Household Energy Affordability

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Abstract

Energy is one of the top expenses for millions of households, making energy affordability an important policy concern for governments. The impacts of the global energy crisis on consumer prices have been significantly felt in household budgets. Despite coming down from their peak in 2022, prices remain elevated compared to pre-crisis levels and households continue to grapple with higher living costs.

This report sets out to identify key trends that are shaping the state of energy affordability around the world today. It explores how system drivers and household energy consumption influence the makeup of energy bills and opens a wider discussion on the social implications of energy affordability for households. Based on a review of over 120 energy affordability policies introduced in 2025 that were tracked by the IEA, it also provides an overview of how governments are addressing energy affordability in different contexts and discusses existing policy options and best practices.

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Executive summary

Household energy affordability continues to be a key priority for governments as energy bills remain elevated

Household energy bills globally have come down from the peaks seen during the global energy crisis in 2022, but on average they were still around 4% higher in real terms in 2024 than they were in 2019. Household energy bills soared in many parts of the world as a result of the Covid-19 pandemic and Russia's full-scale invasion of Ukraine in 2022, which introduced a period of extreme volatility and a sharp run-up in prices. At the peak of the crisis in 2022, bills rose 16% year-on-year. This fuelled inflationary pressures and pushed energy affordability to the top of the political agenda. For most households around the world, energy is the third-largest expense after food and housing.

Household bills are sensitive to movements in underlying fuel prices; oil price pressures eased in 2025, but natural gas markets remained relatively tight in many parts of the world. Benchmark oil prices were around USD 15/barrel lower at the end of the year than at the start, reflecting a large global supply surplus and bringing gasoline prices back to pre-crisis levels. Meanwhile, relatively slow growth in supply kept natural gas import prices elevated in the first six months of 2025, before coming down as new LNG export projects began operating; residential natural gas prices in Europe and Japan were on a downward trend in 2025, but they remain around 10-30% above pre-crisis levels in real terms. North America, by contrast, saw residential natural gas prices rise by around 5% in 2025, though they remain well below prices in Europe and other importing regions.

The prices paid by households for energy vary widely from country-to-country, reflecting not just the cost of supply but also various additional levies, taxes and subsidies. For gasoline, taxes can account for as much as 70% of the final price charged to consumers, as is the case in some countries in Europe. It can also be subsidised and delivered at prices below market value, as in many parts of the Middle East. Electricity is generally subject to less tax compared to oil, but the range is equally wide, with different types of taxes, fees, levies and surcharges amounting to as much as 50% of electricity bills in some countries, or as low as zero in others. On average, the electricity system cost, i.e. the actual cost of producing and transporting the energy to consumers, makes up around 75% of the cost of electricity for households.

Electricity bills are becoming a key factor in household energy affordability in the Age of Electricity

Electricity is an increasingly important part of household energy spending; its share in residential energy use around the world has risen from less than 20% in 2000 to 30% today. In advanced economies, it has reached 40%. This is driven by growing appliance ownership and the electrification of end uses through the purchase of electric vehicles or heat pumps, which pushes down spending on oil and natural gas. With residential electricity consumption per household currently growing at around 2% a year (while oil and natural gas use is stagnant or declining), total household spending on electricity topped USD 1 trillion for the first time in 2024.

The size and composition of electricity tariffs depend in large part on policy and market design. Household electricity prices are typically made up of three main components: energy supply costs; network charges; and taxes and levies (minus any applicable subsidies such as social tariffs or targeted support). All of these costs are shaped by a complex mix of available resources, market design, infrastructure investment, and policy and regulatory choices. Renewables tend to have a dampening effect on wholesale power prices because of their low marginal cost. However, their upfront capital costs need to be covered, and variable sources such as wind and solar may incur additional balancing costs. Network charges, for grids and storage, are becoming an increasingly significant part of many household electricity bills. Electricity is often taxed at a higher rate than natural gas for residential use, on an energy equivalent basis.

In advanced economies, lower-income households remain the most exposed to energy affordability risks

More than 120 million households in advanced economies spend more than 10% of their income on residential heating, cooling and appliances. Adding the spending on private transportation pushes up the total share of income spent by the poorest households on energy to over 20%. For these households, energy spending can compete directly with other essential expenditures like food. Disparities in energy affordability across different parts of society are driven not only by income but also by the efficiency of housing and appliances. In many countries lower-income groups tend to live in less energy-efficient homes and are unable to pay for energy retrofits. This exacerbates the energy affordability gap between low- and high-income groups.

A lack of affordable energy remains a huge challenge for many emerging and developing economies

Energy affordability – including the huge unresolved issue of access to electricity and clean cooking – is a major obstacle to social and economic advancement in emerging and developing economies. Some 730 million people worldwide do not have access to electricity today, eight out of ten of whom live in sub-Saharan Africa. Around 2 billion people lack access to clean cooking solutions, with women and children suffering the worst impacts on their health and spending a large part of each day collecting firewood and other biomass.

Closing the access gap will require close attention to affordability constraints. In sub-Saharan Africa, the IEA estimates that 40% of the population without electricity are unlikely to be able to afford a basic level of electricity provision. Nearly 60% of households without access to clean cooking would need to spend over 10% of their income to cover the upfront costs. In many cases, considerations of affordability mean that even some households that have access to clean cooking options continue to use traditional fuels.

Lower energy efficiency levels of homes and appliances in many emerging and developing economies put additional strains on energy bills. High efficiency air conditioners and other appliances have greatly reduced running costs and are not necessarily more expensive to buy but are not always easy for consumers to access or identify.

A lack of access to affordable heating and – increasingly – cooling options lead to major health risks

Exposure to the cold is the current leading cause of temperature-related mortality around the world, estimated at 4.5 million deaths each year. Households that cannot afford to keep their home sufficiently warm are at a higher risk, and generally have higher medical bills, mainly due to respiratory issues. The societal costs associated with excessive cold in homes outweigh the investment required to make building improvements: for example, research in a number of advanced economies suggests that every USD 1 spent on building improvements can generate as much as USD 2.5 in societal health-related cost savings, but this requires an integrated approach across departments.

A lack of access to affordable cooling is leading to heat-related mortality in many countries. This is becoming more prevalent with rising temperatures: the World Health Organization highlights evidence that the exposure of vulnerable populations to dangerous levels of heat has increased fourfold over the last twenty years. Access to cooling technologies such as air conditioners and fans can reduce risks of heat-related health issues. However, cooling is not affordable to all, with air conditioner ownership, for example, being concentrated in higher-income groups. As 2025 IEA analysis on The Future of Electricity in the Middle East and North Africa shows, a continued focus on energy efficiency will be critical in ensuring affordable access to cooling and managing electricity demand growth.

Governments introduced over 120 policies to enhance affordability in 2025 but only a third of them are targeted

The IEA has tracked over 120 new or updated demand-side policies across 45 countries – together accounting for about half of global energy demand – that have the explicit intent to improve household energy affordability in 2025. Most policies focused on improving energy affordability in people’s homes through energy retrofitting and promoting more efficient appliances, or improving access to affordable personal transportation, such as electric scooters and motorcycles.

However, just one-third of all tracked demand-side energy affordability policies in 2025 specifically targeted the households that need support most. Untargeted policies don’t always ensure that the support benefits those who need it the most. For example, even though lower-income households often live in homes with lower energy performance, less than half of all public spending on retrofits and other building incentives are expressly targeted at these homes. Targeted policies are often more effective in addressing energy poverty issues than non-targeted measures. It was found that where policies were targeted, income thresholds were most frequently used to separate population groups.

Targeted policy action can make energy more affordable and deliver lasting reductions in household energy bills

Effectively enhancing energy affordability starts with identifying and targeting the households most at risk. Placing affordability at the centre of energy policy can improve people's lives and deliver benefits across wider policy goals. Governments can consider both demand- and supply-side policies to enhance energy affordability, combining regulation and incentives to permanently lower people’s energy bills. The IEA will continue to support governments in tracking energy affordability using various indicators, analysing policy trends and sharing best-practice examples from countries across the world.

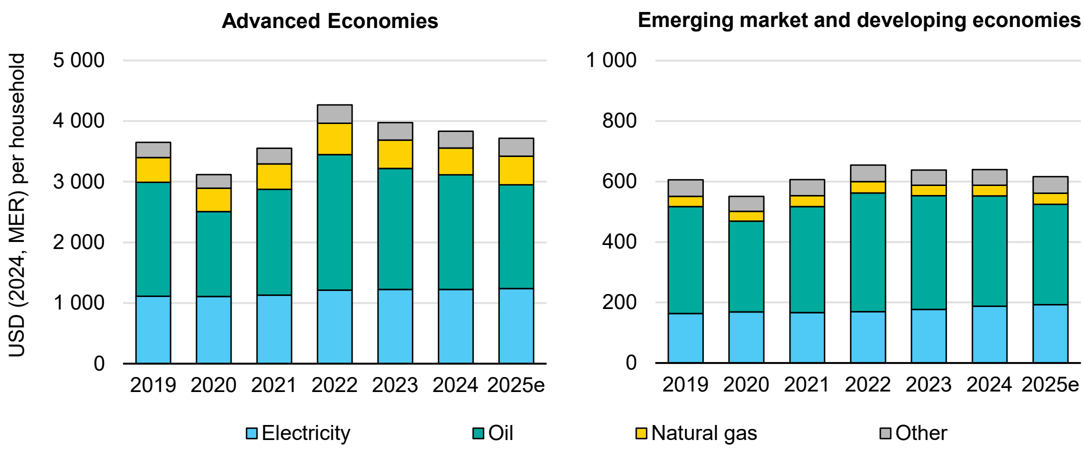
Chapter 1. How affordable is energy?

Household energy spending has come down from 2022 peaks but remains elevated compared to pre-crisis levels

For most households around the world, spending on energy is the third largest regular expense, after housing and food. In advanced economies, households spent an average of USD 3 800 on energy in 2024, and around USD 600 in emerging markets and developing economies (EMDE). Globally, around 50% of household energy spending goes towards oil, primarily petrol and diesel for personal transport, and around 30% to residential electricity use. Natural gas, mainly used for residential heating and cooking, makes up most of the remainder.

The early 2020s were marked by pronounced volatility in global energy markets, driven by a succession of major shocks with lasting consequences for households and economies. The COVID-19 pandemic was the first of these disruptions. Average global household energy expenditure fell by 13% in real terms in 2020, largely due to a more than 20% decline in transport energy spending as mobility collapsed during the pandemic. As economic activity resumed, energy spending rebounded in 2021, nearly returning to 2019 levels.

Annual real household energy expenditure, advanced economies and emerging markets and developing economies, 2019 to 2025e



Notes: MER = Market exchange rate. Household energy consumption includes residential energy use and consumption of individual transport fuels. Values are inflation-adjusted real terms. 2025e = estimated values for 2025.

This upward trend intensified in 2022, when Russia's full-scale invasion of Ukraine and the subsequent cut to pipeline gas deliveries to Europe triggered sharp increases in energy prices. Consumers in Europe were the most directly affected, but the price effects spread to many other parts of the world as well. Even as many governments put in place buffers to shield consumers from high prices, average real household energy expenditure globally shot up by 13% in 2022 above the 2019 pre-crisis levels. It has come down gradually since then.

Energy price pressures are felt differently across fuels and regions

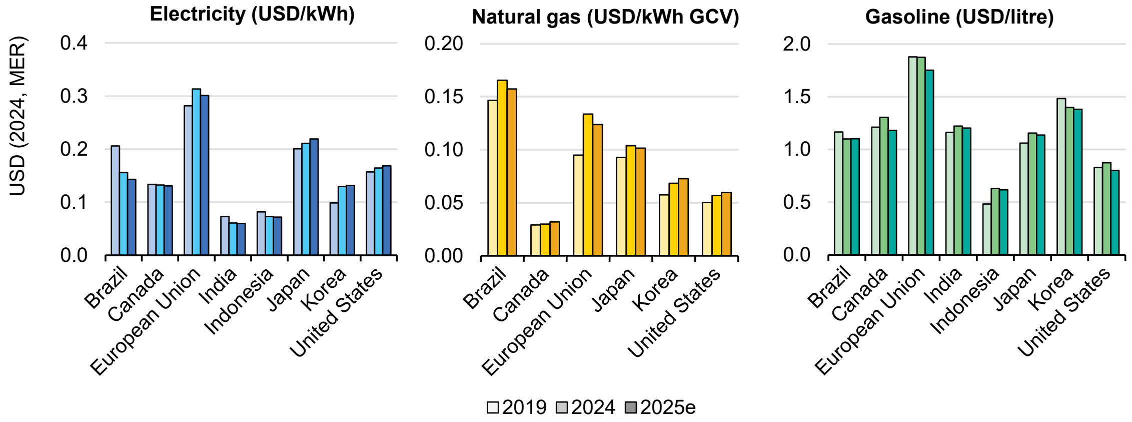
The lingering effects of the global energy crisis are still being felt in many parts of the world, particularly as consumers continue to grapple with the general increase in living costs. However, there are significant variations by fuel and geography.

Gasoline prices have fallen in most countries in real terms, by up to 10% year-on-year in 2025, returning to, or dropping below, pre-crisis levels. Softening oil market balances are feeding through to lower pump prices to varying degrees due to different market designs and pricing structures. Volatility remains high, with geopolitical tensions still exerting considerable influence on crude oil price movements.

In contrast to oil, there is no global natural gas price, rather a series of regional prices that are connected by an increasingly liquid market for internationally traded gas, primarily LNG. In Europe and Japan, retail natural gas prices declined from 2024 to 2025, reflecting improved supply conditions. Rising demand, notably from power generation, alongside growing LNG exports, pushed up retail prices for natural gas in North America by around 5% year-on-year in real terms, though average prices remain less than half the levels in Europe.

Electricity prices have also been on the rise in many markets. In the United States, price increases in 2025 were driven by a complex set of factors including higher natural gas prices, growing electricity demand, and investments to modernise grids and improve resilience (see Chapter 2). In Japan, prices increased modestly, due in part to a scaling back of subsidies. In many other countries, retail electricity prices were broadly stable or declined slightly, due in large part to easing wholesale price pressures.

Household energy prices for selected fuels and countries, 2019-2025



IEA. CC BY 4.0.

Notes: kWh = kilowatt-hour. GCV = Gross Calorific Value. MER = market exchange rate. Inflation-adjusted real prices. 2025e = estimated values for 2025. Brazil's electricity price and Indonesia's gasoline price in 2024 are interpolated.
Source: IEA (2026), End-Use Prices Data Explorer. EIA (2026), Natural Gas Prices.

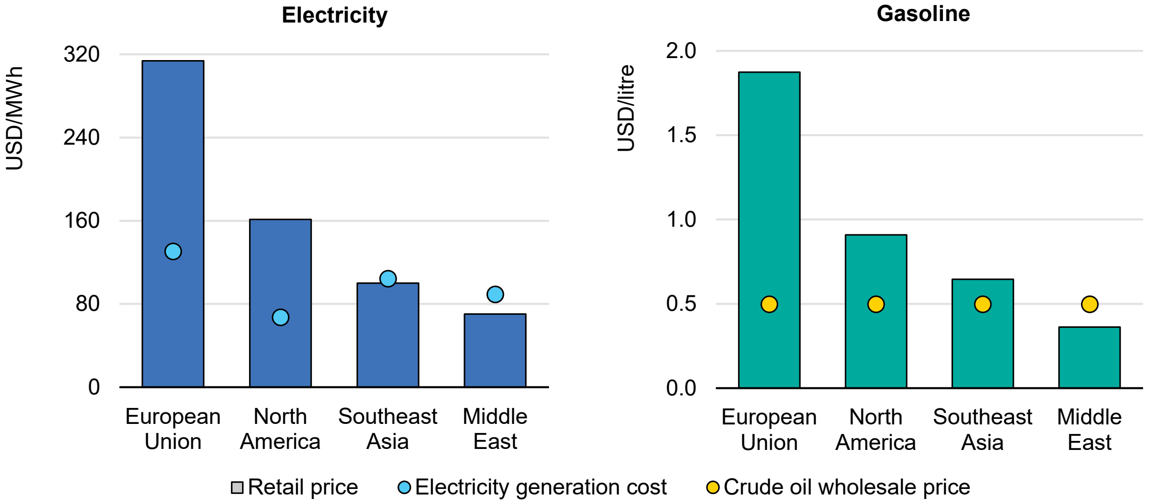
The relationship between wholesale and retail prices is shaped by a complex interplay of markets and policies

Household energy bills are made up of several components. A key distinction is between wholesale prices, which reflect energy supply costs, and retail prices, which include network charges, taxes, levies and other surcharges, as well as subsidies in some cases. Wholesale prices are volatile and strongly influenced by global commodity markets, while the retail price elements are more shaped by regulation, policy and market design.

In the European Union, average generation costs – which are closely linked to wholesale electricity prices – in 2024 averaged USD 130/MWh. Network charges and taxes added USD 180/MWh to this, meaning that average retail prices reached USD 310/MWh. In North America, network charges and, to a lesser extent, taxes, make up more than 50% of retail electricity prices. In the Middle East and Southeast Asia, by contrast, retail electricity prices are often set below wholesale prices, reflecting subsidies that keep consumer prices low.

The extent to which changes in international crude oil prices are reflected in retail prices also varies greatly. Refinery costs, marketing and distribution add around USD 40-50/barrel to the oil price, with the rest reflecting taxes, customs duties and other levies. Oil products are the most heavily taxed energy commodity globally: Taxes and levies on gasoline account for over 50% of the price in the European Union, and around 15% in North America.

Wholesale and retail gasoline prices, and retail electricity prices compared to average electricity generation costs in selected regions, 2024



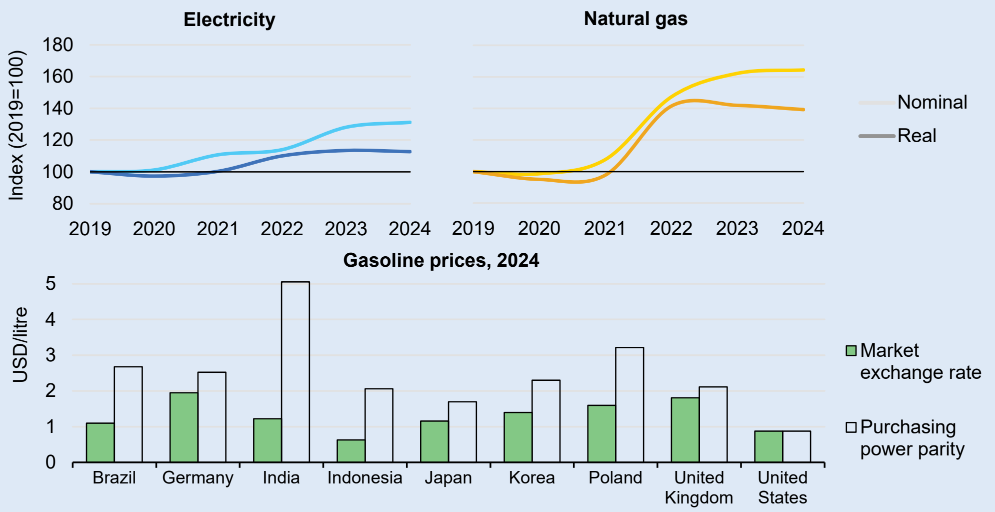
Notes: Electricity generation costs reflect the long-run cost of generating power, including capital recovery and operating and maintenance costs, fuel costs and CO_2 prices, where relevant, as well as any supplementary costs related to balancing, ancillary services and capacity markets. They are shown instead of wholesale power prices to enable comparisons between generation costs between liberalised and regulated markets.

