Energy Efficiency 2024

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Abstract

Energy Efficiency 2024 is the IEA's primary annual analysis on global energy efficiency developments, showing recent trends in energy intensity and demand, prices and policies. The report provides sector-specific analysis on buildings, appliances, industry and transport and explores system-wide themes such as electrification, flexibility, investment and employment. This report is launched in parallel with the new IEA Energy Efficiency Progress Tracker, which can be accessed directly through the IEA website.

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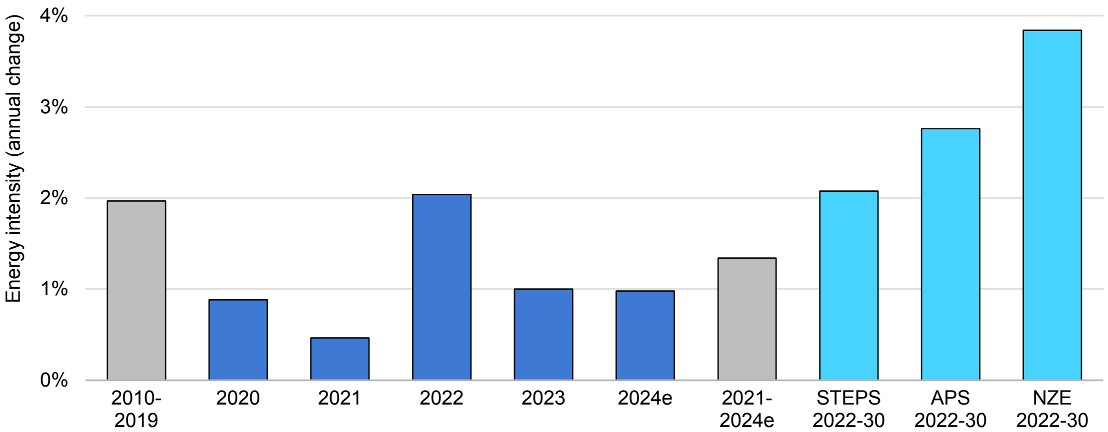
Executive summary

A year on from the historic agreement to double global energy efficiency progress, the world is not yet on track to achieve it

At the COP28 summit at the end of 2023, nearly 200 countries reached a landmark agreement to work together to collectively double the global average annual rate of energy efficiency improvements by 2030. This was the strongest recognition yet by governments of energy efficiency's central role in clean energy transitions, providing an important focal point for greater national ambition and accelerated action. A year on from this historic agreement, however, this has yet to translate into faster efficiency progress, and a major step up in policy implementation is required.

Global energy efficiency progress – measured by the rate of change in primary energy intensity – is set to see only a weak improvement of about 1% in 2024. This is the same rate as in 2023, and around half of the average rate over the 2010-19 period. While energy efficiency progress had accelerated in some countries in response to the global energy crisis, overall improvements in energy intensity have since slowed. Recent years have produced large regional differences in progress, but the disparities have been smaller in 2024: intensity improvements in advanced economies slowed, while progress in many emerging and developing economies held steady or slightly increased.

Global annual improvement in primary energy intensity, 2010-2024e, and by IEA scenario, 2022-2030



Notes: STEPS = Stated Policies Scenario, APS = Announced Pledges Scenario, and NZE = Net Zero Emissions by 2050 Scenario. 2024e = estimated values for 2024. Energy intensity of the global economy is an indicator of energy efficiency, composed of total energy supply over gross domestic product. Positive percentages indicate a reduction in energy intensity year-on-year.

Energy efficiency is key to meeting global goals such as moving away from fossil fuels and lowering emissions

Energy efficiency progress is crucial for the transition away from fossil fuels. In a pathway aligned with the IEA's scenario for achieving net zero energy sector emissions by 2050, accelerating energy efficiency improvements can deliver over 70% of the projected decline in oil demand and 50% of the reduction in gas demand by 2030. This oil demand reduction, which would be roughly equivalent to total oil use in China in 2024, comes in large part from technical efficiency gains, such as improving the fuel efficiency of vehicles, and electrification, including switching to EVs. The reduction in natural gas demand related to efficiency, which would be more than Europe's total natural gas use in 2024, comes largely from measures such as insulating buildings and the electrification of heating.

Accelerating energy efficiency improvements can deliver over a third of all carbon dioxide (CO_2) emission reductions between now and 2030 in a pathway aligned with reaching net zero emissions by 2050. This involves speeding up electrification and improvements in technical efficiency. From 2010 to 2022, improvements in energy intensity contributed to a cumulative reduction in global CO_2 emissions of almost 7 gigatonnes (Gt).

Meeting global efficiency ambitions requires a step up in policy implementation

Governments representing more than 70% of global energy demand have implemented new or updated efficiency policies in 2024. Kenya, for example, updated its building energy code to make efficiency requirements for new buildings mandatory. The European Union updated regulations to achieve a zero-emission building stock by 2050, including measures to promote retrofits of existing buildings. China updated appliance standards and strengthened national targets for efficiency, and the United Stated tightened its fuel economy standards for heavy-duty vehicles. This past year, governments have allocated about USD 60 billion for efficiency measures in buildings and about USD 45 billion for low-emissions vehicles. This brings total efficiency funding earmarked by governments over the past five years to above USD 1 trillion.

However, policy implementation must accelerate to improve energy efficiency progress and align with global climate ambitions. For instance, around the world, almost half of newly built floor area is not yet covered by efficiency requirements, and the regulations in place vary significantly among countries in their scope and stringency. Similarly, just three out of five industrial electric motors in use globally are covered by minimum energy performance standards.

Efficiency investment in 2024 is projected to remain flat

Combined public and private investment on efficiency in end-use sectors (buildings, transport and industry), including investments in electrification such as electric vehicles or heat pumps, is expected to increase by around 4% in 2024 to about USD 660 billion, matching the all-time high set in 2022. This is around 10% more than all expected upstream investment in oil and gas in 2024. Energy efficiency investment has risen by nearly 50% since 2019. In some cases, efficiency investments quickly lead to energy intensity improvements, while in others, structural factors – such as increased industrial output – can offset some or all of the gains. On a net zero pathway, investments in improving the efficiency of buildings, transport and industry triple from USD 660 billion today to about USD 1.9 trillion in 2030.

There are regional differences when it comes to efficiency investment, with emerging and developing economies expected to see the fastest growth this year. Efficiency investment is expected to rise by around 60% in Africa, about 40% in the Middle East and around 20% in Central and South America. However, these regions only account for about 5% of global end-use investment, which is heavily concentrated in Europe, the Asia-Pacific region and North America. In 2024, investment is expected to continue increasing by almost 10% in China, as well as in the broader Asia-Pacific region. Meanwhile, efficiency investment in advanced economies is projected to largely stay flat in 2024.

Nearly 10 million people work in energy efficiency-related jobs, but shortages of skilled workers risk hindering progress

As of 2024, the number of people employed in jobs related to energy efficiency has reached nearly 10 million. The number of efficiency jobs dipped significantly during the Covid-19 pandemic and only recovered to 2019 levels in 2023. Several regions have yet to return to pre-pandemic levels of efficiency-related employment, including China, which has the largest efficiency workforce at 3.5 million, and North America, which follows with 1.4 million. Most other major regions see efficiency employment at similar levels to 2019. India and Africa are among the few places that have seen efficiency employment grow in recent years, adding over 50 000 and 15 000 new jobs in this category since 2019, respectively.

Shortages of skilled workers persist across key efficiency occupations, often risking delays in project implementation. They are most pronounced for heating, ventilation, air conditioning (HVAC) and heat pump installers, construction workers and electricians. Almost four out of five construction companies globally indicate they experience a shortage in skilled workers. Across the whole energy sector, women accounted for less than 20% of workers in 2023, compared with 39% of the global labour force, highlighting a potentially important means of expanding the efficiency workforce.

Coping with rising temperatures and spikes in electricity use from heatwaves requires faster rollout of efficient cooling

Another year of extreme heat is affecting people's lives across the globe, with temperatures reaching 50°C in some places. As a result, sales of air conditioners (ACs) rose sharply in many parts of the world in 2024, providing much-needed cooling. At the same time, the increasing use of ACs has put strains on grids, with over 40 countries, representing about half of global energy demand, reaching new peak electricity demand records, with many others suffering blackouts. With AC sales projected to grow further, efficient models can mitigate their impact on electricity demand. Even though energy performance standards are implemented around the world, sales of inefficient appliances remain all too common.

New IEA analysis shows that efficient cooling technologies do not necessarily cost more to buy than less efficient ones. In Southeast Asia and Latin America – regions heavily affected by heatwave-driven electricity demand peaks – it is possible to buy two different AC models at the same price point, with one twice as efficient as the other. However, due to their lower energy use, efficient appliances are usually much cheaper over their lifetime: Best-in-class models, such as highly efficient refrigerators, can save up to 40% in total costs compared with inefficient ones. However, more efficient models are often less readily available or identifiable compared with their less efficient counterparts.

Electrification is a bright spot in 2024, driven by rising sales of electric vehicles

Electrification is a major driver of efficiency improvements and an area where global progress has sped up this year. In 2024, the level of electrification – defined as the share of electricity in total final energy demand – is set to grow at a rate of nearly 2%, almost double the average annual rate of change achieved between 2010 and 2019. Still, annual growth in the electrification rate of 2% is about half of what is seen on a net zero pathway, where the level of electrification rises from 20% today to nearly 30% by 2030. China has seen a particularly strong growth rate in the level of electrification, achieving about 4% each year in 2010-19 and around 3% annually from 2021 to 2024.

Electrification offers fast efficiency gains across technologies, but end-use energy prices matter for determining the effect on energy bill savings. Electrified technologies can be several times more efficient than those based on fossil fuels. The most efficient mid-size electric car, for instance, uses around half the primary energy of an equivalent internal combustion engine (ICE) vehicle. Similarly, heat pumps often consume less than 25% of the energy used by gas boilers. Still, the benefits of electrification for energy bills depend in part on the price difference, including taxes and other charges, between electricity and fossil fuels, particularly gas.

Governments increasingly turn to efficiency to lower bills

In 2024, households and businesses are still living with the effects of the global energy crisis that led to an unprecedented rise in energy bills. Large spikes in gas, oil and electricity prices forced consumers to pay more for energy at home and at fuel pumps. In OECD countries for which data is available, consumer energy prices in 2024 have declined by an average of almost 15% from peak levels, yet they are on average still over 40% higher than in January 2021. At the same time, government initiatives to shield consumers from the worst of the price increases are coming to an end. Between early 2022 and mid-2023, governments across the world allocated USD 940 billion to short-term affordability measures, peaking at over USD 500 billion in 2022. They have fallen to USD 100 billion in 2024.

Policy action to improve efficiency is the single best approach to simultaneously achieve sustained energy intensity gains, reduce costs for consumers and enhance access to energy services. This year, several countries have turned to efficiency policies as a lever to lower bills, targeting those households most in need. In 2024, countries and regions representing at least 30% of global energy use – including Brazil, Canada, the European Union, Mexico, the United Kingdom and the United States – have policies in place specifically targeting affordability for lower-income families through enhanced energy efficiency.

Emerging and developing economies are key to global efficiency progress and are ramping up policy action

Emerging and developing economies will account for an increasing share of global energy demand. The implementation of strong efficiency policies can help meet climate goals while creating jobs, improving lives and reducing costs. China, India, Southeast Asia, Africa and Latin America together account for almost half of global energy demand today and are expected to see rapid growth in coming years, making them a major force in global energy efficiency progress.

Many of these countries and regions have strong track records in energy efficiency improvements. China, which achieved an average annual energy intensity improvement of almost 4% over the 2010-19 period, is a notable example. India, with strong policies for industry and electric vehicles, among others, is expected to see a 2.5% annual improvement in 2024. In an effort to mitigate rising electricity demand due to heatwaves, Southeast Asia is implementing policies to promote efficient cooling, while several African countries are implementing regulations to drive efficiency in second-hand markets for appliances and vehicles. The harmonisation of standards, which is key to accelerating the deployment of efficient devices, is also ramping up in some regions.

International co-operation is crucial to accelerate progress

The COP28 doubling goal is a global goal, and international co-operation can further enhance its achievement in varying economic, social and technological contexts. With governments currently preparing their next round of Nationally Determined Contributions (NDCs) under the Paris Agreement, there is a window of opportunity to ensure that ambitious energy efficiency measures are a central plank of long-term national plans. NDCs are an important focal point of international discussions and signal ambition on energy efficiency to other governments and investors.

International co-operation can also address issues that hinder efficiency progress, such as the dumping of inefficient equipment. Large quantities of equipment that do not meet efficiency standards in the countries where it is manufactured are currently exported to regions with weaker regulatory frameworks, especially to Sub-Saharan Africa. The harmonisation of standards between countries makes it easier to enforce regulations. Countries can share technical capacities, co-ordinate controls at borders, increase bargaining power in import negotiations, and reduce the risk that equipment enters from neighbouring countries with less strict regulations. Manufacturers also have an important role to play in both minimising the impacts of their operations and improving the efficiency of their products globally.

To increase visibility of energy efficiency and progress towards the global target, the IEA is launching a new Energy Efficiency Progress Tracker. This extends the analysis of *Energy Efficiency 2024* to provide detailed insights around the most up-to-date regional indicators on energy efficiency progress, such as energy intensity, demand and the level of electrification.

The IEA is working closer than ever with governments to ensure that energy efficiency, as a central pillar of secure, affordable and inclusive energy transitions, is prioritised through well-designed and implemented policies and actions. The IEA is providing policymakers with concrete tools to accelerate progress through its Energy Efficiency Policy Toolkit, which is developed in consultation with energy ministers and senior officials each year at the IEA Annual Global Conference on Energy Efficiency. The IEA has trained close to 3 000 policy makers from 120 countries to support the implementation of more effective policies. It is also working directly with energy efficiency policy makers around the world to support the policy responses required to deliver the COP28 global energy goals.

The policies and technologies to double global efficiency progress by 2030 already exist today

The policies and technologies required to accelerate efficiency progress are available today, but implementation needs to speed up across the world to reach global goals. The IEA publishes Energy Efficiency Policy Toolkits to help policymakers with concrete tools. An integrated policy approach – combining **regulations**, **information** and **incentives** – is the most effective way to realise progress across all sectors.

Key early actions for doubling energy efficiency progress

Buildings

- In countries with building energy codes in place, strengthening the efficiency requirements or expanding the scope from new to existing buildings can deliver quick efficiency gains.
- Retrofitting existing buildings provides a means to generate early efficiency gains, local jobs and greater comfort and affordability.

Appliances

- In countries where appliance ownership is high and energy performance standards are in place, tightening them and incentivising the replacement of inefficient devices can accelerate efficiency progress.
- In emerging and developing economies, where appliance ownership is still rising, standards can ensure that inefficient equipment does not form the basis of market growth, while energy labels can inform consumers about their purchase decisions.
- In regions where access to clean cooking technologies remains limited, most notably in Sub-Saharan Africa, accelerated action on delivering clean cooking

for all is the fastest route to efficiency gains, while reducing premature death and enhancing quality of life.

Industry

- Electrification can speed up efficiency progress, particularly in less energy-intensive industries.
- Standards can raise the efficiency of industrial motors – a key source of energy demand – while incentives can promote the early replacement of inefficient motors and accelerate stock turnover rates.

Transport

- Countries can speed up the shift to electric vehicles through scrappage schemes and rebates. In many emerging and developing economies, promoting electric two- and three-wheelers can further increase access to affordable electric mobility.
- Fuel economy standards can improve the efficiency of ICE vehicles, in particular for heavy-duty vehicles, where standards are often absent despite their high energy use.

Chapter 1. Global trends

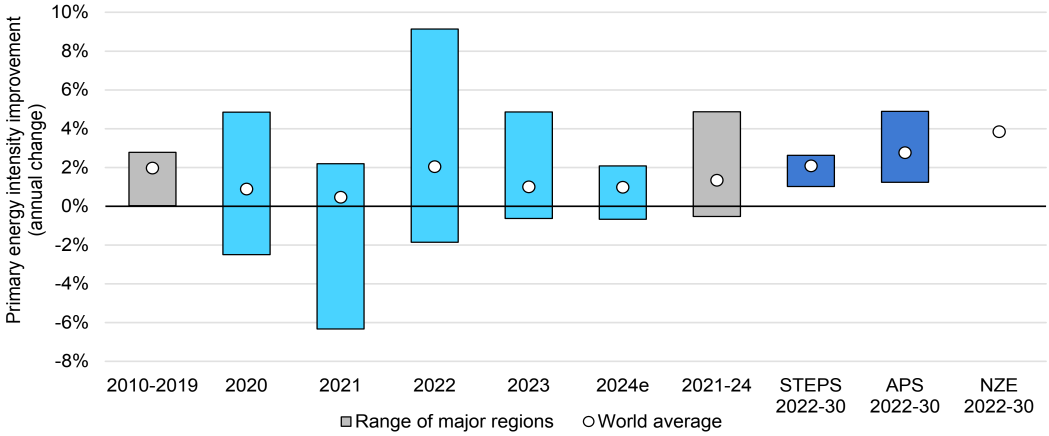
1.1 Energy intensity and demand

A year on from the historic agreement to double global energy efficiency progress, the world is not yet on track to achieve it

Energy intensity is defined as the amount of primary energy used to produce a given amount of economic output and is the main global indicator to track energy efficiency. Despite relatively weak global GDP growth of 3%, energy demand is expected to expand by 2% in 2024 – about the same as in 2023 and above the 1.4% average annual growth last decade. This combination of strong energy demand and slow economic growth means that energy intensity progress – or the reduction in the energy intensity of the economy – in 2024 is expected to be the same rate as in 2023, around 1%.

While the energy crisis marked a possible turning point for energy efficiency in some countries, global energy intensity progress has been lacklustre in 2023 and 2024. This is partly explained by strong growth in energy demand in emerging markets and developing economies that more than offset a fall in energy demand in advanced economies. This comes after the energy crisis sparked by the Russian Federation's (hereafter "Russia") full-scale invasion of Ukraine that saw global energy intensity progress rise in 2022 to 2% on average globally.

Primary annual energy intensity improvement, world average and range across major regions, 2010-2024e, and by scenario, 2022-2030



Notes: STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; NZE = Net Zero Emissions by 2050 Scenario. 2024e = estimated values. Improvement is defined as a reduction in energy intensity. Regions include Africa, Europe, Asia Pacific, Middle East, Eurasia, North America, Central and South America. Light grey denotes the Compound Average Growth Rate (CAGR) for timeframes, light blue are single years, dark blue are CAGR of IEA scenarios.

Source: IEA analysis based on the Energy Efficiency Progress Tracker.

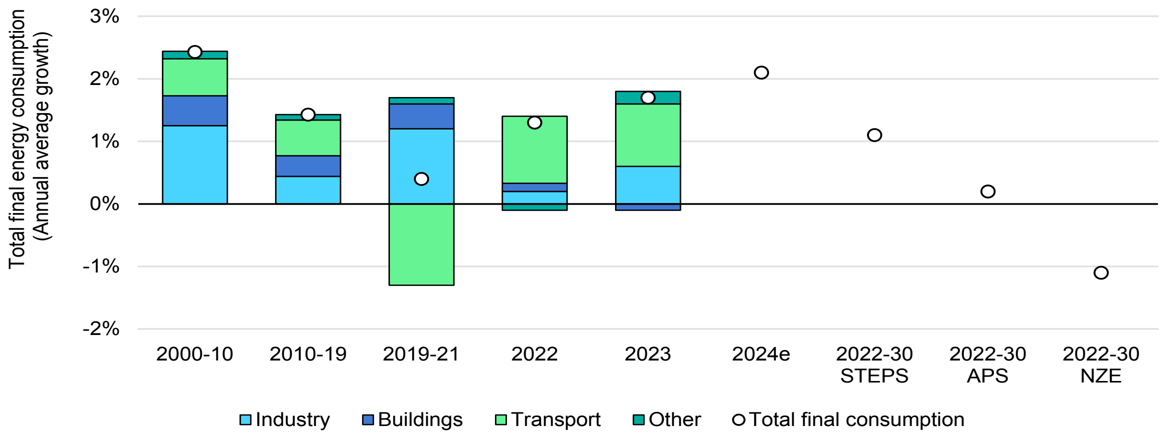
The slow energy efficiency progress in 2024 comes after the historic milestone at COP28, where nearly 200 countries agreed to collectively double the global average annual rate of energy efficiency improvements by 2030. This represented a key milestone for energy efficiency in the global policy arena. A year on from this historic agreement, however, policy responses have yet to translate into faster efficiency progress and a major step up in policy implementation is required.

Industry and cooling-driven electricity demand is pushing energy use higher despite oil demand pressures easing

One of the main drivers of slower global energy intensity progress in recent years has been the strong growth of energy consumption in the industrial sector. Industry accounted for around 75% of final energy demand growth during the years shaped by Covid-19 (2020-21). After a short pause in 2022 during the energy crisis where industrial demand stabilised due to high natural gas prices, energy use in industry from manufacturing sectors recovered in 2023. In 2024, industry is estimated to account for about two-thirds of the expected 2.5% increase of global gas demand.

Energy demand in buildings declined by 0.5% in 2023 as warmer winters in countries with major heating needs reduced heating demand, offsetting increased consumption from other end uses. However, electricity demand is expected to rise by 4% in 2024, up from 2.5% in 2023, driven by a global shift towards electrification. In hot regions, including India, the Middle East and Southeast Asia, exceptionally warm weather also led to sharply higher electricity use for cooling in buildings.

Annual change in final energy consumption, total and by sector, world, 2000-2024e and by scenario, 2022-2030



Notes: 2024e = estimated value. STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; NZE = Net Zero Emissions by 2050 Scenario.
Source: IEA (2024), World Energy Outlook 2024.

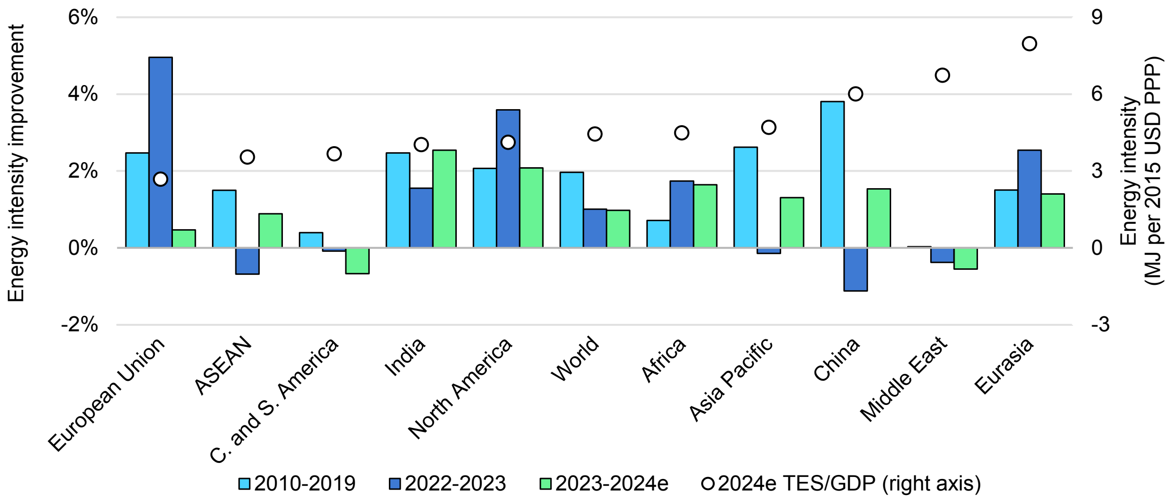
In 2024, a notable slowdown in transport energy demand growth is expected compared to 2023, with motor gasoline demand rising by just under 0.5 mb/d as the post Covid-19 rebound fades. This is also driven by slowing economic growth in the People's Republic of China (hereafter, "China") and increased fuel efficiency combined with the shift to electric vehicles (EVs) that exert downward pressure on fuel demand.

Out to 2030, the IEA Stated Policies Scenario (STEPS) sees average annual energy intensity improvement of around 2% and energy demand growth of about 1% per year this decade. In the IEA Announced Pledges Scenario (APS), a 3% rate of improvement stabilises energy demand at current levels. In the Net Zero Emissions by 2050 Scenario (NZE Scenario), a 4% annual rate of intensity improvement is seen while energy demand decreases by 1% per year. Overall energy demand is 7% lower in the NZE Scenario in 2030 than it is today, even as the economy expands by over 25%.

Energy intensity progress slows in advanced economies while it accelerates slightly in many emerging economies

While global energy intensity progress is expected to improve by around 1% in 2024, just as in 2023, this year's regional drivers are very different. Most notably, intensity progress in 2023 was strong in advanced economies. The European Union saw energy intensity progress of around 5% and the United States registered an improvement of 3.5%. At the same time, China – the country that has led global improvement over the previous decade – has recently seen slower progress and registered a 1% deterioration in energy intensity in 2023, compared to an annual average of 3.8% improvement in 2010-2019. Progress in India was also lower in 2023, at about 1.5%.

Primary energy intensity and annual change, by region, 2010-2024e



Note: 2024e = estimated values; TES = total energy supply.
Source: IEA analysis based on the Energy Efficiency Progress Tracker.

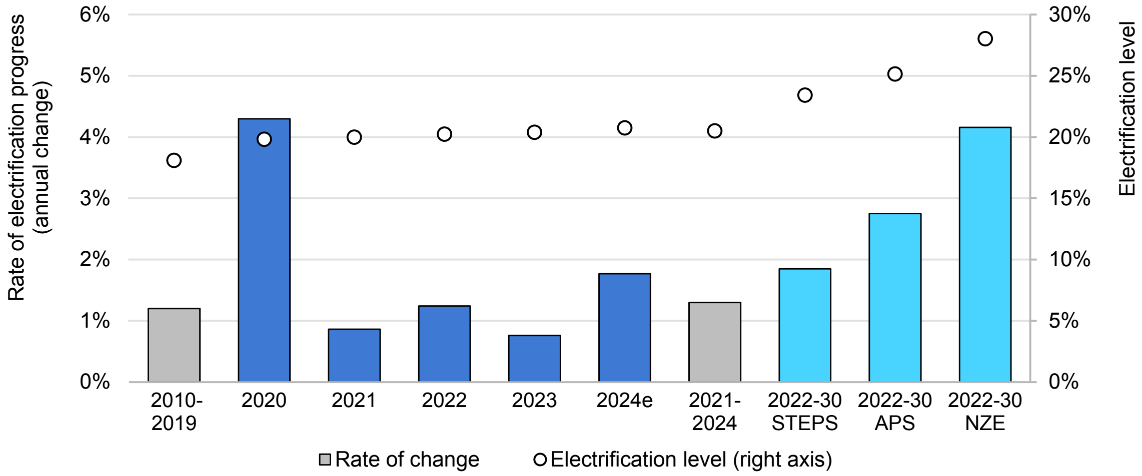
In 2024, however, the main regional drivers of progress have shifted. Energy intensity improvements in advanced economies slowed, with the European Union expected to reach about 0.5% and the United States expected to reach 2.5%. At the same time, progress in many EMDEs held steady or slightly rose off the low base in 2023. China's energy intensity improvement returned to around 1.5% in 2024, with similar changes in Southeast Asia. India's energy intensity progress accelerated to around 2.5% in 2024.

Efficient electrification is a bright spot in an otherwise weak year of energy intensity progress at the global level

Electrification – the process of replacing fossil-fuel-powered technologies with efficient, electric alternatives – is a key driver of energy intensity progress, and an area where the global rate of improvement is set to increase in 2024. The level of electrification, defined as the share of electricity in final energy demand, is expected to rise by just under 2% in 2024, compared with a long-term average of about 1% per year in 2010-2019.

Strong electricity demand growth of 4% in 2024 was not just the result of electrification of the global economy. Rising sales of air conditioners also increased electricity demand, especially in India and Southeast Asia, as recurring heatwaves drove the need for cooling. EV sales continue to advance as well, and could reach around 17 million in 2024, with one in five cars sold globally being electric. China accounted for around 60% of global sales in 2023.

Rate of change and level of electrification, world, 2010-2024e, and by scenario, 2022-2030



Notes: 2024e = estimated values. STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; NZE = Net Zero Emissions by 2050 Scenario. TFC = total final consumption. Electrification level is defined as the share of electricity in total final energy demand. Rate of electrification progress is the annual percentage change in the electrification level. Light grey denotes the Compound Average Growth Rate (CAGR) for timeframes, light blue are single years, dark blue are CAGR of model scenarios
Source: IEA Analysis based on the Energy Efficiency Progress Tracker.

Electrification progress has been particularly fast in China, with the level of electrification increasing by around 4% per year in the last decade and continuing at a slightly weaker 3% between 2021 and 2024. The current share of electricity in final energy demand is around 24% in the Asia Pacific region, 22% in North America and Europe, but only 11% in Africa, 13% in Eurasia and 16% in the Middle East.

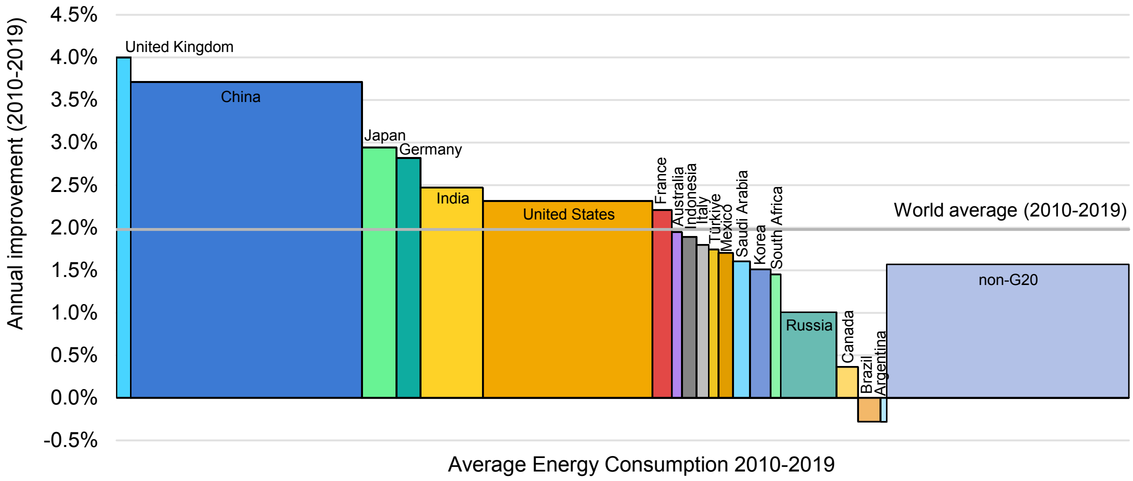
Global energy intensity progress needs to accelerate to achieve a sustained rate consistent with net zero pathways

The landmark COP28 agreement to double the global average annual rate of energy efficiency improvements by 2030 is an important ambition. While it does not imply a commitment for countries to double progress at a national level, nor sets specific individual targets for countries, it can be insightful to analyse what levels of energy intensity progress individual countries have reached over a sustained period of time, and how these compare to the global average during the same period.

A global analysis for the decade from 2010 to 2019 shows that almost all (91%) of the 150 countries for which complete data exists have improved energy intensity by 4% or more in at least one year. More than half (52%) even did so at least three times. The challenge is to achieve this rate of 4% – the global average annual rate of progress in the NZE Scenario between 2022 and 2030 – consistently over a sustained period of time.

When looking at the average across the decade, only one G20 country, the United Kingdom, achieved a 4% improvement on average across the decade from 2010 to 2019. China came close to the 4% level as well, posting average improvements of around 3.7% annually over the same period.

Average energy intensity improvement, selected countries, 2010-2019



What factors contributed to the United Kingdom reaching a 4% average annual energy intensity improvement in the last decade?

Over the period 2010-2019, the United Kingdom was the only G20 country to reach a 4% average annual energy intensity improvement. While progress was strong throughout the decade, four robust years of performance, including two years above 8% in 2011 and 2014, played a particularly key role. There were many factors that contributed to this progress, including policy-induced gains in energy efficiency, structural shifts in the electricity mix, milder than usual weather in 2019 reducing heating demand, and structural changes in industry towards higher-value-added activities. Over the decade, total energy supply fell by 17%, with coal use declining by 80% while renewable power generation grew fivefold to 119 TWh in 2019. This led to major improvements in energy intensity on the supply-side as thermal generation technologies are characterised by high heat losses. This effect is likely to have contributed over 50% of the total primary energy intensity improvement alone as the energy savings in total energy supply were three times larger than in total final consumption.

Significant reductions were also made in final energy demand, which fell by a cumulative 9% in 2010-2019, while the economy expanded by 19%. Residential energy use fell by 21%, even as the population and number of dwellings grew by 6% and 8%, respectively. Over the same period, energy use in commercial buildings declined by 15%. However, another important factor in the residential sector was a difference in the weather between 2010 and 2019, with the number of heating degree days around 20% lower in 2019 compared with 2010, which was an unusually cold year. As space heating is the main use of energy in the UK residential sector, this means a large part of the observed reduction use in households was likely due to the weather rather than efficiency improvement measures. Industrial energy demand decreased by 16% from 2010 to 2019, partly due to industrial restructuring, with a 26% decline in steel production. Demand from non-energy uses, such as feedstock for fertilisers and chemicals, fell by 12%. Transport energy use remained stable, despite a 16% rise in passenger vehicle kilometres travelled.

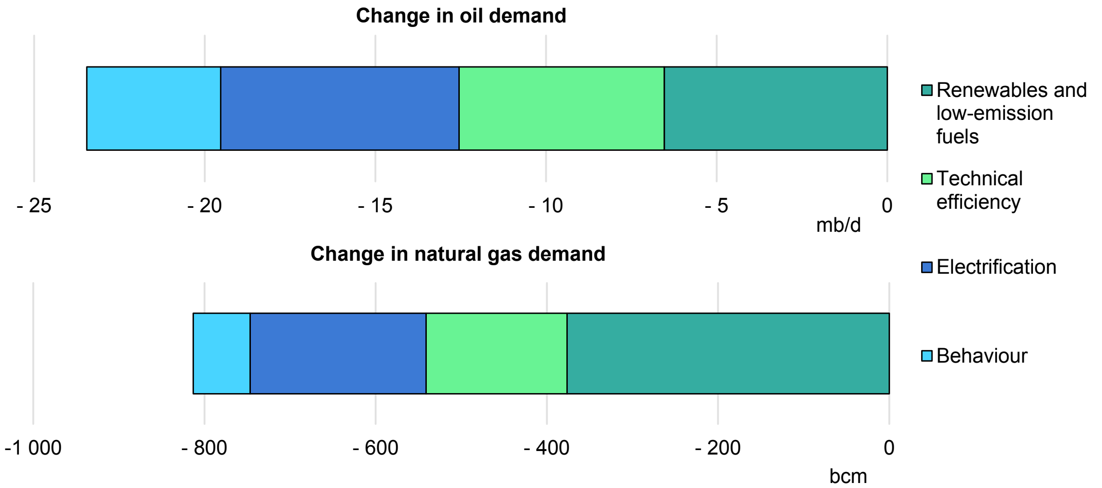
Further gains may have been possible with stronger energy savings in transport and if high-impact buildings retrofit programmes had been maintained. The electrification of transport and heating also offers opportunities for a step change in efficiency compared with what was possible in the past. For instance, impressive reductions in gas use were made through condensing boiler efficiency requirements in the United Kingdom, contributing to a fall of residential gas use of 30% between 2010-2019. However, over the same period there was only a limited shift towards electrification of heating with heat pumps. This suggests that significant efficiency potential remains, even for countries with strong historical progress.

Energy efficiency is key to moving away from fossil fuels

The combination of enhanced efficiency through the electrification of heating and transport can play an important role in the peaking of fossil fuel demand. Electrification not only yields large energy savings, but also offers a pathway to switch from fossil fuel use to renewable energy – a powerful driver of system efficiency and decarbonisation. Looking at the major heating countries, residential gas demand has already peaked, plateaued, or is declining in 34 out of a total of 78 countries tracked around the world, representing half of all energy demand. Similarly, 93 out of 146 countries representing 60% of total gasoline consumption have seen their demand already peak, plateau or decline.

In the IEA COP28 Full Implementation Case, which is an IEA pathway consistent with the NZE Scenario, around two-thirds of the reduction in oil demand by 2030 comes from measures related to energy efficiency. Electrification, such as switching to EVs accounts for around 30% of the demand reduction from efficiency measures. Technical efficiency measures, such as improving the fuel efficiency of heavy-duty vehicles, are responsible for about a quarter of the reduction, while behavioural measures, such as promoting a modal shift towards public transport or cycling, account for over 15%. Energy efficiency measures are similarly responsible for more than half of the reduction in natural gas demand by 2030 in the IEA COP28 Full Implementation Case relative to the STEPS, with the other half coming from renewables and low-emission fuels. Electrification, such as replacing gas boilers with heat pumps, is responsible for about a quarter, while technical efficiency measures, such as insulating buildings, accounted for a fifth of the decline. The remainder is due to behaviour change such as reducing the set temperature of the thermostat.

Oil and gas demand in the IEA COP28 Full Implementation Case relative to the Stated Policies Scenario, 2030



Note: The COP28 Full Implementation Case is a pathway consistent with the IEA Net Zero Emissions by 2050 Scenario.
Source: IEA (2024), From Taking Stock to Taking Action: How to implement the COP28 energy goals.

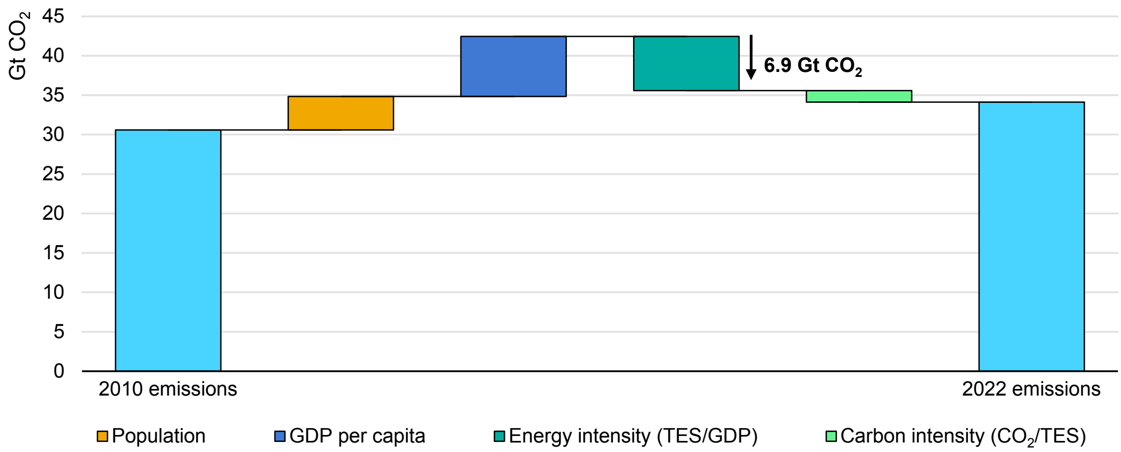
Energy efficiency improvements could deliver over a third of all CO_2 emission reductions between now and 2030

Over the past two decades, the rise in global GDP per capita and population has been accompanied by a rise in worldwide greenhouse gas emissions. However, progress in energy efficiency has significantly mitigated this rise in emissions. During the period between 2010 and 2022, more than 82% of the total reduction in CO_2 emissions achieved at the global level was due to improvements in energy intensity. This amounts to nearly 7 Gt CO_2, equivalent to almost the combined CO_2 emissions of the United States and India in 2022.

Not only has the contribution of energy intensity to emissions reduction been significant on a global scale, but its impact has been even more pronounced in certain regions. The Kaya Decomposition analysis, a tool to express the change in the energy related CO_2 emissions in four major indicators (carbon intensity, energy intensity, GDP per capita and population), reveals that in Southeast Asia and Africa, almost the entire reduction in CO_2 emissions during this period was driven by changes in energy intensity.

In the COP28 Full Implementation Case, which is an IEA pathway consistent with the NZE Scenario, accelerating energy efficiency improvements could deliver over a third of all CO_2 emission reductions between now and 2030, compared to the STEPS. This involves an acceleration in the electrification of end uses, such as switching to electric vehicles and heat pumps, and rapid improvements in technical efficiency, such as retrofitting buildings.

Contribution of energy intensity improvements to the reduction of CO_2 emissions, Kaya Decomposition, 2010-2022



Note: TES = total energy supply.
Source: IEA analysis based on data from the IEA Global Energy and Carbon Tracker.

IEA launches a new Energy Efficiency Progress Tracker to provide countries with the most recent data on global trends

Nearly 200 countries committed to the groundbreaking collective agreement on energy at the COP28 summit in late November 2023, with the aim of keeping within reach of the Paris Agreement target of limiting global warming to 1.5°C. The historic agreement meant that governments collectively recognised for the first time that to transition away from fossil fuels in energy systems in a just, orderly and equitable manner, accelerating action is needed in this decade. The agreement includes collective goals to double the global average annual rate of energy efficiency improvements and triple renewable energy capacity globally by 2030.

To support these goals, the IEA has joined forces with the United Nations in tracking and reporting on the energy-related outcomes of the first Global Stocktake at COP28, which will help to build a consensus on the actions needed to deliver the transitions to 1.5°C, and support the next round of Nationally Determined Contributions.

In an effort to increase visibility and progress towards the global target, the IEA has launched a new Energy Efficiency Progress Tracker in parallel with this report. This online tool provides increased visibility around the most up-to-date regional and country level indicators of energy efficiency progress. This draws on the IEA's unique and world-leading data capabilities, covering historical progress, the latest view on current year energy demand and intensity trends, combined with a future outlook on energy and intensity. Earlier, the IEA launched a detailed Renewable Energy Progress Tracker at the beginning of 2024, which also supports this process.

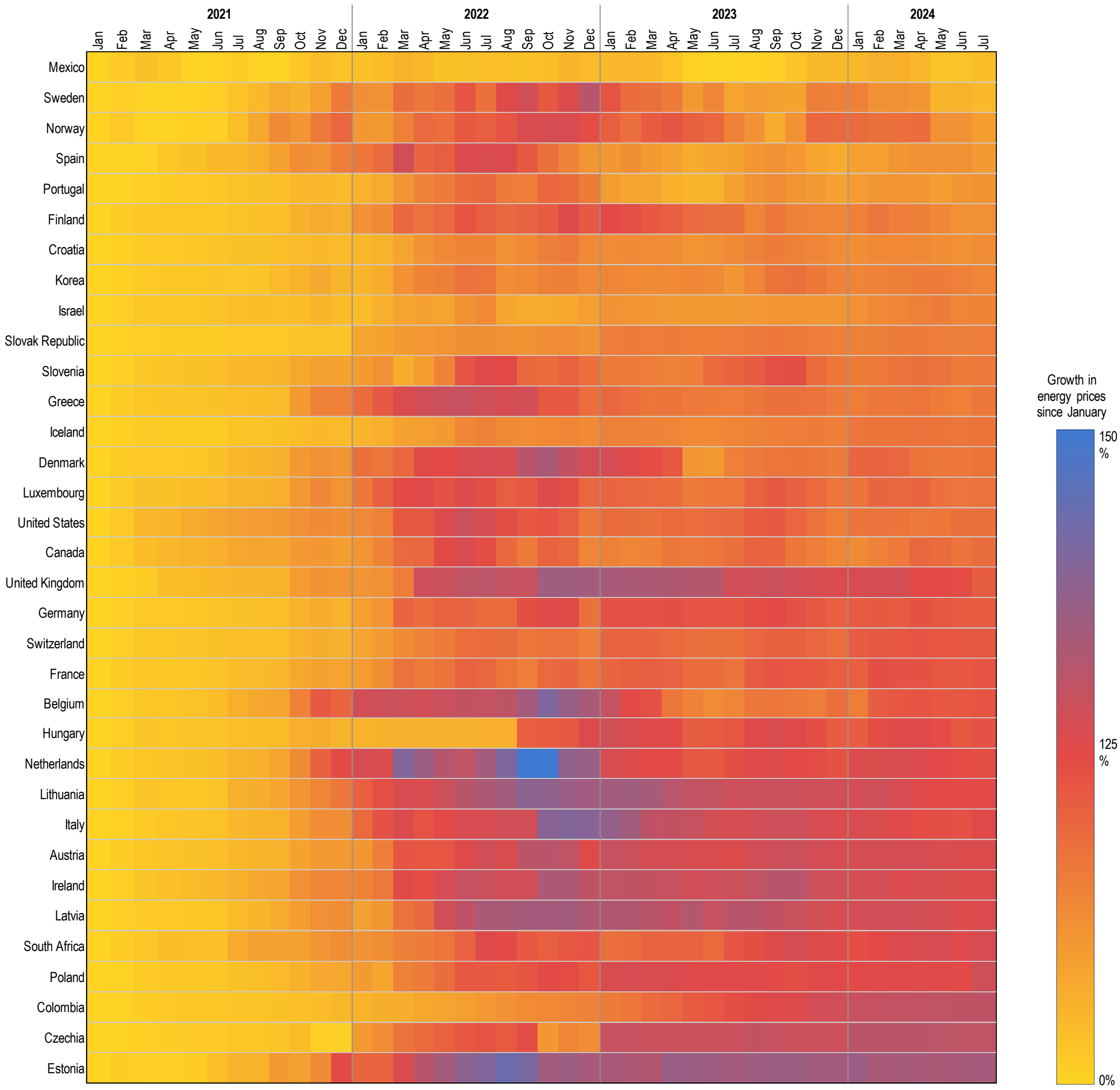
1.2 Prices and affordability

Consumer energy prices are slowly coming down in many regions, but remain higher than before the global energy crisis

In 2024, households and businesses across the world are still living with many of the effects of the global energy crisis that has seen an unprecedented rise in energy bills at the same time as a broader cost-of-living crisis. Large spikes in gas, oil and electricity prices in the past few years led to consumers paying higher home energy bills and at fuel pumps across all regions, as well as indirect price rises in food and other goods. In Europe, consumers were particularly hard hit by higher natural gas prices. In most OECD countries, energy price inflation reached its peak in mid- to late-2022, at which point wholesale energy prices began to ease and government spending to mitigate consumer price rises took effect.

