International Energy Agency

Energy Efficiency 2020

Abstract

Energy Efficiency 2020 is the latest edition of the IEA's annual update on global developments in energy efficiency. Through analysis of energy data, policies and technology trends, it provides a comprehensive view of energy efficiency trends worldwide.

Energy efficiency plays an essential role in accelerating clean energy transitions and achieving global climate and sustainability goals. This year's report focuses on the impact of the Covid-19 pandemic on energy efficiency and global energy markets this year, as well as analysis of 2019 trends. By analysing the inclusion and impacts of energy efficiency in stimulus packages, the report also highlights the role of efficiency in supporting sustainable recovery efforts around the world by creating jobs and stimulating spending while reducing greenhouse gas emissions.

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Executive summary

Energy efficiency progress, already lagging, faces further setbacks from the pandemic

Since 2015, global improvements in energy efficiency, as measured by primary energy intensity, have been declining. The Covid-19 crisis adds an extra level of stress. As a result of the crisis and continuing low energy prices, energy intensity is expected to improve by only 0.8% in 2020, roughly half the rates, corrected for weather, for 2019 (1.6%) and 2018 (1.5%). This is well below the level needed to achieve global climate and sustainability goals. It is especially worrying because energy efficiency delivers more than 40% of the reduction in energy-related greenhouse gas emissions over the next 20 years in the IEA's Sustainable Development Scenario, which shows how to put the world on track to achieve international climate and energy goals in full.

Investment in efficiency is projected to fall 9% in 2020

Investments in new energy-efficient buildings, equipment and vehicles are expected to decline in 2020, as economic growth falls by an estimated 4.6% and income uncertainty affects consumer and business decision making. Sales of new cars are expected to fall by more than 10% from 2019, keeping the overall vehicle stock older and less efficient, although the share of electric vehicles in new car sales is anticipated to grow to 3.2%, up from 2.5% in 2019. In industry and commercial buildings, lower energy prices have extended payback periods for key energy efficiency measures by 10% to 40%, which reduces their attractiveness compared with other investments.

Changed mobility patterns are having huge impacts on energy demand and intensity

Travel restrictions and lockdowns are having major impacts on long-distance and urban transport. Transport sector energy consumption is projected to fall by 10% in 2020 compared with 2019, including an 11% drop in oil consumption of around 6 million barrels a day. This accounts for around two-thirds of the total expected decline in global oil demand in 2020.

The enormous drop in transport demand is also reducing aviation and rail passenger load factors (for example, to just 28% in April for international flights), increasing the energy use per passenger and kilometre travelled.

Without concerted efforts to bolster efficiency, energy intensity in industry may increase

Current conditions suggest industry is likely to become more energy intensive, as a higher share of manufacturing is claimed by upstream energy-intensive industries. For example, in Europe and the United States, automotive manufacturing – a less energy-intensive manufacturing process – was 30% lower year-on-year in the first half of 2020, while basic metals manufacturing – a highly energy-intensive sector – was around 15% lower.

Uncertainty about future revenue is likely to be leading businesses to reprioritise investments, with spending on efficiency measures facing pressure as energy prices remain low.

Efficiency measures in buildings face delays in some markets

Technical efficiency improvements in some markets have been delayed as lockdowns and physical distancing curtail building contractors' physical access to premises. Smart meter installations were 80% to 90% lower at the height of lockdowns in India and the United Kingdom but had returned to 2019 levels by the third quarter of 2020. Economic uncertainty could further delay investments in the buildings sector, with future growth projections for materials such as energy-efficient glass around 6% weaker than pre-pandemic projections.

Do-it-yourself renovations are up in some markets, however, which could boost the technical efficiency of residential buildings in the short term. In Australia, for example, insulation sales were 20% to 40% higher in the first half of 2020 than a year earlier.

Appliance efficiency is likely to improve in the short term

A bright spot for technical efficiency gains is the appliances sub-sector. Data through the end of the third quarter of 2020 indicate that the Covid-19 crisis has increased households' interest in new appliance purchases, with at least some appliances replacing older, inefficient models. Since the pandemic began, online shopping search indices were up by 20% to 40% for many appliance types worldwide, indicating that sales of appliances could be higher than usual. If these trends are confirmed, they would increase the technical efficiency of the global appliances stock.

Stimulus funding for actions to improve energy efficiency has been uneven so far

In all sectors, the design of government stimulus packages implemented as part of Covid-19 recovery policies will heavily influence technical efficiency by supporting investments in new stock, and structural changes. Both will affect energy intensity.

The IEA has tracked USD 66 billion of funding for energy efficiency-related measures announced as part of governments' stimulus packages to the end of October. A large share (USD 26 billion) has been allocated to the buildings sector – unsurprisingly, as investments in the efficiency of buildings are estimated to create around 15 jobs for every USD 1 million spent. Around USD 20 billion has also been announced to accelerate the shift to electric vehicles, including for new vehicle charging infrastructure.

Yet many opportunities remain untapped; IEA tracking reveals a spending imbalance across sectors. No announcements have been made to increase the penetration of super-efficient appliances, while spending on road vehicle efficiency beyond electric vehicles is minimal to date.

Announced spending on efficiency is also imbalanced on a regional basis. Spending announcements from European countries dwarf announcements from other parts of the world. Europe accounts for 86% of announced public stimulus funding for efficiency worldwide, with the remaining 14% split between the Asia-Pacific region and North America.

Increasing stimulus spending on energy efficiency could create millions more jobs

We estimate that the efficiency-related stimulus spending announced to date could generate the equivalent of 1.8 million full-time jobs between 2021 and 2023, nearly two-thirds of which would be in the buildings sector, 16% in industry and 20% in transport. Based on announcements made to date, over 80% of efficiency jobs are destined to be created in Europe, where most stimulus funding has been allocated.

However, the IEA Sustainable Recovery Plan, which was released in June 2020, suggests further economic recovery actions targeting energy efficiency could create nearly 4 million additional jobs globally through public and private sector investment in buildings, transport and industry.

The crisis is changing how we use energy in buildings ...

The buildings sector is witnessing a partial shift in energy demand from commercial to residential buildings, as social distancing and teleworking reduce use of commercial buildings and increase activities that use energy in the home. In the first half of 2020, electricity use in residential buildings in some countries grew by 20% to 30% while falling by around 10% in commercial buildings.

In commercial buildings, essential services are accounting for a larger share of energy use. These services are often more energy-intensive, so the energy intensity of commercial buildings is likely to increase. For example, food sales outlets, which have largely continued to operate during the pandemic, are more than twice as energy-intensive as the average office in the United States, where many offices have been largely unoccupied during the crisis.

As shops and offices re-open, commercial buildings could become more energy intensive if occupants expect higher ventilation rates to reduce the risk of Covid-19 transmission. Around 30% of a building's energy is dissipated in ventilation and exfiltration. This would only increase with higher ventilation rates.

... and transport

Long-distance transport is witnessing dramatic falls in activity across all modes, with commercial aviation likely to be 60% lower in 2020 and rail demand 30% lower. The difference between these drops suggests that, at least domestically, some switching from planes to trains and cars is taking place. Shifts from aviation to rail would reduce energy intensity whereas a shift to road vehicles may increase energy intensity.

In cities, people are moving away from public transport, which is down 50% in some countries, to private cars and active modes of transport such as walking, cycling or using other non-motorised vehicles.

It is uncertain if behaviours that may be positive for energy efficiency will persist when the crisis passes, but in the absence of targeted government policies, a return to pre-pandemic behaviours is likely.

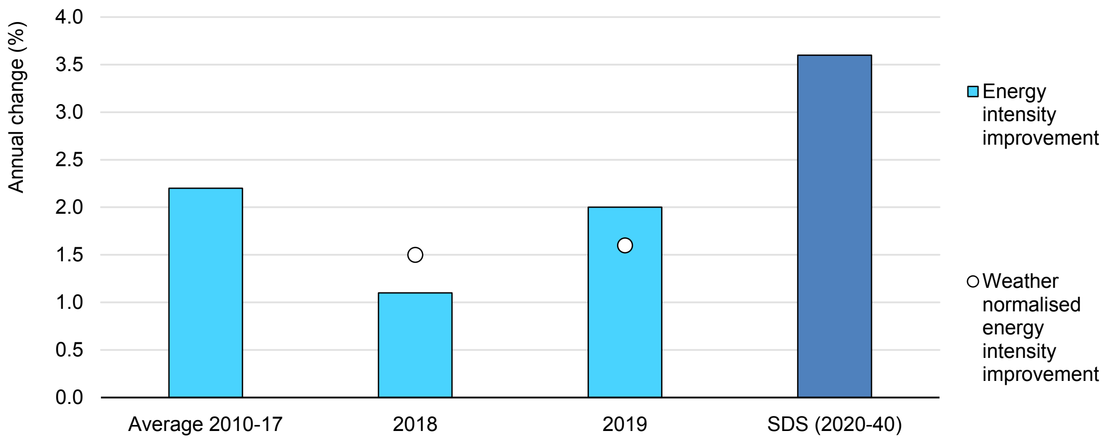
1. Covid-19 and energy efficiency

Even before the crisis, action on energy efficiency was urgently needed

In recent years, the IEA has been highlighting the need for urgent action to counteract the slowing rate of energy efficiency improvement[1] observed since 2015.

In 2019, it seemed the downwards trend in global energy efficiency improvements could begin to flatten. Global primary energy intensity improved by 2% in 2019, compared with 1.1% in 2018.

Figure 1.1 Average annual change in primary energy intensity improvement, historically and in the IEA Sustainable Development Scenario



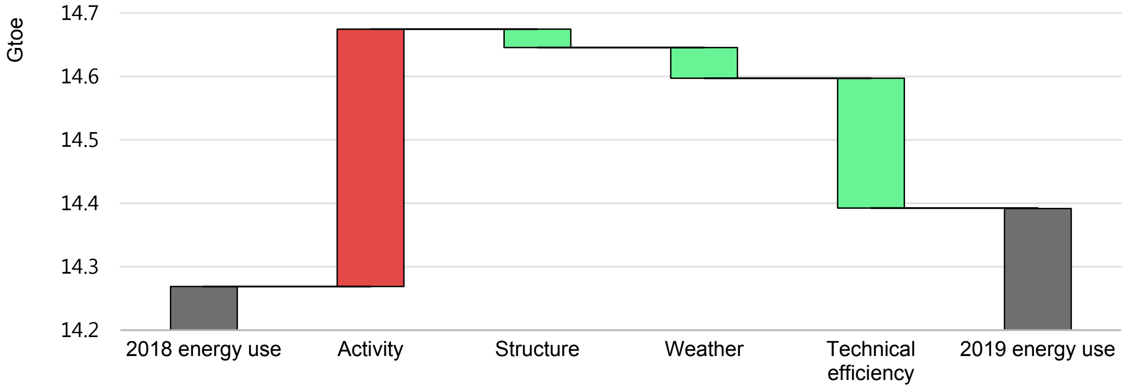
Note: SDS = IEA Sustainable Development Scenario.
Source: IEA, Global Energy Review 2019.

Three main factors contributed to this rate of improvement. First, technical energy efficiency improvements were crucial, offsetting almost half of the potential increase in global energy demand that would have occurred due to economic growth. Second, global economic growth itself was significantly lower in 2019, at 2.9% compared with 3.6% in 2018. This reduced the size of the "activity effect" – the increase in energy demand due to economic activity – by nearly a fifth. Third, more

[1] In this report, energy intensity is said to "improve" when less energy is needed for a given activity. An energy intensity improvement is expressed as a positive number, while a worsening of energy intensity is expressed as a negative number.

temperate weather in key parts of the world reduced the need for coal, gas and electricity for heating and cooling, which so energy demand was over 10% lower than would have been expected from economic activity.

Figure 1.2 Change in global primary energy demand and causes, 2018 compared with 2019



Note: Red columns are factors that increased energy demand, green columns are factors that reduced energy demand.
Source: IEA, Global Energy Review 2019.

This final factor – weather – is critical to properly interpreting what first appears to be an improvement in global energy intensity in 2019. Correcting for the weather, the energy intensity improvement rate in 2019 (1.6%) was almost identical to 2018 (1.5%).

Box 1.1 Key terms used in this report

Activity: An action that creates demand for energy. A change in activity that effects a change in energy use is referred to as the "activity effect".

Structure: The mix of activities within an economy or sector. A change in structure that effects a change in energy use is referred to as the "structural effect".

Energy intensity: Energy use per unit of activity. Lower/higher energy intensity could indicate that energy is being used efficiently/inefficiently but not always. For example, making steel is an energy-intensive process, but energy intensity varies between steel factories for a range of reasons.

Technical energy efficiency (technical efficiency): The ratio of energy use per unit of activity or services provided by energy-using *technologies*, such as buildings, appliances and equipment, industrial equipment and processes, and vehicles. For example, a car that uses 1 litre of fuel to travel 20 kilometres is more technically efficient than one that uses 2 litres of fuel to travel 20 kilometres.

The Covid-19 crisis adds a new layer of uncertainty for global efficiency efforts

Against a backdrop of slow energy efficiency improvements, the Covid-19 crisis adds a new layer of uncertainty. First, the current economic crisis threatens to delay investments by businesses and households in more efficient technologies. While investments may not have changed significantly yet (particularly as projects are often agreed years in advance), the resilience of investments will be tested in the coming years, particularly if the crisis deepens.

Second, the crisis has triggered changes to behaviour and markets that are also adding uncertainty about energy efficiency progress. For example, the unprecedented drop in aviation transport demand could change the energy intensity of international travel and freight forever, depending on how the aviation industry recovers after the pandemic. Meanwhile, increased rates of teleworking are changing the way we move around cities. Such changes could reduce energy intensity in some instances but increase it in others.

Third, the shape of government policy responses to the economic crisis will have a strong bearing on energy efficiency progress, for better or worse. In industry, for example, stimulus funding in the past has sometimes resulted in ageing, inefficient facilities operating for longer. If governments do not consider the energy system in the design of Covid-19 stimulus packages, similar results could ensue.

On the other hand, the socio-economic benefits of energy efficiency are now becoming widely recognised. Governments are starting to rise to the challenge of "building back better" from this crisis, announcing billions of dollars in stimulus spending to increase energy efficiency, particularly in buildings and transport.

Thus, while the full impact of the Covid-19 crisis may take years to properly understand, the crisis clearly poses both risks and opportunities for global energy efficiency.

2020: An atypical year for tracking changes in energy efficiency

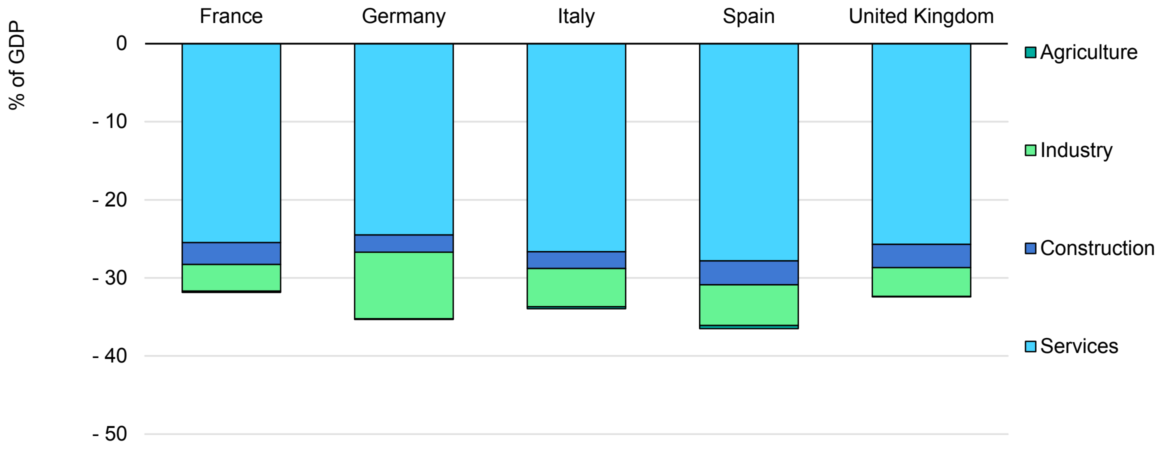
Overall, the IEA expects global primary energy demand in 2020 to decrease by 5.3% from 2019. With global GDP falling by 4.6%, primary energy intensity improvement is projected to increase by only 0.8%, the lowest rate since just after the last global economic crisis in 2010. This is well below the average annual improvement of more than 3% which would be consistent with meeting international climate and sustainability goals.

However, exogenous shocks like the Covid-19 pandemic make it difficult to measure progress on energy efficiency accurately using metrics such as primary energy intensity[2] because they have such large effects on both the numerator and denominator.

In the current crisis, primary energy intensity mainly reflects the pandemic's impacts on the economy rather than efforts to use energy more efficiently. For example, OECD analysis of five European economies shows that the crisis is likely to affect each economic sector directly and indirectly to varying degrees, with the largest impacts in the services sector. While these changes could increase energy intensity overall in these economies – as a higher share of output comes from energy-intensive industry than from less energy-intensive services –they reveal nothing about changes in energy efficiency in these economies.

[2] Primary energy intensity is useful as a high-level indicator of global energy efficiency progress, reflecting how efficiently the world uses energy for economic growth. However, it is not appropriate for tracking demand-side or sectoral energy efficiency because it includes changes to the energy supply mix. It also includes the impact of structural changes in the economy (for example, shifts to more or less energy-intensive industries) so is not able to measure improvements in technical energy efficiency. Therefore, it is important to examine other metrics to assess energy efficiency progress, including metrics involving final energy demand. See *Energy Efficiency Indicators: Fundamentals on Statistics*.

Figure 1.3 Structural impact on economic sectors as a direct and indirect result of lockdowns



Notes: GDP = Gross value-added + taxes – subsidies. Gross value-added (GVA) is a common proxy for output. This illustrative effect on GDP demonstrates a subsequent illustrative effect on gross value-added assuming constant taxes and subsidies.
Source: OECD, Economic Outlook 2020.

For the reasons above, and to maximise its relevance for policy makers given the current, unique circumstances, *Energy Efficiency 2020* differs from previous editions in focusing more on current market trends with possible implications for energy efficiency.

To do so, it draws heavily on a range of frequently updated data from smart meters, smartphones and web searches, in addition to official energy statistics from governments.

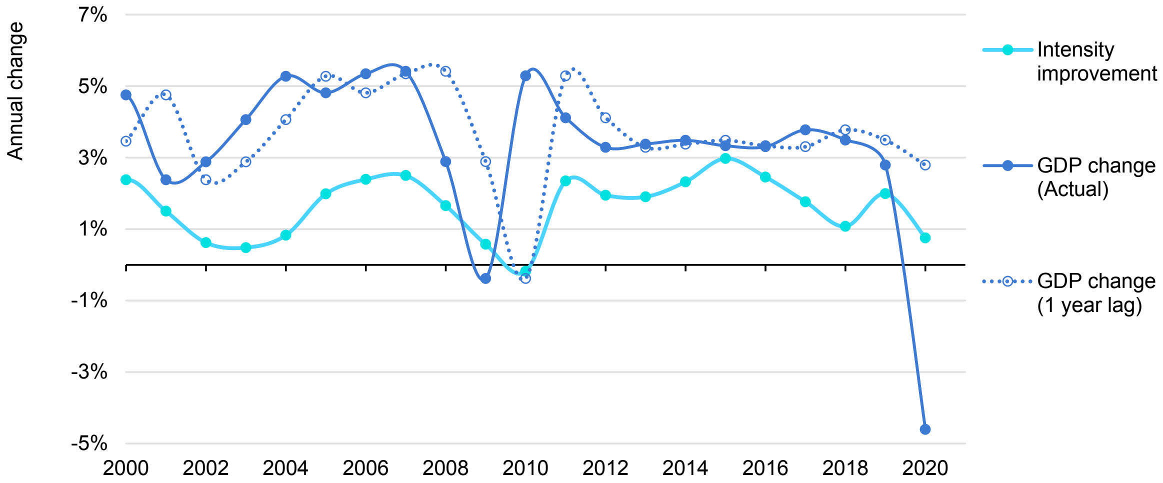
This report does not provide quantitative projections of future energy demand, intensity or technical efficiency. For scenario modelling of the pandemic's possible impacts on energy demand and efficiency over the next 10 years, readers are directed to the *World Energy Outlook 2020*.

Economic crises can increase energy intensity

Although energy intensity may not be a reliable indicator of energy efficiency progress during the current crisis, *historical* energy intensity data, in concert with historical economic data, are useful in projecting trends in the years immediately following the crisis.

Historical GDP and energy intensity data suggest that large falls in GDP, like those occurring in 2020, tend to be followed by falls in the *future* energy intensity improvement rate. For example, global GDP in 2006 and 2007 was increasing at over 5% per annum, fell to 3% in 2008 then to zero in 2009. Energy intensity data show corresponding falls in energy intensity improvements not only in 2008 and 2009, but also in 2010, when global GDP growth returned to pre-crisis levels of around 5%. This lag between falls in GDP and changes in energy intensity suggests that economic recessions can push down energy intensity beyond the immediate period of the economic downturn.

Figure 1.4 GDP relationship with energy intensity improvements, 2000-20



Sources: IEA, World Energy Outlook 2020; International Monetary Fund (IMF), IMF Datamapper.

One reason for the longer-lasting impact of recessions on energy intensity is that investment in technical efficiency improvements, as with investment in general, tends to slow in recessions, as business and household incomes become more uncertain. In 2020, the IEA estimates energy efficiency investment is likely to fall by around 9%, suggesting the slow rate of energy intensity improvement will continue into 2021. Lower energy prices during recessions (due to lower demand) compound this effect by making energy efficiency investments a lower priority, as energy comprises a lower share of household and business costs.