Energy prices in the context of inflation, wages and purchasing power

Nominal residential energy prices – the amount households see on their energy bills – have risen sharply in some places in recent years. For example, in 2024 the nominal price of natural gas in Europe was about 65% higher than in 2019, while nominal electricity and gasoline prices were around 30% and 15% higher, respectively. Part of this increase in nominal prices reflects general inflationary pressures, but part of it is specific to energy, i.e. where energy has become more expensive relative to other goods and services. After adjusting for inflation, natural gas prices in real terms in Europe were still almost 40% higher than in 2019, and electricity prices were 10% higher. Much of this increase occurred in 2022/23. Gasoline prices, by contrast, declined slightly in real terms in 2024 compared to 2019, helped by softening oil market balances in recent years. Assessing the implications of these price changes for households also requires consideration of wage growth. One way to do this is to examine the share of income spent on energy; for the median household in Europe this was around 10% in 2024, similar to levels in 2019, although this may also reflect changes in energy consumption.

Accounting for inflation and wages is essential to track affordability within a given country over time. Comparing affordability *between* countries requires adjusting for the relative purchasing power of incomes. For example, India's gasoline prices are below average based on market exchange rates (MER) but, when adjusted using purchasing power parities (PPP), they are substantially higher. While PPP-adjusted prices provide a useful basis for cross-country comparisons, they can overstate burdens in countries with incomplete access to energy or high income inequality, and should be interpreted alongside access and distributional indicators.

Nominal and real retail electricity and natural gas price trends, European Union, 2019-2024 and gasoline prices for selected countries, 2024



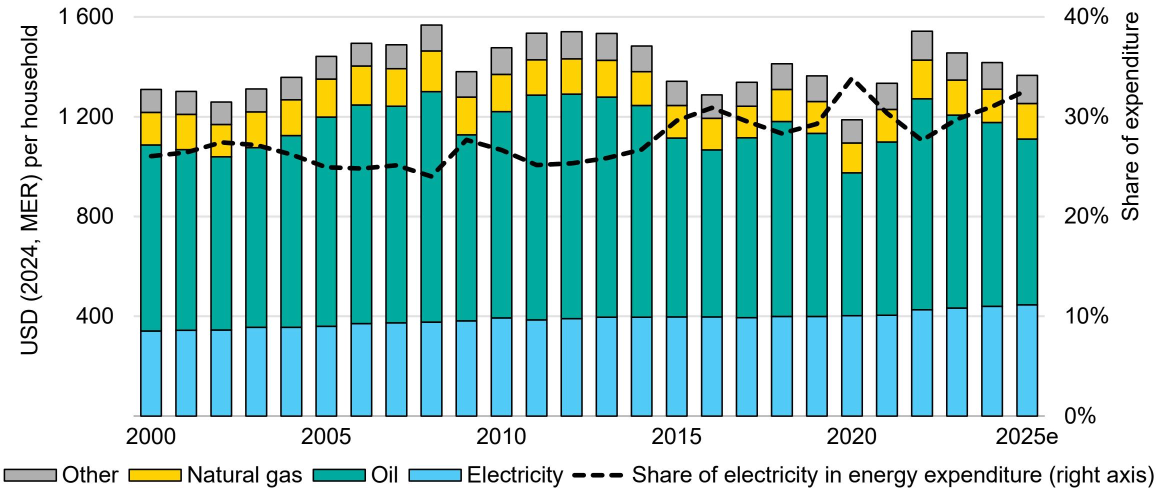
Note: Currency conversion in top chart uses market exchange rate to USD.

Retail electricity prices are becoming a defining indicator of affordability in the Age of Electricity

Electricity has become an increasingly important part of worldwide household energy expenditure. Since 2015, average residential electricity use per household has risen at around 2% a year while oil and natural gas use has been stagnant or declining. Rising electricity consumption reflects higher incomes and growing appliance ownership – for example global air conditioner ownership at the household level increased from 30% in 2015 to 40% in 2024 – as well as the electrification of end uses through the purchase of electric vehicles or heat pumps.

In 2000, electricity bills accounted for 26% of total household energy spending globally. In 2024 they averaged 31%, marking the first year in which household spending on electricity globally exceeded USD 1 trillion. While electricity bills have risen consistently at a rate of 1% to 3% per year since 2000, expenditure on fuels has been much more volatile: for oil, year-to-year consumer spending is around seven times more volatile than for electricity, and for gas it is around five times more volatile. As the share of electricity grows, households become less directly exposed to fuel price volatility and more exposed to regulated and infrastructure-dependent costs, heightening the importance of electricity market design and consumer protection.

Household energy expenditure and electricity share, 2000-2025e



Notes: MER = Market Exchange Rate. Values are inflation-adjusted real terms.

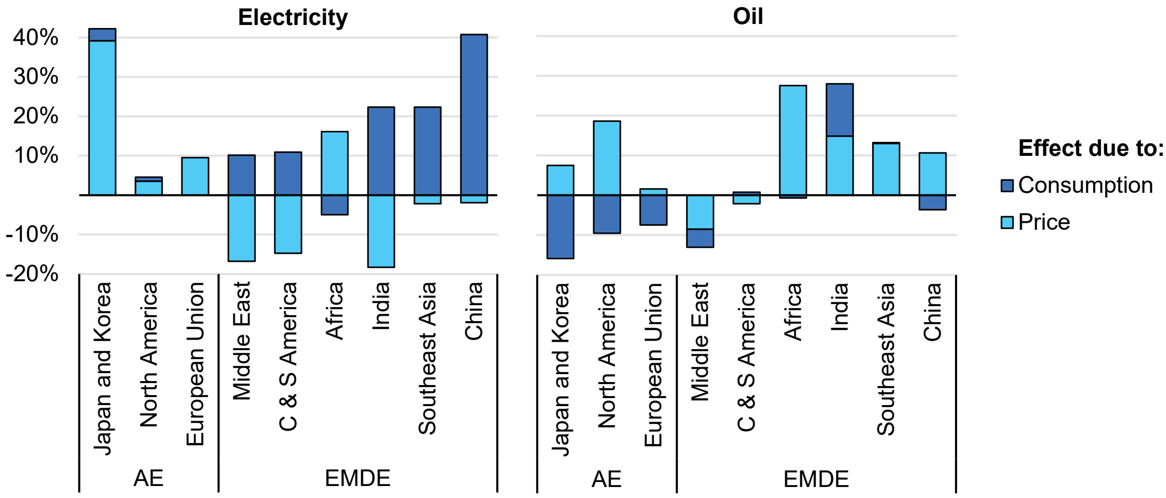
Prices drive higher electricity bills in advanced economies; consumption does so in emerging markets

Household energy bills reflect the interaction of energy consumption and prices. Consumption itself is shaped by multiple factors, including unit energy costs, efficiency and access improvements, changes in energy service demand linked to economic or demographic trends, and other influences such as the weather.

In advanced economies, energy use per household is around 20% lower than it was in the year 2000, largely due to declines in oil and natural gas. Policy measures have also helped, notably through accelerated building insulation retrofits and support for more efficient heating technologies, particularly heat pumps, which now account for around 25-30% of total buildings space heating demand in Japan and the United States. Higher prices have therefore been the primary driver of rises in household energy spending. In some regions – notably the European Union, Japan and Korea – falling petrol and diesel consumption has more than offset higher pump prices, leading to a net decrease in overall spending.

In emerging markets and developing economies, rising energy spending is driven more strongly by rapid economic and population growth. This effect is far more pronounced for electricity than for oil: since 2019, higher household electricity consumption explains 95% of the net increase in electricity bills, with only 5% of the increase explained by higher prices. For oil, around 35% of spending on gasoline and diesel is due to higher consumption, with the remainder driven by higher prices. In some cases, notably the Middle East, oil bills are lower due to lower prices as well as lower consumption.

Change in household energy bills by effect in selected regions, 2019-2024



Notes: AE = Advanced economies, EMDE = Emerging markets and developing economies. C & S America = Central and South America.

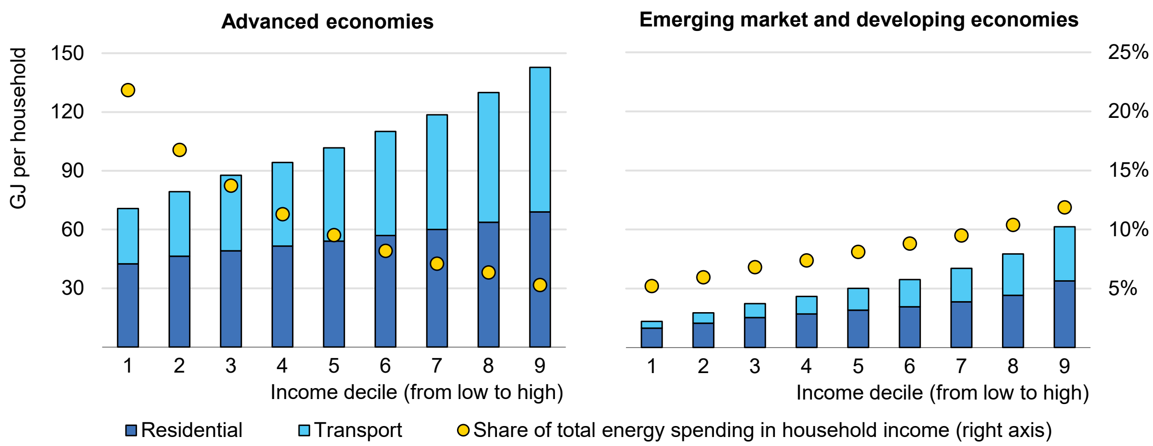
Low-income households in advanced economies spend over 20% of their income on energy, double the average

Despite the easing of energy prices, the effect of policy measures, and real income growth in regions such as Europe or Central and South America, energy affordability remains a major concern for households. In advanced economies households in the lowest income decile spend over 20% of their income, more than twice the share of a median household, on energy, despite consuming around a third less. For the over 120 million households that spend more than 10% of their income on residential energy only (i.e. excluding transport expenditure), energy costs often compete directly with meeting other basic necessities like housing and food.

In EMDEs, the disparities between income groups are even wider, with the lowest-income households consuming one-fourth that of the highest-income ones. Households in EMDEs in lower income brackets also spend a lower share of their disposable income on energy than higher-income households. This is because these households often have lower levels of ownership of energy-consuming equipment. More than 30% of residential energy demand in EMDEs is met by the traditional use of biomass, which is not accounted for in expenditure metrics.

Furthermore, some 730 million people worldwide remain without access to electricity, and 2 billion people lack clean cooking options. Vehicle and appliance ownership rates are also much lower among households in EMDEs than in advanced economies, and the energy prices are on average lower and often subsidised. Other needs such as food and shelter therefore absorb a larger share of income.

Share of total energy spending on household income and household energy consumption by income decile, 2024



Notes: Household energy consumption includes residential energy use and consumption of private transport fuels. Income refers to household disposable income. Household disposable income deciles represent the weighted average of the deciles of each country grouping assessed. This analysis considers government subsidies such as energy price caps that directly affect the energy prices paid by consumers. It does not include direct payments to households such as energy assistance cheques.

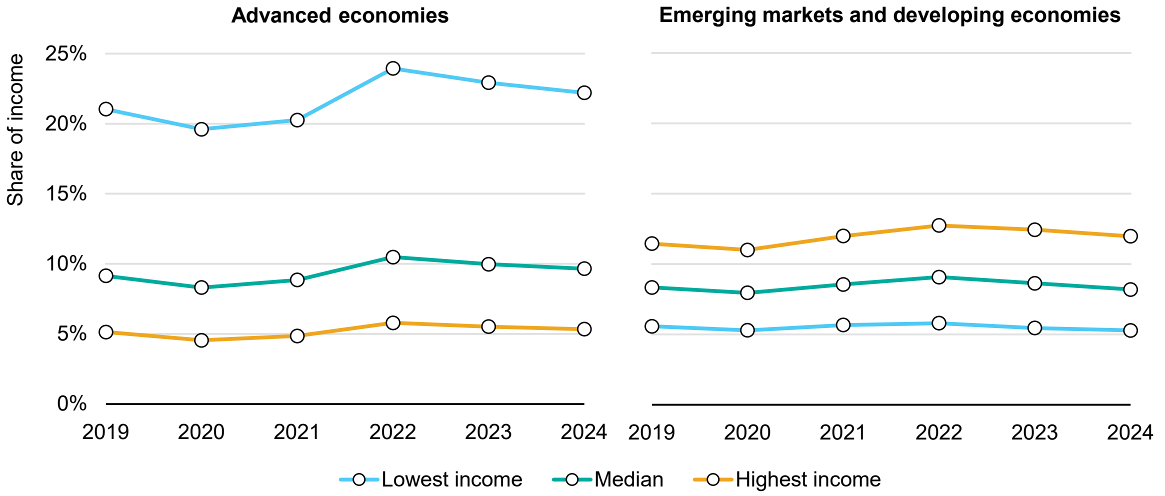
Inequality in energy affordability has not improved this decade

Recent shocks to global energy markets have brought household energy affordability into sharper focus. The surge in energy prices following Russia's full-scale invasion of Ukraine exposed low-income households to more severe pressure on their household budgets.

At the height of the crisis in 2022, low-income households in advanced economies spent about a quarter of their income on energy, an increase of 4 percentage points from 2021, compared with less than 2 percentage points for median income households. In an uncertain world, low-income households remain vulnerable to renewed and heightened energy affordability pressures.

Although the share of income spent on energy has declined to near pre-crisis (2019) levels across the income distribution, the improvement has been less pronounced for low-income households. Ultimately, the unequal distribution of energy spending across income groups has remained largely unchanged over the period 2019-2024. In advanced economies, low-income households consistently devote a significantly higher share of their income to energy than median and high-income households. In 2024, the share for low-income households still stands at 22%, or 2.3 times that of median households. In EMDEs, the distribution of energy spending across income groups has likewise remained broadly stable over time.

Household energy spending as a share of household income, 2019-2024



Notes: Lowest income = 1st decile; Median = 5th decile; Highest income = 9th decile. Household energy spending includes expenditure on residential energy and individual transport fuels. Income refers to household disposable income. Household disposable income deciles represent the weighted average of the deciles of each country grouping assessed.

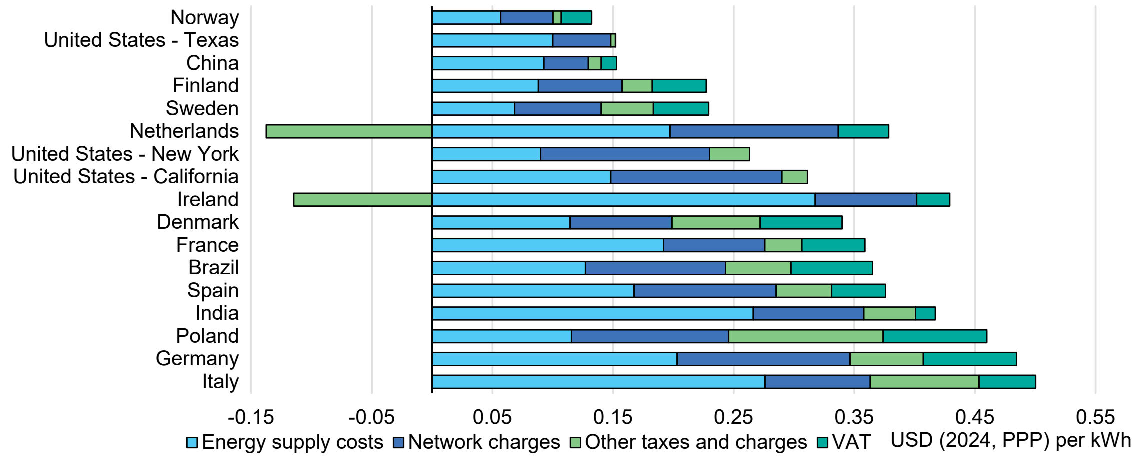
Chapter 2. Electricity supply and affordability

2.1 What drives electricity bills?

The affordability of electricity is climbing the political agenda in many parts of the world as households and businesses grapple with higher bills. In the emerging Age of Electricity – where reliable electricity is increasingly central to modern daily life – the affordability of electricity is becoming a defining indicator. Globally, the share of electricity in residential energy use has risen from less than 20% in 2000 to 30% in 2024; in advanced economies, it has reached 40%.

Household electricity prices typically comprise three main components: energy supply costs; network charges; and taxes and levies (including environmental levies or renewables support, minus any applicable subsidies such as social tariffs or targeted support). All of these costs are shaped by a complex mix of available resources, market design, technology preferences, infrastructure investment, policy priorities, and regulatory choices. How residential electricity prices are set – including the elements included, the balance between fixed and variable charges, and their interaction with tariffs for other consumer categories (notably large industrial consumers) – varies widely across countries, and this is a key consideration for policy design.

Residential electricity prices by component, 2024



Notes: IEA analysis based on Eurostat (2026); EIA (2026); California Public Utilities Commission (2025); Public Utility Commission of Texas (2025); China NDRC (2025); Brazil ANEEL (2025); India CEA (2025). VAT = value added tax. PPP = power purchasing parity. KWh = kilowatt-hour. Other taxes and charges refer to the net balance of taxes and policy levies after accounting for any rebates, exemptions or government credits applied through the bill, which can result in a negative value when support exceeds charges.

Across almost every region tracked in this report, poorer households consume a higher share of electricity within their overall modern energy consumption than do middle- or higher-income households. For the latter groups, oil used for private transportation accounts for a larger share of overall spending on energy. As a result, changes in electricity prices tend to have disproportionate affordability impacts on low-income households.

Energy supply costs

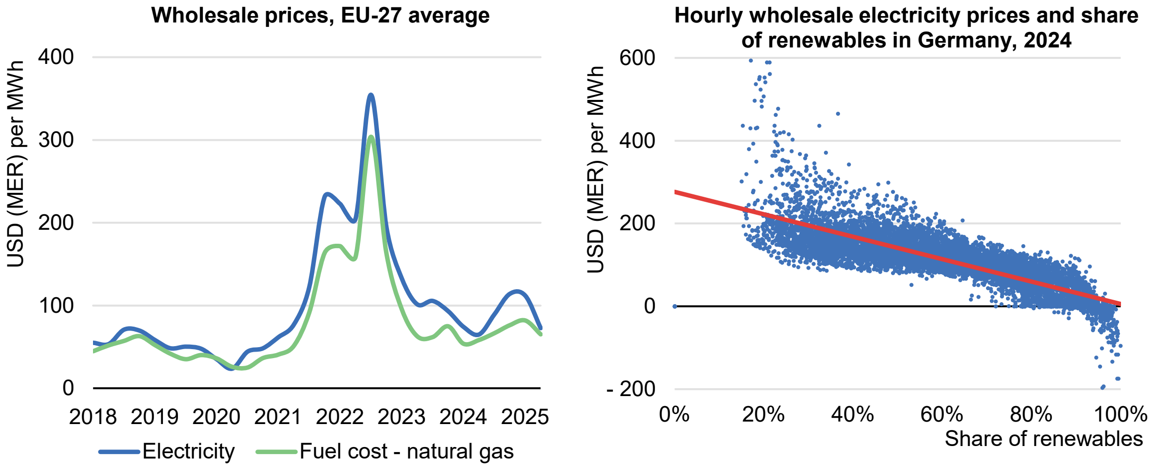
Energy supply costs cover the cost of generating electricity, including the costs of building and maintaining a fleet of power plants, and producing or importing fuels such as coal and natural gas. They also include hedging and balancing costs (although the latter may also be part of network charges), as well as supplier margins, including profits. Where applicable, CO_2 prices are reflected in energy costs. On average, energy supply costs make up around 50% of household electricity bills across a sample of advanced economies; within this broad grouping there is large variation between countries, and over time.

In liberalised markets, which make up around 50% of the world by share of total power generation, energy supply costs are generally reflected in wholesale electricity prices. These prices have been volatile in many markets in recent years, largely due to volatility in gas markets: in Europe wholesale electricity prices spiked in 2021 following Russia's withholding of gas supplies to Europe and the subsequent invasion of Ukraine in early 2022, which sparked a global energy crisis. In markets – such as Europe – where gas-fired power plants often set the marginal price, fluctuations in gas prices have a direct and outsized influence on wholesale electricity prices.