While prices have started to come down from their 2022 peak levels, they remained elevated over 2023 and into 2024 compared to pre-crisis levels. In OECD countries for which data is available, the energy consumer price index (which accounts for household energy and transport fuel bills) has fallen by an average of almost 15% from peak levels but is on average still over 40% higher than in January 2021.

Growth in energy prices (change in Energy Consumer Price Index), selected countries, January 2021-July 2024

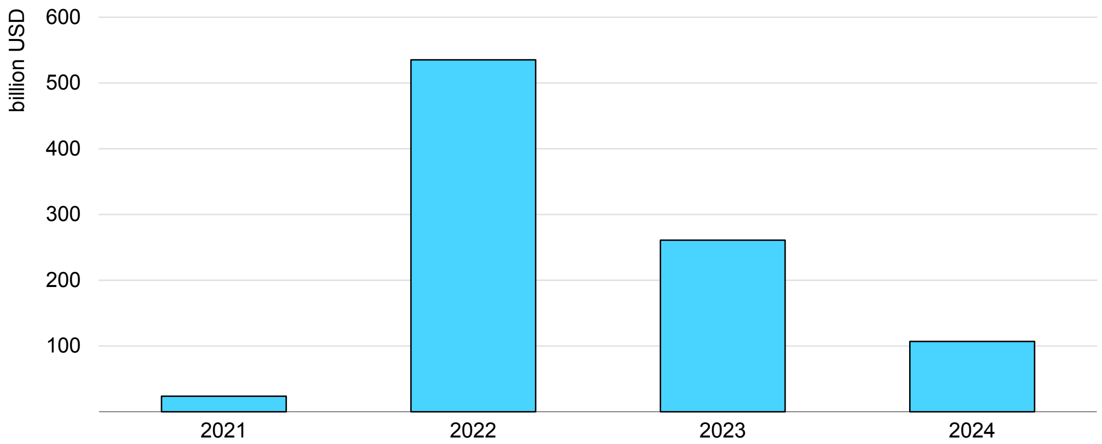


Note: Countries are ordered from the smallest percentage increase in Energy CPI between January 2021 and July 2024 (top) to the largest percentage increase (bottom).
Source: IEA analysis based on data from OECD Data Explorer, Consumer price indices.

Short-term government initiatives designed to shield consumers from price spikes are ending in most countries

As detailed in the IEA's State of Energy Policy 2024, during the energy crisis governments allocated close to USD 940 billion to short-term consumer support measures in an attempt to shield them from rising energy bills. Earmarked spending reached a peak of USD 535 billion at the height of the energy crisis in 2022. The level of spending, however, was uneven across regions, with most of the support allocated by European governments. Measures including tax reductions, cash transfers, vouchers and price regulations provided buffers for consumers when prices were highest. In addition, fossil fuel subsidies peaked in 2022, reaching an unprecedented USD 1.2 trillion. However, those measures weighed on public expenditure, and as wholesale energy prices started to decline, governments reduced spending, with most support directly from government balance sheets being phased out in the first half of 2024. Some countries have been reinstating pre-crisis VAT levels on energy, with Germany, for example, returning to 19% in Q2 2024 after a cut to 7% in Q4 2022, while Spain increased its VAT to 10% in Q1 2024, after dropping from 21% to 5% in Q4 2022. This rollback of support measures in part accounts for the relatively slow deflation of consumer prices seen over the past year. Of the USD 940 billion spent during the energy crisis on short-term consumer support, about one-fifth was explicitly targeted to low-income groups or the most-impacted industries.

Earmarked government support for consumer energy affordability measures by budget allocation year, 2021-2024



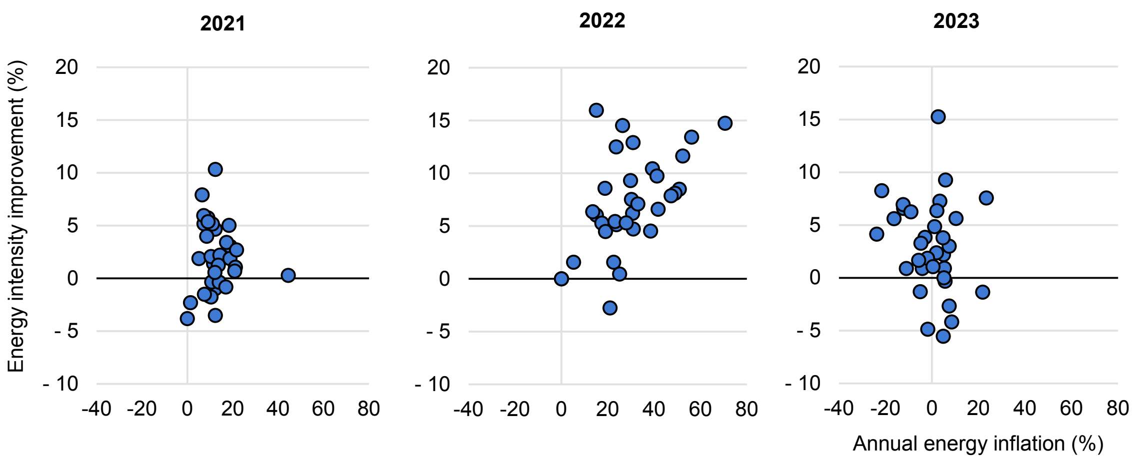
Source: IEA analysis based on data from IEA (2024), State of Energy Policy 2024.

Higher prices do not necessarily lead to immediate efficiency gains, but action on efficiency can mitigate future price rises

In 2022, OECD countries that saw the greatest consumer price increases tended to experience larger improvements in energy intensity. While this may suggest that higher prices promote efficiency gains, there are reasons for a more cautious interpretation. Much of this change may have been driven by end users foregoing energy services or by reduced industrial output with many energy-intensive industries affected by plant shutdowns or production curtailments.

As reported in Energy Efficiency 2023, despite a strong response to the crisis in the form of new standards and regulation, it takes time for such policies to drive observable demand change. This is further highlighted by the fact that 2022 was an exceptional year, as the relationship between prices and energy intensity improvements is much less pronounced in other years, including 2021 and 2023. Policy action to improve energy efficiency is the single best approach to achieving sustained energy intensity gains while reducing costs for consumers and maintaining access to critical energy services.

Annual improvement in primary energy intensity versus annual energy inflation (change in the Energy Consumer Price Index), selected countries, 2021- 2023



IEA. CC BY 4.0.

Source: IEA based on data from OECD Data Explorer, Consumer price indices.

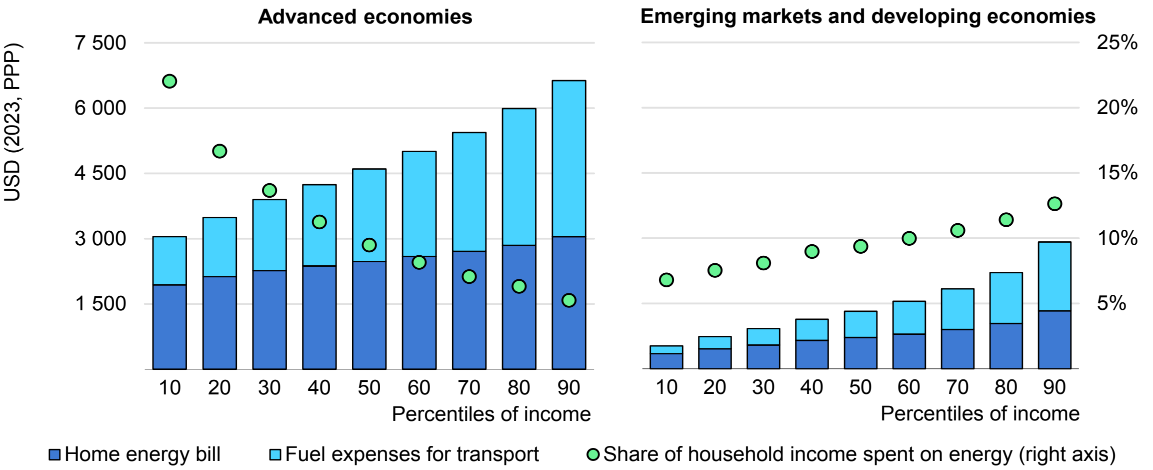
Targeting energy efficiency measures at lower-income households can optimise impact while easing public spending

In the NZE Scenario, energy efficiency is an important policy lever to reduce household energy expenditure. Compared to current policy settings, the NZE

Scenario sees household spending on energy decrease by 30% in advanced economies and 20% in EMDEs by 2050, partly driven by efficiency measures such as building retrofits. In particular, for governments with less fiscal capacity to invest in financial support for affordability, targeted efficiency measures (directed towards lower-income groups) can provide cost-effective, quick and sustained gains, and mitigate the impact of future price rises on energy bills.

A recent IEA report on Strategies for Fair and Affordable Clean Energy Transitions finds that in advanced economies the share of household income spent on energy (residential energy and transport fuels) by the poorest 10% is four times higher (22%) than the share spent by the richest 10%, despite the fact that poorer households consume only about half as much energy. In EMDEs, households consume only a third of the energy compared to advanced economies. In advanced economies, over two-thirds of household energy use is for water heating, space heating and cooling, making thermal adjustment one of the largest determinants of energy bills. Efficiency policies can, for example, promote improved insulation or limit the energy use of heating and cooling devices. This can alleviate energy poverty[1], improve health, and redirect spending to other essential goods and services.

Annual household energy expenditure by income decile, 2019-2023 average



Source: IEA (2024), Strategies for Fair and Affordable Clean Energy Transitions.

[1] While there is no agreed threshold of energy poverty, it generally refers to disadvantaged individuals, families or communities who are unable to afford some defined level of energy service. Please refer to IEA, Strategies for Fair and Affordable Clean Energy Transitions (p.26), for further definitions of energy poverty and affordability as used in this report.

Policy design can increase access to affordable energy efficient technologies for lower-income households

In 2023, 20% of clean energy investments were made by households, mostly in energy efficiency. However, these were driven by higher-income households, more able to afford the upfront investment for efficient technologies. In the United States, for example, the upfront investment cost of a heat pump, a deep home retrofit or an EV represent about 15% of annual household income for the poorest 20% of the population. For the top 20% income group, efficient or less efficient alternatives amount to around 2% of annual income. Policy design can help make efficient technologies more affordable for lower-income groups. For example, policies promoting electric public transport or two- and three-wheelers lead to more affordable electric mobility options than policies promoting electric cars. Similarly, retrofit grants targeted at lower-income households can help to address affordability issues. When grants are untargeted, high-income groups often capture most of the benefits.

Selected policies promoting affordability through efficiency measures, 2024

Country	Policy
Brazil	The Energy Efficiency Program mandates utilities to allocate part of their revenue to efficiency. Half of the investments were directed to low-income groups, saving 15% on the electricity use.
Canada	The Greener Homes Affordability Program will provide USD 588 million to fund low- and medium-income households in reducing heating costs through retrofits.
Czechia	The New Green Savings Programme Light provides up to 100% of the costs of efficiency measures for low-income households, with a maximum of USD 6 500 per home.
Chile	The Housing and Neighbourhood Improvement Programme provides subsidies up to 80% of the costs for home upgrades, reducing costs for low-income families.
EU	The revised Energy Efficiency Directive raises efficiency obligations, mandating member states to prioritise energy poor, vulnerable and low-income households as beneficiaries.
France	The Renovation Mortgage provides mortgages to low-income groups for renovations. From 2024, a zero-interest version of this loan is available for up to USD 54 400.
Ireland	The National Retrofit Plan targets 500 000 upgrades by 2030, focusing on low-income households. In 2023, 6 000 energy-poor homes were retrofitted.
Mexico	The Pilot Project for Efficiency Measures integrates efficiency in self-built housing.
New Zealand	The Warmer Kiwi Homes covers up to 90% of the costs to purchase and install insulation and an efficient heater for homes built before 2008 in low-income areas.
Portugal	The Long-Term Strategy aims to eradicate energy poverty by 2050. It allocates USD 326 million for efficiency in for homes in 2021-2025 for low-income households.

Country	Policy
Slovenia	The ZER call offers a 100% subsidy for energy-poor households, up to USD 19 600, with a total budget of USD 5.4 million.
United Kingdom	The Home Upgrade Grant II provides USD 805 million from 2023-2025 to improve energy performance in low-income households that live in inefficient homes.
United States	The Weatherization Assistance Program helps 35 000 low-income households by improving home efficiency, generating up to USD 372 annual savings per house.

1.3 International developments

Collective aim to double global efficiency improvements by 2030 sets benchmark for progress in coming years

At the COP28 summit, countries committed to work together to collectively double the global rate of energy efficiency improvements by 2030 and recognised the role of energy efficiency as the "first fuel" in the clean energy transition. This global doubling goal is the strongest recognition yet by governments of energy efficiency's central role in clean energy transitions. The goal was agreed alongside several other 2030 energy system goals, such as a target to triple renewables capacity and significantly reduce methane emissions from the energy sector. The COP28 agreement has brought into sharp focus the steps that governments need to take to achieve the target. In 2024, several international agreements built on the COP28 outcome on energy efficiency.

In the G7 Climate, Energy and Environment Ministers' Communiqué, for example, political leaders reaffirmed the goal and called on governments to take additional steps towards achieving the COP28 ambition. Similarly, in the Ministerial Outcome Statement from the G20 Energy Transitions Ministerial Meeting in Brazil in October 2024, the ministers of G20 countries agreed to support the implementation of efforts to double the global average annual rate of energy efficiency improvements and improve energy efficiency and energy savings as the first fuel.

The doubling energy efficiency goal was also the focus of other international meetings across 2024. In May, more than 650 people from over 70 countries gathered in Nairobi, Kenya, for the IEA 9th Annual Global Conference on Energy Efficiency. The joint statement of the Conference co-chairs, Kenya's Minister of Energy and Petroleum Davis Chirchir and IEA Executive Director Fatih Birol, urged governments to implement policy action towards the doubling goal as part of Nationally Determined Contributions and wider energy transition plans.

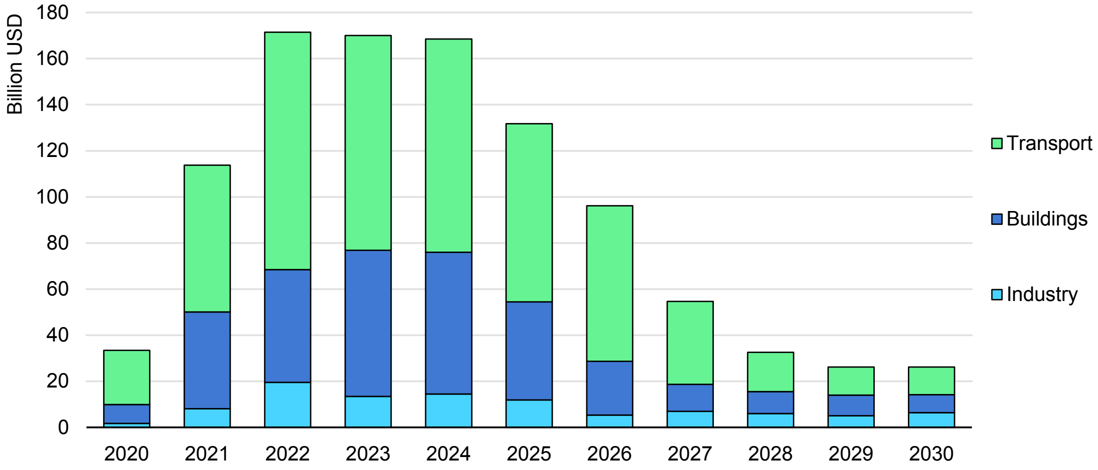
At the event, a consortium of business leaders led by the Energy Efficiency Movement, the International Business Council of the World Economic Forum and the Kenya Association of Manufacturers came together to identify key areas where the private sector can collaborate with governments to further progress towards the doubling goal. The resulting Nairobi Business Leaders' Action Plan on Public-Private Collaboration to Double Energy Efficiency Progress this Decade highlights five key building blocks for action, and has been used as the basis for deeper collaboration internationally.

1.4 Policy developments

Over USD 1 trillion in government spending has been earmarked to support energy efficiency this decade

As of September 2024, governments worldwide have earmarked over USD 1 trillion on energy efficiency spending from 2020 to 2030. This includes spending to promote efficient buildings and industries, mass and alternative transit, and low-carbon vehicles. Notably, this energy efficiency-related spending accounts for more than half of all government support for clean energy investments. 80% of the spending earmarked for efficiency was in the European Union, the United States, and China. Disbursement for energy-efficient buildings accounts for a large share of efficiency support, with earmarked spending expected to reach USD 340 billion by 2030. In 2024, USD 60 billion was allocated for buildings, with new support from Germany's Special Climate and Transformation Fund and Poland's Clean Air Programme. Earmarked government spending for low-emissions vehicles amounts to around USD 290 billion by 2030. In 2024, low-emissions transport incentives are about USD 90 billion, mostly from China and the United States. China promotes efficient transport through its New Energy Vehicle tax exemptions, while the United States sees continued disbursements from the Inflation Reduction Act. In industry, Germany launched its Carbon Contracts for Difference scheme, earmarking USD 4 billion to incentivise industries to adopt low-carbon technologies. Canada supports industry through the Clean Technology Investment Tax Credit, focusing on low-carbon heat and low-emission vehicles.

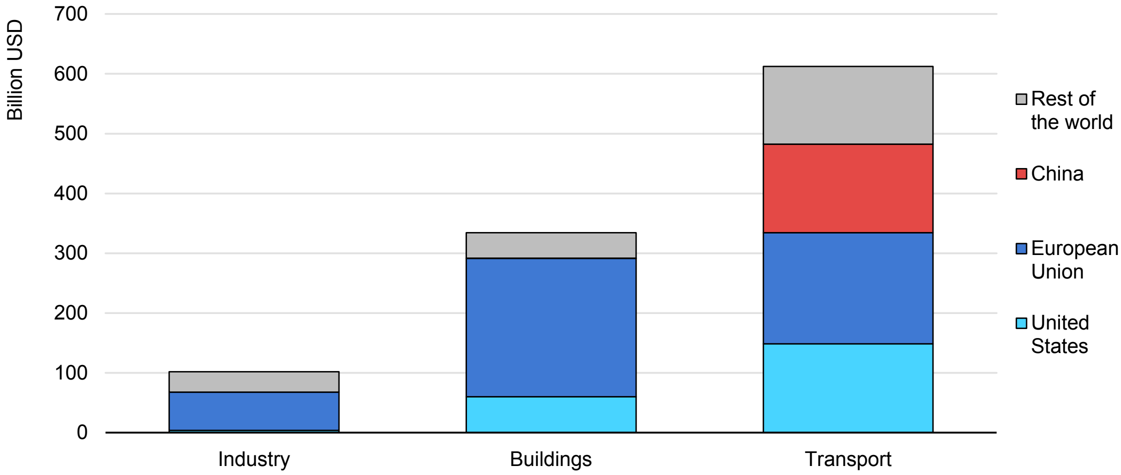
Earmarked government spending for energy efficiency, by sector, 2020-2030



Notes: Earmarked government spending shows planned disbursements and indicative forward-looking spending across budget timelines as validated between 2020 and H1 2024. These estimates do not translate into disbursement projections up to 2030, as it is expected that governments will route more spending packages through annual approval processes.
Source: IEA (2024), State of Energy Policy 2024.

This year sees many governments across various regions strengthen their energy efficiency policy mix. A notable development in 2024 is the number of new or updated policies to promote efficiency in buildings. The United States and Canada announced new strategies to decarbonise buildings, while the European Union updated its Energy Performance of Buildings Directive (EPBD), and Korea launched a new energy management programme for medium and large buildings. New standards for appliances are also being rolled out, such as Mexico's standard for air conditioners, Brazil's standard for refrigerators, and Nigeria's ongoing review of its Minimum Energy Performance Standards (MEPS) for air conditioners. Meanwhile, China and Türkiye both unveiled updated targets to accelerate energy efficiency progress at the national level.

Earmarked energy efficiency-related government support, by sector and region, 2020-2030



Source: IEA (2024), State of Energy Policy 2024.

Selected policy developments, by region and country, 2024

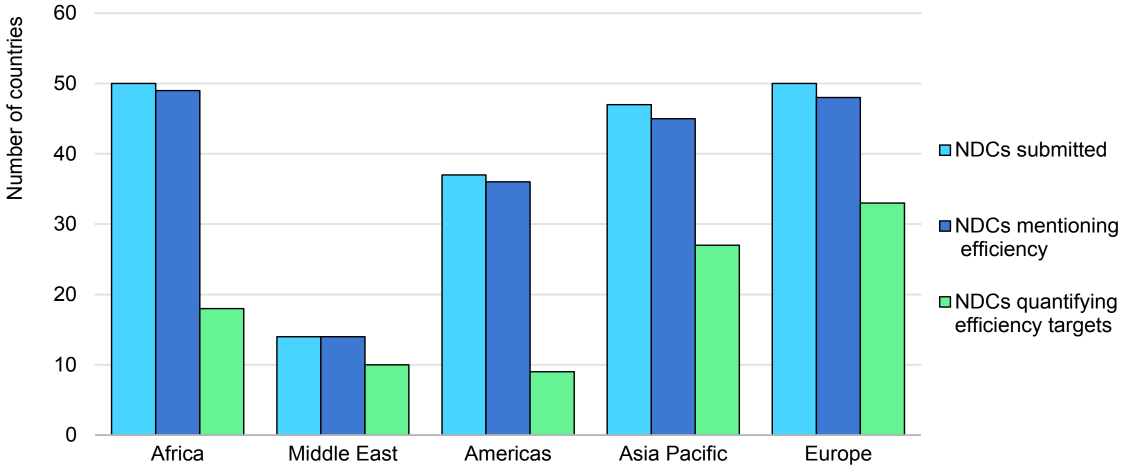
Region	Policy update
Asia Pacific	• **China** published an Energy Conservation and Carbon Reduction Action Plan targeting 2.5% energy intensity improvement in 2024 and energy savings of about 2.9 EJ in 2024 and 2025. • **Japan** announced a Strategy for Energy Efficiency and Transition to Non-Fossil Energy 2024, prioritising energy-saving technologies on efficient heat use in industry and buildings, and enhanced data processing and vehicle performance. • **Korea** launched the Energy Intensity Target Management Programme for medium and large buildings, setting energy use targets per unit area and assigning ratings based on the achievement of these relative goals. • **India** revised guidelines for electric vehicle charging infrastructure to set ambitious roll-out targets for urban and highway locations by 2030. • **The Philippines** strengthened regulation to mandate annual efficiency audits for smaller energy users in the commercial, manufacturing, and building sectors. • **Australia** implemented a New Vehicle Efficiency Standard, aiming to reduce emissions from new passenger vehicles by over 60% and halve the emissions of new light commercial vehicles by 2030.
North America	• **The United States** released a National Blueprint to reduce energy use intensity in buildings by 35% by 2035 and by 50% by 2050, compared to 2005. • **Canada** released the Canada Green Building Strategy that includes almost USD 600 million to accelerate retrofits and a regulatory framework that allows the phase out of oil heating in new buildings as early as 2028. • **Mexico** published a draft new standard for central air conditioners.
South America	• **Brazil** implemented regulation on Energy Efficiency Indexes for refrigerators, targeting a 17% increase in efficiency for products in the market from 2028. • **Chile**'s new energy efficiency standard for light vehicles came into effect, targeting a 45% increase in efficiency for new vehicles. • **Bolivia** received a USD 35 million loan from the Inter-American Development Bank to increase the efficiency of public lighting systems.
Europe	• **The European Union** revised the Energy Performance of Buildings Directive, mandating zero-emission new buildings by 2030, introducing MEPS for non-residential buildings, and mandatory long-term renovation strategies. • **Germany** amended the Energy Service Act and Energy Efficiency Act, mandating energy audits for companies with an energy use above 2.77 GWh per year.

Region	Policy update
Europe (continued)	• **France** announced a plan to produce one million heat pumps by 2027, aiming to create 47 000 jobs, including 30 000 installers. • **The United Kingdom**'s Public Sector Decarbonisation Scheme commits almost USD 680 million to support efficiency in schools, hospitals and public buildings. • **Türkiye** plans to invest USD 20 billion in energy efficiency by 2030, aiming to reduce energy consumption by 16%, and save USD 46 billion in energy by 2040.
Africa	• **The African Union** is developing the African Energy Efficiency Strategy and Action Plan, targeting a 50% increase in energy productivity by 2050. • **The Southern African Development Community** approved MEPS for air conditioners and refrigeration, aiming to cut consumer bills by USD 840 million per year. • **South Africa** enacted the Climate Change Act to boost energy efficiency across the nation with sectoral emission targets. • **Kenya** launched its first National E-mobility Strategy Draft, guiding the development of electric mobility in various transportation modes.

Energy efficiency targets should be an important pillar of the updated Nationally Determined Contributions in 2025

Countries have outlined their plans and targets for reducing greenhouse gas emissions in their NDCs and update them when policies change and new goals are set. NDCs are climate action plans defined by the countries party to the Paris Agreement for mitigating greenhouse gas emissions and for adapting to climate change impacts. These are crucial in guiding global efforts, as they outline a nation's plans and targets for reducing emissions in line with their common but differentiated responsibilities and respective capabilities. The 195 countries party to the Paris Agreement accounted for 95% of total global emissions in 2019, and have all submitted NDCs.

Number of countries with energy efficiency targets in their Nationally Determined Contributions as of 2024, by region



Energy efficiency is frequently mentioned in NDCs as a cost-effective mitigation option, with costs under USD 20/t CO_2-eq by 2030. 190 countries explicitly mention efficiency in their national plans, and 96 of these provided quantified information on their specific mitigation targets. Overall, countries in every region of the world show engagement in the global effort to improve energy efficiency. For example, 71% of countries in the Middle East and 66% of countries in Europe have a quantified efficiency target in their NDC. This reflects a strong commitment to achieving their energy efficiency goals. The Asia Pacific region also shows promising momentum with 58% of NDC submissions featuring quantified targets. The Americas have a relatively limited number of countries with quantified efficiency targets, just nine in total. In Africa, 36% of NDCs include numeric targets for efficiency. As countries prepare to update their NDCs in 2025, it will be crucial to see the role energy efficiency will be given in the plans. Quantified targets can help solidify energy efficiency plans and can signal countries' intentions to contribute to the COP28 goal to collectively double global energy efficiency progress by 2030.

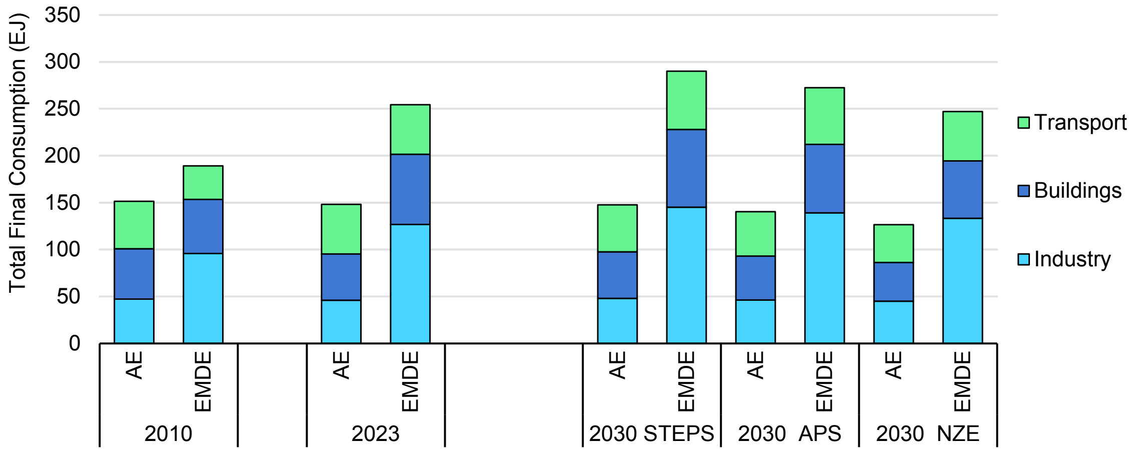
Chapter 2. Sectors

Greater efficiency progress across all end-use sectors can help mitigate rising energy demand towards 2030

Global final energy consumption rises by 1.3% per year on average from 2023 to 2030 under current policy settings in the Stated Policies Scenario. Demand stabilises in the Announced Pledges Scenario, while it falls by about 1% per year on average in the Net Zero Emissions by 2050 Scenario over this same period. The level of improvement in energy intensity over this decade will in part determine whether the world develops along a high-, medium-, or low-energy demand pathway.

Global total final energy consumption was approximately 445 EJ in 2023, with the industrial sector responsible for the largest share at 39%, followed by buildings (including appliances) at 28% and transport at 27%. The remaining 6% came from other end uses. Total energy demand in advanced economies has declined on average by 0.5% per year over the past decade, while in EMDEs it has increased by around 2.6% per year over the same period. EMDEs accounted for almost two-thirds of global energy demand in 2023 and will dominate global consumption for the rest of the decade. EMDEs see an average annual growth of nearly 1.9% between 2023 and 2030 in the STEPS while advanced economies post declines in all three scenarios.

Total final consumption by sector in advanced economies and emerging markets and developing economies, 2010-2023, and by scenario, 2030



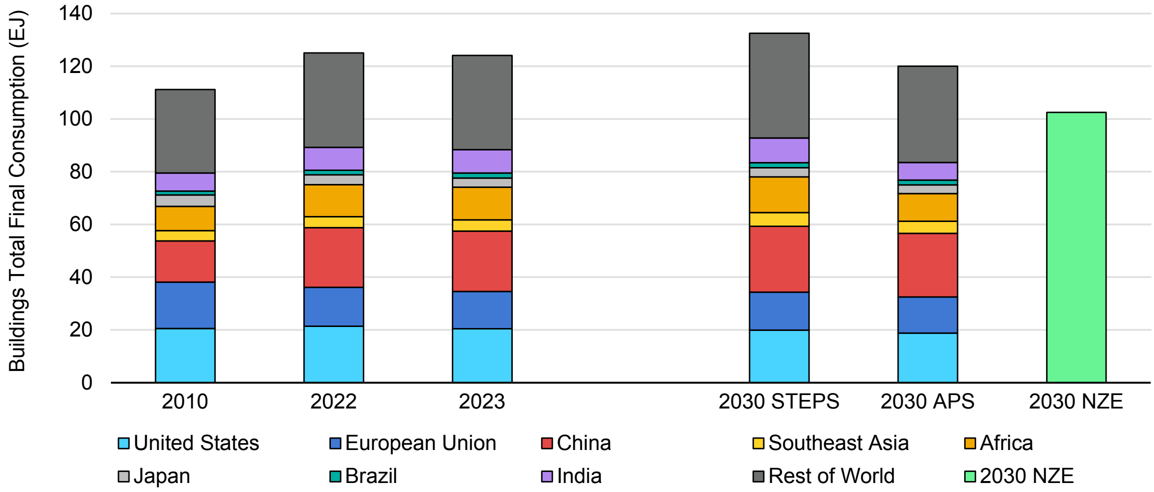
Notes: AE = advanced economies; EMDE = emerging markets and developing economies. STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; and NZE = Net Zero Emissions by 2050 Scenario.
Source: IEA analysis based on World Energy Outlook 2024 extended dataset.

2.1 Buildings

Energy intensity progress in buildings accelerates in 2023

Energy demand in buildings was over 120 EJ in 2023 and accounted for 28% of global total final energy consumption, with demand having increased by an average of 0.9% annually between 2010 and 2023. The United States, the European Union and China were responsible for almost half of all energy use in buildings in 2023. Under current policy settings, building energy demand grows to over 130 EJ in 2030. In the APS, energy use in buildings in 2030 is slightly below 2023 levels at around 120 EJ. The NZE Scenario sees energy efficiency progress in buildings increase substantially by 2030, with all new buildings and a significant share of existing ones becoming zero-carbon-ready, which would lead to a 17% reduction in total final energy use in buildings to a little over 100 EJ globally.

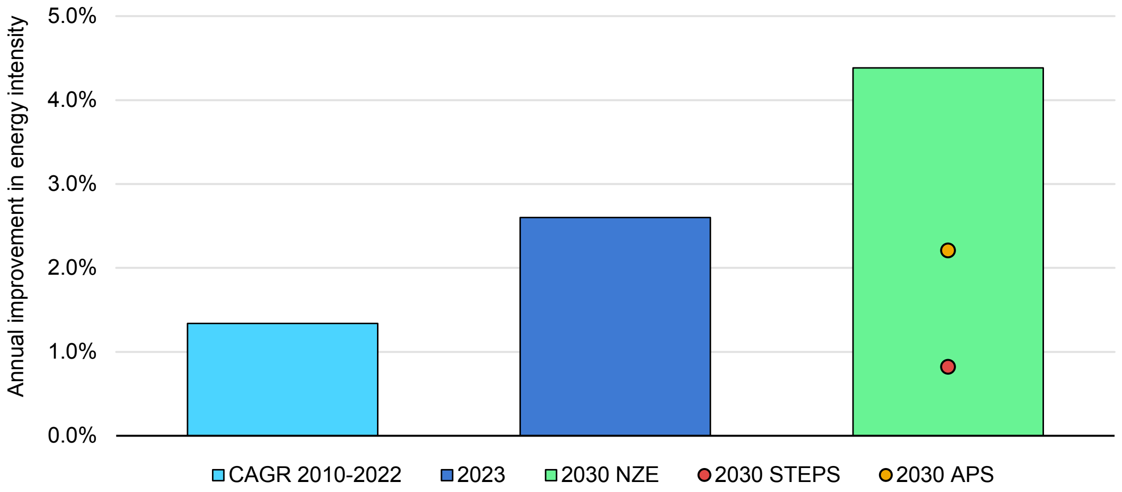
Total final energy consumption for buildings, 2010-2023, and by scenario, 2030



Notes: STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; and NZE = Net Zero Emissions by 2050 Scenario. International bunkers final consumption included in Rest of World.
Source: IEA analysis based on World Energy Outlook 2024 extended dataset.

Energy intensity in buildings decreased between 2010 and 2023, with an average annual improvement of 1.4%, reaching a cumulative total of 17% reduction over the entire period. Last year saw energy intensity improvements of 2.6% globally. In the STEPS, intensity in buildings improves by just under 1% per year on average by 2030. This rate of improvement more than doubles in the APS to 2% per year. In the NZE Scenario, the average improvement rate for the buildings sector is 4.4% annually from now until 2030 – more than three times the average rate of 1.4% registered between 2010 and 2023.

Global energy intensity progress for buildings, 2010-2023, and by scenario, 2030



Notes: STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; NZE = Net Zero Emissions by 2050 Scenario. CAGR = compound annual growth rate.
Source: IEA analysis based on World Energy Outlook 2024 extended dataset.

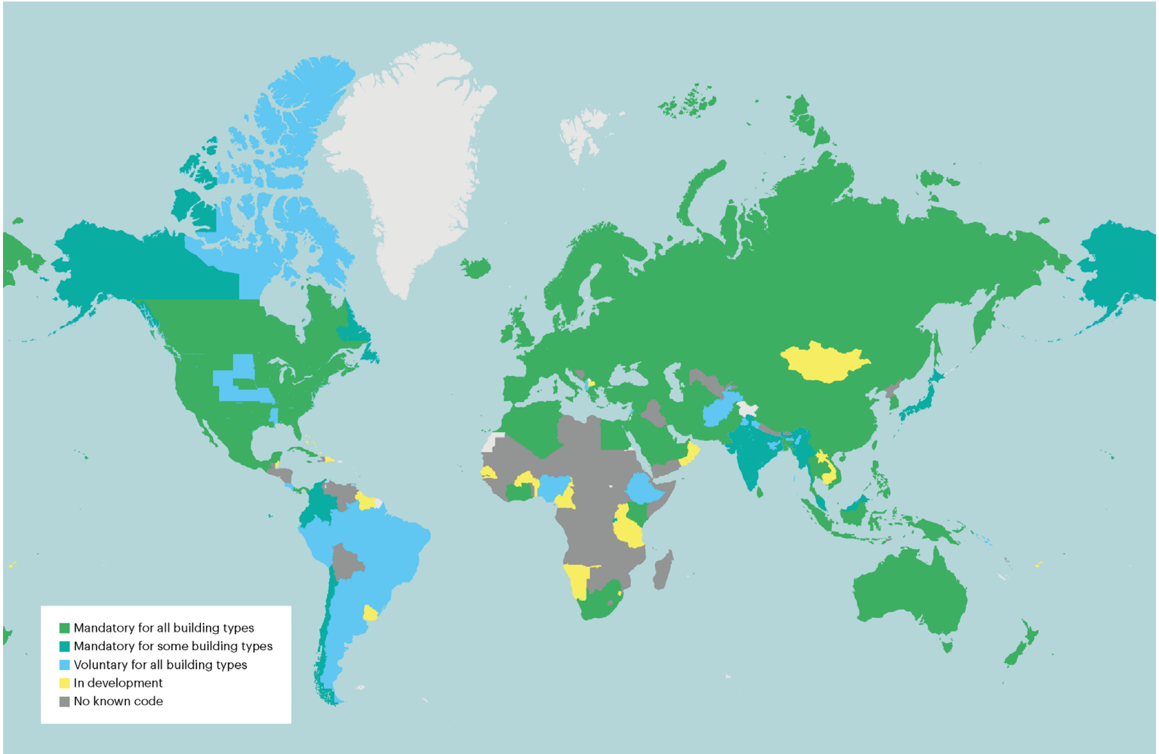
Key early actions in buildings for doubling energy efficiency progress

- **Regulations**: Enforcing mandatory energy efficiency requirements for buildings, for example as part of building energy codes, can prevent locking in inefficiency in buildings. In places with high construction rates, this is important for new buildings. Kenya made the requirements in its building energy code mandatory for new buildings in 2024, and also included smart solutions in the code, starting from March 2025. Existing buildings can be made more efficient by applying the mandatory requirements of building energy codes to them and making those more stringent with every update. The European Union updated the Energy Performance of Buildings Directive in 2024, which includes measures to encourage the use of Building Automation Control Systems and a requirement for all new buildings to be zero-emission buildings from 2030 onwards.
- **Incentives**: Grants can help homeowners afford the upfront investment costs of retrofits. In 2024, Canada announced new funding of almost USD 600 million (CAD 800 million [Canadian dollars]) under the Greener Homes Affordability Program that will support directly-installed and fully-funded home retrofits for low- to median-income households.
- **Information:** Government-supported training programmes can boost the skills of efficiency professionals and ensure that there are sufficient workers to implement retrofits. The United Kingdom funded training providers, such ascolleges and technical schools that run accreditation programmes, to offer courses in retrofitting and installing insulation in 2023 and 2024. Additional funding is planned from 2025 to 2028.

Almost half of newly built floor area is not yet covered by energy efficiency requirements

Building energy codes are an important regulatory tool to establish minimum efficiency targets for residential and commercial buildings, with the number of countries implementing new or updating existing ones expanding in recent years. As of mid-2024, globally there were 85 mandatory building energy codes for residential buildings and 88 for non-residential buildings. However, more than 100 countries worldwide do not have in place mandatory requirements for energy efficiency in buildings. As a result, around 2.4 billion square metres of floor space was built in 2022 that was not mandated to meet any energy-related performance requirements. In 2023, this number increased to 2.55 billion square metres – meaning more than 50% of all newly built floor area in the world is not yet covered by mandatory energy efficiency requirements, potentially locking in inefficiencies in building envelopes for at least several decades (until the next renovation).

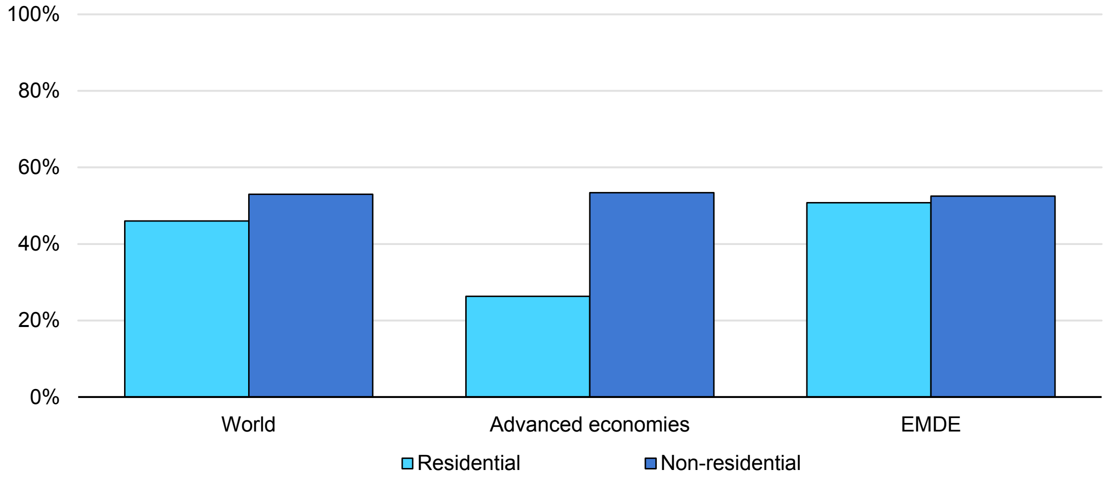
Global status of building energy codes in 2023



Notes: The map tracks known national building energy codes and those where a national mandate for adoption exists. In cases where the national mandate exists, the map shows its status and not its adoptions at the sub-national level (e.g. Brazil, Mexico, India). In cases where building energy codes are not mandatory at the national level, the map shows implementation at the sub-national level jurisdictions (e.g. the United States, Canada, Belgium).

Rapid growth in new construction is expected in emerging markets and developing economies in the coming decades but about half of residential and non-residential buildings in EMDEs were not yet covered by mandatory energy efficiency requirements in 2023. To accelerate efficiency progress, it is important for all countries to have a clear implementation plan in place, including monitoring and verification processes to expand and enforce the requirements of building energy codes for most of their buildings.

Portion of newly built floor area not covered by buildings regulations, 2023



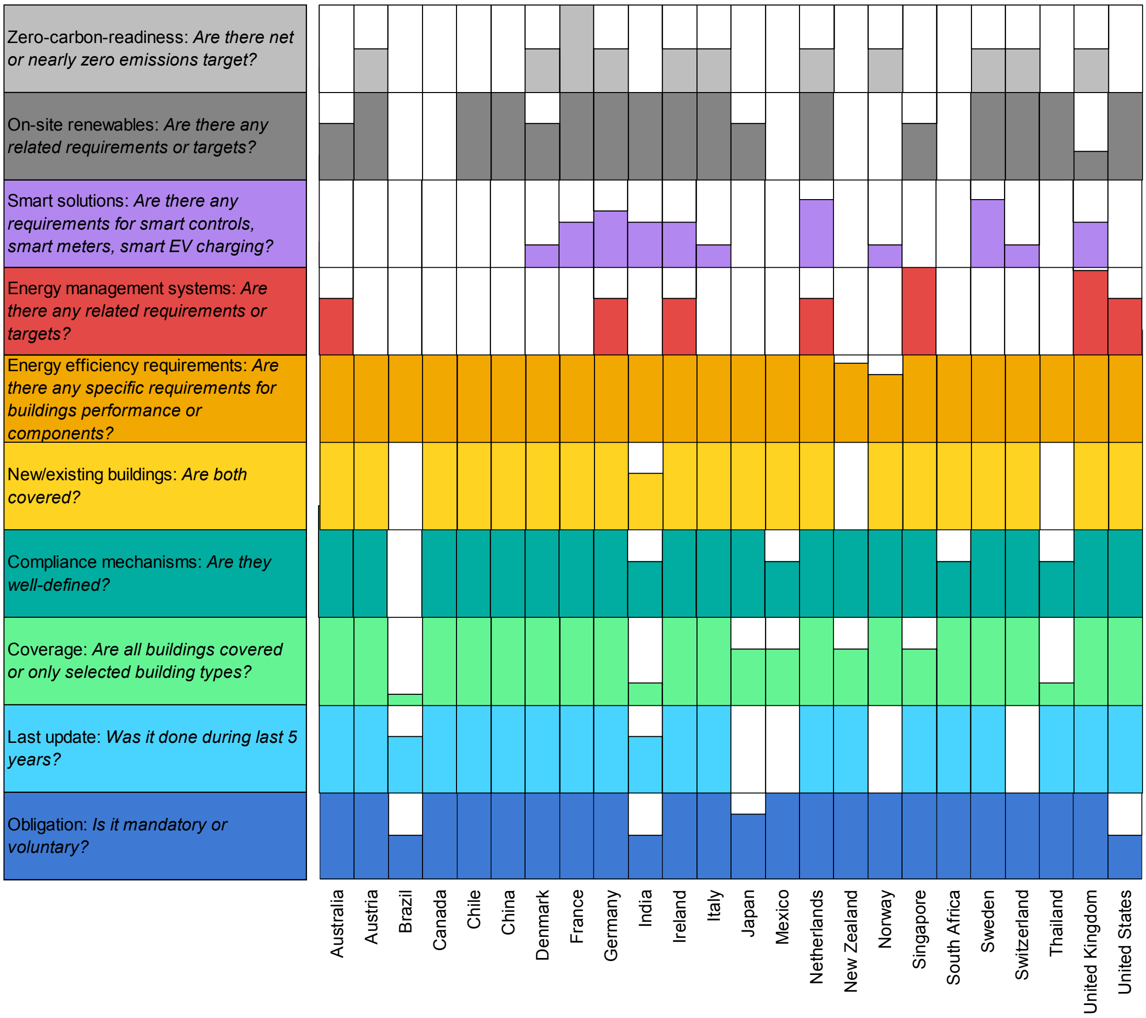
Note: EMDE = emerging markets and developing economies.
Source: IEA analysis based on World Energy Outlook 2024 extended dataset.

