NDC ASPECTS

Policy Brief

Decarbonising residential buildings: a global perspective

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Key messages

- Globally, the building sector was responsible for 34 % of energy demand and 37 % of energy and process-related CO_2 emissions in 2022. Building decarbonisation strategies and policies vary among world regions due to their distinct socio-economic development framework, climate conditions, building stock status, and energy consumption including their fuel mix.
- To decarbonise its residential buildings, the EU concentrates on improving the existing building stock via energy renovations while imposing stringent requirements for new buildings. India's policies mainly target new buildings, whereas China's address both new and existing dwellings. Regarding energy usage, space heating is the primary focus of EU policies, while India emphasizes cooking and cooling, and China addresses both heating and cooling.
- Policymakers in the EU, China, and India have acknowledged the necessity of implementing comprehensive policy packages to decarbonize their residential building stock. Key existing policies and options to further enhance them include:
  - While the EU and China align targets with climate goals, India lacks a clear sectoral roadmap and should therefore adopt one.
  - Both China and India can explore the potential of implementing energy efficiency obligations (EEOs) and carbon pricing to advance residential building decarbonization.
  - Certain EU member states (MSs) should reduce electricity taxes to accelerate heating electrification.
  - Minimum Energy Performance Requirements (MEPRs) are implemented across all regions, although China should expand mandates for building codes in rural areas and existing buildings, and India should expedite the adoption of MEPRs at the local level.
  - EU MSs have enforced Energy Performance Certificates (EPCs); India and China need to scale up their residential building information disclosure practices.
  - Key appliance policies are well-established in all three regions.
  - Integrated business models such as the One-Stop-Shop (OSS) promoted by the EU could accelerate energy renovation efforts.
  - Training and certification are included in national policies in all three regions, with India needing more involvement from recognized entities.

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Introduction

Globally, the building sector was responsible for 34 % of energy demand and 37 % of energy and process-related CO_2 emissions in 2022. Despite some progress made in the last two decades, the building sector is not currently on track to achieve net zero emissions by 2050. Meeting this target requires significantly more substantial actions. Global building energy intensity must decrease by approximately 37% compared to 2015 levels, reaching a milestone of 96 kWh/m² by 2030. However, in 2022, the energy intensity in buildings was 145.3 kWh/m², reflecting only a marginal 5.1% decrease compared to 2015. The shortfall can largely be attributed to the increasing number of new builds without energy performance requirements in many countries and the low rate of energy retrofits in many others (United Nations Environment Programme, 2024).

In many developing and emerging economies, building energy demand is expected to surge because of the rapid expansion of new construction and increasing energy service needs due to economic growth. It has been forecasted that approximately 80% of the projected growth in floor area by 2030 will be concentrated in these economies (IEA, 2023), where many countries do not have adequate energy performance requirements (United Nations Environment Programme, 2024). Consequently, the latest IPCC report highlights that the building sector in developing countries holds the greatest potential for mitigation by 2050 (Cabeza et al., 2022). Meanwhile, in most developed nations, despite enhancements in building energy efficiency since 1990, substantial mitigation potential remains within the extensive existing building stock that necessitates renovation (IEA, 2021c). The global policy landscape for building decarbonisation is diverse. While some nations lack substantial policies, others have made progress in implementing national policies to achieve net-zero buildings (United Nations Environment Programme, 2024).

This policy brief outlines policy efforts aimed at decarbonizing residential buildings in three major economies: the EU, China, and India. It maps existing policies and examines key aspects, focusing on new construction, renovations, heating, cooling, and cooking (Xia-Bauer et al., 2024). It prioritizes residential buildings due to their higher per capita CO2 emissions compared to commercial buildings worldwide.

Residential building decarbonization in the EU, China, and India

Background

The European Union (EU), China, and India collectively accounted for more than 40% of global CO_2 emissions. Meanwhile, each of them has set long-term national climate targets. The EU aims to be climate-neutral by 2050 and reduce its greenhouse gas (GHG) emissions to at least 55% compared to 1990 by 2030 (European Commission, 2023). China has pledged to peak its CO_2 emissions before 2030 and achieve carbon neutrality before 2060, while India aspires to reach net-zero emissions by 2070 (MOEFCC, 2022). Residential buildings significantly contribute to final energy consumption and emissions in all three regions.

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In the EU, the residential sector contributed to 27% of the total final energy consumption in 2021. It is worth noting that between 75% to 95% of EU buildings existing today will still be in use in 2050, and nearly all of them will require energy renovations to support the achievement of the EU's climate targets (BPIE, 2017). However, the annual energy renovation rate of residential buildings is currently less than 1% (Filippidou et al., 2023) and many of these renovations achieve low energy savings (European Commission., 2019).