A weaker economy also lowers government tax revenues, which may prompt changes in government spending priorities, reducing public funding available for energy efficiency programmes.

Unless governments intervene to support energy efficiency improvements, therefore, the adverse impacts of the current recession on global energy intensity could linger, at least during the 12-month period after the economy bounces back.

Data gathered by the end of the third quarter of 2020 and presented below suggest that while the impacts on technical efficiency have been relatively minor in the short term, a deepening recession may jeopardise technical efficiency improvements in coming years. In addition, although governments in some parts of the world appear to be recognising the need for energy efficiency measures by including them in stimulus spending, in other parts of the world, energy efficiency has yet to be prioritised.

This crisis presents an opportunity to shift to a more efficient energy system, with multiple benefits

Although economic crises can hinder energy intensity progress, there are several reasons why this crisis presents an opportunity for accelerating the shift to a more efficient energy system.

First, unlike past recessions, the current one is the result of a health crisis that is forcing changes to workplaces and travel patterns. It is too early to predict the permanence of such changes; if efforts to manage the pandemic are successful, behaviour may quickly revert to pre-crisis patterns, or become even more energy-intensive. However, some responses to the crisis – such as public investment in active transport infrastructure in cities – could reinforce behaviour that is more energy efficient, leading to permanent change.

Second, this crisis is occurring against a backdrop of huge changes to the energy system that provide opportunities to boost efficiency. The electrification of the energy system is continuing, and large- and small-scale renewable energy is growing rapidly. Solar power, in particular, has remained resilient during the pandemic and is set to increase its share of power under all IEA scenarios.

A greater share of variable renewables connected to grids requires new technologies, policies and regulatory approaches to manage electricity security and minimise overall investment requirements. In this context, the demand side of energy systems is becoming increasingly important, in terms of overall efficiency and as a provider of demand flexibility. Efficient end-use technologies lower overall system size requirements and hence grid investment needs. Efficient technologies that modulate energy use depending on when renewables are available are becoming more widespread, offering the possibility of improving both end-use and system efficiency.

Third, investing in energy efficiency offers a wide range of benefits, including reducing greenhouse gas emissions and improving air quality. These benefits are particularly relevant given increasing evidence linking air quality and health, including evidence from the current crisis. Efficiency also delivers socio-economic benefits that directly contribute to economic recovery, such as job creation and industrial productivity, as outlined in the IEA Sustainable Recovery Plan. Energy-efficient economies are not only more productive but also more resilient in times of crisis. For example, energy-efficient social housing can help cap energy costs for the most vulnerable, while also reducing costs for public health budgets.

2. Buildings

A complex interplay of factors will determine how the Covid-19 crisis influences energy intensity in the buildings sector in the coming years.

In the short term, three trends are visible:

- a partial shift in energy demand from commercial to residential buildings, as social distancing measures and teleworking reduce people's use of commercial buildings and increase energy using activities in the home; on some metrics, this will increase the overall energy intensity of the buildings sector
- an increase in the share of energy use from more energy-intensive sub-sectors, leading to higher energy intensity per unit of activity in commercial buildings
- restrictions in professional contractors' access to residential properties, delaying technical efficiency upgrades; in some markets, however, increased rates of do-it-yourself renovations may be boosting technical efficiency.

Table 2.1 Crisis-induced factors that could affect energy intensity in buildings

Type of effect	Factor	Potential impact on energy intensity improvement
Activity and structural	More activity in residential buildings; less in commercial buildings.	↓
	A greater share of services sector energy use comes from more energy-intensive services sub-sectors.	↓
	Commercial building ventilation rates are increased for health reasons.	↓
Technical efficiency	Economic recession and job losses lead to lost income for owners (partly due to lower rental payments) and tenants, and lower rates of building renovation and stock turnover.	↓
	Continuing low fuel prices prolong the payback period for building energy efficiency upgrades.	↓
	Continued health risks prevent professional energy efficiency contractors from accessing residential buildings, delaying building upgrades.	↓

Type of effect	Factor	Potential impact on energy intensity improvement
	Energy services companies lose revenues and possibly default, starving the market of providers.	↓
	Government stimulus spending targets building retrofits and efficient new buildings.	↑
	Higher residential energy bills due to increased time at home encourages homeowners to invest in efficient building upgrades.	↑
	Commercial building owners take advantage of the absence of tenants and building users to upgrade buildings without inconveniencing tenants.	↑
	More time spent at home encourages do-it-yourself renovations as people invest in increasing their comfort.	↑

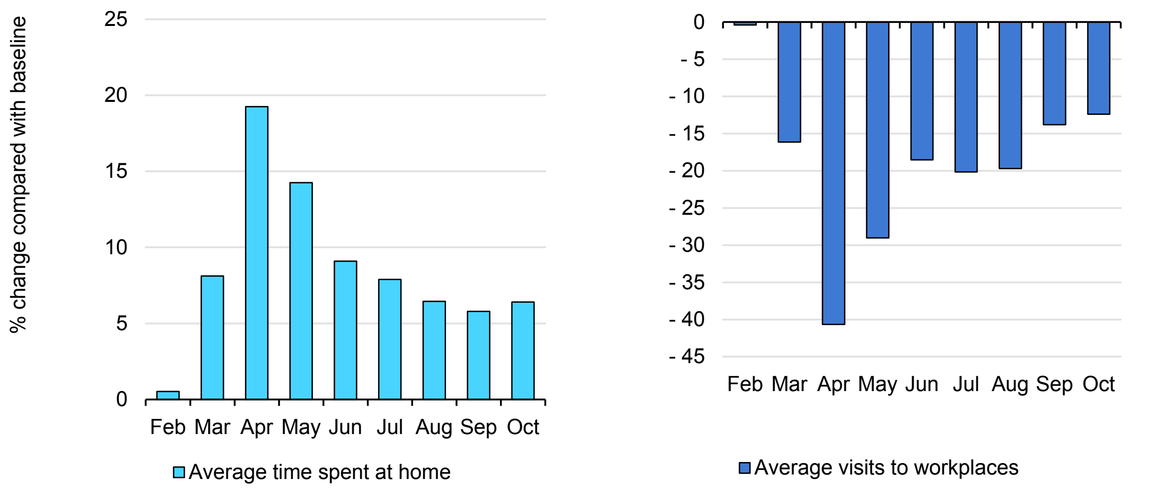
In the longer term, the duration of the health and economic crisis will have a significant impact on energy intensity in buildings. A lasting health crisis could continue to limit commercial building use, prolonging energy intensity trends seen in 2020. As more people return to work during the pandemic, demands for higher ventilation rates in commercial buildings for health reasons could lead to spikes in energy intensity. If the economic recession deepens, households and businesses may reduce spending on building upgrades, which will slow technical efficiency improvements. Current forecasts suggest the pandemic has dampened growth expectations for the buildings and construction sector.

However, the buildings sector will soon benefit from increased government investment, as buildings have been the primary target for energy efficiency stimulus spending announcements to date. In some regions, the scale of this investment could be large enough to significantly boost technical efficiency.

Activity and structural impacts

Energy use grows in residential buildings and falls in commercial buildings

Figure 2.1 Changes to average time spent at home (left) and visitors to workplaces (right), average over selected countries



Notes: The data show how visitors to (or time spent in) categorised places change compared with Google's baseline days. A baseline day represents a normal value for that day of the week. The baseline day is the median value from the five-week period 3 January to 6 February 2020. "Home" refers to the "Residential" category, which shows a change in duration whereas the "workplace" category measures a change in total visitors. Countries include: Australia, Austria, Belgium, Brazil, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Morocco, Netherlands, New Zealand, Norway, Poland, Portugal, Singapore, Slovakia, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, United Kingdom, United States.
Source: Google LLC, Google COVID-19 Community Mobility Reports, accessed 10 November 2020.

On average, people across major economies reduced visits to workplaces by over 60% in April, with visits still down 20% to 30% from June to September, as teleworking appeared to become more normalised. Time spent at home had increased by nearly 30% at the height of the lockdowns and was still 5% to 10% higher between June and October. The increase in time spent at home is being used to conduct activities that consume energy, leading to significant and complex shifts in energy demand.

In some parts of the United States, average residential electricity use on weekdays was up by 20% to 30% in late March and early April, particularly for cooling homes in warmer climates. In India, electricity demand also rose as residential cooling loads increased, while in Europe heating energy use contributed to 40% higher electricity consumption year-on-year in March and early April.

In contrast to the residential sector, energy consumption in commercial buildings has declined. Electricity demand in the commercial and service sectors in the People's Republic of China ("China") decreased by 3% during the first two months of the year as the Covid-19 pandemic began but has since rebounded. In the United States, commercial electricity demand was 8% below last year's levels between April and September, as shops were closed or operated under limited hours and offices remained partially occupied or empty.

However, even when commercial buildings such as offices remain unoccupied, most continue to consume energy, for maintenance of heating, ventilation and air conditioning (HVAC) systems, or to power computing servers, for example. Working from home has net benefits for energy use and emissions, but these come mainly from reduced commuting.

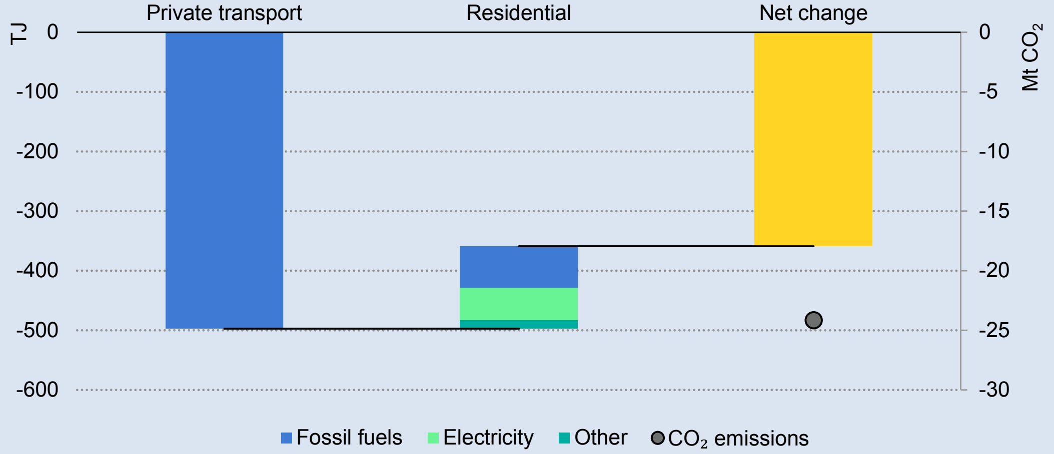
While the net effects of the shift from commercial to residential buildings will vary by country and by fuel, minor decreases in buildings sector electricity use as a whole have been observed in some countries. In Australia, electricity demand was about 2% lower after residential demand growth nearly entirely offset falls in commercial demand. In Europe, after a 13% decline below the five-year average in April, cross-sector electricity demand partly recovered during the summer months. As coronavirus cases started to increase again in autumn, however, power demand slightly dropped, for example in Italy and Belgium in October.

At least on some metrics (such as energy use in buildings per unit of economic output), the shift from commercial to residential buildings will increase the energy intensity of the buildings sector.

Box 2.1 Working from home can save energy and reduce emissions. But, how much?

A day of working from home could increase daily household energy consumption by 7% to 23% compared with a day working at the office. The magnitude of the change depends on regional differences in the average size of homes, heating or cooling needs, and the efficiency of computers and other IT equipment and appliances used at home. In most parts of the world, the extra demand in winter is larger than in summer, due to space heating, while the energy mix in winter also typically shifts more towards fossil fuels.

Change in annual global CO_2 emissions and final energy consumption by fuel in the "home working" scenario



Note: Other = heat, modern biomass and other renewables.

A day working from home would, on average, reduce energy consumption and CO_2 emissions by cutting time and fuel spent commuting by car. For workers who normally make only short commutes by car, however, or mainly take public transport, working from home could lead to a small net increase in energy demand and emissions from higher residential energy use, depending on the residential fuel mix.

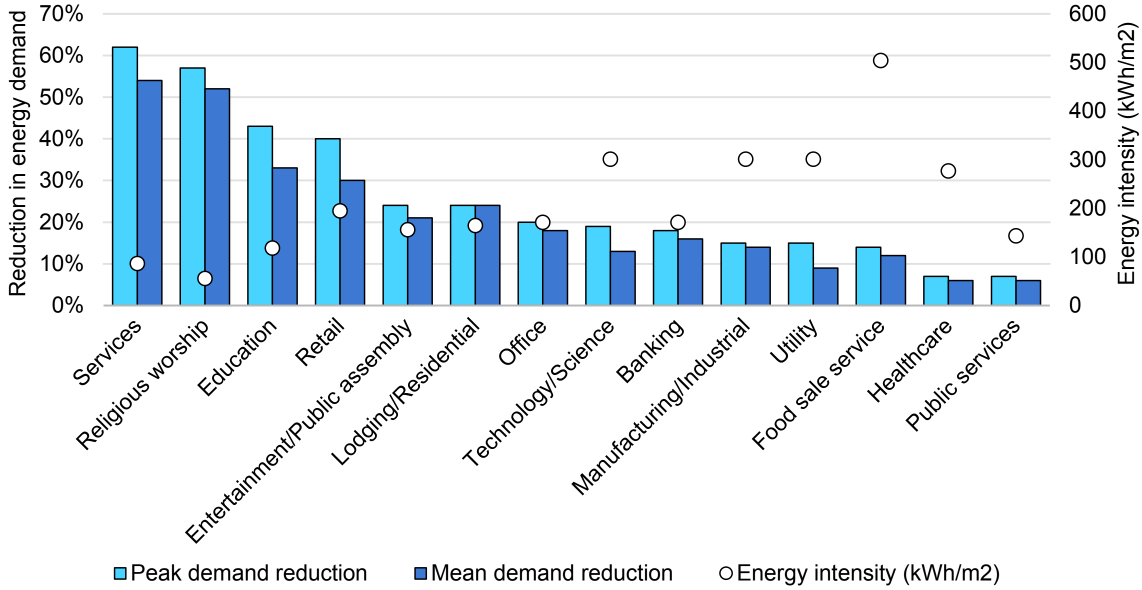
Globally, nearly one job in five could be done from home. If all of these people were to telework for just one day a week, around 1% of global oil consumption for road passenger transport would be saved each year. Accounting for the corresponding increase in household energy use, global CO_2 emissions could fall by 24 million tonnes annually. (Reduced use of computers and other IT equipment at work leads to additional, though minor, reductions in electricity consumption that are not reflected in this estimate.)

Overall, this is a notable decline but small in the context of the emissions reductions that would be necessary to put the world on a path towards meeting key long-term sustainable energy and climate goals. Over time, a more significant shift to home working could further reduce demand for office space and energy for commercial buildings, leading to a greater overall reduction in energy consumption. However, energy demand reductions from office buildings and avoided commutes could be partly cancelled out if habitual home working leads workers to consume more energy by moving to larger homes outside cities that require more heating and cooling energy, and opting for more energy-intensive transport.

In addition to enabling teleworking, the use of video conferencing could also reduce jet fuel demand as well as emissions by substituting long-haul business trips. Based on current aircraft efficiencies, halving business trips to destinations further than six hours flight away would be likely to reduce the annual number of flights by less than 1% but would save around 50 million tonnes of CO_2.

A higher share of energy use from energy-intensive essential services

Figure 2.2 Reduction in energy demand under stay-at-home orders and average energy intensity (by building type), two US regions



Notes: Reduction in energy demand as compared with expected usage under regular conditions. Services include, e.g., dry cleaners, copy centres, barber shops or repair shops. Food sale service includes, e.g., supermarkets and restaurants.

Sources: Uplight, *The Impact of Quarantine on Non-Residential Utility Customer Energy Use*; EIA, *Commercial Buildings Energy Consumption Survey*.

While the pandemic has generally reduced energy demand in commercial buildings, decreases have varied widely across business sizes, customer segments and regions. Smart meter data from two regions in the United States show that larger businesses have been less affected than smaller businesses, with essential businesses and services such as supermarkets and hospitals being the least affected.

While many commercial buildings have resumed a more "business as usual" level of service since the height of lockdowns, the crisis appears to have stimulated bigger falls in energy use in commercial buildings that are less energy intensive (such as services, religious worship or education buildings). Commercial buildings that are more energy intensive – such as restaurants, supermarkets and hospitals – have experienced less severe declines in demand. While global data are limited, available data suggest that energy intensity in commercial buildings may have increased on an energy per unit of service basis.

"Urban flight" has affected energy intensity less than longer-term urbanisation

Reports of "urban flight" –migration of city dwellers to less densely populated areas – have emerged since the onset of the Covid-19 crisis, leading to suggestions that energy intensity in buildings could increase. As buildings in less densely areas tends to be larger, they often use more energy, particularly for heating or cooling.

A survey in the United States suggested some temporary migrations have been observed but was inconclusive on cause, which was also the case in analysis of real estate and moving companies' data. In Europe, there were also some temporary moves from cities to less dense areas in 2020 but no evidence of permanent migrations.

Ultimately even if reports of people moving from primary to secondary cities in developed economies becomes a trend, and result in higher energy use per occupant, the global pattern of increasing urbanisation is unlikely to reverse, which will have a bigger impact on energy demand and intensity than Covid-19 driven migrations.

Box 2.2 How could Covid-19 affect the use of heating, cooling and ventilation systems in buildings?

Concerns over the spread of Covid-19 via airborne particles, and a possible correlation between air quality and health impacts of the virus, are drawing increasing attention to ventilation systems in buildings.

Guidance by ASHRAE (formerly the American Society of Heating, Refrigerating and Air-Conditioning Engineers) outlines best practice approaches to minimising the risk of transmission of airborne infectious disease. The recommendations include inspection and maintenance of heating, ventilation and air-conditioning (HVAC) systems, filtration using MERV 13 filters or better for filtration, and higher rates of outdoor air exchange. The Federation of European Heating Ventilation and Air Conditioning Associations (REHVA) recommends supplying as much air to buildings as possible by opening windows and increasing the use of outdoor air, while avoiding the use of energy-savings settings on demand-controlled ventilation systems.

Under normal conditions, 30% of energy delivered to buildings is dissipated in the air that leaves buildings through ventilation and exfiltration, so increasing ventilation rates will also increase the energy used by buildings' heating and cooling systems. It is therefore important for HVAC systems to operate as efficiently as possible.

Installing, recommissioning and upgrading HVAC systems will enhance building performance as well as protecting health.

Some HVAC engineers already foresee that increased demand for ventilation (such as requiring the purging of an entire building's air once every 24 hours) will have significant costs for energy efficiency. Reducing these costs, while meeting the health imperatives for increased ventilation rates, will require innovative technologies such as smart HVAC control systems, more advanced filtration systems and novel dehumidification technologies for energy recovery.

Technical efficiency impacts

Predicting the impact of the Covid-19 crisis on progress in the technical efficiency of buildings is difficult due to poor data availability. However, lockdowns are likely to have delayed technical efficiency improvements in the buildings sector in the short term, despite some countries reporting increased rates of home renovation.

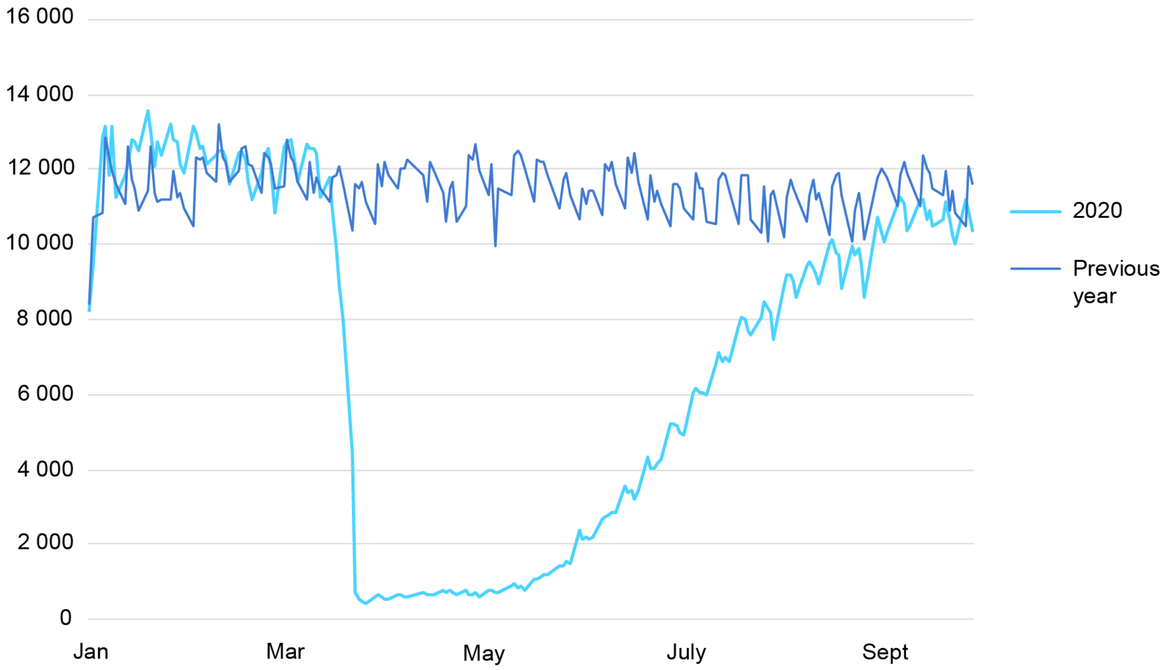
Longer term, a deepening recession could dampen consumer and business confidence, discouraging efficiency investments in buildings. However, governments have been quick to recognise that energy efficiency upgrades for buildings can deliver economic growth and employment. In countries that are targeting stimulus spending at the buildings sector, the technical energy efficiency of the building stock could improve significantly in the next few years.