Comprehensive building energy codes can help improve efficiency in buildings, lower bills and ensure optimal comfort

To progress towards a zero-carbon-ready building stock, new and existing building energy codes should enforce high and modern standards for energy efficiency, ensure optimal thermal comfort, integrate smart features, and become more stringent over time. The IEA developed a new building energy code content assessment (BECCA) tool that collects and evaluates the available elements of a country's buildings regulation, offering the opportunity to assess potential areas of improvement.

The BECCA tool contains ten elements that the IEA considers important in a comprehensive building energy code for the transition to zero-carbon-ready buildings. The analysis compares to what extent national building energy codes include these elements and can provide insights for further policy development, particularly for the next building energy code update or revision cycle. The BECCA tool does not account for the level of compliance with the regulations or the challenges of implementing them. It also does not include requirements that have not yet been adopted into national building energy codes, such as the recent EU EPBD requirements for building automation and control systems.

Overview of building energy code content analysis for selected countries

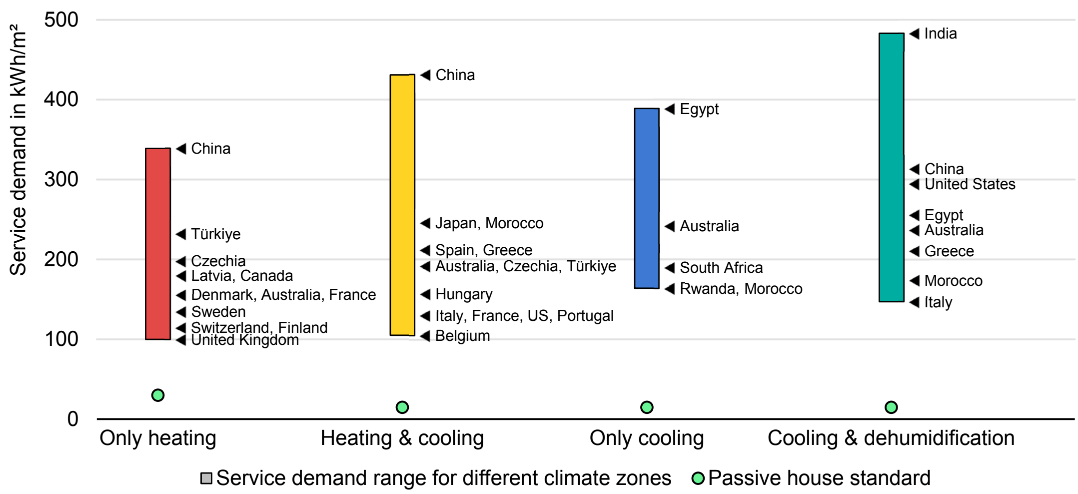


Comprehensive building energy codes, like those in the Netherlands and Ireland, contain most of the elements analysed, including requirements for energy management and smart solutions. France stands out with requirements for reaching net zero emissions and mandating connected thermostats from 2027. Singapore has voluntary requirements for smart solutions like sensors and controls. The analysis based on the BECCA tool evaluates the content of building energy codes but does not reflect to what level they have been implemented and enforced in practice. Around 70 countries updated their codes in the past five years. Several countries, mainly in Europe, have requirements for zero-carbon-readiness. Most codes, such as in Chile, China and Thailand, have provisions for on-site renewables. Some codes, such as in Australia, Singapore, the United Kingdom and the United States, mandate energy management systems, primarily for large buildings. Smart solutions are less often integrated – a key area for development. A few countries have requirements for building automation systems and EV charging. The analysis also confirms there is a shift towards more comprehensive regulations.

New IEA methodology compares stringency of energy efficiency requirements in different countries and climates

Not all building energy codes clearly stipulate quantifiable requirements for the energy efficiency of buildings. Even among the requirements that are available, cross-country comparisons are quite challenging given the complexity of methodologies, a great variance in metrics used, such as thermal transmittance or U-value/R-values, building energy demand, overall thermal transfer value, climate conditions, building practices and patterns of building energy use. The IEA has developed a methodology to compare the overall building energy performance across countries and climate zones, using the requirements for different components of the building envelope indicated in building energy codes.

Estimated service demand for buildings compliant with building energy code requirements in selected counties to achieve optimal comfort, by climate zone

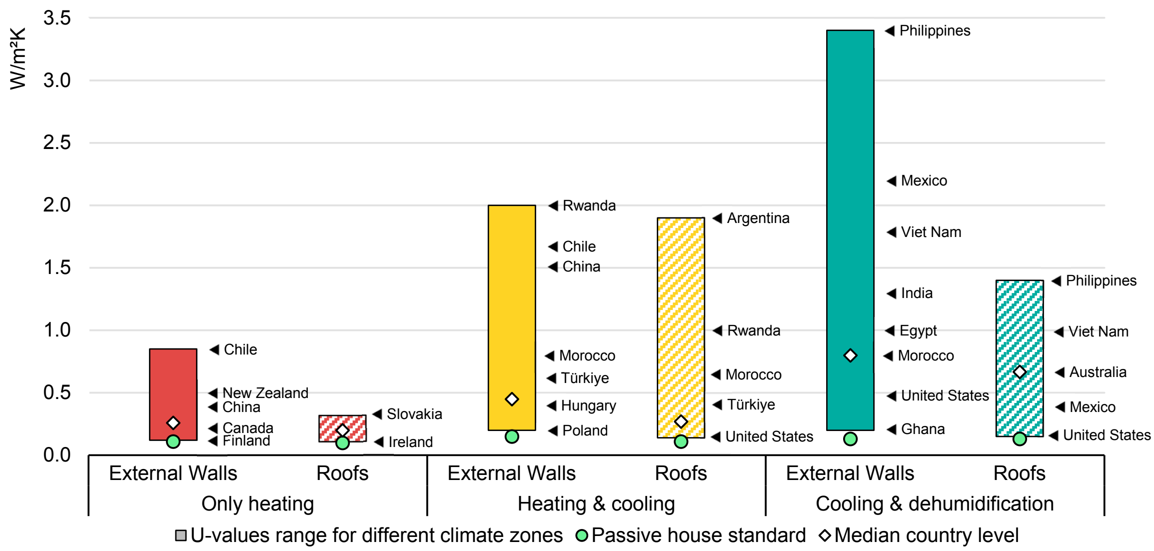


Notes: Service demand is the amount of energy needed to achieve a comfortable indoor temperature consistent across all settings (i.e. 21°C), considering needs for heating and cooling, based on the climate of the location without taking into account the type and efficiency of heating and cooling systems. It may differ from the actual final energy demand in buildings in each specific country. The calculations use data for U-values for external walls, roofs, floors and glazing, a fixed ventilation level, and solar gains to estimate service demand of a hypothetical building with the same design and building geometry characteristics fixed across all analysed countries and climate zones (a two-storey residential house with a floor area of 140m² was used in the estimations).

The results show that there is a large variation among countries in terms of the estimated required levels of energy service demand in building energy codes. In climates where heating plays an important role in building energy demand, countries such as the United Kingdom, Finland and Belgium have some of the most stringent requirements. Among climate zones where cooling is more relevant for building energy use, countries such as Rwanda, Morocco and South Africa have the strictest building energy codes in terms of estimated service demand requirements. At the same time, countries across all climate zones have notably much higher energy service demand than that of a passive house standard, well-known for its very high requirements for building envelopes in line with the zero-carbon-ready building (ZCRB) level of performance.

Those building energy codes that have requirements for U-values for different building components can be compared to the passive house standard based on the data for projects documented in the Passive House Database for comparable climate zones. The results show that most countries have requirements for building envelope components that are less stringent than the passive house standards. In terms of U-values for external walls and roofs, there is a large variation among all the climate zones. However, some countries have requirements for U-values that are very close to the identified best practices, for example: for external walls Finland (Only Heating), Poland (Heating and Cooling), Ghana (Cooling and Dehumidification); and for roofs Ireland (Only Heating), the United States (Heating and Cooling, and Cooling and Dehumidification).

U-values for external walls and roofs by climate zone (W/m²K) based on requirements for building energy codes, selected countries



Notes: The results are presented for selected countries based on the analysis of the data for 44 countries that were identified to have related requirements in their buildings regulations (where it was possible to make the distinction the requirements for residential buildings were taken for this analysis). Not all analysed countries are shown for each element and climate zone.

In the Only Heating climate zone, the building energy code requirements for external walls in countries like Finland, Switzerland, Ireland, Sweden and Norway are quite close to the passive house benchmark. The same is true for Poland, Belgium, the United States and Italy in Heating and Cooling zones; and Ghana in the climate zone that needs both Cooling and Dehumidification. In the Cooling and Dehumidification zone, most of the analysed countries have requirements that are still quite far from the passive house benchmark and therefore allow for higher heat losses (and solar gains) through external walls.

Improving efficiency in existing buildings is pivotal to accelerate progress, and requires an integrated approach

Fewer building energy codes regulate existing buildings than new buildings. As of 2023, around 50 countries had efficiency requirements for existing buildings in their national building energy codes, often only applying at the point of major renovation. Most of these are in Europe. Next to regulation, other policies can also promote efficient solutions in existing buildings, such as integrated renovation programmes or one-stop shops that offer support to guide people through a home renovation. One-stop shops provide a range of services, including assistance in applying for permits and grants, technical advice to choose the best mix of upgrades, guidance in selecting contractors, information about quality assurance, and access to affordable financing options.

To support the rise of one-stop shops, the European Commission funded a community of practice, EU Peers, for renovation service providers to exchange best practices. To stimulate the market for home renovations, Ireland developed a one-stop shop registration platform for companies. All registered one-stop shops follow standardised guidelines, ensuring quality of service. The goal is to help achieve a renovation target of the carbon equivalent of 500 000 homes, upgraded to the B2 Building Energy Rating standard by 2030. The programme resulted in savings of around 29 GWh to date, equivalent to the average annual electricity consumption of more than 7 000 Irish households.

In Hungary, a not-for-profit one-stop shop offers renovation advice in co-ordination with local governments, with a focus on rural areas. The Latvian city of Riga established a municipally funded one-stop shop to support the renovation of multi-family buildings. It provides residents with advice about the optimal mix of efficiency measures, gives financing options, and assists in subsidy applications.

In Australia, the state of Victoria set up a register of accredited service providers that can help consumers access discounted appliances and equipment. Under the scheme, a household receives a discount when purchasing an approved product from an accredited provider. Eligible upgrades include double glazing windows and weather sealing as well as energy efficient appliances. The programme is expected to reduce greenhouse gas emissions by 28 Mt, equivalent to the annual emissions from 8.5 million cars.

In Canada, the Deep Retrofit Accelerator Initiative provides funding to organisations to convene and co-ordinate retrofit actors in developing deep retrofit projects for commercial, institutional, and mid- or high-rise multi-residential buildings. Access to resources, tools and a community of practice provide additional capacity building support.

In Ukraine, the State Agency on Energy Efficiency and Energy Saving set up the State Fund for Decarbonisation and Energy Efficient Transformation to provide soft loans to businesses and local governments to promote energy efficient technologies. It also has an online platform and a network of regional centres to offer expertise and guidance on energy efficient renovation, despite challenges posed by Russia's full-scale invasion of Ukraine.

Spotlight: Does a heat pump work in a house with poor insulation?

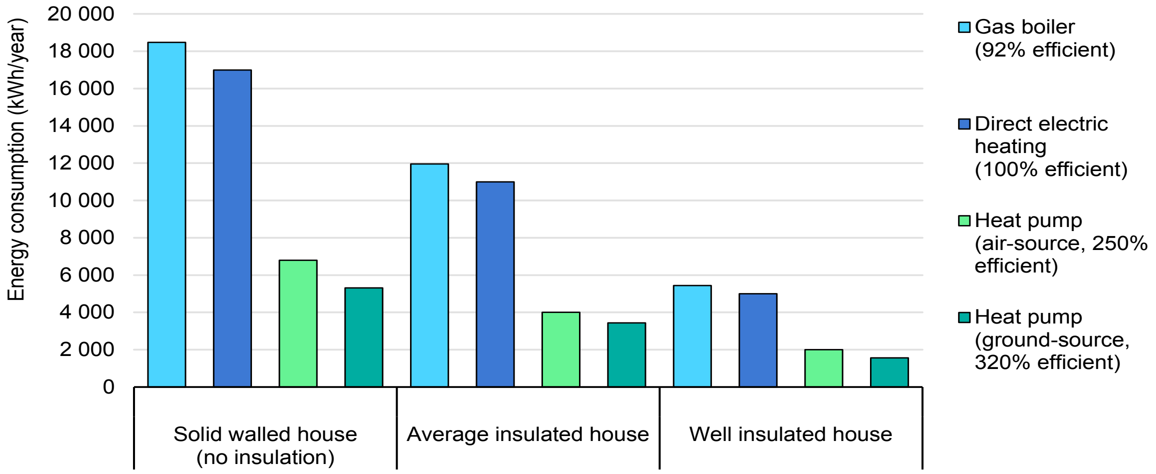
Even with poor insulation, heat pumps still save energy

As well as reducing CO_2 emissions, a heat pump can use three to five times less energy than an efficient gas boiler. However, an often-heard argument when considering replacing a gas boiler is that the house needs to be well-insulated for the heat pump to work.

Heat pumps do work best in a well-insulated house because their heat output is at a lower temperature than a traditional boiler, and they perform best when providing a consistent heat output with minimal heat losses. If a house loses a lot of heat through the fabric or air leakage, the heat pump needs to produce more heat and therefore have a larger capacity to achieve and maintain the desired level of thermal comfort. So, the best option is to both insulate the house well and install a heat pump, with the synergy between the two providing the greatest benefits. To offer the same level of comfort, a well-insulated home also requires a smaller heat pump than a poorly insulated house, which can be cheaper to buy as well as to run.

However, new IEA analysis of heating systems finds that even in poorly insulated homes, heat pumps provide energy savings compared to gas boilers, as the efficiency gains are so significant. Shifting from a 92% highly efficient gas boiler (minimum performance according to the current UK regulation) to a high efficiency air- or ground-source heat pump, using the United Kingdom as an example, results in 60-70% of energy savings for a solid walled house (with no insulation). Adding high levels of insulation along with the heat pump can lead to an impressive 90% reduction in annual energy demand for heating.

Heating demand for different heating technologies and levels of insulation, United Kingdom

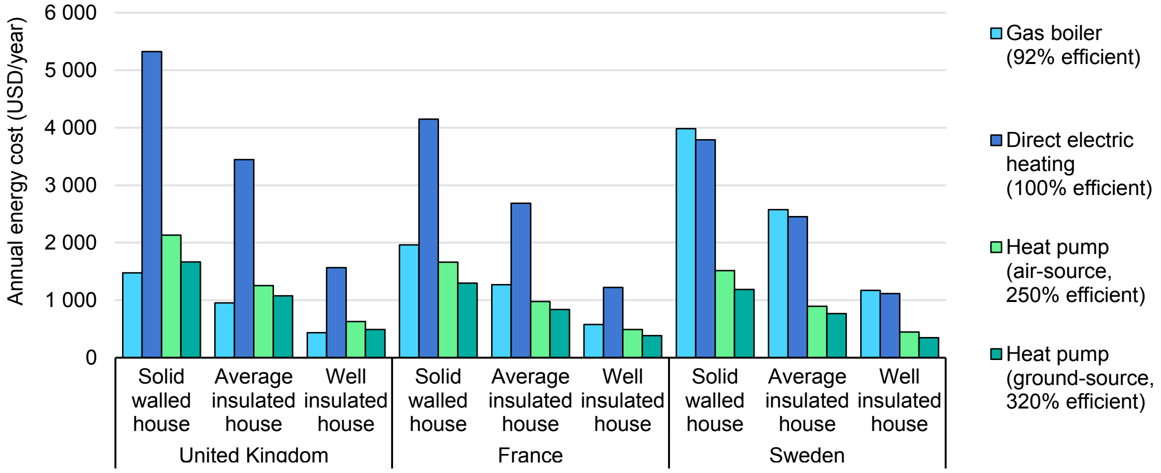


Note: Annual heating demand estimations are based on a typical two-storey residential house.

Heat pumps can also lower energy bills, but this depends on the cost of gas and electricity in each country

Due to their higher efficiency, heat pumps consume less energy than gas boilers to produce the same amount of heat. However, whether switching from one to the other lowers energy bills depends on the difference in gas and electricity prices. In countries where electricity and gas prices are similar, such as Sweden, heat pumps can greatly reduce bills – by 60-90%, depending on the level of insulation. In countries where electricity is two to four times as expensive as gas, like in France, heat pumps can still reduce energy bills, but the gains will be smaller, especially in poorly insulated homes. In countries where electricity is more than quadruple the price of gas, such as the United Kingdom, switching to a heat pump results in much smaller financial benefits – and can in some cases even lead to higher bills, though this can be mitigated through improving the insulation of the building envelope. As pricing mechanisms change to favour low-carbon electricity instead of gas, the financial benefits of heat pumps can become even greater.

Energy cost for different heating technologies and levels of insulation, selected countries



Notes: Annual heating demand estimations are based on a typical two-storey residential house. The analysis assumes tariffs for gas and electricity for each country. United Kingdom: USD 0.31/kWh (electricity), USD 0.08/kWh (gas); France: USD 0.25/kWh (electricity), USD 0.11/kWh (gas); Sweden: USD 0.23/kWh (electricity), USD 0.22/kWh (gas).

2.2 Appliances

Energy consumption of appliances is increasing, but efficiency offers rapid improvements due to high turnover rates

Appliance ownership has been rising with increasing household income and expanding access to electricity, particularly in EMDEs. One of the most energy consuming appliances globally are refrigerators. They are plugged-in 24 hours a day, and while 20 years ago the average number of refrigerators per household was 0.6, now that number is over 0.8. This has improved living standards, but also increased energy use.

In largely saturated markets like Europe or North America, energy consumption increased by about 25% despite strong improvements in efficiency and decisive policy action due to trends towards larger or more units, as well as decreasing household size. At the same time, markets with a significant amount of first-time uptake, such as Africa, the Middle East or Asia Pacific, have increased their consumption up to almost threefold. In the NZE Scenario, the share of appliances in buildings electricity consumption decreases from 46% today to 42% in 2030. With their shorter lifetimes compared to other building technologies like the envelope or heating and cooling systems, appliances can deliver faster energy savings in the timeframe to 2030.

Key early actions for appliances for doubling energy efficiency progress

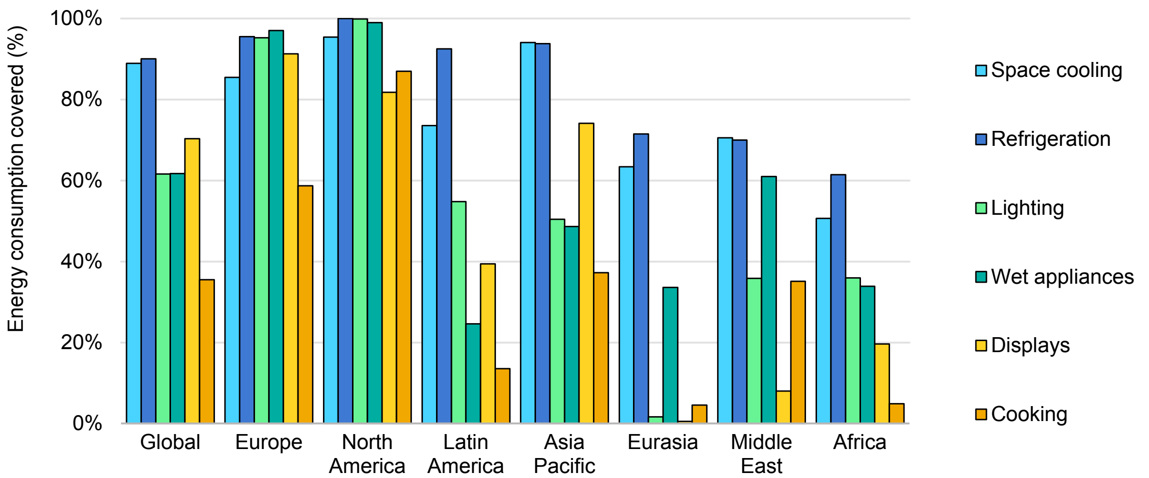
- **Regulations**: Minimum energy performance standards (MEPS) help to eliminate the worst performing equipment from the market. In countries where MEPS have been applied in combination with labels, appliances now typically consume 30% less energy. In 2024, China implemented a new Action Plan to improve its standards.
- **Information:** Labels inform consumers about the most efficient equipment and potential cost savings. They influence purchase decisions, impacting the efficiency of the stock. In the European Union, refrigerators and freezers were the first products covered by a mandatory label in 1995. Since then, the label was updated three times. Combined with regularly updated MEPS, the EU label has improved cold appliances' efficiency by 60%.
- **Incentives**: Rebates and loans can lower the upfront cost of new efficient equipment. They incentivise replacing old equipment early to improve stock efficiency. In 2024, Singapore implemented a new policy, the Climate Friendly Household Programme, offering households USD 225 towards the purchase of high-efficiency appliances.

Coverage of energy performance standards is rising across technologies, but there is potential for international alignment

MEPS are one of the most frequently used policies to improve the efficiency of appliances. They mandate a specific efficiency level under which products are not allowed to be sold. Given sufficient market surveillance, they eliminate the least efficient products. MEPS are covering an increasing share of energy use for appliances as they are used by most of the largest energy consuming countries. Over 120 countries have MEPS in place for at least one end use. There are differences, however, among regions and the type of appliances that are regulated. While about 90% of energy use for air conditioners and refrigerators is covered by MEPS, only 60% of the energy use of wet appliances is. MEPS for cooking appliances have only recently been implemented in more regions, with 36% of their energy use covered. More countries have also implemented regulation for distribution transformers. These reduce grid losses and make the energy system more efficient. While most countries in Europe, North America, Latin America, and Southeast Asia have MEPS in place for key appliances, countries in Africa, the Middle East, and Eurasia have less policy coverage.

Development of MEPS has increased in recent years, and more countries are expected to follow suit. International co-operation can also play a key role in policy implementation. The UNEP initiative United4Efficiency makes model guidelines for a large array of end uses available for free to help policymakers implement MEPS that are comparable across borders. The initiative helps minimise trade barriers for manufacturers to adjust products for each market and enables cross-border co-operation in the installation of test laboratories to minimise cost. Some countries, however, still face difficulties in establishing successful regulatory frameworks due to relatively weak market surveillance and institutional capacity.

Energy use coverage of minimum energy performance standards for appliances by region, 2024



Notes: MEPS coverage for space cooling, refrigeration and lighting is shown for residential sectors. Space cooling includes air conditioners and fans. Refrigeration includes refrigerators and freezers. Wet appliances include clothes washers, clothes dryers, washer-dryers and dishwashers. Displays include televisions and computer screens. Cooking includes basic hobs, conduction, induction and gas stoves.

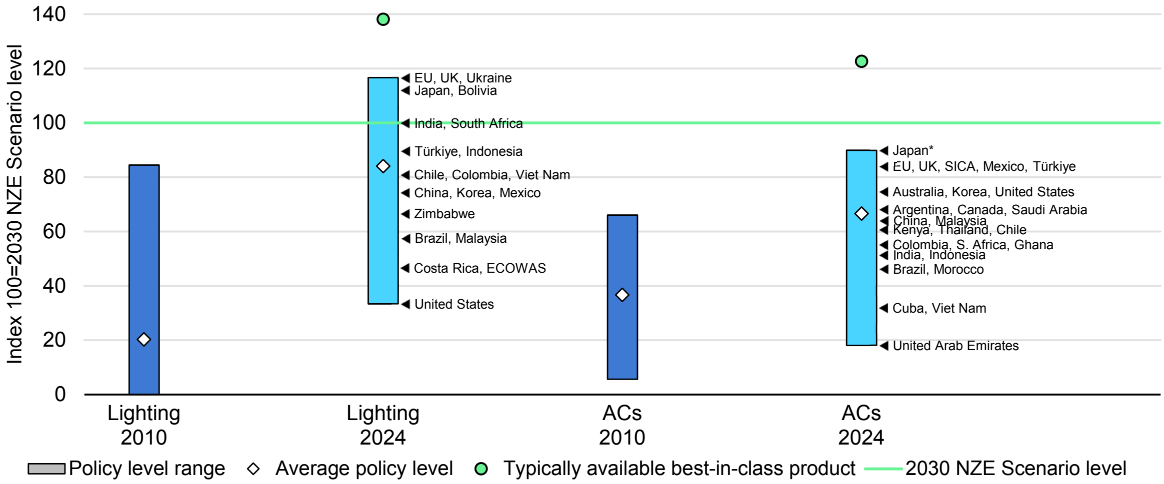
Sources: IEA analysis based on the IEA policies and measures (PAMS) database, and CLASP Policy Resource Center.

Energy performance standards are becoming more ambitious

While countries are increasingly introducing MEPS, the key to achieving a strong market impact is the stringency of the standards. For the minimum requirements to continuously improve the market average energy performance, they must be frequently updated to keep up with technological developments. In 2024, several countries updated their MEPS for air conditioners and refrigerators. However, the ambition level for MEPS across countries still varies widely. The IEA Efficiency Policy Level Index provides a comparative analysis of MEPS stringency for ACs and lighting in the residential sector. Analysis of all countries worldwide is covered in this year's report. Respective analysis is also available for industrial electric motors and fuel economy standards in passenger vehicles, presented in the industry and transport sections in this chapter.

The Efficiency Policy Level Index shows MEPS stringency progress across countries, reaching 100 when it is in line with the NZE Scenario pathway and 0 for the currently available least efficient equipment globally. Highly efficient devices are widely available for all analysed end uses, far surpassing the pathway in the NZE Scenario. MEPS stringency has significantly improved over the last decade on average. MEPS in major markets will likely lead to a phase out of all lighting equipment not in line with the NZE Scenario pathway. Ambitious air conditioner MEPS are also in place, though none reach the NZE Scenario pathway yet, highlighting the potential for further tightening standards to speed up progress.

Minimum energy performance standards, lighting and air conditioners, IEA Efficiency Policy Level Index, global country range, 2010 and 2024



*Japan does not regulate air conditioners for each device but uses a minimum average performance across all devices per manufacturer.

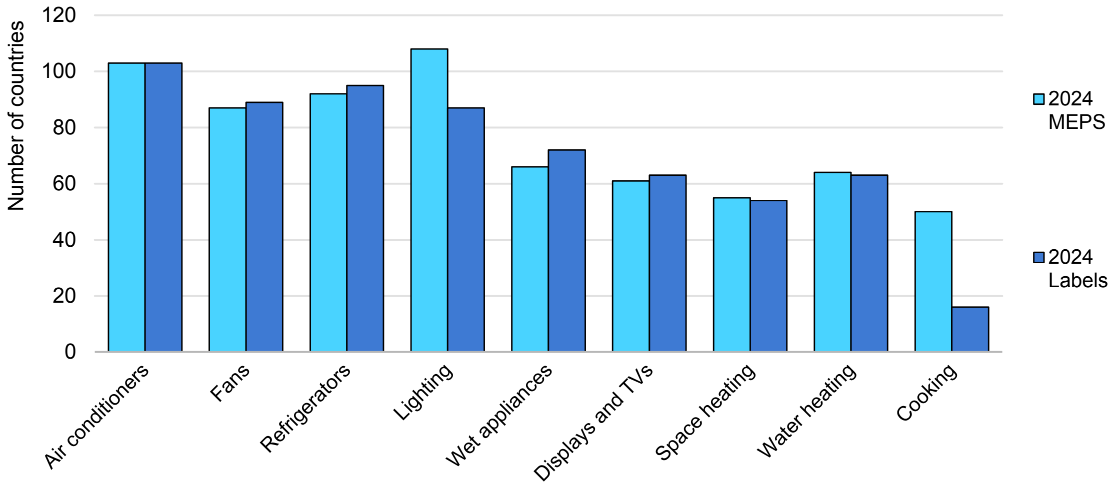
Notes: Efficiency policy levels refer to the most commonly sold type of each end-use equipment type. An index of 100 denotes the MEPS stringency level for 2030 in the Net Zero Emissions by 2050 Scenario (NZE Scenario). ACs = Air conditioners. ECOWAS = Economic Community of West African States (currently active members: Benin, Cabo Verde, Côte d'Ivoire, Gambia, Ghana, Guinea Bissau, Liberia, Nigeria, Senegal, Sierra Leone, Togo). SICA = Sistema de Integración Centroamericana (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama). NZE level for lighting is 90 lm/W. For ACs it uses a Seasonal Energy Efficiency Ratio (SEER) of 5-6.5. Country samples represent 74% of global total final energy consumption for lighting, and 87% of global total final energy consumption for ACs.

Many countries combine minimum energy performance standards with labels in an integrated policy approach

Many countries are implementing mandatory labels in parallel to MEPS. While MEPS can aid in eliminating the worst performing equipment from the market, labels help consumers notice the energy consumption of products, which can help them save money over the life of the appliance. The maintain their function of distinguishing energy performance, labels need to be updated frequently. A recent study by the European Commission on the energy efficiency of refrigerators and freezers shows that labelling these products, in combination with MEPS, helped cut average annual energy consumption by more than 60%. The cut in energy consumption is equivalent to an estimated reduction in consumer expenditure reaching over USD 17 billion per year in 2030.

With appliances commonly used daily by consumers, choices and usage patterns such as the set temperature of an air conditioner are heavily impacting energy use. Whether led by government, utilities or civil society organisations, making energy efficiency information part of the general sales advice and providing public educational campaigns can have a lasting impact. Incentives can help to increase the speed of uptake of more efficient products and the replacement of inefficient older equipment, enabling consumers to immediately reduce consumption and achieve cost savings. Schemes to encourage upgrading to more efficient appliances might include government-funded rebates on products or financing offers with subsidised interest rates. The IEA published an Energy Efficiency Policy Toolkit for appliances with more information on options in policy packages.

Number of countries with minimum energy performance standards and labels for appliances, global, 2024

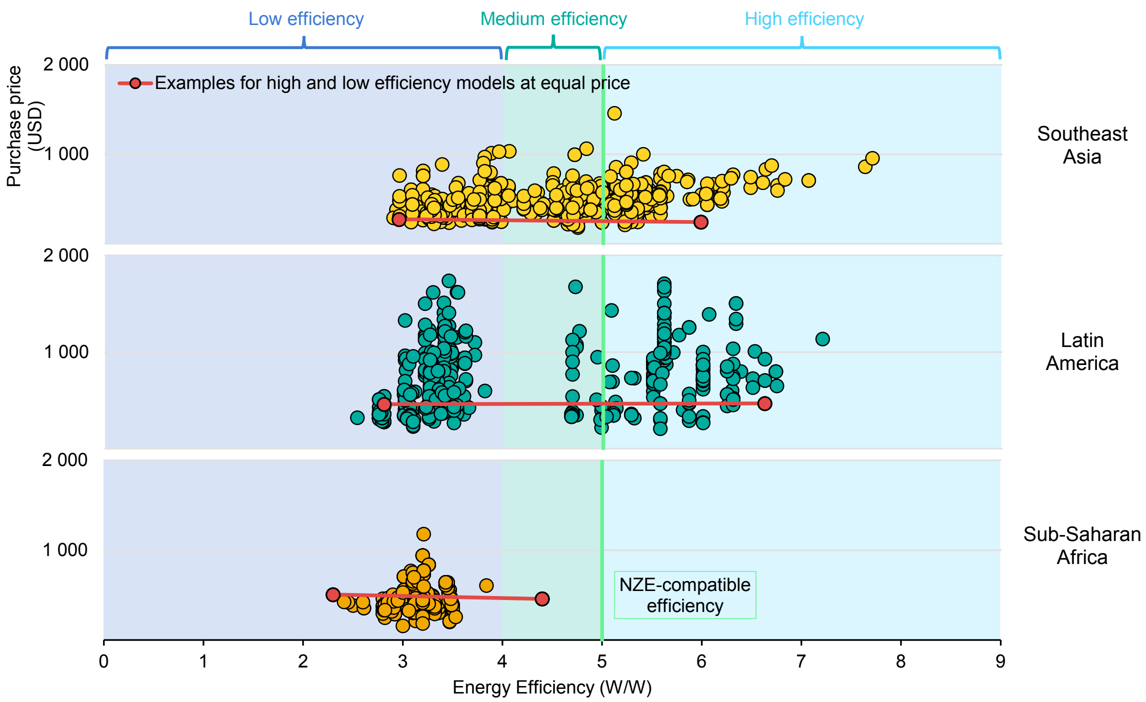


More efficient devices are not necessarily more expensive

Governments are sometimes cautious about tightening MEPS due to concerns about the upfront costs associated with more efficient equipment. Recent IEA analysis on product prices and efficiency levels, collected using data from local stores, shows that users can opt for more efficient models without paying a premium. They are, however, often less readily available or not as easily identifiable as their less efficient counterparts. The analysis shows that long-standing efficiency policies contribute to having more efficient products but also widen the range of available models at affordable prices. This is the case for the analysed countries in Southeast Asia and Latin America that have had policies for over 20 years, and in sub-Saharan Africa, where policies have been implemented more recently.

Affordable highly efficient models are available for various products, such as refrigerators, air conditioners, and fans. For example, in Southeast Asia, a budget of USD 300-400 offers dozens of AC models with efficiencies ranging from 3 Watt/Watt to 6 W/W. Even if improving the products' efficiency increases manufacturing cost, this does not necessarily determine purchase prices on the market. These depend more often on marketing strategies and brand positioning. Innovative best-in-class products can be more expensive when first introduced, but they adapt over time to the average prices as the market efficiency increases and competitors match their performance level.

Purchase price and efficiency of air conditioners in selected regions



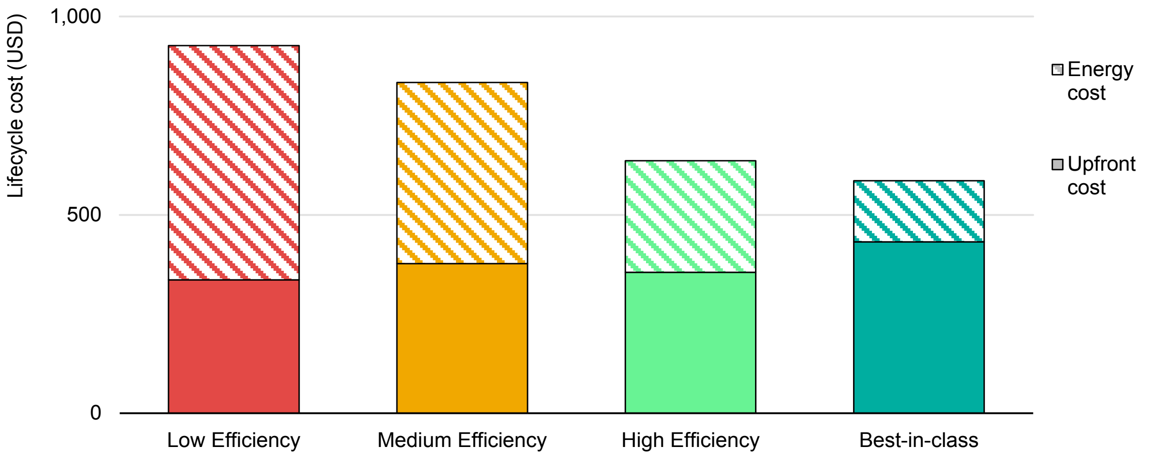
Notes: Air conditioners are wall-mounted single split type. Purchase prices are normalised to equipment with 3.5 kW cooling capacity. NZE compatible efficiency considers equipment efficiency levels for new air conditioners in the Net Zero Emissions by 2050 Scenario.

Efficient models are significantly cheaper when considering both upfront investment and energy costs

As people gain access to electricity, they acquire new equipment often starting with light bulbs, followed by televisions, and finally fans, particularly in hot places. As available power increases and electricity becomes more reliable, refrigerators are installed as well. The IEA considers two bundles of electricity services to determine household energy consumption and cost in the setting of improving access. The first is an essential bundle that includes four lightbulbs operating four hours per day, a fan running three hours per day and a television for two hours per day, which combined consume 500 kWh per household per year with standard appliances. The second is an extended bundle, which includes the essential bundle doubling the hours for the fan and the television, plus one standard mid-size refrigerator. With increased access, more people pass from an essential to the extended bundle. An inefficient refrigerator adds more than 400 kWh to the bundle's annual demand, resulting in a total of 1 250 kWh per household, while a best-in-class refrigerator would add only about 130 kWh.

Best-in-class models can reduce annual electricity consumption of an extended bundle of appliances by more than half, from around 1 250 kWh to 500 kWh, including best commercialised LED lighting, high tech refrigerators, new LED televisions and ceiling fans. For many products, such as refrigerators, highly efficient models use less than half of the energy of inefficient models. A best-in-class model can save up to 40% in total cost compared to an inefficient one over its lifetime, even when purchasing an innovative product at a premium. Promoting access to new best-in-class efficient models when they first enter the market has proven very effective, whether by reducing their upfront cost or using innovative financing mechanisms, among other schemes.

Upfront cost and lifetime energy cost of available mid-size refrigerator-freezers by efficiency rating in Ghana

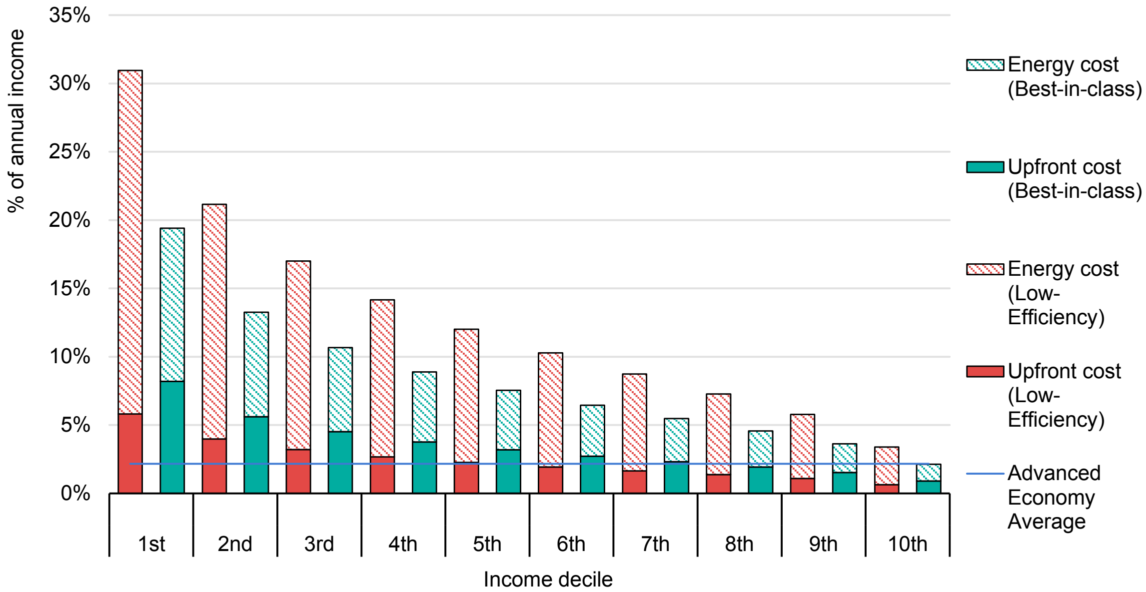


Notes: Analysis includes selected samples of two-compartment refrigerator-freezers with a market average total volume.

A common incentive is to provide rebates for models in the top efficiency classes. Several governments have introduced new rebate programmes. In Malaysia, the Sustainability Achieved Via Energy Efficiency 4.0 programme, implemented in

December 2023, provides a rebate of up to USD 85 to households that purchase air conditioners and refrigerators with 4-star or 5-star energy efficiency labels. In Singapore, the Climate Friendly Households Programme, enhanced in April 2024, offers USD 225 to purchase appliances with at least three ticks (out of five) on the energy label; it was claimed by 50% of the eligible households by June 2024. In the Australian state of Victoria, the Victorian Energy Upgrades programme supports households and businesses to reduce their energy use providing discounts for a targeted suite of appliances, including reverse cycle air conditioning for heating and cooling, hot water systems and clothes dryers. Rebates for induction cooktops are slated to be added to the programme in late 2024. Argentina launched the Programa de Reconversión y Eficiencia Energética that enables the payment for products in monthly instalments.

Estimated share of income spent on an inefficient and a highly efficient extended bundle of appliances, by income decile in sub-Saharan Africa



Note: Upfront cost is annualised by average lifetime. Average income per decile is used to determine the share of expenses.

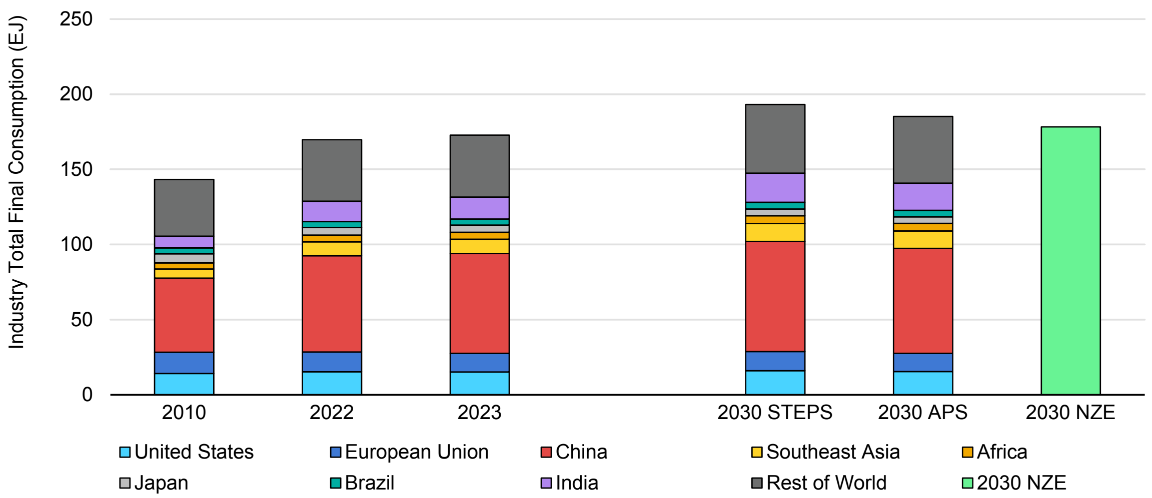
Annual expenses for extended appliance bundles can also be halved when opting for best-in-class products. This is particularly important for families in low-income deciles, as energy can represent a large share of their expenditure. Highly efficient equipment also reduces the need for infrastructure investments. For instance, the reduction in peak electricity demand resulting from more efficient appliances can reduce the cost of projects such as mini-grids in sub-Saharan Africa. In this context, using high efficiency products can save each new user nearly USD 300 in connection fees, facilitating electricity access.

2.3 Industry

Industrial energy use is growing, but changes in the fuel mix are tempering the increase in emissions

The industry sector accounted for over 170 EJ of total final energy consumption in 2023, or approximately 39% of today's global total. Energy demand from industry increased by 2% in 2023 and emissions by less than 1%. Energy use in industry has risen by around 1.5% per year from 2010 to 2023. Between 2010 and 2023 industrial energy consumption grew at an annual rate of over 5% in India and 2% in China, while it fell by 1% in the European Union and 1.8% in Japan. Around 38% of global industrial energy consumption is in China, greater than the combined consumption of the European Union, the United States, Southeast Asia, India and Japan.

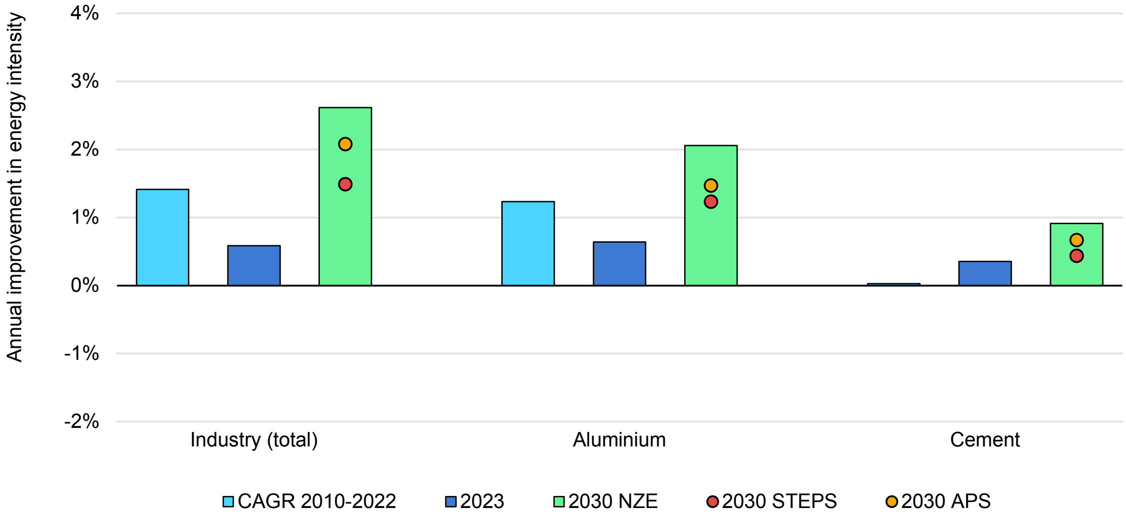
Total final energy consumption for industry, 2010-2023, and by scenario, 2030



Note: STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; and NZE = Net Zero Emissions by 2050 Scenario. International bunkers final consumption included in Rest of World.
Source: IEA analysis based on World Energy Outlook 2024 extended dataset.

