatively modern and it has access to nuclear energy sources.

## Retrofitting

Early progress in improving China's existing stock of buildings revolved around efforts to replace ageing heating systems. District heating systems, widely established in the 1980s and 1990s across China's colder northern provinces, were often coal-based and lacked adequate payment systems to incentivise efficient energy use. Poor insulation in many buildings also led to significant heat loss. In 2008, China launched a pilot programme aimed at improving heat efficiency in older northern buildings, particularly those in urban areas constructed before 2000. This was later expanded under the 11<sup>th</sup> FYP in 2011. [By the end of 2015](#), 990 million square metres of existing residential buildings in China's northern heating regions had undergone heat metering and energy-efficiency retrofits. [These efforts](#) have significantly improved comfort levels in ageing buildings and saved approximately 0.2 exajoules annually (roughly equivalent to the total energy demand of Mongolia).

The 13<sup>th</sup> FYP period (2016-2020) saw China complete 514 million square metres of energy-efficiency retrofits in residential buildings, with 185 million square metres completed in commercial and public buildings. More recently, the [14<sup>th</sup> Five-Year Plan for Building Energy Conservation and Green Buildings](#) (March 2022) set a national retrofit target of over 350 million square metres by 2025. [The Work Plan on Building Sector Efficiency and Decarbonisation](#) (March 2024) mandates green standards for all new urban buildings, with the goal of increasing energy retrofits and decarbonised buildings. In August, China's Central Committee and State Council released guidelines on developing [a “high-quality urban environment,”](#) underlining that the focus of policy in the next ten years should be on improving the quality of the built environment rather than expanding it.

### **Taiyuan city large-scale building retrofit finance programme**

[Taiyuan's retrofit programme](#) demonstrates how structured risk-sharing, private capital mobilisation and community engagement can transform ageing housing stock at scale. The programme targeted multi-family apartment buildings built between 1966 and 2006. By the end of 2023, 2 337 buildings across 652 communities had been retrofitted, benefiting 180 000 residents.

Upgrades included wall and roof insulation, waterproofing, basement insulation, and window and door replacement. [Government](#) sources reported strong results:

- Winter indoor temperatures increased by 3-5°C
- Summer indoor temperatures decreased by 2-3°C
- Energy consumption was reduced by 50%
- 193 600 tonnes of coal equivalent emissions were abated
- RMB 100 million ([~USD 13.9 million](#)) was made in cost savings

Residents also reported sharply lower electricity bills (in some cases down two-thirds), improved comfort and noise insulation, rising rental demand and revitalised neighbourhood commerce.

### **Innovative public-private partnership structure**

The project was led by China Railway 17<sup>th</sup> Bureau Group (RBG17) and private investor Far East Horizon, who formed a Special Purpose Vehicle (SPV) to manage financing, construction and operations.

The SPV model mobilised RMB 2.326 billion ([~USD 323 million](#)) in private capital. Risk was shared between public and private partners, with construction and performance risks allocated to the SPV. Over 30 community representatives supported outreach and feedback integration, which improved transparency and trust amongst residents.

## **Building labels and certificates**

The [Building Energy Efficiency Label](#) (equivalent to what is often called Energy Performance Certificate or EPC) launched in 2008, is a key mechanism in China that provides information on energy usage in buildings. The label is mandatory for large new public buildings over 20 000 square metres, as well as for public buildings applying for energy-efficiency retrofit subsidies. In some regions, it has also been piloted for residential buildings. The system includes both a design-stage label, based on planned performance, and an operational-stage label, which reflects actual energy use. Labels must be publicly displayed within the building and are often required in official procurement documents.

Complementing this, the Green Building Evaluation Label (GBEL), also known as the China Three-Star Rating System, was introduced in 2006 and serves as the national Green Building Certification scheme. It assesses buildings across a broad range of sustainability criteria and applies to both residential and public buildings. It is frequently required for government-sponsored projects. In 2021, the Ministry of Housing and Urban-Rural Development published the [“Management Measures for Green Building Labels”](#), formalising the national procedures for awarding, issuing and managing the green building label.

### Key government targets for building energy conservation and green building development during the 14<sup>th</sup> Five-Year Plan period (2021-2025)

Main indicator	2025 target
Area of energy-saving retrofits in existing buildings	350 million m <sup>2</sup>
Area of ultra-low-energy and near-zero-energy buildings constructed	50 million m <sup>2</sup>
Share of prefabricated buildings in new urban construction	30%
Newly added solar PV installed capacity on buildings	50 million KW
Newly added geothermal energy application area in buildings	100 million m <sup>2</sup>
Renewable energy substitution rate in urban buildings	8%
Share of electricity consumption in total building energy use	55%

### Appliances and equipment

China has one of the world's most comprehensive energy efficiency policy packages for household appliances, which has contributed to building efficiency. It brings together multiple measures to promote energy efficiency across the sector and guide consumers towards purchasing the most efficient appliances available on the market. Minimum energy performance standards (MEPS) prohibit the sale of appliances that fail to meet a minimum efficiency threshold, and the [China Energy Label \(CEL\)](#) informs consumers of appliance energy efficiency and enables easy comparisons between different models. The MEPS and CEL cover more than [40 appliances](#) and industrial components.

China was the first country in the world to introduce a QR code and an app for consumers in its labelling system that provides details on product use, repair and replacement options, recycling, annual energy consumption and relevant government policies. The China National Institute of Standardisation (CNIS) estimates the programme saves [180 TWh of electricity per year](#), or around 20% of China's total appliance energy [consumption in 2020](#). By the end of 2024,

approximately 26 000 manufacturers and 3.56 million product models were registered in the [product registry database](#).

## Electrification

China's substantial progress in building electrification has been spurred by ambitious national goals. The current FYP set a target for a 55% share of electricity in the total energy consumption mix of the building sector by 2025, and the [Carbon Peaking and Neutrality Blueprint for Urbanisation and Rural Development \(July 2022\)](#) sets a 2030 target for 65%. In 2025, China also released the [Heat Pump Action Plan](#) that promotes the use of heat pumps in the buildings sector, providing more options for efficient, electric heating.

## Financial incentives

China has launched several major retrofit schemes focusing on both energy efficiency upgrades and broader urban renewal. At the national level, the [Subsidy Fund for Affordable Housing Projects in Urban Areas](#), established in 2014, supports energy conservation renovations of older residential buildings, especially in the northern heating region. By 2022, it had attracted around RMB 30 billion in central government funds.

Simultaneously, the [Subsidy Fund for Energy Conservation and Carbon Emissions Reduction](#), set up in 2015, provides financial assistance to projects that reduce energy use and emissions. More recently, [the Peak Carbon Construction Pilot Scheme \(November 2023\)](#) designates select cities (as well as industrial parks) to explore methods of green development, including through the retrofit of energy systems and green construction, with a focus on refining finance mechanisms. In 2024, the Ministry of Housing and Urban-Rural Development issued the [Implementation Plan for Promoting Equipment Renewal in Construction and Municipal Infrastructure](#), aiming to upgrade heating equipment. It focused on the replacement of outdated coal-fired boilers with heat pumps. It also requires that old heat pumps ( $\geq 10$  years) be assessed for replacement, with financial support provided through channels such as central budget investments.

### **Qingdao city's green insurance for energy-efficient buildings**

Qingdao's [green insurance mechanism](#) is an example of an innovative risk-sharing tool to finance green building projects in China. The mechanism is part of the larger [Qingdao Green Building Implementation](#) plan. By enabling early access to low-interest green loans and reducing performance risk through insurance-backed guarantees, the mechanism has increased financing options while also accelerating project timelines.

The flagship case saw China Pacific Insurance Company (CPIC) and China Industrial Bank (CIB) issue an RMB 80 million ([~USD 11 million](#)) green loan to Hetou Construction Co (HCC) for its zero-carbon factory in the Sino-German Eco Park. The insurance product linked loan issuance to performance outcomes and provided multiple layers of support.

Overall, the Qingdao city's green insurance innovations have leveraged RMB 13.2 billion ([~ USD 1.86 billion](#)) in loans to help enterprises finance green building projects. In doing so, it demonstrated the replicability and scalability of green insurance as an effective risk-sharing tool to provide financial security for green loans.

## 2. International trends in the energy efficiency of buildings

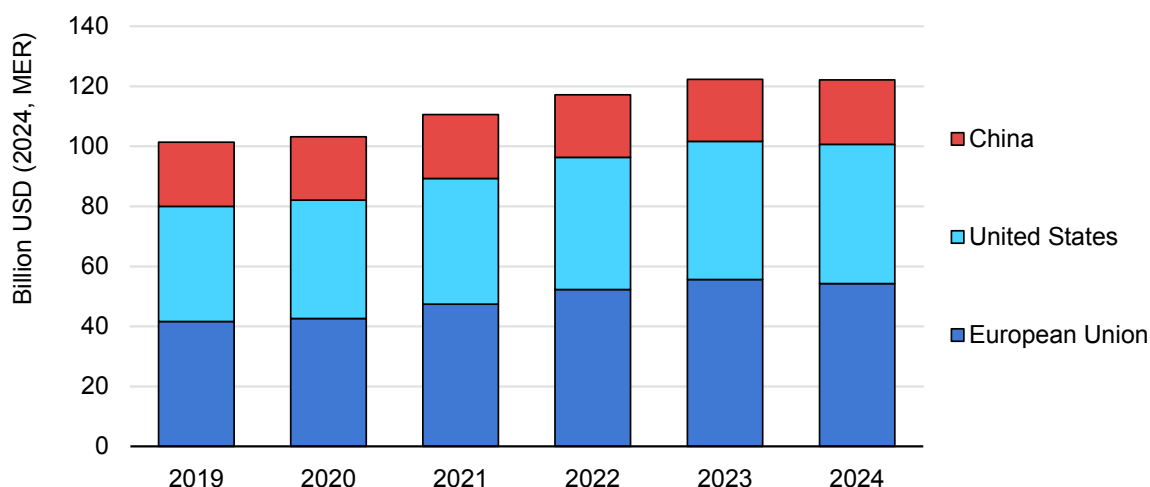
The global buildings sector stands at a critical juncture in the fight against climate change, [accounting for](#) 30% of global final energy consumption and 26% of energy-related emissions. This section examines global trends in building energy efficiency and the evolving policy landscape that will shape the sector's trajectory towards net zero emissions.