Renewables, on the other hand, tend to have a dampening effect on wholesale power prices because of their low marginal cost of supply. This is clearly visible in European markets, where higher shares of wind and solar in the daily electricity generation mix tend to be associated with lower wholesale prices.

However, variable renewables also entail additional balancing costs. As the share of wind and solar PV in the electricity mix increases, grid operators must manage mismatches between forecast and actual generation from variable sources. This requires redispatch and countertrading to balance demand and supply in real time to maintain grid stability. Balancing costs vary depending on the location of the renewable production relative to the main centres of demand, system flexibility constraints, transmission line congestion – including on interconnectors – and forecast inaccuracies. High congestion and a lack of flexibility can lead to reduced renewables output or curtailment, incurring additional costs. Such costs have risen in several European countries where the deployment of variable renewables has outpaced grid expansion. EU-wide grid congestion increased 14.5% in 2023, pushing system management costs above EUR 4 billion. In general, however, remedial costs are below EUR 5/MWh, representing a modest addition to the overall supply costs to household.

Wholesale electricity prices compared to natural gas-fired power fuel costs in the European Union and share of renewables in power generation in Germany



Notes: LHS: The fuel cost of natural gas, derived from the World Energy Outlook's weighted average European gas import price assessment, is then applied to a 55% efficient gas-fired power plant. MER = market exchange rate. MWh = megawatt-hour. RHS: IEA analysis based on ENTSO-E (2025). Each point represents one hour of observation; hours are not ordered chronologically.

In addition to ongoing fuel costs, balancing, and operation and maintenance, energy supply costs need to cover capital recovery for power plants built in previous years, through annuity payments spread over the economic lifetime of these assets. In Europe, Japan and Korea, for example, capital recovery is high relative to what it is in other advanced economies, as consumers are still paying for investments in all types of generation assets added in recent decades, including nuclear, gas turbines and renewables. Capital recovery rates in the United States and India are lower. Recovery of past investments is most often made through charges included directly or indirectly in consumer electricity bills.

Network charges

In many parts of the world, the costs of building and maintaining electricity grids, which are reflected in network charges, are becoming an increasingly significant part of household electricity bills. This reflects a combination of ageing networks, rising electricity demand, the integration of variable renewables, and growing requirements for system flexibility and resilience – notably due to increasing climate- or weather-related impacts on electricity security, such as wildfires or storms. Utilities must also invest in digitalisation and smart technologies to manage the grid efficiently.

In a scenario based on today's stated policies, transmission and distribution grids need to expand by around 30% by 2035. This expansion is driven by rising electricity demand particularly in EMDEs, while replacement of ageing lines is a key driver of additional costs in advanced economies. Around USD 730 billion is spent globally on grids by 2035 in this scenario, up from USD 390 billion today. This additional investment, if carefully managed, may not necessarily increase costs to consumers: as electricity demand rises in parallel, the fixed costs of new infrastructure can be spread across a larger volume of consumption, and may even lead to lower electricity prices in real terms, but there are clear risks if investments are delayed or if they are poorly aligned with system needs.

Grid investments often serve multiple purposes, including enhancing reliability, supporting electrification and accommodating all types of generation. As a result, the costs associated with transmission upgrades, balancing and congestion are typically spread across all users and generators, rather than being attributed to any single component of the power system.

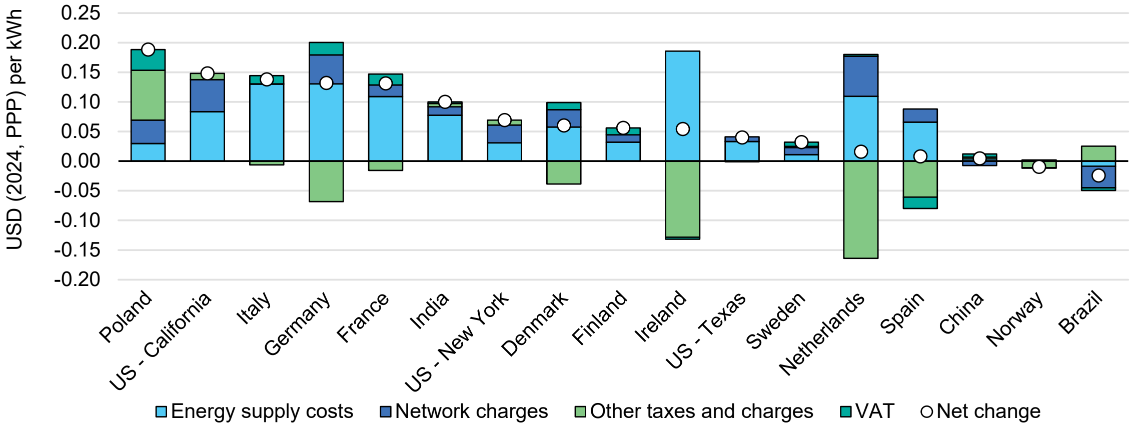
In many countries, network charges are set by regulators based on a tariff determination method which assesses utility and operator costs (and, in some cases, there are performance-linked tariffs to encourage operators to meet operational or investment indicators). However, the allocation of these costs across consumer segments varies significantly. For example, in Germany and the Netherlands, industrial consumers receive sizeable discounts on network costs to improve their competitiveness. In the People's Republic of China: (hereafter, "China"). and India, by contrast, industrial and commercial consumers bear a larger share of grid costs in order to keep electricity tariffs low for households and farmers. Sizeable investments to serve new loads, notably data centres, add an additional layer of complexity to tariff-setting strategies.

Network charges paid by residential consumers span a wide range across countries, from as low as USD 12/MWh in Korea to well over USD 100/MWh in several European countries. Of the total residential electricity tariff, the portion attributable to electricity grids represents 20-30% in most cases, with some exceptions due to the particularities of certain countries.

Since 2019, increases in energy network charges have accounted for around 20% of the increase in electricity prices across the countries shown below. The majority of recent price increases have instead been driven by higher energy supply costs. In some cases, these increases have been offset by policy interventions that have reduced charges, or provided other means of bill relief, such as direct payments.

The addition of a capacity market charge in 2021 explains the rise in the tax component in Poland over this period, while declining charges in Ireland, the Netherlands and Spain stem from rebates and sustained reductions in electricity taxation following the energy crisis in 2022.

Change in household retail electricity price components in selected countries and regions, 2019-2024



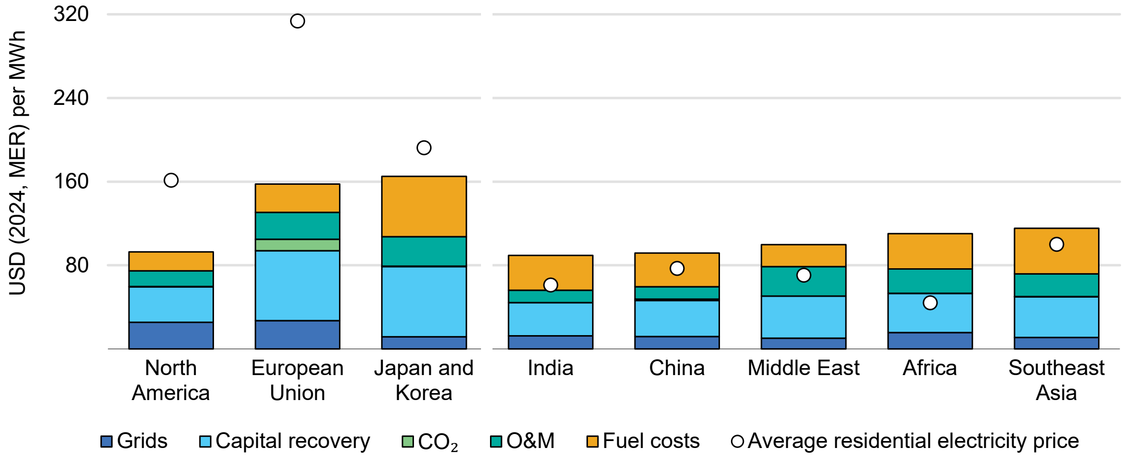
Notes: US = United States; KWh = kilowatt-hour; PPP = purchasing power parity; VAT = value added tax. Other taxes and charges refer to the net balance of taxes and policy levies after accounting for any rebates, exemptions, or government credits applied through the bill, which can result in a negative value when support exceeds charges.

Source: IEA analysis based on data from Eurostat (2026); EIA (2026); California Public Utilities Commission (2025); Public Utility Commission of Texas (2025); China NDRC (2025); Brazil ANEEL (2025); India CEA (2025).

Adequate investment in grids and system flexibility is essential to avoid reliability issues and price spikes. However, poorly designed cost-recovery mechanisms can disproportionately affect low-income or low-consumption households. For example, setting the fixed and variable components of the household electricity bill can have large distributional effects: a higher share of fixed charges can disproportionately penalise low-consumption households. An increasing reliance on fixed charges can also weaken incentives for energy savings and reduce the efficacy of variable price changes on consumption patterns. Conversely, if the fixed component is too low, it is difficult to guarantee revenues that bring forward the needed grid investments. Striking an appropriate balance between fixed and volumetric components of network charges is therefore a key design choice.

In many EMDEs, residential electricity tariffs are often set below the electricity system cost (which reflect both energy supply and network costs) in the name of affordability, resulting in persistent revenue gaps for utilities. These gaps limit the ability of utilities to cover operating costs, to service debt and recover past investments, while constraining maintenance, grid expansion and new generation investment, including in clean energy. Financial pressures have intensified since 2020, as COVID-related demand shocks and bill relief measures weakened cash flows, followed by higher fuel costs during the global energy crisis particularly in import-dependent countries. Where fiscal space is limited, prolonged under-pricing of electricity leads to underinvestment, declining service quality and rising fiscal risk, ultimately undermining both affordability and energy security and sustainability objectives.

Electricity system costs and average residential electricity prices in selected regions and countries, 2024



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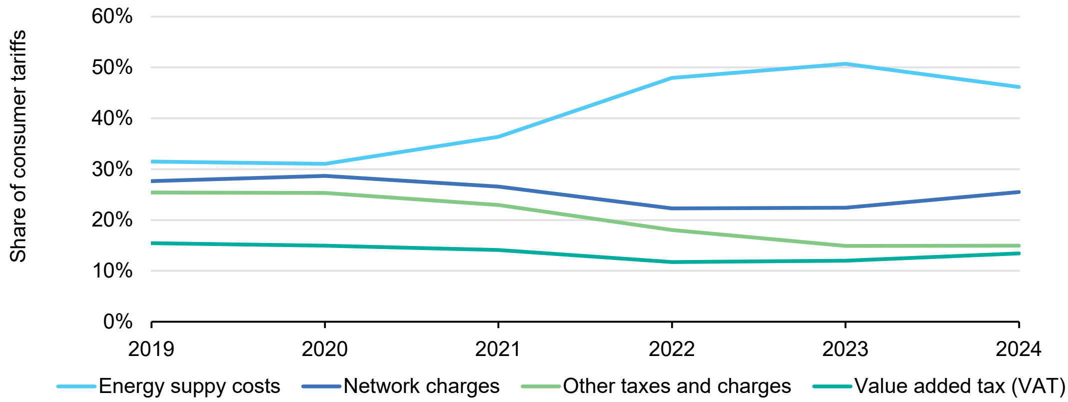
Notes: MWh = megawatt-hour; MER = market exchange rate; Grids include capital recovery costs for electricity transmission and distribution systems and grid operation and maintenance costs. O&M = power generation operation and maintenance. The average residential electricity price is a consumption-weighted average of national residential electricity prices. System costs are derived from the World Energy Outlook 2025.

Taxes and levies

Taxes and levies constitute a significant share of household energy bills, especially in several advanced economies, where taxation has long been used as a source of public revenue as well as a tool for influencing consumption patterns. During the global energy crisis, many governments reduced taxes and levies to cushion consumers from rapidly rising energy prices. In the European Union, retail price interventions, including VAT reductions and lower network tariffs, were among the most widely used affordability measures, alongside targeted transfers and social tariffs. Taxes and levies are therefore both a cost driver and a policy lever for energy affordability.

Electricity price components in the EU27 as a share of consumer tariffs, 2019-2024



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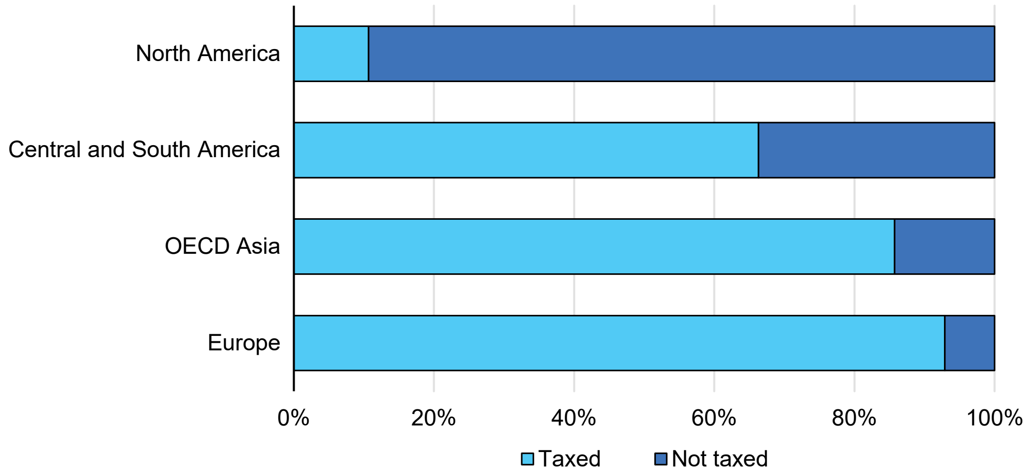
Notes: IEA analysis based on data from Eurostat (2026).

Tax coverage is complex and varies across regions, reflecting a combination of fiscal objectives, policy goals and legacies of energy system regulation, resulting in wide variation across countries and energy sources. In OECD Europe and in Asia, at least 85% of household electricity use is subject to a direct tax, while coverage is much lower in other regions of the world. For example, in the United States there are no federal taxes imposed directly on electricity consumption (although state and local taxes are in some cases applied). Moreover, the tax treatment of electricity relative to other fuels also varies; in the European Union, electricity is, on average, taxed at about twice the average rate applied to natural gas for residential use on an energy equivalent basis.

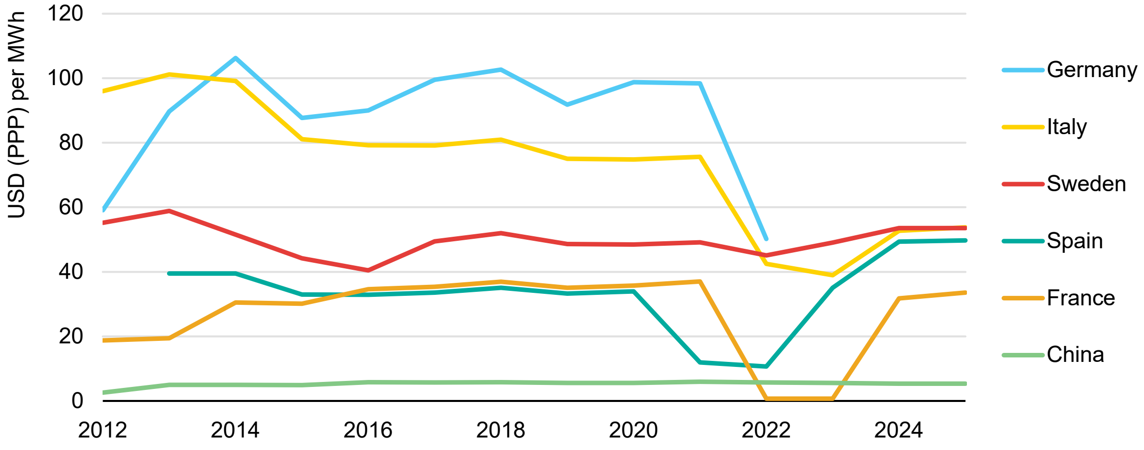
Coverage of residential electricity consumption by national taxes in selected regions, 2024



Notes: OECD Asia = Australia, Japan, Korea and New Zealand. Sample includes over 70 countries for which the International Energy Agency collects energy tax data (2025). The assessment includes ad valorem, excise and other taxes at the national level, excluding state level taxes.

Renewable energy subsidies or environment-related taxes – when mentioned explicitly in power bills – range from USD 2/MWh to USD 45/MWh, making up 2% to 15% of the average global residential retail price in 2024. In some cases, environmental charges related to power system transformation are recovered through general taxation rather than electricity bills. Additional surcharges that may appear on electricity bills include electricity subsidies for vulnerable consumer groups; waste management; repayment of electricity system debt; decommissioning of old nuclear or fossil fuel infrastructure; and other incidental costs.

Renewable energy surcharges for retail consumers in selected countries, 2012-2025



Notes: PPP = purchasing power parity. Germany's renewable energy surcharge (EEG) was removed in 2022.
Sources: IEA (2025), Renewables 2025.

While tax reductions can provide rapid relief during periods of price volatility, they also involve trade-offs. Broad-based tax cuts tend to benefit higher-consuming households disproportionately and may weaken price signals that encourage energy efficiency and fuel switching. As a result, many governments have increasingly paired temporary tax relief with more targeted measures, such as social tariffs or income-based transfers, to balance affordability concerns with longer-term electricity policy objectives. The gradual reintroduction of taxes and levies following the crisis also raises political and distributional challenges, particularly where these charges fund network investment or system decarbonisation.

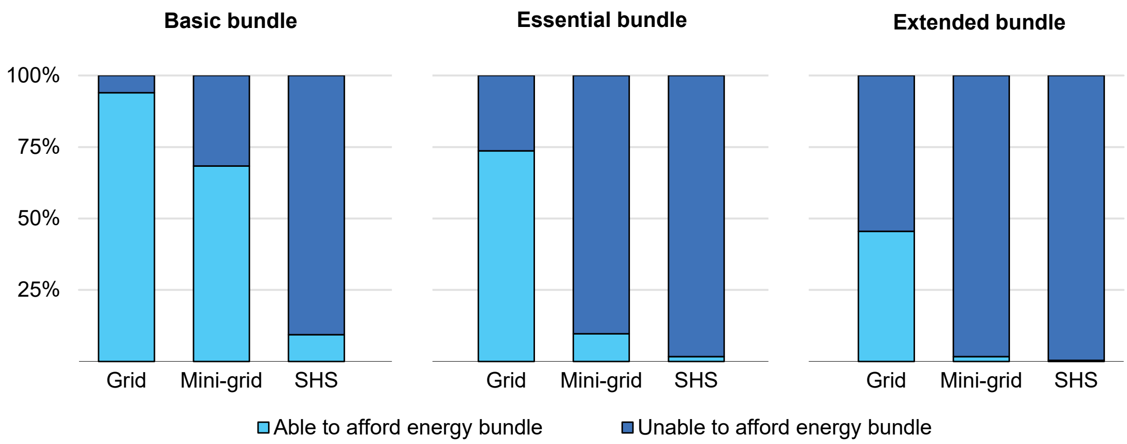
2.2 Affordability challenges for electricity access in Africa

Affordability remains a major barrier to modern and reliable electricity access across Africa. This depends both on the ability to pay upfront connection costs and on the affordability of ongoing electricity use. In many cases, households gain access but cannot afford regular consumption. This challenge is especially acute in sub-Saharan Africa, where average annual household income is around USD 1 400.

Today, around 730 million people still lack access to electricity, around 600 million of them in sub-Saharan Africa. Expanding access can be achieved through extending the national grid, deploying mini-grids, or solar home systems (SHS). The IEA has assessed the affordability of these three access pathways using local income data and geospatial analysis. The analysis shows that even a basic bundle of electricity – which is equivalent to the electricity needed to power task lighting, phone charging and a radio, equivalent to 50-75 kWh per household per year – remains unaffordable for around 40% of the households expected to gain access by 2035 (or 16 million people connecting via the grid and 200 million relying on decentralised solutions). In rural areas, grid extension is often uneconomic due to long distances and low household consumption, making off-grid solutions the preferred option. Grid-based electricity appears the most affordable option, but this is due to a high rate of subsidisation and service delivery at below-cost.