In the NZE Scenario, annual growth in industrial energy demand is less than 0.5%, driven by deployment of more efficient technologies and processes, material efficiencies, recycling and electrification. China continues to drive industrial energy demand growth along with India, which in the STEPS sees the largest growth of any country to 2030, at 4% per year. Global industrial energy intensity was static in 2023, with an improvement of 0.6%. However with hard-to-abate sectors accounting for almost three-quarters of energy use in the sector in 2023, progress on energy efficiency can be challenging, due to the long lifetime of assets, high investment volumes of new plants and the limited availability of low-emissions technologies or processes to reduce the emissions intensity of production in these sectors.

Global energy intensity progress for total industry and by major segment, 2010-2023, and by scenario, 2030



Notes: STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; and NZE = Net Zero Emissions by 2050 Scenario. International bunkers final consumption included in Rest of World.
Source: IEA analysis based on World Energy Outlook 2024 extended dataset.

Key early actions in industry for doubling energy efficiency progress

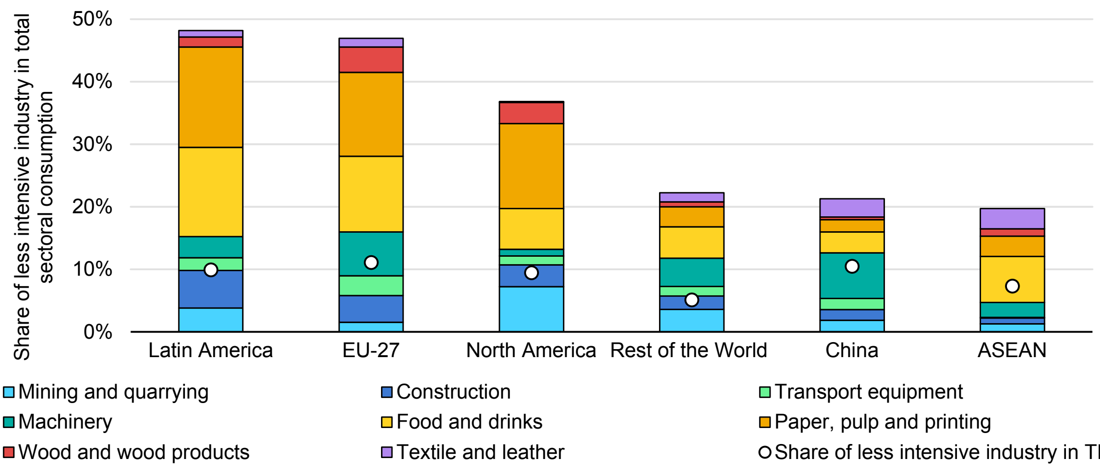
- **Regulations**: Standards for the minimum efficiency level of motors can help to eliminate the most inefficient models from the market. This can prevent technology "lock-in" effects for new motors with long lifetimes. Regulation has the largest scope for impact but takes time to implement. In June 2024 South Africa adopted new legislation requiring all new motors to have a minimum efficiency class of IE3 by 2025.
- **Information**: Industrial Energy Efficiency Networks act to guide industries in becoming more efficient, in line with government policies, and to improve government insight into industry for more effective policy development. The over 2 000 participating industries in Germany's Energy Efficiency and Climate Protection Networks Initiative, report exceeding their savings targets by more than 10%.
- **Incentives**: Grants for the replacement of old motors can be used to accelerate the uptake of more efficient alternatives. In India, Energy Efficiency Services Ltd. implemented a national motor replacement programme, offering an innovative financing business model to Indian industries, and lowering the upfront investment cost of efficient motors.

Less intensive industry can deliver on energy efficiency goals

The IEA generally splits the industrial sector into two groupings: intensive (hard-to-abate) and non-intensive. Intensive industries require large quantities of energy, often at high temperatures and pressures, and are typified by long life assets (iron and steel, chemicals, cement and non-ferrous metals, pulp and paper). Non-intensive industry includes the light industry sectors with less intensive energy demand and generally operating with lower temperature and pressure profiles. The term ‘less intensive industry’ refers to the light industry subsectors such as food and drink, textiles etc., with the inclusion of the pulp and paper sector, as these subsectors share many potential energy efficiency actions.

There are substantial opportunities to increase energy efficiency, both rapidly and at scale, in the less intensive industry sectors between now and 2030. Technologies and methods required to increase efficiency for these industries are proven, economically feasible and more readily available. Less intensive industry sectors account for approximately half the use of energy of heavy industry sectors at a global level in 2022. However, at the national levels, the less energy intensive sectors can account for a more significant portion of the total industrial energy use. In 2022, the less intensive industries represented over 45% of total industrial energy use in Latin America and the European Union, and approximately 37% in North America. In all three cases, the less intensive industry sectors accounted for 10% of total final consumption. At the national level, for example, less intensive industries used up to 75% of industrial energy use in Finland and Sweden, while in Chile almost half of the industrial demand was used in the mining and quarrying sectors. For most countries the less intensive industries are of significant economic importance and a major source of employment. For example, the food and drinks industry is the EU's biggest manufacturing sector in terms of jobs (4.6 million) and value added (+2% of EU gross value added).

Share of less intensive industries in total industry sector energy consumption, and in total final consumption in selected regions, 2022

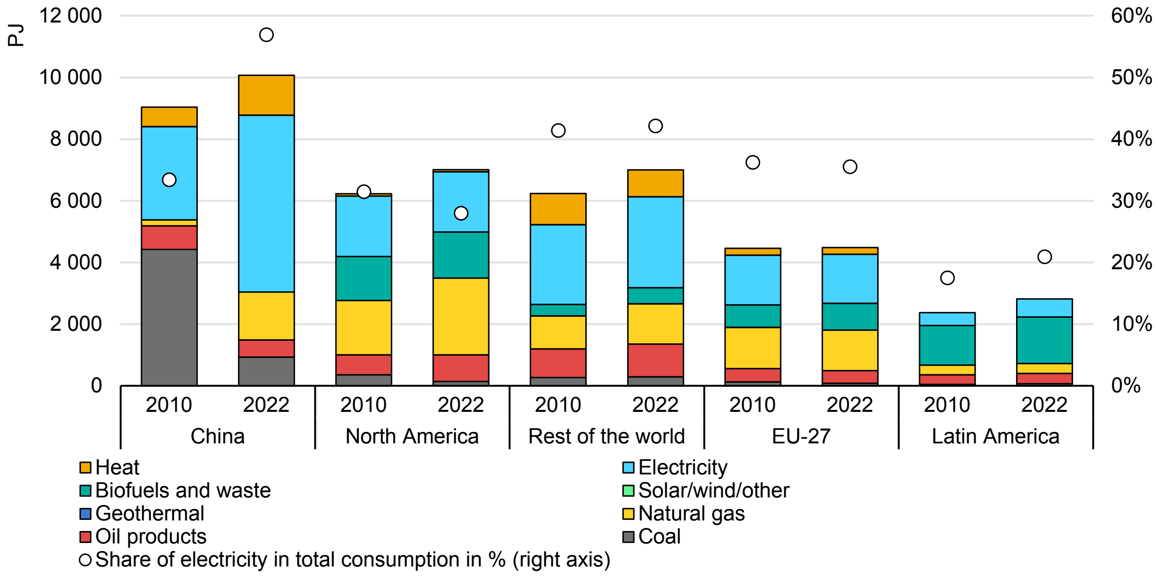


Electrification offers quick efficiency gains, particularly for less intensive industries

The energy use of less intensive industrial sectors at a global level has seen the fuel mix changing, with the share of fossil fuels contracting. While total energy consumption in these sectors is up by almost 13% from 2010 to 2022, the share of fossil fuel use declined from 45% to 36% in the same time frame. Coal use fell by 68% during this period while natural gas consumption, primarily used for heating, increased by around 49%. Between 2010 and 2022 the share of electricity in total energy consumption increased from 33% to reach over 40%, increasing by 1.7% per annum on average.

The less intensive industry sectors have significant potential for heating system electrification, due to characteristically low to medium temperature heat requirements, where almost 50% of all heat consumed is below 100ºC and approximately 72% of all heat consumption in processes is below 200°C. For example, in China the electrification of process heating in light industry has seen strong positive progress. From 2010 to 2022, electricity as a heating source in light industry grew from 18% to 35%, and natural gas rising from 4% to nearly 29%, as industrial players phased out the use of coal-based methods. In June 2023, the China National Light Industry Council released its Carbon Peaking Implementation Programme for Key Areas of Light Industry. The plan aims to further phase out coal energy use, placing a stronger emphasis on electrification, greater use of energy-saving equipment, and accelerated withdrawal of inefficient production capacity.

Less intensive industry energy consumption by fuel in selected regions, 2010 and 2022

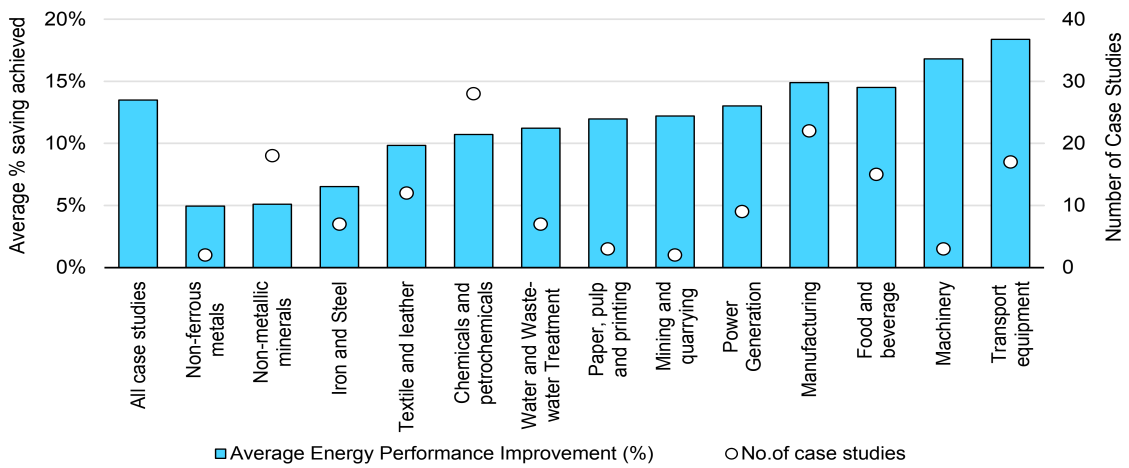


IEA. CC BY 4.0.

Energy management systems have achieved energy savings across all industry sectors

Energy management systems (EnMS) enable energy consumers to manage their energy use to achieve both energy efficiency and cost savings. A key framework for EnMS is the international standard ISO 50001. This is based on a continuous cycle of monitoring, targeting and implementing efficiency measures. In 2023, the International Organization for Standardization (ISO) issued certificates in 105 countries, 58% of the 9 500 awarded to industry were to less intensive industry. More generally, there are signs of increased policy focus on EnMS. In 2023, the European Union adopted a recast of the Energy Efficiency Directive requiring enterprises with an energy use above 85 terajoules (TJ) to implement EnMS. Through the Green Industrial Facilities and Manufacturing Program, Canada provides funding for the implementation of efficiency solutions in industry, including EnMS. Analysis based on over 200 EnMS case studies from 2016-2024 in 40 countries showed average energy savings of 13.5% across all sectors. The less intensive industry sectors achieved 10-18% savings and heavy industries 5-11% of their total energy use. The savings generally increase year-on-year, independent of location or subsector.

Energy management system analysis: Average energy savings achieved (%) per sector



Source: IEA analysis based on data from CEM (2024).

Average annual energy savings of energy management systems, survey sample, 2016-2024

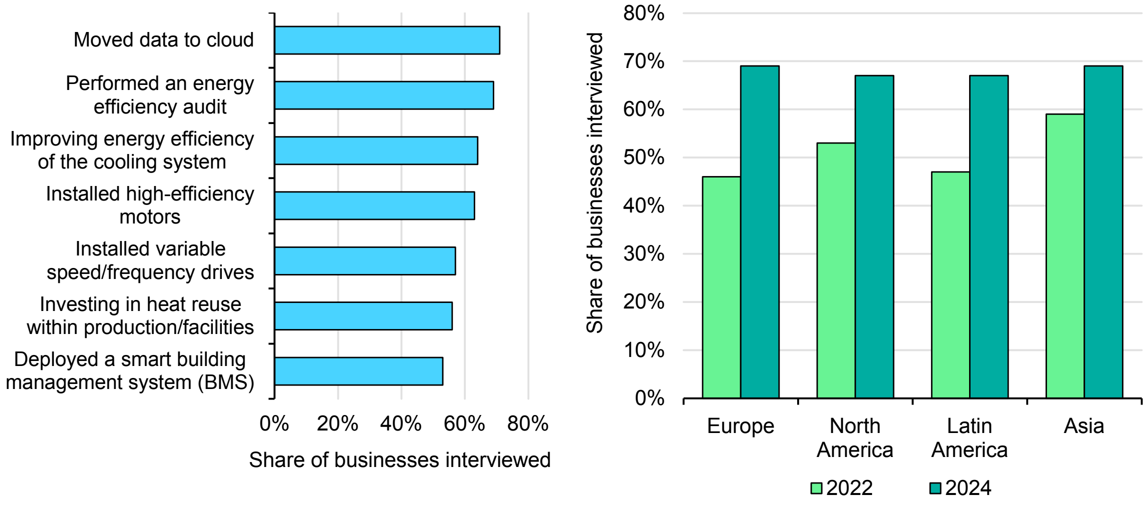
Time frame	Number of case studies	Annual average savings
1-3 years	137	11%
4-6 years	47	18%
7-9 years	9	25%

Source: IEA (2024), based on data from CEM 2024.

Industry players signal accelerating action on efficiency

In 2024, several industry players showed their willingness to work with policymakers to accelerate energy efficiency progress. At the IEA's 9th Global Conference on Energy Efficiency, firms across the globe took part in a business leaders' roundtable discussion, focusing on key steps to promote increased investment and stronger action from the private sector, in collaboration with governments, to accelerate efficiency progress. This led to the Nairobi Business Leaders' Action Plan.

Share of businesses investing in energy efficiency measures, 2024 (left), share of businesses investing in performing energy efficiency audits in selected regions, 2022 and 2024 (right)



Notes: Europe includes Germany, Italy, Spain, Sweden and the United Kingdom; North America includes the United States; Latin America includes Argentina, Brazil and Mexico; and Asia includes China, India, Indonesia and Malaysia.
Source: IEA (2024), From Insight to Implementation: Business Perspectives on Energy Efficiency Investments; The Energy Efficiency Movement.

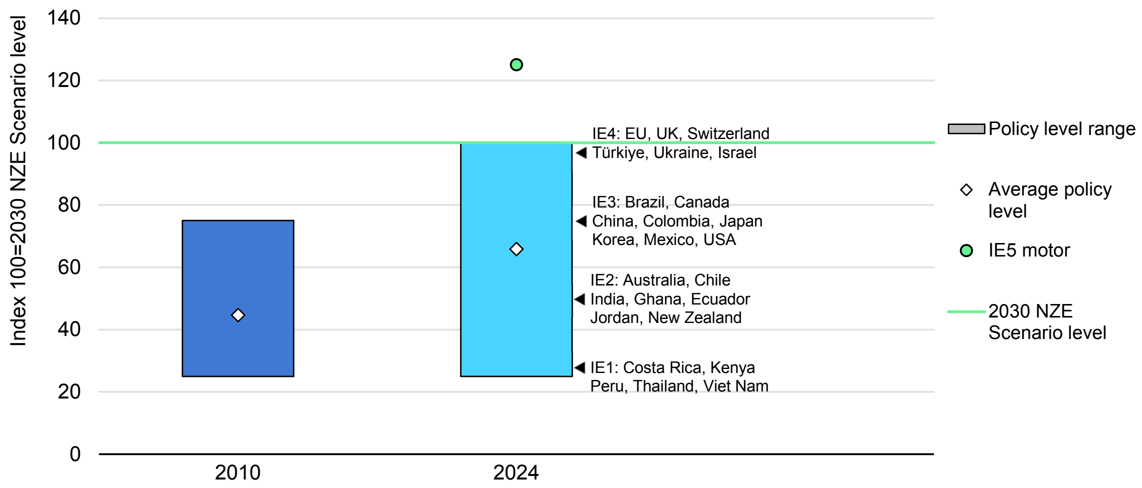
In a 2024 industry sector survey, across 13 countries and 1 280 enterprises, almost half of the respondents declared their ambition to achieve net zero emissions within the next five years. Almost all (99%) respondents reported being committed to making energy efficiency improvements in the next three years, with 61% already investing. Cost was identified as the biggest barrier to energy efficiency improvements (53%), while savings achieved are the most common reason for investing (52%), followed by compliance with corporate sustainability commitments (48%). Over two-thirds of the respondents have performed energy efficiency audits, an increase across all the regions, especially in Europe and Latin America, since 2022. With the prospect of increased electrification, 44% of companies identified efficiency as a crucial instrument to combat grid issues and power shortages, especially in Mexico (62%) and Brazil (54%).

More stringent standards increase energy efficiency in motors

2024 has seen many countries intensifying their efforts to improve energy efficiency in industry through policies such as more stringent MEPS for electric motors, especially in countries with a large industrial sector and that have relatively low efficiency levels in their existing motor stock. In Ghana, the industrial sector contributes around 30% to the country's GDP and employs 21% of the population, but the motor stock has a relatively low level of efficiency. To address this, Ghana has implemented 19 new regulations on updated energy efficiency standards, including one for electric motors. Similarly, in Chinese Taipei, where the industrial sector is expanding, the Energy Administration released an amended notice raising MEPS for a number of motor categories, to take effect in 2025.

China also issued draft revisions for two mandatory national standards, specifically targeting the energy efficiency grades and MEPS for motors. Targets for 2025 and 2030 were also issued for the replacement and upgrading of key products including motors. These are supported by implementation guidelines for the replacement, upgrading, and recycling of motors. Egypt highlighted efficient motor regulations as one of the key mitigation projects in their second update of their NDC in 2023, and aims to allocate USD 11.6 billion to efficient motors under industry projects. South Korea is preparing to implement new MEPS for three-phase induction electric motors, targeting IE4 (Super Premium) efficiency levels. with the aim of implementing the new standards by 2026.

Minimum Energy Performance Standards, industrial electric motors, IEA Efficiency Policy Level Index, global country range, 2010 and 2024



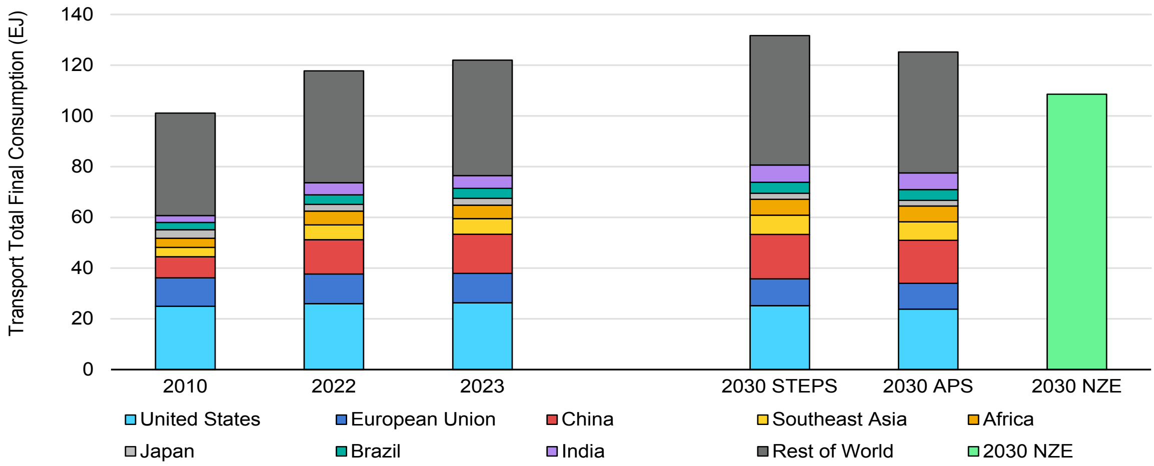
Notes: efficiency policy levels refer to the most commonly sold type of equipment. An index of 100 denotes the MEPS stringency level for 2030 in the Net Zero Emissions by 2050 Scenario (NZE Scenario). IE1 = Standard Efficiency, IE2 = High Efficiency, IE3 = Premium Efficiency, IE4 = Super Premium Efficiency, IE5 = Ultra Premium Efficiency. Country sample represents 81% of global total final energy consumption.

2.4 Transport

Transport energy consumption passing pre-pandemic levels with regional differences

Total final energy consumption in the transport sector amounted to about 122 EJ in 2023, just over one-quarter (27%) of the global total, and the sector was responsible for around 8.2 Gt CO_2 emissions in 2023. From 2010 to 2023, total final energy consumption in the sector grew on average by 1.45% per year. The United States, the European Union, and China are responsible for around 44% of total transport energy demand.

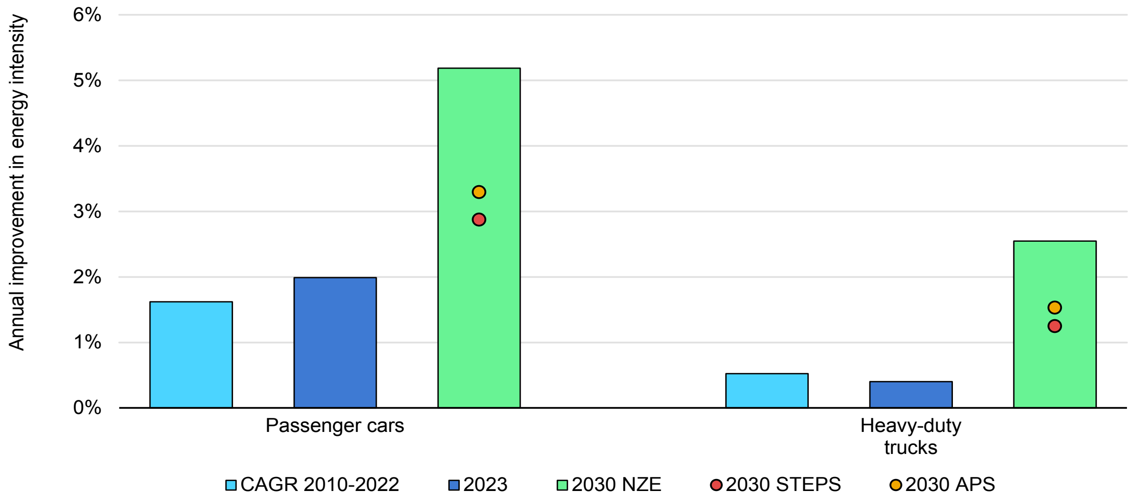
Total final energy consumption for transport, 2010-2023, and by scenario, 2030



Notes: STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; and NZE = Net Zero Emissions by 2050 Scenario. International bunkers final consumption included in Rest of World.
Source: IEA analysis based on World Energy Outlook 2024 extended dataset.

Transport was the end-use sector most impacted by the Covid-19 pandemic, with demand falling by 14% in 2020, followed by a slow return to 2019 levels. Aviation saw the greatest decline, with February 2024 marking the first month where revenue-passenger kilometres (pkm) were at the same level or higher than in February 2019, according to International Air Transport Association data. The Covid-19 pandemic continues to change travel patterns. Studies indicate that half of global companies have cut their business flights by approximately 50% since 2019, and hybrid work in advanced economies looks to be stabilising at permanently higher levels. In passenger cars, energy intensity progress improved by 2% in 2023 compared with an average of 1.6% between 2010 to 2022. This is the result of two counterbalancing trends: increasing electrification versus increasing weight and size. Energy intensity improvements in heavy-duty vehicles remained relatively flat in 2023.

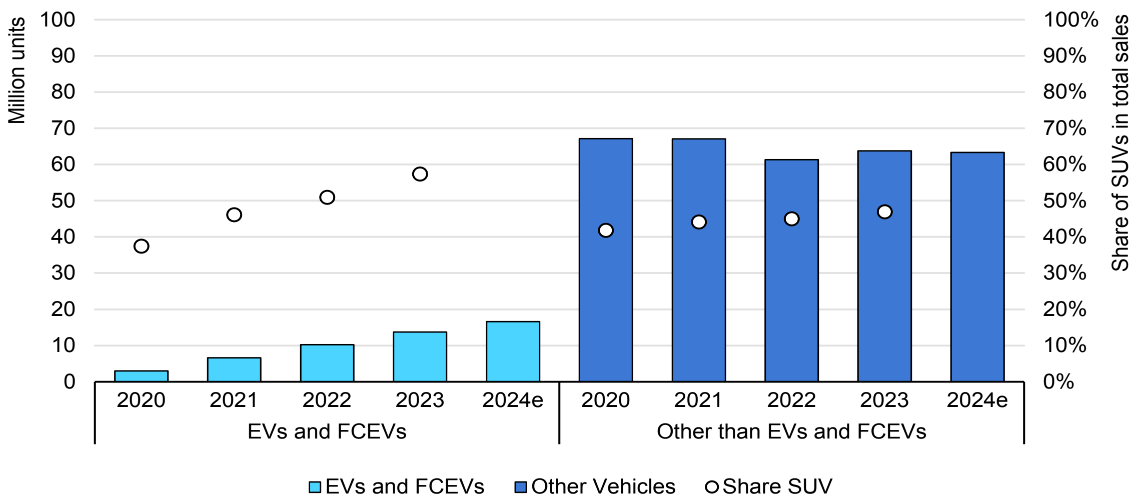
Global energy intensity progress for passenger cars and heavy-duty trucks, 2010-2023, and by scenario, 2030



Notes: STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; and NZE = Net Zero Emissions by 2050 Scenario. International bunkers final consumption included in Rest of World.
Source: IEA analysis based on World Energy Outlook 2024 extended dataset.

EV sales account for nearly 20% of total global car sales. There were over 250 000 new registrations per week in 2023, more than the annual total in 2013. Improvements in energy intensity have been partially offset, however, by the shift towards larger and heavier cars, with SUVs accounting for 48% of total car sales in 2023. For heavy-duty vehicles, efficiency progress is slower due to lower electrification levels and fewer fuel economy standards.

Annual new vehicle sales by car type and share of SUVs, global, 2020-2024e



Notes: FCEV = Fuel Cell Electric Vehicles. 2024e are estimated values for 2024.

Key early actions in transport for doubling energy efficiency progress

- **Regulations:** Fuel economy standards help improve the efficiency of new vehicles by setting limits to fuel consumption per mile and they play a key role in reducing oil demand and CO_2 emissions by 2030. The United States issued updated standards for passenger cars in 2024. The new proposal sets out a 2% increase in Corporate Average Fuel Economy (CAFE) targets for passenger vehicles from model years 2027 through 2032.
- **Information:** Labels help consumers to identify the most efficient vehicles. They can cover new and used vehicles. In Korea, an energy efficiency rating system is applied to all EVs sold from 1 April 2024. The introduction of the rating system is expected to make it easier for consumers to compare EV efficiency and, as a result, help ensure that the most efficient EVs are attractive.
- **Incentives**: Scrappage schemes of inefficient vehicles can help consumers to shift to more efficient and electric alternatives. For example, the Indian government offers consumers a scrap value for vehicles older than 15 years that have not passed the vehicle fitness test.

Efficiency policy for heavy-duty vehicles steps up a gear

Trucks and buses accounted for more than 35% of direct CO_2 emissions from road transport in 2022, despite representing fewer than 8% of vehicles. Electrification rates of heavy-duty vehicles remain low, with 3% of bus sales and 0.9% of truck sales electric in 2023. Several governments implemented policies in 2024 to improve the efficiency of heavy-duty vehicles and accelerate the adoption of electric trucks and buses.

The European Union revised standards in 2024, which are now one of the most stringent emission standards for heavy-duty vehicles globally. The scope was extended, with over 90% of heavy-duty vehicles covered by the standard – compared with 65% before the update. The targets were also strengthened, with the European Union now aiming to reduce emissions from heavy-duty vehicles by 45% by 2030, compared to 30% previously. The United States also tightened standards to reduce emissions from heavy-duty vehicles beginning in 2027. These depend on the vehicle type and are 40-60% stronger than before. The regulations are expected to result in sales of zero emissions vehicles (ZEV) representing up to 60% of total car sales by 2032. California's Advanced Clean Trucks rule requires manufacturers to ensure a higher share of their trucks are zero emission models, producing no tailpipe emissions at the point of use, as well as requirements to operate zero emission fleets. New Mexico adopted Zero Emission Truck mandates in 2023, scheduled to begin in 2026, joining ten other states with such mandates. In Chile, medium-duty truck standards will be defined this year as part of the energy efficiency law, coming into effect from 2026.

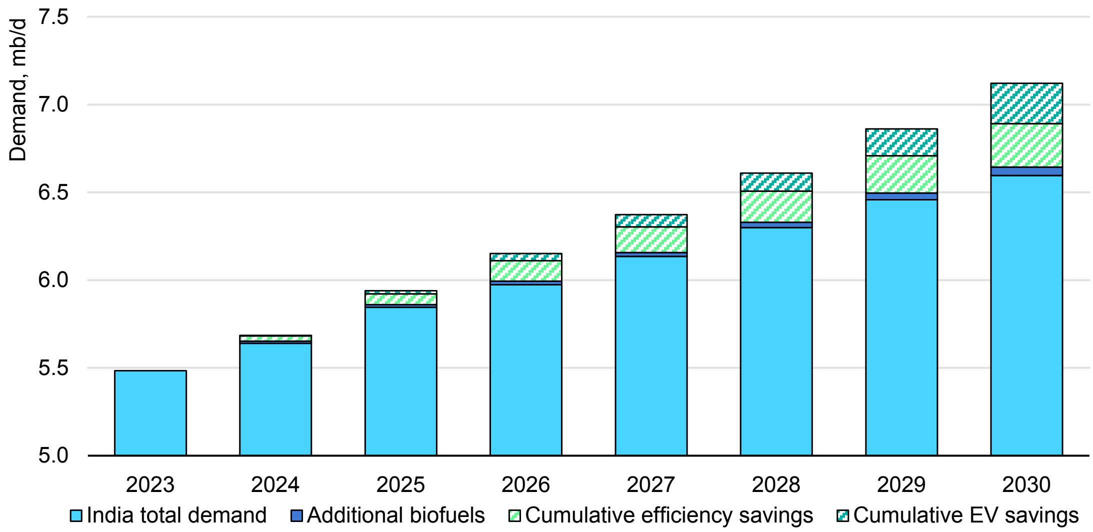
Road fuel demand is approaching its peak

Transport is the sector most heavily reliant on oil, which in 2022 accounted for almost 91% of total transport energy demand. Global road fuel demand is plateauing this year, and total transport energy use is expected to follow close behind in the coming years. Total efficiency gains across all transport segments, including road, maritime and aviation, are expected to reduce oil demand growth by 4.7 mb/d from 2023 to 2030, equivalent to the entire oil demand of Africa in 2024. Most savings in OECD road fuels come amid stricter environmental regulations in Europe and the United States.

The shift from ICE vehicles to electric cars avoided over 0.7 mb/d of road fuel demand in 2023. The global EV fleet consumed about 130 TWh of electricity in 2023 – roughly the same as Norway's total electricity demand. On the global scale, EVs accounted for about 0.5% of the world's total final electricity consumption in 2023, and around 1% in China and Europe. By 2035, electricity demand from electric vehicles accounts for nearly 10% of global final electricity consumption in both the STEPS and APS.

On the regional level, China's use of gasoline is set to peak by 2025. This is due to increasing sales of electric vehicles and the impacts of infrastructure investments, such as high-speed rail, which have blunted gasoline demand growth. India's oil demand in the transport sector is expected to rise by about 1.3 mb/d, with growth similar to China.

Impact of efficiency and electric vehicles on oil demand in India, 2023-2030



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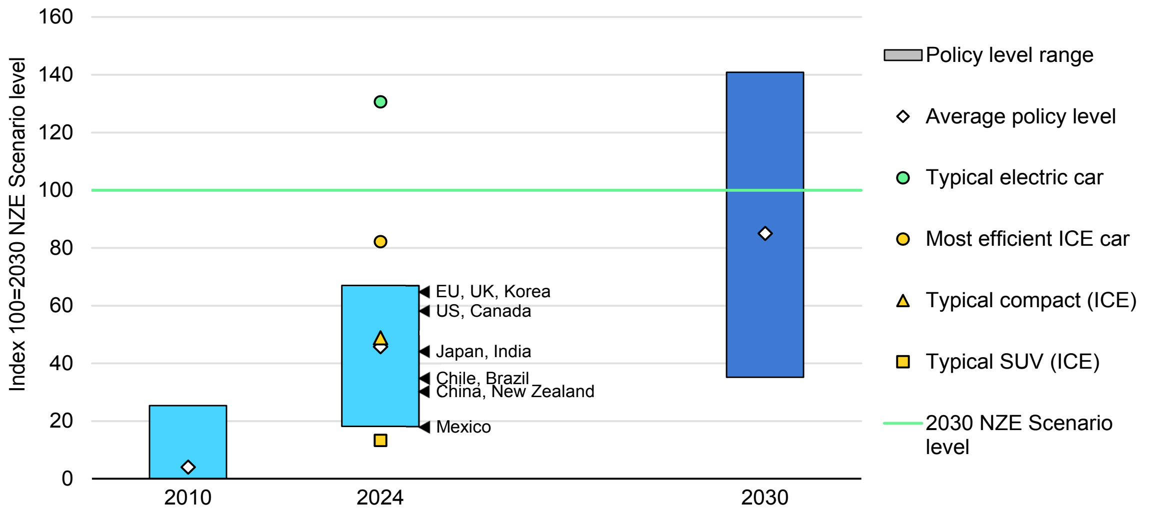
Source: IEA (2024), Indian Oil Market Outlook to 2030.

Policy action on passenger cars is driving forward

2024 sees efficiency policy developments targeting both ICE passenger cars and EVs. Australia is set to advance with the implementation of the New Vehicle Efficiency Standard (NVES). Starting in 2025, it will establish increasingly stringent CO_2 emission targets for new light vehicles. The regulation is projected to save 87 Mt CO_2, by reducing CO_2 from new passenger cars by 60% and from light commercial vehicles by 50% by 2030. The United States has finalised new fuel economy standards aimed at significantly enhancing fuel efficiency across vehicle categories. In April 2024, updated standards for passenger cars and light trucks were issued. These target 2% annual fuel economy improvements in 2027-2031 for passenger cars and in 2029-2031 for light trucks.

Canada announced its New Electric Vehicle Availability Standard in December 2023, which includes a target that 100% of new vehicle sales will be electric vehicles by 2035. From model year 2026, at least 20% of new light-duty vehicles sales must be ZEVs, increasing to 60% by 2030 and 100% by 2035. Canada committed USD 1.2 billion to deploy 84 500 EV chargers by 2029 and USD 444 million for incentive programmes to make electric vehicles more affordable. Germany improved its car energy efficiency labelling in 2024, with more comprehensive information provided on each vehicle's carbon emissions and fuel efficiency. The labels also include projections on future costs highlighting the benefits of more efficient choices. This new approach was mandatory from 1 May 2024.

Fuel economy standards, passenger cars, IEA Efficiency Policy Level Index, global country range, 2010, 2024 and 2030



Notes: ICE = internal combustion engine. All fuel consumption is normalised to the Worldwide Harmonised Light Vehicles Test Procedure (WLTP) and tank-to-wheel efficiencies according to the International Council on Clean Transportation (ICCT) methodology. Fuel economy standards for 2024 are in force, 2030 values are those defined for the year 2030 in policies in force as of 2024. All example vehicle models are year 2023. Most efficient ICE car: Mazda 2 Hybrid 1.5, Typical compact (ICE): Ford Fiesta, Typical SUV (ICE): Nissan Qashqai, Typical electric car: Tesla Model 3. An index of 100 denotes the fuel economy policy level for 2030 in the NZE Scenario (3 lge/100km). It covers only usage phase efficiency and does not allow lifecycle assessment. Country sample represents 69% of global total final energy consumption.

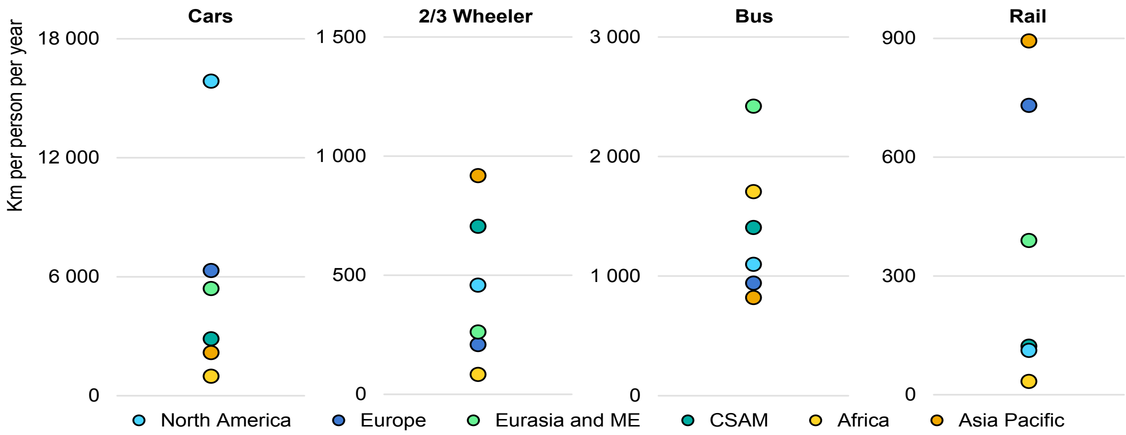
Affordability and accessibility are key for transport efficiency

There are major disparities in transport use across regions, reflecting differences in infrastructure, policies and income levels. In North America, the average distance travelled per person is more than quadruple that of the global average. In EMDEs car ownership per capita is over five times lower than in advanced economies. Countries in Asia use the most two- and three-wheelers, while bus transport is important in Eurasia. These variations in transport activity produce unequal patterns in transport fuel use across countries and income brackets, and between urban and rural areas.

IEA analysis shows there is a correlation between income levels and the use of private motorised vehicles. The upfront investment costs of an electric vehicle can be high for low-income households, limiting their access to this technology. Well-designed policies to promote affordable electric mobility should include a focus on public and shared transport, which is disproportionally used by low-income households, and provide support for more affordable forms of electric transport, including two- and three-wheelers.

Several governments have implemented policies to promote affordable electric transport. India's Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme allocated the largest level of funding to the most affordable electric vehicles such as two- and three-wheelers and covered a greater part of their purchase price. The subsidy for electric two-wheelers was around 45% of the cost, compared to around 19% for electric cars. Similarly, Italy and France provide higher EV grant amounts for lower-income applicants. France, to further support low-income households, implemented a scrappage scheme, where the premium is adjusted based on income and can be used to purchase efficient, second-hand cars, and also launched a leasing scheme, allowing drivers to lease an EV for EUR 40 per month without a down payment.

Passenger kilometres per capita by transport mode across regions, 2023



Source: IEA (2024), Strategies for Affordable and Fair Clean Energy Transitions.

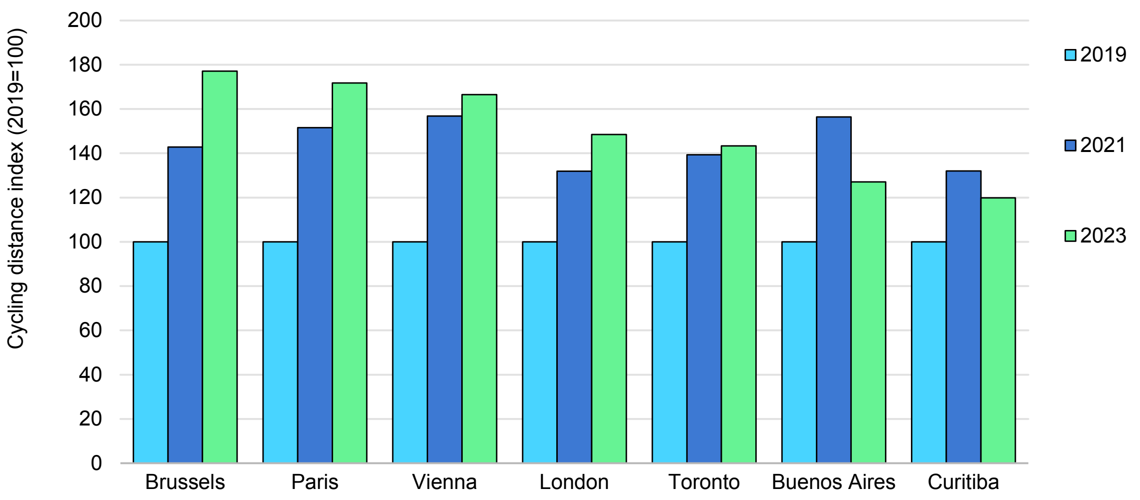
Clean transport alternatives keep gaining traction in cities

A wide array of transport uses takes place in cities, making them an important source of energy demand. A modal shift from private vehicles, electrification of public transport, and increased adoption of clean technologies are helping to reduce emissions and congestion in urban areas.

The Covid-19 pandemic saw a decline in the use of transport, and while mass transit use has not yet regained pre-pandemic levels in many advanced economies, a recovery has been seen in many EMDEs. New systems have also come into place across the globe, such as in Mexico to Denmark. Electrification can play an even greater role to accelerate efficiency progress in cities. Senegal launched a new, all-electric BRT system in Dakar in May 2024, with over 300 000 anticipated passengers per day. Similarly, Indonesia put 100 e-buses on trial in its Transjakarta BRT system in 2023, with the goal of full electrification by 2030.

Increased cycling uptake has also become a popular trend. Since 2019, the distance cycled rose by up to 80% in major cities worldwide, with many of them making efforts to sustain these gains, including by continuing to introduce cycle lanes and car traffic restrictions. Furthermore, the electric bike boom, with global annual sales exceeding 65 million units, is also contributing to reducing car use, for example through facilitating longer-distance travel. In Paris, for instance, the average distance travelled by electric bikes can be 40% higher than conventional ones. E-bikes in urban and suburban areas are displacing around 70 kb/d of oil demand in 2023.

Index of total cycling distance for selected major cities, 2019-2023



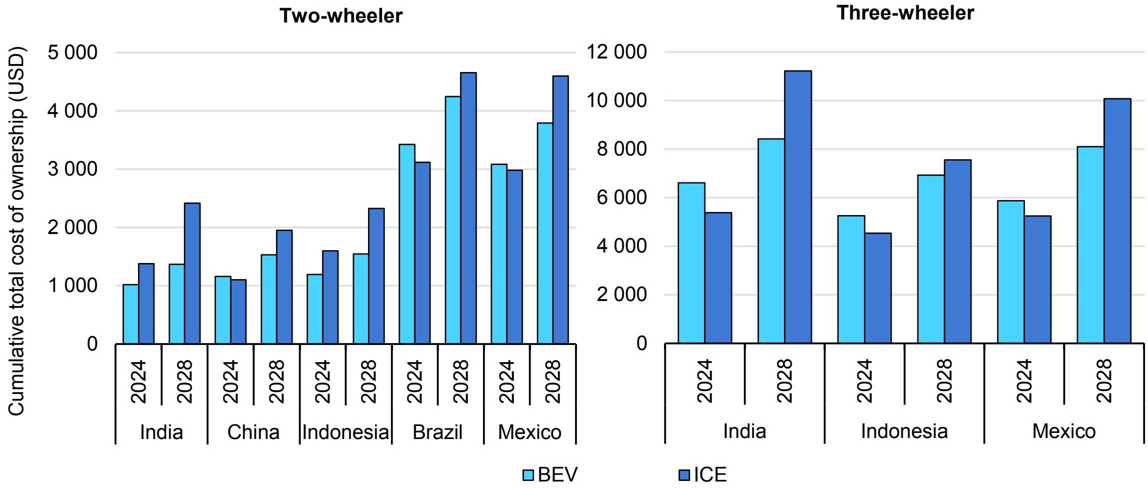
Source: IEA analysis based on data from Google's Environmental Insights Explorer.

Electric two- and three-wheelers become cost-competitive

Electric two- and three-wheelers are essential for the global shift to sustainable transport, particularly in Asia, Africa and Latin America. Electric models represented 13% of all two- and three-wheeler sales in 2023. Especially in Asia, policies have accelerated the manufacturing and adoption of electric two- and three-wheelers, boosting their price competitiveness. The India PM E-DRIVE initiative promotes electric two- and three- wheelers, after the FAME II policy ended in 2024. Thailand also supports electric two- and three-wheelers, focusing on domestically manufactured motorcycles. While markets for these vehicles are still small in Latin America, governments are promoting them to combat pollution and reduce fossil fuel use.