The [IEA Energy Efficiency Market Report](#) states that global energy efficiency progress is set to improve by 1.8% in 2025, up from around 1% in 2024. Preliminary estimates indicate that several key regions are showing some signs of stronger progress compared to their average since 2019. For example, energy intensity progress in 2025 is estimated to be over 3% in China and over 4% in India, well above their averages between 2019 and 2024. In the United States and the European Union (EU), on the other hand, progress in 2025 is set to fall to under 1% after several years of stronger performance following the energy crisis in 2022, when energy prices surged in some parts of the world following Russia's full-scale invasion of Ukraine. Accelerating energy efficiency improvements could deliver around one-third of all energy-related CO<sub>2</sub>-emission reductions between now and 2030, the largest share of any sector or technology, in a pathway aligned with the COP28 target of doubling energy efficiency improvements.

Globally, energy consumption in the buildings sector increased by around 0.7% per year between 2015 and 2024. Growth in the demand for energy services, particularly space heating, space cooling and appliances, outpaced efficiency improvements, electrification and reductions in the traditional use of biomass. Over the same period, global energy intensity in buildings remained broadly unchanged, at just over 130 kWh/m<sup>2</sup>/year.

Many countries have ramped up policy action. Most of the new or updated efficiency-related policies in 2025 were in the buildings sector, and half of these were incentives, including grants, low-interest loans and targeted support for low-income and vulnerable households. Since 2019, combined spending on building retrofits and envelopes in China, the United States and the European Union has increased by over 20% to around USD 120 billion in 2024. Regulatory instruments, such as building energy codes, have also been reinforced in some countries, with several governments also strengthening standards and labelling schemes for household appliances such as air conditioners and refrigerators.

### Estimated spending on building retrofits and envelopes in China, the United States and the European Union, 2019-2024



IEA. CC BY 4.0.

Notes: An energy efficiency investment is defined as the incremental spending on new energy-efficient equipment or the cost of refurbishments that reduce energy use (excluding labour). The intention is to capture additional spending compared to the reference technology and which leads to reduced energy consumption. MER = market exchange rate.

Source: IEA (2025), [World Energy Investment](#).

## Regional variations and market dynamics

Energy demand trends vary significantly between advanced economies and emerging markets. Advanced economies are expected to see energy demand stabilise until 2030, followed by a gradual decline, while emerging markets anticipate continued growth driven by rising incomes, population expansion and urbanisation. This divergence presents both challenges and opportunities for global energy efficiency efforts.

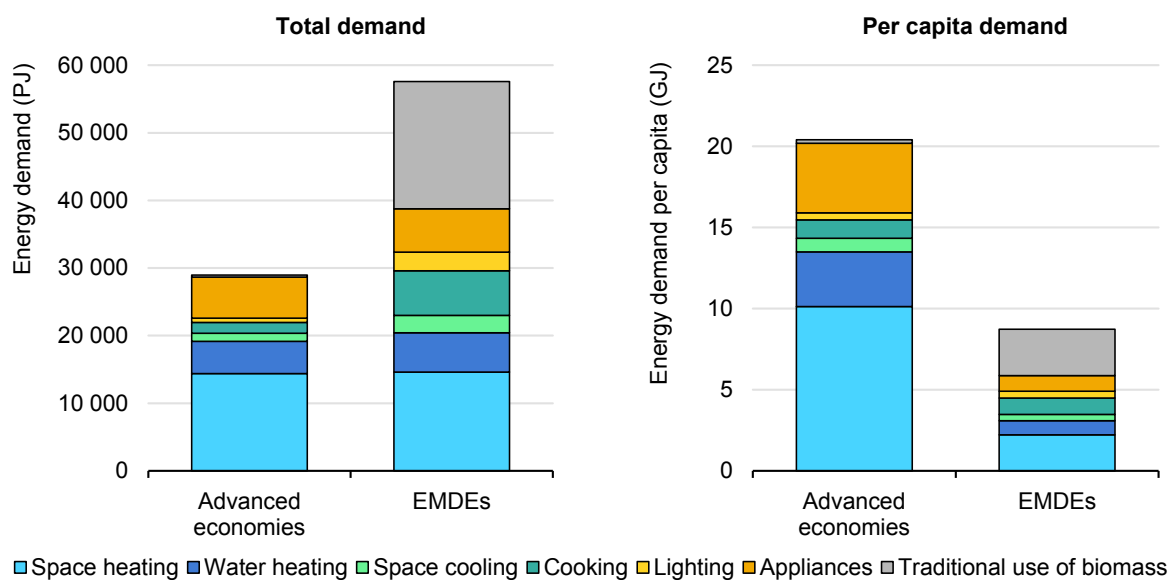
In 2024, [global electricity consumption](#) in buildings increased by more than 600 TWh (5%), accounting for nearly 60% of total growth in electricity consumption. Key drivers included rising demand for air conditioning (see below), which was bolstered by severe heatwaves in countries such as China and India, and demand for power from new data centres.

The increasing global air conditioning (AC) stock in recent years [is estimated](#) to have made up about 18% of the total electricity demand growth in the buildings sector and 8% of the total electricity demand. Residential AC stock in China has been growing annually by around 6% on average since 2019. Currently, it is estimated that 80% of households in China are equipped with an AC unit. For reference, it is estimated that above 90% of households in Japan and the United States have an AC unit, and around 20-25% of households in the European Union and India have one.

The residential sector makes up about 70% of global energy demand in buildings, while commercial and public buildings account for the remaining 30%. Around two-thirds of global residential energy demand is in emerging markets and developing economies (EMDEs), and around one-third in advanced economies. In advanced economies, most energy in homes is used for space and water heating, together accounting for about 70%. This is followed by the use of electrical appliances, such as refrigerators, televisions and washing machines, with households owning up to [40 different appliances](#).

In EMDEs, per capita space and water heating energy use is less than one-fourth that of advanced economies, due to a large share of the population living in warmer climates and lower access to affordable energy services. Growing populations, rising incomes and [hotter summers](#) are increasing the total residential energy demand in EMDEs, particularly for space cooling.

**Energy demand in the residential sector by end use in advanced and EMDEs, 2023**



Note: EMDEs = Emerging Markets and Developing Economies.

Source: IEA (2025) [Energy Efficiency Market Report](#).

## International policy priorities

### Building modern energy codes

Progressing towards a zero-carbon building stock requires that both new and existing building energy codes embed comprehensive and forward-looking requirements. Modern codes should ensure high levels of efficiency, maintain thermal comfort, integrate smart and demand-response features, and expand progressively to cover life cycle impacts such as embodied carbon.

Recent [IEA findings](#) indicate that while many countries have mandatory codes in place, effective implementation remains a key challenge. Globally, as of mid-2025, there were 95 mandatory building energy codes or standards for residential buildings and 97 for non-residential buildings. Yet around half of all countries worldwide do not have mandatory requirements in place for energy efficiency in buildings. As a result, 2.6 billion square metres of floor space were built in 2023 that were not mandated to meet energy performance requirements.

Eight governments implemented new or updated building energy codes in 2025. For example, Japan's updated [Building Standards Act](#) mandates compliance with higher insulation and energy standards for all new homes and small buildings. Meanwhile, India's [Energy Conservation and Sustainable Building Code 2024](#) has been updated with stronger efficiency requirements for commercial buildings. And in Singapore, the 2025 [Mandatory Energy Improvement Regime](#) targets existing large buildings. When cooling-energy use intensity is in the worst-performing quartile of its peers, the owner must do an audit and implement improvements.

The importance of cooling is also being reflected in the development of new building codes. In 2025, over 60 building energy codes globally had some sort of mandatory requirements for space cooling in residential buildings. Yet, in many countries that are facing rapidly rising cooling demand, passive cooling requirements in building energy codes are lacking or remain insufficiently robust, with weak or absent provisions to address heat avoidance. Several countries are taking steps to address this. For instance, Pakistan's [Energy Conservation Building Code](#) sets mandatory U-values (thermal transmittance) for roofs, walls and glazing and Ghana's [Sustainable Cooling for All Roadmap](#) calls for passive-design provisions in its building code.

## Energy performance certificates: The EU model

The European Union has established itself as a global leader in building energy performance certification, with the revised [Energy Performance of Buildings Directive \(EPBD\)](#) entering into force in May 2024. The EPBD mandates that all new public buildings must meet zero-emission standards by 2028, and that all new buildings must do so by 2030. The directive introduces minimum energy performance standards for both residential and non-residential buildings, requiring renovation of the 16% worst-performing non-residential buildings by 2030 and 26% by 2033.

Originally introduced in the EU in 2002, [energy performance certificates \(EPCs\)](#) are now mandatory for all buildings across the bloc. The revision of the EPBD in 2024 introduces a unified energy rating scale for all Member states, making it easier to compare buildings across borders. The certificate scheme plays a key

role in helping decision makers understand how energy-efficient buildings are, while also encouraging a shift in the real estate market towards greener buildings.

The EPC system employs a standardised rating scale, typically from A to G, to indicate a building's energy efficiency, with 'A' representing the most efficient and 'G' the least. The Irish EPC, [for example](#), includes ratings for both energy intensity (kWh/m<sup>2</sup>/yr) and CO<sub>2</sub> emissions (kgCO<sub>2</sub>/m<sup>2</sup>/yr). The implementation of EPCs has led to increased awareness among property owners and tenants regarding energy consumption, prompting investments in energy-saving measures. The 2024 update to the EPBD also introduces other tools to provide further information on a building's future energy performance potential. They include:

- [Building Renovation Passport](#): a document – in electronic or paper format – outlining a long-term (up to 15-20 years) step-by-step renovation roadmap to achieve deep renovation for a specific building. EU Member states must ensure the availability of this instrument.
- [Smart Readiness Indicator](#): an index measuring a building's ability to sense, interpret, communicate and actively respond to changing conditions in relation to the operation of systems, the external environment (including energy grids) and the needs of building users.

However, the EU's EPC scheme faces several implementation challenges. One of these is that EU countries have [very different](#) types of buildings and energy policies, making it difficult to create common standards. In addition, EPCs are often [underused](#) and are not always applied in a way that incentivises the most efficient choice.