China has an extensive residential building stock, exceeding 53 billion m² in 2021. Meanwhile, most of China's residential building stock is relatively young and will remain in use for an extended period. Residential buildings have continued to account for a substantial portion of China's energy consumption, totalling 16.4 million terajoules (TJ) and representing 70% of the total building energy consumption. The country has diverse climates, leading to varying heating and cooling demands. For instance, the northern region predominantly experiences cold and severely cold climates and relies on district heating systems, whereas the southern region primarily employs decentralized heating solutions. Furthermore, China's demand for space cooling has exhibited the fastest growth globally. Cooling, primarily using individual air conditioning units (AC), currently constitutes approximately 7% of the total final energy demand in buildings (IEA, 2021a).

In India, residential buildings covered a vast floor area of 15.3 billion m^2 in 2017. In contrast to the EU and China, a significant portion of India's building stock expected to be in place in 2040 is yet to be constructed. Urbanization and replacement of informal settlements with new modern buildings will trigger a substantial increase of residential building stock surging from less than 20 billion m² today to over 50 billion m² within two decades (IEA, 2021b). The residential sector stands as the second-largest final energy consumer, adding up to 6.7 million TJ in 2020 (IEA, 2022). India's predominately tropical and sub- tropical climate leads to limited heating demand and high cooling demand. In the year 2020-2021, the residential sector accounted for approximately 32% of the total electricity consumption (Government of India et al., 2022). Climate conditions, e.g., the frequent heatwaves, coupled with improved income and living standards are anticipated to drive a rapid growth in AC ownership, from currently 8% surging to 40% by 2037-38 (Ministry of Environment, Forest & Climate Change, 2019). Furthermore, traditional biomass for cooking, in particular, in rural areas, currently accounts for 12% of the nation's overall final energy consumption (IEA, 2021b).

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Different technology pathways to decarbonize residential buildings

Considering the disparities in climate conditions, heating and cooling demand, and socio-economic drivers, it becomes evident that effective residential building decarbonization strategies differ across the three regions.

In the EU, addressing the challenge posed by the extensive existing building stock is crucial in the pursuit of building decarbonization. Deep energy renovation emerges as the cornerstone strategy in this endeavour. Additionally, the crucial role of electrification in heating, closely intertwined with the rapid expansion of renewable energy sources in power generation, is of utmost importance.

In China, the rapid pace of urbanization and new construction trends necessitate ambitious standards for new buildings. Achieving near-zero or zero-energy standards is imperative for decarbonisation. Moreover, prioritizing energy retrofits for the significant existing building stock remains critical. Furthermore, the rapid growth in air conditioning usage underscores the need for widespread adoption of highly energy-efficient AC units – heat pumps, complemented by improvements in building envelopes.

In India, the rapid growth of new building stock and increasing ownership of air conditioning units highlight the critical need to prioritize energy efficiency enhancement in new buildings. This includes promoting passive cooling strategies and widespread adoption of highly energy-efficient air conditioning units. Additionally, addressing the prevalent use of traditional biomass for cooking – and switching to electricity, which not only contributes to carbon emissions but also carries significant health implications, is essential for India's building decarbonization efforts.

Policy efforts for decarbonizing residential buildings in the three regions

Policymakers in all three regions have implemented distinct sets of policy measures to decarbonize the residential building sector. A comparison of key policy instruments across the three regions is provided below.

- ***Overarching instruments***: Each of the three regions has developed **policy roadmaps** pertaining to the building sector: the long-term renovation strategies outlined by EU Member States as required by the Energy Performance of Buildings Directive (EPBD), China's Carbon Peak Action Plan (CPAP), and India's Cooling Action Plan (ICAP). The policy roadmaps of EU Member States and China encompass strategies for the overall building sector, addressing both new constructions and existing residential buildings. The EU's roadmap particularly emphasizes building renovation, while China aims to enhance the stringency of new building standards and concurrently undertake renovations in its existing building stock. Additionally, China has a separate roadmap for cooling, focusing on cooling appliances and equipment. Furthermore, the timelines of these roadmaps differ: the EU's aligns with its 2050 climate target, whereas China's corresponds to its 2030 carbon peak objective. In contrast, India's roadmap specifically targets cooling, including space cooling within buildings, and primarily recommends adoption and compliance with

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building energy codes. However, it lacks specific targets and a defined timeline for achieving a net-zero building stock.

Some EU Member States have already implemented ***carbon pricing*** for the use of fuel in buildings, and the EU plans to incorporate it into its Emissions Trading System (ETS) starting in 2027, named ETSII for buildings and road transport. However, China and India have not yet adopted or planned this approach for their building sectors. Additionally, there is a notable disparity in ***electricity pricing*** between the EU and China. In the EU, the current high taxes and levies on electricity result in higher operational costs for heating electrification compared to heating with fossil fuel (Rosenow et al. 2023). Conversely, in China, the low residential electricity prices and the promotion of 'time-of-use' tariffs (ToU) have the potential to reduce heat pump operational costs, thereby encouraging the adoption of heat electrification. Moreover, all three regions implement ***energy efficiency obligations (EEOs)***, which can deliver cost-effective energy savings over a long period. However, residential buildings are notably absent in the Indian and Chinese EEO schemes.