Partly driven by government policies, the cost of electric two- and three-wheelers has become competitive with ICE models. Electric two- and three-wheelers are cheaper over their lifetime due to the lower maintenance costs and fuel efficiency compared to ICE models. The total cost of ownership for electric two- and three-wheelers is comparable to that of ICE vehicles after the first year of ownership in several countries. By the fifth year, EVs are consistently cheaper across all analysed countries. The total cost of ownership of electric three-wheelers can be up to 25% lower than for ICE models, while electric two-wheelers have a total cost of ownership that is up to 43% lower than that of ICE models. In the APS, by 2030, EVs dominate sales of two- and three-wheelers, accounting for 77% of sales in China, 72% in the European Union, and 50% in the rest of the world. With this, a further reduction in the total cost of ownership is expected.

Cumulative total cost of ownership after the first and fifth year of ownership of two- and three-wheelers, selected countries



Notes: TCO = total cost of ownership; ICE = internal combustion engine; BEV = battery electric vehicles. TCO values represent the cumulative cost of ownership for the first and fifth year from the date of purchase (2023). It covers initial purchase cost, maintenance and operational costs, insurance as well as financing cost for a three-year loan.
Source: IEA analysis based data from UNEP (2023), Global Emerging Market Overview for Electric Two and Three Wheelers.

Chapter 3. System-wide themes

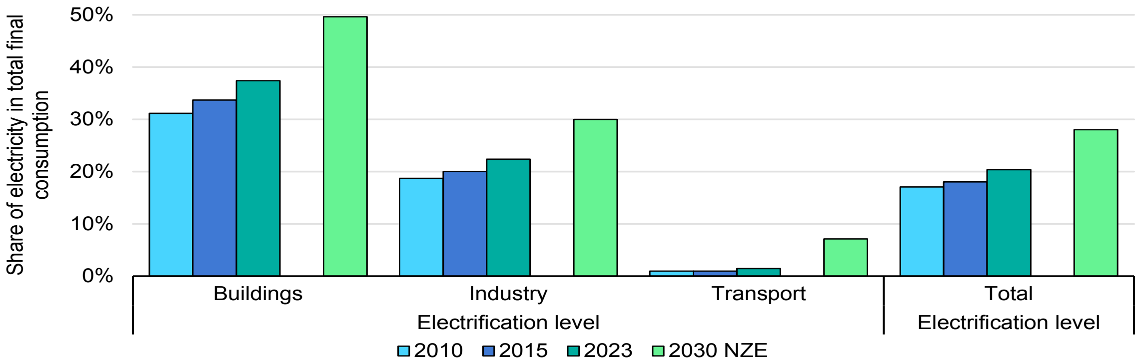
3.1 Electrification

Electrification grows rapidly across all sectors, powering improved energy efficiency gains

The level of electrification increased in 2024, driven by the use of efficient, electric end-use technologies in transport, buildings and industry. Increased electrification efforts, coupled with economic growth, are set to push electricity demand growth in 2024 to the fastest pace since the post-Covid-19 rebound in 2021. Strong electricity consumption growth in China and India propelled global demand higher and, along with Southeast Asia, will continue to be the main drivers of electricity use this decade. In the Net Zero Emissions by 2050 Scenario (NZE Scenario), the share of electricity reaches nearly 30% of total final energy consumption by 2030, with rapid growth in electrification and the use of renewables for power generation.

Electrification levels vary among sectors. In transport, just 1.5% of all energy use was electricity in 2023, but its share has rapidly increased since 2015 as sales of electric cars and two- and three-wheelers ramped up. In buildings, where electricity provided 37% of total energy demand in 2023, the use of heat pumps is improving water and space heating efficiency while induction stovetops are increasingly replacing gas for cooking. In EMDEs access to clean cooking through electrification is providing efficiency gains and health benefits. In the industrial sector, light industries are electrifying low- and medium-temperature heating and motor-driven systems.

Share of electricity in final energy consumption by sector, 2010-2023, and Net Zero Emissions by 2050 Scenario, 2030



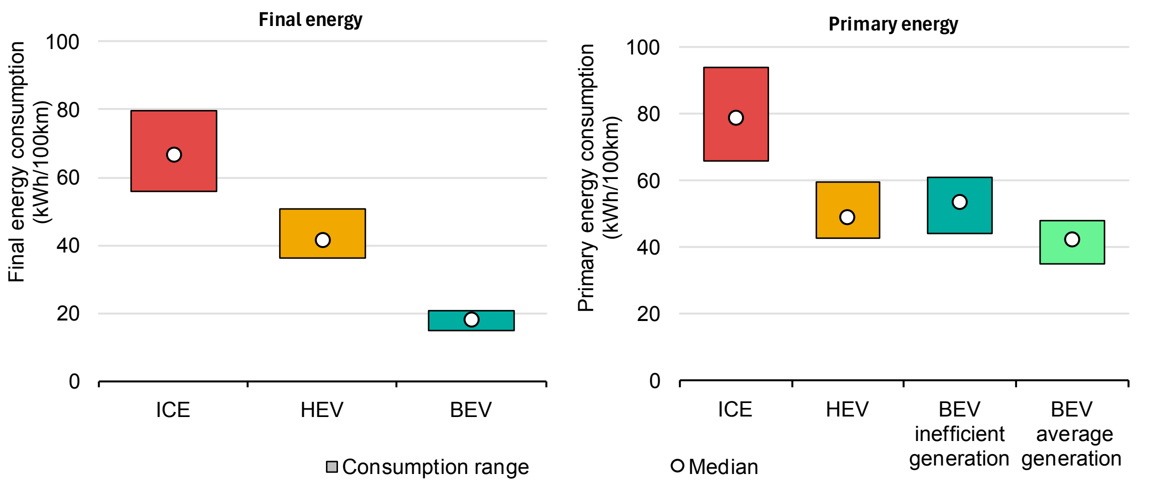
Source: IEA analysis based on data from IEA (2024) World Energy Outlook, extended dataset.

Efficient electrification can reduce energy use by more than two-thirds for key end-use technologies

Switching from fossil fuels to electrified technologies, such as heat pumps and electric vehicles, can cut energy use by more than two-thirds. The most efficient mid-size battery electric vehicle (BEV), for instance, uses around one-fourth the energy of the most efficient mid-size internal combustion engine (ICE) vehicle. ICE cars convert only about 16-25% of the input energy into motion. Hybrid EVs convert slightly more at 24-38%, given that they incorporate an electric motor to reduce energy consumption during idle times and low speeds, and to enable regenerative breaking. Going fully electric eliminates thermal losses incurred by ICEs, leading to energy-to-motion conversion rates of over 80%. Similarly, efficient heat pumps need less than one-fourth of the energy used in traditional heating systems such as gas boilers. Best-in-class systems working at low temperatures can reach even higher efficiency levels.

The generation of this electricity can also have conversion inefficiencies on the supply side, resulting in higher primary energy use. The global average efficiency of power generation is over 45%, while countries with more inefficient power plants, such as aged coal-based generation, have conversion rates of around 35%. The global average value increases with the use of renewable energies to generate electricity. Just as electrification leads to improved efficiency gains, energy efficiency also acts as an enabler for electrification. Flexible and efficient technologies help optimise electricity use, reducing the impact on the grid, allowing for faster electrification and the integration of variable renewable energy.

Final and primary energy consumption for mid-size cars available in the US market



Notes: HEV = hybrid electric vehicle; BEV = battery electric vehicle; and ICE = internal combustion engine. HEV includes only full hybrid models, able to perform all-electric driving over short distances. Average generation considers a primary energy to electricity conversion efficiency of 46%. Inefficient generation considers a conversion efficiency of 35%. Transmission and distribution losses are considered.

Sources: IEA analysis based on World Energy Balances and Worldwide Harmonised Light Vehicle Test Procedures (WLTP), Fuel Economy data.

Policy support for electrification is increasing, with a strong focus on incentives

Ethiopia became the first country in 2024 to ban the import of non-electric cars, aiming to accelerate uptake of EVs and reduce fuel imports. India is rapidly electrifying its railways, targeting 100% electrification by 2025. It also set a goal of deploying 50 000 new electric buses by 2027, and plans to replace 800 000 diesel buses with electric ones over the next seven years. In Chile, the city of Santiago has the largest electric bus fleet outside of urban areas in China, with nearly 2 500 buses. Other cities in Chile are expected to follow suit, with Antofagasta already starting to electrify its public transport system as well in 2024, putting 40 electric buses on the street.

In the buildings sector, over 25 governments are supporting the purchase of heat pumps by providing financial incentives, including low-cost loans or funding for upfront costs to consumers. In Canada, the government strengthened its Oil to Heat Pump Affordability programme in October 2023 by raising the funding level per applicant for 2024 from CAD 10 000 to CAD 15 000. The programme incentivises low- to median-income households to replace their oil-driven heating systems with more efficient electric heat pumps by providing funding to cover most or all of the installation costs. In the United Kingdom, heat pump grants were increased by 50% in October 2023, leading to a 49% rise in monthly applications between November and April this year. The German government launched new funding options in 2024, offering subsidies that can cover up to 70% of the costs of purchasing and installing a new heat pump. The US government allotted a budget of USD 4.5 billion for the Home Electrification and Appliances Rebate Program, which provides rebates for heat pumps and electric cooktops, among other technologies. In Massachusetts, the Mass Save programme offers support from a specialist to design an electrification implementation plan, combined with rebates and incentives for purchasing electric equipment, including heat pumps, induction stoves, and other appliances. Other states such as California have incentives for the electrification of gas equipment and the adoption of EVs and eBikes.

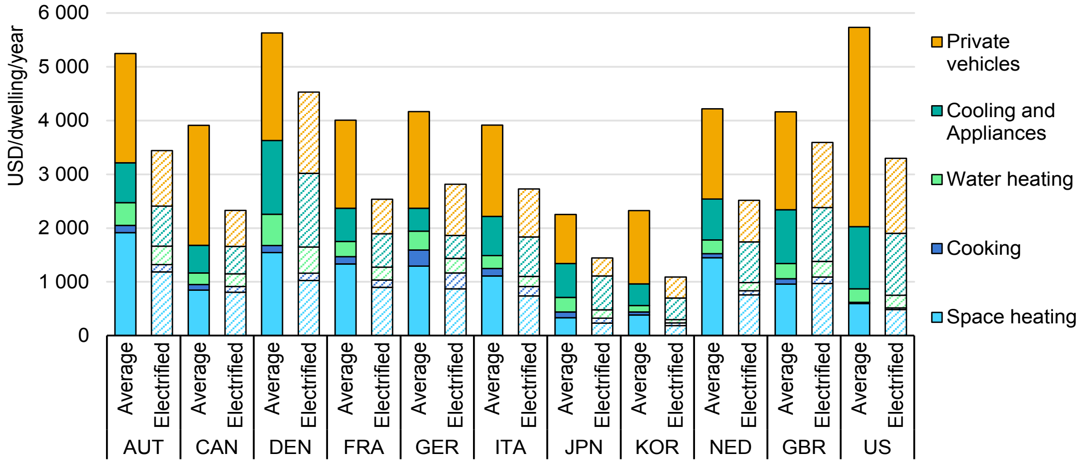
Germany ended its purchase subsidy programme for EVs, with almost an immediate impact on sales growth. In the Netherlands, the government has cancelled the obligation to use hybrid systems or heat pumps in new installations that had been expected to come into force in 2026. The European Commission also delayed the proposal of the Heat Pump Action Plan, which was expected to boost the roll out of heat pumps. The new government in the United Kingdom, however, has signalled it will reinstate the ban of new petrol and diesel ICE cars by 2030, which the previous UK government had delayed until 2035.

Tariff structures affect the benefits of faster electrification

The benefits of electrification on consumer energy bills depend on the price difference between electricity and fossil fuels, particularly natural gas. Given the energy savings of electrifying, bills will generally be lower when the price ratio of electricity to gas or gasoline is less than 2.5. In most analysed countries, residential electricity prices are competitive against gasoline prices, which often have higher tax rates. However, this is not always the case with natural gas, with electricity prices up to four times higher than gas in some countries. Wholesale electricity prices were lower than natural gas prices during nearly 20% of the year in 2023 but this has not always fed through to residential rates.

Out of 28 analysed OECD countries, half have electricity prices at least 2.5 times higher than natural gas. On average, taxes on electricity are slightly lower than those for natural gas, but large variations exist among countries. The Netherlands and Sweden have some of the highest taxes on gas, while Italy, Germany and Belgium tax electricity at higher rates, leading to higher ratios. In the United Kingdom, electricity is four times more expensive than gas. Considering different tariffs, the savings associated with electrifying a house vary. While the benefits of heat pumps are evident in countries such as Austria and the Netherlands, they are less so in countries with tariffs that are relatively low for gas or high for electricity. Electric vehicles offer savings in most countries, especially when home charging is available. To increase competitiveness, some countries are offering reduced rates for EV charging during night hours. Ireland offers reduced night rates between 2:00-5:00 a.m., France offers night rates with a 25% discount (50% lower for EV charging), and the United Kingdom offers reduced tariffs designed specifically to work with heat pumps.

Energy expenditure comparison of an average home and a fully electrified one, by end use, 2024



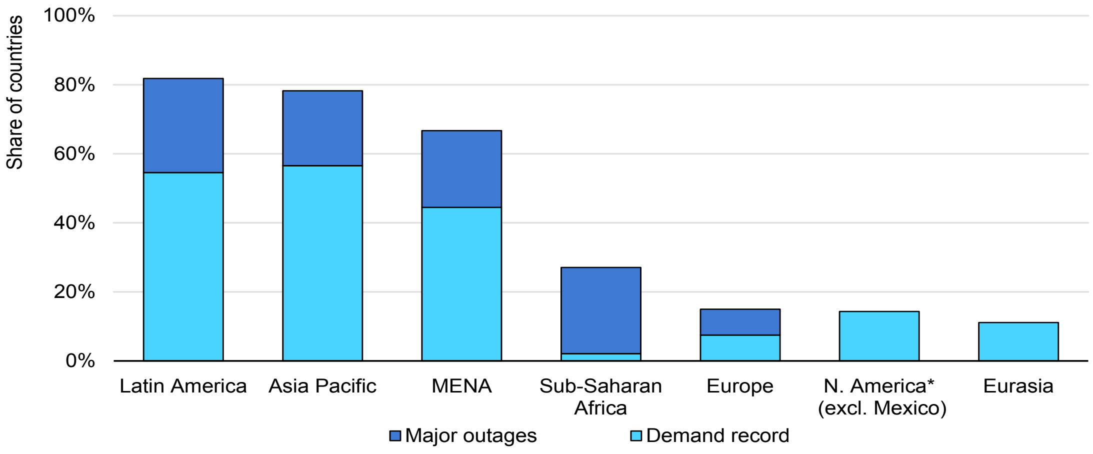
Note: AUT = Austria, CAN = Canada, DEN = Denmark, FRA = France, GER = Germany, ITA = Italy, JPN = Japan, KOR = Korea, NED = Netherlands, GBR = United Kingdom, and US = United States.
Source: IEA analysis based on data from the IEA End-Use Prices Data Explorer.

Spotlight: How can energy efficiency alleviate rising heatwave-driven electricity demand?

Another year of high temperatures leads to new electricity demand records and power outages

Global temperatures have reached new heights in recent years. 2023 was the warmest year on record, and 2024 is on track to beat it. The frequency and intensity of heatwaves are increasing, causing extreme temperatures of up to 50ºC in some regions, with multiple national temperature records broken during 2024. Ensuring that cooling needs are met is of primary importance. The extreme temperatures are driving strong demand for much-needed cooling technologies such as air conditioners. However, these are also pushing up electricity use to record levels and straining power grids around the world. In 2024, more than 40 countries representing nearly 70% of global electricity demand, including Brazil, China, India, Mexico and the United States, reached new power peak demand records during heatwaves, while many others suffered major power outages and rolling blackouts. Electricity grids in countries with high AC ownership and hot climates are particularly impacted. Nearly 80% of countries in Latin America and Asia Pacific either reached new peak demand records during a heatwave or suffered heat-related grid disruptions. In Europe, a heatwave hit the Balkan region in June, leading to major power cuts, and in July temperatures reached 43°C, resulting in record electricity demand in Serbia and Croatia. In sub-Saharan Africa, where AC ownership is low, prolonged droughts combined with severe heat events caused power system outages and rolling blackouts throughout 2024.

Percentage of countries within a region reaching new all-time peak demand records or suffering major disruptions attributed to extreme heat events, 2024



* North America's share is based on 14 major regional transmission organisations (RTOs) and independent system operators (ISOs) in the United States and Canada. MENA = Middle East and North Africa.

Note: Countries that experienced both electricity demand records and outages are only included in one category.

Source: IEA analysis based on data from the Real-Time Electricity Tracker.

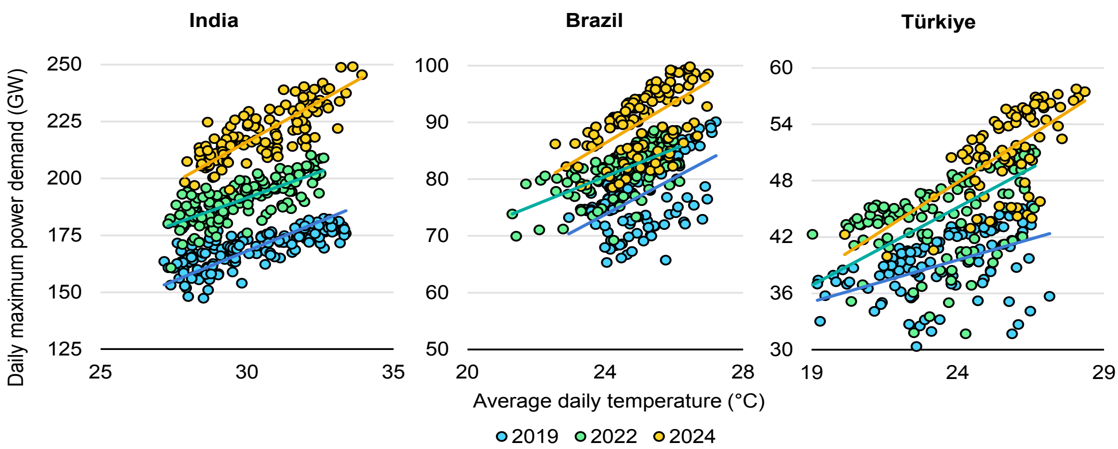
Electricity demand in emerging economies continues growing at a record pace, fuelled by new air conditioner installations

World electricity consumption is forecast to grow by 4% in 2024, with increased cooling demand in EMDEs a major driver. India's electricity consumption is expected to grow by over 8% this year, amid fast economic growth and rapid electrification paired with record cooling demand. While many factors contribute to electricity consumption growth, peak demand is mainly driven by AC ownership and maximum daily temperatures, increasing the need for new infrastructure.

New IEA analysis for several regions shows that during cooling seasons, the peak demand-temperature curves have shifted upwards and become steeper, indicating peak electricity demand has risen at every temperature level, but more so when there are high temperatures. In India each 1°C increase leads to additional peak demand of over 7 GW, up from around 4 GW in 2019. This reflects the rapid growing stock of air conditioners seen in the last five years and shows the increased impact of heatwaves on the grid. In this same period, annual peak demand rose by nearly 40%. In Brazil and Türkiye, countries with lower power demand overall, a 1°C increase leads to an extra 3.6 GW and 2 GW, respectively, posing similar levels of strain on their grids.

In the Middle East and parts of the United States, space cooling can represent more than 70% of peak residential electrical demand on extremely hot days. On the warmest days in Texas, where almost every household owns at least one AC, cooling demand can take a 50% share of total peak demand. On a global average basis and in EMDEs such as India and Brazil, the share of cooling in total peak demand is between 10% and 20%.

Daily peak demand versus average daily temperatures during cooling seasons in selected countries, 2019, 2022 and 2024



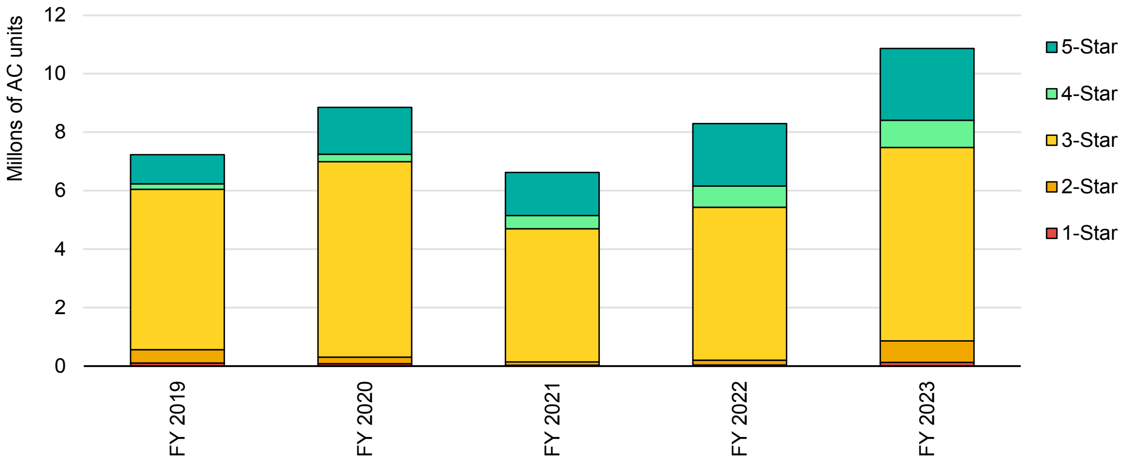
Source: IEA analysis based on data from the Real-Time Electricity Tracker and Weather, Climate and Energy Tracker.

Air conditioner sales are rising rapidly in many regions, with less efficient models dominating sales

The increasing intensity and extended duration of heatwaves in already hot and humid climates have shifted cooling appliances from being luxury items to becoming necessities. As a result, sales of air conditioners have risen this year in many countries. In Japan, domestic AC sales increased for four consecutive months, with an annual growth of 11%, after suffering its hottest summer on record. In India, production volumes of ACs have also been growing in recent years. The Indian Bureau of Energy Efficiency uses production volumes as an estimate for sales, given that imports are limited. Estimated sales volumes increased by more than 25% year-on-year between 2021 and 2023, with nearly 11 million units sold last year. The AC market experienced unprecedented growth in 2024, as the country faced intense heatwaves, with temperatures exceeding 50°C. Many manufacturers in India reported record-breaking sales in the first half of the year, estimated to have reached 14 million, with demand outpacing inventory plans. Peak electricity demand rose to over 250 GW, nearly 15% higher than in the same month last year. The government had to take emergency measures to manage the crisis, including deferring power plant maintenance work and reopening idled coal units.

Air conditioners vary in their levels of efficiency. Sales in India are still largely dominated by models in the lower efficiency classes (1-3 Stars on a five-point scale on the efficiency of air conditioners in India), while efficient models (4-5 Stars) account for the minority of sales. For new products, in 2023, 3-Star models accounted for 61% of units produced, well ahead of 5-Star models, which accounted for 23%. Some households also rent second-hand inefficient models to cope with extreme heat.

Annual air conditioner production volumes in India by efficiency rating, Fiscal Year 2019-2023



Notes: Energy efficiency thresholds were upscaled before FY 2023, leading to an increase of models classified as 2-Star. Produced units are used as a proxy for sales by the Indian Bureau of Energy Efficiency.
Source: IEA analysis based on data from Impact of Energy Efficiency Measures reports of the Indian Bureau of Energy Efficiency.

High-efficiency air conditioners limit the increase in power demand during heatwaves

Despite the fast growth in the last few years, AC ownership in EMDEs is still well below that of advanced economies. Only around 5% of households in sub-Saharan Africa are equipped with an air conditioner, fewer than 20% in India and around 30% in Brazil, but the share of ACs in homes is set to increase sharply as income levels rise. The implementation of an integrated policy package to promote energy efficient air conditioners is essential for providing much-needed cooling demand while mitigating the impact on electricity grids. The following policy actions can be part of a comprehensive approach:

- **Implement and update labelling schemes**: IEA analysis shows that high efficiency air conditioners are not necessarily more expensive than average models, while they can cut electricity consumption in half. Comparative labels can help users identify best-in-class models when making a purchasing decision.
- **Implement minimum energy performance standards**: These standards can exclude inefficient models from the market and lower energy expenditure for consumers. MEPS should be in line with international best practices and harmonised across the region.
- **Promote access to highly efficient models**: Offering rebates and other financial mechanisms to purchase highly efficient models at lower prices can enable more consumers to buy them.
- **Provide financial and technical support to local manufacturers**: Manufacturing processes might need adaptations to produce more efficient air conditioners. Offering financial incentives and technical support can encourage manufacturers to make the necessary changes.
- **Promote demand-response-ready models**: Promoting and enabling the utilisation of demand-response ready air conditioners can ease the strain on grids during high temperature events. Load shifting by pre-cooling during low demand or high solar PV generation hours reduces peak demands and works best in well-insulated buildings.
- **Encourage** behavioural change: Promoting actions such as keeping windows closed during heatwaves and shading them with shutters or blinds during the day, combined with passive cooling measures, can help reduce the need for air conditioners. Setting the cooling temperature set-point of the air conditioner higher lowers both energy demand and bills.

Buildings and urban infrastructure should also be addressed. Air temperatures and the urban heat island effect can be lowered by promoting the expansion of vegetation, green areas, water sources, and green roofs and facades. Using high-albedo surfaces on external walls, streets and sidewalks also reduces the increase in temperatures. Mandatory building energy codes that address cooling needs can limit the increase in energy demand associated with new buildings, while retrofits are an effective way to reduce the cooling demand of existing buildings.

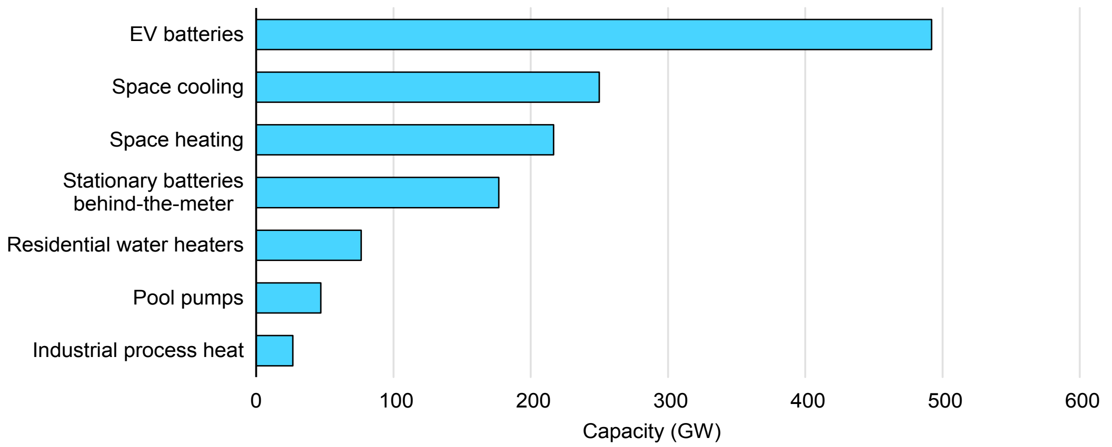
3.2 Flexibility

Unlocking flexibility can mitigate pressure on grids and improve affordability

As more renewables are added to electricity systems globally, the need for new sources of flexibility is growing, driving greater interest in demand-side management. Today, almost all flexibility comes from traditional thermal-powered generation and hydropower. However, as variable renewables increase, demand response enabled by smart, connected appliances and user behaviour, as well as battery storage, are emerging as effective sources of flexibility. Future energy systems are expected to include several flexibility services integrated and connected to each other.

2023 saw the fastest global renewables growth rate ever recorded, with almost 565 GW of capacity additions, a more than 60% increase on 2022. Stronger growth underpins the need to scale up flexibility supported by efficient technologies to ensure that more renewables can be integrated into power systems, but also to manage electricity price volatility during the different phases of renewable integration. There is an opportunity for new business models, with the smart demand response market valued at more than USD 29 billion globally in 2024 and estimated to grow at a CAGR of around 19% between 2024 and 2032. Last year, battery storage in the power sector was the fastest growing commercially available energy technology, with deployment more than doubling year-on-year, adding a total of 42 GW to global capacity. This was driven by China, which accounted for 55% of annual global growth in 2023. In California, where battery storage markets are quite mature, batteries are now on occasion becoming the main source of electricity during peak hours. However, global markets have been slow to adapt and unlock demand response.

Available global demand response capacity in selected applications, 2030



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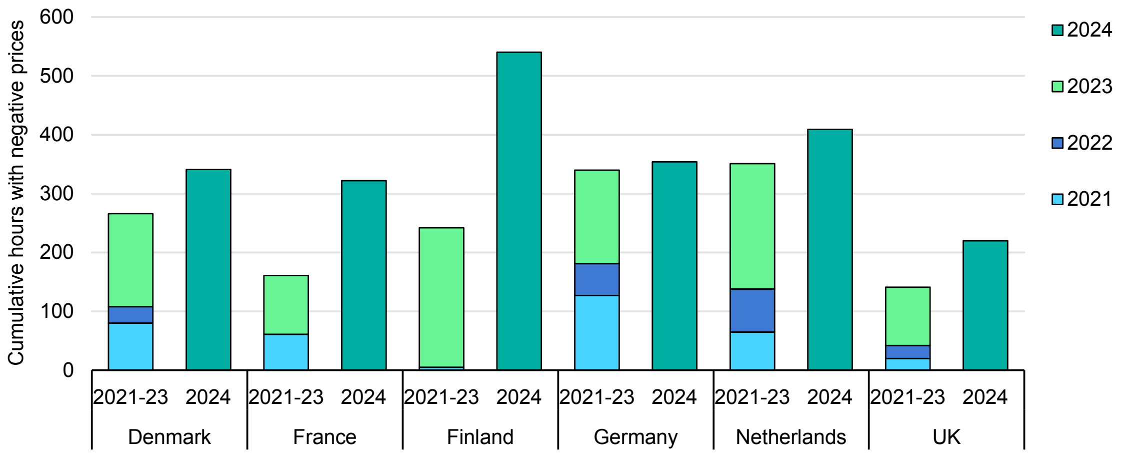
More countries experienced negative electricity prices in 2024, signalling the need for new tariff structures and more flexibility

As shares of renewables increase in some markets, the low prices driven by, for example, high levels of solar generation on mild sunny days when demand is also low, can lead to negative pricing – a situation which results in generators paying to supply electricity to the grid. Some markets, such as South Australia, have experienced negative electricity prices many times in previous years already. In other regions, such as Europe, this year saw negative prices become much more frequent than before. The first half of 2024 saw negative electricity prices across Europe, often surpassing the total hours of negative prices seen in the three previous years. During the spring, negative pricing was due to a combination of factors, including sunny days, strong winds, low demand due to mild weather, and the limited flexibility of thermal power plants to further reduce their output. In summer, following a 58% increase in total installed capacity between 2021 and 2023, solar PV output was the main driver for negative prices, clustered in the hours around noon. Finland saw an increase in negative prices after Europe's largest nuclear reactor began operation in May 2023.

Negative pricing sends a market signal for flexible supply and demand, including storage, and should be supported by suitable market rules. They have the potential to encourage generators to be more flexible to avoid financial losses and push consumers to invest in technologies that shift consumption, and prompt investment in storage by causing arbitrage opportunities. In South Australia in Q4 2023, battery operators earned more money during negatively priced periods than they spent on charging in positively priced ones. However, although these conditions can boost flexibility markets or increase exports, periods of negative pricing risk slowing new investment in renewables due to lower earning potential.

Total hours of negative prices in selected countries, January-September period, 2021-2024



Source: IEA analysis based on data from the IEA's Real-Time Electricity Tracker.

Governments are rolling out policies to support flexibility through storage, demand response and market mechanisms

A number of governments have rolled out policies to support flexibility in 2024. The United Kingdom is set to release its first Flexibility Markets Strategy in Q4 2024, building on an already large flexibility market. A record 6.4 GW of capacity in flexibility markets was tendered in 2023, of which almost 4 GW was contracted, reflecting a nearly twofold increase from the 2 GW contracted in 2022. In France, the system operator issued a call for tenders for demand response to cover the period of 2025-2026 to contract up to 2.9 GW in capacity. Australia announced six new projects as part of the New South Wales Peak Demand Reduction Scheme to deliver around 1 GW of grid firming flexibility. The Netherlands announced funding of USD 108 million to support the integration of battery storage and solar projects as it aims to overcome power grid constraints and flexibility challenges. The investment is scheduled to commence on 1 January 2025 and will continue through 2034. Ireland launched an initiative in 2024 for flexible demand connections, where a customer agrees to a schedule of when their demand may be higher or lower, as part of plans to begin to develop local flexibility markets to complement network reinforcement.

In 2023, India changed the electricity tariff structure to incentivise consumers to shift demand to off-peak hours by announcing time-of-use tariffs, applicable from 2024, for commercial and industrial users, and from 2025 for all other consumers except agriculture. In Japan, the flexibility market was expanded in April 2024 to include three fast response markets for battery storage systems. Early indications show that auctions were undersubscribed, leaving room for new participants to enter the market. Thailand recently opened a Renewable Energy Forecast Centre and a Demand Response Control Centre. Both centres will later be replicated at the regional level in grid control centres as part of the Smart Grid Development Plan for the Medium Term (2022-2031) to integrate up to 8 GW of new renewable capacity.

Digitalisation is presenting opportunities for consumers to help unlock flexibility

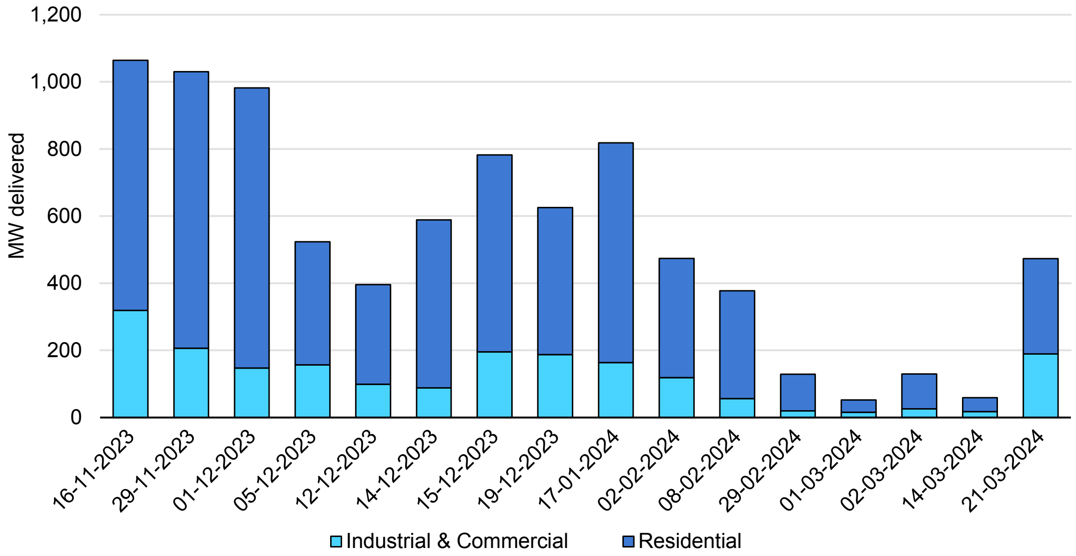
Some regions are already making progress in unlocking the potential of consumers to utilise real-time energy data and participate in flexibility markets, with compensation acting as an incentive for behavioural change for those who can and want to participate. In the United Kingdom, the Demand Flexibility Service trial was used during winter 2023/2024 to reduce demand as a contingency service. It delivered more than 3.7 GWh of flexibility, with over 2.6 million domestic consumers and 8 000 industrial and commercial users reducing or shifting their electricity use at key times. On average, domestic customers contributed almost 80% of the total flexibility requested. The success of this seasonal scheme has led system operators to request it be available all-year-round.

Further changes are underway following a study commissioned by the United Kingdom government on how to deliver a data sharing infrastructure. This includes the creation of a governance framework to maximise the benefits of data sharing to unlock flexibility. Data can be used, for example, to identify vulnerable households, enable more targeted policies and provide added value for customers. Initial costs are estimated at USD 16-37 million, with fixed expenditure of USD 28 million annually. Similarly, Octopus Energy is testing a residential tariff that follows wholesale prices based on half-hourly meter data, and EDF is trialling an automated EV smart charging scheme where 300 participants will provide flexibility during peak loads in exchange for lower bills. The French transmission system operator also launched a platform to access the demand-side flexibility of buildings in 2024.

In Australia, operators announced plans to work with energy delivery service providers to develop a consumer energy resources data exchange, and India is developing a digital registry of installed solar PV, with India Smart Grid Forum signing a memorandum of understanding with a Gujarat-based utility company in 2024.

In the United States, a three-year pilot was initiated in Q4 2023 examining the potential for demand response for smart heat pumps. Additionally, California has approved expanding pilot dynamic-rate programmes through 2027 as part of a summer energy reliability programme. Federal funding has been allocated to improve grid flexibility and resilience (USD 10.5 billion), support innovation for grid-edge technologies in communities (USD 65 million), and to develop systems to better support the dynamic electric grid and the growth of EVs, energy storage, and the electrification of buildings and industry (USD 50 million).

Flexibility delivered in test events throughout the Demand Flexibility Service trial in the United Kingdom during winter 2023/2024, by customer segment



Source: IEA analysis based on data supported by National Grid ESO Open Data.

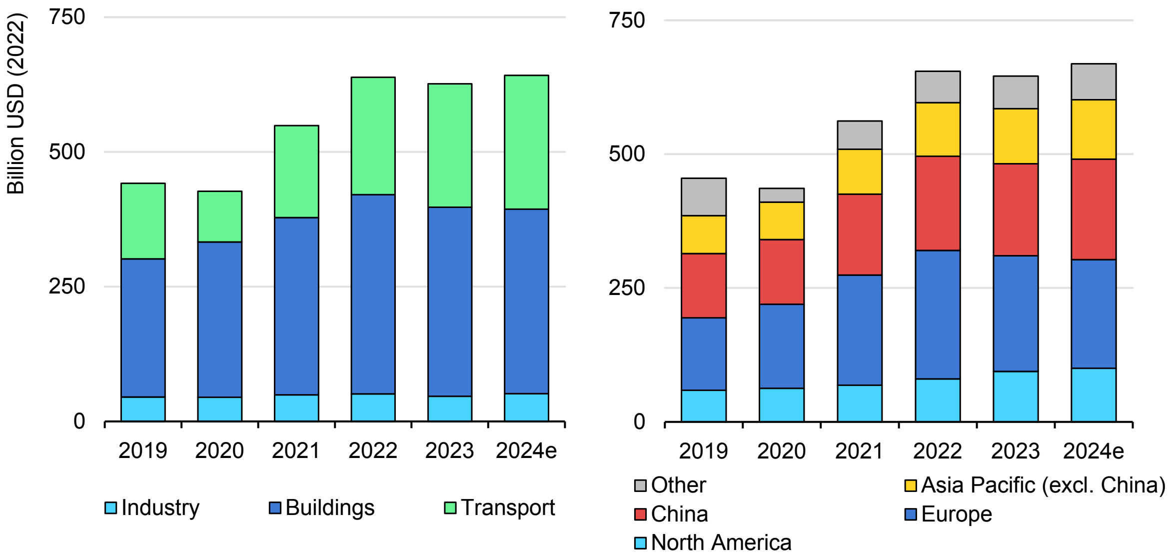
3.3 Finance

Efficiency investment is resilient and projected to reach about USD 660 billion in 2024

Combined public and private investment in end-use sectors on efficiency, including electrification, is set to increase slightly by nearly 4% in 2024, matching the all-time high in annual investment of about USD 660 billion set in 2022. This is around 10% more than all upstream oil and gas investment in 2024. Investment has risen by a strong 45% since 2019, as the energy crisis and Covid-19 pandemic prompted massive government spending to stimulate consumer investment in energy efficiency. Since 2019, end-use investment in transport risen by an estimated 77%, followed by 34% for buildings and 13% in industry.

More recently, investment trends have been more mixed. Between 2022 and 2024, investment is estimated to have declined by 7% in the buildings sector and risen by 14% in transport, while it stayed steady in the industrial sector. Spending on efficient electrification is rising rapidly, primarily through EVs in China, Europe and North America. However, most other areas of efficiency spending are declining from recent highs as the effects of high energy prices ease and Covid-19 stimulus spending winds down. As a result, overall global end-use investment has plateaued over the last two years, with higher inflation and interest rates making it more expensive to implement and finance energy efficiency upgrades.

Global investment in energy efficiency, electrification and renewables for end uses by sector and region, 2019-2024e



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Notes: An energy efficiency investment is defined as the incremental spending on new energy-efficient equipment or the full cost of refurbishments that reduce energy use. The intention is to capture spending that leads to reduced energy consumption. 2024e are estimated values.

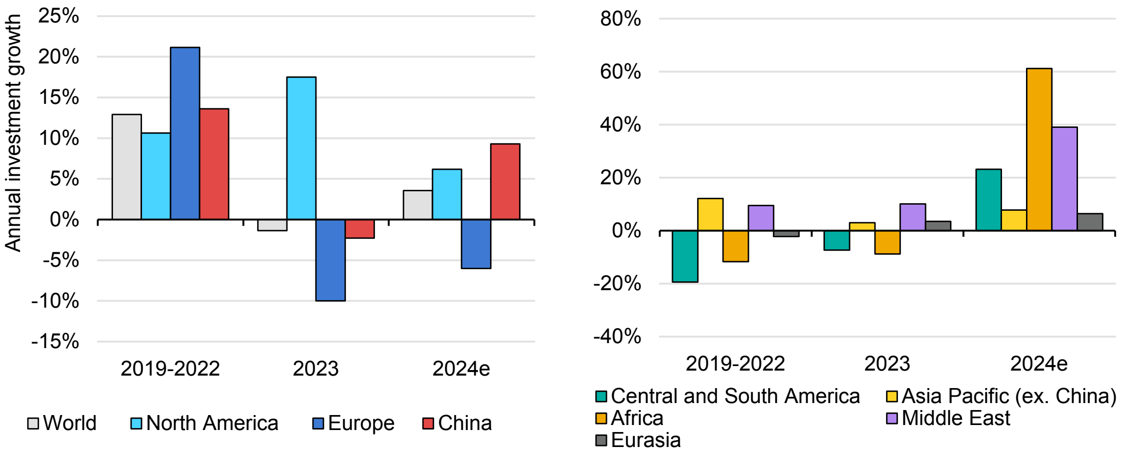
Source: IEA (2024), World Energy Investment.

Emerging economies expected to lead investment growth in 2024, while larger markets stabilise after high crisis spending

Behind the global story of nearly 4% expected growth in efficiency-related investment in 2024, there are important regional differences. Efficiency-related investment in emerging markets and developing economies is estimated to rise strongly in 2024 compared to 2023, increasing by around 60% in Africa, about 40% in the Middle East, and more than 20% in Central and South America. China is expected to see growth of nearly 10% in 2024, after slightly slower gains in 2023. This comes against the backdrop of a decrease in energy efficiency-related investment in both Central and South America and Africa in 2019-2023. Spending in advanced economies is expected to decline or see growth moderate compared with 2023 levels, falling slightly in Europe and rising by around 5% in North America. However, this comes after energy efficiency-related investment growth of more than 20% in Europe in 2019-2022, and above 10% in North America in 2019-2023.

Despite this year's strong growth in EMDEs, most efficiency investment – around 95% – is still concentrated in Europe, the Asia Pacific region, and North America. These regions cover around 75% of global energy demand. Efficiency investment rose by a combined 55% in Europe, the Asia Pacific region and North America over the last five years. Europe represents the largest regional market, with around USD 200 billion – one-third of total global investment – followed closely by China, also accounting for almost one-third. Other Asia Pacific countries, such as India, Japan, Korea, and the APEC region, together with North America, make up the other one-third of total investment. This highlights the potential to broaden efficiency investment activity beyond these established markets to other regions including Central and South America, Africa, Eurasia, and the Middle East.

Annual energy efficiency investment by selected country and region, 2019-2024e



Note: An energy efficiency investment is defined as the incremental spending on new energy-efficient equipment or the full cost of refurbishments that reduce energy use. The intention is to capture spending that leads to reduced energy consumption. 2024e = estimated values.

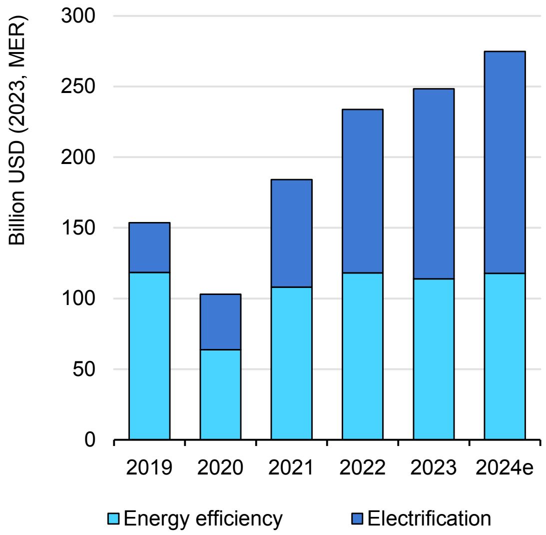
Source: IEA (2024), World Energy Investment.