## Attracting private investment to renovate inefficient buildings

Households and the private sector finance over [90%](#) of energy-efficiency related investment in buildings, whereas public spending accounts for just a small proportion. While public funds are important, the costs of renovating all inefficient buildings extend far beyond what public programmes alone can address. In 2024 and 2025, there were [some signs of a decline in public budgets](#) for retrofit programmes, after a decade of expansion, highlighting the need for private capital if investment levels are to continue rising. Governments have announced or updated various market-based instruments to attract private capital for retrofitting in 2025, such as energy supplier obligations and auctions.

In response to the revised [EU Energy Efficiency Directive](#), several EU countries have updated or implemented energy efficiency obligation schemes in recent years. For example, Spain introduced an energy supplier obligation scheme at the end of 2023. In 2024, the scheme generated around [1 900 GWh](#) in energy savings, equivalent to the annual electricity use of over half a million households. Between

January and September 2025 alone, it generated nearly [3 000 GWh](#) of savings. Hungary also updated its [energy efficiency obligation scheme](#) in 2025, including higher targets between 2025 and 2030, to align with the updated EU legislation.

Financial institutions are increasingly offering green mortgages that provide preferential interest rates for energy-efficient homes, though market growth depends on establishing clear regulatory frameworks and standardised criteria. Energy service companies (ESCOs) represent a mature model for private investment, using energy performance contracts to deliver comprehensive retrofits with guaranteed energy savings. The [global ESCO market is growing](#) and is estimated to have invested around USD 15 billion in 2025, with China's ESCO market being around USD 2.3 billion.

### **Germany's BEG-KfW model: a success in mobilising private capital for building retrofits**

Germany's [Federal Funding for Efficient Buildings \(BEG\)](#) channels grants and concessional loans via KfW (Development Bank), the state development bank. Core residential products (e.g., [KfW 261](#)) combine low-interest loans with repayment subsidies tied to verified efficiency levels, delivered through borrowers' regular banks (the Hausbank principle). This blend shortens payback, smooths cash flow and keeps private lenders actively involved.

In 2023, [BEG supported about 286 000 projects](#). Beneficiaries (households, firms, municipalities) invested EUR 31 billion ([USD ~33.6 billion](#)), while federal funds totalled EUR 7.6 billion ([USD ~8.3 billions](#)). Roughly 95% of cases were individual measures (BEG EM) such as insulation, windows and heating systems' replacements – showing that most activity (and co-investment) currently concentrates on measure-by-measure upgrades rather than whole-building deep retrofits.

These results demonstrate a leverage of approximately 4:1 – i.e., each public euro catalysed around four euros of beneficiary investment in 2023 –, strong evidence that the BEG-KfW approach mobilises private capital at scale, even in a higher-interest environment.

[Independent evaluators](#) determine whether the scheme meets or exceeds annual climate-impact targets, while noting the need to simplify administration and lift the share of deep, whole-building renovations to align with long-term stock decarbonisation goals.

## **Affordability, health and comfort benefits**

Energy efficiency improvements deliver [significant co-benefits](#) beyond carbon reduction, particularly for vulnerable populations. Efficient building design can help

balance airtightness, targeted ventilation and humidity to shape indoor exposures. Sealing unintended leakage reduces [dampness-related problems](#), such as mould and dust-mite growth, and pollutants which cause respiratory and allergy symptoms, while designed ventilation (mechanical or natural) supplies fresh air and removes humidity, CO<sub>2</sub> and indoor pollutants. Controlling humidity in tropical and temperate climates (keeping relative humidity roughly in a mid-range rather than very high) not only reduces mould and mite proliferation. It also reduces viral and bacterial survival on surfaces and in aerosols.

Energy efficiency measures keep homes warmer in winter and cooler in summer, providing safer and healthier living conditions as the climate continues to change. For example, in 2023 nearly 50% of the lowest-income households in [Canada](#) relied on inefficient heating, and approximately 14% of all Canadian households faced challenges maintaining safe indoor temperatures due to increasing energy costs. Supporting technologies such as [heat pumps](#) and thermal insulation can also have positive benefits for health and wellbeing.

Passive cooling measures are often low-cost and deliver significant improvements in indoor comfort, concurrently reducing heat-related health risks. This is particularly important for low-income and vulnerable populations who may lack access to mechanical air conditioning. Programmes such as [Brazil's "Beat the Heat in Cities"](#) actively support cool roofs, shading and nature-based solutions, targeting communities in the hottest areas to reduce heat-stress mortality. Moving to sustainable heating, cooling and air filtration solutions supports health and safety while greatly improving quality of life and affordability.

### **Singapore: Integrating healthy indoor environments into building design**

In Singapore, the Building and Construction Authority's Green Mark and Super Low Energy (SLE) [frameworks](#) embed both humidity control and airtightness into building practice, helping to create healthier indoor environments. The [Green Mark](#) incorporates requirements for air leakage limits, outdoor air supply and filtration, while encouraging designs that limit moisture ingress. The SLE takes this further by driving deeper reductions in cooling demand through high-performance envelopes, efficient HVAC systems and comprehensive humidity management.

[Several buildings](#) in Singapore have obtained the SLE certification by implementing a mixture of passive and active measures along with smart energy management systems that monitor healthy indoor environments. These programmes demonstrate that in a tropical climate, airtight and energy-efficient construction are compatible with health outcomes, provided building design integrates mechanical or hybrid ventilation and careful humidity control.

## The role of buildings in grid integration and digitalisation

[Grid-interactive buildings](#) are emerging as critical infrastructure for supporting renewable energy integration and grid stability. Buildings can help promote grid stability by becoming energy generators and intelligently controlling loads to unlock demand-side flexibility. The transition from unidirectional energy delivery to bi-directional flow leverages the growth of on-site generation behind the meter, while accelerating digitalisation of buildings helps increase efficiency, cut costs, mitigate climate change, strengthen resilience and improve occupant wellbeing.

Countries are also investing in digital optimisation (using advanced sensors and controls, communication, fault detection and automation) to enable smarter co-ordination of equipment and continuous adjustment for efficiency improvements. Digital optimisation can typically deliver energy savings between [5% and 40%](#), and can boost the impacts of physical upgrades, although the savings vary depending on technologies applied and specific energy-use characteristics of each building. Several governments have implemented policies in recent years to enable advanced building optimisation and automation, and to promote the use of smarter sensors and control systems.

### Selected policies promoting digital optimisation in commercial buildings

Country/region	Policy
European Union	The <a href="#">2024 Energy Performance of Buildings Directive</a> mandates non-residential buildings to have building automation and control systems installed that can detect opportunities for efficiency improvements.
Singapore	The <a href="#">2024 Mandatory Energy Improvement Regime</a> expands on the <a href="#">Building Energy Code</a> to promote smart building solutions, such as automated sensors and enhanced monitoring capabilities.
France	From 2025, the <a href="#">Building and Housing Code</a> mandates automation and control systems in existing commercial buildings. Prior to 2025, these systems were mandatory only for new commercial buildings.
India	In 2025, the Union Territory of Chandigarh set up a public <a href="#">energy management team</a> to improve HVAC automation and enhance advanced energy management practices in government buildings.
Germany	The 2024 revised <a href="#">Building Energy Act</a> requires commercial buildings to install an automation system of at least class B, which corresponds to an advanced building automation and control system ( <a href="#">on a scale from A, the highest performance, to D, non-automated</a> ).
Australia	Australia expanded its <a href="#">Commercial Buildings Disclosure programme</a> requiring mandatory disclosure of commercial building energy performance to take advantage of digital and technology capabilities.

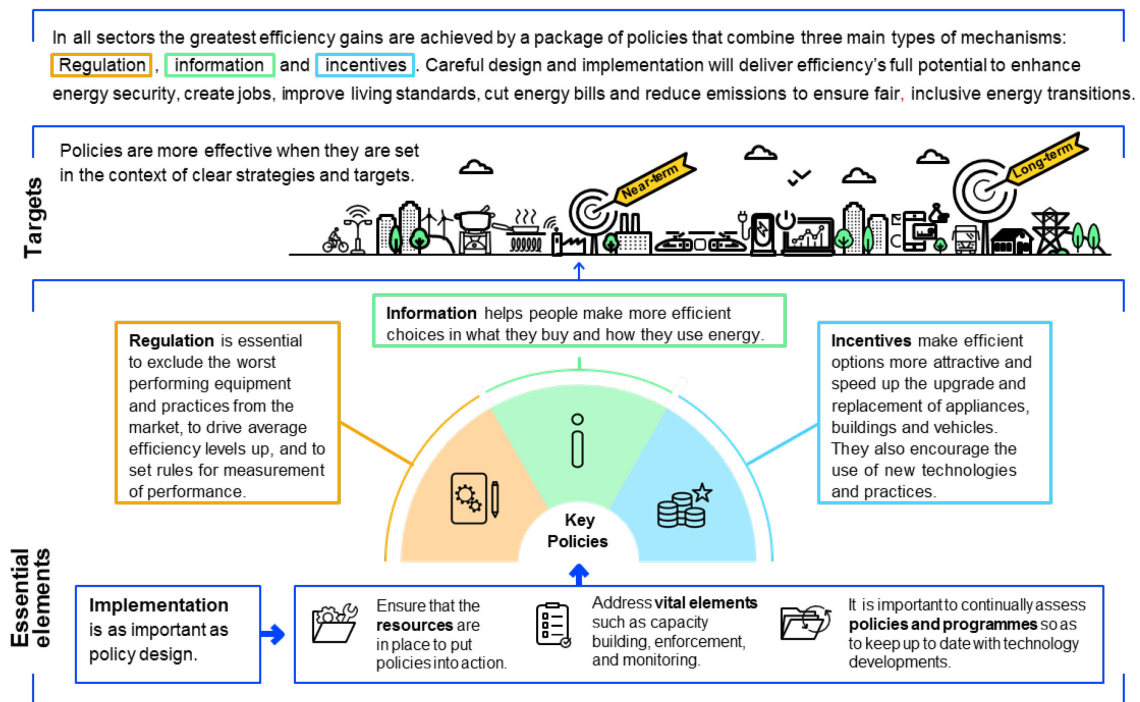
# 3. Policy opportunities in China

## Developing a comprehensive policy package

Implementing energy efficiency measures requires a well-designed and integrated policy framework. International experience shows that an effective policy package combines regulatory instruments, financial incentives, and information-based tools to drive improvements in building energy performance and enhance the flexibility of the broader energy system. Such a framework is most effective when grounded in clear, ambitious, yet achievable targets – such as improving energy efficiency, decarbonising the buildings sector and enabling active grid interaction – and these targets must be effectively communicated to all relevant stakeholders. The package is used to highlight potential opportunities for practitioners in China that could drive energy efficiency improvements in the building sector.