Lockdowns prevented access to residential buildings, delaying efficiency improvements

In residential buildings, physical distancing has limited the installation of equipment and systems requiring professional installation. For energy-efficient renovations, reports suggest limited access to properties in the first half of 2020 is likely to have delayed the installation of equipment such as insulation, glazed windows, and efficient heating and cooling systems, such as heat pumps.

The impact of physical distancing on professional installers' access to properties is reflected in smart meter installations in the United Kingdom. Installations fell from around 12 000 per day to less than 1 000 per day at the height of the lockdowns. A similar trend was reported in India, where Energy Efficiency Services Limited reported a drop in installations to around 2 000 per day, from 10 000 per day under normal conditions.[3]

Figure 2.3 Daily smart electricity meter installations, United Kingdom



Source: ElectraLink, Open Data.

As with smart meter installations, which had returned to 2019 levels by September in the United Kingdom and elsewhere, other professional equipment installers also reported increased access to properties by the third quarter of 2020. Energy efficiency professionals have also adapted by offering virtual consultations. However, new lockdowns, in response to the second wave of the virus that has affected several parts of the world, could lead to more delays in efficient equipment installations in residential buildings.

A spike in renovations may increase residential buildings' technical efficiency in some wealthy countries

Data from some countries suggest that the increased time spent at home has encouraged homeowners to undertake work on residential properties, including energy-efficient renovations. With professional tradespeople denied access to some

[3] Information provided to the IEA from Energy Efficiency Services Limited

buildings for health reasons, homeowners appear to be adapting by turning to do-it-yourself (DIY) renovations, or commissioning tradespeople to work on upgrades where health concerns are lower (such as installing underfloor insulation).

For example, interviews with energy efficiency product and service providers in Australia[4] suggested that demand had increased for lower-cost energy efficiency measures, with increases of 15% in LED lighting sales and 145% in online sales of DIY draught-proofing. One company reported a 30% increase in sales of DIY insulation products, and in March an insulation installer noted a 270% month-on-month increase in customer inquiries. However, some interviewed noted significant declines in more expensive residential energy efficiency products and services.

The United States has seen a similar increase in home improvement activities in 2020. DIY builders are thought to have contributed to a 50% increase in wholesale lumber prices, while a Bank of America survey of over 1 000 people on consumer attitudes during the Covid-19 crisis found that over 70% of households have intentions to make home improvements in 2020, with more planned for next year. Major US home improvement chains Home Depot and Lowe's, which combined operate close to 4 300 stores, recorded over USD 65.4 billion in net sales in the three months to the end of July 2020, a 26% increase on the same period last year.

In addition, wealthy households may have redirected some of the increase in disposable income – gained by not spending in other sectors of the economy, like travel – to energy efficiency improvements, to benefit from the gains in comfort such investments can deliver. For example, anecdotal evidence from the United States suggests that sales of higher-efficiency residential HVAC systems have increased since the Covid-19 crisis began. Some consumers are investing in high-efficiency air conditioners with a seasonal energy efficiency rating of 16 to 20; normal purchasing trends tended towards systems with a rating of 13.

Weaker outlooks for global construction hint at lower rates of efficient building construction and upgrades

Covid-19 is expected to severely curtail global construction industry investment. The latest estimates anticipate annual year-on-year growth of only 1.2% from 2019-2020, down from 3.1% at start of 2020. Dramatic contractions took place in some major regional markets: 4.4% in Germany and 7% in Canada from 2019 levels, as well as 2.2% in India and 7.7% in Malaysia. Despite the slowdown, overall construction in

[4] Unpublished analysis by the Energy Efficiency Council of Australia, shared with the IEA.

China is expected to increase by 1.9% from 2019. Given the size of China's market, this helps to keep the global estimate on a slight upward trend.

The building construction industry is expected to follow similar trends to those of overall construction (which includes non-building construction such as bridges and roads). Some projections suggest a recovery that sees pent-up demand pushing annual growth rates above pre-pandemic levels, but these remain highly uncertain. US data suggest that newly completed privately owned houses that have sold or are for sale have increased by 8% in August 2020 compared to the previous year.

The "green" building materials market is expected to achieve an annual growth rate of 8.6% by 2027, down from 11.7% in 2019. Demand for green building is projected to continue to grow by 11.6% in China and 13% in Latin America by 2027. The energy efficiency glass market is expected to reduce in size by around 6% to 2027 compared with pre-pandemic growth rates. Despite falls in residential sales in the first half of 2020, demand for thermal insulation is estimated to maintain its growth rate at around 4% per year, with demand for these products in high-income northern climates boosted by continued government support. This trend reflects anticipated demand for residential cooling and a shift to home working.

Policy responses to the crisis will strongly influence whether these forecasts for the buildings sector – and the technical efficiency of buildings – prove to be accurate. Analysis of buildings sector policies to date gives some reason for optimism, particularly in Europe, where large-scale building renovation policies have been announced. However, in other regions, policies to support high levels of building renovation are yet to reach the same scale.

Box 2.3 Covid-19 impact on efficient building products: Insulation sales dip, but bright spots remain

The effect of the crisis on the technical efficiency of the building stock can be seen in the balance sheets of major energy efficiency building equipment producers, which reflect the impact of lockdowns, physical distancing and a weak economy.

For example, insulation producers globally reported falls in sales of 5-20% in the first half of 2020, with sales particularly low in the second quarter, during the height of lockdowns.

Regional differences suggest demand-side factors have inhibited insulation sales, with sales higher in regions with smaller health and economic impacts from the virus. For example, in the second quarter of 2020 some companies reported stable sales in

Nordic countries, Canada and Australasia, where incomes are high, the impacts of Covid-19 have been less severe and insulation is important for thermal comfort.

In Australia, DIY renovations have reportedly spurred an increase in sales for residential insulation products, with some companies reporting year-on-year growth of 20% to 40% in the first half of 2020.

Note: Australian information is from unpublished analysis by the Energy Efficiency Council of Australia, shared with the IEA. For Australasia, see Kingspan 2020 Interim Results.

3. Appliances

The Covid-19 crisis could has affected the energy intensity of appliances via a range of structural and technical efficiency factors. In the short term, three main appliance purchasing and usage patterns seem to be emerging:

- First, in some countries, people are purchasing new appliances, such as cooking equipment or home entertainment devices, to perform services that would normally have been procured outside the home. Similarly, people are buying additional IT equipment for working or studying from home.
- Second, lockdowns and consumer uncertainty have led to temporary delays in some appliance purchases, but these have been largely offset by post-lockdown spikes in demand and in some cases, stronger online sales.
- Third, the types, timing and frequency of appliance use are changing, as people spend more time at home. As usage increases, appliances may also be reaching the end of their lifetimes sooner, leading to replacement purchases.

Table 3.1 Crisis-induced factors that could affect appliance energy intensity

Type of effect	Factor	Potential impact on energy intensity improvement
Activity and structural	Use has risen for most household appliance types, increasing residential energy use.	↓
Technical efficiency	*Longer term*: Economic recession and job losses lead to lower rates of appliance and equipment replacement in the next 1-2 years.	↓
	Longer term: Regulators delay planned strengthening of minimum energy performance standards during the economic crisis.	↓
	Short term: More frequent use of appliances due to increased time at home shortens appliance life and accelerates replacement.	↑
	Short term: Higher residential energy consumption due to increased time at home encourages home owners to invest in efficient appliances and equipment.	↑
	Government stimulus spending targeted at appliance recycling schemes, replace ageing, inefficient appliances with models that exceed minimum energy performance standards.	↑

All factors considered, the short-term outlook globally is for an increase in appliance purchases and use, spurred by lockdowns and social distancing. While more time at home will increase appliances' energy use, growth in new appliance purchases and replacements will lead to technical efficiency improvements in some markets, reducing the energy intensity of the global appliances stock.

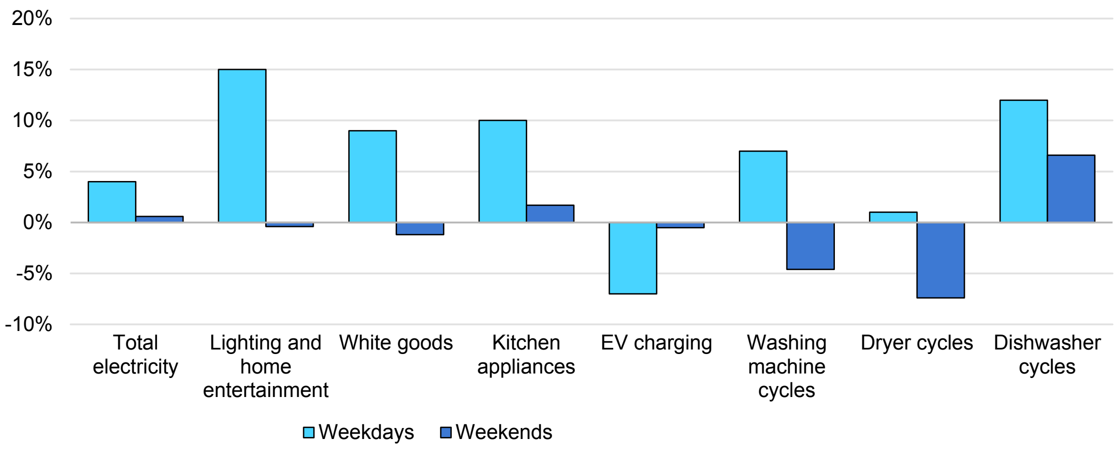
Longer-term changes to the technical efficiency of the global appliance stock will depend on the shape of the economic recovery, including government stimulus packages: a slow recovery might delay purchases of newer, more efficient models for both first-time and replacement appliances, and a quick recovery boost such purchases.

Activity and structural impacts

Residential appliance use is up, contributing to higher energy use per floor space in residential buildings

The Covid-19 lockdowns have changed energy use profiles in residential buildings, with hourly demand patterns on weekdays resembling those of a normal Sunday. Electricity utility data show how the changing use of appliances is responsible for the changing shape of residential electricity demand.

Figure 3.1 Changes in energy usage for one utility in the Netherlands, lockdown period compared with pre-lockdown period



Source: Quby, *What self-quarantine does to household energy usage: while others guess, Quby measures*.

For example, smart meter data from one utility in the Netherlands showed that washing machines and dryers run more frequently during the week and less on weekends. Another noticeable change was the reduced demand for electric vehicle charging, as people made fewer trips during the lockdown, whereas the use of lighting and home entertainment went up significantly.

Digital technology use is up for both for work and entertainment, as options for in-person leisure activities are limited. Web searches for popular media streaming services were 60% higher than 2019 levels[5] at the height of lockdowns, and interest has remained higher all year, compared with 2019. This pushes up not only residential energy consumption but also demand in data centres and by networks: global Internet traffic surged by almost 40% between February and mid-April. However, several network operators in Europe reported that network electricity usage remained flat despite data traffic spiking by 50% or more. This decoupling between data traffic and energy use follows broader energy efficiency trends in the sector in recent years, with the energy efficiency of data transmission and computing doubling every two to three years.

While it is difficult to predict the permanence of these behavioural changes, these usage patterns are likely to remain in the short term as several countries have introduced new Covid-19-related restrictions in the second half of 2020.

These changes will increase residential building energy intensity (energy use per floor space). On an energy use per *activity* basis, changing appliance use may have benefits for energy intensity because some activities may be less energy intensive when performed with household appliances than with commercial appliances. For example, cooking a meal at home – depending on the meal and number of people eating – could use as little as half a kilowatt-hour, whereas research from the United Kingdom suggests cooking a restaurant meal could require 1.5 kWh to 3.3 kWh, as energy-intensive appliances such as deep fryers and heat lamps tend to remain on constantly.

However, changes in the energy intensity for specific activities (like cooking) are unlikely to be distinguishable from the rest of overall buildings sector energy intensity changes driven by Covid-19. Overall, increased residential energy use – combined with changes in commercial building energy intensity resulting from lower patronage while buildings remain open – is expected to increase the energy intensity of the buildings sector.

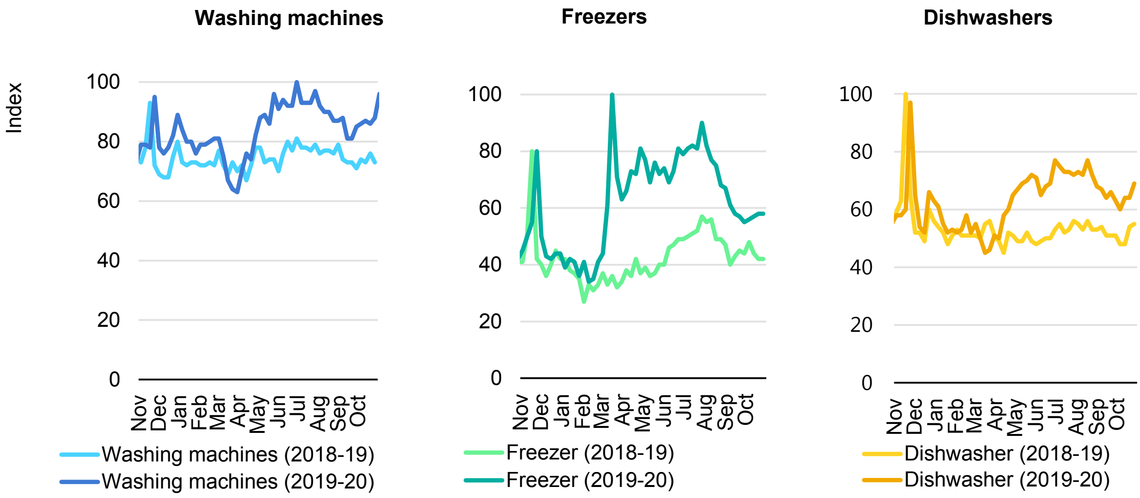
[5] Worldwide Google Trends searches for the topics of "Netflix" and "Amazon Prime Video".

Technical efficiency impacts

In the short term, the Covid-19 pandemic is likely to have improved the technical efficiency of the appliance stock, as increased time spent at home appears to have boosted purchases of new appliances, which tend to be more efficient than older models. In the longer term, some effects of the pandemic could boost appliances' technical efficiency while other effects could hinder efficiency gains (see table above). A deeper recession, for example, would slow purchases of new appliances and appliance replacements.

Lockdowns spur purchases of new appliances in the short term, which could bolster technical efficiency

Figure 3.2 Worldwide weekly online shopping search indices for selected whitegoods, 2018-19 and 2019-20



Notes: Worldwide searches within the Shopping category for the following topics: washing machine, freezer, dishwasher. Figures are indexed to the highest value. "Worldwide" refers to all countries where the Google search engine is available, and therefore excludes China.
Source: Google Trends.

In some countries, prompted by lockdowns, people have bought additional appliances to use in the home. Online shopping search indices suggest demand initially increased for appliances seen as essential in a crisis, such as freezers to guard against food shortages. Deep freezer purchases were reportedly 45% higher in the first quarter of 2020 compared with the first quarter of 2019 in the United States and more than doubled in Turkey in the same timeframe[6].

When lockdowns came into place, interest in purchases of whitegoods such as dishwashers and washing machines initially tailed off worldwide but by May had increased by 20-40% year-on-year for certain appliances. US whitegoods sales increased by 6% year-on-year in March and by the third quarter of 2020, many manufacturers reported shortages as supply chains affected by Covid-19 safety protocols struggled to keep up with demand. In Turkey, whitegoods sales rose by 11% in the first half of 2020 compared with the first half of 2019.[7] Similar trends were reported in Korea and Singapore, where sales for cooking appliances and dishwashers went up. In China, refrigerator sales initially declined in March, as non-urgent purchases were postponed, but had bounced back by summer, boosted by stronger online sales.

Sales of small appliances such as soda machines and bread makers also grew during lockdowns, particularly in the United States, as people sought to limit time spent food shopping and increased DIY leisure activities. Globally, IT equipment purchases jumped, as people in Europe, North America and Asia adapted to working from home.

As a result of these trends, the global stock of appliances is likely to have become more efficient because new purchases are covered by minimum energy performance standards and/or labelling programmes in many markets, guaranteeing that new purchases are more efficient, particularly compared with replacement appliances.

For example, in countries where shopping search indices for refrigerators indicate increased intent to buy, performance standards are likely to have been strengthened since the last purchase was made (given the long lifetimes of refrigerators) while labels are also likely to have been updated, alerting consumers to the most efficient models.

[6] Sales data provided by the White Goods Manufacturers' Association of Turkey (TURKBESD).
[7] Sales data provided by the White Goods Manufacturers' Association of Turkey (TURKBESD).

Table 3.2 Refrigerator search indices for selected countries, most recent update of minimum energy performance standards and types of labels in place

Country	Change in average online search indices (2020 compared with 2019)	Most recent update to standards	Labels
Brazil	1.7%	2015	Mandatory comparative and voluntary endorsement
India	2.6%	2007	Mandatory comparative
Japan	12.1%	2006	Mandatory comparative and voluntary endorsement
Mexico	8.6%	2018	Mandatory comparative and voluntary endorsement
Sweden	10.6%	2017	Mandatory comparative and voluntary endorsement
United States	11.5%	2014	Mandatory comparative and voluntary endorsement

Note: Data are average of 6 January to 31 October 2020 compared with the same period in 2019 of searches within the Shopping category for the topic of "refrigerator".
Source: Google Trends.

Pace of appliance efficiency improvements depends on shape of the economic recovery

In both developed and developing markets, appliance replacements will on average be more energy efficient, even in an economic recession, for two main reasons. First, policies such as performance standards and labelling have been continually strengthened in many countries, reinforcing the general trend for new appliances to be much more efficient than those coming to the end of their lifetimes.

Second, unlike other energy-efficient equipment, which sometimes has higher upfront costs, efficient appliances are not always more expensive for consumers to purchase. For example, efficient air conditioners are found at all price points in many Southeast Asian countries, dampening the risk that consumers will shy away from high efficiency appliances during the recession, despite facing higher energy bills due to increased time spent at home.

Box 3.1 More efficient appliances are not more expensive: Evidence from Southeast Asia

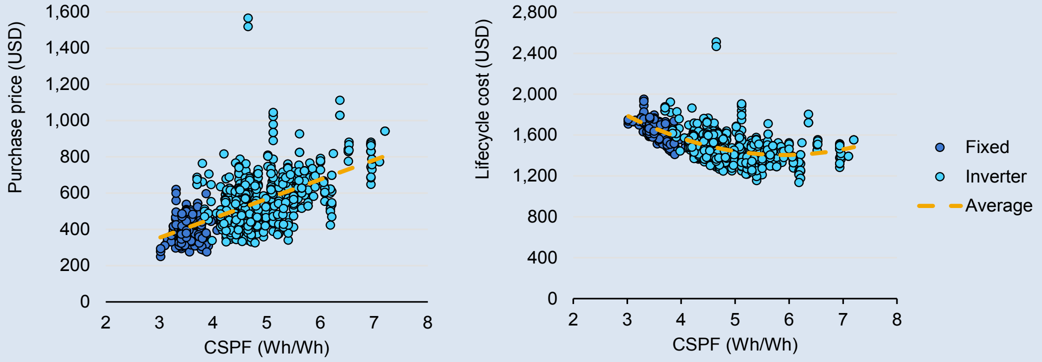
During an economic crisis, consumers facing the threat of unemployment or lower wages may be even more motivated to look for the cheapest options when it comes to buying appliances.

While energy-efficient appliances often tend to be cheaper across their lifetime (as they have lower running costs), consumers can sometimes struggle to calculate the lifecycle costs of an appliance, meaning purchasing decisions are often made based on the purchase price alone, a well-known barrier to increasing energy efficiency.

Appliance labels can help overcome this barrier by providing consumers with information on the energy use of appliances, which is crucial in calculating lifetime costs. The energy usage information on appliances labels is becoming more accurate, as it is increasingly based on testing procedures that are more representative of real behaviour.

However, even if consumers have neither access to information nor a desire to calculate lifecycle costs, evidence from Southeast Asia shows that some energy-efficient appliances can be cheaper on purchase price alone. For example, in Viet Nam, there are several models of air conditioner available with a seasonal performance factor of 5 or over that are well below the average purchase price of USD 530.[8]

Purchase price (left) and lifecycle cost (right) versus efficiency of air conditioners by technology in Viet Nam, 2019



Note: The Cooling Seasonal Performance Factor (CSPF) is the ratio of the total annual amount of heat that the equipment can remove from the indoor air when operated for cooling in active mode to the total annual amount of energy consumed by the equipment during the same period. Wh/Wh = Watt-hour of cooling output per Watt-hour of electricity input. Based on data from CLASP and the Ecology and Environment Institute.

[8] Purchase prices normalised to 12,000 BTU/h.

Despite the recent surge in appliance purchases, however, if the economic crisis deepens appliance replacement rates are likely to slow in the next one to two years, as economic uncertainty and lower incomes discourage non-essential purchases. Consumers would be likely to hold onto ageing, less efficient appliances for longer. Continuing low energy prices could also hold people back from seeking to increase energy efficiency in response to higher household energy consumption from spending more time at home.

Stimulus policies will also play an important role. Policies that encourage appliance purchases directly (such as appliance recycling programmes) or by providing, for example, lower-income households with cash incentives, are likely to result in higher appliance turnover rates. However, stimulus policies specifically targeting appliance efficiency are yet to be announced (see *Tracking Policy Responses to the Crisis*).

Box 3.2 How could a slow recovery and slower appliance replacement rates affect efficiency and energy demand?

Prolonged virus outbreaks and a slow economic recovery could significantly dampen consumer confidence and incomes (particularly for low-income households), curbing purchases of appliances, air conditioners, cars and other items.