Affordability gaps widen at higher consumption levels. The essential bundle – which represents the power needed for the equivalent of more lighting, a fan and a television, equivalent to roughly 500 kWh – is unaffordable for 70 million people connecting via the grid and 315 million using decentralised solutions, equivalent to around 65% of households without access today. The extended bundle – representing the electricity needed to power a refrigerator, lighting, and a fan, equivalent to roughly 1 250 kWh – is unaffordable for almost all households using mini-grids or SHS, and for more than half of those connecting to the grid. Upfront connection costs are a key constraint. In sub-Saharan Africa, the average first-time grid connection costs around USD 50, roughly half of monthly household income across the 26 African countries analysed by the IEA. Connection charges vary widely, reflecting differences in subsidies and payment terms.

Share of population gaining access in sub-Saharan Africa able to afford electricity by technology and IEA bundle



Notes: SHS = solar home systems. Percentages refer to the population gaining electricity access by 2035 under the ACCESS scenario, by technology (grid, mini-grid and SHS). Technologies are allocated using a least-cost geospatial analysis (OnSETT). Income level is estimated using the Relative Wealth Index. Affordability is assessed across three service levels: a basic bundle (more than one light point providing task lighting, phone charging and a radio, broadly equivalent to 50-75 kWh per household per year), an essential bundle (four light bulbs for four hours per day, a fan for three hours per day, and a television for two hours per day, equivalent to roughly 500 kWh), and an extended bundle (a refrigerator, lighting for four hours, television for four hours, a fan for six hours, equivalent to roughly 1 250 kWh).

Sources: IEA analysis based on electricity tariff data in 45 African countries, collected by the Toulouse School of Economics.

Improving affordability will require targeted financial and policy interventions. Developers report that local commercial bank lending often carries interest rates above 15%, compared with around 5% in advanced economies. Using development finance institution (DFI) funding to de-risk projects and lower financing costs could enable an additional 35 million people to afford the basic electricity bundle, and 5 million to afford the essential bundle. For SHS, similar reductions in financing costs could make the basic bundle affordable for an additional 2 million people.

Beyond financing, DFIs could help reduce capital costs, while governments could introduce targeted demand-side subsidies to support electricity use at levels that are both affordable for households and viable for project developers. Since the economic benefits of electricity access take time to materialise, these measures should be paired with rural development programmes so that electricity access, job creation, and economic growth reinforce one another.

2.3 Supply-side options to reduce costs and improve electricity affordability

Household electricity affordability is shaped by the interplay of a complex set of factors, including policies, fuel prices, available resources, technology preferences, market design, infrastructure investment and fiscal choices. Trade-offs exist between efforts to provide consumers with low-cost electricity and ensuring that sufficient investments are made in resilient and sustainable electricity supply over the long-term. Moreover, when short-term supply shocks or long-term stresses push up the cost of electricity, policy makers face choices about how to distribute these costs: to the energy industry, to the government balance sheet, different types of energy consumers, or the general public. The resulting balance of risks and liabilities has important implications for consumer behaviour and investments across the electricity system. There are a number of policy considerations in play, and the remainder of the chapter presents some key options being considered.

Aligning energy supply costs with long-term affordability

Energy supply costs remain a major driver of household electricity bills. In many EMDEs, electricity generation costs – as a subset of overall supply costs – are often inflated by currency risk and elevated financing costs, which feed through to higher retail tariffs or fiscal pressure when governments cap prices.

Where fossil fuel generation frequently sets the marginal price, fuel procurement strategies play an important role in ensuring that utilities are not overly exposed to short-term volatility or supply shocks in commodity markets. Striking a balance between long-term contracts and spot market exposure is essential to mitigate high power supply costs in times of crises, while preserving flexibility to benefit from periods of lower prices, particularly as a wave of low-cost liquefied natural gas entering the global market over the next decade is expected to exert downward pressure on prices.

Expanding low-cost renewables is a central lever for lowering electricity generation costs by reducing reliance on high marginal cost thermal plants and lowering average wholesale prices and exposure to fuel price volatility. However, outcomes depend critically on deployment design. Competitive auctions, standardised power purchase agreements, and price-based support instruments such as two-sided contracts for difference (CfDs) can lower remuneration and financing costs while providing revenue certainty for producers. By stabilising revenues while limiting windfall gains during periods of high wholesale prices, two-sided CfDs mobilise capital-intensive low-carbon supply while protecting consumers from extreme price spikes, as reflected in the 2024 EU electricity market reform.

Maintaining sufficient dispatchable capacity, storage and system flexibility is essential in helping to provide stable power prices. Capacity mechanisms and competitive ancillary services markets can help ensure adequacy and system stability, improving efficiency in the provision of balancing services. It is however important to ensure that these mechanisms are designed to provide least-cost service provision. In EMDEs, where high investment risk inflates financing costs, reducing the cost of capital through regulatory stability, long-term planning and access to concessional finance is critical to containing electricity prices for households.

Managing network costs through proactive investment and regulation

Network charges account for a growing share of household electricity bills in some countries, reflecting ageing infrastructure, rising electricity demand and the need to integrate new generation. Underinvestment, slow permitting and misaligned planning can create congestion and reliability risks that later require costly remedial actions, raising overall system costs and feeding through to higher tariffs. At the same time, poorly designed cost-recovery mechanisms can disproportionately burden low-income households.

Proactive investment in transmission and distribution networks, aligned with generation, deployment and anticipated demand growth, can reduce long-term system costs by easing congestion and improving access to low-cost supply. Delays in grid expansion risk increasing renewable curtailment and reliance on higher-cost generation, raising average electricity prices. Measures such as digitalisation, dynamic line rating and performance-based regulation can increase utilisation of existing assets and strengthen incentives for least-cost network solutions, limiting capital expenditure passed through to tariffs.

Where cost recovery would otherwise raise bills sharply, managing short-term impacts through targeted compensation or lifeline tariffs can help distribute costs more equitably without weakening investment incentives or resorting to across-the-board price suppression. Moreover, the degree to which network investments are directed or incentivised by regulated bodies, state-owned utilities or private companies, has a bearing on how risk is shared across the public and private sector.

Using fiscal tools to support affordability without distorting price signals

Taxes and levies form a significant share of electricity bills in many countries and often reflect legacy policy choices rather than current system needs. In some cases, electricity is taxed more heavily than other energy sources, discouraging electrification and increasing overall household energy costs.

Rebalancing energy taxation to avoid penalising electricity, phasing down legacy renewable surcharges, and shifting remaining obligations to broader tax bases can lower household bills while supporting electrification. Germany's removal of the renewables levy (EEG) from electricity bills illustrates how such reforms can reduce costs without undermining investment frameworks. Several countries, including Ireland and Italy, have reduced the value-added tax (VAT) on electricity to ease price pressures. However, across-the-board tax reductions can be regressive, with the largest absolute benefits accruing to higher-consuming households.

To address distributional concerns, some countries, such as China, India and Korea, have employed consumption-linked charges such as increasing block tariffs, which protect basic electricity needs while charging higher rates for larger volumes of consumption. During periods of acute price stress, temporary reductions in electricity-specific taxes or levies can provide rapid relief, particularly when combined with targeted transfers or social tariffs that protect vulnerable households while preserving underlying price signals.

Improving retail price design and co-ordination across the system

In several markets, a disconnect has emerged between wholesale electricity prices and the energy component of retail tariffs, limiting households' ability to benefit from falling wholesale prices. Improving pass-through while preserving wholesale price signals is therefore important for both efficiency and affordability.

Time-of-use and tiered tariffs (such as the Social Electricity Tariff in Brazil) can protect basic consumption needs while allowing households with flexible demand to reduce bills. However, dynamic tariffs may not be beneficial for low-income households as they may not be able to accommodate swings in the cost of electricity, or adjust consumption as easily as higher income households who are able to invest in smart appliances, heat pumps or electric vehicles. More broadly, aligning generation targets, grid planning and permitting processes can reduce delays, financing costs and regulatory risk, helping ensure that low-cost capacity is delivered at scale and reflected in household electricity prices.

Retail tariff design also has important distributional effects. Higher fixed charges improve revenue stability and reflect network costs, but are regressive, disproportionately burdening low-income households. More volumetric tariffs can support affordability and incentivise efficiency, but risk undermining cost recovery. A balanced approach, of low fixed charges paired with progressive, tiered or time-of-use volumetric rates, can better align revenue adequacy with household affordability goals.

Emphasising the importance of long-term system planning

Like many areas of policy making, trade-offs exist between short- and long-term priorities. Supply-side investments made to address near-term security or price pressures can impose lasting costs on households if assets become underutilised or obsolete before the end of their cost-recovery period. Investments in thermal generation, oversized networks, or long-term contracts may be necessary to ensure system stability, but they can also risk locking consumers into higher tariffs as demand patterns, technology costs, or decarbonisation requirements evolve.

When such assets are underutilised, their costs may nevertheless be socialised through regulated tariffs or public budgets, raising bills even as cheaper alternatives become available. Modular investments, shorter contract durations, and technologies compatible with multiple future pathways preserve option value, reducing the risk of future cost lock-in and ensure that a balance is struck between short- and long-term affordability-enhancing measures.

Chapter 3. Demand-side focus on household energy affordability

3.1 Household energy affordability: drivers and opportunities

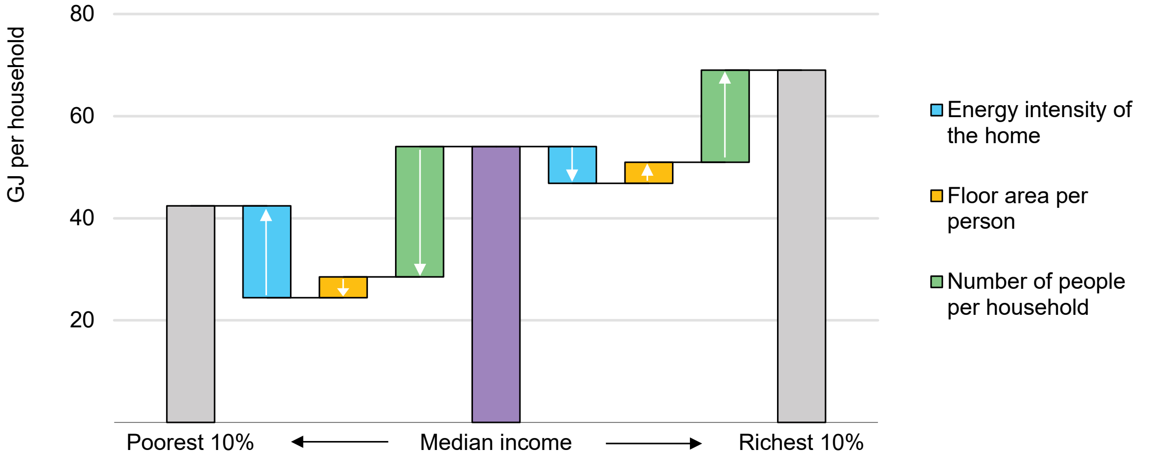
Alongside incomes and prices, the size, occupancy and efficiency of homes are drivers of energy affordability

Household energy affordability is not just affected by energy prices and people's income, but it is also strongly shaped by demand-side factors, such as the amount of energy consumed in a home. In advanced economies, the poorest decile of households uses over 40% less energy in their homes than the richest decile does. The lowest-income households devote one quarter of their income, or twice the share of a median household, to energy, despite consuming around a third less. This is due not only to energy prices and income, but also the dwelling energy intensity, the size of a home and the household composition.

Over two-thirds of household energy use in advanced economies goes to water heating and space heating and cooling, making the energy used to keep a home sufficiently warm or cold a major portion of energy bills. These factors are influenced by dwelling size: in many European countries, the richest 10% of households occupy homes three to four times larger than those of the poorest 10%. The number of people in a household is another key driver of energy consumption differences. In advanced economies, poorer households tend to be smaller; the opposite is generally true in EMDEs. Small low-income households often have high per capita energy needs for a dwelling, pushing their share of income spent on energy above commonly-used fuel poverty thresholds.

The energy performance of a home is based on the amount of energy needed per square metre. Homes that are better insulated or heated more efficiently use less energy to provide the same level of thermal comfort. In colder climates, where most energy in a home is used for space and water heating, the energy costs of households in well-insulated homes are half those of households living in poorly-insulated homes.

Key drivers influencing residential energy consumption disparities across income groups in advanced economies, 2024



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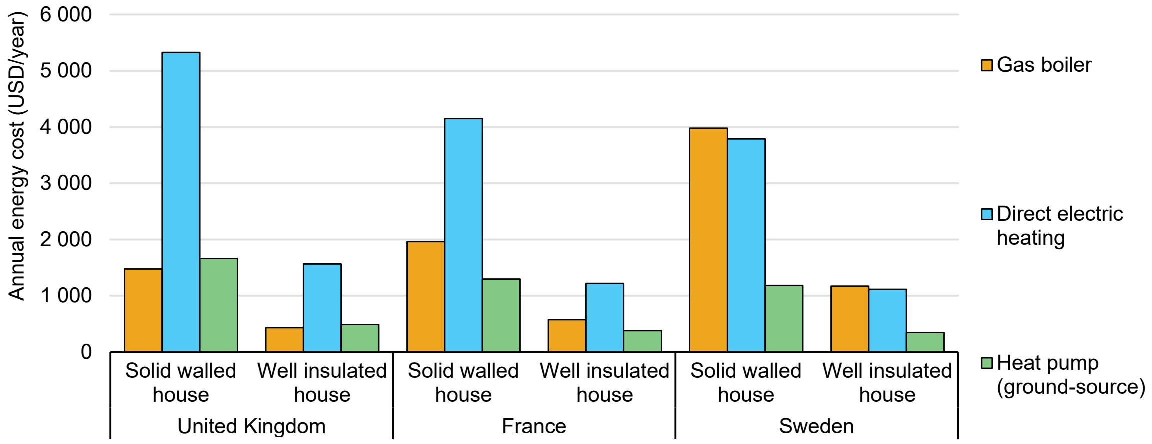
Notes: Descending arrows mean these factors lower energy consumption compared to the median household, while ascending arrows reflect an increase in energy demand compared to the median. The energy intensity of a home is calculated as the total energy consumed by the building over the course of one year, divided by the floor area. Poorest 10% and richest 10% refer, respectively, to the residential energy consumption per household in the 1st and 9th deciles.

Similarly, a heat pump heats a home using three to five times less energy than an efficient gas boiler. The energy bill savings resulting from using a heat pump depend on the difference in gas and electricity prices. When these prices are similar, heat pumps can reduce heating energy expenditure by 60-90%. In countries where the price of electricity is much higher than gas, the financial benefits of a heat pump are smaller – and switching can in some cases even lead to higher energy bills, though this can be mitigated through better insulation of the home.

Heating costs with different insulation levels and heating systems, selected countries, 2024



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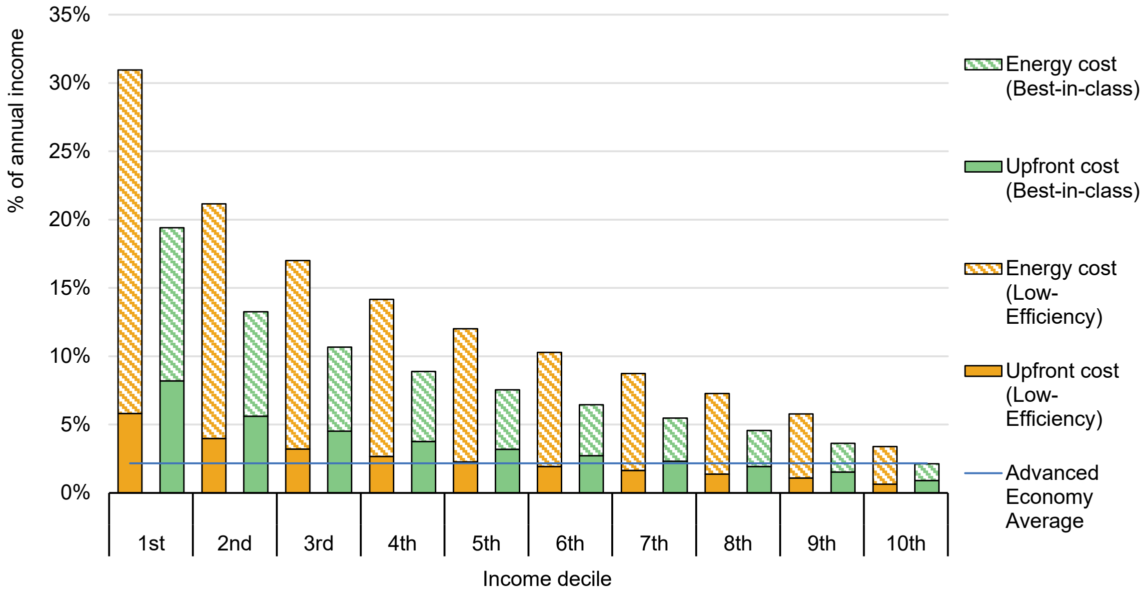
Notes: Annual heating demand estimations are based on a typical two-storey residential house. The analysis uses the following tariffs for gas and electricity: United Kingdom: USD 0.31/kWh (electricity), USD 0.08/kWh (gas); France: USD 0.25/kWh (electricity), USD 0.11/kWh (gas); Sweden: USD 0.23/kWh (electricity), USD 0.22/kWh (gas). Solid walled houses do not have a cavity between the layers and are not insulated.

Appliances can represent an important part of household energy spending, particularly in emerging markets

In many EMDEs, energy affordability is driven by spending on space cooling and household energy appliances such as lighting, refrigerators and cooling. The household expenditure on energy appliances varies significantly depending on the efficiency and capacity of the end use technologies. Efficient air conditioners, for example, can use less than half the energy of less-efficient models, cutting energy costs in half. Over their lifetime, purchasing efficient appliances can save up to 40% in the combined purchasing and energy costs as compared to inefficient ones. Improving the average efficiency of end-use technologies on the market can increase the use of energy services and raise living standards as more people are able to afford them.

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



Notes: Upfront cost is annualised over lifetime. Average income per decile is used to determine the share of expenses.

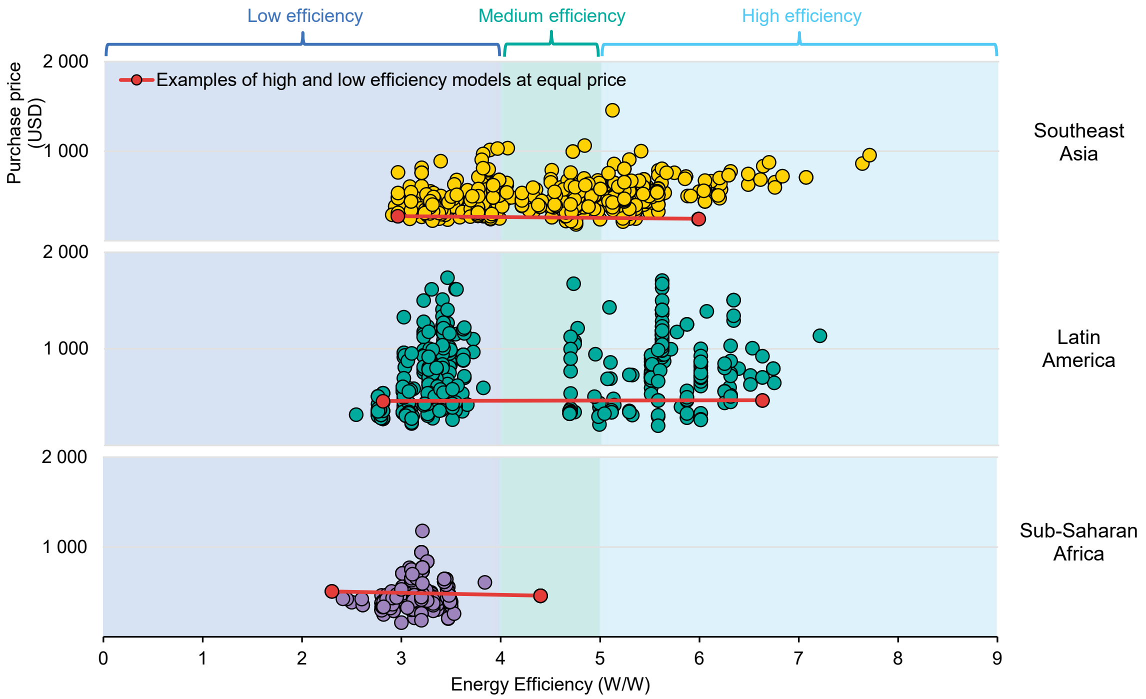
The purchase and energy costs of appliances can account for a significant part of households' disposable income. Households in emerging economies can sometimes spend up to a quarter of their income on the energy costs of appliances alone. As a result of these cost barriers, these basic energy services are often not affordable for many lower-income households. In many cases, poorer households compromise on their usage of appliances because they cannot afford it. Ensuring affordability not just for the upfront costs but also for running costs is essential to making these key technologies more widely accessible.