### Policy package for energy efficiency in buildings

#### Policy Packages for Energy Efficiency



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Source: IEA (2025), [Energy Efficiency Policy Toolkit 2025](#).

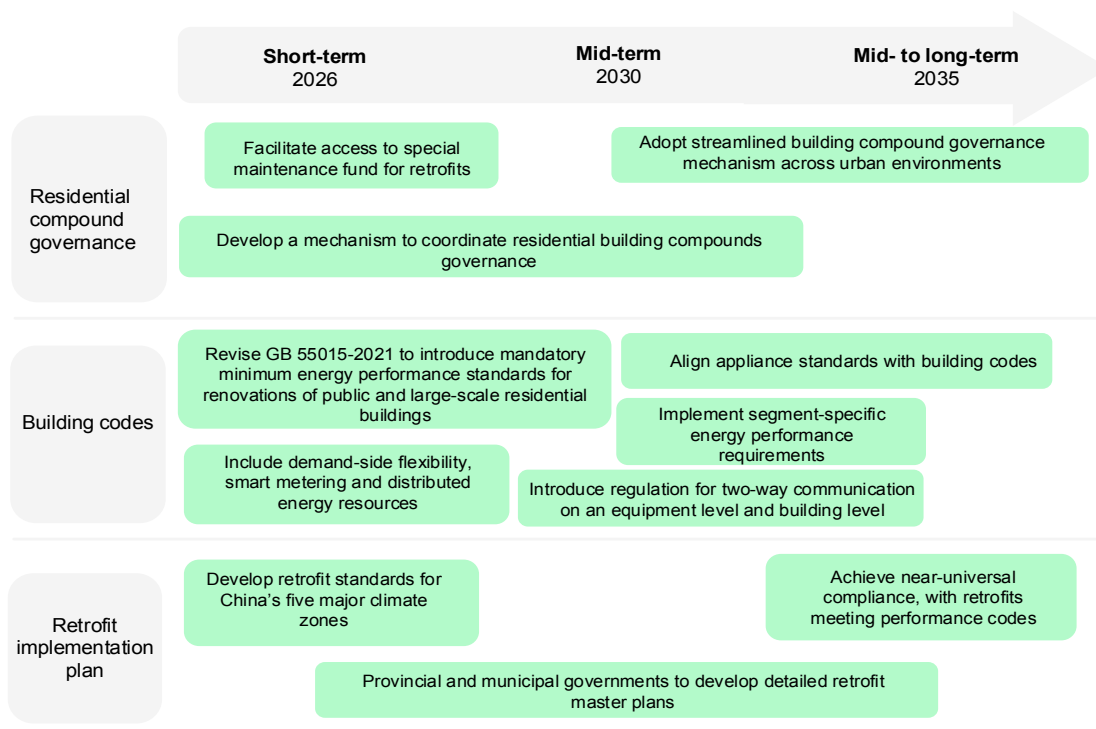
# Policy opportunities for improving energy efficiency in buildings in China

China is improving the quality of its building stock by offering greater energy services and living quality to its population; however, this does not need to come at the expense of energy efficiency. Indeed energy efficiency plays an important role in [building affordability](#), comfort, [health](#) and [value](#). Through observation of international best practice, data analysis and liaison with experts, the IEA has identified several overarching policy opportunities that could allow China to accelerate progress in raising energy efficiency levels in buildings. The policy package outlined above serves as a framework; as such, policy options are divided into regulation, information and incentives.

## Regulation

**Regulatory measures** serve to exclude the worst-performing equipment and practices from the market, to drive average efficiency levels up, and to set rules for the measurement of building performance. They can include targets for energy efficiency improvements, building codes and policies that ensure buildings are equipped with smart interactive technologies.

### Suggested timeline for key regulatory measures to accelerate energy efficiency in China's buildings sector



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## Develop a mechanism to coordinate building compounds governance

One major challenge to implementing energy upgrades in China is the sophisticated mix of entities that manage residential compounds, including property owners' committees, residents, property management companies and neighbourhood-level government offices. Compound management often suffers from fragmented responsibilities and conflicts of interest between these groups. Without a unified governance entity, it is difficult to coordinate the use of shared space, ensure fair income distribution, maintain facilities and install renewable energy or EV charging infrastructure. A mechanism that unifies homeowner committees, property management companies and local government representatives could streamline energy upgrade processes and facilitate better co-ordination on the use of collective funds.

For example, the [residential special maintenance fund](#), which all residential and commercial building owners are required by law [to contribute](#) to, suffers from chronic underspending due to lengthy and cumbersome approval processes. Such a mechanism could ensure these funds are used to finance energy-efficient retrofits. Several examples exist across China of successful building compound coordinating bodies.

### United Kingdom – [Flat Management Company](#)

In the UK, apartment block residents can form a legally registered flat management company to collectively manage shared spaces and facilities. Homeowners become directors, make decisions on maintenance and upgrades, handle finances, and comply with legal and tax obligations, ensuring accountability and coordinated management. If the members own shares in the company, they usually transfer their shares to the new owners when they sell their flat. This ensures that the limited company represents the interests of current flat owners.

Leaseholders can also set up a Right to Manage Company (RTM), which allows long-term leaseholders in blocks of flats to be involved in the management of their buildings. To register a flat management or RTM company, the application must include the bespoke articles of association, be limited by guarantee, as well as have a name ending 'RTM Company Limited' and a chosen director. The process can be completed either online or by post. Duties are clearly outlined in the "Companies Act 2006" and include articles on conflict resolution, ensuring the success of the company, as well as integrity. The flat management company provides a clear legal and governance framework that enables leaseholders and owners to effectively implement changes to their buildings. Adapting a similar model in China (with appropriate legal

reform) could improve co-ordination and funding for residential compound management, including energy efficiency upgrades.

### Strengthen building code standards for existing buildings so that they reflect carbon goals

[Building energy codes](#) are among the most effective policies to not only boost energy performance and reduce emissions, but also to improve occupants' health, comfort and productivity. Buildings built after a code is introduced can use [up to 50%](#) less energy. China's latest building code, enacted in 2022 ([GB 55015-2021](#)), focuses on new buildings and major renovations and aligns with several retrofit schemes launched in various regions. However, it stops short of establishing a national-level standard for all existing buildings.

By issuing national-level mandatory minimum energy performance requirements for buildings undergoing major renovations, starting with public and large-scale residential buildings in urban areas, and including these requirements in the building energy codes, China could accelerate retrofits nationwide. In time, China could also consider adding segment-specific energy performance requirements for envelope and systems in existing commercial and large-scale residential buildings into building codes.

#### Thailand – Mandatory [Building Energy Code](#) for existing buildings

Thailand's Building Energy Code (BEC) mandates that buildings over 2 000 m<sup>2</sup>, undergoing significant renovation, meet minimum performance standards for envelope, lighting, air conditioning and total energy consumption. Compliance is enforced through building permit systems: significant renovations must comply with BEC criteria to gain approval. In a study of 42 commercial building [retrofits](#) undertaken between 2011 and 2020 (mainly for heating, ventilation and air conditioning), it was found that energy savings ranged from 6% to 31%. Building retrofits with high-performance ACs were seen to deliver total estimated electricity savings ranging from 38% for hotels to up to 58% for retail buildings.

Thailand's BEC demonstrates that linking [energy codes to permitting processes](#) can deliver both environmental and financial dividends. It also highlights that using renovations as a trigger for code compliance is an effective measure to enforce retrofits.

Many [countries](#) are also updating their building codes to include advanced technology and construction plans that align with wider carbon neutrality goals. According to IEA analysis, for the world to meet net zero by 2050, mandatory [zero-carbon-ready building energy codes](#) should be in place globally by 2030, for both new buildings and the retrofit of existing buildings. China could consider updating GB 55015-2021 with zero-carbon-ready codes for new buildings and, eventually, existing buildings to align with its own carbon neutrality goals.

### Selected international zero-carbon-ready codes

Country	Policy instrument	Target and timeline	Key quantified metric
<b>England (UK)</b>	“Future Buildings Standard” for non-domestic + “Future Homes Standard” for residential	From 2025 new non-domestic buildings will be “zero-carbon-ready” (i.e., minimal fabric + low-carbon heat) ( <a href="#">Future building standards</a> )	Aim: new non-domestic buildings meet a primary energy/CO <sub>2</sub> target such that no further major retrofit is needed as the grid decarbonises
<b>Australia</b>	“Trajectory for Low Energy Buildings” + updates to the National Construction Code (NCC)	Building sector: net zero emissions by 2050; new buildings moving towards “zero-carbon-ready” levels in coming iterations ( <a href="#">dcceew.gov.au</a> )	The report “Built to Perform” estimated that a strengthened building code could deliver ~78 million tCO <sub>2</sub> cumulative emissions savings to 2050. ( <a href="#">Green Building Council of Australia</a> )
<b>European Union</b>	The Energy Performance of Buildings Directive (EPBD) – requiring “nearly zero energy buildings” and moving towards “zero-emission buildings”	Member states: new buildings must be “nearly zero energy” since December 2020; revised EPBD aims for “zero-emission buildings” by 2030 for all new buildings ( <a href="#">EPBD</a> )	The EU also links performance to primary energy use, CO <sub>2</sub> emissions and minimum building-services efficiency. ( <a href="#">EPBD</a> )
<b>Japan</b>	Net zero energy buildings and building code updates ( <a href="#">Zero energy buildings</a> )	New houses target net zero energy standard by ~2030 per industry commitments ( <a href="#">Targets 2030</a> )	Focuses on combining high efficiency + renewables to meet net zero energy

## Introduce regulation for two-way communication on equipment level and building level

Through high-level policy guidance, such as the 14<sup>th</sup> FYP, China has underlined the need to develop its grid and integrate buildings into the network. The [DL/T 698.45-2017](#) is an example of a standard in China that supports data exchange between distributed energy resources (such as rooftop PV and storage) and the grid, laying technical foundations for building-to-grid interactivity interoperability.