For example, people will buy fewer new, additional refrigerators if consumer confidence falls. Consumers will also delay the replacement of existing ones, which has implications for energy demand as new refrigerators can be around twice as efficient as the models they replace. IEA modelling of global refrigerator stocks shows that a 10% fall in refrigerator sales in 2021 would have two main energy-related effects:

- fewer purchases of new additional appliances, thus lowering electricity demand. Globally this effect would be around 1.4 TWh in 2021.
- a reduction in the replacement rate of existing older, less efficient appliances with more efficient new ones, which will raise electricity consumption. In 2021, this effect would be around 1.2 TWh.

The net impact would be a minor decrease in demand (0.2 TWh) but at a cost of lower economic growth and fewer energy services (due to the reduction in people obtaining new additional appliances). This shows that policy makers seeking a more sustainable path to recovery should design policies to increase replacements of inefficient appliances with the most efficient models available. Doing so could stimulate economic growth, increase access to energy services and improve the efficiency of energy services all at once.

4. Industry

Energy demand is expected to be much lower across all industrial sectors in 2020, as lockdowns have reduced production and consumer demand. The difference in the scale of drops in energy use between energy-intensive and less energy-intensive sub-sectors (the "structural effect") will be a big determinant of changes in overall industry sector energy intensity. The last major financial crisis in 2008-09 showed that government stimulus spending can favour more energy-intensive industrial output. This crisis could have a similar outcome, depending on the design of stimulus packages.

Technical efficiency progress faces several challenges in the absence of targeted policy interventions, as shown by the example of high-efficiency industrial motors, where the crisis could sideline efficiency investments, especially from light industries where significant energy savings potential exists.

Table 4.1 Crisis-induced factors that could affect industry energy intensity

Type of effect	Factor	Potential effect on energy intensity improvement
Activity and structural	Covid-19 reduces energy demand among most industries but especially in less energy-intensive industries.	↓
Technical efficiency	Economic recession results in lower expenditure on new, energy-efficient capital purchases.	↓
	Continuing low energy prices elongate the payback period for energy efficiency upgrades.	↓
	To support industry growth, untargeted government stimulus and relaxed regulations keep aging facilities in use, delaying energy efficiency improvements.	↓
	Energy services companies, funded through shared-savings models, suffer reductions in revenues and possibly default, starving the market of providers.	↓
	Lower demand results in facilities running at lower capacity, which tends to be more energy-intensive	↓
	Government stimulus spending is tied to or specifically targets improvements in energy efficiency.	↑
	Lower demand results in retirement or mothballing of aging facilities.	↑
	The economic crisis increases competition, compelling businesses to turn to energy efficiency improvements as a way to reduce costs.	↑

Note: The direction and colour of the arrows indicates if the factor is likely to increase or decrease energy intensity. Green upwards arrows = an increase in energy intensity improvement; Red downwards arrows = a decrease in energy intensity improvement.

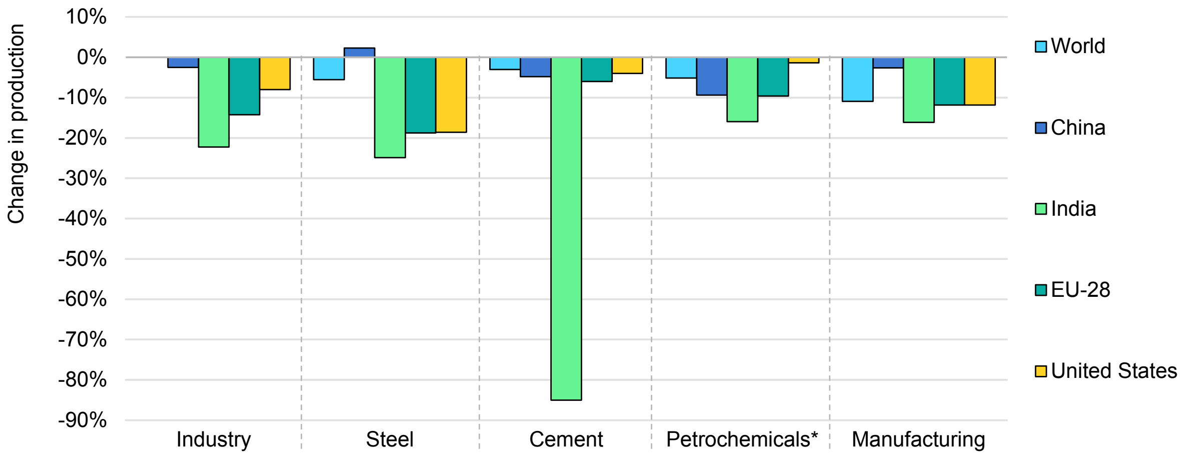
Activity and structural impacts

Industrial activity falls in most sub-sectors, reducing energy use

Industrial energy consumption is expected to be significantly lower in 2020 due to lower production. Across most industries, production was lower in the first half of 2020 than in the first half of 2019. Lockdowns reducing workers' movements curtailed production, while demand for upstream products fell from other sectors of the economy.

In India, the world's second largest producer of cement, cement production was about 85% lower than in the same period in 2019, due to a combination of cement facility closures and weaker construction activity, both in India and in countries to which it exports cement. Investment in new building construction and retrofits, a major end-use for cement, is expected to decline by around 10% globally in 2020.

Figure 4.1 Change in tonnage production, selected sectors, first half of 2020 vs. first half of 2019

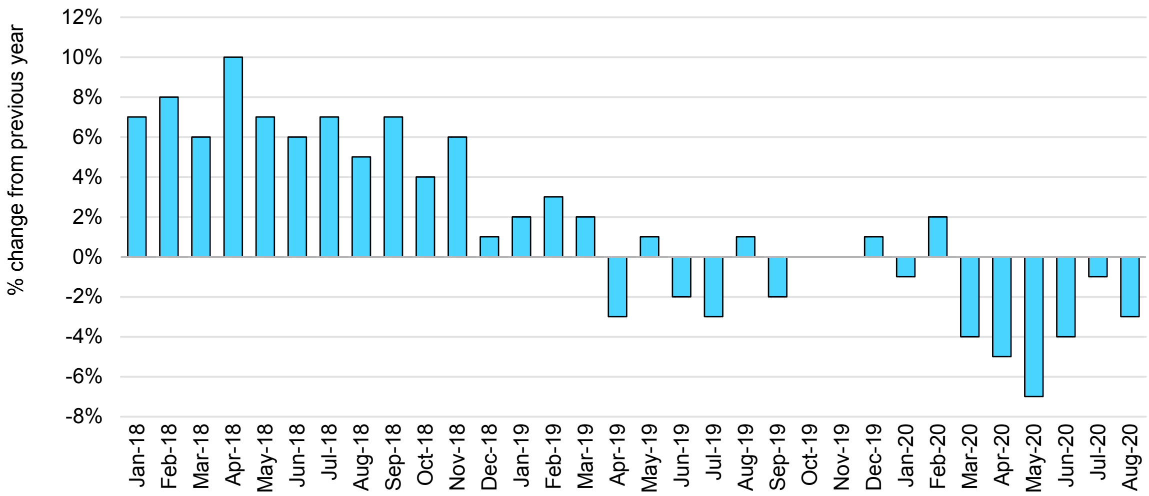


Note: Ethylene is taken as a proxy for petrochemicals. When no reported data are available, estimates have been made.

Sources: MoSPI, IIP; St. Louis Fed, Industrial Production; Trading Economics, Euro Area Industrial Production, China Industrial Production; World Steel Association, Statistics; Global Cement, Chinese cement output falls by 4.8% to 1Bnt so far in 2020, Indian cement production falls by 85% in first half of 2020; St Louis Fed, Cement and Concrete Product; IFC, The Impact of COVID-19 on the Cement Industry; Platts, Global Polyolefins Outlook 2020; Investing, Chinese Manufacturing PMI, Eurozone Manufacturing PMI; Quandl, PMI Composite Index; FXEmpire, India Manufacturing PMI, United States Manufacturing PMI, accessed 27 August 2020.

Certain sectors have already rebounded, particularly in China. After lockdowns were lifted in March-April, China's steel sector increased production beyond 2019 levels for the first half of 2020, while reports suggest cement production also rebounded strongly in May. However, the net yearly result for 2020 is still expected to show lower industrial production and energy demand than would have occurred without the Covid-19 crisis.

Figure 4.2 Monthly US natural gas consumption by industrial sector, Jan 2018-Jun 2020



Source: US Energy Information Administration, Industry sector consumption of natural gas falls amid slowing economy.

The impacts of lower industrial production have flowed through to energy use. In the United States, electricity use by industry was 9% lower year-on-year in April, while natural gas use by industry fell 8% in May 2020, the largest year-on-year decline since the last global recession in 2009. Although industrial gas use had been flat before the pandemic (growing by only 0.1% in 2019) the pandemic has cut demand significantly, with the US Energy Information Administration projecting that industrial gas use will fall by 4.4% in 2020.

Stimulus spending has already helped revive upstream industries such as iron and steel

In some countries, government economic stimulus measures targeting industry are already reviving industrial production. In China, 4 638 km of railway and urban rail infrastructure, worth USD 14.7 billion, was approved between January to June 2020 to help stimulate demand. These projects alone are expected to consume 23.8 million tonnes of steel, around 5% of China's steel production, in the first half of 2020.

Likewise, a growing preference for private travel because of the health crisis, steady demand, as well as new stimulus measures for electric vehicles, are also likely to boost demand for iron and steel used in automobile manufacturing, in addition to reviving the automobile sector.

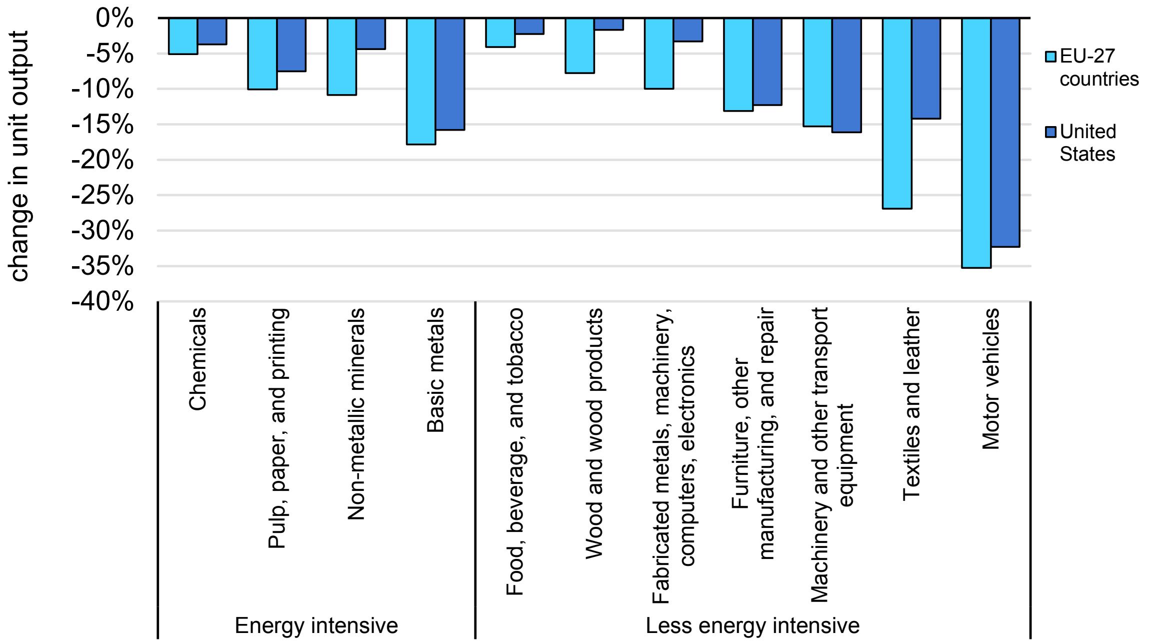
The current crisis is likely to shift industrial output to more energy-intensive manufacturers

From an energy perspective, if the output of less energy-intensive industrial[9] sub-sectors (such as textiles, machinery and equipment) declines more than the output of more energy-intensive sub-sectors (such as iron and steel, and cement), the overall energy intensity of industry would *increase* in the next few years. This is referred to as the "structural effect" on industrial energy intensity.

In the United States and Europe, lower consumer spending because of the current crisis has hurt manufacturing of less energy-intensive durable goods, such as motor vehicles, to a greater degree than more energy-intensive chemicals manufacturing, for example. It is currently too early to discern if global industrial output has shifted towards more energy-intensive manufacturing as a share of industrial output in 2020. However, in the United States, if data from the second half of 2020 are similar to the first half of the year, industry is likely to become more energy intensive, primarily due to a relatively larger share of output from the energy-intensive chemicals sector.

[9] Industry defined in this section is the "manufacturing industry" in relation to the system of national accounts.

Figure 4.3 Industrial sub-sector output change, first half of 2020 vs. first half of 2019, EU-27 countries and United States



Source: Eurostat, Production in industry (sts_inpr_m), accessed 25 October 2020. FRED, Industrial Production: Total Index, accessed 26 October 2020.

As economies rebuild from the recession, experience after previous economic crises shows that the design of government stimulus, in combination with the level of countries' economic development, could play a significant role in shaping industrial energy intensity. A growing economy is more likely to pursue stimulus by increasing construction of buildings and public infrastructure, which would lead to higher output from energy-intensive basic metals and cement production. In contrast, a developed economy would not require essential physical infrastructure to the same extent, so opportunities to stimulate manufacturing are present more in higher value sub-sectors like specialty chemicals or automotive production, which are less energy intensive.

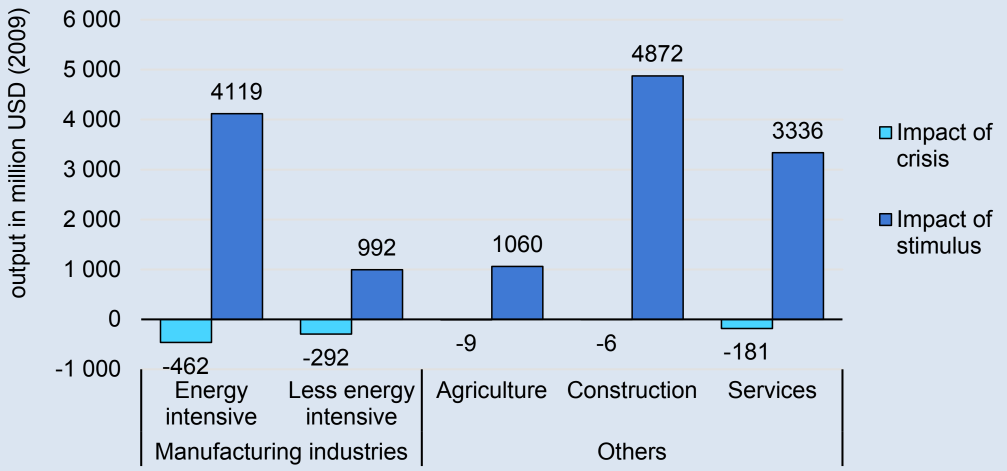
For example, during the 2008-09 global recession, China (a fast-growing economy) implemented a large stimulus package that shifted its manufacturing sector to more energy-intensive manufacturing. This pushed up energy intensity in the industry sector globally because of the size of China's industrial output and energy demand relative to other countries.

By tying industry financial assistance to energy efficiency upgrades, governments could help to reduce possible rebounds in industry energy intensity as stimulus packages are rolled out in response to the current crisis.

Box 4.1 Influence of government stimulus on industrial structure and energy demand after the last global economic crisis

Analysis of the Chinese stimulus package of CNY 4 trillion (USD 586 billion in 2009) during the 2008-09 financial crisis found an impact of 4.5% on GDP growth and only 1.8% on energy consumption. The stimulus package targeted public infrastructure, housing, health care, education and research. The resulting increase in construction indirectly generated higher output in energy-intensive manufacturing industries such as basic metals and cement than in less energy-intensive sectors such as textiles, machinery, and food and beverages.

Estimated impact of the 2009 stimulus package in China on the structure of manufacturing industries

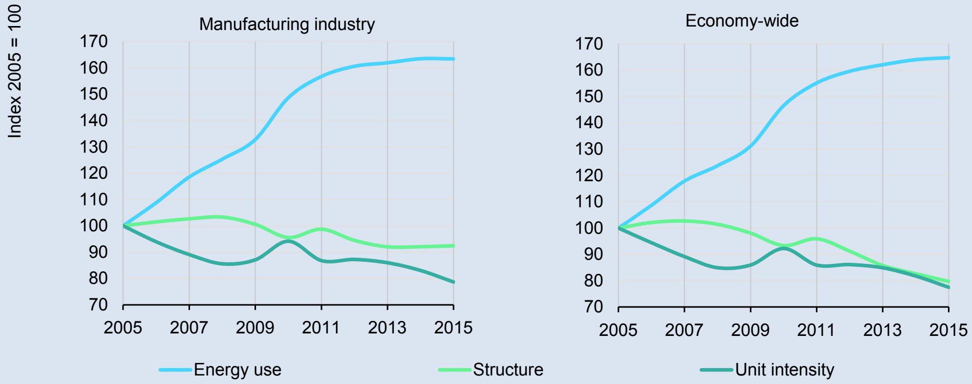


Note: Energy-intensive industries include: iron and steel; aluminium; chemicals; cement and non-metallic minerals. Less energy-intensive manufacturing industries include food, beverage and tobacco; textile and leather; machinery, transport equipment and electronics. Due to the grouping limitations in the input-output model in the study, the pulp and paper industry is grouped with wood and furniture manufacturing, a less energy-intensive industry.

Source: Yuan et. al., The impact on Chinese economic growth and energy consumption of the Global Financial Crisis: An input–output analysis.

The result was a more energy-intensive structure within the manufacturing industries but less energy intensive for the whole economy, when construction and services are also considered.

Index of structural effects, energy use and unit energy intensity in China (2005-15) for the manufacturing industries and the overall economy



Notes: The group of manufacturing industries include the sub-sectors of basic metals; chemicals; non-metallic minerals; transport equipment and machinery; food, beverages and tobacco products; paper and printing; wood; textiles and leather; rubber and plastics; furniture and other manufacturing. The economy-wide group includes manufacturing industries along with agriculture, construction and services.

A reduction in the index value of structure implies a lower share of energy-intensive components than of other components in the analysed group. A reduction of index in unit intensity implies a collective increase in efficiency of energy use at the component level (i.e. sub-sector level).

Sources: IEA, Energy Efficiency Indicators; Asian Development Bank, Input-Output Economic Indicators.

Beyond the immediate impacts, the evolution of the industrial structure depends less on stimulus and more on countries' economic and social development strategies, such as innovation and trade policies to support the growth of less energy-intensive, high value-added industries.

Technical efficiency impacts

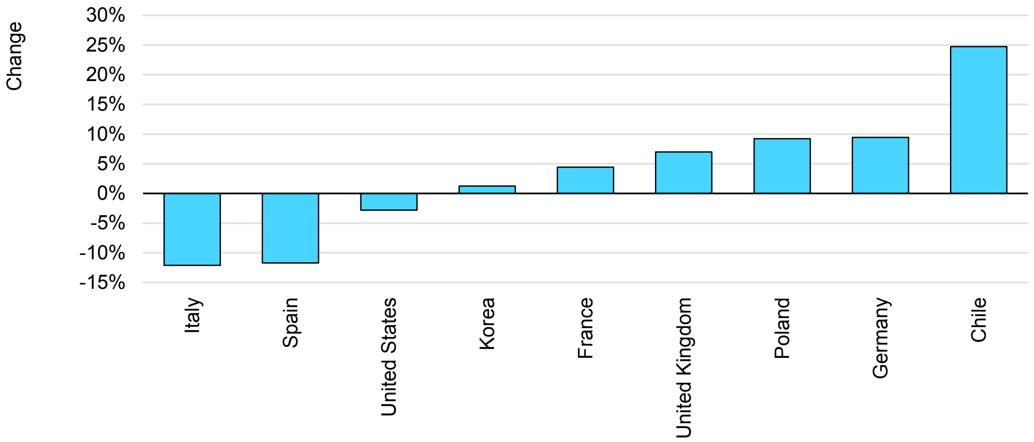
As investment is weak and attention is focused on reviving production levels, investments in energy efficiency are at risk of being deprioritised because they take a long time to pay for themselves – even longer under current conditions, with energy prices remaining low. Measuring the benefits from energy efficiency will be essential, as efficiency will be competing for investment with core business activities such as marketing or production optimisation. Without policy action to tie stimulus packages to energy efficiency investments, there is a risk that energy efficiency upgrades will be delayed.

As the table at the beginning of this section shows, several factors may either increase or decrease the technical efficiency of industry. Under current economic circumstances, the strongest factors are likely to be those that lower efficiency.

The market for more efficient motors and motor systems could stall

Given the predominance of motors in industrial processes, improving the energy efficiency of installed motor systems is a key way of increasing industrial technical efficiency. New regulations will increase the energy performance of new industrial motors. At the same time, industrial motors have continued to enjoy short payback periods during the crisis, which are estimated to have been extended by only 10% from a typical period of three to four years, owing to their longer hours of usage and the relatively stable industrial electricity prices.