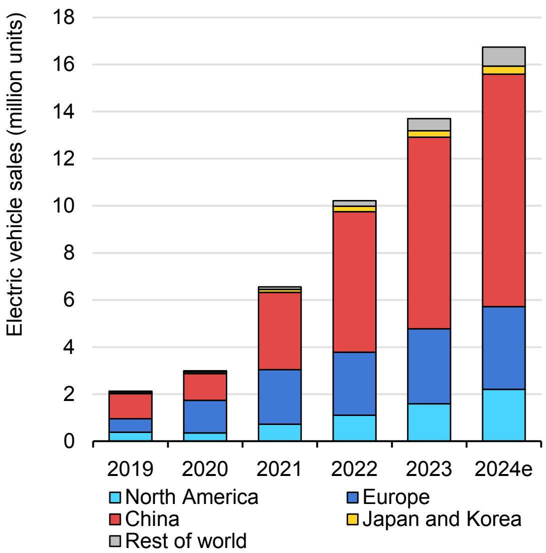
Around one in five new cars sold globally is electric, while two- and three-wheelers drive electrification in emerging markets

Between 2010 and 2024, investment in the electrification of road transport reached new highs, driven by the steady rise of global EV sales. In 2023, approximately 14 million electric cars were sold worldwide, accounting for 18% of all cars sold, and this number could reach 17 million in 2024. China, Europe, and North America were largely responsible for the increase in transport investment in 2023, accounting for around 95% of all global electric car sales. With government subsidies for the purchase of EVs winding down in Europe and China, it remains to be seen how consumer demand adjusts to this new normal. Sales also rose in EMDEs, most notably in Latin America, where almost 90 000 electric cars were sold in 2023.

In many EMDEs, two- and three-wheelers continue to dominate vehicle sales. The two-wheeler market is led by China, followed by countries in Southeast Asia. Global electric two-wheeler sales dropped by 18% in 2023, primarily driven by supply chain issues in China from Covid-19 restrictions. India saw strong growth of around 40% in electric two-wheeler sales in 2023, while the rest of Southeast Asia also saw steady growth. Global electric three-wheeler sales rose by 30% in 2023, with China and India combined accounting for around 95%. In 2024, India continues to experience growth in both two- and three-wheeler markets, stimulated by the introduction of the Electric Mobility Promotion Scheme, the successor of the FAME 2 programme.

Energy efficiency investment spending in the transport sector and electric car sales, 2019-2024e





Notes: The electric cars category includes battery electric vehicles and plug-in hybrid passenger vehicles. 2024e = estimated values.
Sources: IEA (2024), Global EV Outlook and World Energy Investment; Marklines.

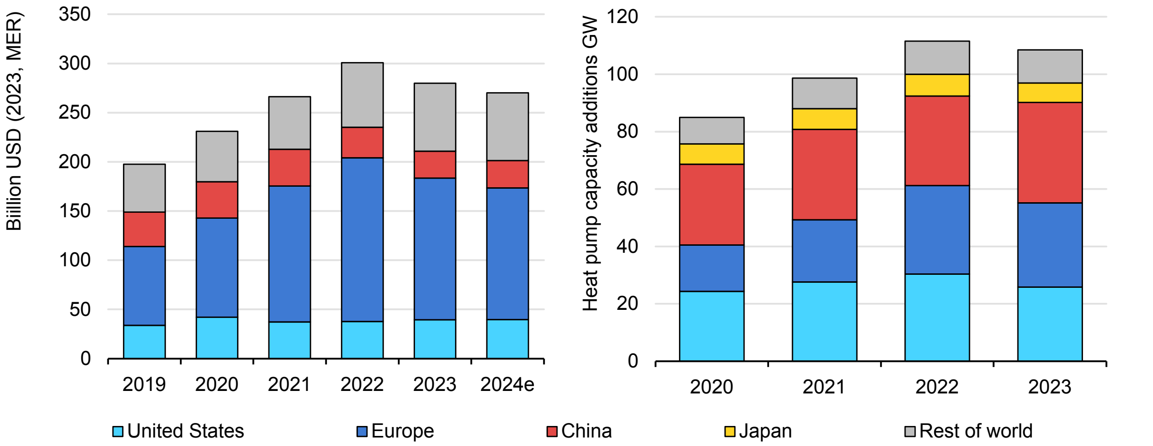
Strong efficiency investment in buildings during the energy crisis fades as heat pump sales ease back from recent highs

Energy efficiency investment in the buildings sector is slowing after its 2022 peak, owing to the decrease in government spending, higher inflation and shrinking disposable income. The sales of heat pumps, one of the key technologies promoted in response to the energy crisis, are no longer growing, after having seen record numbers in 2022.

In Europe, heat pumps are seen as central to reaching long-term climate and energy goals, and the technology is well-integrated into national legislations. According to the European Heat Pump Association, more than 3 million heat pumps were sold across 21 European economies in 2023, bringing the total stock to around 24 million. About one-third of sales in 2023 were air-to-air heat pumps and a little over one-third were air-to-water heat pumps. Sales of air-to-water heat pumps saw the largest increase in 2022 and remain higher in 2023 compared to the 2019-2021 period.

The sales growth of heat pumps is showing signs of slowing down, however, due to a combination of high electricity prices and the phase out of government subsidies that were initiated in response to the energy crisis. Italy phased down its Superbonus programme in 2024, which offered households tax credits of up to 110% of the cost of energy saving renovations and was responsible for more than half of the country's building sector investments in 2023. In China, heat pump deployment has seen a modest increase. Overall, the trend underscores the important role played by government spending to stimulate investment in building renovation.

Energy efficiency investment spending in the buildings sector, 2019-2024e, and heat pump capacity additions, 2020-2023



IEA. CC BY 4.0.

Notes: Spending on electrification (e.g. heat pumps) is included in the total spending; "2024e" are estimated values; Capacity additions include heat pumps that deliver heat directly to households and residential or commercial buildings for space heating and/or domestic hot water provision. It also includes natural source heat pumps, including reversible air conditioners used primarily as heating equipment. It excludes reversible air conditioners used only for cooling, or used as a complement to other heating equipment, such as a boiler.
Sources: IEA (2024), World Energy Investment; IEA (2024), Clean Energy Market Monitor.

Lower interest rates set to help households continue to drive the bulk of efficiency investment

Households are the prime source of efficiency spending, accounting for most of the investment (70%) in buildings and half of all spending in the transport sector. Since 2019, investment by households has increased by about 40% in the buildings sector and doubled in the transport sector, according to the IEA's World Energy Investment 2024 report. Interest rates shape the cost of capital for efficiency investment and are a powerful force in the overall pace of development of an economy. Discounted interest rates through green loans for energy efficient building renovations, including installing energy-saving equipment, can thus be a powerful tool for stimulating investment, especially in emerging economies where the cost of consumer loans is prohibitively high.

The Canada Greener Homes Loan Program offers 10-year interest free loans for home energy efficiency retrofits, up to a maximum of almost CAD 40 000. Additionally, the Canada Greener Affordable Housing Program provides low-interest rate loans to affordable housing providers for multi-family buildings. In the United States, government-sponsored enterprises such as Fannie Mae and Freddy Mac have been offering green mortgages for purchasing or refinancing of energy efficient properties. The Connecticut Green Bank offers Smart-E loans, designed to help homeowners access low rate, flexible term financing. In Australia, the government's green bank – Clean Energy Finance Corporation – partners with commercial banks to offer households low interest loans for energy efficiency upgrades.

Development finance institutions (DFI) have supported the deployment of green mortgages in EMDEs. In Colombia, five banks offered green mortgages in 2021. In Peru, the International Finance Corporation supported BBVA to develop its green lending business line. In Mexico, a Green Mortgage Programme supports new construction and purchase of energy-efficiency homes.

In Europe, the Energy Efficient Mortgages Initiative helps households identify renovation measures and match them with financing options. In the United Kingdom, the green mortgage market is growing, with lenders providing products offering discount rates for building or buying energy efficient properties as well as credit lines, rate discounts and cashbacks for energy retrofits of existing properties. Ireland launched the Home Energy Upgrade Loan Scheme providing low interest loans over 10 years.

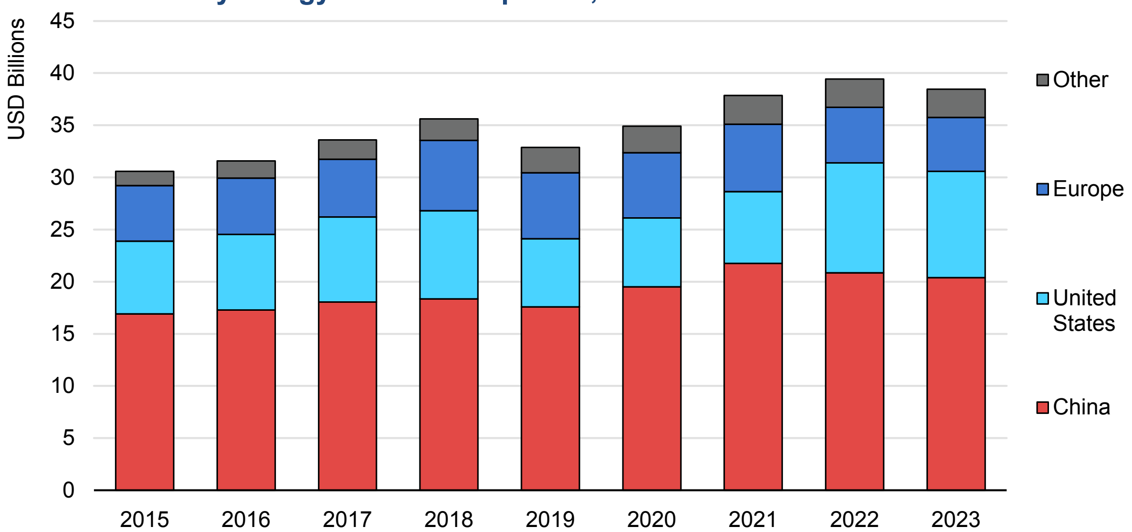
Despite increasing numbers of sustainability-linked product offerings, the European Banking Authority showed that green loan volumes are low, estimated at 4.5% of total loans held by credit institutions. To increase volumes, lending institutions could become effective "salespersons" for green financing products. Banks can scale up efficiency investment by expanding affordable consumer loan offerings. Governments can stimulate demand with the right policies addressing energy performance standards, data requirements, as well as incentives and grants that can be combined with loans. The United Kingdom launched the Green Home Finance Accelerator to support lenders to develop, test, and pilot new and innovative green finance products for homeowners.

The market for energy service companies posts a slight decrease in 2023, led by cuts in public subsidy programmes

The IEA-UNEP 2024 Global ESCO Survey sees the energy service company (ESCO) market decreasing by 2.2% in 2023. However, this comes against the backdrop of strong growth in recent years, and the total market size remains above USD 35 billion. The slight decline in 2023 is partly driven by public budget cuts, given it is a significant client of ESCOs. The global market is dominated by China, the United States and Europe, which together account for more than 90% of all ESCO investment.

The US market experienced a 54% increase in ESCO activity between 2021 and 2023, driven by strong federal and state-level policies. For example, the Federal Energy Management Program offers funding for federal agencies to improve efficiency through energy performance contracts. Many states have also created their own policies that contribute to the ESCO market. New York helps schools on performance contracts with ESCOs, and California offers similar assistance to schools and hospitals. Other regions, such as the European Union, saw ESCO investment decrease in 2023. High upfront costs, extended payback periods, and uncertainties due to fluctuating energy prices contributed to a slight contraction in 2023. China's ESCO market has evolved into the world's largest, with investments surpassing USD 20 billion in 2022 and 2023, around half of the global total. Investments in the ESCO market are primarily concentrated in the buildings sector, which accounts for approximately 50%, followed by 21% in industrial applications and 16% in energy supply, demand flexibility and energy storage. According to the ESCO survey, ESCOs in China achieved CO_2 emissions reductions of over 100 Mt in 2023.

Total investment by energy service companies, 2015-2023



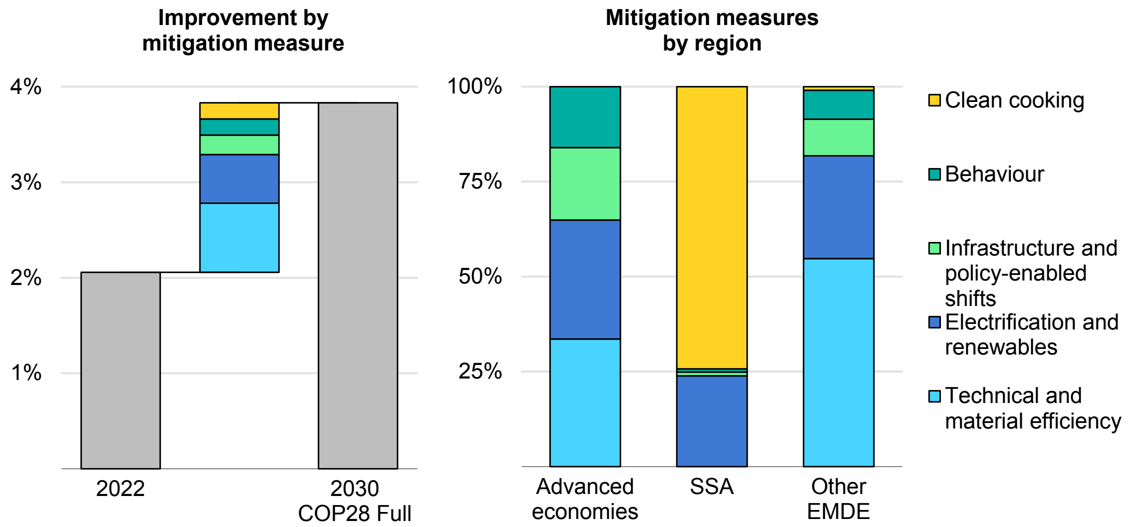
Source: IEA analysis, calculations and estimates based on IEA-UNEP annual global ESCO market surveys (2023) in collaboration with the Global ESCO Network.

Spotlight: What is required to scale up energy efficiency investments by 2030?

Governments should develop comprehensive investment strategies tailored to their unique circumstances

In the NZE Scenario, investment in end uses such as more efficient buildings, transportation and industry triples from around USD 650 billion per year today to about USD 1.9 trillion per year by 2030. The IEA highlights in its Taking Stock to Taking Action report how a comprehensive approach to energy efficiency action is the most effective way to accelerate progress, with an array of available diverse measures tailored to each country's specific circumstances.

Key elements of energy efficiency improvements in the IEA COP28 Full Implementation Case



Notes: COP28 Full = IEA COP28 Full Implementation Case, which is a pathway in line with the Net Zero Emissions by 2050 Scenario. SSA = sub-Saharan Africa; Other EMDEs = emerging markets and developing economies outside of sub-Saharan Africa.
Source: IEA (2024), From Taking Stock to Taking Action: How to implement the COP28 energy goals.

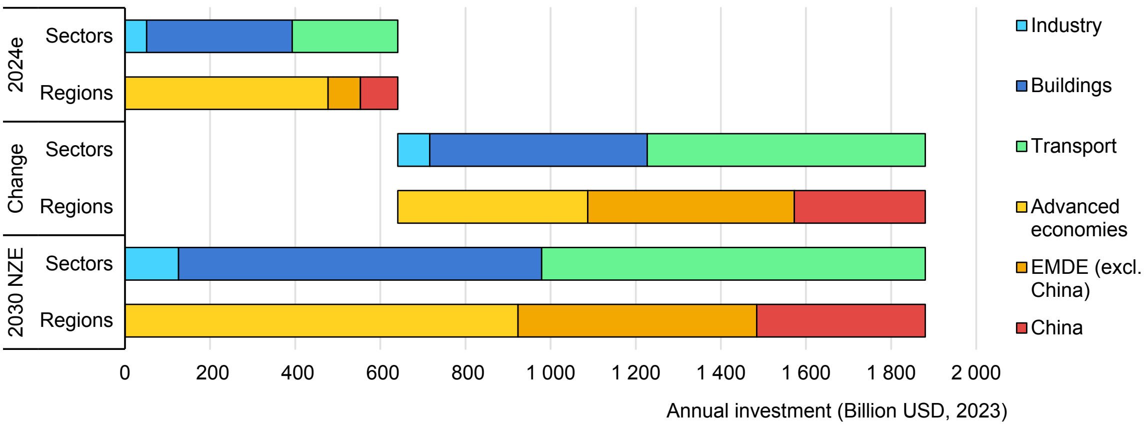
In emerging economies, where many people are getting access to new modern accommodation and appliances for the first time, investments in technical efficiency dominate. This involves improving the performance of buildings through better insulation and appliances, including heating and cooling. Transport electrification also plays a role, particularly through electric motorbikes and three-wheelers. In sub-Saharan Africa, the switch to clean cooking fuels dominates the mitigation measures. In advanced economies, the bulk of efficiency improvements come from replacing older infrastructure with newer, more efficient and increasingly electricity-dominated systems. This includes a large-scale diffusion of electric vehicles and charging infrastructure as well as heat pumps in buildings and industry. Retrofits of energy-intensive buildings – such as hospitals, shopping malls, office buildings, schools, and universities – as well as district heating and cooling also offer quick wins to accelerate energy efficiency progress. Behavioural change also plays an important role and can be supported through investments in public transport systems and digitally-enabled devices such as smart thermostats.

Which sectors and regions are key for increasing investment?

While investment in energy efficiency has risen by 50% compared with 2019 levels, spending has not been evenly distributed around the world. Efficiency investment is highly concentrated, with almost 90% of spending occurring in China and advanced economies.

In the NZE Scenario, energy efficiency investments in advanced economies almost double by 2030, while in China and other EMDEs, investments grow four to seven times, compared to today. Due to the rapid rate of urbanisation in most developing economies and the need to construct highly efficient zero-carbon-ready buildings, the investment seen in the buildings sector stands out in the NZE Scenario. A sixfold increase in spending is seen in China and even higher increases in other EMDEs. While industry is one of the most difficult sectors to decarbonise, its funding often yields the best results. Key actions include upgrading facilities to handle more recycled materials; electrification, especially in light industry; and switching to efficient, electric motor-driven systems.

Energy investment in end-use sectors, 2024e, and Net Zero Emissions by 2050 Scenario, 2030



Notes: NZE = Net Zero Emissions by 2050 Scenario. An energy efficiency investment is defined as the incremental spending on new energy-efficient equipment or the full cost of refurbishments that reduce energy use. The intention is to capture spending that leads to reduced energy consumption. 2024e = estimated values.
Sources: IEA (2024), World Energy Investment 2024, and World Energy Outlook 2024.

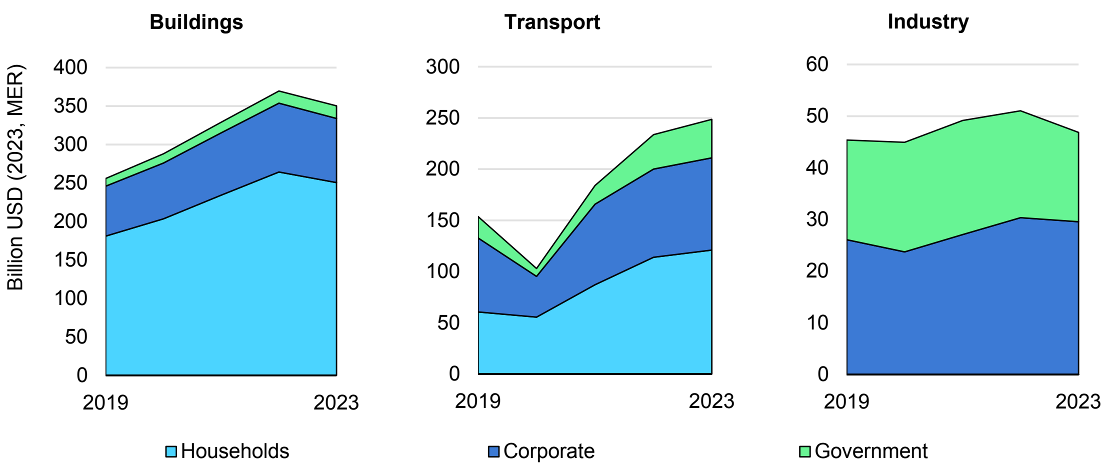
What are the key sources of investment in energy efficiency?

In contrast to other areas of clean energy investment, the majority of energy efficiency investment spending comes directly from households, accounting for more than 70% of total spending in buildings and close to 50% in transport. Efficiency investments in the building sector are spent on constructing new homes and undertaking renovations, investing in rooftop solar and batteries, or purchasing an EV or heat pump. Households and businesses most typically use their own equity, sourced from savings or balance sheets to fund efficiency investments. This accounts for just over half of efficiency investment spending, with commercial debt making up the other half. Around 80% of debt finance is provided by commercial banks or other financial institutions.

Many households do not have access to debt finance at competitive interest rates and projects are often too small for commercial lenders to finance directly at scale due to the high share of transaction costs in each deal. Project aggregation and securitisation solutions such as sustainability-linked bonds can play a role here to lower costs of capital and provide access to more finance. These issues are particularly pertinent in EMDEs where the costs of capital can be up to four times higher than in mature economies – a key barrier for future investments.

Households and small and medium-sized enterprises (SMEs) also require technical assistance to access debt for financing of clean energy projects. In the industrial sector, and in EMDEs in particular, finance is more likely to come from public sources, such as DFIs. These institutions can act as holders of both debt or equity in projects and can assist in attaining grants and strengthening project viability to attract other commercial funding.

Energy efficiency investment in the buildings, transport and industrial sectors, 2019-2023



Source: IEA (2024), World Energy Investment 2024.

What are the financing solutions and business models that can best support greater efficiency investment?

Increasing investment on energy efficiency can be supported by a variety of financial instruments. A selection of possible financing solutions with proven ability to aggregate projects and achieve scale are described below.

Selected financing solutions and business models to scale up energy efficiency investment

Financial instrument	Primary application	Usage
Credit lines	Residential and light industry	Credit lines aggregate small projects that might otherwise not qualify for commercial finance. By standardising the project appraisal and loan processing, they reduce transaction costs. For instance, in the West Balkans, EBRD's credit lines supported 18 000 households to invest over USD 100 million in energy-saving technologies such as insulation, heat pumps, new windows or solar panels. The EBRD Green Economy Financing Facility is supported by USD 7 billion worth of investment in green technologies. Governments can enable credit lines through robust policies and regulation and encourage retail banks to invest in efficiency.
Sustainability-linked loans	Commercial, municipal and utility services	Loan instruments where borrowers receive preferential terms depending on sustainability performance objectives are called sustainability-linked loans. Such instruments accounted for USD 1.7 trillion between 2018 and 2024, with just 7% of loans including efficiency as a key metric. A notable example is China Hongqiao Group's USD 300 million loan aimed at reducing carbon emissions in the aluminium sector. Governments can bolster this instrument by setting standards for transparency and address greenwashing. France offers zero-interest loans for low-emission vehicles.
Green leasing	Commercial buildings	Green leasing includes dedicated clauses covering the building's environmental performance and the obligations of tenants and landlords to reduce energy use and waste. Green leases are used in both advanced and emerging economies. In the United States, green leases have the potential to reduce energy use in office buildings up to 22%. For the building owners, a green lease is a tool to meet the minimum energy efficiency requirements.
Green Social Sustainability bonds	Commercial and public buildings, heavy industry, municipal and utility services	Green Social Sustainability bonds are a fixed-income investment instrument to fund projects that provide positive environmental and social benefits. Green bonds reached an annual volume of almost USD 600 billion in 2023, with about 10-20% of those including energy efficiency aspects. They are used in several regions, including Asia and Latin America. The EC has designed a voluntary European Green Bond Standard to foster transparency and market best practices. Reduced transaction costs and improve transparency are required to scale up use of this instrument.

Financial instrument	Primary application	Usage
Energy service companies	Light industry	ESCOs provide comprehensive energy saving solutions, including arranging or securing any required finance. In countries with the right mix of regulatory support and technical skill, the ESCO model has delivered significant energy efficiency investment. A healthy ESCO market requires policies that incentivise energy efficiency and a robust legal system for resolving disputes.

What are the main steps that governments can take to help households and businesses increase investment levels?

While different regions have varying needs and require tailored approaches, the following policy actions can help governments drive accelerate growth in energy efficiency-related investments:

1. **Improve access to affordable capital for households and businesses.** For instance, increasing the availability of sustainability-linked loans with low interest rates and providing technical assistance to households and SMEs can help drive investments, as well as low and zero interest rate financing for efficient vehicles.
2. **Leverage public funds to attract private investment, while providing support for vulnerable groups**. This may involve deploying public funds as a combination of grants, financial instruments and project development assistance to trigger private sector financing. Potential efficiency gains in public services and utilities (such as water and wastewater, street lighting) can be significant.
3. **Put in place dedicated capacity building programmes for public officials to strengthen institutional capacities and ensure access to innovative solutions.** This could involve training programmes on established and innovative financing instruments best suited for buildings, transport and industry sectors.
4. **Strengthen international co-operation to direct the flows of funding to EMDEs**. A particular focus can be given to lower the cost of capital to attract more investment in these regions.
5. **Focus on supporting industrial financing options.** While industry is one of the most difficult sectors to decarbonise, it is also the one where financing can deliver the best results. Only 6% of the total rise in efficiency-related investment can deliver 20% of the total intensity improvements by 2030. This may involve a variety of instruments, including ESCOs, green leasing and green loans available for SMEs and heavy industry.

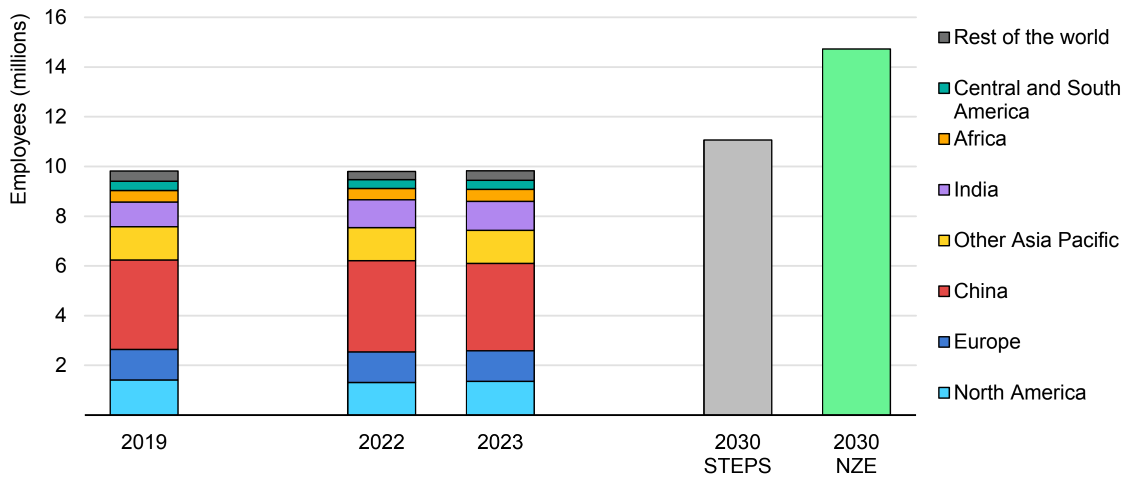
3.4 Employment

Energy efficiency employment has reached a total of nearly 10 million people in 2023, but growth is uneven across regions

Over the last three years, energy efficiency employment has reached nearly 10 million people in 2023. In the 2022-2023 period, job creation has mainly been driven by the manufacturing and installation of heat pumps, one of the fastest-growing sectors despite still representing a relatively small number of jobs. Most people working on energy efficiency are employed in the industrial sector, followed by jobs to design and manufacture appliances, and to install building equipment and retrofits.

However, efficiency-related employment is spread unevenly across regions. The number of people working in energy efficiency worldwide dipped significantly during the Covid-19 pandemic and only recovered to 2019 levels in 2023. Several regions have yet to return to pre-pandemic levels of employment, including China, which has the largest efficiency workforce at 3.5 million, and North America, which follows with 1.4 million. India and Africa are two of the few places that have seen efficiency employment grow in recent years, adding over 50 000 and 15 000 new jobs since 2019, respectively. Most other major regions see employment at similar levels to 2019. In the NZE Scenario, energy efficiency jobs grow by nearly 5 million between 2023 and 2030. This is almost four times higher than the growth seen under current policy settings. Employment growth is driven by building retrofits, followed by industry and appliances. Employment in other sectors, including HVAC, post smaller growth.

Energy efficiency employment, by region, 2019-2023, and global, Stated Policies Scenario and Net Zero Emissions by 2050 Scenario, 2030

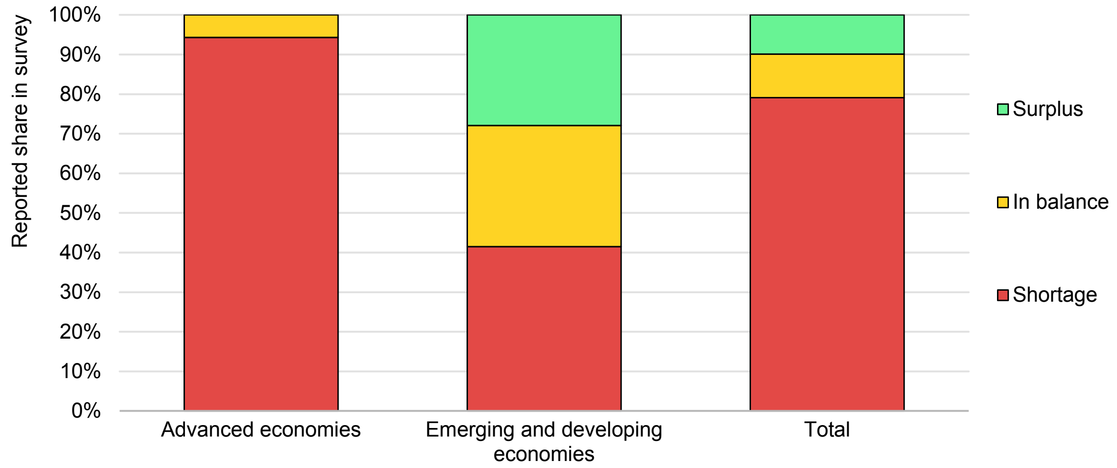


Notes: STEPS = Stated Policies Scenario; NZE = Net Zero Emissions by 2050 Scenario.
Source: IEA analysis based on *World Energy Employment 2024* (forthcoming).

A shortage of skilled workers is a major barrier to meeting the growing workforce demand

Currently, shortages of skilled workers persist across key energy efficiency jobs. These are most pronounced for HVAC and heat pump installers, construction workers and electricians. Shortages differ by region. In the construction sector, while a major shortfall occurred in North America, Western Europe and Australia in the past year, smaller shortages occurred in the Middle East, Asia and Africa. This is partly explained by demographics, as populations in advanced economies have higher retirement rates.

Reported availability of construction workers, survey of employers in selected markets, 2024



Notes: Results based on a construction market survey conducted across 91 markets and 42 countries. Surpluses are notably observed in South America, Africa and Asia.
Source: IEA analysis based on data from the International Construction Market Survey 2024 by Turner & Townsend.

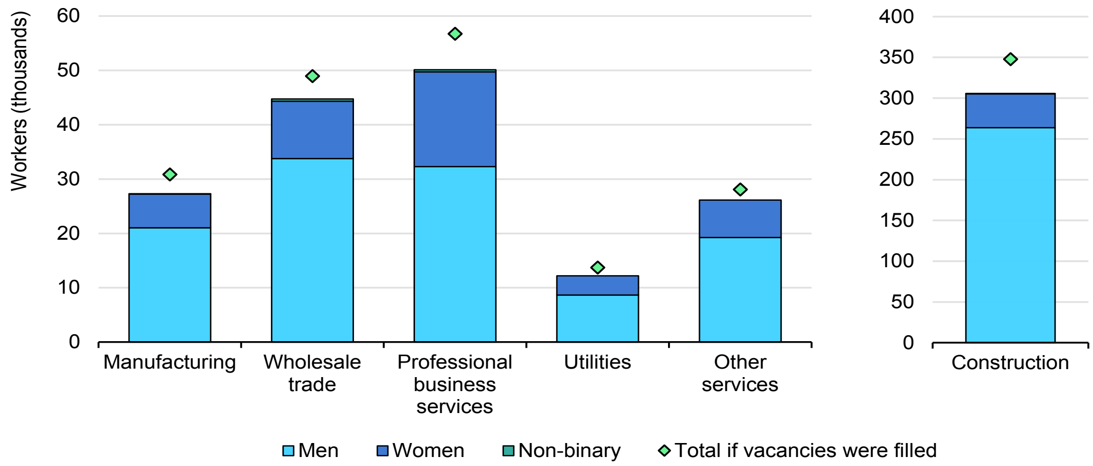
People working in energy efficiency-related jobs work across the clean energy value chain, including in installation and repair but also in the manufacturing, supply and distribution of efficient equipment. In many cases, energy efficiency jobs require at least one to two years of training, as well as basic science, technology, engineering and mathematics education. Investing in early stages of education, vocational education training, tertiary education and lifelong learning opportunities are all essential to build a skilled energy efficiency workforce.

Achieving an adequately skilled workforce will require strong co-ordination and collaboration among governments, the private sector, labour unions, and training and education institutions. This involves, for example, aligning certification and training with job demand and creating quality jobs that retain workers. This collaboration should include identifying labour, skills and training needs, including for digital and other emerging skills, to understand the scale of investment required.

Increasing gender diversity can help address labour shortages

Diversifying the energy efficiency workforce can help address labour shortages, capitalise on the experience women can bring and provide equal opportunity for all genders. Women currently represent 39% of the global workforce, yet only account for less than 20% of workers within the energy sector. Although estimates vary by country, women are considerably under-represented across all energy subsectors. In Canada, where women make up 18% of the energy efficiency workforce, the gender gap worsens when it comes to occupations that require physical and manual labour, including construction or technician professionals. At the same time, those jobs see the largest labour shortages across the energy efficiency sector. In Canada, addressing the sectoral gender gaps could increase the number of energy efficiency jobs by 13%, with most growth in the construction sector.

Total employment in energy efficiency by gender and potential employment if vacancies were filled, Canada, 2023-2024



Source: IEA analysis based on data from Eco Canada.

The under-representation of women in efficiency jobs leaves a large part of the labour market potential untapped. In 2023, fewer than 6% of women were employed as insulation workers, air conditioning and refrigeration mechanics, building construction labourers or electricians. LinkedIn data finds that men are three times more likely to possess skills related to energy management and energy efficiency. Targeted policy interventions can promote a more diverse efficiency workforce.

Some governments are implementing policies already. Panama implemented a programme to retrain workers from traditional energy sectors, focusing on electro-mobility skills such as EV maintenance. In India, the Mahila Housing Sewa Trust trains women from rural and low-income households to become energy auditors. These auditors advise households in informal settlements on how to reduce energy costs and make their households more energy efficient by switching their lighting and appliances to more energy efficient products.

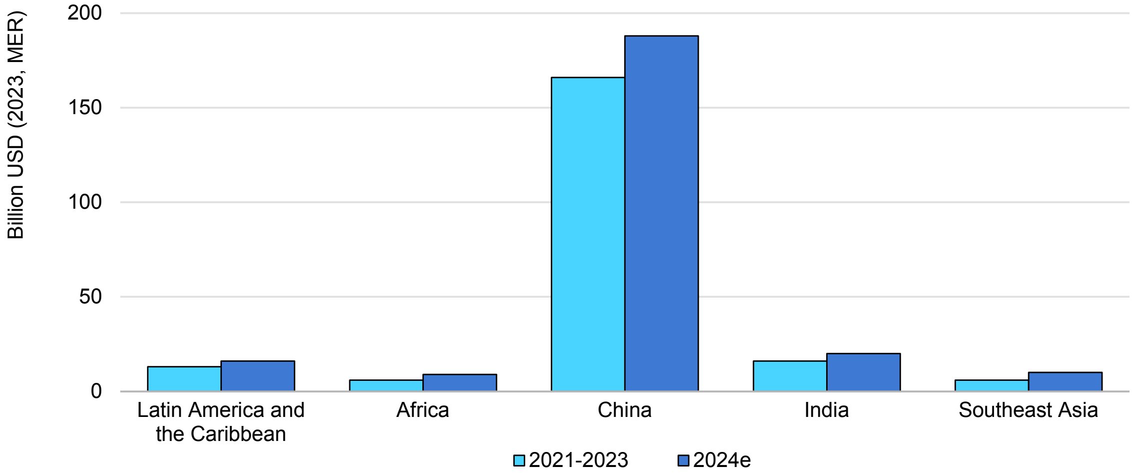
Chapter 4. Regions

Emerging markets and developing economies are key to a global doubling of energy efficiency progress

Emerging markets and developing economies will account for a growing share of global energy demand. The implementation of strong energy efficiency policies in EMDEs can help meet their climate goals while also creating jobs, improving lives, and reducing costs. China, India, Southeast Asia, Africa, and Latin America together account for almost half of global energy demand, making them a major force in global efficiency improvements in the coming years.

From 2012 to 2021, China and India improved energy intensity more than the global average. China posted slower progress in 2023 due to an energy-intensive post-pandemic recovery but have since raised its efficiency targets in 2024. In India, efficiency improvements are expected to reach 2.5% this year. New and updated policies to promote efficient buildings and technologies will help emerging economies accelerate progress even further. However, a major obstacle for many countries is a lack of affordable financing, due in part to the high cost of capital in EMDEs. Policies that improve regulatory frameworks and mobilise lower cost financing, among others, would help close the investment gap.

Average annual end-use investment, selected regions, 2021-2024e



Notes: 2024e = estimated values; MER = market exchange rate.
Source: IEA (2024), World Energy Investment.

Bolstering Ukraine's energy security through improved efficiency in buildings

Ukraine faces a critical energy security challenge for the 2024/2025 winter amidst a step change in the intensity of attacks on its energy infrastructure by Russian military forces. In September 2024, the IEA published a special report with ten actions that can help to address Ukraine's pressing energy security vulnerabilities. Improving energy efficiency is one of them and essential for reducing energy consumption, mitigating energy shortages, and bolstering long-term energy security in Ukraine.

The buildings sector is particularly vulnerable, with heightened risks to energy supplies after unprecedented bombardments this year. Residential buildings consume nearly one-third of the country's energy. It is estimated that peak electricity demand could grow from 12 GW in summer to 18.5 GW in winter 2024/2025, driven mainly by increased heating in buildings in cold months. Simple, low-cost measures like lowering heating temperatures and insulating district heating pipes could provide immediate relief, while measures such as sealing air leaks, insulating and replacing inefficient windows could reduce energy use by up to 30%. A government efficiency campaign could help to raise awareness, drive nationwide energy savings and reduce pressure on the grid ahead of winter.

Over half of the housing stock in Ukraine has been damaged or destroyed by Russia's attacks. As of January 2024, around 250 000 buildings were affected, accounting for close to 90 million m^2. It is vital that energy efficiency is a central focus during reconstruction to avoid locking in inefficiencies in buildings until the next renovation cycle, which could take several decades. Ukraine has already implemented policies to support individuals repairing or reconstructing their homes through the eRecovery compensation programme and Vidnovydim programme. However, neither programme mandates efficiency measures, and most rebuilding efforts are done by residents using their own funds. Implementing these projects with the "build back better" principle, a central pillar in Ukraine's National Recovery Plan, can promote adherence to modern efficiency standards, including those in the EU's directives on energy efficiency and the energy performance of buildings.

Prior to Russia's full-scale invasion of Ukraine, about 80% of Ukraine's residential buildings were considered energy inefficient. Despite existing policies and standards, the retrofit rate was just 0.1% per year. Ongoing programmes such as ENERGODIM and the new State Fund for Decarbonisation and Energy Efficient Transformation are key to financing energy efficiency improvements in buildings. However, international technical and financial support is crucial for accelerating the rate and the depth of energy efficiency improvements in buildings.

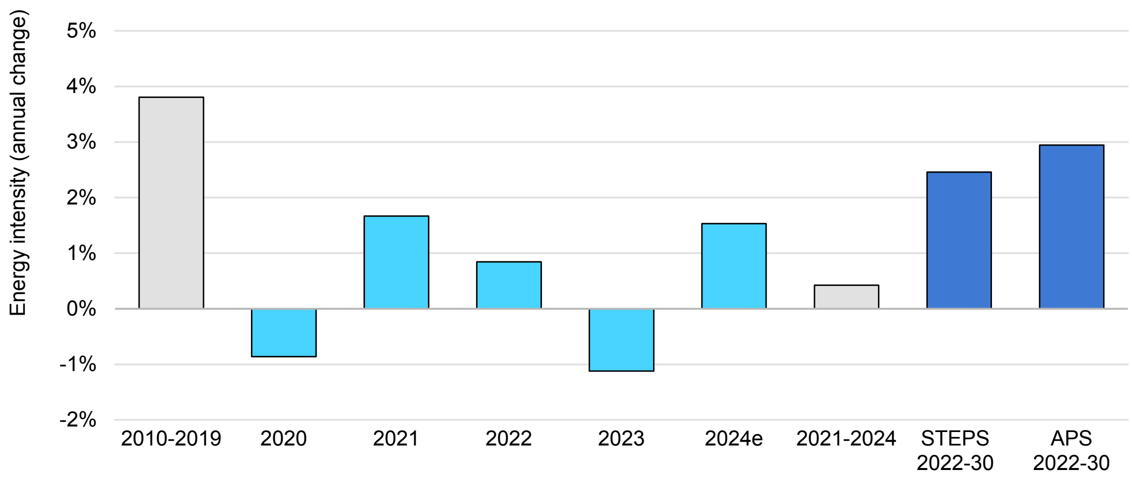
The IEA has pledged its readiness to support Ukraine by offering technical expertise and analysis of existing international best practices, particularly on energy efficiency and power systems. By scaling up energy efficiency investments, Ukraine can enhance its energy independence and offer healthier and warmer homes to its citizens in the winter to come and beyond.

4.1 China

China aims to accelerate progress following a recent slowdown in energy intensity improvement

China has made significant progress on energy efficiency since 2010, achieving an annual energy intensity improvement of at least 4% on four occasions between 2011 and 2023. The strongest consecutive improvements, averaging over 4%, were delivered between 2011 and 2016. They peaked at over 6% in 2015 and 7% in 2016. Annual progress dropped below 3% between 2016 and 2020, before declining further in 2020 to below zero due to the Covid-19 pandemic. A rebound in 2021 to nearly 2% was followed by a slowdown in 2022 and 2023. This reflected a slower-than-expected economic recovery, with progress of 0.8% in 2022 and a decline of 1.1% in 2023. However, the improvement in 2024 is expected to be similar to 2021, with progress of about 1.5%.

Primary energy intensity improvement, China, 2010-2024e, and by scenario, 2022-2030



Notes: 2024e = estimated values. STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario.
Source: IEA analysis based on the Energy Efficiency Progress Tracker.

Policy approaches to energy efficiency in China over the past decade have centred on national targets for economy-wide energy intensity improvements within each Five-Year Plan (FYP) period, combined with a cap on energy consumption under the Dual Energy Control mechanism – a central plank of the country's "dual carbon" goals to reach peak carbon emissions by 2030 and carbon neutrality by 2060. Energy intensity targets are also included in China's Nationally Determined Contribution for 2021-2025. Progressively lower targets for intensity improvements have been set during the past four FYP periods, ranging from 20% (2006-2010) to 16% (2011-2015), 15% (2016-2020), and 13.5% (2021-2025). Primary energy intensity in China was reduced by 43% from 2000 to 2021.

China launched a special action plan with updated energy efficiency targets for 2024 and 2025

To meet its stated efficiency target of 13.5% between 2021 and 2025, China would need to achieve improvement rates of more than 5% per year in 2024 and 2025. In May 2024, China issued its 2024-2025 Energy Conservation and Carbon Reduction Action Plan, which emphasised the need to make every effort to complete the binding indicators set in the 14th Five-Year Plan. This includes a target to improve national energy intensity by 2.5% for 2024, with a higher goal of 3.5% specifically in large-scale industries.

Overall, the action plan aims to deliver energy savings over the two years equivalent to 100 Mt of coal (2.9 EJ), roughly equivalent to the total energy supply of the Netherlands in 2020. This action plan was followed by specific energy and carbon reduction action plans over 2024 and 2025 for the cement, steel, synthetic ammonia, electrolytic aluminium, data centres, and petrochemicals industries.

In the same month, the National Development and Reform Commission (NDRC) also published a notice on conducting in-depth energy efficiency diagnoses for principal energy-consuming entities. It seeks to improve information collection on energy consumption across major energy-using sectors, requiring all regions to establish energy-saving management files for key energy-consuming units by the end of 2025 and to assess progress against industrial energy efficiency benchmarks.

China also updated its national definition of "dual energy consumption and intensity control" in 2024 to exclude raw material energy and non-fossil energy. In August 2024, the General Office of the State Council announced that the reduction of carbon emission intensity will be used as a binding indicator for national economic and social development, and energy consumption intensity will no longer be used as a binding indicator.