To further improve this, China could develop mandatory policies across all levels of two-way communication, encompassing equipment, building automation and building-to-grid interaction. This could involve, for instance, mandating open communication standards (e.g., [CTA-2045](#)) for all major appliances to enable demand-response capabilities and communication with building energy management systems and the grid. These measures could eventually support the expansion of China's "[virtual power plants](#)".

China could also consider establishing mandatory requirements for "grid-readiness" in all building types, including specifications for electric systems, pre-wiring for connected equipment (solar PV, storage, EV charging), and the utilisation of open communication protocols (e.g., BACnet, Modbus, Matter). Additionally, China could implement mandatory standards for automated communication between all building types and the grid, using protocols like OpenADR (Open Automated Demand Response) and [IEEE 2030.5](#) (Smart Energy Profile 2.0), to facilitate seamless information exchange and interaction.

## Harmonise appliance energy efficiency standards with building energy codes

China has strong energy efficiency standards for appliances and a labelling system that is over [two decades old](#). Establishing consistency between building standards and the classification system for appliances could promote the uptake of more efficient home appliances as well as greater efficiency in building energy consumption. The Minergie Buildings Label (see box below) is one example of a building label that has integrated appliance efficiency with building energy efficiency labels.

### Switzerland – [Minergie Buildings Label](#)

Minergie is a public-private association that provides the Minergie label, a voluntary certification system for new and renovated buildings that has proven influential in shaping building standards in Switzerland. To obtain the [Minergie-A](#) or [Minergie-P](#) label, users are required to submit information on the energy efficiency of appliances

and ensure they meet minimum standards. When determining the minimum performance of lighting, for example, factors such as the building's natural light and the presence of smart controls are taken into account. For other appliances (dishwashers, refrigerators, washing machines, dryers, induction stove tops, etc.), the label is prescriptive, requiring each appliance to meet a certain EU efficiency class. In most instances, the required class is well above the average.

Minergie harmonises appliance energy efficiency standards with building energy codes by directly linking building certification to minimum appliance efficiency classes and lighting performance standards, ensuring consistency across systems and enabling progressive tightening over time.

## Develop a comprehensive retrofit implementation plan

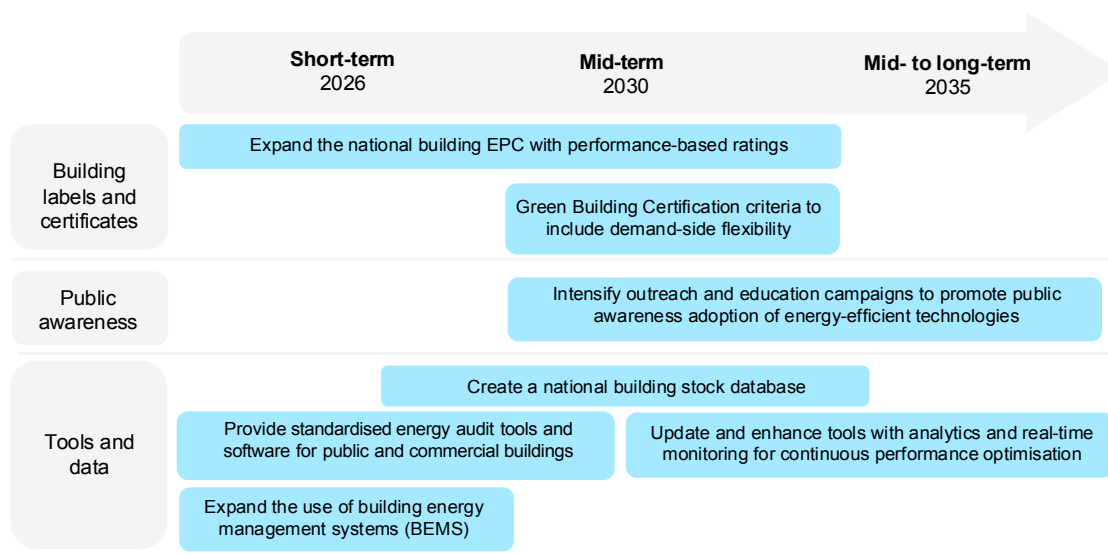
China currently has national-level targets for retrofits and has launched several regional programmes to encourage building renovations, including in the northern heating region. By requiring provincial and municipal governments to develop detailed retrofit master plans aligned with national targets and adapted to local climatic and socio-economic conditions, China can ensure a consistent yet flexible approach to implementation.

Additionally, this plan could be long-term to ensure that deep energy retrofits are sustained. In China, retrofit and building upgrade targets are determined in a five-year policy cycle, which may not be long enough for large retrofit projects. Countries such as the [United Kingdom](#) and [New Zealand](#) have established permanent commissions that have mandates to deliver on infrastructure and renovation. China could consider establishing a similar body to deliver on long-term building retrofit projects and to ensure the alignment of building renovations with nationwide strategic goals. For more information, please refer final section on Retrofitting.

## Information

**Information instruments** such as EPCs provide transparency about a building's energy use, allowing consumers to make better-informed decisions. They can also help deliver insights to governments on a country's building stock, which in turn can inform new policies, including regulatory updates to the building energy code. Other information tools include campaigns to raise awareness and acceptance among stakeholders and one-stop shops that facilitate easy access to grants and other incentives, alongside guidance and quality assurance.

## Suggested timeline for key information tools to accelerate energy efficiency in China's buildings sector



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### Scale up the national building energy performance certificate schemes

Currently, building EPCs in China are not mandatory for all building types and vary across regions. China has already begun public consultations across the building sector to inform a national EPC. Making this mandatory nationwide could establish a common language for energy efficiency in buildings. Categories could be adapted to climatic regions and be administered locally, as is the case for the European Performance Certificate (see Section 2).

China's 2024 [draft](#) standard for a national building energy performance certification scheme is an important step in the right direction. Further progress could be driven by clearer objectives and performance thresholds linked to China's carbon goals, including a timetable for tightening ratings, phasing out fossil-fuel systems, and integrating low-carbon energy and fabric upgrades. Additionally, it could be strengthened by improving transparency in data and methods, clarifying roles of different stakeholders (e.g. local governments enforce compliance in permitting, energy auditors conduct inspections and/or modelling, third-party verifiers conduct EPC evaluations, etc.), verification, enforcement and linking poor ratings to required audits or retrofits.

To further reinforce this framework, China could consider strengthening Green Building Certification (not to be confused with the EPC) programme mandating post-construction disclosure of energy performance for all participating public buildings and large private buildings. Expanding requirements to include performance-based ratings (energy intensity and carbon intensity) could

strengthen accountability and drive improvements in building performance by creating clearer benchmarks for investors and homeowners. It would also encourage retrofits. China could also update the Green Building Certification criteria to include demand-side flexibility, smart metering and distributed energy resources in both design and use.

## Create a national building stock database

While China has made efforts to monitor the energy performance of buildings in real time, collecting data can be expensive and quality may vary. A more cost-effective approach may be to establish a building stock database that is online and publicly available. Centralising data from certified buildings, retrofits and energy use to create a transparent database can inform future policies and support performance benchmarking by region and building type.

The [EU Building Stock Observatory](#) is one example that aims to provide transparent and reliable information on the EU's building stock. This supports the monitoring of current EU energy policies and will contribute to future policy making. It includes fact sheets on the 27 EU Member states with easily downloadable data on energy consumption, greenhouse gas emissions, social aspects and household energy use. China could consider establishing a similar database across provinces to support local policy makers in tailoring their building policies to local needs.

### **Denmark: Comprehensive [EPC database](#)**

In Denmark, all EPCs are registered in a central database administered by the Danish Energy Agency (DEA) and are displayed on a website accessible to the [public](#). This aligns with requirements set out by the EU's [Energy Performance of Buildings Directive \(EPBD\)](#). Denmark's database includes data from both the auditing consultant charged with producing the EPC and a report for the building owner with energy performance information, as well as property and land values. When the certificate is uploaded by users, relevant information is automatically added to the database without manual input, rendering the platform more user-friendly.

### **Quality control and compliance**

The DEA regularly performs quality checks on the certificates. When errors are identified, relevant parties are required to rectify them. In the case of a significant error, the company receives a notification which could lead to a legal warning, eventual fines and license suspension.

### **Link with the national energy renovation strategy**

This database is closely linked with the [Danish Strategy for Energy Renovation of Buildings](#). This provides a strategic framework that allows policy makers and building stakeholders to make informed decisions on energy savings for different building types and monitor progress.

### **Challenges and policy implications**

Some users find the platform [less intuitive and state that it lacks frequent updates](#) since EPCs are only required to be updated every 10 years. In addition, there are [concerns over the discrepancy between the calculated energy use and actual energy consumption](#). Despite these challenges, Denmark demonstrates that a central EPC database can be an effective policy tool to disseminate information on building energy efficiency and strengthen compliance.

## **Expand the use of building energy management systems (BEMS)**

China has several standards on building energy management and [intelligent design](#) in place. For example, [the Smart Building Evaluation Standard \(T/CREA 002-2023\)](#) introduced performance-based criteria, linking building automation with real-time energy performance and occupant comfort. The current building code requires certain buildings, such as large public buildings with centralised HVAC/air-conditioning systems, to be equipped with monitoring systems. Systematically expanding the scope of buildings which require BEMS, first in large-scale commercial and public buildings, then gradually in residential buildings, could improve the overall monitoring and optimisation of energy use in China's building stock. For older buildings, China could integrate the mandatory installation of BEMS into existing retrofit programmes to improve operational energy efficiency.

### **South Korea: Mandatory [BEMS](#) Design Standard**

In 2017, South Korea introduced a mandatory BEMS design standard, requiring all new public buildings with a floor area larger than [10 000 m<sup>2</sup> to install certified](#) energy management systems. In 2023, the threshold was reduced to [500 m<sup>2</sup>](#) and includes residential buildings containing more than 30 apartments.

To systematically verify the energy-saving effects of BEMS and address challenges such as varying data management systems, the country [established](#) a national standard (KS F 1800-2). This standard covers the following:

- **Data collection:** Specifies measurement points and collection methods.
- **Analysis:** Defines data storage codes.
- **Utilisation:** Standardises criteria and methods for calculating energy savings.