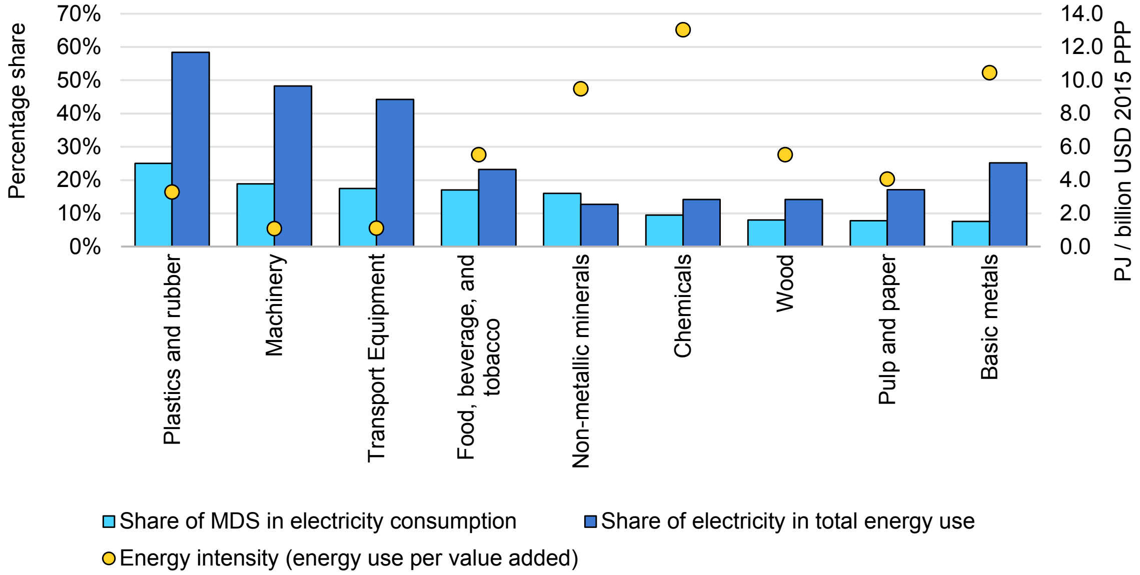
Figure 4.4 Industrial electricity prices in major economies, first half of 2020 vs. first half of 2019



Sources: IEA, Energy Prices, accessed 25 October 2020. Eurostat, nrg_pc_205, accessed 25 October 2020. EIA, Average Price of Electricity to Ultimate Customers, accessed 25 October 2020.

Despite this modest impact on payback period, the current crisis makes motor upgrades less likely because industries are tending to focus instead on their core business, on reducing costs and on maintaining liquidity. This is especially true for less energy-intensive industries where overall energy use is a less significant contributor to operating costs. Nonetheless, it is in these less energy-intensive industries – where electric motor-driven systems are a significant use of electricity and of energy overall – that the largest share (70%) of industry sector energy savings potential exists.

Figure 4.5 Motor-driven system electricity use as a share of electricity use by industry sub-sector



Notes: MDS = motor-driven system. PJ = petajoules. PPP = purchasing power parity.
Source: US EIA, Manufacturing Energy Consumption Survey. IEA, Energy Efficiency Indicators.

Moreover, despite new regulations increasing the efficiency of motors, motor-driven units such as pumps, fans and compressors still have limited coverage by minimum energy performance standards and rely on original equipment manufacturers to increase the energy efficiency of their products, depending on their perception of market needs.

So far, few stimulus packages for industry contain energy efficiency measures, with notable exceptions in Denmark and France, which have earmarked funds industrial efficiency projects starting in 2021.

5. Urban transport

Movement restrictions, lockdowns and border closures during the Covid-19 pandemic have transformed personal mobility in cities, heavily reducing energy demand. A range of crisis-induced factors could influence the energy intensity of urban mobility.

Despite some easing of restrictions during mid-2020, some trends emerging from the crisis in 2020 are:

- lower travel demand (particularly for business) and reduced commuting (as a result of teleworking)
- a shift away from public transport to private cars and active transport, and growth in e-commerce and delivery services
- a slight improvement in new road vehicle technical efficiency, because electric vehicles' share of new car sales has risen.

The longer-term outlook for urban transport energy intensity remains unclear but economic uncertainty and continuing low fuel prices could slow vehicle upgrades, resulting in lower technical efficiency.

Table 5.1 Crisis-induced factors that could affect passenger transport energy intensity

Type of effect	Factor	Potential effect on energy intensity improvement
Activity and structural	Modal shifts in urban transport, from public transport to cars.	↓
	Modal shifts in urban transport, from public transport to active transport.	↑
Technical efficiency	Economic recession results in low consumer confidence, leading to lower vehicle replacement rates in some markets or uptake of cheaper, less energy-efficient vehicles.	↓
	Continuing low fuel prices encourage the purchase of less efficient vehicles and fuels.	↓
	Government stimulus spending targets more efficient vehicles and modes of transport.	↑

The design of government stimulus spending could improve technical efficiency, for example by providing incentives for consumers to replace older, less efficient vehicles. It could also determine whether behaviours that improves energy intensity continue – for example, by providing urban infrastructure that encourages the public to use more energy-efficient active transport modes, such as cycling. Stimulus measures not tied to efficiency improvements could lead to strong rebounds in energy use, if or when passenger transport activity returns to pre-crisis levels.

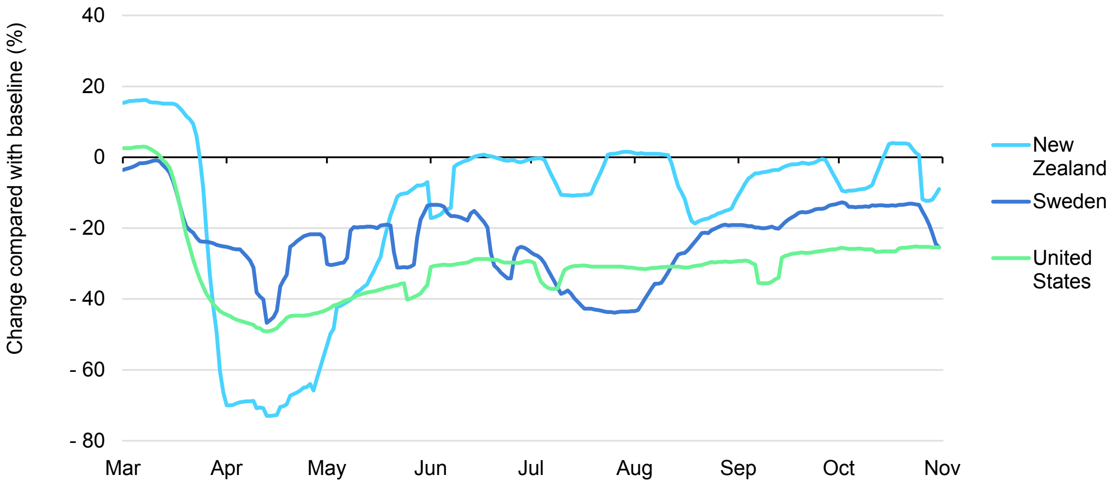
Transport has already been the focus of a significant number of government stimulus spending announcements, designed to shift travellers to less energy-intensive modes of transport and improve the technical efficiency of vehicles. However, stimulus spending announcements have primarily focused on supporting electric vehicles and charging infrastructure, with less support directed to other efficient transport modes.

Activity and structural impacts

Steep reductions in urban mobility, particularly for commuting

Stay-at-home restrictions, workplace and school closures, and other movement restrictions resulted in steep reductions in urban mobility in March and April. While restrictions have been eased in many countries, smartphone data show that visits to workplaces and retail and recreation[10] as of the end of October remain below baseline levels in most countries. Travel to workplaces remains about 25% lower in Canada, Mexico and the United States, and 15% to 30% lower in most European countries. In contrast, travel to workplaces has remained largely unchanged in countries less affected by Covid-19, such as New Zealand.

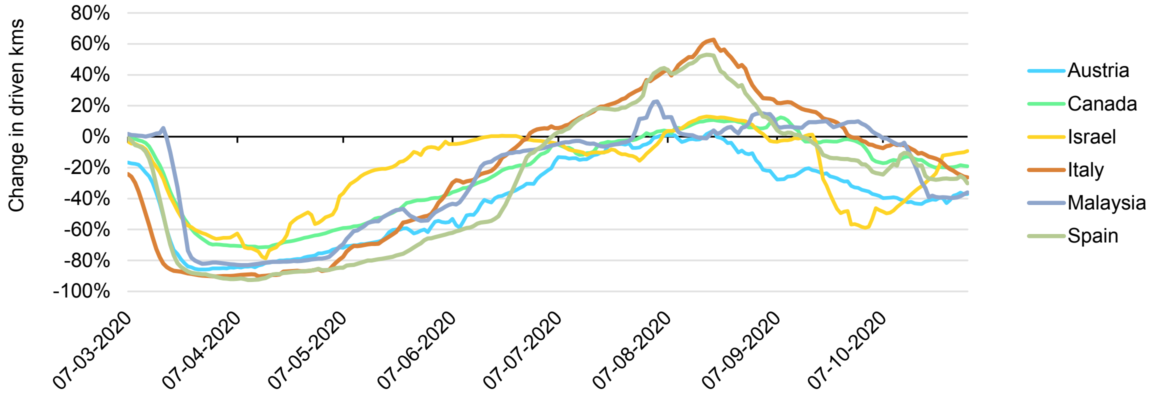
Figure 5.1 Change in travel to workplaces in select countries, March to October 2020



Notes: Values are relative to the five-week period between 3 January and 6 February 2020. Data represent the number of visits recorded to places of work.
Sources: Our World In Data; Google LLC Google COVID-19 Community Mobility Reports.

[10] Retail and recreation includes places like restaurants, cafés, shopping centres, theme parks, museums, libraries and movie theatres, and excludes groceries and pharmacies.

Figure 5.2 Change in driven kilometres in select countries, March to October 2020



Notes: Values are relative to the two-week period between 11 February and 25 February 2020. Data represent the increase or decrease in driven kilometres as a percentage change compared with a baseline. The changes for each day are compared with a baseline value for that day of the week and a seven-day average is applied.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Source: Waze, COVID-19 Impact Dashboard.

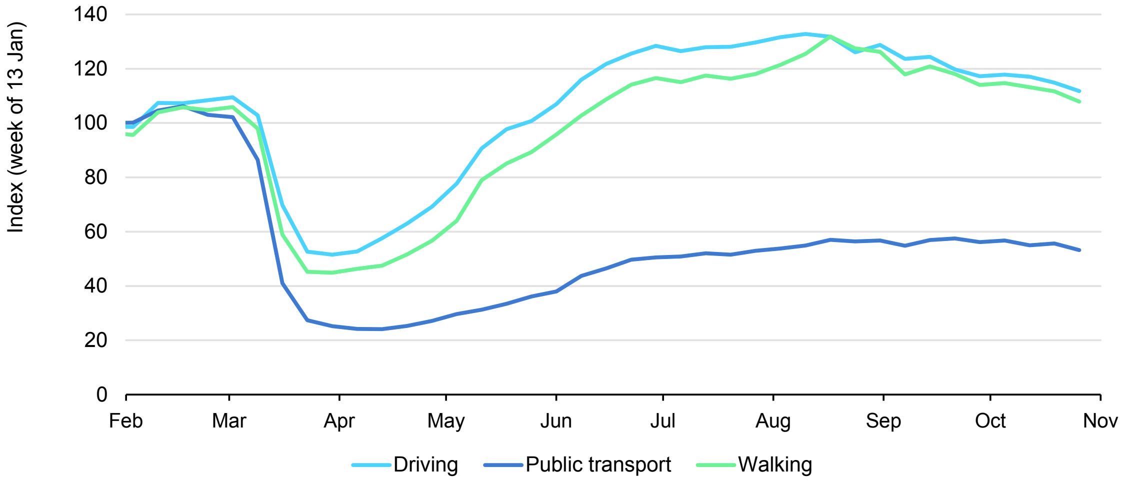
In some countries, impacts of the second wave of the Covid-19 pandemic on mobility were becoming visible in September and October. For example, smartphone data from Israel suggest that the three-week lockdown imposed on 18 September reduced the average driven kilometres per day by around half.

Modal shifts in cities: Away from public transport and towards private transport

While transport activity is likely to be lower than normal across all modes in 2020, trip data from smartphones suggest that in most countries, the decline in public transport trips exceeds declines in private transport modes such as walking and driving.

Data from the United States illustrate the types of modal shifts occurring around the world. After lockdowns and movement restrictions were introduced in the United States, weekday transport demand for all modes plummeted below typical levels during March and April. By mid-May, trips by car and walking had recovered (and exceeded pre-pandemic levels) but public transport remained far below typical usage levels, as people remained fearful of the infection risk.

Figure 5.3 Index of changes in work week transport trip requests by mode, compared with baseline, February to October 2020, United States

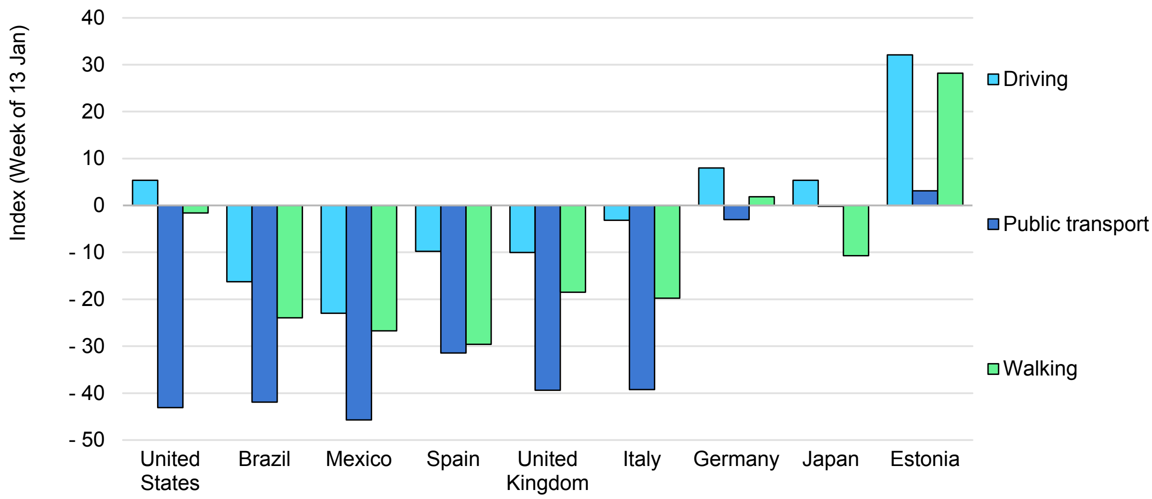


Note: Baseline is average over the working week beginning 13 January. A trip request is a request for routing directions made via the Apple Maps smartphone application. Working week = Monday to Friday inclusive.
Source: Apple, Mobility Trends Reports.

Among the urban mobility modes, public transport (bus, metro and rail) has been hit the hardest. In countries where the health crisis has been particularly severe, trips by public transport remain around 40% lower than before the pandemic.

In contrast, driving, walking and cycling have experienced a more substantial recovery in trips, with some of these modes exceeding pre-pandemic levels.

Figure 5.4 Average working week transport trip requests by mode (average of all weeks, 13 Jan to 31 Oct 2020 inclusive), compared with baseline

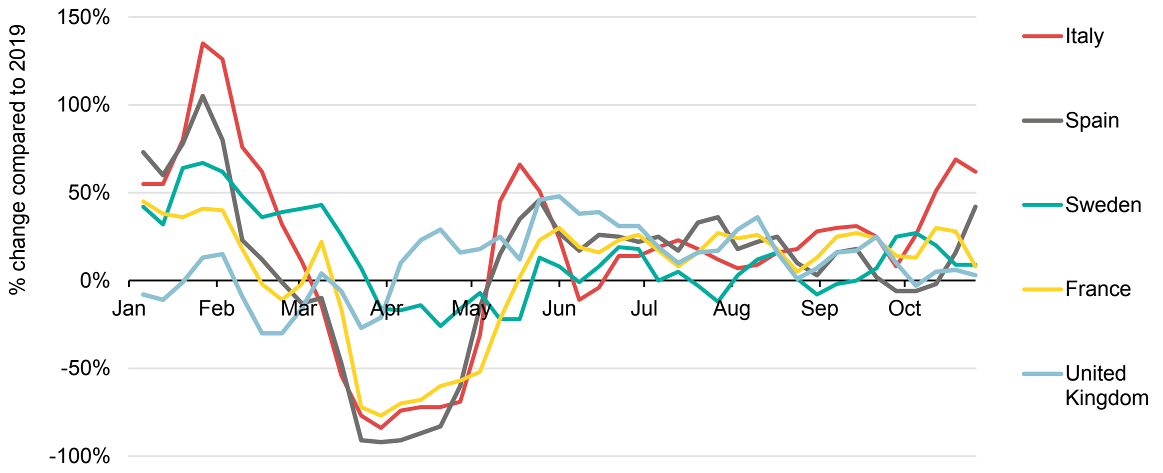


Note: Baseline is the average for the working week beginning 13 January. A trip request is a request for routing directions made via the Apple Maps smartphone application. Working week = Monday to Friday inclusive.
Source: Apple, Mobility Trends Reports.

Some countries have registered net increases in average trips by car for the year to date. In Germany, Japan and the United States, car trips have increased from the pre-pandemic period, while public transport trips remain lower than usual. Road congestion in Bangkok, Beijing and Shanghai has nearly returned to pre-crisis levels as movement restrictions ease.

The pandemic also appears to be boosting active transport modes. Automated bike counters show increases in many North American regions and European countries. In September, for example, bike counts in France, Italy and the United Kingdom were up 15% to 25% compared to the same period in the previous year. In Jakarta, Indonesia, bike sales have increased over 1000%. The introduction of new infrastructure is also facilitating change: in Mexico City cycle use increased by 132% after new cycle lanes were introduced. In some countries, including Italy and the United States, average weekly walking trips have also increased since the start of the pandemic, and especially since the summer began.

Figure 5.5 Weekly bike count trends by country, 2020 compared with 2019



Note: The analysis represents the percent change in ridership between corresponding weeks in 2020 and 2019. Values shown are two week moving averages.
Source: EcoCounter.

The trend towards private transport modes has also been strong in regions where the health crisis has been less extreme. For example, in Estonia, trips by car and walking are 30% higher than before the pandemic, while public transport trips have barely changed. The fact that modal shifts are apparent even in countries where the impacts of Covid-19 have been minor suggests that fear of contracting the virus could be a powerful cause of behavioural changes in the transport sector. A recent survey of attitudes in 25 of the world's largest energy-using countries indicates that these shifts could persist, with higher shares of people intending to use their cars more than before the pandemic compared with those intending to use their cars less.

The use of shared micromobility services – individualised public transport such as shared bicycles, electric bicycles and electric scooters – plummeted nearly to zero in March and April, but has since begun to recover. Shared bike use has rebounded substantially, particularly in Chinese cities. In Beijing, the number of bike sharing users had more than doubled as of May, while averaging longer trip distances (3 km) than before the crisis.

Whether this preference for private transport translates to higher energy use per trip will depend on whether people replace public transport with active transport modes (such as walking and cycling), shared micromobility or cars. Policies will play a major role; several countries have introduced policies to encourage higher active transport use in cities.

Technical efficiency impacts

Economic uncertainty countered by price breakthroughs

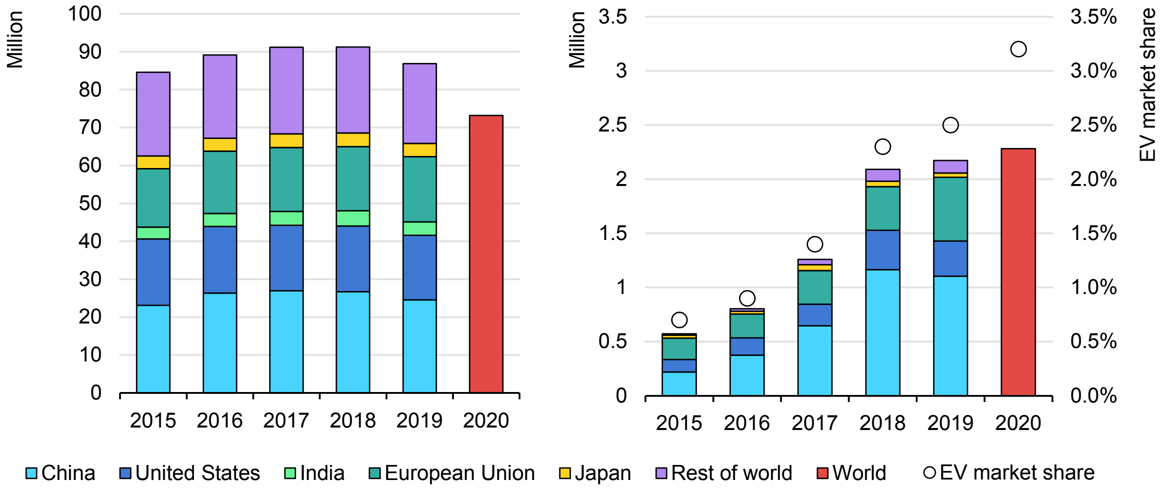
While the main impact of the pandemic on passenger transport energy demand in 2020 has been the sharp reduction in activity, crisis-induced changes to incomes, fuel prices and policies will also affect transport technical efficiency. Road vehicle replacement rates for 2020 are expected to be lower globally, keeping older, less efficient vehicles in the market for longer.

According to one consumer sentiment survey, new vehicle purchases in the US and European markets will be about 25% lower than normal in 2020. In emerging markets such as China, consumers appear more willing to purchase new vehicles. However, despite recent changes, over 70% of Chinese car buyers are buying their first car, meaning that higher purchasing in this market is unlikely to improve efficiency through vehicle replacements.

In Japan, new car sales and registrations of second-hand vehicles fell in the first half of 2020 compared with 2019. However, while second-hand vehicle registrations had almost returned to 2019 levels by September, new car sales were still at only 84% of 2019 levels, suggesting a slowdown in overall fleet fuel efficiency.

Despite early signs of higher growth in key markets such as China, global car sales are projected to be 16% lower in 2020.