China scales up energy efficiency investment through retrofits and accelerated trade-in of appliances and cars

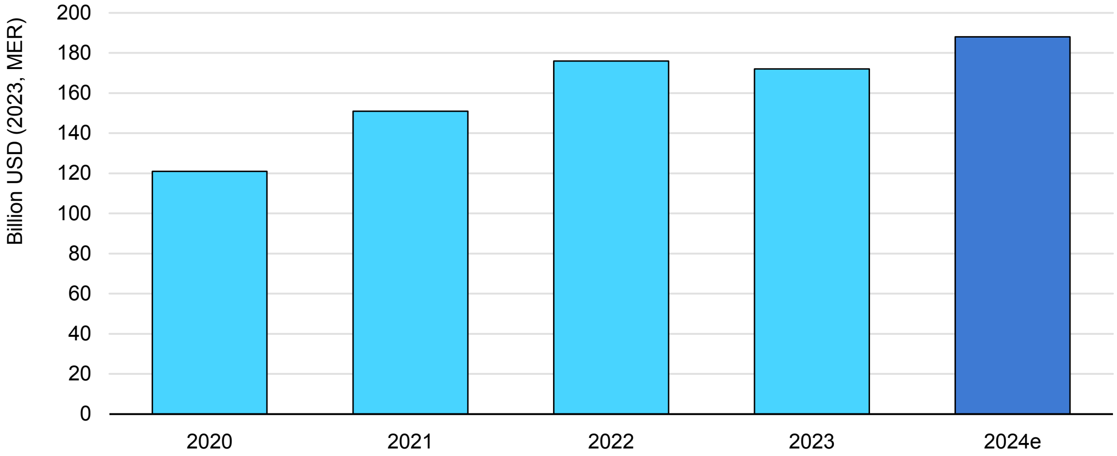
In 2023, investment in end-use sectors in China was over USD 170 billion, an increase of more than 40% since 2020. This was driven by a continued rapid increase in electric vehicle sales, while investment in efficient buildings declined slightly last year due to lower construction activity. In 2024, investment is expected to grow to over USD 180 billion.

China's real estate sector saw a continued slowdown in activity in 2023, with the supply of state-owned land for real estate construction use falling by over 20%, investment reduced by almost 10% and floor space of new buildings lower by about 20%, to nearly 954 million m^2. Under its two-year action plan the government has set out targets to complete 200 million m^2 of energy-saving retrofits and build 20 million m^2 of ultra-low/near-zero energy consumption buildings over 2024 and 2025. The government has set out a series of targets for the buildings sector, including an electrification level of 55% and 65% by 2025 and 2030, respectively.

The NDRC revised its minimum energy performance standards in 2024, expanding their coverage and setting higher 'Energy Saving' and 'Advanced' labelling levels for 43 products. For primary heating or heat pump water heaters with capacity below 10 kW, the revised MEPS set a minimum level for the coefficient of performance (COP) of 3.7 watts/watts (W/W), an energy-saving level of 4, and an advanced level of 5. It set COP levels for multi-connected air conditioning (heat pump) units with capacity between 50 kW and 68 kW of 3.3 (minimum), 4 (energy saving) and 4.8 (advanced). Updates will also be released regularly.

China's State Council released an action plan to promote large-scale equipment updates and trade-ins of old consumer goods in March 2024, as part of broader plans for economic recovery that were set out by the State Council and NDRC in July 2023. General aims related to energy efficiency include improving the efficiency of home appliances and water efficiency standards; promoting a green and smart home appliance certification system; and guiding home appliance manufacturers to increase the supply of green, smart and low-carbon home appliances based on standards to promote industrial upgrading and product-based green transformation. The actions aim to further grow the market share of energy efficient home appliances and increase the amount of used home appliances recycled by 30%, compared with 2023 levels.

End-use investment, China, 2020-2024e



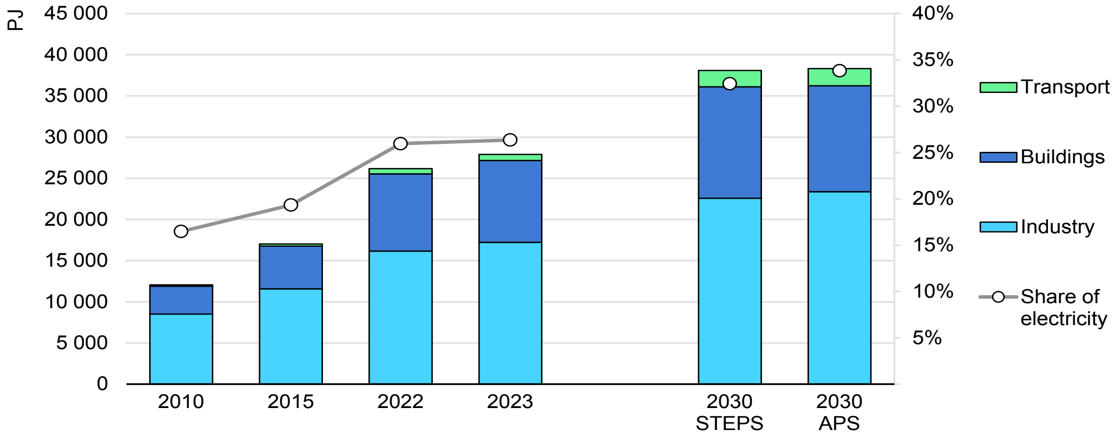
Notes: 2024e = estimated values; MER = market exchange rate.
Source: IEA (2024), World Energy Investment.

Electricity demand continues to increase rapidly amid challenging peak summer temperatures

Total electricity consumption in China has increased significantly over the past decade, rising by more than 80% from 2010 to 2019. Consumption in 2023 grew 7% to reach over 9 000 TWh, compared to global average annual growth of 2.2%. In the first half of 2024, electricity use increased 6.5%, and the China Electricity Council projects total growth this year of 9 800 TWh. China's electrification level – the share of electricity in total final consumption – also rose to more than 25% in 2023, tracking towards a target of 30% by the end of 2025. Electrification efforts to date have primarily focused on the industry and buildings sectors, with targets of 30% and 55%, respectively, by 2025.

Peak electricity load hit a record level in 2023, with a 50 GW increase in maximum daily load compared to 2022 – a year-on-year rise of around 4%. Projections indicate that peak load in 2024 could exceed this record by a further 100 GW. Under pressure to manage increasingly extreme peaks, the government now monitors electricity use in key regions more closely, incentivises greater interprovincial electricity trading, and promotes more use of energy storage. On the demand side, multiple provinces and cities have also introduced measures to prepare for peak summer demand, including simulating power shortages and expanding policies for peak-shifting. The Zhejiang province introduced an adjusted Industrial and Commercial Peak and Valley Time-of-Use Electricity Price Policy in 2024. The province forecasted that peak summer demand could reach 120 GW. This past summer the policy was estimated to have increased electricity use in off-peak periods (00:00-08:00) by 0.8% and decreased consumption in peak periods (8:00-11:00; 13:00-17:00) by around 1.6%. As a result of the measures, peak load was reduced by 0.5 GW and electricity cost savings for industrial users by around 4%.

Electricity consumption by sector and share of electricity in total final consumption, China, 2010-2023, and by scenario, 2030



Notes: STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario.
Source: IEA (2024), World Energy Outlook.

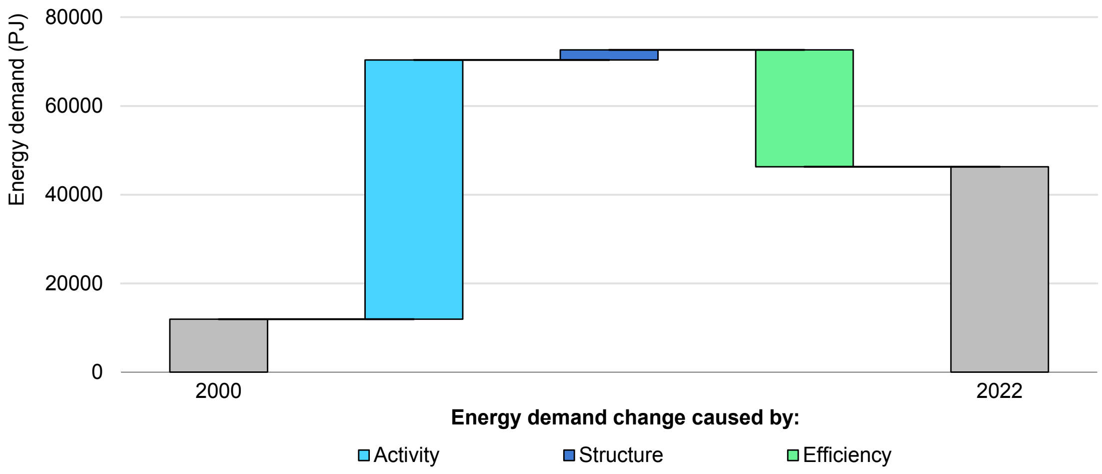
Without energy efficiency, industrial energy demand in China would have been more than 50% higher

China's industrial energy demand has almost quadrupled since the beginning of the century, from around 12 000 PJ in 2000 to about 46 000 PJ in 2022. However, without the effects of energy efficiency, demand would be more than 50% higher in 2022, at around 73 000 PJ.

An important driver of this change is the phaseout of coal use in industry, which dropped from 65% to 45% of total industrial energy use between 2010 and 2022, driven by policies to prevent air pollution and save energy. Electrification has also become a priority in industry. In 2021 (during its 14th FYP) China set industrial electrification as a priority area for industrial decarbonisation with end-use electrification reaching 27.6% in 2023.

China's less-intensive industry sectors have also seen progress in the electrification of process heat. These sectors accounted for around 10% of all industrial heat in 2022. Energy demand for industrial heat is expected to grow 10% by 2030 after growing by around 7% between 2010 and 2022, with the share of coal as a primary fuel input dropping from over 60% to just 13%. This was driven by policies addressing air pollution and encouraging clean manufacturing, for example, by eliminating the use of fuel-type coal gasifiers and coal-fired heating and drying furnaces by the end of 2020.

Decomposition of industrial energy demand, China, 2000-2022



Note: Activity effects refer to changes in the output of industry; structure effects refer to changes in the share of energy intensive industries compared to the total industrial sector; and efficiency refers to changes in the energy intensity of the industrial sector.
Source: IEA analysis based on the IEA decomposition database.

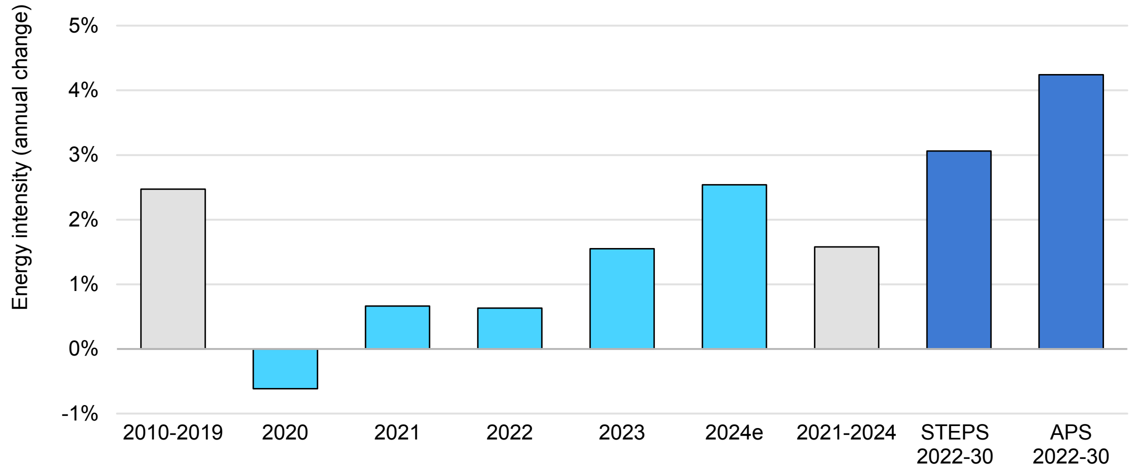
4.2 India

India posts strong energy efficiency improvements in 2024, accelerating progress compared to the past four years

As the fastest growing major economy in 2023, India is on track to be the third-largest economy by 2030, behind the United States and China. India's energy demand growth is projected to outpace all other countries by 2050 due to higher economic growth, increasing population and rising urbanisation. Energy efficiency policies and programmes have an important role to play in managing the expected growth in energy demand as more people get access to much-needed cooling technologies and other appliances.

While the annual primary energy intensity improvement in India dropped to below 1% in 2021 and 2022, it has since improved consistently. In 2024, the rate of improvement is expected to reach 2.5%, similar to the average energy efficiency progress recorded during the 2010-2019 period. The annual rate of energy efficiency improvement is around 3% in the Stated Policies Scenario and just over 4% in the Announced Pledges Scenario.

Primary energy intensity improvement, India, 2010-2024e, and by scenario, 2022-2030



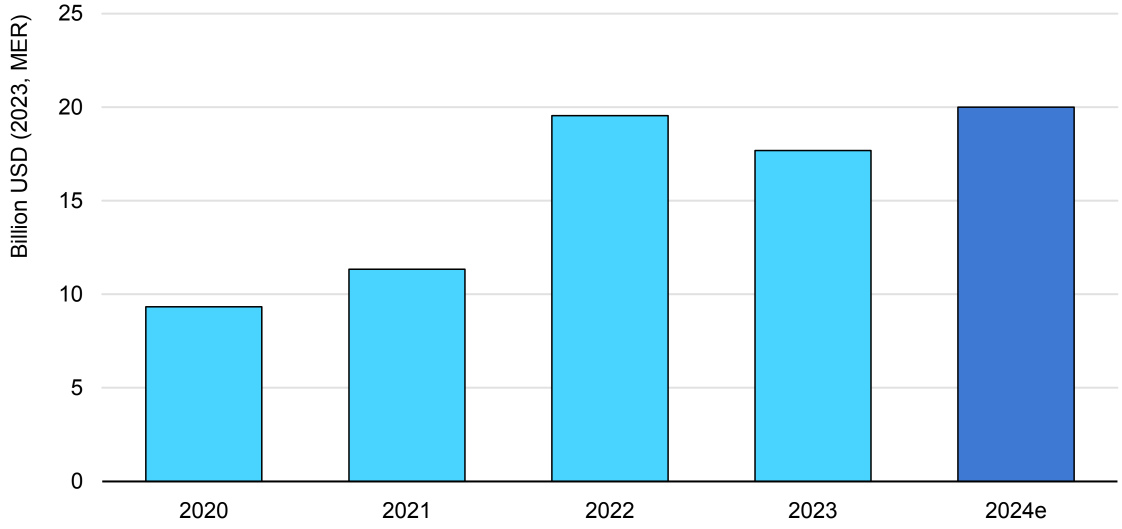
Notes: 2024e = estimated values. STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario.
Source: IEA analysis based on the Energy Efficiency Progress Tracker.

India has a robust energy efficiency programme in place. Its Standards and Labeling programme covers 39 different appliances, 16 of which are mandatory and 23 are voluntary. India is also strengthening and expanding building energy codes for residential and commercial structures through its Energy Conservation and Sustainable Building Codes, incorporating both energy efficiency and sustainability features. The Perform, Achieve and Trade (PAT) scheme for industries has been pivotal in bringing down energy consumption in energy-intensive industries. India is now planning to include the PAT scheme within the upcoming Carbon Credit Trading Scheme. In the transport sector, India has programmes for fuel efficiency in the form of corporate average fuel economy standards, as well as various schemes to promote electric mobility. India also published a Voluntary Action Plan on Doubling the Global Rate of Energy Efficiency Improvement by 2030 during its G20 presidency in 2023.

India scales up investment in energy efficiency through a combination of policy instruments

Investment in end-use sectors in India was around USD 18 billion in 2023, almost twice as high as four year earlier. In 2024, investment is estimated to grow to nearly USD 20 billion. Policies in India have relied on different policy instruments to address market barriers to energy efficiency. In industry, the market-based PAT scheme aims to reduce consumption in energy-intensive industries by allowing the trading of energy savings certificates. Similarly, in the transport sector, tax benefits and purchase incentives under Faster Adoption and Manufacturing of Electric Vehicles scheme have been instrumental in accelerating increased use of EVs. Finally, the Production Linked Incentive (PLI) programme provides incentives to achieve economies of scale in domestic manufacturing of battery electric vehicles. While public finance will remain an important catalyst, the mobilisation of domestic and international private finance can help to scale up investment. Energy service companies and financial institutions will play an important role in de-risking and increasing energy efficiency investment.

End-use investment, India, 2020-2024e



Notes: 2024e = estimated values; MER = market exchange rate.
Source: IEA (2024), World Energy Investment.

Can Energy Efficiency Services Limited's initiatives in demand aggregation help grow India's energy service company market?

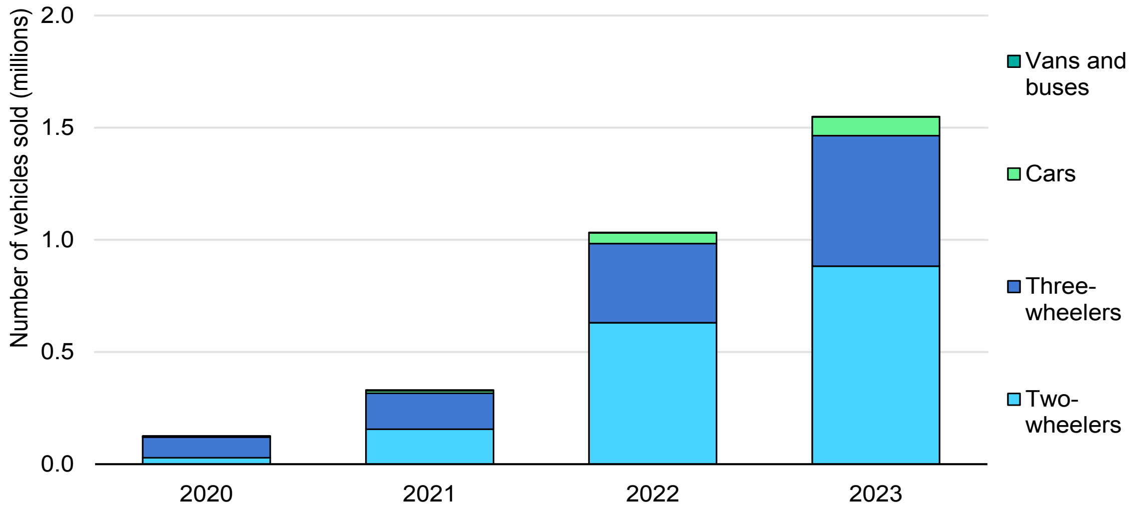
In total, India's energy efficiency market is valued at around USD 18 billion. The ESCO market size in India is almost USD 900 million. India's state-owned super-ESCO, Energy Efficiency Services Limited (EESL), had revenue of approximately USD 190 million last year, accounting for over 20% of the total ESCO market in the country. It has deployed new business models in efficiency projects, such as the Unnat Jyoti Affordable LEDs for All programme, which uses energy performance contracts and the extension of on-bill financing to the consumer. EESL has also started demand aggregation programmes. The National Energy Efficient Fan Programme targets the bulk procurement of 10 million efficient fans to grow the market and achieve economies of scale. The Street Light National Programme aims to replace conventional streetlights with efficient LEDs.

In addition, the National Efficient Cooking Programme aims to scale up solar-based induction cooking solutions. While the public sector continues to provide the foundations for a market shift to efficient products, the private ESCO market has not yet been able to achieve scale. Private ESCOs face several challenges, including a lack of buy-in from end-users, inadequate standard monitoring protocols, insufficient data for baseline assessments and challenges in accessing financing. To address these issues, the government has initiated the Partial Risk Guarantee Fund, with the support of the World Bank, to back loans to ESCOs. EESL's approach in standardising the procurement, execution and monitoring of projects provides guidance for reinforcing the private market. EESL's initiatives have led to cumulative energy savings of over 58 billion kWh and a reduction of over 46 Mt of greenhouse gas emissions to date.

Two- and three-wheelers lead India's electric vehicle momentum as government policies boost local manufacturing

India aims for 30% of all vehicles sales to be electric by 2030. It has supported EV deployment through the FAME scheme, which provided subsidies on the purchase price of electric buses and two-, three-, and four-wheelers. The average subsidy under the scheme was 45% of the purchase price in the case of electric two-wheelers, 35% for three-wheelers, and 19% for four-wheelers. The FAME scheme was implemented in two consecutive stages: Phase I (FAME) ran from 2015 to 2019, and Phase II (FAME II) continued from 2019 to March 2024. The policy has significantly helped support the deployment of EVs, particularly in the two-wheeler and three-wheeler markets, which constitute more than 80% of total EV sales in India. In the past three years, sales of electric two-wheelers have increased fivefold, while sales of electric three-wheelers have tripled. In order to promote domestic manufacturing the scheme provides incentives for vehicles made in India, which make up 80% of electric car sales and 75% of electric two-wheeler sales since 2010. Globally, India is the largest market for electric three-wheelers and the second-largest market for electric two-wheelers. In 2023, the share of electric two-wheelers was 5% of total all two-wheeler sales in India, while electric three-wheelers accounted for over half of all three-wheeler sales. The electric car market in India is still small, accounting for less than 2% of new car registrations. However, growth in sales suggests that the country could be approaching a tipping point as electric car sales in 2023 rose by 70% to 80 000, compared with total car sales growth of under 10%. The impact of the FAME II scheme is evident from the fact that it led to a 40% increase in EV sales in the month prior to its closure. As a successor to FAME II, India implemented the Electric Mobility Promotion Scheme (EMPS) from April to September 2024. Subsidies offered under the EMPS were nearly 50% lower than under the FAME II scheme. After FAME II ended and the EMPS began in 2024 with reduced incentives, sales in April and May were about 10% lower compared to February.

Electric vehicle sales, by category, India, 2020-2023



Source: IEA (2024), Global EV Outlook.

Policy support for EVs continues with the PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) scheme launched in September 2024. A successor to the FAME and EMPS programmes, it supports the development of charging infrastructure and the deployment of electric two-wheelers, three-wheelers and electric buses through purchase incentives. To attract global EV manufacturers to set up production facilities in India, the government announced the Scheme to Promote Manufacturing of Electric Passenger Cars in India in March 2024. It initially allows global automakers to sell imported electric cars in India at a lower import duty and will require them to achieve a domestic value addition of 25% within three years and 50% within five years. India also provides supply-side incentives to boost local manufacturing under the PLI scheme. Tax benefits are also offered, with the Goods and Services Tax (GST) on EVs reduced from 12% to 5% and the GST on chargers/charging stations for EVs reduced from 18% to 5% in 2022. This is supplemented with information campaigns under India's Go Electric programme. Currently 28 out of 36 states and union territories have dedicated EV policies.

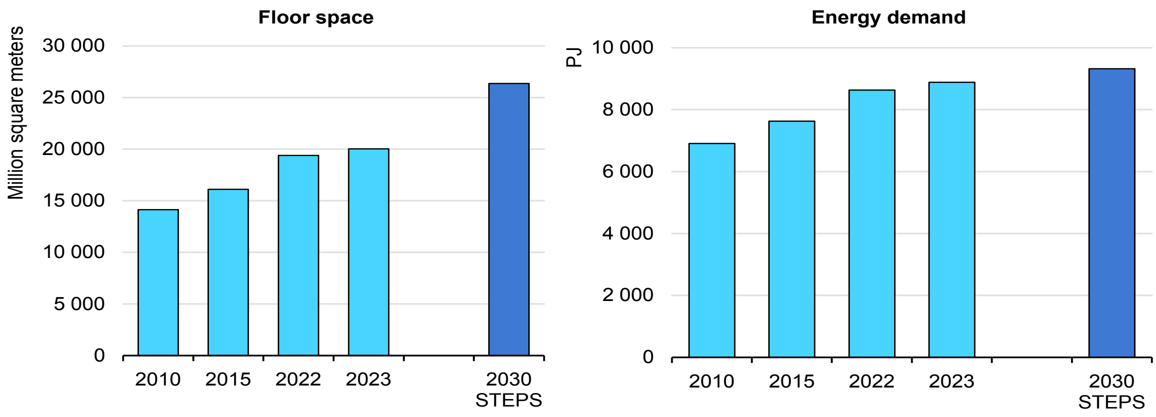
India is strengthening building energy codes, providing the policy signal to states for stronger compliance

Buildings account for over one-third of total energy consumption in India. From 2010-2023, the total floor area of buildings grew at an average of 2.7% per year.

In the same period, energy use in buildings increased by 1.9% per year. There has been a strong national policy focus on developing and implementing building energy codes. For example, the commercial energy conservation building code (ECBC) was introduced in 2007, and then updated in 2017. The residential building energy code, Eco-Niwas Samhita (ENS), was introduced in two parts in 2018 and 2021. These codes set requirements for new buildings. Both building energy codes have been revised in the Energy Conservation and Sustainable Building Code for commercial and office buildings and residential buildings in 2024.

Building energy codes set at a national level in India have to be implemented at state-level before they become mandatory, as buildings are a state-governed subject. National codes serve as a basis that states can adopt with amendments based on local climatic conditions. In India 25 of the 36 states and union territories have adopted the code for commercial buildings, of which 12 have adopted the Energy Conservation Building Code in municipal building bylaws. Most state-level ECBCs align with the national standards, but states like Sikkim and Chhattisgarh have stricter requirements. Adopting the residential code is mandatory for states under the 2022 Energy Conservation Act. While several states and union territories, including Telangana, Andhra Pradesh, Arunachal Pradesh and Chandigarh, are preparing to roll out the ENS code, no state has yet fully implemented it. Stronger compliance is essential if the codes are to lead to efficiency gains. It is estimated that effective implementation can provide energy savings of 25-35% and that compliance of the future building stock with the ECBC can save about 300 TWh of electricity by 2030. This could result in a peak demand reduction of 15 GW and prevent 250 Mt CO_2 emissions.

Total floor space and total final energy consumption for buildings, India, 2010-2023, and Stated Policies Scenario, 2030



Note: STEPS = Stated Policies Scenario.
Source: IEA (2024), World Energy Outlook.

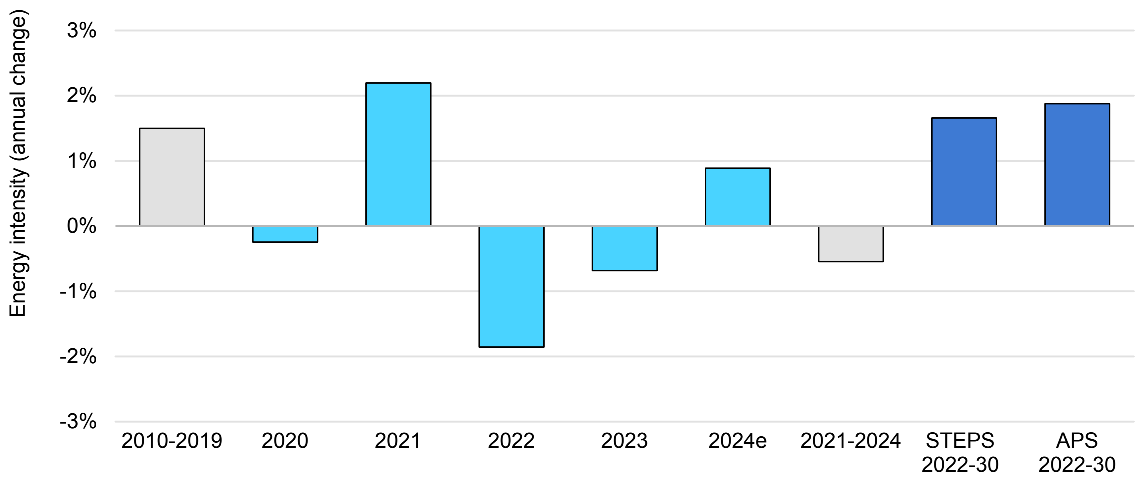
4.3 Southeast Asia

Energy efficiency progress in Southeast Asia follows global trends this year, seeing a slight improvement in 2024

Southeast Asia accounts for 9% of the global population, 6% of the world's GDP, and 4% of world energy consumption. The region is expected to rapidly expand its energy demand by 2050, due in large part to increased urbanisation, population growth and rising standards of living. Southeast Asia is defined here as the group of the ten member countries of the Association of Southeast Asian Nations (ASEAN) – Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam.

In Southeast Asia, energy intensity improvements have varied year to year and accelerating progress is challenging for a growing and industrialising emerging region. Achieving a faster trajectory will require an increase in ambition and implementation, but there are already positive signs of progress. Since 2015, every ASEAN country has reached an annual energy intensity improvement of 4% at least once. Over the past decade, some countries in the region, such as Indonesia, Malaysia and the Philippines, reached energy intensity improvements at around the global average of almost 2% per year between 2010 and 2019. In 2024, energy intensity is estimated to improve by around 1% compared to last year, in line with the global average.

Primary energy intensity improvement, Southeast Asia, 2010-2024e, and by scenario, 2022-2030



Notes: 2024e = estimated values. STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario.
Source: IEA analysis based on the Energy Efficiency Progress Tracker.

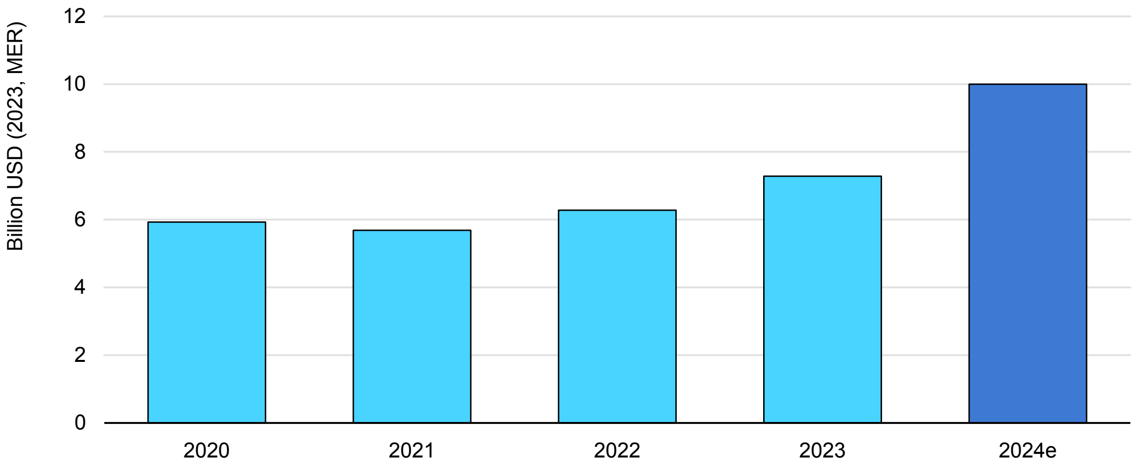
Accelerating progress requires a shift of investments from fossil fuels towards energy efficiency

Over the coming years the region is likely to see a continued reliance on fossil fuels, in part supported by high fuel subsidies which strain government budgets. Indonesia reformed its energy subsidies in 2022, resulting in a 30% increase in fuel prices. Malaysia saw fuel prices jump by 56% in June 2024 after introducing a new diesel subsidy restructuring plan, which targets subsidies to reduce the burden on public budgets. Despite this, diesel prices in Malaysia remain some of the cheapest in the region.

Energy sector investments are currently dominated by fossil fuels, with Southeast Asia accounting for just 2% of global clean energy investment and total energy investment per capita of less than a third of the global average. In 2023, investment in end-use sectors in Southeast Asia were around USD 7 billion, up from around USD 6 billion in the prior four years. High financing costs are a major barrier for further growth in investment. Improved regulatory frameworks and international support would help to manage investment risks.

Further support is needed to help raise private capital for higher levels of investment. Indonesia and Viet Nam have received multi-billion-dollar (USD) pledges through their respective Just Energy Transition Partnerships (JETP), both of which were launched in 2022 to accelerate their clean energy transitions. In Indonesia, the first Comprehensive Investment and Policy Plan was published in November 2023, detailing part of the pathway to scale up the energy transition. Recognising the important role of energy efficiency, Indonesia's JETP launched the Energy Efficiency and Electrification Working Group in early 2024.

End-use investment, Southeast Asia, 2020-2024e



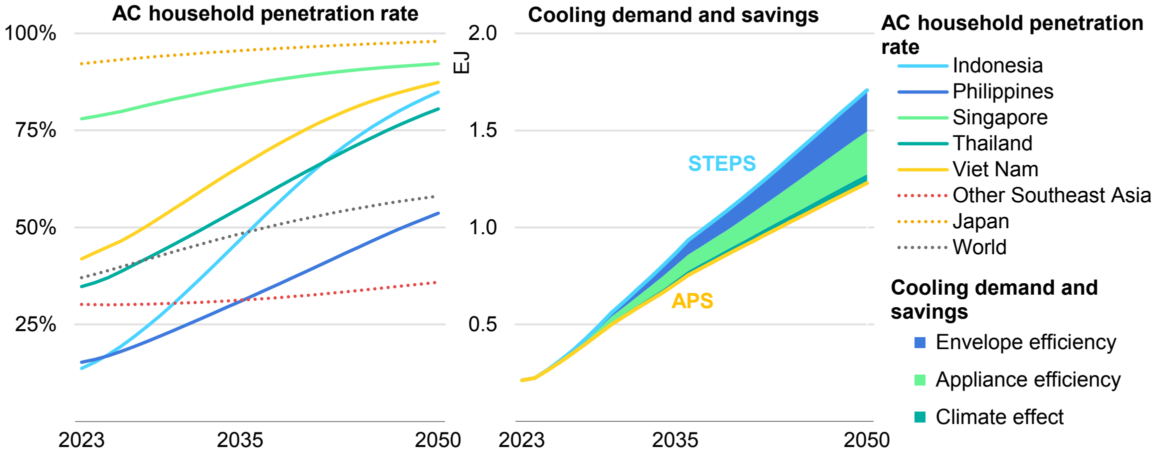
Note: 2024e = estimated values; MER = market exchange rate.
Source: IEA (2024), World Energy Investment.

The projected rise in energy demand from cooling technologies can be tempered by improving efficiency

The buildings sector has seen the largest increase in electricity demand in Southeast Asia, led higher by strong growth in the number of buildings and rising appliance ownership. This trend is set to continue, with the stock of air conditioners (ACs) projected to grow ninefold, from around 30 million units in 2020 to 275 million units in 2040, to provide greater access to cooling that is vital amid rising temperatures and increasingly frequent heatwaves. Household AC ownership is already high in Singapore, Brunei, and Malaysia, while rising incomes are driving increases in the Philippines, Thailand and Indonesia. Indonesia is expected to see the sharpest rise in household AC ownership, from 14% in 2023 to 85% in 2050.

Southeast Asia experienced another crippling heatwave in 2024, putting pressure on energy systems for rising cooling demand. Thailand has seen consistent record-breaking temperatures since 2023 that resulted in record power demand. Myanmar beat temperature records and Cambodia saw its highest temperatures in 170 years. Since 2022, more than 400 million students globally have had to stay home due to unsafe temperatures in schools, including millions this year in the Philippines. As the 2024 heatwave sent peak demand to unprecedented levels in Viet Nam, customers were called upon to reduce their electricity consumption to help avoid blackouts, which were also experienced in 2023. Appliance policy can help mitigate such risks to electricity systems. In April 2024, Singapore introduced a USD 225 (SGD 300) voucher for many households to purchase energy and water-efficient appliances. Singapore also mandated that household water heaters and commercial storage refrigerators would be added to MEPS and labelling by April 2025.

Air conditioner penetration and cooling demand, Southeast Asia, 2023-2050, by scenario



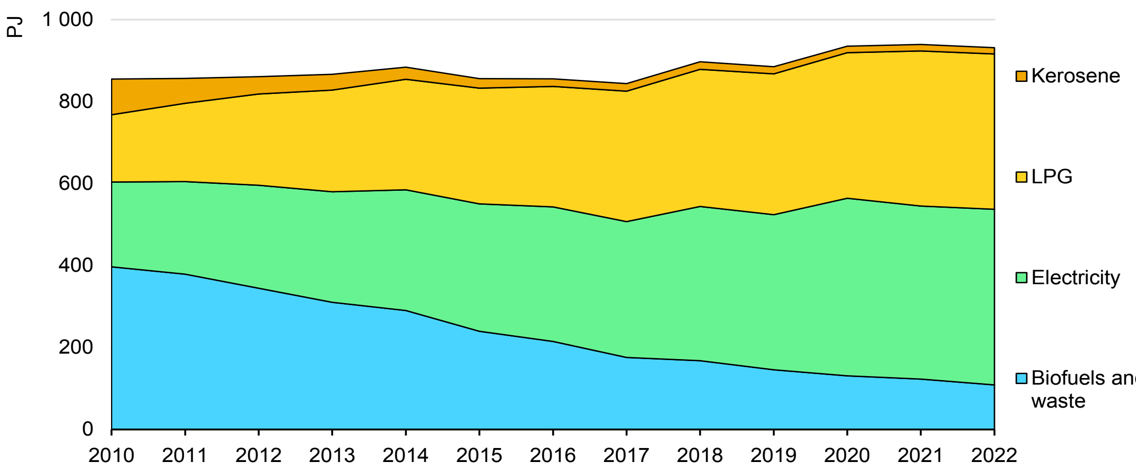
Note: STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario.
Source: IEA (2024), Southeast Asia Energy Outlook (SEAO).

Clean cooking has improved lives and greatly reduced kerosene and traditional biofuel use in the region

The number of people using traditional biofuels for cooking in Southeast Asia decreased by almost 70% from 2000 to 2023, and the share of the population with access to electricity increased from around 60% to 97%. These positive changes are thanks to strong policy action to convert to cleaner cooking alternatives and increased access to electricity.

Indonesia has made concerted efforts to transition away from fossil fuels by providing subsidies for clean cooking. The government launched a clean cooking programme in 2007 to convert from traditional and kerosene-based stoves to LPG stoves. While this reduced kerosene use by 92%, the LPG subsidies associated with the programme weigh heavily on public expenditure. Since 2021, the government has piloted various programmes to reduce LPG use and transition to induction stoves and electric rice cookers. In January 2024 it announced that it would continue a more targeted version of the LPG subsidy scheme for its induction stove programme.

Residential energy consumption in Indonesia, by fuel, 2010-2022



IEA. CC BY 4.0.

Industry accounts for the largest source of energy demand and transport shows greatest potential for efficiency gains

Southeast Asia's energy demand from the industrial sector is expected to increase by 65% by 2050, driven by expansion of manufacturing. Transport demand is also projected to continue to grow, but oil will meet a decreasing share as electric vehicles increase. A number of countries have or are developing regulations and incentives to encourage transport efficiency. Indonesia is currently developing fuel economy standards for heavy-duty vehicles, with the support of the IEA. These standards will help to increase the efficiency of internal combustion engine trucks while encouraging the uptake of EVs. Indonesia issued a regulation reducing the value-added tax for qualifying electric vehicles in January 2024, and the International Council on Clean Transportation estimates this incentive could equate to roughly USD 2 700 per vehicle. To promote EVs, Malaysia recently announced incentives to purchase electric two-wheelers (up to USD 520 per person) and for EV charging facilities, as well as investment in 150 electric buses.

Opportunities to increase regional efficiency targets abound

There are both signs of progress and opportunities to increase ambition in the region. While there are regional ASEAN and national energy intensity targets, annual energy intensity progress is expected to be just below 1% in 2024. Plans are in place to update the current regional energy intensity reduction target of 32% by 2025 (compared to 2005) for the 2025-2030 ASEAN Plan for Action on Energy Cooperation. The ASEAN Centre for Energy projects the region is likely to achieve this goal by 2026.

Among some of the more encouraging signs in 2024, Viet Nam approved its 8th Power Development Plan, which will amend the Law on Using Energy Efficiency and Conservation to accelerate efficiency progress by introducing more stringent MEPS, developing energy management models for high consuming sectors, designing a framework for energy service companies, and mobilising investment in more energy efficient equipment, especially in Viet Nam's industrial sector. Thailand's new Power Development Plan 2024-2037 also includes an updated energy efficiency plan. The IEA will continue to provide support and launched its Regional Centre for Co-operation in October 2024. Based in Singapore, this is the IEA's first office outside of its Paris headquarters and demonstrates the importance of Southeast Asia for clean energy transitions.

Country	Target
ASEAN	32% energy intensity reduction by 2025, based on 2005 levels
Brunei Darussalam	45% energy intensity (TFC/GDP) reduction by 2035, based on 2005 level
Cambodia	Energy reduction of 10% in all sectors, compared to business as usual by 2030
Indonesia	1% energy intensity reduction per year up to 2025
Lao PDR	Reduction of total final consumption (TFC) of 10% by 2030 and 20% by 2040, compared to business as usual

Country	Target
Malaysia	21% energy savings by 2040, compared to business as usual
Myanmar	Reduction of national electricity demand by 20% by 2030, compared to 2012
The Philippines	>10% energy saving on electricity from all sectors by 2040, based on 2016 levels
Singapore	35% energy intensity reduction by 2030, based on 2005 levels
Thailand	30% energy intensity reduction by 2037 in TFC from 2010 level
Viet Nam	Reduction in energy intensity in TFC by 8-10% by 2030 compared to business as usual

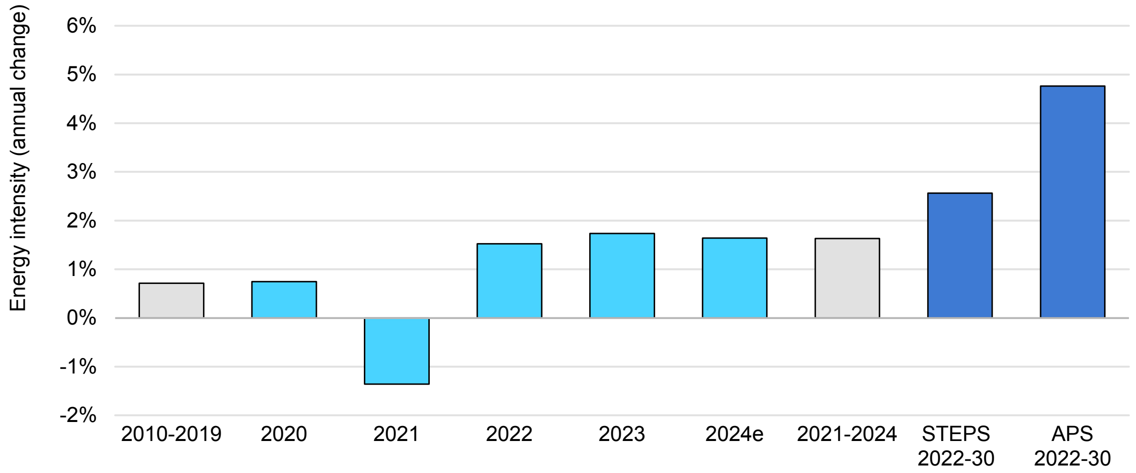
4.4 Africa

Annual efficiency progress has nearly doubled in 2022-2024 compared to the last decade, amid rapid economic growth

Average annual energy intensity improved in Africa by around 1.6% on average in 2022-2024, more than twice the average annual rate in 2010-2019. Progress slowed during the Covid-19 pandemic due to lower economic growth in 2020 and rebounding energy demand in 2021, but the continent has seen efficiency recover since 2022. Since 2010, energy demand rose by 2.2% on average per year, while annual GDP growth averaged around 3%, leading to a rise in energy intensity of 9% across the period. Between 2010 and 2019, several countries achieved annual intensity gains of at least 4% on average over the period: Gabon, Côte d'Ivoire, and Rwanda each improved by 4%, while Togo and Ethiopia reached 4.5% and 5.7%, respectively.

Governments are taking steps to implement policies that accelerate this progress. For example, Ethiopia adopted legislative initiatives to enhance efficiency and set a target of 8% annual improvement until 2050 in the country's Long-term Low Emission and Climate Resilient Development Strategy (2020-2050). The African Energy Commission and the European Union are developing the first African Union Energy Efficiency Strategy (AfEES), with goals for the continent as a whole. The strategy includes plans for each sector of the energy system. It also aims to increase energy productivity by 50% by 2050 to ensure the long-term decoupling of economic growth from energy consumption.

Primary energy intensity improvement, Africa, 2010-2024e, and by scenario, 2022-2030



IEA. CC BY 4.0.

Notes: 2024e = estimated values. STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario.
Source: IEA Energy Efficiency Progress Tracker.

Investments in efficiency can mitigate energy demand growth

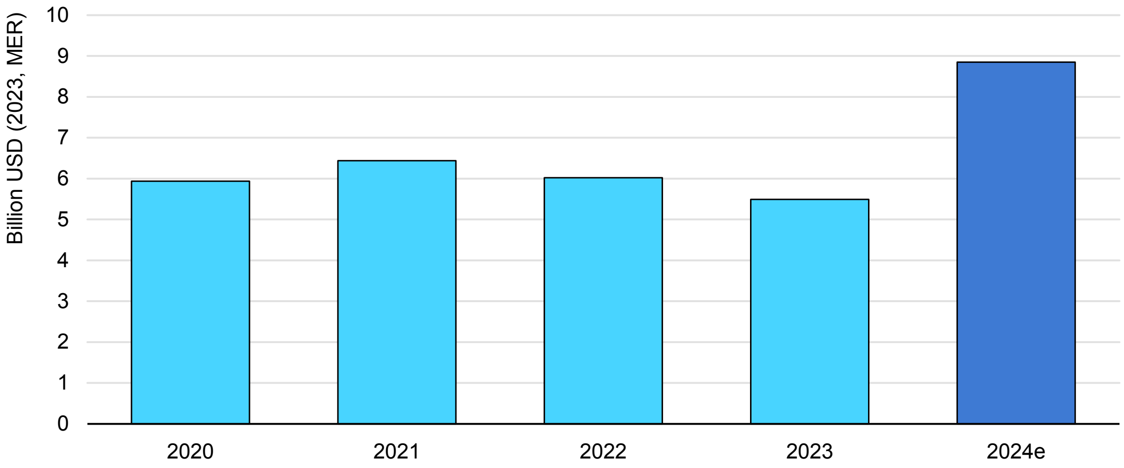
Investment in Africa's end-use sectors is expected to rise significantly to USD 9 billion in 2024, up from just over USD 5 billion in 2023. Despite this growth, Africa captures only 3% of global energy investments, totalling about USD 110 billion, with nearly USD 70 billion directed toward fossil fuels and energy grids. The continent faces several barriers to attracting more investment, including a growing debt burden, low credit ratings, and high capital costs.