While mandatory installation has not yet been extended to the private sector, voluntary adoption is delivering tangible results. For example, [a food research institute](#) that first received BEMS installation approval in 2021 successfully renewed its certification – the first case of such an extension in the nation. The institute developed and applied 24 energy-saving control logics to improve the operational efficiency of heating, cooling and ventilation systems, achieving an average annual energy savings of 8.4% over the past three years. The engineering team also obtained BEMS operation manager certification, strengthening skills and building an in-house energy management system.

### **Link with the National Energy Renovation Strategy**

Korea's 2021 Nationally Determined Contribution (NDC) explicitly set an emissions reduction target of [200 000 tonnes of CO<sub>2</sub>](#) through the introduction of innovative energy management systems, such as BEMS and Home Energy Management Systems (HEMS), as part of its broader building-sector mitigation strategy, which also includes green retrofits and high-efficiency appliances.

## **Provide standardised energy audit tools and software for public and commercial buildings**

Tools and software can standardise and facilitate energy audits by streamlining data collection and analysis to identify inefficiencies and recommend targeted improvements for building performance. Researchers in China have created various methods for this; however, their use to policymakers varies depending on building type. In China's residential buildings sector, heating and cooling account for the largest portion of energy consumption, and the standards for these are strictly enforced through China's building code. Therefore, identifying a building's year of construction and the corresponding building code will provide sufficient information on energy performance and related retrofit needs without the need for specialised software. However, in public and commercial buildings, where energy usage and needs are more complex, tools and software can support consistent diagnostics and retrofit decision-making. These tools could be open access and integrate energy efficiency and decarbonisation measures, as well as lifecycle cost assessments.

### Canada: [RETScreen](#)

RETScreen is a clean energy management software developed by Natural Resources Canada that supports the assessment of energy efficiency, renewable energy and cogeneration projects. For retrofits, it is especially valuable as it enables users to model the energy performance of existing buildings, evaluate costs, savings and greenhouse gas reductions, and benchmark performance against peers and best-practice standards. The software also integrates financial analysis, including payback periods and investment returns, which strengthens the business case for renovation. Beyond planning, RETScreen can be used to monitor actual performance after implementation, helping to ensure that retrofits deliver the expected savings and emissions reductions. By combining technical, financial and emissions analysis in a single platform, RETScreen reduces uncertainty and helps stakeholders prioritise retrofit measures with the greatest impact.

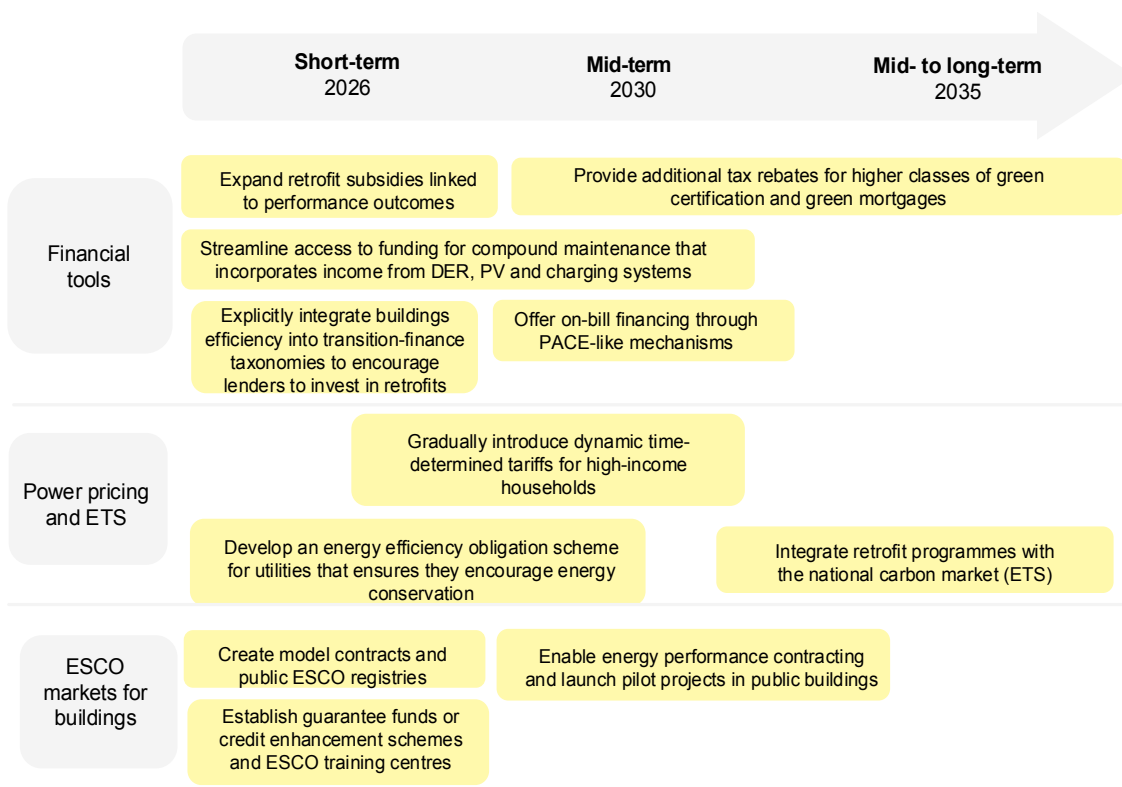
### Expand awareness campaigns on retrofit and equipment programmes

China has strong experience in implementing awareness campaigns that aim to increase the uptake of energy-efficient products. However, as new products and practices emerge, local authorities could promote new energy-efficient retrofit programmes, audit tools, tax incentives and appliance trade-in schemes, to ensure that consumers are aware of the latest technology and financial options. The government can further highlight public buildings as demonstration sites and engage with digital platforms to expand individual consumer awareness.

## Incentives

**Financial incentives** such as green mortgages, energy performance-based preferential loans and grants can motivate consumers and developers to increase investment in energy-efficient solutions.

## Suggested timeline for key incentives to accelerate energy efficiency in China's buildings sector



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### Expand retrofit subsidies linked to performance outcomes

China could strengthen its retrofit [subsidy system](#) by adopting a performance-based disbursement model. Under this approach, initial grants could support upgrades such as insulation, windows and heating systems, while subsequent payments would depend on verified energy savings over a defined monitoring period. This would shift the emphasis from meeting upfront requirements to achieving real efficiency gains, encouraging developers and building managers to focus on long-term performance. Targeting districts with older building stock, high energy demand or acute heating and cooling needs, and using digital tools such as smart meters and Internet of Things (IoT) sensors to verify outcomes, would ensure both impact and transparency.

For instance, a pilot in a northern province with high heating needs such as Liaoning, could focus on apartment blocks from the 1980s, which often have poor insulation and inefficient heating. Residents could receive an initial grant to upgrade windows and building envelopes, with further subsidies released once winter heating demand is demonstrably reduced over two years. This would both unlock additional funding and deliver tangible savings on energy bills, showing how performance-linked incentives can drive measurable efficiency improvements while enhancing social welfare.

In China, home and building ownership exists under a time-limited leasehold system (residential buildings for 70 years and 40-50 years for other building types). This may disincentivise owners from applying for subsidies or investing in retrofits, as there may be uncertainty about the long-term payoffs. In 2007, [a law clarified](#) that the government would not repossess properties at the end of the leasehold period without compensation. China could consider safeguarding property owner retrofit investments if their leasehold is not extended by introducing a regulation that stipulates retrofit compensation.

### Public grant programmes for residential energy retrofits, selected countries, 2021-2024

Country	Retrofit programme description	Number of houses/ grants	Cumulative funding (USD)
Canada*	The <a href="#">Canada Greener Homes Grant</a> and <a href="#">Oil to Heat Pump Affordability program</a> funded measures such as insulation and heat pumps. Starting in 2025, the <a href="#">Canada Greener Homes Affordability Program</a> targets retrofit funding at low-to-median-income households.	405 000 grants	1.4 billion
Denmark	The <a href="#">Building Pool</a> , <a href="#">Heat Pump Pool</a> and <a href="#">Energy Renovation Pool</a> provide grants for building energy retrofits.	60 000 grants committed	210 million
France	The <a href="#">MaPrimeRénov</a> scheme funds individual measures and deep renovations. In 2025, <a href="#">USD 3.9 billion</a> became available, targeted at low-income groups in poorly insulated homes.	2.3 million houses	13.7 billion
Germany	The <a href="#">Federal Funding for Efficient Buildings</a> programme funds individual measures and full renovations. Over 100 000 applications were submitted in the first half of 2025.	3.8 million houses	37.3 billion
Ireland	The <a href="#">Better Energy Homes Scheme</a> funds individual measures, and the <a href="#">National Home Energy Upgrade Scheme</a> and the <a href="#">Warmer Homes Scheme</a> fund (deep) renovations.	80 000 houses	760 million
Japan	The <a href="#">Energy Conservation Subsidy</a> and the <a href="#">Eco-Home grant</a> have promoted building upgrades, efficient water heaters and window replacement. The <a href="#">Home Energy Saving Campaign</a> was launched in 2025.	1.9 million grants	415 million
Netherlands	The <a href="#">Investment Subsidy for Sustainable Energy and Energy Efficiency</a> funds individual measures, such as insulation and heat pumps. In 2025, the amount of funding for each insulation measure increased.	860 000 houses	1.8 billion
Norway	The <a href="#">Enova Housing Grant</a> and <a href="#">Program for improving energy conditions in housing associations</a> fund upgrades such as insulation and metering. From 2025, support can be granted before the renovation starts.	57 000 houses	180 million

\*For Canada, data is based on fiscal years, not calendar years.

Note: Currency conversions are based on the average exchange rate to USD in 2024.

Source: IEA (2025), [Energy Efficiency 2025](#).

## Incentivise advanced energy classes (2- and 3-Star Green Buildings)

China could accelerate the uptake of advanced energy performance standards by strengthening incentives for buildings that achieve higher levels of green certification, such as 2- and 3-Star Green Buildings. Additional measures could include tax rebates [or floor-area ratio \(FAR\) bonuses](#) to reward developers who invest in more efficient designs and technologies. Existing initiatives in cities such as Shenzhen and Beijing, where local funds already support green building development, could provide scalable models to be replicated nationwide.