Figure 5.6 Global car sales (left) and electric car sales (right) by key markets, 2015-20



Note: EV = electric vehicle. EV market share = electric car share of new car sales.
Sources: IEA, World Energy Investment 2020 and Tracking Clean Energy Progress.

Despite lower overall sales, new cars added to the fleet in 2020 will include a larger proportion of electric vehicles, which have a higher level of technical efficiency.

Global electric car sales in 2020 will slightly exceed 2019's total to reach more than 2.3 million, achieving a record share of 3.2% of car sales, up from 2.5% in 2019. This brings the total number of electric cars on the road worldwide to a new record of about 10 million, around 1% of the global car stock.

Despite the global recession, prices of electric vehicles are continuing to fall because electric cars are gradually becoming competitive in some countries on the basis of the total cost of ownership. This factors in fuel expenses, purchase costs as well as the impact of recent low oil prices, which have eroded the competitiveness of electric vehicles to an extent. In addition, governments have been quick to use stimulus packages to boost financial support for electric vehicles, including USD 12 billion allocated by G20 economies, which will further help to support demand.

6. Long-distance transport

As with urban transport, the Covid-19 pandemic has dramatically curbed long-distance transport, modifying energy intensity via a mix of structural and technical efficiency effects.

Short-term changes include:

- lower load factors in passenger aviation and rail, due to lower demand and the impacts of lockdowns
- low fuel prices, leading to inefficient freight shipping routes
- a reduction in cargo freight capacity in passenger flights, leading to cargo-only flights in less efficient aircraft
- retirements of some of the least efficient planes, trains and ships.

Table 6.1 Crisis-induced factors that could affect long-distance transport energy intensity

Type of effect	Factor	Potential effect on energy intensity improvement
Activity and structural	Lower load factors in passenger aviation and rail transport, leading to higher energy use per passenger.	↓
	Modal shifts in passenger transport, from aviation to cars.	↓
	Modal shifts in passenger transport, from aviation to rail.	↑
	Modal shifts in freight transport from sea to inter-continental rail.	↓
Technical efficiency	Higher shares of the aviation fleet used for cargo versus passenger flights.	↓
	Economic stimulus for airlines and automotive companies is not tied to energy efficiency improvements, leading to rebounds in less efficient transport.	↓
	Continuing low fuel prices encourage the purchase of less efficient vehicles and fuels.	↓
	Government stimulus spending targets more efficient vehicles and modes of inter-city transport.	↑
	Lower demand for long-distance travel, leading to the retirements of some of the least efficient planes, trains and ships.	↑

Note: A shift from aviation to cars may lead to higher or similar energy intensity, depending on the trip.

In the longer-term, the future of long-distance passenger transport is extremely uncertain. The impact of the crisis on the economic viability of the aviation sector is a key unknown, which could result in modal shifts from aviation to rail or cars for certain domestic and short-haul international journeys.

Freight transport has been less severely affected than passenger transport, as consumers are continuing to purchase goods and services that require transport, even during lockdowns. However, the demand shocks triggered by the pandemic have been felt particularly hard by freight shipping, used for long-distance transport of fuels, raw materials and finished products.

Aviation and rail

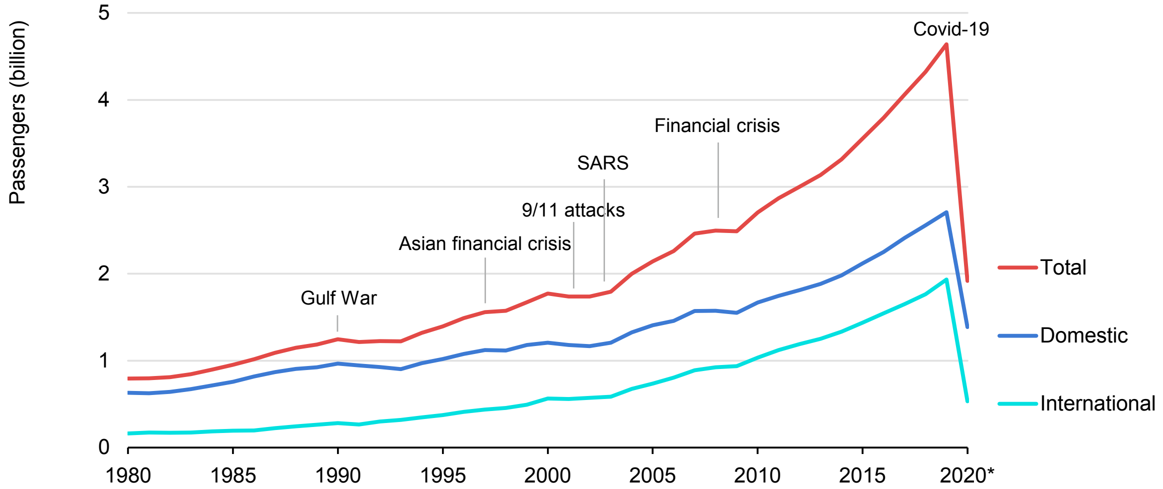
Activity and structural impacts

An unprecedented collapse in air and rail travel could trigger long-distance modal shifts

The Covid-19 crisis has led to an unprecedented collapse in commercial flights and air passenger traffic. At the height of travel restrictions in April, there were 65% to 75% fewer commercial flights globally compared with April 2019, and a 98% reduction in international passenger demand. While flights have since gradually resumed, they remained at around 45% of 2019 levels as of September.

As of mid-November, the International Civil Aviation Organization expected air passenger traffic for 2020 to be 60% lower than in 2019. The largest drops are expected in Asia-Pacific, followed by Europe.

Figure 6.1 World air passenger traffic evolution, 1980-2020



Source: International Civil Aviation Organization (2020). ICAO Economic Impact Analysis of COVID-19 on Civil Aviation.
Note: a) Historical figures are subject to revision and estimates for 2020 will be updated with the evolving situation; and b) For latest update please refer to ICAO Economic Impact Analysis of COVID-19 on Civil Aviation.

Global passenger rail demand for 2020 is expected to decline by up to 30% compared to 2019 according to scenarios developed by the International Union of Railways (as of July 2020). Another projection from September by the consultancy SCI Verkehr estimates a 36% drop from 2019. An estimated USD 45 billion to USD 60 billion in revenue losses are expected in 2020, nearly all from Asia (53%) and Europe (44%) where there are significant passenger rail services.

On average, trains are at least 12 times more energy efficient per passenger than air travel. Therefore, a net shift from aviation to rail, resulting from lower falls in demand for rail than for aviation, would substantially reduce energy use and emissions.

Covid-19 could accelerate the shift from air to rail travel in Europe and China. Higher demand for rail, and lower-than-expected growth in aviation would see an additional 800 high-speed trains in operation in Europe within the next decade, and nearly 200 fewer planes required globally. Earlier IEA analysis had already shown that around 14% of all flights could be competitively shifted to high-speed rail. Several night train routes are emerging (or re-emerging) in Europe, typically on ideal overnight routes of around 10 to 16 hours.

Some countries have also announced policies that may help accelerate a shift from air to rail in the medium to long term. In May, the French government announced that bailouts for Air France would be contingent on the national carrier ceasing to offer short-haul domestic flights when rail presents a viable alternative (trips that take less than two hours and 30 minutes). In China, which has a large potential to shift domestic flights to high-speed rail, rail stimulus announcements in the first half of 2020 are so significant they have already buoyed steel demand there.

In other countries, however, at least some of the domestic aviation trips are likely to be replaced by car travel. According to one US survey in May, around 60% of respondents intended to travel more by car (compared with around 35% by plane), up from 33% in a comparable 2018 survey (60% by plane). A European survey showed similar splits: 50% by car, 30% by plane, and 10% by train.

Potential trends in long-distance modal shifts are still emerging. However, energy intensity is likely to be significantly reduced by shifts from aviation to rail, little changed by shifts from aviation to cars and increased by shifts from rail to cars.

Travel restrictions and capacity constraints reduce fuel economy of passenger aviation and rail

In the aviation sector, travel restrictions, quarantine requirements upon arrival, high ticket prices, and the need for physical distancing have limited the number of passengers per aircraft, increasing fuel consumption per passenger. In April the average load factor for international flights plunged by two-thirds to just 28%, meaning that only about one in four seats were occupied.

In Australia, caps on international passenger arrivals to manage the virus have resulted in some flights having as few as 30 passengers (a load factor of around 10%), while some US and Asian airlines are keeping middle seats empty. As a result of such restrictions and lower demand, the International Air Transport Association expects the average load factor to fall from 83% in 2019 to 63% in 2020 .

Rail passenger load factors have also fallen, because of lower demand as people chose to travel less via mass transport and safety measures during the height of the Covid-19 crisis. Maximum capacity requirements were temporarily introduced for train travel in France, Italy and elsewhere, which increased energy use per passenger.

Most rail operators no longer impose seating restrictions and have instead introduced measures to maximise the space between passengers where possible, as well as improving ventilation and cleaning procedures. However, while rail capacity is recovering in some countries, such as China, in others load factors have continued to be lower.

Technical efficiency impacts

Higher shares of air freight are affecting the average technical efficiency of aviation

The impacts on air cargo have been less severe than on passenger aviation. Global demand for air cargo fell by 18% in June compared with June 2019, recovering from lows in April when demand fell 28%. This is partly because air freight is continuing to play a vital role in the rapid transport of goods necessary for Covid-19 responses.

Overall, the share of cargo in total air traffic has increased. For example, cargo Boeing 747s accounted for more than 90% of all 747 flights in August compared with around 70% in January. The rising share of cargo flights is having negative impacts for aviation as cargo aircraft tend to be older and less efficient than passenger aircraft.

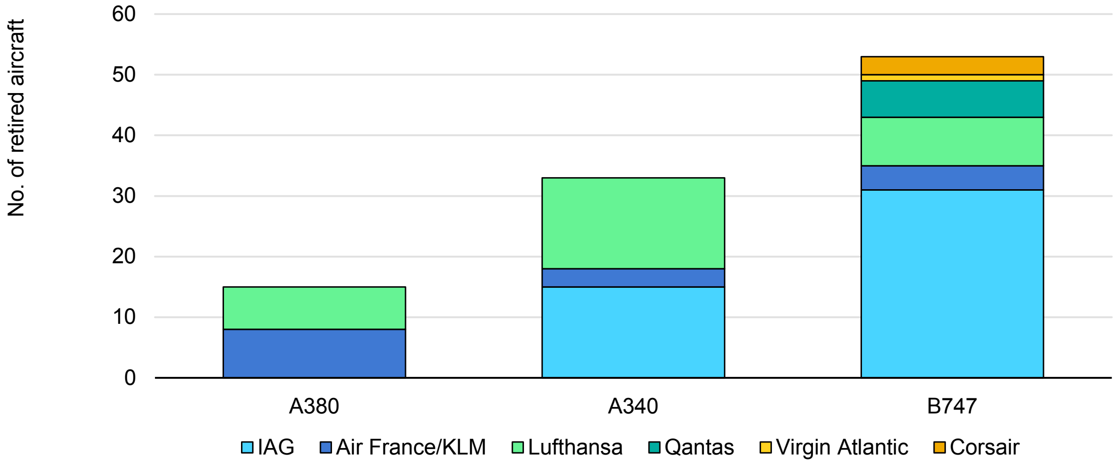
One of the less reported impacts of the severe drop in passenger aviation is the flow-on effects this is having for freight transport, as many passenger flights also reserve space in cargo holds for freight. As passenger flights were reduced, belly capacity for international air cargo fell by 70% in June compared with the previous year. This has been partially offset by the surge in cargo-only operations of passenger aircraft, which were up 35% in April. However, retrofitted or modified passenger planes offer limited cargo capacities compared with regular cargo aircraft, resulting in low fuel efficiency levels.

Early retirements of inefficient, high-capacity passenger planes: A silver lining for energy efficiency?

Lower demand for long-distance travel has accelerated the retirement of ageing or uneconomical planes, particularly large, four-engine aircraft, which are less energy efficient than smaller long-haul aircraft due to inherent design factors and lower seating densities.

Nearly half of the Airbus A340-600 fleets, almost 30% of the A380 fleets and 70% of the Boeing 747 fleets are to be retired or placed in long-term storage. In July, Boeing announced that B747 production would end by 2022, while Airbus completed initial assembly of the last A380 in September. A range of airlines have announced retirements of older, less efficient aircraft of other sizes. In total, more than 550 aircraft are unlikely to fly again.

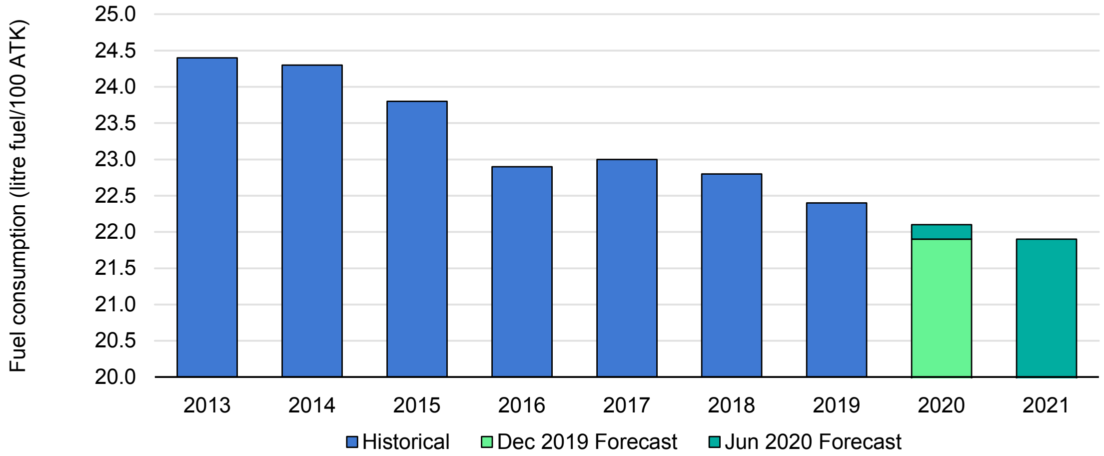
Figure 6.2 Number of retired four-engine aircraft (scrapped or long term storage) by model and airline since March 2020



Source: Analysis based on data by Planespotters.net.

However, some of these retirements have been pulled forward by merely one year. At the same time, airlines are delaying and cancelling orders for new, more efficient planes as fuel prices continue to be low and demand will take years to rebound. Meanwhile, aircraft manufacturers are reversing their initial plans to increase production in 2020 and beyond.

Figure 6.3 Global aviation fuel consumption, 2013-21



Notes: ATK = Available Tonne Kilometres.
Sources: International Air Transport Association, *Airline industry economic performance*.

In sum, the International Air Transport Association forecasts that fuel consumption improvements will slow down in 2020 and levels initially expected to be reached this year will only be achieved in 2021. Although early retirements of planes have made only a minor impact, fuel consumption improvements would be even lower without them.

The crisis is also drawing attention to the fuel cost savings made possible via more efficient aircraft, as airlines find themselves in deep financial stress. For example, more efficient Boeing 787s and Airbus A350s accounted for almost half of long-haul traffic during the second quarter of 2020, compared with only a quarter in 2019. Order books suggest that despite cancellations, more efficient aircraft types will continue to play a role in airlines' future plans.

Box 6.1 How will recent retirements of very large aircraft affect air travel if it returns to pre-crisis levels?

Early retirements of some of the world's largest aircraft have improved the average fuel efficiency of the aircraft fleet in 2020, which will reduce energy use and emissions when flights start to increase again. However, the impact is minor.

If flights return to 2019 levels, replacements of very large aircraft (Airbus A380s and Boeing 747s) by smaller, more efficient aircraft that were triggered by Covid-19 would improve average fuel efficiency of the global aircraft fleets by just 0.2%. Although the impact is slightly larger when only looking at long-haul fleets, it stresses the need to accelerate fleet renewals in addition to replacing very large aircraft with smaller models. Typically, new models are 15% to 25% more fuel efficient than their predecessors with similar sizes and ranges. In 2020, this process has slowed, as airlines are avoiding major investments and aircraft manufacturers are reducing production capacities.

Accelerated retirements of less efficient diesel trains for passenger rail

Covid-19 could further accelerate the reduction in the diesel locomotive fleet, particularly in passenger rail. The market for diesel locomotives is expected to shrink by 24% between 2020 and 2024 compared with pre-pandemic projections. However, in freight rail – especially in markets with very few electrified networks, like the United States and the Russian Federation ("Russia") – investments in diesel locomotives are expected to continue.

Shipping

Activity and structural impacts

Shifts from ships to rail along Asia to Europe routes may increase freight energy intensity

Freight shipping activity has fallen as a result of record drops in cargo and oil demand. Global container trade volumes declined 8% through the first half of 2020, after bottoming out in April when it fell 17% compared with April 2019. Data from EU ports show that ship arrivals declined by 16.5% through the first half of 2020 compared with the first half of 2019.

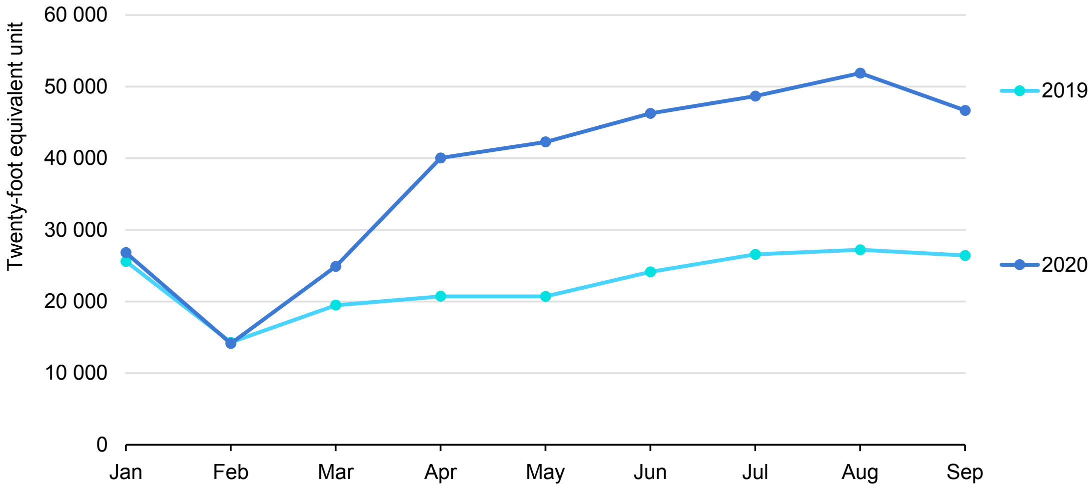
Global freight rail volumes are also projected to decline by up to 10%. The largest revenue losses are expected in Europe, accounting for about a third of the global losses projected in 2020. Freight rail traffic in continental Europe is projected to drop by 20%. In India, rail freight demand fell by 28% during April and May compared with April and May 2019, with lower coal loads contributing to 60% of the reduction.

In China, however, which has the largest share of global freight activity, freight rail has been resilient, with volumes up 3.6% year-on-year through the first half of 2020. This increase is the result of a shift from marine to rail on selected routes.

Ocean freight has been affected by capacity constraints as ships have been withdrawn and strong European demand for personal protective equipment from China has filled up the available air freight space. As a result, traders in Europe and Asia have increasingly shifted to using rail corridors linking the two continents. Rail is likely to have mainly replaced ocean freight (which is slower but cheaper) more than air freight (which is much faster but more expensive). This may slightly increase energy intensity, as rail is more energy intensive than ocean freight but less energy intensive than air freight.

Freight turnover on Eurasian routes was 30% higher in March compared with 2019, and 90% higher in August.

Figure 6.4 Eurasian rail freight turnover, 2019 and 2020



Source: Eurasian Rail Alliance Index.

East to west rail routes have become so popular that capacity constraints are now being reached. Congestion is starting to increase rail shipping times, which are normally about one week faster than ocean shipping.

Technical efficiency impacts

Economic downturn pushes down marine fuel prices, with mixed implications for energy intensity

As of 1 January 2020, the International Maritime Organisation lowered the maximum sulphur content of shipping fuel oil from 3.5% to 0.5%. To comply with the new regulations, freight ship operators can either use very low sulphur fuel oil or continue to use high sulphur fuel oil in combination with scrubbers, devices that reduce sulphur dioxide emissions but use more energy.

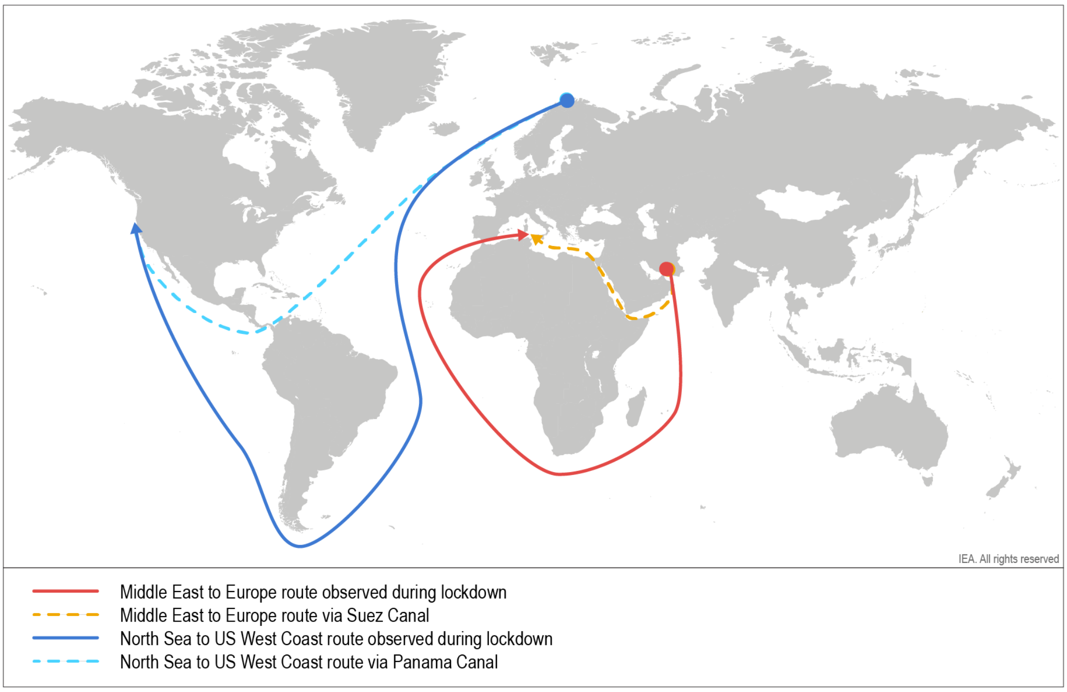
Very low sulphur fuel oil prices (linked to Brent crude oil prices) were high before the pandemic, making high sulphur fuel oil and scrubbers the more economical choice for compliance for large ships. However, the economic crisis has narrowed the price difference between the fuel oil types – from around USD 160 per million tonnes in the first quarter of the year to around USD 50 in the third quarter. As a result, the payback period for using high sulphur fuel oil and scrubbers is now six to seven years on a scrubber worth USD 3.5 million.