Efficient appliances are not necessarily more expensive than inefficient ones

IEA analysis on product prices and efficiency levels, using data collected from local stores, has shown that in major markets such as Latin America, Southeast Asia, and sub-Saharan Africa, consumers can opt for models of appliances such as refrigerators, air conditioners, and fans that are more efficient but not necessarily more expensive. For example, in Southeast Asia, highly-efficient air conditioners can be found at prices comparable with units only half as efficient, but these are often less widely available to consumers.

However, the purchase price of air conditioners can still form a barrier for lower-income households. Not only do households in higher-income countries have higher levels of air conditioner ownership than do those in lower-income countries, but within countries themselves, adoption is also highly concentrated in high-income households. For example, in East Asia and the Pacific, only about 25% of low-income households own an air conditioning unit, compared to over 75% of the richest households.

Purchase price and efficiency of air conditioners in selected regions, 2024



Notes: Air conditioners are wall-mounted single-split type. Purchase prices are normalised to equipment with 3.5 kW cooling capacity.

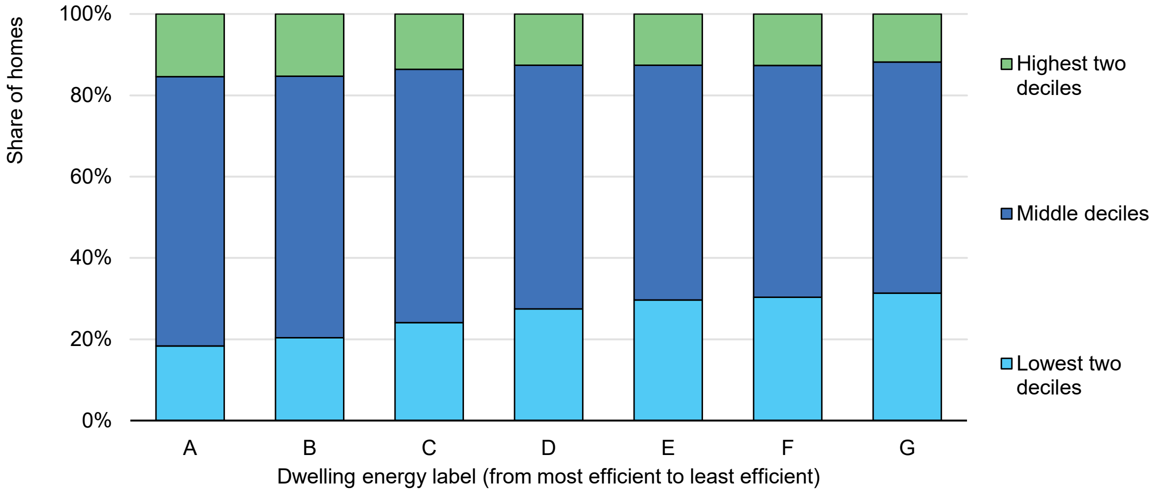
Given the relatively high upfront costs of air conditioners, alternatives such as ceiling fans also remain an important way to increase access to affordable cooling.

Analysis based on market data for Brazil shows that high-efficiency ceiling fans are also available at prices comparable to less-efficient models, and can decrease lifetime costs by up to 10%. Air conditioners can also be combined with fans, achieving similar levels of comfort at a lower setpoint and leading to 30% savings. The fans themselves consume significantly less energy, enhancing the energy affordability of cooling.

There are disparities between income groups in the efficiency of the home and the ability to pay for retrofits

Energy affordability risks are higher for households living in inefficient homes, and there are often disparities between population groups in the energy performance of their home. In some countries, such as Canada and France, studies indicate that lower-income households and other vulnerable groups tend to live in older and less energy-efficient homes. In some other places, such as the Netherlands and the United Kingdom, country-level data show smaller differences between lower- and higher-income households with regards to the efficiency of their home. Data does not always take into account factors like dwelling type (apartment or detached home) and tenure (owner-occupier or renter).

Distribution of energy performance certificates in private rental homes in France, by income class, 2025



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Source: IEA analysis based on data from France Statistical Data and Studies Department (accessed January 2026).

When looking at the private rental sector in France, lower-income households tend to live in homes with lower energy performance. Of all privately rented homes rated G (the least efficient ones), 31% are occupied by people in the lowest two income deciles, while 12% are occupied by people in the two highest income deciles. On the other hand, in A-rated homes (the most efficient), the share of the lowest-income occupants is below 18%. Similarly in the United Kingdom, higher-income households are more likely to live in energy-efficient privately rented homes.

However, social housing can be, in some countries, relatively more energy-efficient, because social housing providers have more financial resources and have been encouraged through policy to upgrade their portfolio. For example, Australia has implemented a Social Housing Energy Performance Initiative, and the United Kingdom is considering setting a minimum energy efficiency standard for social housing, something the Netherlands announced in 2025.

Improvements in the efficiency of a home can enhance energy affordability. This is particularly important for lower-income households who are most at risk of energy poverty. For example, 25% of the EU population lived in a home that had undergone energy efficiency improvements between 2018 and 2023. However, the share among people classified as being at risk of poverty or social exclusion was only 18%, pointing to persistent inequalities in access. Lower-income households are less able to afford a retrofit. While retrofitting a typical home might pay itself back over a building's lifetime, upfront investment for sufficient levels of insulation and a high-performance heat pump is significant (typically around USD 40 000, although there are large variations between countries and types of measures).

Affordable public transport is key for low-income groups, who have lower levels of private vehicle ownership

In advanced economies, higher-income groups spend more on private transport fuels in absolute terms. However, this represents a smaller share of their disposable income – often less than 3%. Lower-income groups, while having lower levels of expenditure on private transport fuels in absolute terms, are spending a larger share of their income on it – up to 7.5%. Differences also exist between households living in rural and urban areas, with the former group having a higher dependency on private vehicles due to a lack of available public transport.

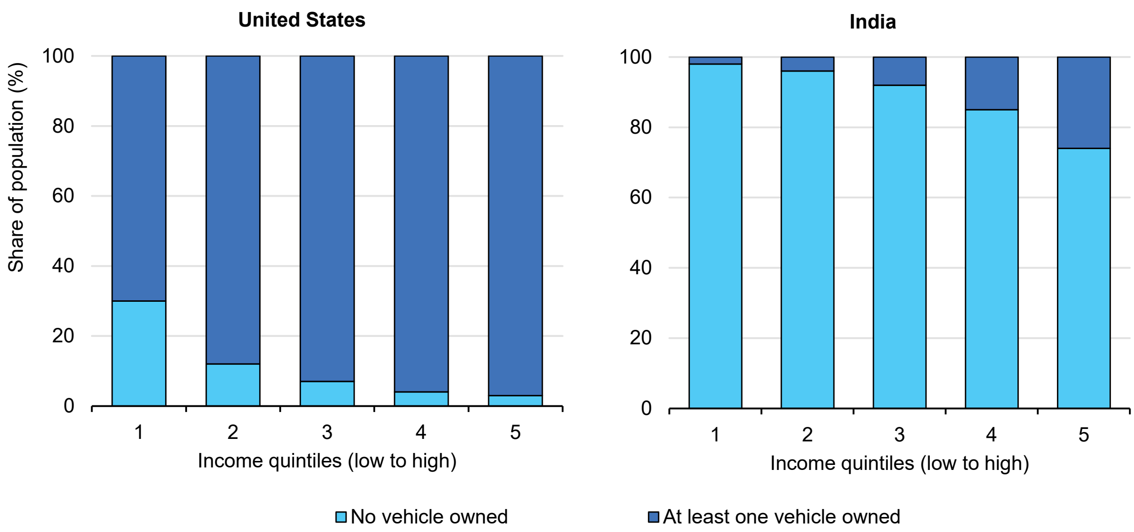
In EMDEs, households travel less than in advanced economies. For example, the lowest-income households in advanced economies still travel more than two-thirds what households in EMDEs via private motorised transport do. Within EMDEs, higher-income households spend much more on transport than lower-income households, both in absolute terms and as a share of their income.

For households using private transport, fuel efficiency is an important driver of transport-related energy expenditure. For example, the annual fuel costs of an efficient internal combustion engine (ICE) car can be half that of a similarly priced inefficient model. However, lower-income groups in both advanced economies and EMDEs have a lower level of private car ownership, as the purchase and fuel costs of private transport constitute important barriers to access.

In OECD countries, higher-income households are over 10% more likely to own a car than lower-income households are. For example, in the United States, where average private car ownership and use are relatively high, nearly one-third of households in the lowest income quintile do not own or lease a private vehicle. In India, almost none of the households in the lower income quintiles own a private car, but ownership levels of private scooters or motorbikes are higher.

For these lower-income groups, public transport modes such as buses are important to provide access to affordable mobility. For example, the lower-income groups in OECD countries were found to use public transport more frequently than higher-income ones did and were often dependent on public transport for daily travel. Public transport can reduce households' overall transportation costs, but in many lower-income areas, the availability of accessible public transportation options is lower than in high-income areas, further exacerbating the transport affordability gap.

Household private car availability, by household income quintile, United States and India, 2023



Source: IEA analysis (2025) based on data from the US Bureau of Transportation Statistics 2023 and India Household Consumption Expenditure Survey (2022-23), National Sample Survey Office.

In major emerging markets, electric two-wheelers are an affordable entry point into private transport

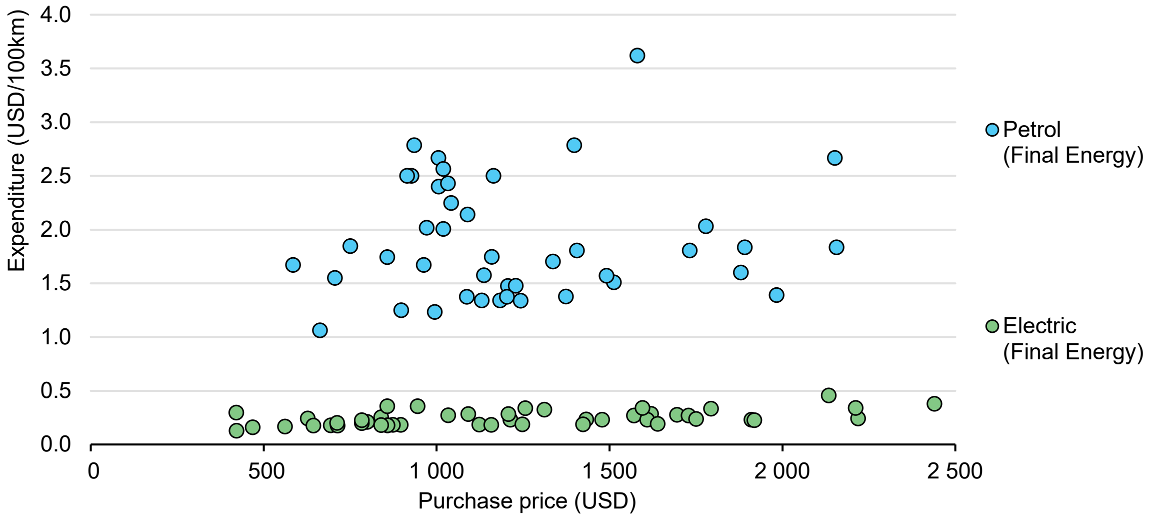
Ownership of electric cars in many countries is still largely limited to high-income households, given the high upfront costs and price premium over ICE models.

Flat-rate grants have often also been taken up by more higher-income households than lower-income ones, further exacerbating the gap in access to electric mobility.

The trend differs somewhat for electric two-wheelers, which are a more affordable entry point to electric mobility and require less energy to operate. New IEA analysis shows that in major two-wheeler markets (China, India, Indonesia and Viet Nam), electric two-wheelers can be purchased for a similar price to petrol alternatives but cost three to five times less to run. Furthermore, electric two-wheelers often do not rely on complex charging infrastructure, as removable batteries allow users to charge at home. This can increase access to affordable private transport for lower-income households.

Despite the affordability advantages of two-wheelers compared to cars, ownership is still often higher for higher-income households than for lower-income ones. For example, around two-thirds of households in urban areas in the highest income quintile in India own a scooter or motorbike, compared to one third in the lowest income quintile. This is also true for electric two-wheelers. However, the energy cost advantages and increasing availability on the market have been driving up sales in recent years.

Energy expenditure and purchase price of common petrol and electric two-wheeler models, China, India, Indonesia, and Viet Nam, 2025



Note: For electric models, energy use was estimated based on declared range and battery capacity. The analysis assumes the following gasoline prices (in USD/kWh): India, 0.13; Viet Nam, 0.093; Indonesia, 0.090; China, 0.123. And for electricity (in USD/kWh): India, 0.77; Viet Nam, 0.080; Indonesia, 0.091; China, 0.074.

3.2 Policy trends

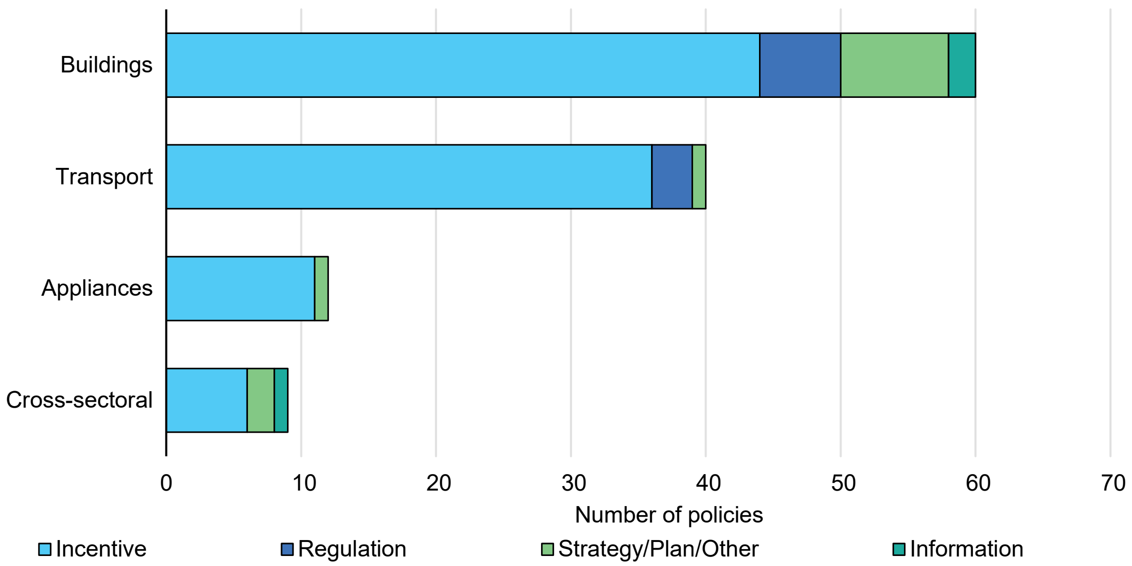
Over 120 demand-side policies addressing affordability were announced in 2025, according to the new IEA Energy Affordability Policy Tracker

Governments have been implementing a variety of policies to enhance energy affordability around the globe. In 2025 alone, governments introduced over 120 new or updated energy policies that explicitly mention energy affordability as an objective, according to the new IEA Energy Affordability Policy Tracker. These policies are spread across over 45 countries, together accounting for about half of global energy demand.

Countries have historically used supply-side policies to improve energy affordability, such as lowering energy costs through components of the energy bill. More recently, policy trends have been designed to address energy affordability from a household energy consumer perspective, as shown in this IEA analysis.

According to the analysis, 75% of the affordability policies implemented in 2025 were incentives, such as economic support for home retrofitting; regulation accounted for 12%, and strategy-wide policies, such as national targets and strategies linked to energy affordability, for 11%. Two per cent of the tracked policies in 2025 focused on providing information to help consumers.

Number of new or updated energy affordability-related policies by type, 2025



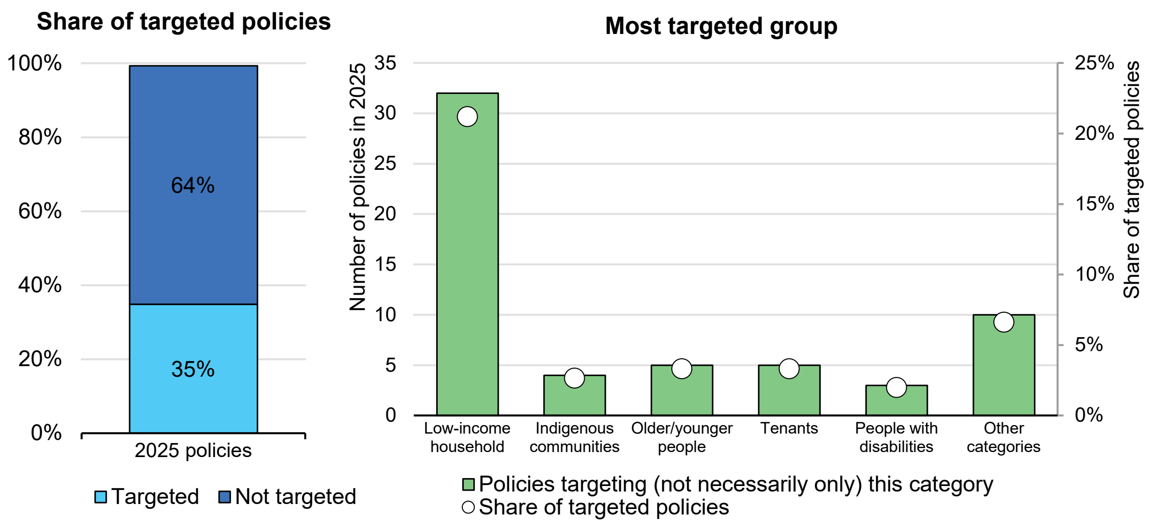
Note: The policy tracker compiled policies announced, updated, or put in place in 2025 that aim to support households in affording energy expenditures, enable households to meet their basic energy needs, improve homes' thermal performance, ensure access to modern energy services and facilitate the transition to e-mobility.

Only one-third of demand-side affordability policies in 2025 targeted the households that need it most

Designing policy support in an inclusive manner can ensure that support is accessible to all social groups, particularly lower-income households and rural communities that may face barriers to accessing energy-efficient technologies or adopting low-carbon transport options. While many countries have been supporting consumers financially, in many cases, these policies are not targeting those in greatest need.

Of all the new and updated demand-side energy affordability policies in 2025 identified in the IEA Energy Affordability Policy Tracker, just over one-third specifically targeted lower-income households or other vulnerable groups. As a result, two-thirds of policies to support household energy costs were not targeted to specific groups in need and benefitted households that might not have the most urgent energy affordability concerns.