By combining financial and regulatory incentives, this approach would help shift the market towards higher-performing buildings, reduce long-term energy demand and signal a clear government commitment to green construction. These approaches have found success in several countries, including Peru, where building with [EDGE](#) has provided opportunities to increase development height in several cities, [including Arequipa](#).

## Expand financing mechanisms through private lenders

China's [Work Plan on Accelerating Energy Savings and Carbon Reduction in the Buildings Sector](#) calls for the expansion of financial mechanisms that support energy conservation and carbon reduction in buildings, while the [Green Finance Taxonomy](#) provides an approved list of energy-efficient and zero-carbon products that are eligible for green financing. China could consider explicitly integrating energy-efficiency projects into transition-finance taxonomies to encourage banks and lenders to invest in retrofits in buildings. It could also expand the use of [green guarantee funds](#) and blended finance to mitigate risks.

## Introduce energy efficiency considerations into the pricing of residential electricity

Currently, China's residential sector, along with agriculture, certain public utilities and public welfare services, belongs to the "priority electricity consumption subjects" and does not fully participate in the power market. Electricity is purchased and sold by grid enterprises at prices determined by the NDRC. China has also [released a policy](#) aimed at ensuring "stable electricity prices for residents, agriculture and public welfare", indicating that in the short term, residential electricity is unlikely to be fully marketised.

China has, however, introduced [tiered pricing mechanisms](#) in certain provinces with three progressively higher pricing levels based on monthly or annual electricity usage. China could also consider gradually introducing dynamic time-determined tariffs, whereby residents pay lower rates during off-peak hours and higher rates during peak hours, starting with higher-income households that

consume more energy. This could incentivise energy-efficient technologies and behaviours while guaranteeing low-cost electricity for vulnerable regions and residents. Additionally, as China is in the process of [reforming its power sector](#), aiming to build a unified national power market by 2030, there is an opportunity to ensure that energy efficiency and demand-side measures are factored into the new system. In 2023, China [strengthened electricity-saving rules](#) and introduced clearer regional responsibilities for improving system efficiency and managing demand. However, it does not yet operate a national energy efficiency obligation scheme for utilities. China could consider adopting such a framework, along with an earmarked utility levy where a portion of profits from utilities is reinvested into energy efficiency.

International experience has shown (see below) that when energy efficiency is included in electricity pricing, significant energy and emissions savings can be made.

#### **France: [White Certificate Scheme](#)**

Energy efficiency obligation schemes help avoid the [market failure](#) wherein electricity suppliers have a business case to increase energy demand. Under the French programme of White Certificate Trading, suppliers of energy (electricity, gas, heating oil, LPG, heat, refrigeration) must meet government-mandated targets for energy savings achieved through residential and tertiary customers. Suppliers are free to select the actions to meet their objectives from a list of ratified activities, such as informing customers how to reduce energy consumption, running promotional programmes, providing incentives to customers, etc.

#### **How the certificate works**

In France, the government issues a set number of Certificats d'Économie d'Énergie (CEE) that corresponds to a saving of 1 discounted cumulative kilowatt-hour cumac (kWhc) of final energy. Parties that fail to comply with their obligation must pay a penalty proportional to the volume of energy savings not achieved, at a rate of EUR 0.02 per kWh cumac, i.e. EUR 20 megawatt-hour cumac (MWhc). For comparison, the purchase price of French white certificates has fluctuated between EUR 6.50 and EUR 9.50 per MWhc since 2019. The penalty is therefore highly punitive and thus it is rare that parties fail to meet their obligations. Those exceeding and undercutting their objectives can trade energy savings certificates.

## Enable energy savings performance contracting

China has the world's [largest and fastest-growing ESCO market](#), and is already employing innovative [energy hosting ESCO models](#). However, most ESCO operate within industry or in the commercial and public buildings sector, with less ESCO activity in the residential sector. To expand the market and ensure quality, China could promote third-party financed retrofits with guaranteed savings through risk-mitigation tools such as credit guarantees, preferential green finance, and standardised energy performance contracts. Model contracts and public ESCO registries would further assure quality, increase transparency, and build confidence among financiers and building owners by providing reliable benchmarks.

To reinforce market capacity, regional ESCO training centres could be established to equip practitioners with technical expertise and foster a skilled workforce capable of delivering consistent, high-quality retrofits. In parallel, targeted training programmes for building managers and local banks could improve understanding of energy performance contract structures, enabling smoother implementation and financing.

## Introduce on-bill financing through property-assessed clean energy-like instruments

Property-assessed clean energy (PACE) and related instruments could offer China an opportunity to unlock private investment for large-scale building retrofits and energy efficiency upgrades while strengthening the financial infrastructure needed for long-term urban decarbonisation.

PACE and similar instruments enable property owners to finance energy efficiency, renewable energy and resiliency upgrades by attaching repayment to property tax bills. These mechanisms typically offer long-term, fixed-rate finance that transfers to subsequent property owners upon sale, ensuring continuity and reducing risk. On-bill financing models enable consumers to repay loans for efficiency upgrades directly through utility bills, aligning repayments with energy cost savings to ensure accessibility and affordability. PACE mechanisms could be adapted to China's market, taking into account the fact that home and building ownership exists under a time-limited leasehold system (residential buildings for 70 years and 40-50 years for other building types).

### PACE-like policy examples

Country	Policy
<b>United States</b>	The United States remain a world leader, with <a href="#">PACE financing exceeding USD18 billion</a> in cumulative investment and encompassing 400,000 participating buildings by 2025, driving measurable reductions in greenhouse gas emissions and generating significant economic impact. Recent regulatory focus has centred on consumer safeguards and expanding C-PACE (commercial) markets.
<b>United Kingdom</b>	In the United Kingdom, the emergence of <a href="#">property-linked finance (PLF)</a> draws inspiration from the PACE model but is tailored to local property tax collection practices and ownership frameworks, with pilots anticipated to resolve questions around lien priority and administrative feasibility.
<b>Australia</b>	In Australia, <a href="#">environmental upgrade agreements</a> function similarly for commercial properties, voluntarily engaging local councils, lenders and property owners to fund upgrades and allocate repayment through council rates. To date, these agreements have reduced energy use and emissions in hundreds of properties, demonstrating potential for further upscaling.

### Integrate retrofit programmes with the national carbon market (ETS) to monetise emissions reductions

Carbon financing for building energy efficiency retrofits through national carbon markets enables project owners to monetise verified emissions reductions by generating and trading carbon credits under emissions trading schemes (ETS). In January 2024, China relaunched its national voluntary carbon reduction scheme, the [Chinese Certified Emissions Reduction](#) scheme (CCER), through which certain emission reduction projects may generate certified reduction credits. Under the rules of the national ETS, covered entities are permitted to use CCER credits to offset up to 5% of their verified emissions. However, it is not yet clear whether the scheme formally includes building retrofits. By including building retrofits in this scheme, China could provide further market incentives to improve the energy performance of buildings.

Several examples already exist internationally. In Europe, the EU ETS Phase 4 (2021-2030) under the [“Fit for 55”](#) package introduces a second, separate trading system commonly called ETS 2 that covers emissions from fuel suppliers for buildings and road transport, among other sectors, expanding the scope of regulated sectors beyond heavy industry and power generation. In North America, California’s [cap-and-trade programme and voluntary carbon schemes](#) reward deep retrofits in the commercial sector. Voluntary markets across the region complement mandatory schemes, adding flexibility and scaling impact. Canada is [expanding retrofit financing](#) through partnerships like the Canada Infrastructure

Bank and Bank of Montreal, which offer loans tied to emissions reduction targets, creating synergies with carbon market revenue. These integrated approaches unlock market-based revenue streams, scale investment and support national net zero goals.

## Retrofitting potential: key technologies and implementation mechanisms

China peaked construction of new buildings in 2014, when newly built floor space across residential, public and commercial buildings totalled 3.6 billion square metres. In 2022, this figure fell [to 3.4 billion](#). The slowing rate of construction and the relative stringency of building codes for new buildings in China mean that in the coming years, retrofitting existing buildings will be crucial to improving the overall energy efficiency in the sector. Retrofitting buildings constructed before 2010 can deliver substantial energy savings to China's buildings sector.

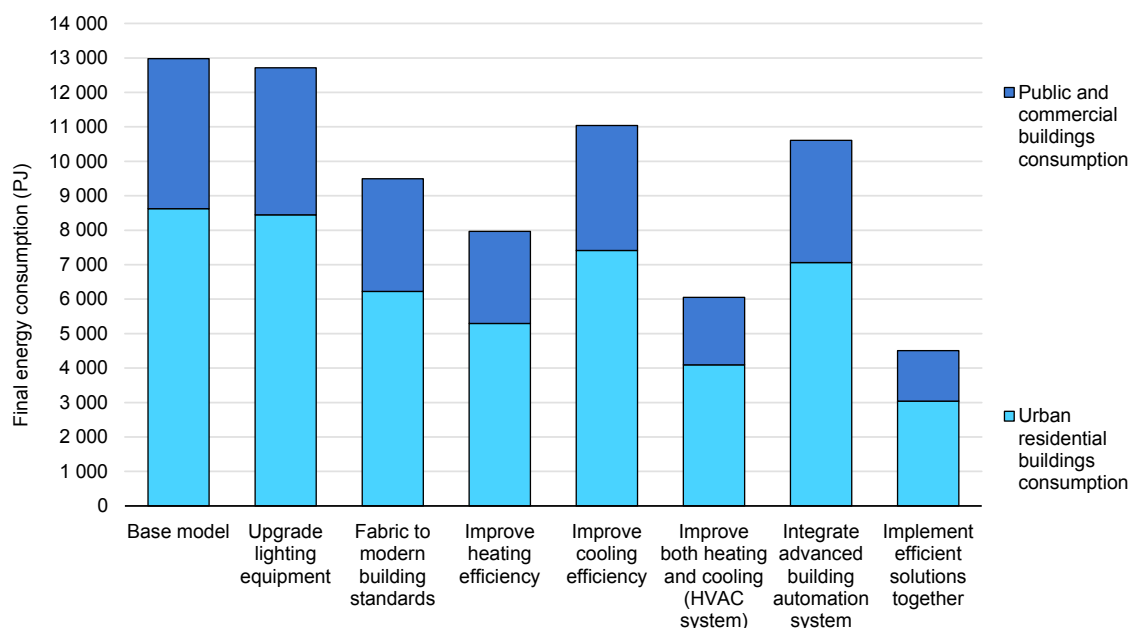
### China can save up to 65% of final energy consumption in certain buildings through retrofits

Based on a preliminary assessment conducted using the IEA Building Energy Efficiency Performance Tool, it is estimated that if all best-on-the-market energy-efficient retrofit measures are implemented simultaneously, the energy consumption of urban residential, public and commercial building stock constructed between 1995 and 2010 in China could be reduced by up to 65%, equivalent to approximately 8 000 PJ.<sup>3</sup> This represents about 1.5 times France's total final energy consumption in 2023. The calculation does not take into account investment cost, but rather highlights the maximum possible savings based on current technology options.