Several measures can support growth in efficiency investment: stronger policy frameworks to reduce investment risk; the use of public capital to leverage private sources; and implementation of new financing structures. The public and private sector have already launched several initiatives. For example, the African Development Bank finances efficiency initiatives through the Sustainable Energy Fund for Africa (SEFA) to unlock private sector investments. By 2030, SEFA aims to approve projects totalling USD 10.5 billion, which is expected to generate 1 614 TWh/year in energy savings. The Partnership for Energy Efficiency in Buildings PEEB Cool initiative provides support to build energy efficient buildings in 11 countries in hot climates. The programme is expected to provide 1.13 million people with better thermal comfort, create 27 000 jobs, and generate over 230 GWh of energy savings per year.

Interest in new financing models is also growing. Energy-as-a-service initiatives, based on payments per use, provide services for various end uses. Companies and projects like ECOFRIDGES in Ghana and Senegal, SokoFresh and Baridi in

Kenya, ColdHubs and KoolBoks in Nigeria, and Energy Partners Refrigeration in South Africa are pioneering cooling-as-a-service, accelerating the path to clean and efficient cooling.

End-use investment, Africa, 2020-2024e



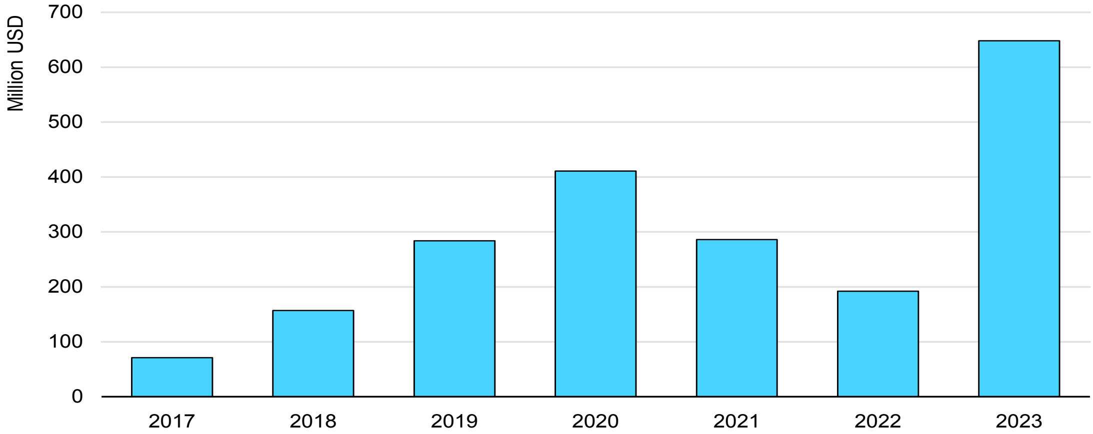
Note: 2024e = estimated values; MER = market exchange rate.
Source: IEA (2024), World Energy Investment.

Regulation can drive efficiency in second-hand markets

Second-hand markets are the main source of energy consuming product sales in Africa. In 2022, vendors of used and refurbished construction equipment reported a 20% increase in sales to African countries. Similarly, used vehicles account for over 80% of all new registrations across the continent. In Nigeria, the demand for affordable mobility led to a ninefold increase in imports of used vehicles from 2017 to 2023. While second-hand markets provide access to appliances, this has come at a cost in terms of energy demand. Second-hand cooling appliances can use two to three times more electricity than new models. Imported used vehicles can be 15-20 years old, increasing fuel use and presenting a public health risk through more frequent accidents and exposure to fine particles.

Governments are implementing measures to regulate second-hand markets. South Africa, Egypt, the Seychelles and Sudan have imposed a ban on the import of used vehicles. As of 2022, 25 countries have regulations to limit the age of imported vehicles, and 19 countries have emissions standards. The Euro 4 emissions standard is currently in use in the Economic Community of West African States (ECOWAS) and the East African Community (EAC) member countries, an example of regional standards harmonisation. (In the European Union, the Euro 4 standard is no longer in force. In 2024, an updated Euro 7 standard was adopted). Morocco improved its regulations in 2024, requiring all new vehicles to comply with the Euro 6 standard – the most stringent vehicle standard applied in Africa to date. For appliances, there has been advancement in mandatory MEPS, for example in Ghana and South Africa. Next to introducing regulations, governments are aiming to make new and efficient products accessible and affordable, with Mauritius, Rwanda, and Ethiopia providing tax incentives for the import of electric vehicles. While financial incentives play an important role, IEA analysis shows that efficient appliances do not necessarily cost more than inefficient alternatives. And while initial costs are similar, efficient appliances are usually much cheaper over their lifetime and can reduce costs by up to 60%.

Value of imported second-hand vehicles in Nigeria, 2017- 2023



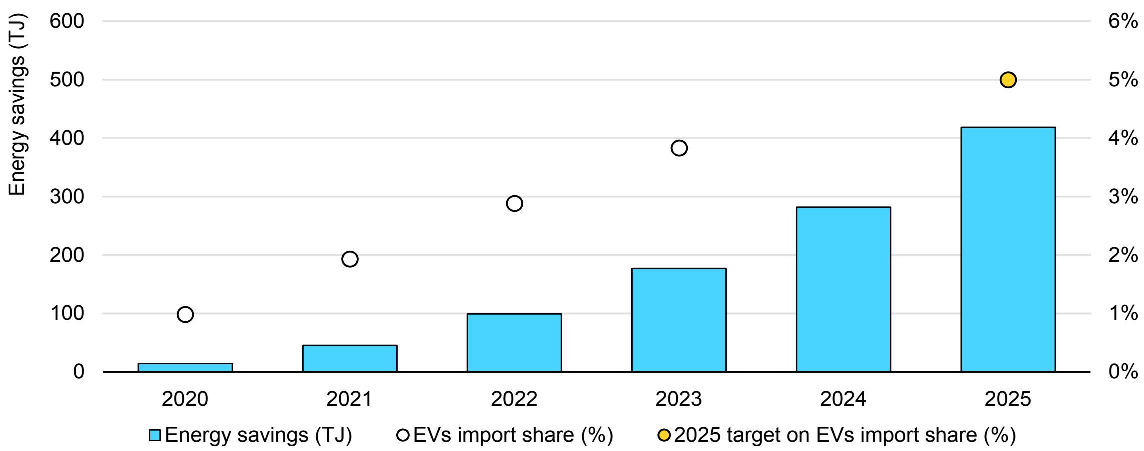
Source: IEA analysis based on data from Nigeria National Bureau of Statistics.

Growing momentum towards electric mobility paves the way for efficient transport

African countries are rapidly adopting e-mobility solutions. In a region where motorisation rates are some of the lowest globally, there is significant potential to leapfrog the transition by adopting EVs and bypassing the era of mass ICE vehicle ownership. Cities are at the forefront of this transition. In Dakar, the Senegalese government launched the first electric bus rapid transit system in Africa in 2023, which is expected to transport up to 300 000 passengers daily. Similarly, electric buses were introduced in 2024 in Addis Ababa, Accra and Cape Town. African cities are also witnessing a remarkable growth in electric two- and three-wheelers. Transport policies contribute to the adoption of e-mobility. Ethiopia became the first country globally in 2024 to introduce a ban on the import of non-electric vehicles. Kenya published its draft e-mobility strategy in 2024 to reduce import reliance, enhance infrastructure capacity, stimulate local manufacturing and improve skills. The strategy aims to address the rise in peak electricity demand, suggesting that e-mobility could help bridge the gap through nighttime charging of EVs. The avoided peak power demand from doing so could power 7 000 electric buses or 200 000 electric motorcycles.

Many African governments view EVs as a way to foster local manufacturing and reduce reliance on imports. Ethiopia opened its first EV manufacturing facility in 2024. Earlier in the year, Ghana's first e-bikes assembly plant opened, and Uganda announced a new plant to manufacture hybrid and electric buses, with an expected annual production capacity of 2 500 vehicles. In Rwanda, Ampersand has partnered with Chinese firm BYD to produce 40 000 electric motorcycles in Kenya and Rwanda by the end of 2026. Nigeria aims to achieve 30% local production of EVs by 2033 as part of its 2023 Automotive Industry Development Plan, with a target for the production of two-, three-, and four-wheelers.

Estimated energy savings from Kenya's target of a 5% share of electric vehicles in of all newly registered vehicles by 2025, 2020-2025

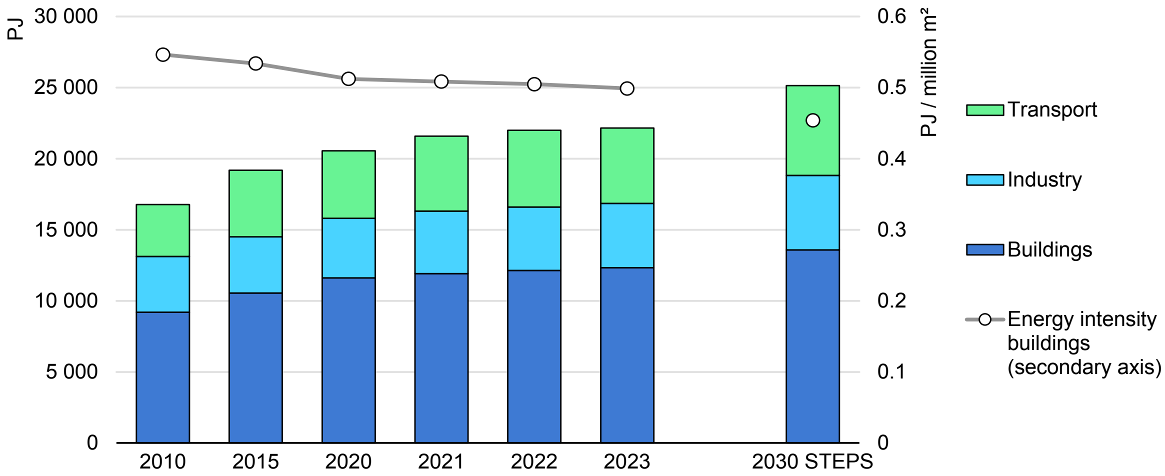


Buildings continue to dominate energy consumption, but efficiency policies are reducing their energy intensity

Buildings are responsible for over 50% of total final energy consumption in Africa. However, there are significant differences between countries. The residential sector in Ethiopia, for example, consumed 86% of total final energy in 2022, twice that of Nigeria (42%) and over six times that of South Africa (13%). On the continent as a whole, total energy consumption in buildings grew by more than 30% from 2010 to 2023. In the same period, the energy intensity of buildings – measured by energy per m^2 of floor space – decreased by 9%. This indicates that energy efficiency policies have helped to offset higher energy demand in a growing number of buildings, with more people gaining access to better living conditions as a result.

Towards 2030, energy demand in buildings continues to grow across the continent in the STEPS. A number of countries, such as Ghana, Côte d'Ivoire, Rwanda, Senegal,South Africa, Egypt and Morocco, already have building energy codes in place to improve energy efficiency. Others, such as Kenya and Nigeria, have planned or are currently implementing building energy codes. Several more countries have taken actions in 2024 to accelerate progress. In South Africa, for example, non-residential buildings larger than 1 000 m^2 are required by the government to be recorded in a National Building Energy Performance Register by August 2024, and to publicly display an energy performance certificate by December 2025.

Total final consumption by sector and buildings energy intensity, Africa, 2010-2023 and in 2030, Stated Policies Scenario



Note: STEPS = Stated Policies Scenario.
Source: IEA analysis based on the World Energy Outlook 2024 extended dataset.

Spotlight: How is the dumping of inefficient equipment affecting efficiency progress?

Differing regulatory frameworks open the door to inefficient equipment dumping

The efficiency of appliances available for purchase varies substantially across different markets globally. IEA market data shows that between emerging markets alone the differences are very large. For example, the median efficiency of air conditioners in the sub-Saharan Africa region is only 3.1 W/W, while it is 4.7 in Southeast Asia, close to the 5-6.5 W/W the NZE Scenario foresees by 2030. At the same time, household budgets for the purchase and use of appliances differ strongly due to global wealth and income inequalities. The result is that access to efficient appliances that reduce household energy expenditure is very unevenly distributed.

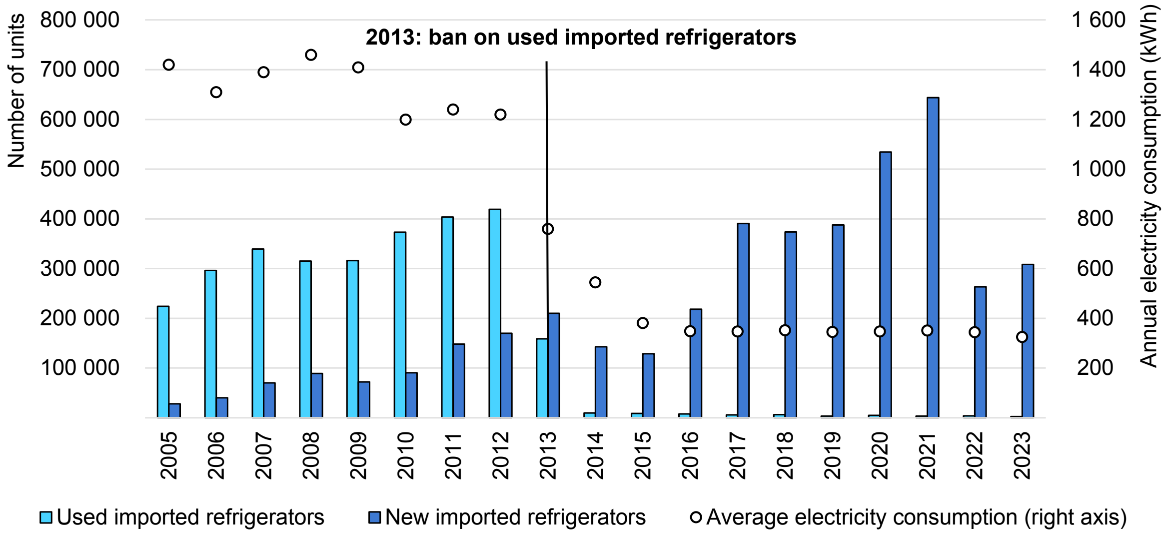
In addition, lower efficiency equipment, both new and second-hand, is typically exported to lower-income countries, thereby hindering the local market's ability to develop more efficient products. This practice, known as environmental dumping, has been defined by the Duke University School of Law as “the practice of exporting to another country or territory products that contain hazardous substances; have environmental performance lower than is in the interest of consumers or that is contrary to the interests of local and global commons; or can undermine the ability of the importing country to fulfil international environmental treaty commitments”. Dumping therefore includes the export of equipment that is treated as waste in the receiving country, equipment that is sold on second-hand markets, or new first-hand equipment that is of inferior environmental and energy consumption performance. The impact of dumping appliances goes far beyond environmental concerns. The embedded inefficiency of these products leads to higher energy bills for consumers and drives up energy demand, straining power systems and requiring new investment in generation capacity. As a result, critical resources are diverted from vital sectors such as health and education, hampering socio-economic development in low-income countries.

Outdated used equipment is flooding markets in lower-income countries, leading to a dominance of inefficient appliances

Every year large quantities of used equipment are exported to countries and regions with weaker regulatory frameworks, especially to the sub-Saharan Africa region. These appliances would be in large part disposed of as electronic waste for recycling in their origin countries but are sold as second-hand equipment instead. Due to their low upfront costs, these appliances are often preferred by consumers, leading to efficiency losses and creating health and environmental issues. For example, refrigerants that are ozone-depleting and are powerful greenhouse gases (e.g. CFCs, HCFCs and HFCs) are typically found in older refrigerators. Furthermore, waste management systems in importing countries frequently become overburdened by the influx of old equipment, leading to substantial waste management challenges that pose further risks to human health and the environment.

To address these challenges, Ghana implemented a ban on the import of used refrigerators and ACs in 2013. This ban, combined with MEPS and labels for new models resulted in three consecutive years of a drop of two-third in refrigerators’ average electricity consumption, which now stands at only one-fourth of the levels before the ban. After existing stock had been sold off, and thanks to these controls, the share of used imported refrigerators on the market decreased from 71% in 2012 to 6% in 2014 and 1% in 2023. International co-operation and experience sharing on how to handle non-compliant imports are helpful to enable countries in the region to protect their markets.

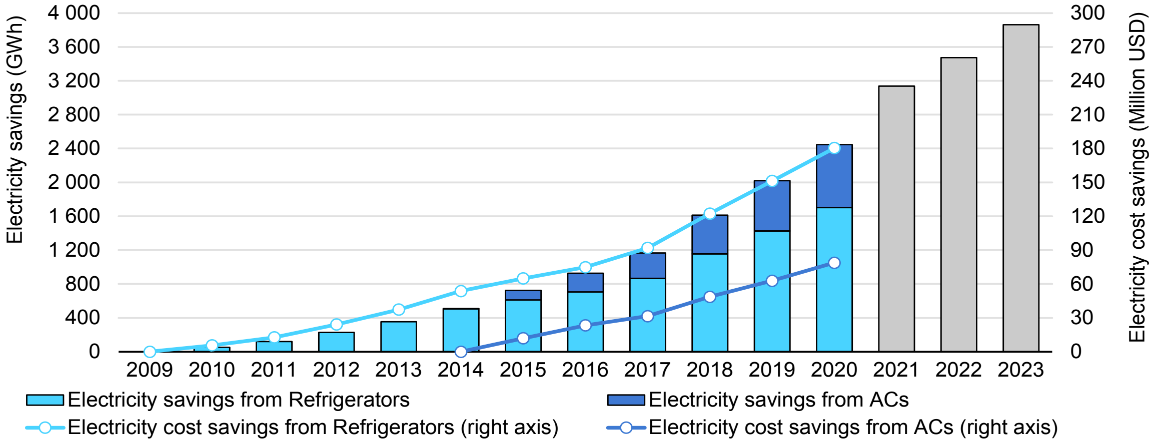
Imports and average consumption of imported refrigerators in Ghana, 2005-2023



Source: IEA analysis based on data from A. Durand, K. Agyarko (2024).

The ban has been equally successful for used ACs, which represented only 1% of total AC imports in Ghana in 2023. The average energy consumption of ACs on the market was 18% lower in 2023 than the level observed before the ban. Between 2010 and 2023, the implementation of energy efficiency policies for appliances in Ghana, including the second-hand import ban and MEPS, delivered electricity savings of over 20 000 GWh, equivalent to 89% of current annual electricity generated in the country. Ghanaian households saved about USD 345 on average in electricity bills, totalling USD 2 billion overall. Furthermore, the electricity savings from 2010 to 2020 allowed 1 160 MW of additional capacity expansion to be delayed, equivalent to nearly one-third of the total thermal generation capacity in 2022.

Electricity savings (GWh) and cost savings (USD) due to refrigerators and air conditioners compliant with energy efficiency policies, Ghana, 2009-2023

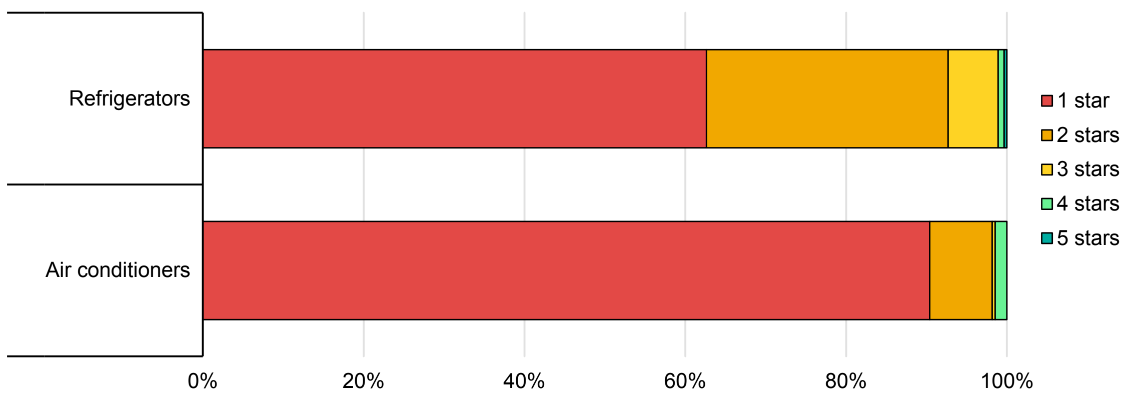


Source: IEA analysis based on data from Durand, A K. et al. (2024), Environmental assessment of used refrigerating appliances: Why does an import ban make sense and what could other countries learn from Ghana?,

Appliances not in line with standards in producer countries are exported to regions with weaker regulations

Bans on imported second-hand models do not prevent international manufacturers from selling new but inefficient appliances that use outdated technology. This practice can also be considered as dumping. Governments can help avoid this through standards and labelling programmes – Kenya has MEPS in place, as well as a comparative label scaled from 1-5 stars, for both air conditioners and refrigerators. However, current IEA analysis reveals that nearly all air conditioners and most refrigerators on sale barely meet minimum energy performance standards. The scarcity of high-efficiency models limits consumer choices and undermines efforts to reduce energy consumption.

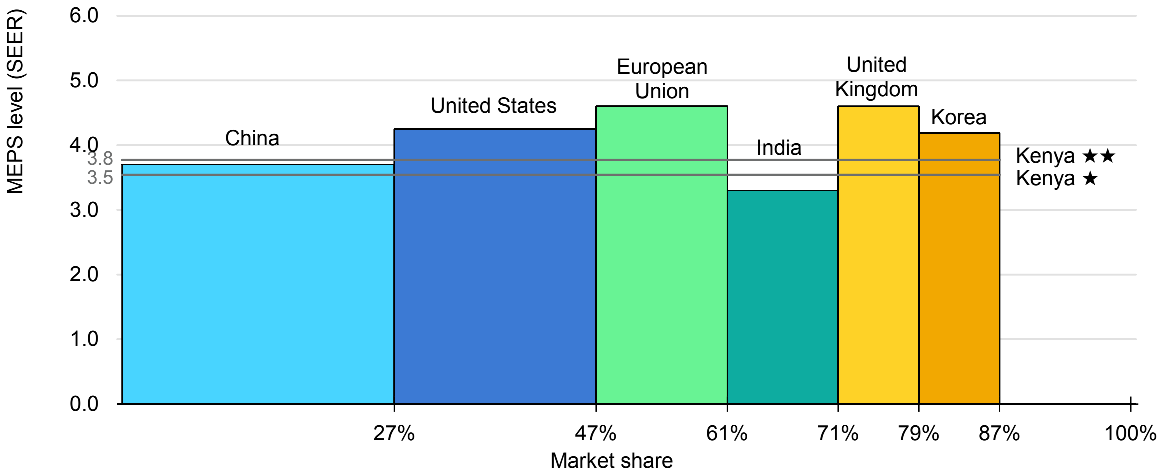
Energy efficiency label levels of refrigerators and air conditioners on the market in Kenya, 2023



Note: Kenya energy efficiency labels range from 1-5 stars, with 5 stars denoting the most efficient model.

Despite a conception that lower-efficiency appliances offer lower purchase prices for consumers, new IEA analysis shows that efficient models in the sub-Saharan Africa region are not necessarily more expensive than inefficient ones. This suggests that cost may not be the primary barrier to adopting energy efficient appliances. A closer examination of appliance imports suggests that international manufacturers may be taking advantage of lower market barriers in emerging economies to engage in inefficient equipment dumping. Kenya imports almost 90% of its air conditioners from China, the United States, India, the European Union, the United Kingdom, and Korea. In most of these countries, devices sold with a 1-star label in Kenya would not comply with the local MEPS in the manufacturing countries; this often also applies to 2-star devices. These inefficient devices and their supply chains seem to be maintained purely for export to countries with weaker regulations.

Minimum energy performance standards levels in manufacturing countries and market share of air conditioners in Kenya compared to Kenya energy efficiency label levels, 2023



Notes: Energy efficiency metrics have been converted to the Seasonal Energy Efficiency Ratio (SEER) using the methodology by W.Y. Park et al (2020), Lost in translation: Overcoming divergent seasonal performance metrics to strengthen air conditioner energy-efficiency policies. Values apply to split type air conditioners, when the regulation distinguishes between types. Differences in test methods for efficiency ratings exist between countries. MEPS = minimum energy performance standards. Kenya energy efficiency labels range from 1-5 stars, with 5 stars denoting the most efficient model.

As in Kenya, over 110 countries have MEPS for ACs in place, making it a common policy option for restricting the import and production of inefficient appliances. However, their implementation requires a regulatory framework and effective institutions for market surveillance and enforcement. Many lower-income countries do not have the institutional capacity to enforce MEPS or classify products on the market using energy efficiency labels. Inefficient, outdated equipment finds its way onto the market when these frameworks are missing or not sufficiently enforced. While this dynamic can be observed primarily in regions such as sub-Saharan Africa, inefficient equipment dumping also happens in other regions. For example, in the absence of MEPS and labels for fans for household use, a 2021 study shows that 95% of fans imported into the European Union originate in China, with just over half of products on the market complying with MEPS in China.

Good policies and international co-operation are needed to prevent the practice of inefficient equipment dumping

Governments have several options to address the dumping issue as part of a policy package covering equipment and appliances. Policies might target second-hand equipment originating from electrical waste meant for recycling, or new equipment exported by global manufacturers making the most of differences in regulations. Effective options include:

- **Ban the imports of second-hand products for major consuming appliances.**
- **Design and regularly update MEPS and energy labels**. For new first-hand models, a regulatory framework sets energy efficiency rules at a desired level, preventing exporters from putting equipment of inadequate efficiency on the market.
- **Harmonise MEPS and labels at regional level**. When the same regulations apply in several neighbouring countries, they are easier to enforce. Countries can share technical capacities and testing facilities, they can co-organise controls at borders, they have a higher bargaining power in import negotiations, and they reduce the risk that equipment enters the country via neighbours with less strict regulations. Regionally harmonising regulations by adopting one framework also supports manufacturers and allows industry to optimise product lines and plan investments. For example, the Southern African Development Community[2] officially approved harmonised regional MEPS for air conditioners and residential refrigeration appliances in 2024. A reduction in annual electricity consumption of nearly 8 TWh is expected, equivalent to four 500 MW power plants, saving 6.5 Mt CO_2 emissions by 2040 and reducing consumers' electricity bills by USD 840 million annually.
- **Engage with exporting manufacturers**: In the same way that governments train and support local manufacturers when passing new regulations, engaging with global exporting manufacturers on standards and labels can facilitate enforcement and prompt industry alignment. Manufacturers also have an important role to play in both minimising the impacts of their operations and improving the efficiency of their products globally.

[2] Angola, Botswana, Comoros, Democratic Republic of the Congo, Kingdom of Eswatini, Kingdom of Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, United Republic of Tanzania, Zambia, and Zimbabwe.

- **Use other frameworks and tools as inspiration**: Montreal Protocol signatories came to a landmark Decision XXXV/13 in October 2023 by engaging both exporting and importing parties in addressing the problem of dumping of products containing substances that deplete the ozone layer (HFCs and HCFCs). This decision opens up the potential to use multilateral funds to prevent non-compliance in the importation of prohibited cooling equipment. It also urges parties to prohibit the export of cooling equipment that would also be prohibited in the market of the exporting party.

Acknowledging the importance of the issue and the responsibility of all countries in dumping problems, in July 2024 the United Nations Secretary-General's Call to Action on Extreme Heat included a call to "prevent dumping of new inefficient equipment that uses obsolete refrigerants".

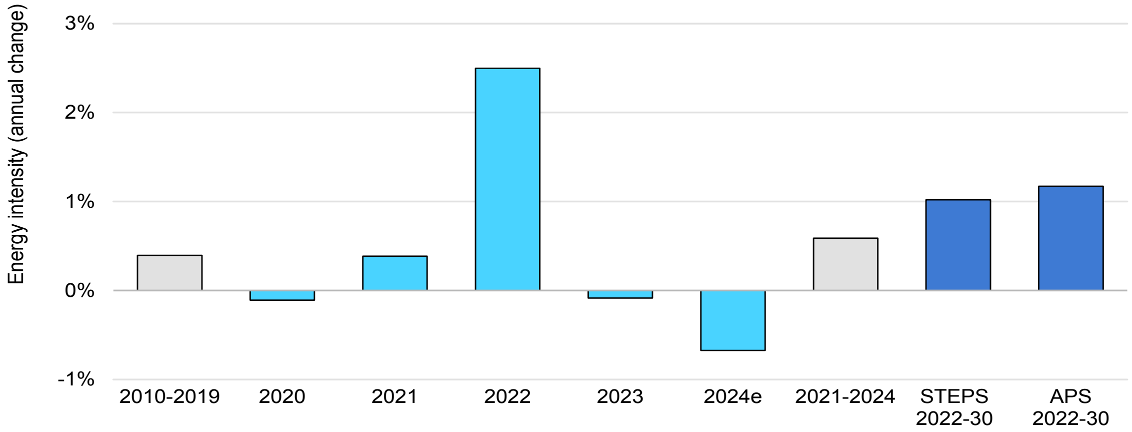
4.5 Latin America

After several years of progress, energy efficiency in Latin America is showing signs of slowing down in 2024

Latin America and the Caribbean account for 8% of the global population, 7% of the world's GDP, and 6% of global energy demand. Over the past two decades, energy efficiency progress in the region has fluctuated, with annual improvements remaining below 3%. From 2010 to 2019, progress was around 0.4% annually on average. This is lower than the global annual average, which nearly doubled from around 1% across the first decade of the century to around 2% across the second. Progress in Latin America accelerated to 2.5% in 2022 but halted in 2023 when energy intensity did not improve at all. The region looks to become slightly more energy intensive in 2024.

One-third of countries in the region have an overarching energy efficiency law in place and half of them designate a specific unit or government body responsible for energy efficiency. Despite slower progress in the region overall, various countries in Latin America have individually reached an annual energy intensity improvement rate of more than 4%. Most countries have successfully achieved this milestone at least once in the last decade, and half of them did so at least three times. In 2022, at least 7 out of 33 Latin American countries showed improvements of over 4%.

Primary energy intensity improvement, Central and South America, 2010-2024e, by scenario, 2022-2030



Notes: 2024e = estimated values. STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario.
Source: IEA Energy Efficiency Progress Tracker.

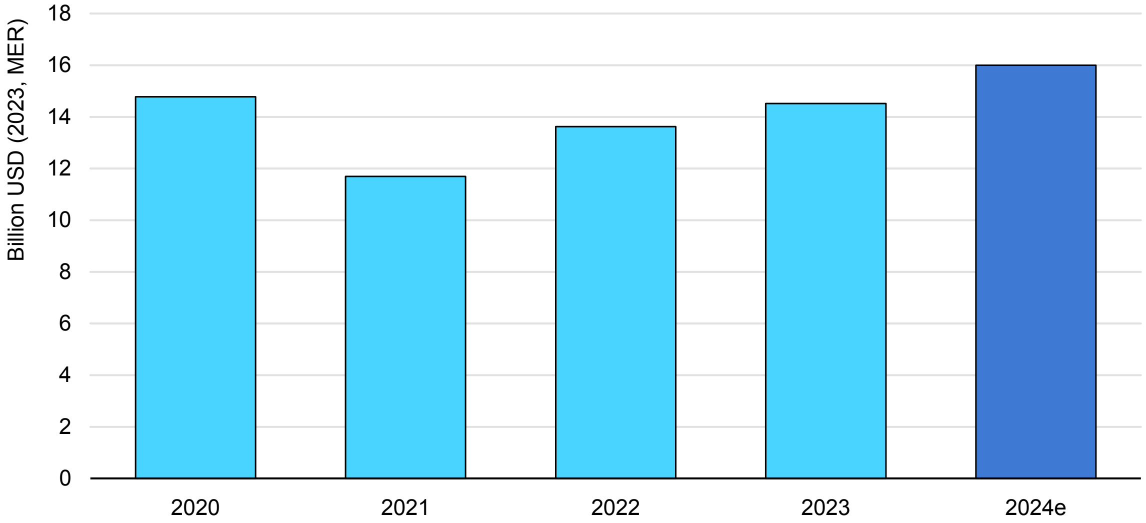
Investments in end-use sectors in Latin America are set to grow in 2024

Energy investment in Latin America and the Caribbean is projected to reach a record high of USD 185 billion in 2024. Investments in end-use sectors are less than 10% of the total but are estimated to grow to around USD 16 billion in 2024. This is approximately 17% higher than the average annual investment in the three years prior, but slightly below the level of 2020.

Countries in the region have generally been prone to high inflation, high debt, and fiscal issues, partially explaining the relatively low levels of investment. Securing financing for efficiency is challenging, due to the relatively small scale of projects that lead to higher transaction costs. Bundling projects to achieve scale could help attract investment.

Several Latin American governments are implementing programmes to scale up energy efficiency investments. In Brazil, the government of São Paulo implemented a mechanism to cover financing guarantees to small- and medium-sized companies for energy efficiency projects under the Programme for Transformative Investments in Energy Efficiency in Industry. The guarantee fund expects to leverage around USD 75 million in efficiency investments. Similarly, the Brazilian Ministry of Mines and Energy announced a USD 18 million public call to invest in the efficiency of existing buildings through renovations and installing renewable distributed generation in the public sector.

End-use investment, Latin America and Caribbean, 2020-2024e



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Notes: 2024e = estimated values; MER = market exchange rate.
Source: IEA (2024), World Energy Investment.

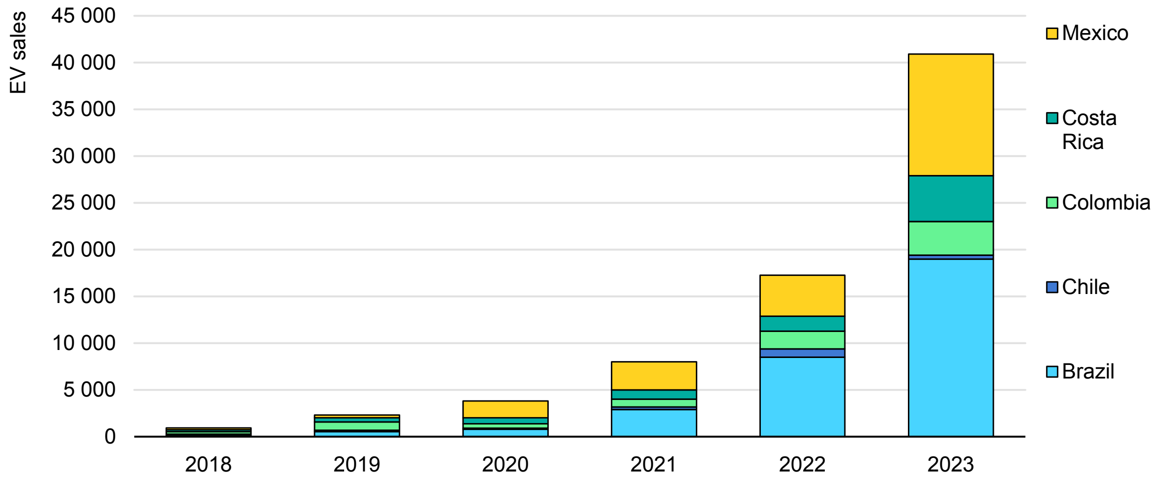
Latin America is a rapidly growing market for electric cars

Latin America relies heavily on fossil fuels in the transport sector, with 86% of energy consumption from oil, which is slightly below the global average of 91%. However, the region has one of the cleanest electricity systems in the world, resulting in significant potential for more efficient and decarbonised electric mobility. Governments in the region can unlock substantial energy savings in this sector by enforcing stricter fuel-efficiency standards for both light- and heavy-duty vehicles, promoting and developing alternative efficient transport methods, and facilitating the early adoption of EVs and charging infrastructure.

Chile, Brazil, and Mexico have either fuel-efficiency or emissions standards for light-duty vehicles. Colombia is also in the process of approving its own standards, but many other countries in the region still lack fuel regulations for cars and no country has fuel-efficiency standards for heavy-duty trucks in place. On the other hand, EV deployment has risen rapidly in Latin America in recent years. In 2023, year-on-year sales of electric cars tripled in Mexico and Costa Rica and doubled in Brazil and Colombia. Electrification of public transport also rose. The number of electric buses grew more than eightfold, from around 700 to almost 6 000 since 2017. Chile has been the main driver of this growth with almost 2 500 electric buses in Santiago – one of the largest fleets of electric buses in any city worldwide.

Chile, Colombia, Costa Rica, El Salvador, Mexico, and Peru use a combination of taxes and subsidies to support electric and hybrid vehicles. Despite the region's strong interest in electric mobility and favourable conditions regarding clean energy sources, most countries are still in the early stages of adoption and have yet to achieve large-scale deployment.

Electric car sales in selected countries, 2018-2023



Source: IEA (2024), Global EV Data Explorer (database).

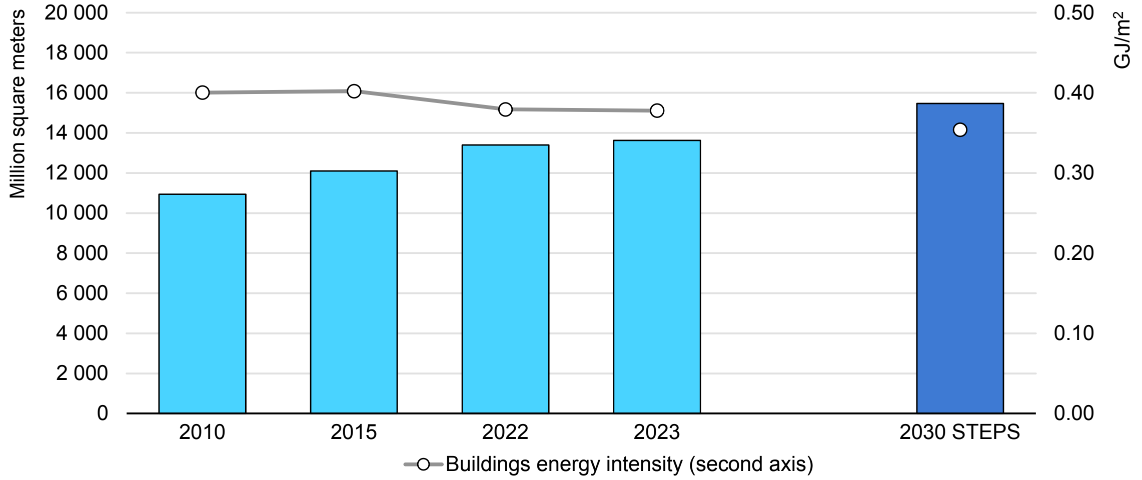
The energy efficiency potential of buildings in the region remains largely untapped

Latin America is currently one of the world's most urbanised regions and by 2030 83% of its population is expected to live in cities. Buildings consume around one-quarter of total final energy in Central and South America. The increasing urban population will require new housing and drive energy demand in buildings upwards, emphasising the importance of implementing and enforcing stricter building codes for newly constructed buildings. All Latin American and Caribbean countries have at least one green building certification system in place. Yet only two-fifths of the countries in the region have mandatory or voluntary building codes. As a result, total energy consumption in buildings grew by 18% from 2010 to 2023, while floor space rose by 25%.

Where building energy codes are in place, it is important to periodically revise them in order to accommodate new technologies and requirements, such as readiness for flexible energy demand. Brazil updated its national standard in 2024 for the performance of all new residential buildings. Since the code first came into force in 2013, the Brazilian government has been working with the industry to regularly update and strengthen the regulation. Several sub-national governments have also implemented public building regulations or energy efficiency measures.

Rio de Janeiro (Brazil), Jalisco, Merida, Mexico City, Yucatan (Mexico), Bogota, and Medellin (Colombia) are some cities and regional governments progressing in energy efficiency in public buildings. For example, the National Commission for the Efficient Use of Energy in Mexico promotes energy efficiency in public buildings, implementing programmes such as the Energy Efficiency in Federal Public Administration (APF) with energy savings of 18.25 GWh in 2023.

Total floor space and buildings energy intensity, Central and South America, 2010-2023 and Stated Policies Scenario, 2030



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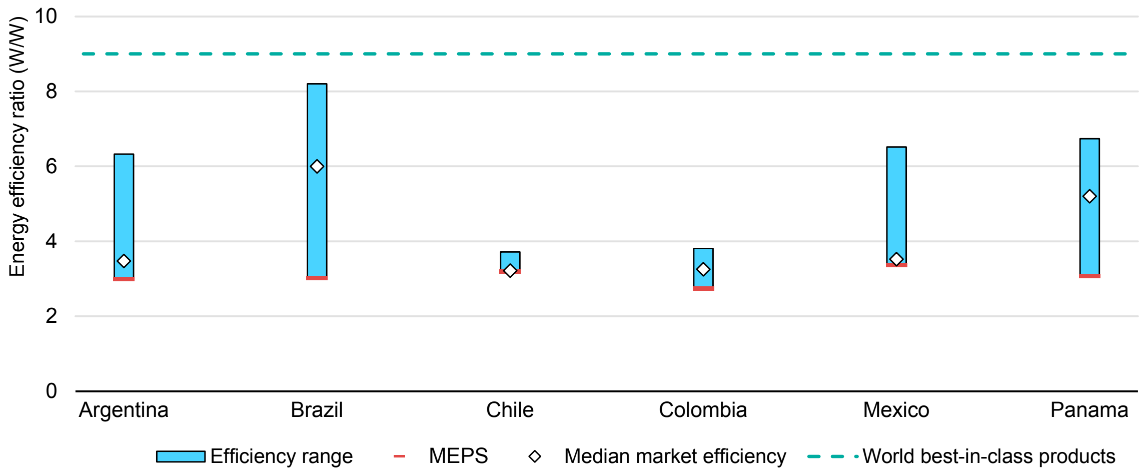
Source: IEA (2024), World Energy Outlook.

A growing number of countries are implementing appliance standards, but existing ones can rapidly become outdated

Today, about two-thirds of countries in the region have implemented MEPS and labels for appliances. Implementing stricter MEPS and labels could avoid almost 40 TWh of electricity use from appliances in Latin America by 2030. For example, standards in Mexico saved 7 900 GWh in 2023, underscoring the benefit of these programmes for consumers and energy systems alike. Implementing and enforcing regulations are important, but existing ones should also be updated as the market and technologies evolve. In several markets, standards are lower than the efficiency levels of most available technologies. Some countries have products on the market that are twice as efficient as the minimum standard, indicating the potential to revise these upward.

Energy efficiency ratings of available air conditioner units in selected countries, 2023



Recently, Brazil increased the stringency of its standard for refrigerators and plans to introduce even higher efficiency levels by 2026. Regional harmonisation can help align standards between countries and prevent dumping of inefficient appliances. The Central American region has adopted its first Technical Regulation on efficiency for refrigerators and freezers, which came into effect in December 2023 in El Salvador and in June 2024 in Costa Rica, Guatemala, Honduras, Nicaragua, and Panama. MEPS are often combined with replacement programmes to accelerate the turnover of old inefficient stock, and deploy newer, more efficient technologies. Colombia completed a pilot in 2023 to replace nearly 30 000 refrigerators in three Caribbean municipalities, offering USD 196 per family. This is estimated to have resulted in a reduction of 24 000 MWh of energy use and the creation of 400 local jobs. In 2024, the programme has expanded to the entire Caribbean region and to include efficient lighting, bringing the total investment to about USD 35 million.

Annex

Abbreviations and acronyms

AC	air conditioner
APS	Announced Pledges Scenario
ASEAN	Association of Southeast Asian Nations
ASHP	air source heat pump
BAU	business as usual
BECCA	building energy code content assessment
BER	building energy rating
CAFE	corporate average fuel economy standards
CAGR	compound annual growth rate
CFCs	chlorofluorocarbons (refrigerant)
CCUS	carbon capture utilisation and storage
CEM	Clean Energy Ministerial
COP	coefficient of performance
EMDE	emerging markets and developing economies
ESCO	energy service company
EU	European Union
EV	electric vehicle
GDP	gross domestic product
GHG	greenhouse gas emissions
GSHP	ground source heat pump
HCFCs	Hydrochlorofluorocarbons (refrigerant)
HFCs	Hydrofluorocarbons (refrigerant)
HVAC	heating ventilation and air conditioning
ICE	internal combustion engine
JETP	Just Energy Transition Partnerships
LDV	light-duty vehicles
LED	Light-emitting diode
LPG	liquified petroleum gas
MEPS	minimum energy performance standards
M&V	monitoring and verification
NDCs	nationally determined contributions
NZE	Net Zero Emissions by 2050 Scenario
NZRB	net-zero-ready buildings
PV	Photovoltaic
SADC	Southern African Development Community
SEAO	Southeast Asia Energy Outlook

SEER	seasonal energy efficiency ratio
SME	small and medium-sized enterprises
STEPS	Stated Policies Scenario
TES	total energy supply
TFEC	total final energy consumption
ZCRB	zero-carbon-ready buildings
ZEV	zero emission vehicles

Units of measure

EJ	exajoule
G CO_2/kWh	gramme of carbon dioxide per kilowatt hour
GJ	gigajoule
Gt	gigatonne
Gt/yr	gigatonnes per year
Gt CO_2	gigatonnes of carbon dioxide
GW	gigawatt
GWh	gigawatt hour
Ktoe	thousand tonnes of oil equivalent
kW	kilowatt
mb/d	million barrels per day
MBtu	million British Thermal unit
Mt	million tonnes
Mt CO_2	million tonnes carbon dioxide
Mtoe	million tonnes of oil equivalent
MW	megawatt
MWh	megawatt hour
PJ	petajoule
t/yr	tonne (metric) per year
t CO_2-eq	tonne of carbon dioxide equivalent
TWh	terawatt hour

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