Share of targeted demand-side energy affordability policies (left) and most-targeted consumer groups (right), 2025



Note: Other categories include large families, families with multiple children, veterans and rural communities.

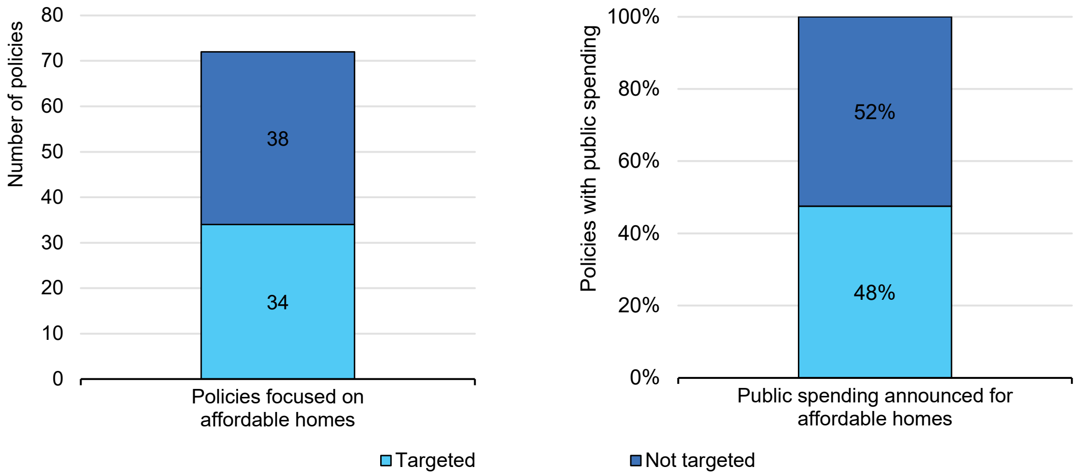
Countries most often use income levels to differentiate policy benefits across population groups. For example, policies may direct benefits to households with incomes below a certain threshold. Other groups, such as indigenous communities, young or older people, or tenants, were also targeted but in a lower proportion.

Addressing energy poverty effectively requires targeted policies

Governments can enhance energy affordability in homes by helping households access building energy retrofits or more efficient equipment and appliances. Of all the new and updated energy affordability-related policies tracked in 2025, three-fifths address household energy costs specifically related to home energy use. These demand-side policies support multiple measures simultaneously: accelerating retrofits to reduce cooling and heating demand; electrifying heating systems; and promoting efficient appliances. This enables households to increase home comfort and afford energy expenditures.

Even though lower-income households are most at risk of energy affordability issues, more than 50% of the affordability policies are not specifically targeted to these homes. Likewise, of all the public investments announced in 2025 for enhancing energy affordability in households, only half were part of a policy including a target related to those most in need. However, a large proportion of the policies lack spending details.

Targeted affordability policies focused on households (left) and share of targeted announced public spending (right), new and updated in 2025



Note: 21 policies did not include details on public spending. 48% of the announced spending is composed of policies including a target.

Home retrofit programmes

Households in poorly insulated homes often spend three times as much on energy as those in well-insulated homes, and energy-poor households often live in poorly insulated homes. As a result, these households stand to gain the most in terms of energy affordability from home upgrades. Providing a larger incentive to a smaller part of the population can improve energy affordability for larger numbers of at-risk groups.

In 2025, several governments put in place or announced targeted retrofit policies. Ireland set out new investments for home energy upgrades in its 2026-2030 Sectoral Capital Plan within the National Retrofit Plan. The upgrades were made available to homeowners, communities and energy-poor households, with the aim of shifting energy use away from fossil fuels.

Similarly, the Czech Republic reopened the New Green Savings Programme for house renovations. The programme introduced advance payments for all applicants and low-interest loans for insulation projects, including preferential subsidies for seniors and low-income households. Few policies were however implemented in 2025 to support household retrofitting in EMDEs. One notable example was in Chile, which launched a pilot version of the My Warmth, My Home programme, financing efficiency upgrades, such as thermal insulation, to 100 social housing units. Despite the fact that few new policies were noted in 2025, several have been implemented in the past, such as China's National Energy Efficient Retrofit Programme from 2008, which supports households in hot-climate zones.

Promoting efficient appliances

Access to more efficient appliances can help low-income households increase their use of basic energy services and raise living standards. Accelerating access to efficient technologies can help households cope with high energy costs and achieve more comfortable homes. In Colombia, the government implemented the programme "Caribe, Change your Energy" that benefits households across the three lowest income deciles by replacing inefficient refrigerators, air conditioners, and lighting. This programme also includes an additional social component to provide capacity building on energy efficiency measures to 2 000 women.

Tracked policies also focused on supporting homes to switch fuels, with consideration for their state of vulnerability. The Canadian Oil to Heat Pump Affordability program helps median- and below-median-income homeowners obtain upfront funding for the purchase and installation of a new electric heat pump. Korea extended the Grade 1 Appliance Refund Scheme in 2025 by adding new items and increasing subsidy rates. This programme targets vulnerable groups at higher rates, including low-income households, people with disabilities, veterans' large families, and families with multiple children.

Renters and apartment owner associations

Affordable energy household policies can also include special considerations for renters. Low-income households are less likely to be homeowners, which can limit their decision-making over home improvements. Policies can also help apartment associations in vulnerable areas access funds. For example, the Canada Greener Homes Affordability Program is providing CAD 800 million (c. USD 600 million) from 2025 to 2029 to deliver fully-funded energy retrofits to low- to median-income households, including renters with landlord consent.

Similarly, Estonia approved a new round of renovation grands for apartment buildings, with EUR 80 million in funding available from autumn 2025. Apartment associations can apply for 30–50% support depending on building location and renovation type, with higher rates for low-value areas, smaller buildings, heritage properties, elevator installation and factory conversions. Countries can also help renters by requiring owners to upgrade homes. France, for example, prohibits the renting of properties with poor energy ratings (‘G’ or below) under the recent Energy Performance Certificate Regulations. Landlords must undertake necessary renovations before leasing their properties.

Off-grid and distributed generation

Enhancing households’ access to electricity through off-grid solutions or supporting those with greater constraints through distributed generation can help households secure basic energy needs. For example, UNEP’s United for Efficiency (U4E) and Nigeria’s Rural Electrification Agency (REA) announced the deployment of energy-efficient off-grid refrigeration solutions in rural communities in 2025. This project seeks to address the lack of sustainable cooling for food preservation, healthcare and economic development in vulnerable communities.

The Colombia Solar Program aims to gradually replace electricity subsidies for low-income households with solar self-generation systems, enabling vulnerable families to cover basic energy needs and cut their bills by an estimated 20-40%. Likewise, in Mexico, the "Sol del Norte" programme aims to install photovoltaic systems in the homes of vulnerable families to reduce electricity costs, reaching an average annual savings of 67% (up to 89% in summer and 49% in winter).

Clean cooking policies

As lower-income households rely on traditional fuels for cooking four times more than higher-income households, well-targeted policies should be designed to close this gap and improve indoor air quality in homes. In 2025, India extended its Pradhan Mantri Ujjwala Yojana (PMUY) targeted subsidy programme to provide clean cooking fuel to poor households. The programme ensures that families previously dependent on traditional fuels like firewood or kerosene have access to LPG (liquified petroleum gas). Over 100 million connections have already been made.

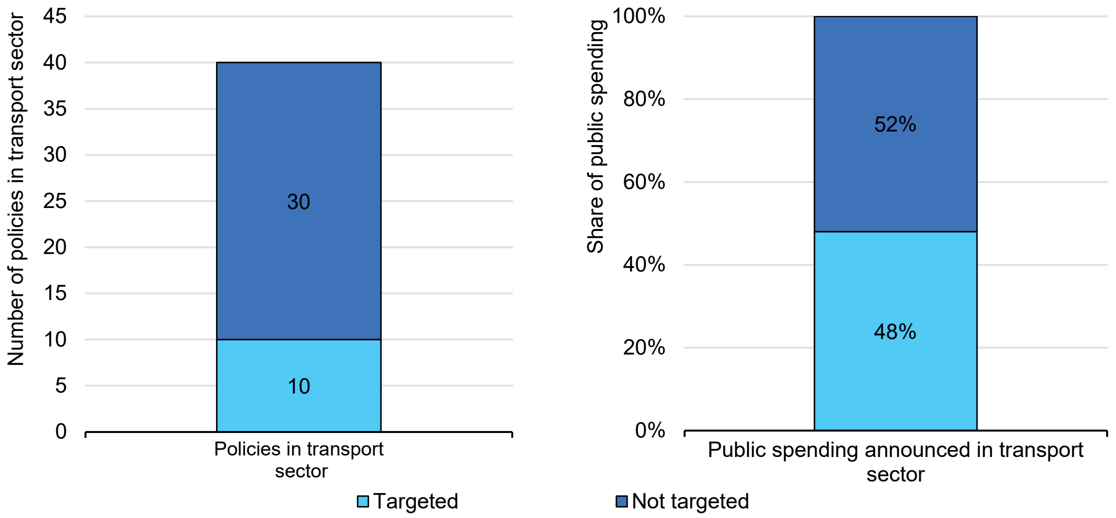
In Mexico, the Efficient Wood Stoves for Well-being Programme undertakes the replacement of traditional wood-burning stoves with more efficient, durable and economical stoves. The project aims to install one million stoves in rural homes, with a particular focus on indigenous communities.

In the transport sector, only 25% of tracked affordability policies target people most in need

For affordability reasons, lower-income households are more likely to rely on public transport. Policies that promote affordable public transport are essential to increase access to reliable travel options for those who are less likely to own a private vehicle.

However, in 2025, governments' affordable energy policies in the transport sector are focused primarily on promoting private electric mobility, including support for the purchase of electric vehicles and charging infrastructure. Less than 10% of the policies in 2025 focused on promoting public transportation. Moreover, IEA analysis found that just one in four energy-affordability-related policies in transport was specifically targeted at lower-income groups and other vulnerable households. This is lower than in the buildings sector, where just under half of all policies tracked in 2025 were targeted towards vulnerable groups.

Targeted affordability policies focused on the transport sector (left) and share of targeted announced public spending (right), new and updated in 2025



Note: Six policies did not include details on public spending.

The share of public spending on targeted energy affordability policies in transport – as opposed to the number of policies – is similar to that in the buildings sector, with around 48% of funds allocated to policies that include targets for vulnerable groups. It follows that more than half of public spending on household energy affordability in the transport sector does not take into consideration the vulnerability of the household. This is relevant, as data show that those with higher incomes are benefitting predominantly from these countries' efforts to increase household affordability.

Further analysis is needed on the role of national governments in providing real support to those who need help in affording energy, not only in the home but also in the mobility sector. Improving access to affordable clean mobility benefits low-income individuals by connecting them to job opportunities and basic services, such as healthcare visits and education, and by connecting remote or marginalised areas to the rest of the city, thereby reducing inequalities.

Demand-side energy affordability policy measures do not necessarily require large public spending

Not all governments have the fiscal capacity to finance large incentive programmes, such as fully-funded retrofits, to address energy affordability. There are, however, demand-side policy instruments that require less-direct public spending. Regulation is an effective way to promote more efficient buildings, appliances, and vehicles, lowering the energy costs for all households – or for a specific sub-group. For example, several countries have announced energy performance standards for rental homes or social housing. In 2025, the Netherlands launched a consultation on regulation requiring owners of rental homes with an energy performance rating of E, F, or G (the most inefficient) to retrofit their buildings to at least an energy label D by 2029. Similarly, England launched a consultation in 2025 on minimum energy efficiency standards for social housing buildings.

Another policy is an energy efficiency obligation scheme whereby the government mandates energy suppliers to achieve savings in the homes of their end users, with the costs being shared across all ratepayers. In 2025, at least five countries had targets for low-income households or other vulnerable consumers in their obligation schemes. For example, France has targeted low-income households since 2015, and from 2015-21, the benefits received by low-income households were higher than those of the average household. Another example is the Brazilian Energy Efficiency Program, which generated more than USD 700 million of investment in energy efficiency improvement measures from 2020 to 2024. Of this, 30% was allocated to low-income consumers.

Some governments have set up funds to pay for targeted measures, which are financed through contributions from suppliers under an energy efficiency obligation scheme. For example, Spain's Energy Efficiency National Fund uses supplier contributions to finance efficiency measures, mainly in low-income households. Similarly, Peru's Social Inclusion Energy Fund (FISE) provides vulnerable households with discount vouchers for liquefied petroleum gas, lower electricity tariffs, and solar PV. It is financed by charging large electricity users and aims to provide over 1.7 million households with low-cost energy. These schemes can unlock significant funding but require careful design in terms of distributional effects to ensure that the costs are spread fairly across consumers.

Chapter 4. Measuring energy poverty and affordability, and their impacts on health and education

4.1 Measuring energy poverty and affordability

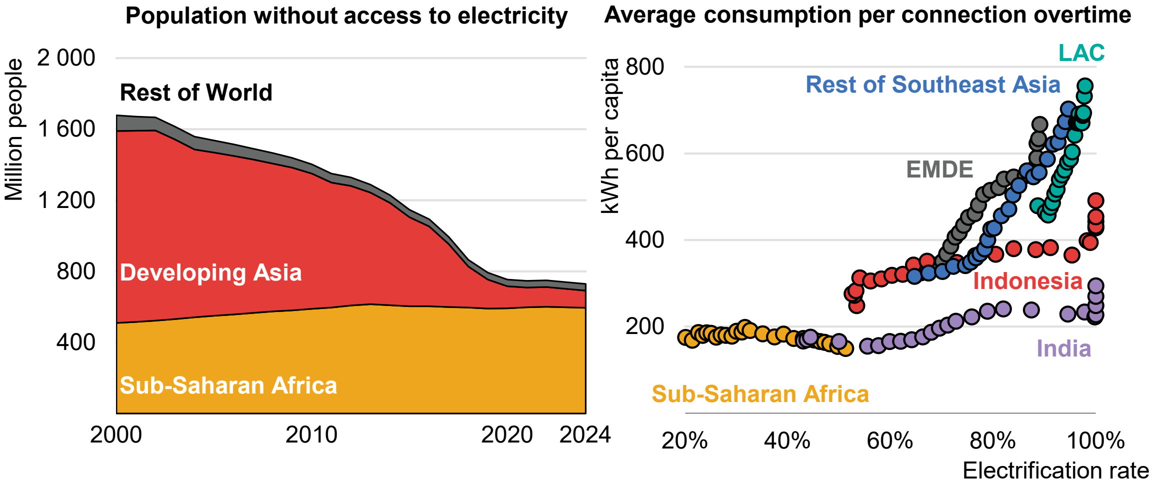
Aligning energy access and affordability goals is essential to enable meaningful energy use

Energy affordability challenges can affect households in different ways. Some households experience affordability pressures when a significant share of their income goes to covering energy costs. Others are simply not able to physically access or afford to meet their basic energy needs and are considered energy poor.

Today, around 730 million people worldwide still lack access to electricity, eight out of ten of whom live in sub-Saharan Africa. Although important progress has been made globally over recent decades, access to electricity now stagnates and affordability challenges risk undermining further gains from expanded access. Recent IEA analysis indicates that of the nearly 600 million people in sub-Saharan Africa who lack access to electricity today, around 40% would be unable to afford basic electricity services (5kWh/month) if they were available.

As countries develop and access expands, household electricity use typically increases. However, improvements in access alone do not necessarily translate into meaningful energy use if broader affordability challenges are not also considered. In sub-Saharan Africa in particular, despite significant progress in electrification, average residential electricity demand from households with access has declined over the past decade. Rising costs of electricity, partly driven by increasing electricity tariffs in many African countries, have reduced households' ability to afford the energy they need, resulting in a decrease in consumption.

Population without access to electricity and average residential consumption per connection by region, 2000-2024



Notes: LAC = Latin America and the Caribbean; EMDE = Emerging market and developing economies.
For households with access, average residential electricity consumption per connection varies widely across regions reflecting differences in ownership of appliances, fuel affordability and supply reliability.

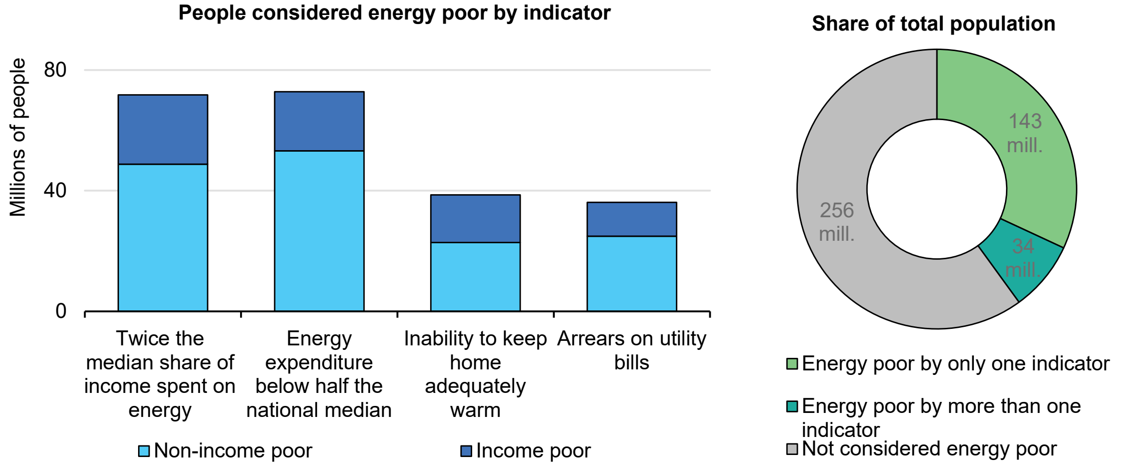
In both advanced economies and EMDEs, many households who have electricity access consume less than they need or face a trade-off with other essential expenses such as food or healthcare. Assessing how energy affordability challenges manifest across populations is important for policy makers to design effective interventions.

Energy affordability challenges affect households across income levels, requiring multiple indicators to capture them

As examined in Chapter 3, energy poverty is a multidimensional issue, shaped by many contextual factors such as a household's level of income, the quality of the building in which it lives and external socio-economic drivers. Research shows that while households in the lowest income deciles are often energy poor, a significant segment of the population which experiences challenges in affording energy, and may be considered energy poor, is not necessarily income poor.

As a result, there is no single measure that can be used to fully reflect the share of the population which can be considered energy poor. Assessments can be based on whether households spend large shares of their income on energy bills, consume too little energy to meet their needs, report being unable to warm their homes, or face utility debts. These indicators do not necessarily capture the same population segments. In the EU, for example, very few people face all four challenges at once, and those who do are all income poor. On the other hand, 40% of the population experiences at least one of them. This represents nearly 180 million people who, for the most part, are not income poor.

Population experiencing energy poverty and income poverty per energy poverty indicator in the European Union, 2024



Notes: Income poor is defined as people whose disposable household income, adjusted for household size, is less than 60% of the national median income.
Source: IEA analysis based on Maier, S. and I. Dreoni (2024), Who is "Energy Poor" in the EU? (Sevilla: European Commission).

Combining self-reported metrics with expenditure metrics helps provide a fuller picture of energy poverty than using each indicator in isolation. For example, a metric based on high energy spending alone may not capture households with constrained budgets who deliberately restrict their energy use to keep costs down. While a metric based on low energy consumption helps capture those households who consume less than the average, it may be skewed by those who live in more efficient homes. The self-reported metric pertaining to the household's ability to keep warm indicates whether thermal comfort needs are being effectively met. The intersection of these indicators helps identify particularly vulnerable populations who face multiple challenges simultaneously.