Box 6.2 Low oil prices change oil tanker delivery routes

Low marine fuel prices, combined with a shortage of fuel storage facilities at the height of lockdowns, resulted in some unusual itineraries for fuel tankers, many of which were essentially repurposed as floating oil storage facilities.

As oil prices hit historic lows in March and April, satellite tracking revealed that some supertankers were taking longer delivery routes in the hope that by the time they reached their destination, oil prices would have risen, more than offsetting the cost of burning extra fuel by taking the longer route.

Illustrative crude oil tanker delivery routes: Frequently taken oil tanker routes compared with some routes taken during March-April 2020



Reports show that at least three supertankers travelled a far more energy-intensive route around the Cape of Good Hope instead of taking the Suez Canal, while

European tankers delivering fuel to the West Coast of the United States were observed sailing around Cape Horn at the tip of South America instead of taking the Panama Canal.

Should low oil prices prevail, more shipping operators might shift to very low sulphur fuel oil, a less energy-intensive option. Without any regulation, however, sustained low oil prices could delay or discourage the adoption of low-carbon alternative fuels, such as LNG in the near term, and biofuels, hydrogen and ammonia in the longer term. They could also reduce the imperative to adopt technical and operational measures to reduce fuel consumption.

Cruises pause but fleet efficiency rises as inefficient ships are retired or retrofitted

Passenger cruise ship operations were projected to serve 32 million passengers in 2020, but have been largely suspended since mid-March. Operations in the United States have been suspended until the end of October, while similar suspensions have been announced in Australia, Canada and New Zealand.

As with the aviation industry, retirements of older ships have been taking place in the cruise liner industry. Carnival, the world's largest operator, announced plans to sell 13 ships for scrap, representing 9% of its capacity. These are likely to be ageing ships that are less energy efficient. Royal Caribbean, another major cruise operator, is also scrapping or selling older parts of its fleet.

As in aviation, financial stress could delay cruise companies' purchases of new ships, meaning the net effect for fleet technical efficiency may not be as large as expected. However, the unexpected downtime during the pandemic is also affording cruise operators the chance to conduct large-scale energy efficiency-related retrofits of the remaining fleet to reduce future operating costs.[11]

[11] IEA conversations with energy efficiency consultants to the cruise ship industry.

7. Tracking policy responses to the crisis

This section focuses on energy efficiency policy announcements made in response to the Covid-19 crisis to the end of October 2020, including changes to regulation and government funding announcements. In addition, it discusses some policies that are not targeted at efficiency but may have an impact on it, such as energy bill relief for households and businesses.

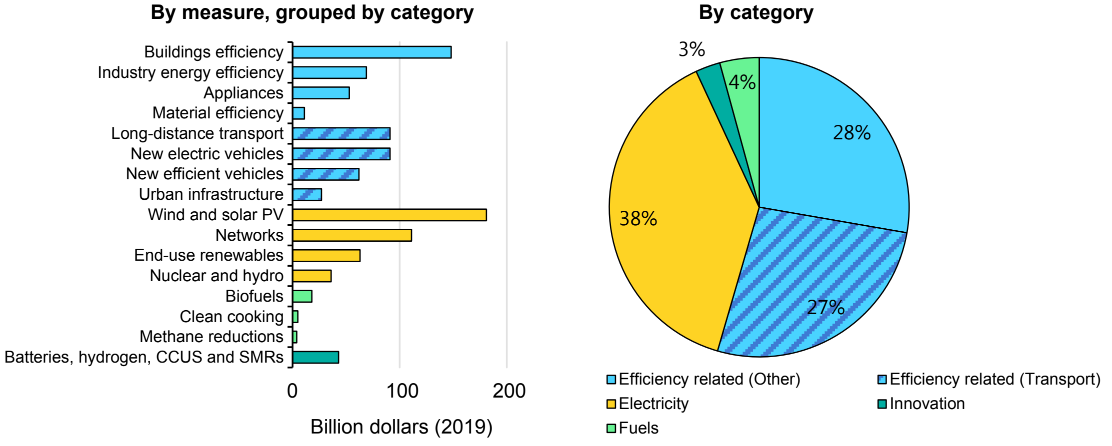
Energy efficiency: At the heart of a sustainable recovery

The IEA Sustainable Recovery Plan shows how the world can maintain and create jobs, boost economic growth and improve energy sustainability and resilience in the energy sector in the wake of the Covid-19 crisis.

Energy efficiency action (including investments in transport and urban infrastructure)[12] comprises the largest component of the plan, more than half of the proposed USD 1 trillion in public and private investment in each of the next three years. Investing in efficiency is central to the plan because many energy-efficient products and services are cost-effective and existing programmes can be ramped up in the near term. In addition, energy efficiency projects are labour-intensive, meaning for every dollar spent, a large amount goes into labour, helping to maintain existing jobs and create new jobs quickly. In some sectors, where skills barriers are minimal, energy efficiency investments can also provide employment for displaced workers.

[12] For the purposes of this analysis, "energy efficiency" includes investments in electric vehicles, urban infrastructure and rail, all of which tend to be more energy efficient when they replace incumbent technologies. It excludes clean cooking and end-use renewables.

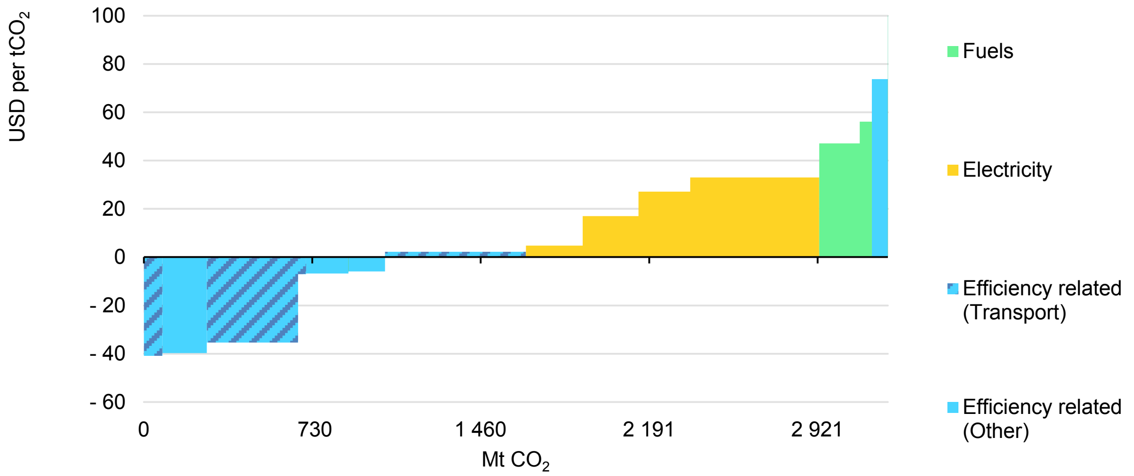
Figure 7.1 Proposed allocation of average annual spending under the Sustainable Recovery Plan by measure and category



Notes: PV = photovoltaic. CCUS = carbon capture, utilisation and storage. SMR = small modular (nuclear) reactor.
Source: IEA, *Sustainable Recovery: World Energy Outlook Special Report in collaboration with the International Monetary Fund*.

Most of the investment in energy efficiency results in energy savings and therefore monetary savings. Crucially, this means the cost per tonne of greenhouse gas emissions abated is often negative, as shown below under the modelled abatement of the measures in the Sustainable Recovery Plan.

Figure 7.2 Cost of abatement and emissions avoided as a result of selected Sustainable Recovery Plan measures, by category



Source: IEA, *Sustainable Recovery: World Energy Outlook Special Report in collaboration with the International Monetary Fund*.

Spending on efficiency is becoming a large part of governments' clean energy stimulus spending

While many governments' economic relief and stimulus announcements are still being formulated, around USD 114 billion of public spending in the energy sector announced to the end of October 2020 is being allocated to measures considered as "clean energy stimulus".[13]

In addition to the spending announcements analysed here, governments are also proposing support for the energy sector via regulatory changes, tax breaks or pauses on levies and royalties, and purchase of debt or equity.

Around 58% of public clean energy stimulus spending announced to the end of October 2020, totalling USD 66 billion, has been allocated to energy efficiency-related measures. The announced efficiency-related stimulus has the potential to create 5 million energy efficiency job-years,[14] when factoring in leveraged private investment (see also *Energy efficiency jobs and the recovery*).

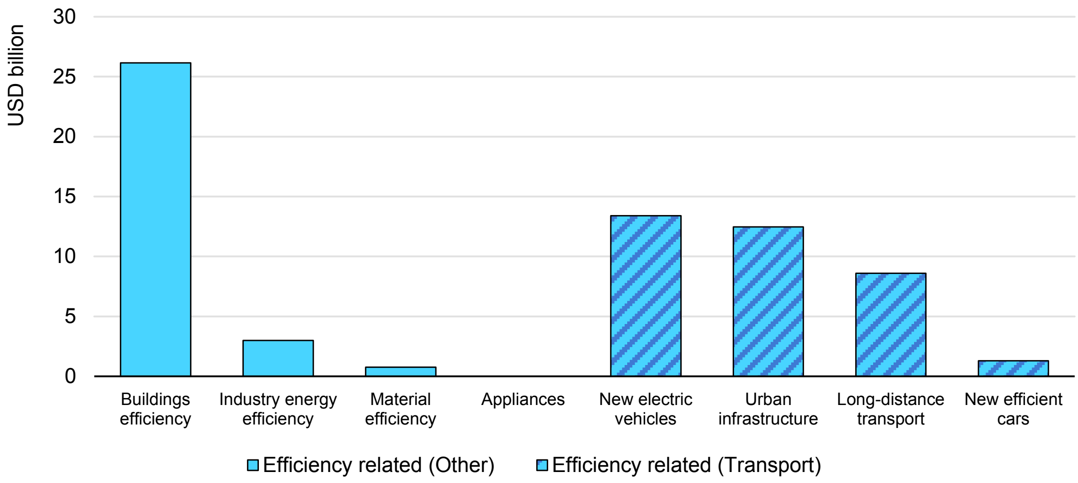
Table 7.1 Announced public clean energy stimulus spending by category[13]

Category	Billion USD	Share of clean energy stimulus spending
Efficiency-related (Total)	65.6	58%
Efficiency-related (Transport)	35.7	31%
Efficiency-related (Other)	29.9	26%
Electricity	23.5	21%
Innovation	22.2	20%
Fuels	2.4	2%
Total	**113.7**	**100%**

Notes: This table provides a breakdown of the funding committed to clean energy stimulus spending. It excludes clean energy-related portions of the European Union's EUR 750 billion Next Generation EU Funds, as details on the spending allocations were still being finalised at the time of writing. Stimulus spending for G20 countries partly based on data from Energy Policy Tracker.
Committed investment in hydrogen is included under "innovation".

[13] "Clean energy stimulus" refers to stimulus investments including renewable energy generation, biofuels, battery storage and clean hydrogen, electricity networks, electric vehicles and charging infrastructure, rail, public transport, cycling and walking, material efficiency, and buildings, appliance and industrial energy efficiency. This analysis focused largely on G20 countries, with selected data included for other OECD nations and other countries where data was available.
[14] One full-time job for one year.

Figure 7.3 Announced public efficiency-related stimulus funding by measure, to end of October 2020



Current spending announcements are unevenly spread between sectors and regions

Building retrofits and electric vehicles dominate efficiency-related stimulus spending

Of the USD 66 billion in public stimulus spending on efficiency-related measures announced to the end of October, USD 26 billion are dedicated to building retrofits. However, limited spending has been announced on high efficiency or near zero energy new buildings.

Around USD 13.5 billion has been announced to help accelerate the shift to electric vehicles, with a further USD 7 billion allocated to electric vehicle charging networks in funds allocated to urban infrastructure. In contrast, less than USD 1.5 billion has been announced for new efficient internal combustion engine vehicles.

In contrast to buildings, no spending has been announced to stimulate the purchase of energy-efficient appliances that exceed minimum energy performance standards. Economic stimulus announcements comprise just USD 3.0 billion for industrial energy efficiency globally, and less than USD 1.3 billion for new efficient vehicles, despite the significant opportunities that exist for efficiency gains in these sectors.

Of the USD 12.5 billion of efficiency spending announced for urban infrastructure, a large proportion has been allocated for new cycling infrastructure, as governments seek to bolster the use of active transport to replace public transport use in the wake of the pandemic. For example, the United Kingdom has committed to invest around

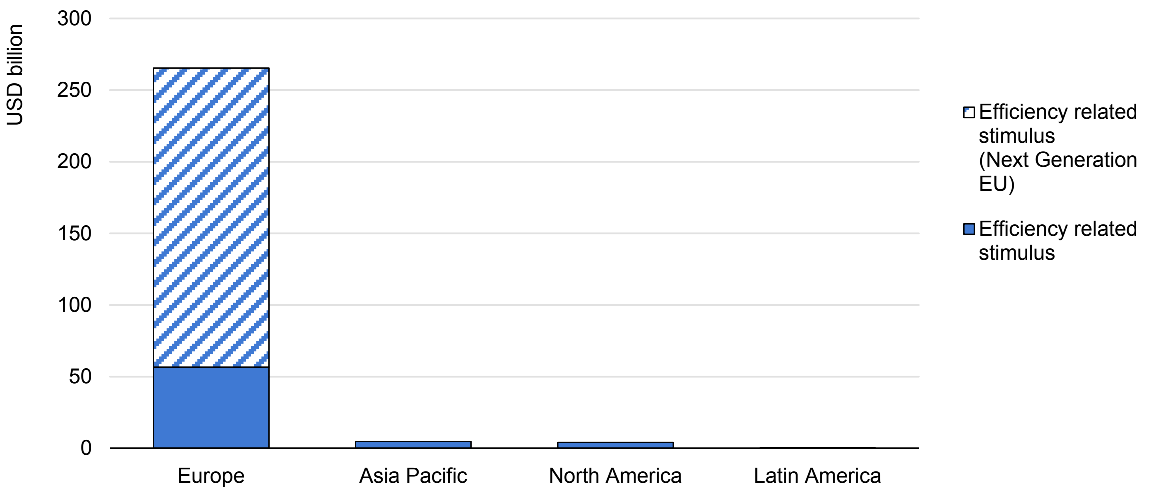
USD 2.5 billion in active transport with new and improved cycling infrastructure, the Canada Healthy Communities Initiative commits USD 22.7 million to a range of initiatives including those that support walking and cycling, and in the Greater Paris Region, France has committed over USD 330 million to create up to 680 kilometres of cycleways.

European governments have announced the vast majority of stimulus spending on efficiency, other regions lagging

European governments have been the most active in announcing support for efficiency-related measures. Around USD 57 billion of spending proposals (or 86% of global stimulus announcements for efficiency) has been announced by European governments to the end of October, with the remaining 14% split between Asia Pacific and North America. Of European announcements, the largest are from France, Germany and Italy.

In contrast, only very small amounts of energy efficiency spending have been announced in Latin America and no major announcements recorded in Africa.

Figure 7.4 Announced public energy efficiency stimulus funding by region, to end of October 2020



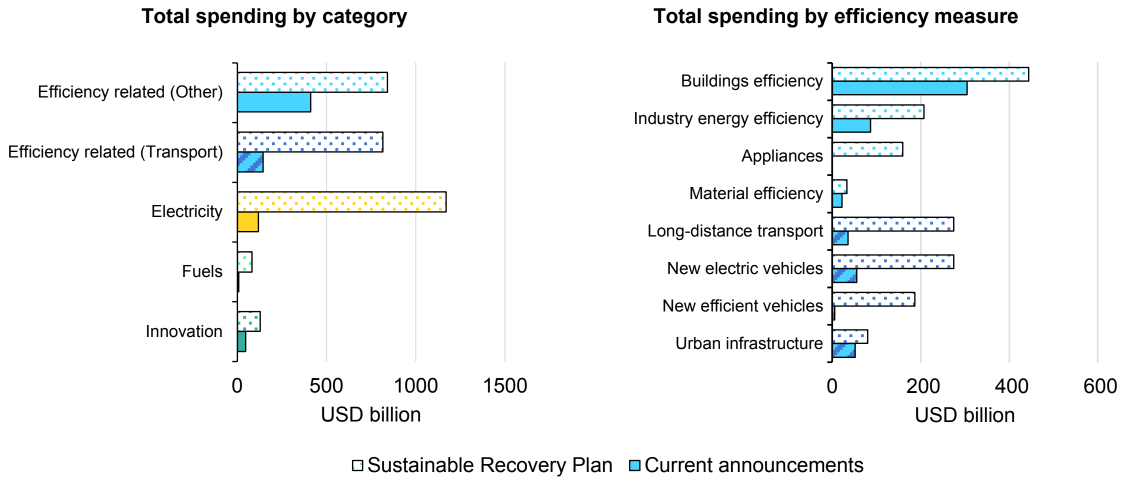
Note: Next Generation EU funds are estimates because at the time of writing, details on spending are yet to be finalised. Estimated spending has been calculated based on funding patterns observed in past EU programmes.

In addition to announcements made at the country level, the European Union has announced a EUR 750 billion (USD 840 billion) stimulus package, of which roughly one-third has been allocated to climate action. If spending follows similar patterns to past EU spending, around USD 190 billion (USD 209 billion) of this package could flow to energy efficiency, which would increase public stimulus spending on efficiency by a factor of four.

Spending announcements for efficiency are not yet at the level outlined in the IEA Sustainable Recovery Plan

Public stimulus support for efficiency announced to the end of October, and the estimated private funds that could be leveraged, are below the levels of potential investment opportunities identified in the IEA recovery pathway.[15] In certain areas, such as appliances and new efficient cars, there have been few stimulus announcements, compared with the opportunity identified in the IEA Sustainable Recovery Plan.

Figure 7.5 Estimated public and private investments from stimulus announcements for clean energy to end of October 2020 by category (left) and for efficiency by measure (right), compared with the IEA Sustainable Recovery Plan



Note: Includes both public and private investment.

Box 7.1 Sustainable recovery in the European Union

On 21 July 2020, EU leaders agreed to spend EUR 750 billion (USD 840 billion) on the economic recovery over the next three years while ensuring that their economies

[15] The recently announced EU stimulus package is omitted from this analysis because at the time of writing, details on spending are yet to be finalised. However, the IEA expects the plan to result in significant spending on the energy sector and energy efficiency.

undertake the green and digital transitions. Around 37% of this EU funding is earmarked for climate action to support the European Green Deal and contribute to achieving the European Union's new 2030 climate targets, which will be updated by the end of the year. Based on current proposals by the European Commission and past funding patterns, around EUR 190 billion (USD 209 billion) of the recovery plan could be allocated to energy efficiency-related measures.[16] A large part of it will focus on buildings, supporting the Renovation Wave for Europe published on 14 October 2020, and the investment opportunity and job creation potential it offers, by at least doubling the renovation rate and retrofitting 35 million building units by 2030. Overall, the efficiency investments would significantly exceed the stimulus pathway outlined for Europe in the IEA Sustainable Recovery Plan, especially when taking into account additional clean energy stimulus investments by EU member states.

Policy decisions made during the crisis will steer energy efficiency progress

As governments respond to the economic crisis, policy action to stimulate energy efficiency sector growth and jobs could help to accelerate energy efficiency progress beyond pre-pandemic levels.

In response to the anomalous energy consumption and emissions data that 2020 is likely to produce, however, some governments have reduced ambitions for energy intensity improvement targets for periods that include 2020. Several governments have also delayed the introduction of new minimum energy performance standards or star ratings for appliances, vehicle fuel-efficiency standards and building energy performance codes.

Delaying policy, and deferring or weakening planned changes to energy efficiency regulations, could slow energy efficiency progress. At the same time, economic stimulus packages that do not build energy efficiency into spending and programmes risk locking in higher energy use and bills in buildings, appliances and vehicles for decades to come.

[16] EU member states will submit recovery and resilience plans by April 2021, which will outline a more precise allocation of funds.

Utility-funded energy efficiency programmes are evolving to address the Covid-19 crisis

Utility-funded programmes are now a widespread tool for improving energy efficiency globally. In Canada and the United States, combined spending on utility-funded energy efficiency and demand response programmes totalled almost USD 9 billion in 2017. As of 2020, there are 49 utility-funded energy efficiency programmes in 24 countries (Croatia launched new energy efficiency obligations in 2019 and Cyprus in 2020).[17]

The Covid-19 crisis has slowed the implementation of energy efficiency measures under utility-funded programmes and forced adjustments to programmes to help utilities and other programme participants adapt to the health crisis.