- ***Regulatory instruments***: All three regions have introduced residential Minimum Energy Performance Requirements (MEPRs). In the EU, the EPBD mandates all Member States to establish national MEPRs for new buildings and extend mandatory MEPRs to existing buildings. Since the 1980s, the Chinese government has implemented mandatory codes for new residential buildings in urban China, covering five distinct climate zones. In 2018, India introduced Eco Niwas Samhita, a voluntary building energy code for residential buildings. The code applies to new residential buildings or the residential component of mixed-use projects on plots of land measuring 500 m² or larger. Additionally, all three regions have implemented minimum energy performance standards (MEPS) for key residential appliances and equipment.
- ***Information instruments:*** Only the EU27 has widely implemented building energy labelling, namely through Energy Performance Certificates (EPCs), which are mandatory in case of sale or lease, to inform potential buyers or tenants about building energy performance and recommended enhancements such as envelope insulation or heating & cooling equipment replacement. China introduced the Building Energy Efficiency Evaluation and Labeling (BEEL) in 2008, and India launched the Residential Building Energy Labeling (RBEL) Program in 2019, but neither has been widely implemented. In contrast, in all three regions, energy efficiency labelling schemes for key appliances and equipment have been implemented alongside MEPS, which together pull and push the market.
- ***Financial incentives:*** Both the EU27 and China have introduced financial incentives for energy retrofitting and low-carbon heating solutions. These incentives primarily take the form of subsidies, but also include additional benefits such as tax credits and soft loans within the EU27. Incentives for new constructions are limited. In contrast, India does not offer direct financial incentives for building energy efficiency. Subsidies are largely allocated for clean cooking purposes.
- ***Policy for promoting business models:*** The energy service companies (ESCOs) markets in the EU27 and China are well-established, thanks to robust policy frameworks that promote their growth. However, ESCO projects for residential buildings are still limited due to the small scale of such projects. In contrast, India's ESCO market is largely undeveloped, with the exception of the state-owned Super ESCO. On the other hand, integrated business models have been observed in all three regions. The EU27 promotes

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One-Stop-Shops (OSS) through its Directives. In India, a similar approach has been adopted with the establishment of Super ESCOs by the government, although with a focus on aggregating demand for energy-efficient appliances. In China, some local governments have adopted Engineering, Procurement, and Construction (EPC) procurement services to retrofit neighbourhoods.

- ***Capacity building policies:*** In all three regions, training and certification programs for professionals involved in building decarbonization have been integrated into national policies. In the EU27, certification is mandated through energy-related legislation, while China incorporates it into occupational regulations and educational programs. In India, a national certification program has been established. While the EU27 requires certification for a wide range of key services, China and India have narrower qualification requirements. However, the recent recognition of "building energy efficiency and emission reduction consultants" in China could enhance capacity for transitioning to net-zero buildings. Moreover, both the EU27 and China involve recognized entities like industry associations and energy agencies in providing training and certification for building decarbonization professionals, a practice currently lacking in India.

Options to enhance policy efforts

In summary, policymakers in the EU27, China, and India have acknowledged the necessity of implementing comprehensive policy packages to decarbonize their building stock. Both similarities and differences are observed in the types of policy instruments employed across these regions.

The EU27 and China have aligned their building targets with climate objectives. Conversely, the absence of a building roadmap in India may introduce market uncertainties regarding net-zero building transformation. Additionally, EU27 MSs have started implemented EEOs for residential building energy renovations, and carbon pricing has been deployed in some MSs, with buildings scheduled to be included in the EU ETS through the ETS II. China and India could explore the potential of these tools as well. However, to accelerate electrification, certain EU MSs need to consider reducing taxes and levies on electricity for heat pump operation costs, in contrast to the situation in China where there are low residential electricity prices and ToU tariffs.

MEPR has been demonstrated as highly cost-effective for building decarbonization and is implemented across all three regions. However, it is crucial for China's residential decarbonization efforts to mandate building codes for rural areas and existing buildings. While both the EU and China have implemented mandatory codes, India's code remains voluntary. Additionally, India should expedite the adoption of MEPRs at the local level. The EU boasts the most advanced policy in building information disclosure. Although building energy labelling has been introduced in both China and India, their widespread implementation remains limited. In contrast, key policies for appliances, including both MEPS and labeling, are well-established in all three regions.

The implementation of ESCOs for energy renovations in both the EU27 and China has been challenging due to the small scale of residential buildings. However, integrated business models, such as the OSS promoted by the EU27, could help address this issue. Finally, training and certification are essential components of national policies in all three regions to overcome capacity barriers. In India, however, there is a need to involve more recognized entities in providing training, especially due to the limited capacity of public agencies.

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POLICY BRIEF

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