While tracking multiple energy poverty indicators can be costly and complex, practical solutions are emerging. Several countries have put in place energy poverty observatories that centralise data which is already collected by utilities, social protection agencies and statistical offices, thereby reducing data fragmentation while providing a wealth of information in a cost-effective way. For example, Brazil set up an Observatory on the Eradication of Energy Poverty in 2025 which groups regional and national-level agencies' data so as to cover a broad range of energy poverty indicators related to energy spending, consumption and household ownership of appliances. Similar initiatives have been implemented in France, Ireland and Portugal.

4.2 High energy bills are not the only way in which affordability affects households

A systematic review of the literature shows that households' ability to afford energy can negatively impact health and educational outcomes, by exposing people to illness risks, hindering productivity levels, reducing study time, and hampering the ease of access to and quality of learning. Recognising the links between energy affordability and key issues such as health and education can assist policy makers in addressing these impacts, which are often treated separately. The impacts of energy affordability on health and education, as well as examples of policy interventions, are explored here.

4.2.1 Energy poverty and health

Globally, energy poverty is associated with higher reported probability of poor physical and mental health. This can increase the need for medical interventions, which can add to the financial burdens faced by households, especially in the lower-income deciles. It also means higher costs for governments financing the delivery of health services. Identifying energy poverty as a driver of health outcomes can facilitate the targeting of affected households and, at the national level, create opportunities to reduce public health expenditures through cross-sectoral interventions.

A review of 45 academic studies on energy efficiency interventions in buildings found that 90% of these studies reported that such measures led to positive health impacts. According to a study, energy policies delivering deep renovations can lead to a 30% reduction in the mortality rate of people over 65 who have a history of cardiovascular hospitalisation. Targeting the most vulnerable populations, such as the elderly, children and low-income households, allows policy makers to fully capitalise on the health benefits of energy policy.

An important area of focus for governments is the increased risk of illnesses and deaths associated with exposure to temperatures that are too high or too low. From 2000 to 2019, temperature-related mortality represented around 9.4% of global annual deaths. Whether households can afford to live in efficient housing or purchase and run the energy technologies needed to adequately heat or cool their homes has implications for their health.

Energy affordability challenges expose millions to cold-related health risks

Exposure to the cold is the leading cause of temperature-related mortality globally, and is estimated to result in 4.5 million deaths each year. Excess winter mortality largely reflects deaths from cardiovascular and respiratory conditions exacerbated by prolonged exposure to cold indoor environments. In the European Union, where 90% of temperature-related deaths are attributable to the cold, the share of households reporting that they are unable to keep their homes adequately warm rose from an average of 6.9% in 2021 to 9.2% in 2024.

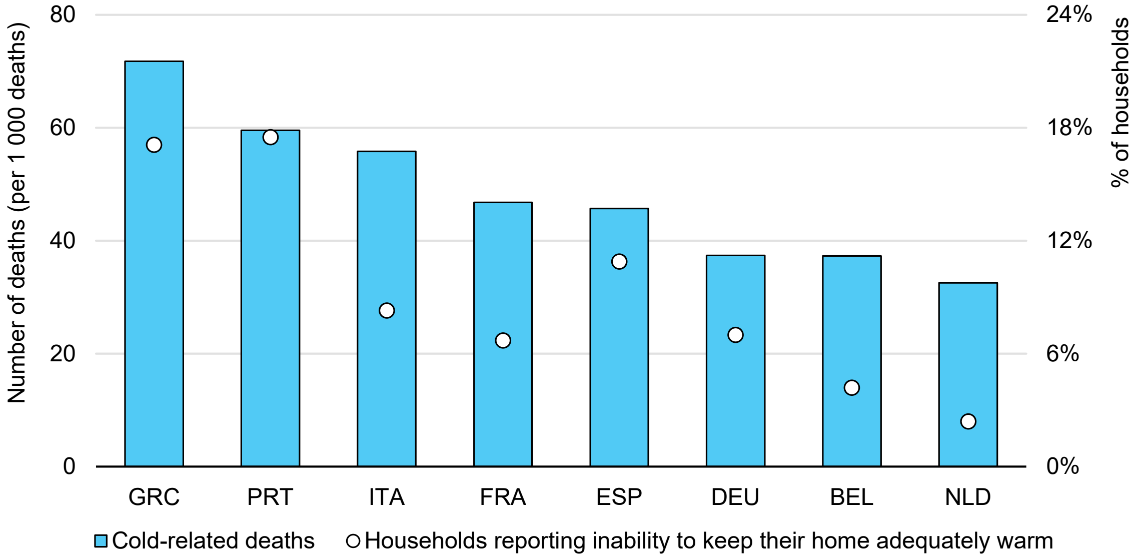
Energy poverty has been consistently associated with excess winter mortality in the region. This excess is better accounted for by structural factors such as the overall quality of the building stock and the vulnerability of households to energy prices than by cold temperatures alone. As such, European countries with higher energy prices, lower levels of housing efficiency, and higher levels of income poverty experience higher energy poverty, which is connected to increased mortality.

In addition to deaths, exposure to cold can lead to significant costs for households and society, especially in terms of increased medical expenses due to illness. IEA analysis based on Eurofound research finds that the inability to keep homes warm is associated with around USD 7 billion in direct healthcare treatment costs for households due to higher medication costs and more frequent medical visits including hospitalisations. An additional USD 121 billion in broader societal costs are estimated to be generated by indirect impacts such as reduced productivity, lost working days and reduced well-being. These estimated costs reflect what society loses when people are not able to work, earn, or consume and how society values these negative impacts in monetary terms.

Improving the energy performance of a home can prevent these adverse health outcomes. Research suggests that the cost of improving buildings to avoid excessive cold in homes is often lower than the associated health-related savings: for example, evidence from several advanced economies indicates that every USD 1 spent on building improvements can generate as much as USD 2.5 in societal health-related cost savings, although these estimates vary across countries.[1]

[1] Different studies estimate health-related savings from housing retrofits using diverse methodologies. For example, evaluations from programmes in France, the United Kingdom and New Zealand typically find returns of wider societal health-related benefits, such as direct healthcare and wellbeing improvements as well as avoided productivity losses and reduced premature mortality, ranging from USD 1.6-2.5 per USD 1 invested. These estimates also depend on national healthcare cost structures and price levels.

Cold-related mortality and households reporting inability to heat their homes adequately in selected EU countries, 2020



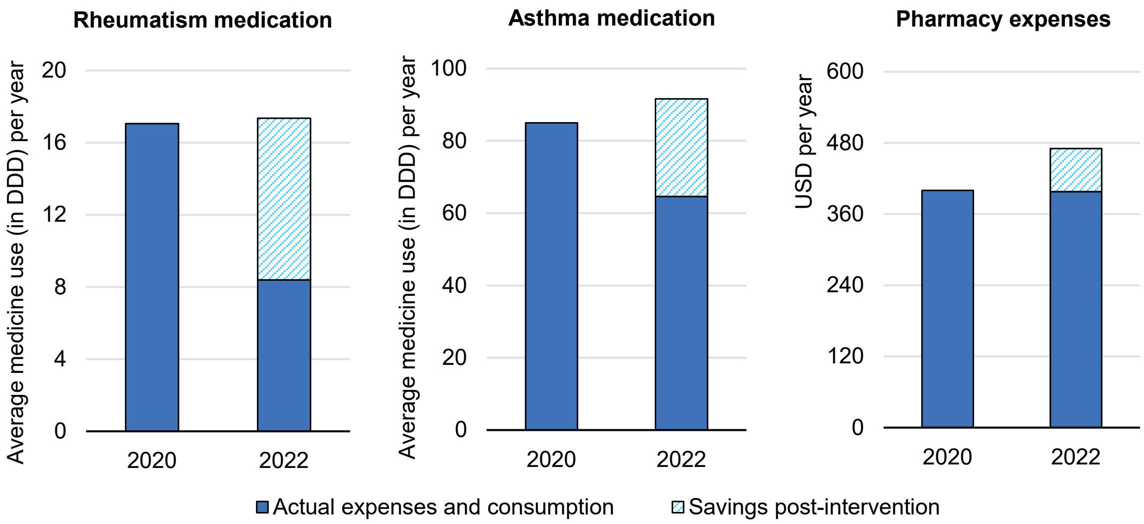
Notes: The country abbreviations represent Greece, Portugal, Italy, France, Spain, Germany, Belgium, and the Netherlands.

Source: IEA analysis based on temperature-related mortality data from David García-León et al. (2024) *Temperature-related Mortality Burden and Projected Change in 1368 European Regions: A Modelling Study*. The Lancet Public Health, vol. 9, no. 9, 2024, pp. e644–e653. Data on households reporting an inability to keep their home adequately warm are sourced from EUROSTAT.

Given the relationship between energy poverty, housing quality and health, interventions that improve energy efficiency and housing quality are an important consideration for governments. In the Netherlands, for example, where dwellings are ranked from A to G based on their overall energy performance, low-income households who live in homes with poor energy labels (F&G) incur healthcare costs that are 5% higher than those living in homes with good energy labels (A&B) because they fall ill more frequently. Those who restrict heating consumption have the highest medical bills. In fact, Dutch households reporting that they turn off the heating to reduce bills face 24% higher medication costs and 40% higher hospital costs than households who do not adjust their behaviour in this way.

Innovative policy design can help target particularly vulnerable populations that experience illnesses related to energy poverty factors. Between 2020 and 2022, households participating in the Energy Helpers programme in the Netherlands, which delivers low-cost energy saving advice through home visits, recorded a 50% decline in rheumatism medication and a 30% decline in asthma medication. The programme has reached 6 000 households since it started. In Ireland, a pilot scheme has been designed to have healthcare professionals prescribe home retrofits to households at risk of energy poverty who have members living with chronic respiratory illnesses. This helped deliver targeted interventions to increase their in-home temperatures and improve the quality of the housing generally. In the two years following the start of the programme, participants reported greater thermal comfort, less difficulty paying bills, and a decrease in medical visits, hospital admissions and respiratory issues.

Impact of the Netherlands' Energy Helpers programme on household medication use and expenses, 2020-2022



Notes: Post-intervention savings are calculated as the difference between projected expenditures and consumption in the absence of the intervention and the actual expenditures and consumption observed in 2022. Average medicine use is based on the World Health Organization (WHO) definition of the Defined Daily Dose (DDD), which represents the assumed average maintenance dose per day for a medicine used for its main indication in adults and is typically expressed in milligrams or equivalent units.

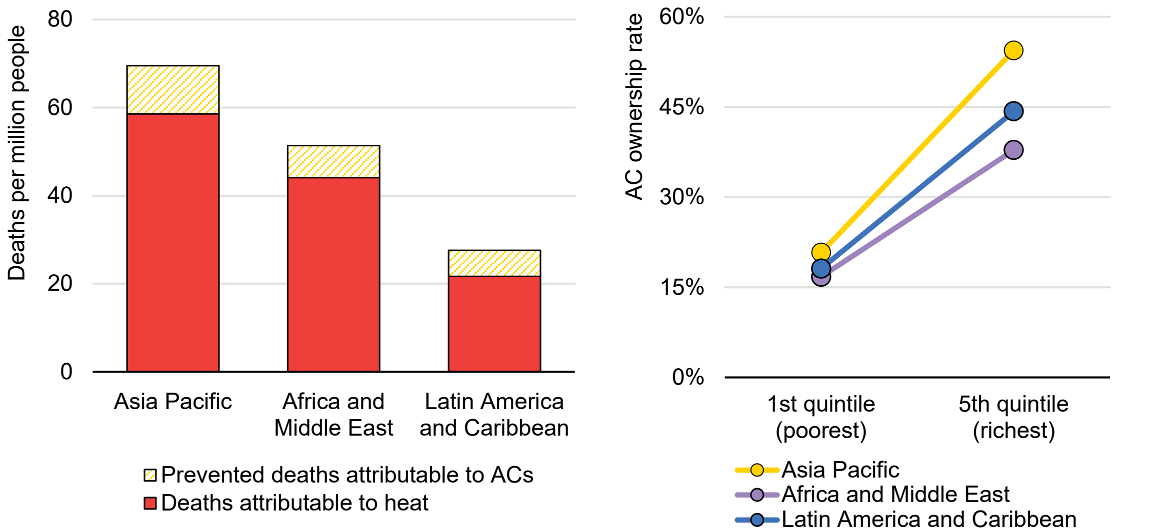
Sources: IEA (2025) analysis based on data from a Quantitative and Qualitative Analysis of the Effects of Energy Help on Households by the Netherlands Organisation for Applied Scientific Research (TNO).

Unequal access to affordable cooling has a significant impact on heat-related mortality

While the leading cause of temperature-related deaths is excessive cold, heat is a growing concern in many regions. Globally, the exposure of vulnerable populations, including children and elderly people, to dangerous heat has increased fourfold over the last twenty years. While Asia accounted for more than half of all heat-related deaths worldwide between 1990 and 2021, Africa experienced the highest average yearly death burden relative to population size. In 2025, Africa and Southeast Asia also experienced the highest global rates of exposure to heatwaves by vulnerable groups. Across the world, densely populated urban areas face a growing risk which disproportionately affects lower-income and vulnerable residents such as the elderly. In Europe, nearly 16 500 excess heat deaths were recorded across 854 cities in 2025, while New York City reports over 500 heat-related deaths each summer on average.

Access to cooling technologies, such as air conditioners, can significantly reduce risks of heat-related illnesses and deaths from high indoor temperatures. Over time, the increased ownership of air conditioners has prevented a significant number of deaths. Globally, 190 000 deaths were prevented each year between 2019 and 2021 as a result of access to air conditioning. However, cooling is not equally affordable to all. As of 2021, only around 15% of the 3.5 billion people living in hot regions[2] owned an air conditioner, with ownership concentrated among higher income populations. In 2020, in Africa, the Asia Pacific, Latin America and the Caribbean, and the Middle East, AC ownership among the richest households was roughly 2.5 to 3 times higher than among the poorest. It is important to note that many households rely primarily on fans and other lower cost or passive cooling solutions, which can also play an important role in reducing heat exposure.

Heat-related mortality and prevented deaths attributable to air conditioners (AC) in 2019, and air conditioner ownership by income quintile in 2020



Notes: The number of prevented deaths attributable to air conditioning was calculated based on the methodology outlined in Romanello, M. et al. (2024). The 2024 report of the Lancet Countdown on health and climate change: facing record-breaking threats from delayed action, The Lancet.

Sources: IEA analysis based on AC ownership data from G. Falchetta et al. (2024), Inequalities in global residential cooling energy use to 2050. Nature Communications, 15(1). Heat-related mortality was calculated based on data from the Institute for Health Metrics and Evaluation (IHME) dataset: Mortality Burden Attributable to Non-Optimal Temperature 1990-2019.

Several examples show that it is possible to deliver low-cost policy interventions for those exposed to high temperatures. In Rio de Janeiro's Parque Arará favela, a project installing lightweight green roofs reduces roof-surface temperatures by around 40% at roughly USD 1 per square foot, avoiding dangerous indoor heat for informal settlements. In India, over the past 15 years, the women-led Mahila

[2] A climate is assumed to be "hot" when, over an entire year, the total amount of heat above 10°C adds up to at least 5 000 degrees.

Housing Trust (MHT) has supported low-income households through multiple low-cost heat-resilience measures. To date, 30 000 homes and several public buildings including a health centre and two schools across 12 cities have benefited from solar-reflective roof and wall coatings, which can reduce indoor air temperatures by 2 to 5°C. Reported co-benefits included reduced heat stress, improved health and productivity, and lower reliance on fans or evaporative coolers and air conditioners.

Turning healthcare facilities into energy anchor loads can improve care and deliver affordable energy to communities

In 2023 WHO estimated that nearly 1 billion people living in EMDEs were served by healthcare facilities with unreliable or no electricity. This has consequences for access to and quality of care, as electricity is needed to provide lighting, power medical equipment and refrigerate vaccines and medication. In Ghana, mortality risk in healthcare facilities rises by 43% for each day with outages lasting longer than two hours. In India, national survey results show that unreliable power in public hospitals is associated with 64% fewer childbirth deliveries as women have to turn to private clinics and around 39% fewer patients can be taken in during the day or stay overnight. Studies show that improved access to affordable and reliable power can improve emergency care, reduce childhood mortality and also help attract and retain more skilled staff by improving their working conditions.

In many regions, expanding energy access is financially challenging because household electricity demand is low and payment capacity is uncertain, making it difficult to justify upfront investment in generation and distribution infrastructure. However, using healthcare facilities as energy anchor loads offers an innovative solution to overcome these constraints by structuring energy access projects around the large, predictable and continuous energy demand of hospitals and medical centres.

As reliable energy consumers, healthcare facilities provide a stable baseload of demand which helps reduce investment risk and improve the financial viability of grid extensions and decentralised energy systems such as solar mini-grids. This, in turn, allows energy providers to deploy systems at a larger and more efficient scale, lowering average supply costs and enabling electricity to be delivered to surrounding households at more affordable tariffs. At the same time, healthcare facilities benefit from improved energy access and reliability, reducing exposure to outages and energy-related disruptions to the delivery of care. In India, analysis suggests that using healthcare facilities as anchor loads for solar mini-grids can simultaneously enhance the financial viability of their deployment, decrease the price of energy by 14% to 22% for consumers in neighbouring communities by substituting diesel generators, and reduce the incidence of power outages at healthcare facilities, resulting in fewer energy-related disruptions to care-giving.

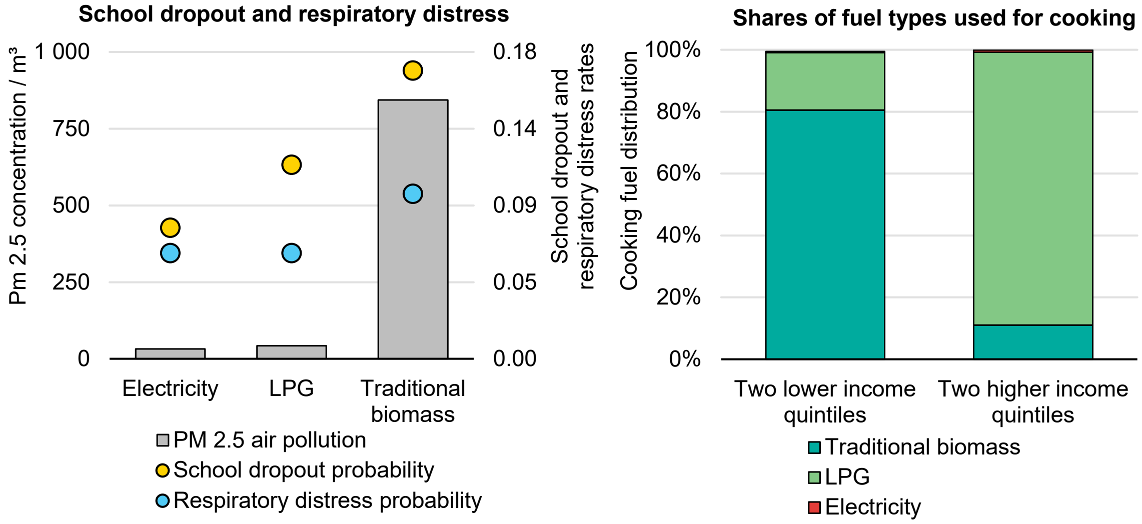
Lack of access to affordable clean cooking solutions results in premature deaths, poorer health, and is linked to lower educational attainment

In addition to thermal comfort, indoor air quality in homes, which is largely influenced by fuel choice for heating, cooling, lighting and cooking, has a significant impact on the health of households. Today, 2 billion people still lack access to clean cooking solutions globally, half of whom live in sub-Saharan Africa. The IEA's progress update on access to clean cooking estimates that in 2023, over 2.5 million premature deaths were caused by indoor air pollution largely resulting from a lack of clean cooking technologies. This disproportionately impacts women and children. According to the World Health Organization (WHO), exposure to smoke in enclosed kitchens more than doubles the risk of acute lower respiratory infections in children under five years old, and women exposed daily to indoor smoke are over three times more likely to develop chronic obstructive pulmonary disease and nearly twice as likely to develop lung cancer.