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<sup>3</sup> Best-on-the-market energy efficiency retrofit measures include the highest performing insulation materials, high-efficiency heating and cooling equipment and building automation and control systems (BACS).

### Estimated yearly total final energy consumption based on different scenarios in buildings constructed in China between 1995 and 2010

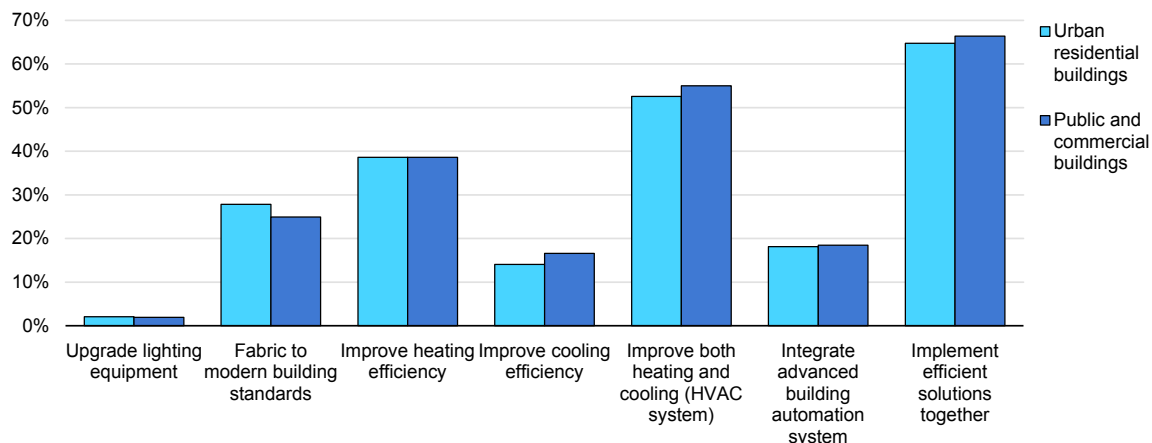


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Notes: Figure based on 2021 consumption data. Final total energy consumption includes district heating, in addition to electricity and other fuels.

Potential energy savings for China's 1995 to 2010 urban residential and commercial building stock from individual retrofit measures were also estimated. This includes upgrades to lighting equipment, building envelopes, heating and cooling systems, as well as the integration of advanced building energy management systems. Estimates indicate that improving heating efficiency and HVAC systems provides the greatest energy savings, delivering 39% and 53%, respectively.

### Estimated percentage energy savings in buildings constructed between 1995 and 2010 in China based on 2021 levels

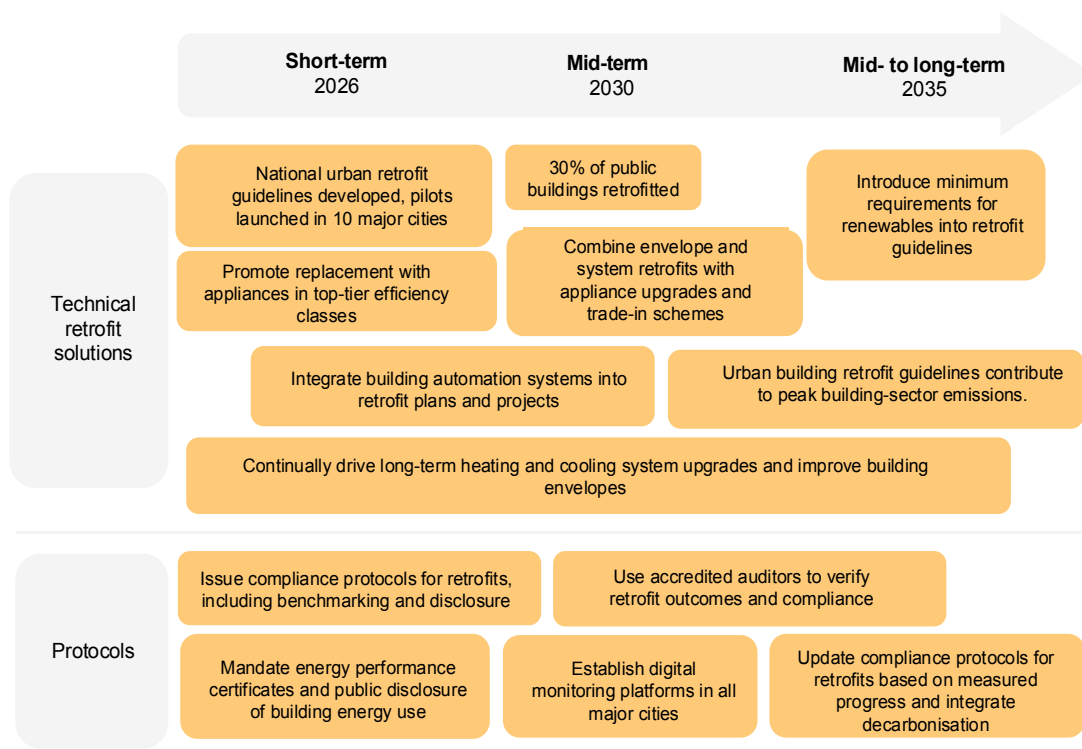


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## Implementation of a roadmap for a retrofit programme for existing buildings in urban areas

This section outlines general implementation options based on international experience and analysis of retrofit potential that could allow China to accelerate its retrofit drive. As policy options are covered in the above, this section outlines technical solutions and protocols.

## Suggested timeline for technical and protocol measures to drive the retrofitting of existing buildings in urban areas



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### Technical retrofit solutions

- **Envelope upgrades:** Improve insulation, window replacements and airtightness based on climate zone needs.
- **HVAC and cooling systems:** Replace inefficient systems with variable refrigerant flow (VRF) units, heat pumps and solar-assisted systems.
- **Lighting and appliances:** Promote replacement with appliances in top-tier efficiency classes (e.g., China Energy Label Grades 1-2).
- **Smart Controls and automation:** Integrate building automation systems (BAS) for energy management, including sensors, timers and smart meters.
- **Bundled retrofit packages:** Combine envelope and system retrofits with appliance upgrades (lighting, air conditioners, refrigerators).
- **Market mechanisms:** Leverage bulk procurement, trade-in schemes and labelling incentives to accelerate deployment of high-efficiency appliances.

### Protocols for enforcement and implementation

- **Benchmarking and disclosure:** Mandate energy performance certificates and public disclosure of building energy use.
- **Digital monitoring:** Establish platforms for real-time energy use monitoring and reporting.

- **Third-party verification:** Use accredited auditors to verify retrofit outcomes and compliance.
- **Compliance protocols:** Develop and implement robust monitoring, verification and enforcement systems.

# Annex

## Definitions

**Buildings:** The buildings sector includes energy used in residential and services buildings. Services buildings include commercial and institutional buildings and other non-specified buildings. Building energy use includes space heating and cooling, water heating, lighting, appliances and cooking equipment. It also includes energy used by data centres and desalination plants.

**Carbon dioxide (CO<sub>2</sub>):** A gas consisting of one part carbon and two parts oxygen. It is an important greenhouse (heat-trapping) gas.

**Coal:** Consists of both primary coal, i.e. lignite, coking and steam coal, and derived fuels, e.g. patent fuel, brown coal briquettes, coke-oven coke, gas coke, gas works gas, coke-oven gas, blast furnace gas and oxygen steel furnace gas. Peat is also included.

**Electricity demand:** Defined as total gross electricity generation less own use generation, plus net trade (imports less exports), less transmission and distribution losses.

**Energy services:** A personal or societal gain from the use of energy. It includes, inter alia, heating, cooling, lighting, entertainment, mobility, nourishment, hygiene and education.

**Gaseous fuels:** Fuels in gaseous form including natural gas, biogas, biomethane, hydrogen and synthetic methane.

**Liquid fuels:** Include oil, liquid biofuels, synthetic oil products and hydrogen-based fuels, i.e. ammonia and methanol.

**Primary energy intensity:** total energy supply divided by gross domestic product. An improvement is defined as a reduction in energy intensity.

**Solid fuels:** Include coal, modern solid bioenergy, traditional use of biomass and industrial and municipal wastes.

**Total final consumption (TFC):** The sum of consumption by the various end-use sectors. TFC is broken down into energy demand in the following sectors: industry (including manufacturing, mining, chemicals production, blast furnaces and coke ovens), transport, buildings (including residential and services) and other (including agriculture and other non-energy use). It excludes international marine and aviation bunkers, except at world level where it is included in the transport sector.

**Total energy supply (TES):** Represents domestic demand only and is broken down into electricity and heat generation, other energy sector and total final consumption.

## Acronyms and abbreviations

AC	Air conditioning
BAS	Building automation systems
BEMS	Building energy management systems
CCER	Chinese Certified Emissions Reduction
CEL	China Energy Label
CNIS	China National Institute of Standardisation
DER	Distributed Energy Resources
EPC	Energy Performance Certificates
EPBD	Energy Performance of Buildings Directive
ESCO	Energy service companies
ETS	Emissions Trading Schemes
EU	European Union
FAR	Floor-area ratio
FYP	Five-Year Plans
GBEL	Green Building Evaluation Label
IEA	International Energy Agency
MEPS	Minimum energy performance standards
OpenADR	Open Automated Demand Response
PACE	Property-assessed clean energy
PLF	Property-linked finance
VRF	Variable refrigerant flow
EDGE	Excellence in Design for Greater Efficiencies
EMDE	Emerging Market and Developing Economies
EV	Electric vehicles
HVAC	Heating, ventilation and air conditioning
IoT	Internet of Things
NDRC	National Development and Reform Commission
PV	Photovoltaics

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