The costs of transitioning towards clean cooking solutions often prevent uptake. In sub-Saharan Africa, nearly two-thirds of households without access would need to spend over 10% of their disposable income in order to adopt clean cooking solutions. Using a 5% affordability threshold, this share rises to 80%. Even when households do have access to clean cooking, the high cost of using it may mean they continue using traditional fuels for some of their cooking. This is the case in many countries, where the reliance of some households on mixed fuels, mainly driven by cost factors, limits potential health gains that could be reaped from switching to cleaner fuels, as even partial reliance on traditional fuels sustains cumulative exposure to harmful pollutants.

IEA analysis based on national surveys from India shows that women using traditional fuels for cooking are more likely to experience respiratory issues than those using modern fuels. Children who live in those households in which traditional fuels are used are exposed to the same health risks also tend to have lower rates of school completion. This is especially true for lower-income households who rely on traditional fuels for cooking four times more than others.

Comparison of estimated impacts of different cooking fuel types on school dropout rates and respiratory symptoms by wealth group in India, 2019-2021



Notes: the school dropout and respiratory distress rates are computed with an electricity baseline which corresponds to observed mean school dropout or respiratory distress among electricity-using households, with adjusted differences for other fuels estimated using propensity-score matching, controlling for household size and wealth level, area of living, and children's age and gender.

Source: IEA analysis based on Demographic Health Surveys (DHS) household data for India (2019-2021).

A lack of access to clean cooking or heating not only causes respiratory infections, chronic inflammation and other negative health impacts but also hinders children's education (an issue discussed in more detail in the next section). In Uganda, one third of all school absences are attributed to respiratory infections linked to household air pollution. Moreover, in many emerging economies, much of the young students', especially girls', time is spent collecting burnable materials needed to cook the household's meals instead of studying at home. In Africa as a whole, the average amount of time that households spend collecting fuel and cooking is four hours each day. The daily gathering of fuels also increases physical fatigue, compounding students' health-related learning barriers.

4.2.2 Energy poverty and education

Energy poverty's overall impact on health and wellbeing can also affect educational outcomes and extend to households' economic opportunities. An analysis of over 33 studies across a decade shows that access to reliable and affordable energy in EMDEs results in higher school enrolments, more study time, and attainment of higher levels of schooling. In all, access to reliable and affordable energy improves educational outcomes by around 15%. It also tends to result in higher lifetime earnings and general improvement of living standards. A 2019 study based on Cambodia's Socio-Economic Survey shows that energy poverty reduced children's earning ability by up to 48% making them more susceptible to illnesses and frequent absences from school.

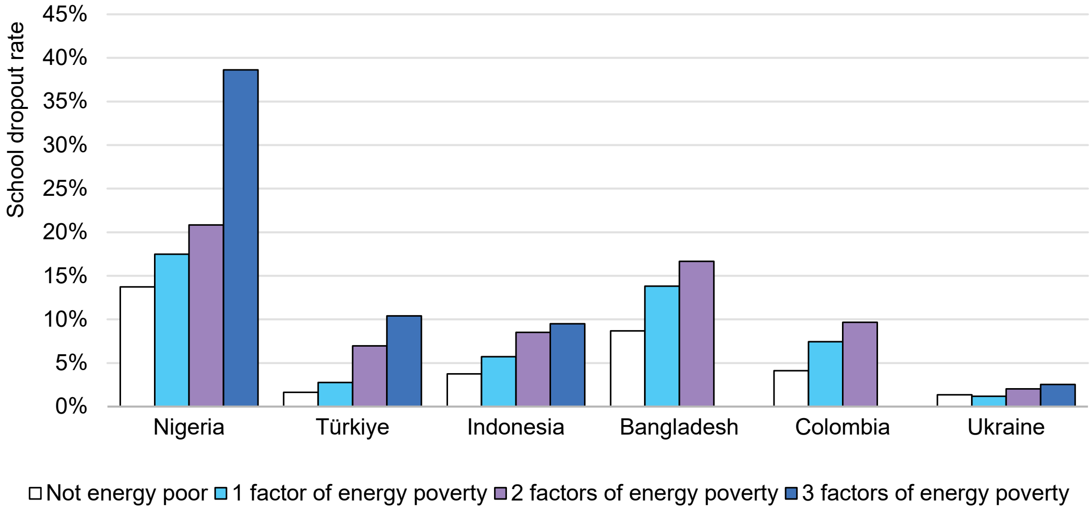
The impact of energy poverty on education is not limited to lower-income households. Evidence from New Zealand and Portugal shows that even among households in relatively higher-income settings, poor heating and lighting conditions lead to reduced concentration and more school absences.

Children living in energy poor households are more likely to drop out of school

Whether or not a home has adequate access to heating and cooling, or to lighting, can affect how children live and study. Evidence shows that dampness, mould, or inadequate heating and cooling systems in homes or schools, can cause illness and discomfort among students, reduce concentration levels, and cause higher absenteeism and likelihood to drop out of school.

IEA analysis of country surveys across several EMDEs finds that children who are more exposed to energy poverty have higher school dropout rates. In Nigeria, dropout rates are around three times higher for children facing three to four simultaneous energy poverty factors compared to those who live in energy secure homes. Similar patterns are observed in Bangladesh and Indonesia, and are consistent in countries with lower baseline dropout rates such as Türkiye. Households which lack modern appliances such as refrigerators, televisions, and computers consistently show the largest dropout rates across countries.

Relationship between school dropout rate and exposure to energy poverty in selected countries, latest year available per country (2015-2024)



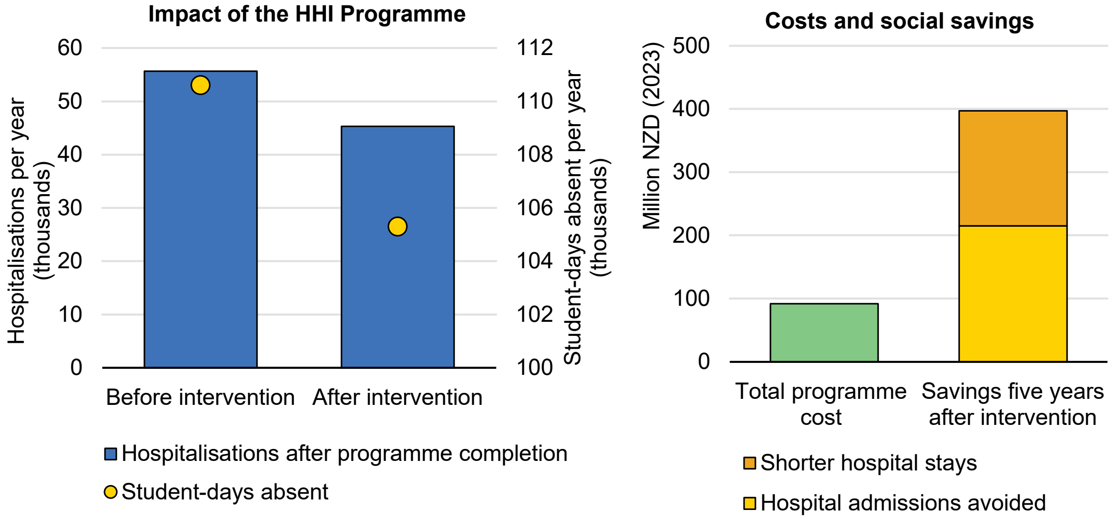
Note: Energy poverty dimensions are constructed from DHS household modules on cooking fuel, lighting source, heating fuel, cooling equipment and ownership of modern energy-related assets. A household is classified as energy-poor in a given dimension if it relies on non-clean fuels or lacks modern energy services. Analysis is computed among households having access to electricity. The school dropout rate encompasses children aged 6 to 17 years old.

Source: IEA analysis based on Demographic and Health Surveys (DHS) household data for Nigeria (2024), Türkiye (2018), Indonesia (2017), Bangladesh (2022) and Colombia (2015).

This trend is visible in advanced economies as well, including Ireland and the United States. Research in New Zealand has found that children living in underheated homes experience more asthma flare-ups, and that childhood asthma alone increases the probability of missing school by 10%.

Targeted housing and energy efficiency interventions can directly improve respiratory health and lead to fewer school absences. In the United States, families who moved into affordable housing certified with very high indoor environmental and energy design standards, including features meant to prevent asthma, reported fewer indoor respiratory irritants, resulting in fewer missed school days. In New Zealand, a study demonstrated that installing more effective home heating systems reduced winter school absences for asthmatic children by 21%, and insulating existing houses reduced the probability of at least one day off school by 51% compared to uninsulated homes. The Healthy Homes Initiative (HHI), a large-scale housing and energy-efficiency programme targeting low-income households in New Zealand which delivered interventions between 2014 and 2023, led to substantial reductions in hospitalisations and illness-related school absences five years after it started. The programme generated net savings for the public health system, which were four times greater than the original total cost of the programme.

Impact of the HHI programme on health and education outcomes and its cost and social value in New Zealand, 2014-2023



Note: The impact of the integrated HHI intervention is 18.6% reduction in hospitalisations. Integrated HHI intervention extends beyond insulation and heating alone to include ventilation and moisture control, housing repairs, household energy-use support and social service linkages. By contrast, insulation and heating alone are associated with an 11.8% reduction in hospitalisations. Hospital admissions avoided are valued by estimating healthcare costs avoided from fewer hospitalisations per year, valued at the average pre-intervention cost per admission. Reduced hospital severity is valued by estimating healthcare costs avoided due to lower average severity and shorter length of stay among post-intervention hospitalisations. Reduced school absenteeism is valued by estimating the social value of fewer student-days absent per year among students covered by the programme.

Source: IEA analysis based on data from Healthy Homes Initiative (HHI): Five-year outcomes evaluation authored by Nevil Pierse, Ellie Johnson, Amelia Guha Thakurta, and Elinor Chisholm from the University of Otago (2024), © Crown Copyright, licensed under CC BY 4.0.

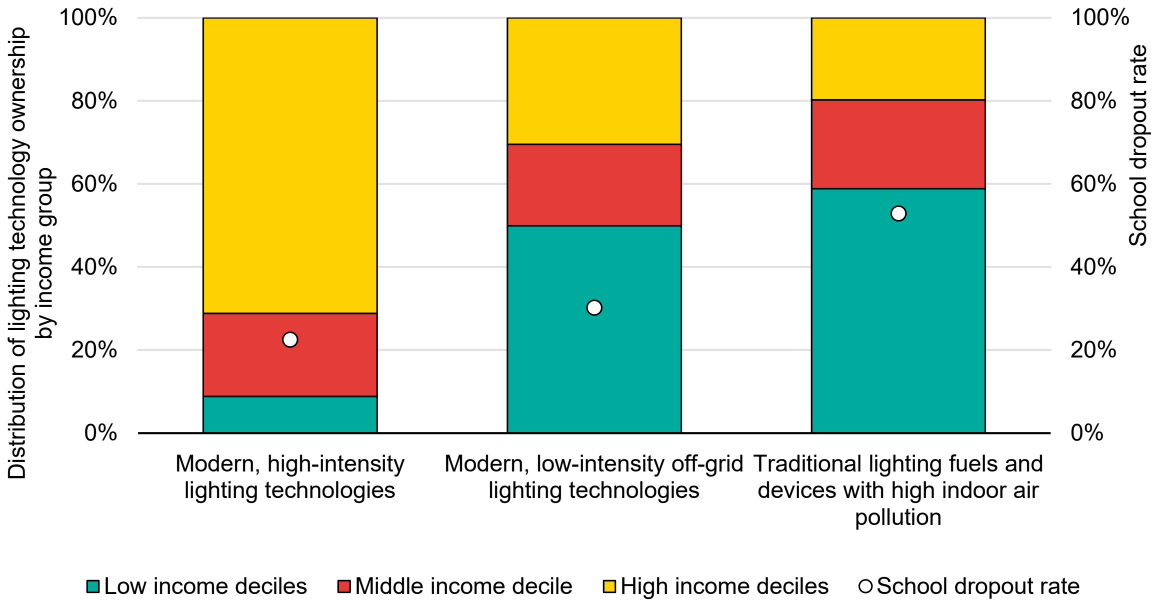
Access to affordable modern lighting enables greater study time at home

The ability to purchase and power technologies needed to study at home also matters. When households are unable to afford or access adequate lighting, this directly impacts the time students can spend reading or studying. A 2017 study carried out in Sierra Leone found that the majority of 800 students surveyed in schools cited electricity cost as a major barrier to studying at home, followed by poor lighting options. In rural India, the lack of access to electricity and adequate lighting in homes was found to reduce overall academic performance by limiting students' ability to study at night and increasing their reliance on kerosene lamps which are expensive and bad for their health. Evaluations of a programme distributing a million solar lamps in four states found that for 873 low-income participant households surveyed, study time increased by over 30%, with stronger outcomes for girls. The initiative which started in 2014, has since been expanded under different schemes providing over 6 million solar lamps for school children.

IEA analysis based on national surveys in Nigeria in 2024 estimated that after accounting for differences in household wealth, region and children's age and gender, children living in households using electricity for lighting were more likely to stay in school than children in households that relied on traditional fuels such as wood, charcoal or lamp oil for lighting. This puts children in lower-income households at a greater disadvantage as they rely on traditional fuels for lighting three times more than high- or middle-income households do. These lighting fuels are associated with a school dropout rate that is more than double that of children who have access to modern high-intensity lighting.

Energy policy tools such as energy subsidies and tariffs can be designed to deliver wider benefits for education. In South Africa, the government provides 50 kWh of Free Basic Electricity (FBE) per month to households who are unable to afford basic services. By ensuring that households can maintain basic electricity use throughout the month, the programme enables consistent indoor lighting and use of essential appliances. Over the last two decades, Brazil's Light for All programme has provided electricity to more than 16 million people in remote and isolated communities, including around 9 million low-income rural residents. The programme combines grid extensions with tailored off-grid solutions such as solar kits, supported by door-to-door identification of households without access and targeted electrification of schools, nurseries and health facilities. Improved access to lighting and basic appliances has translated into strong education outcomes with evening study time increasing by at least 40%, and the enabling of more than 300 000 women to start or resume their studies.

Estimated school dropout rate of children and type of fuel used for lighting by household income group in Nigeria, 2024



Notes: The estimated rate is computed with an electricity baseline which corresponds to the observed mean school dropout rate among electricity-using households, with adjusted differences for other fuels, estimated using propensity-score matching controlling for household size and wealth level, area of living, children's age and gender. Modern, high intensity lighting sources include electricity, solar lanterns and inverters. Modern, low-intensity off-grid sources include rechargeable and battery torches and biogas lamps. Traditional lighting sources include kerosene, gasoline, oil lamps, candles, wood, charcoal, crops and dung. The school dropout rate encompasses children aged 6 to 17 years old.

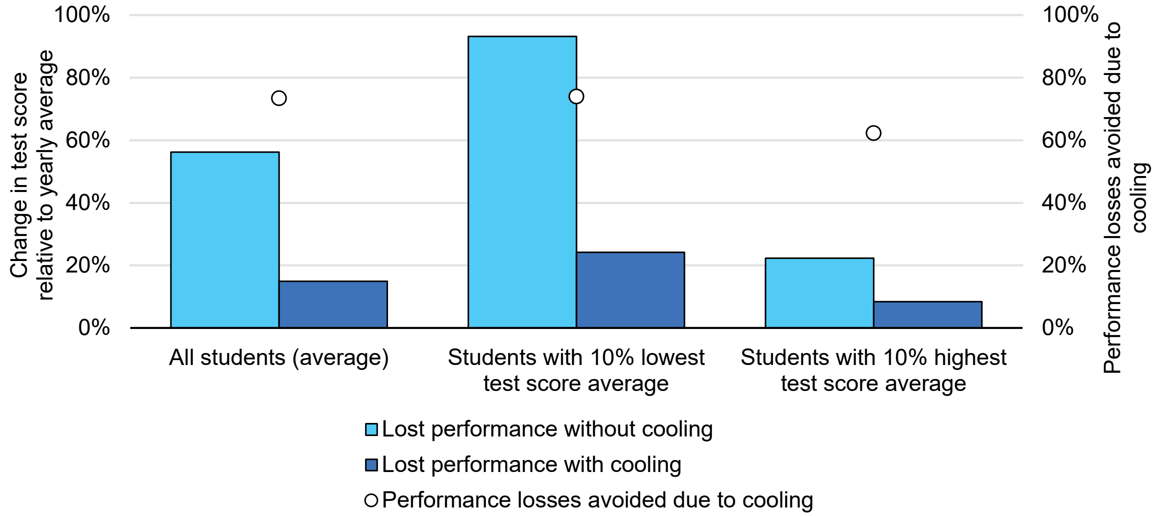
Source: IEA analysis based on data from Demographic and Health Surveys (DHS) household data for Nigeria (2024).

Adequate heating, cooling and lighting in schools are determinants of academic performance

While addressing household energy affordability is key to improving overall living conditions, directing interventions to reduce the cost of energy in educational infrastructure can help secure the delivery of learning at source. Today, over 200 million children in the world attend primary schools that do not have electricity.

Whether schools can access and afford the power they need to keep classrooms at adequate temperatures, provide adequate lighting and power digital equipment has a direct impact on students' attention and performance. Evidence from Japan shows that each day of extreme heat lowers students' exam performance, particularly among those with lower average test scores, and that school cooling infrastructure substantially reduces overall learning losses.

Heat-related exam performance losses and the mitigating role of school cooling in Japan, 2025



Notes: Change in test scores relative to yearly average refers to heat-related reductions in students' standardised exam performance in Japanese public schools, expressed as percentages of annual learning progress and interpreted as a decrease in the knowledge and skills typically acquired over a school year. Values shown are model-based estimates derived from published causal effects of extreme-heat exposure and are expressed as a share of annual learning progress by school cooling.

Source: IEA calculations based on data from M. Akesaka and H. Shigeoka (2025), *Hotter Days, Wider Gap: The Distributional Impact of Heat on Student Achievement*. SSRN Electronic Journal. This study analyses nationwide exam scores of approximately 22.8 million public-school students in grades 6 and 9 in Japan between 2007 and 2019.

Targeted energy interventions in schools, especially when integrated with energy efficiency measures, can generate multiple gains in a cost-effective way. In Tunisia, the installation of 140 photovoltaic panels and 50 solar water heaters in four boarding schools since 2012 has helped enable full energy self-sufficiency while generating surplus electricity, of which 70% is redistributed to three neighbouring schools and 30% is used to pay electricity bills. This shift, complemented by insulation measures that increased overall building efficiency, reduced energy expenditures on heating and lighting across the four schools and ensured continuous access to electricity and hot water, improving thermal comfort and hygiene for more than 570 students. In the coming years, the expansion of these interventions aims to benefit over 120 000 students across more than 550 schools.

Annex

Abbreviations and acronyms

AC	Air conditioner
AEs	Advanced economies
CfD	Contract for difference
CO_2	Carbon dioxide
DDD	Defined Daily Dose
DFI	Development finance institution
EMDEs	Emerging markets and developing economies
GCV	Gross Calorific Value
ICE	Internal combustion engine
LNG	Liquid natural gas
LPG	Liquefied petroleum gas
MER	Market exchange rate
OECD	Organisation for Economic Cooperation and Development
PPP	Purchasing power parity
SHS	Solar home systems
VAT	Value Added Tax

Units of measure

EJ	exajoule
Gt	gigatonne
Gt/yr	gigatonnes per year
Gt CO_2	gigatonnes of carbon dioxide
GWh	gigawatt hour
kW	kilowatt
kWh	kilowatt hour
mb/d	million barrels per day
MBtu	million British Thermal unit
Mt	million tonnes
Mtoe	million tonnes of oil equivalent
MW	megawatt
MWh	megawatt hour
PJ	petajoule
t CO_2-eq	tonne of carbon dioxide equivalent

See the IEA glossary for a further explanation of many of the terms used in this report.

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