In Australia, the New South Wales Energy Savings Scheme administrator has provided case by case concessions and flexibility to both obligated parties and participating energy efficiency service providers due to Covid-19 impacts. These include extensions to reporting dates, and dates to meet obligations or pay penalties, as well as extensions to audit due dates. The Victorian Energy Upgrades Program has also made adjustments due to Covid-19 lockdowns, restricting eligible upgrades to critical repair activities, such as to space and water heating systems.

In Europe, Italy's white certificate scheme has also made allowances due to the crisis, with a proposed extension to deadlines for the 2019 compliance year. France's white certificate scheme has made similar concessions, including a six-month extension to the time limit on creating certificates for completed activities, a 12-month extension on certificate multipliers for heating and insulation upgrades, and the introduction of new multipliers to help non-residential buildings upgrade away from fossil fuel heating.

In the United States, policy makers are also adapting to the impact of the crisis. The Michigan Public Service Commission has recommended rolling the 2020 and 2021 energy utility-funded programme targets into one, to maintain the programme's energy efficiency targets while providing some flexibility due to the disruption in 2020. In Colorado, Xcel Energy's utility energy efficiency and demand management

[17] Note by Turkey: The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".
Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

programmes are set to go ahead in 2021 and 2022 with investment and energy savings targets higher than those in 2019 and 2020.

Further details on the challenges and solutions for utility-funded energy efficiency programmes during the Covid-19 pandemic and recovery can be found in the IEA article published in August 2020.

Energy bill relief is often being delivered alongside efficiency stimulus

Several governments have introduced measures to defer energy bills or provide other support for vulnerable households as the pandemic pushes down their incomes and increases their risk of energy poverty. To the end of October 2020, governments had announced around USD 13.7 billion in support for consumers to manage higher energy bills. In Indonesia, for example, 24 million low-income households have been offered free electricity for six months, while 7 million additional households have benefitted from electricity bill discounts.

Alongside bill relief packages, some countries are also announcing energy efficiency spending. Stimulus spending on building renovation programmes has been announced in Canada (USD 220 million), France (USD 7.7 billion) and Germany (USD 2.2 billion). Over time, these investments in energy efficiency will provide ongoing bill relief while creating jobs and delivering economic, health and environmental benefits.

Box 7.2 How do stimulus policy announcements compare with the Recommendations of the Commission for Urgent Action on Energy Efficiency?

In response to a global slowdown in energy efficiency improvement, the IEA executive director convened an independent high-level commission in June 2018 to examine how progress on energy efficiency could be accelerated through new and stronger policy action. The 23-member Global Commission for Urgent Action on Energy Efficiency was composed of current and former national leaders, ministers, chief executives and global thought leaders. Members of the commission worked together to produce a set of 10 recommendations – finalised during the Covid-19 crisis – to encourage governments to implement more ambitious energy efficiency actions. Several of the recommendations were intended to encourage governments to deploy energy efficiency measures for their short-term economic stimulus benefits and their contribution to achieving long-term clean energy transitions.

Several governments are taking action to make policy consistent with the recommendations. Germany's stimulus policy package shows a strong focus on building renovation, expanding a pre-existing mechanism – the CO_2 Building Renovation Programme – by an additional EUR 1 billion. This step will help to unlock the job creation potential of buildings sector energy efficiency (Recommendation 2), a sector that tends to be particularly labour-intensive. Similarly, Italy has supercharged the Eco Bonus programme to provide 110% tax incentives from 1 July 2020 to 31 December 2021 for energy efficiency building renovations, installation of rooftop solar PV, and electric vehicle charging stations.

Spain's Law on Climate Change and Energy Transition, approved in May 2020, sets out a long-term vision and policy framework to achieve carbon neutrality by 2050. The law puts energy efficiency at the heart of Spain's cross-governmental climate action, committing to improve efficiency and reduce primary energy consumption by at least 35% by 2030 (Recommendations 1 and 10). It focuses strongly on building renovation, adding to Spain's existing long-term strategy for energy rehabilitation in the buildings sector (Recommendation 2). Under the law, the national government will closely collaborate with municipalities to expand more efficient and clean modes of transport in key urban areas, including by establishing low-emission zones no later than 2023 and investing in alternative mobility infrastructure (Recommendation 7).

Canada's recent announcement that will step up its Community Efficiency Financing Initiative creates more opportunities for municipalities and sub-national partners to take stronger efficiency action (Recommendation 7). The new USD 300 million fund supports municipalities' financing programmes for home energy performance upgrades, which have proven to be effective in overcoming barriers such as access to capital or uncertainty about the cost and quality of retrofits, while creating local jobs and reducing emissions.

China's new policy for supporting private energy conservation, announced in July 2020, sharply focuses on scaling up private sector efficiency investment through a range of financial instruments (Recommendations 3 and 4). Preferential tax incentives create opportunities for more efficient use of energy and water resources among businesses, while the policy strongly encourages financial institutions to incorporate efficiency criteria in their finance services. Sub-national governments play a key role in implementing and monitoring these measures (Recommendation 7).

Beyond emergency stimulus, efficiency measures have continued

While energy policy makers have turned their attention to the Covid-19 crisis, they have also continued to implement policies and regulation planned before the crisis, which could magnify the impact of new announcements. Policy changes that have proceeded as planned in 2020 include:

- The Australian Energy Market Commission released its final determination on a new rule for wholesale demand response mechanism. Under the rule, large industrial and commercial consumers will be able to sell demand response in the wholesale electricity market either directly or through aggregators (demand response service providers) for the first time, starting in late 2021.
- Brazil launched a new Procel Lab Programme to help startups develop new energy-efficient solutions. The Brazilian Electricity Regulator also announced a new website to publish data from Brazil's Energy Efficiency Obligation Programme.
- China is implementing its Green and High-Efficiency Cooling Action Plan, released in 2019. This includes improved minimum energy performance standards for residential air conditioners, which came into force on 1 July 2020.
- Denmark launched a new programme, Skrotningsordningen, to subsidise the replacement of oil burners with heat pumps in buildings located away from the district heating or gas grid.
- Germany introduced tax deductions for building renovations (Steuerliche Förderung der energetischen Gebäudesanierung), which allow homeowners to deduct from income taxes 20% of the cost of renovations, up to EUR 40 000.
- The Netherlands introduced a suite of policies including a revolving fund for heat projects (Warmtefonds), Regional Industrial Cluster Programmes targeting the industrial sector, and a new digital platform providing a full-service solution to residents and building owners in the consultation, implementation and financing stages of building renovations.
- New Zealand's State Sector Decarbonisation Programme was announced, which includes NZD 200 million in capital funding to help reduce the public sector's energy-related carbon emissions. This funding will support decarbonisation projects including low-emissions heating and cooling, energy-efficient lighting, and low-emissions vehicles. Approximately NZD 80 million in funding has already been allocated for a range of projects, including replacing coal boilers in schools, universities and hospitals with low-emissions alternatives.
- Spain began developing an action plan to implement its National Strategy Against Energy Poverty 2019-24, which will provide support to the 3.5 million to

8.1 million citizens living in energy poverty, including energy efficiency measures focusing on buildings and appliances.

- Turkey published new definitions and energy use limits for near-zero energy buildings and began implementing the 2019 Presidential Decree on Energy Savings in Public Buildings, which requires public buildings over 10 000 m^2 or consuming over 250 tonnes of oil equivalent per year to save 15% of final energy consumption between 2020 and 2023.
- In Viet Nam, a range of new minimum energy performance standards and labels for appliances came into force, including for rice cookers, washing machines, televisions, and refrigerators.

8. Energy efficiency jobs and the recovery

One of the most important benefits of energy efficiency is job creation. Many measures taken to improve the efficiency of cities, buildings and transport systems are labour intensive.

With clean energy transitions continuing to scale up, energy efficiency jobs have grown steadily in recent years. In some countries, energy efficiency is estimated to be one of the largest employers in the energy sector. Estimates are often uncertain, however. For example, in Australia there are 60 000 to 236 000 efficiency-related jobs, depending on the estimation technique.

Table 8.1 Estimated energy efficiency jobs in selected countries and regions

Country	Efficiency-related jobs (pre Covid-19 crisis)
United States	2.4 million
Europe	1 million - 3 million
China	729 000 - 730 000
Canada	472 000
Australia	60 000 - 236 000
Brazil	33 000 - 62 000

Note: Definitions of energy efficiency jobs differ between regions and the numbers provided in this table are therefore not directly comparable or additive. United States: as of February 2020; China: as of 2018, energy service companies only; Europe: as of 2020, buildings sector only (preliminary estimates subject to change); Canada: as of 2019; Australia: as of 2019; Brazil: as of 2018.

Sources: NASEO and EFI, *The 2020 U.S. Energy & Employment Report*; Wang Qingyi, 2019 Energy Statistics; BPIE (Unpublished), Working Paper: Examining the impact of Covid-19 on building efficiency employment in Europe; ECO Canada, *Energy Efficiency Employment in Canada*; EEC, *Energy efficiency employment in Australia*; Mitsidi, *Job creation potential in Brazil from 2018 to 2030* (in Portuguese).

Insufficient policy action risks efficiency job losses

The Covid-19 crisis endangers energy efficiency jobs because of lockdowns, people's reluctance to allow strangers into their homes and the crisis-induced global recession. In the buildings sector, for example, social distancing requirements have prevented energy efficiency contractors from gaining access to residential properties to perform retrofits, leading to delayed revenue streams.

At the same time, low fuel prices have lengthened the payback periods for efficiency upgrades. Together with reductions in disposable incomes, this is likely to have made energy efficiency investments less attractive. There are also cases of funding for US energy efficiency programmes being cut or redirected to provide bill relief to customers, as utilities have to deal with rising levels of non-payment.

While business has remained steady in 2020 for energy service companies, thanks to contracts agreed in earlier years, they may face job losses if projected falls in revenue for 2021 eventuate. The situation is highly dependent on government support, however, and the sector involved. For example, a survey of German energy service companies found that while the pandemic has affected certain companies in selected sectors, on the whole business activity is expected to remain healthy until mid-2021, supported by existing contracts and generous government support.[18] In Brazil, many energy service companies are small-to-medium sized businesses that rely on support from the country's utility obligation programme to implement projects. Cuts to the pool of funding under this programme threaten to push these companies out of business. In the United States, one of the largest energy efficiency markets, energy service companies have reported furloughing staff or cutting staff salaries. Some companies have had to lay off up to half their staff. Businesses operating in the residential sector have been particularly affected.

In general, efficiency job growth in the United States remained flat in July and unemployment continued to be high, although some energy efficiency employees were able to return to work in summer after months of persistent job declines. However, the data do not include workers who had their hours reduced and are now significantly underemployed.

[18] Information provided to the IEA from DENEFF EDL_HUB, an association of ESCOs representing over 70% of the German ESCO market.

Figure 8.1 Net changes in US energy efficiency jobs, March to July 2020

Source: BW Research Partnership, *Memorandum: Clean Energy Employment Initial Impacts from the COVID-19 Economic Crisis, July 2020*.

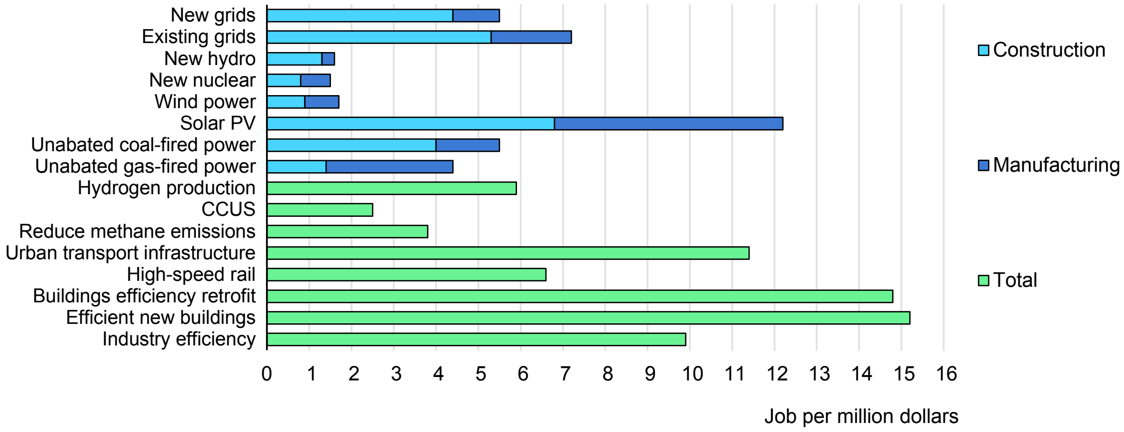
Worldwide, 4.3 million jobs directly provided by the energy sector as a whole are at risk or have already been lost because of the Covid-19 crisis.[19] In the energy efficiency sub-sector, jobs at risk include workers involved in efficient appliances and building materials manufacturing, industrial energy efficiency and building retrofits. Energy efficiency is the second most affected sub-sector in the energy sector, behind vehicle manufacturing.

Government economic stimulus for energy efficiency can jump-start the jobs machine

Due to the labour-intensive nature of many energy efficiency upgrades, USD 1 million spent on energy efficiency is estimated to generate between six and 15 jobs on average, depending on the sector. As energy efficiency investments can also be mobilised quickly, they are one of the most attractive investments in the energy sector for governments seeking to protect existing jobs or generate new jobs during the recession.

[19] Includes energy efficiency, bioenergy, electricity, coal, oil and gas.

Figure 8.2 Construction and manufacturing jobs created per USD 1 million of capital investment in the Sustainable Recovery Plan

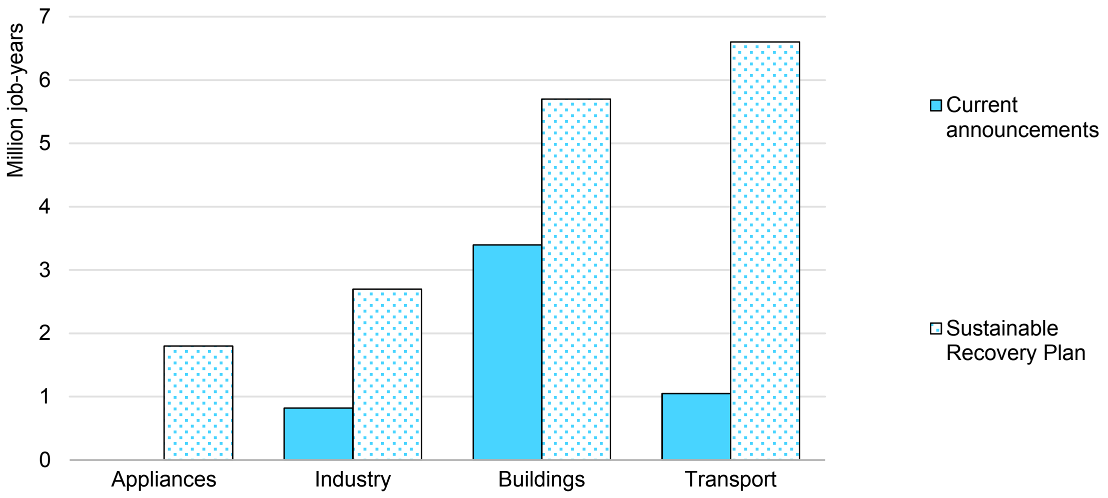


Source: IEA, *Sustainable Recovery: World Energy Outlook Special Report in collaboration with the International Monetary Fund*.

Stimulus spending on efficiency is beginning to tap into its job creation potential but opportunities remain

Although government stimulus packages are still being developed, announcements to the end of October indicate that spending is being directed to sectors with a high potential to create jobs. Buildings efficiency measures (including new efficient buildings and retrofits) are receiving the bulk of announced efficiency spending. With every USD 1 million spent on buildings efficiency likely to create around 15 jobs on average, spending commitments to date are estimated to create around 3.4 million job-years. This trend may continue as momentum builds through initiatives such as the EU Renovation Wave for Europe.

Figure 8.3 Estimated energy efficiency job creation potential from committed stimulus investments to end of October 2020 and in the Sustainable Recovery Plan



Note: Industry includes industrial energy efficiency improvements and materials efficiency. Transport includes new efficient cars, new electric cars, long-distance transport and urban infrastructure. All numbers include job-years generated from a combination of public money and estimated leveraged private investment.

Table 8.2 Estimated energy efficiency job-years by region from stimulus announcements to date in industry, buildings and transport

Sector	Europe	Asia Pacific	North America	Latin America
Industry	798 000	17 000	3 000	
Buildings	2 824 000	302 000	268 000	1 000
Transport	723 000	245 000	80 000	

Note: In this analysis, countries considered within each region are limited based on available data to date. Asia Pacific includes: Australia, China, India, Indonesia, Japan, New Zealand, and Korea. Europe includes: Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Russian Federation, Spain, Sweden, Switzerland, Turkey and the United Kingdom. Latin America includes: Argentina, Brazil and Mexico. North America includes: Canada and the United States. All numbers include job-years generated from a combination of public money and estimated leveraged private investment.

Building efficiency retrofits – for example, of existing homes, schools, hospitals or municipal facilities – could create a substantial number of jobs in the coming years because they are among the most labour-intensive of clean energy measures. As much as 60% of expenditure on home energy efficiency retrofits could go towards labour, activating local value chains and boosting the economy.

Significant opportunities remain, however, to unlock the job creation potential of energy efficiency. The IEA Sustainable Recovery Plan projects that USD 160 billion of public and private spending on appliance efficiency over three years could protect or create 1.8 million job-years. But recent stimulus announcements have paid little attention to supporting appliance upgrades and customer demand for these upgrades, which may result in a substantial efficiency slowdown and jeopardise jobs in appliance manufacturing.

While USD 3 billion of public funding has been announced to date for industrial energy efficiency, this is only one-third of the spending opportunities outlined in the IEA Sustainable Recovery Plan. Combined with estimated leveraged private investment, economic stimulus spending on industrial efficiency could protect or create around 2.1 million job-years, compared with the estimated 590 000 estimated from current spending.

The currently committed public stimulus spending related to energy efficiency, combined with the leveraged private investment this is expected to attract, could protect or create over 5 million job-years. While many governments are still in the process of designing energy sector stimulus packages, the IEA Sustainable Recovery Plan shows that nearly 12 million more job-years could be generated if governments commit the additional USD 210 billion required to unlock a further USD 890 billion of private investment.

Table 8.3 Estimated job-years that could be created by efficiency-related stimulus announcements to date, by efficiency measure

Efficiency measure	Estimated jobs-years
Building retrofits	3 209 000
Industry energy efficiency	590 000
New electric cars	312 000
Railways	237 000
Charging infrastructure	230 000
Material efficiency	229 000
New buildings	188 000
Public transport	124 000
Walkways and bike lanes	122 000
New efficient cars	24 000

Note: Job-years are created from a combination of government and estimated private spending.

9. Energy efficiency in 2019

This section summarises energy efficiency trends in 2019. It updates and builds on analysis from several IEA publications, including Global Energy Review 2019, Tracking Clean Energy Progress and World Energy Investment 2020.

Energy intensity and efficiency

The global energy intensity improvement rate was flat

Global energy intensity improved by 2% in 2019. While notionally a significant increase on the 2018 rate of 1.1%, these numbers on their own mask the strong influence of weather in both years.

In 2019, more temperate weather in key regions contributed strongly to improving energy intensity, mostly in the form of reduced heating and cooling demand, while in 2018 the opposite occurred. Normalising for the weather impact, the improvement in the energy intensity of the global economy was 1.6% in 2019, almost identical to the weather-corrected 2018 rate of 1.5%.

Technical efficiency improvements were 5% lower than 2018

Despite contributing the most to energy intensity improvements in 2019, total energy savings from efficiency were around 5% lower than in 2018. This decline partly reflects stagnation in the passing of new energy efficiency policies in recent years. In addition, slower economic growth reduced purchases of new equipment covered by energy efficiency regulations, thereby slowing the replacement of inefficient stock.

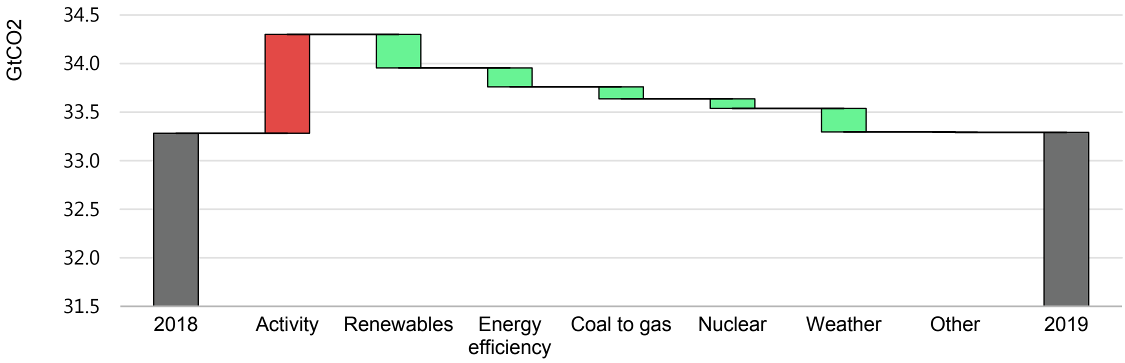
The major global energy users – in order, China, the United States, Europe and India – contributed the most to global energy efficiency savings in 2019, owing to their size. Although China's energy efficiency savings were large in absolute terms, they dropped substantially in 2019. This greatly reduced global efficiency-related energy savings, because of the magnitude of China's energy demand relative to other countries. Although several factors reduced China's efficiency savings, a key cause was a stimulus package implemented in 2019 that channelled support to energy-intensive sectors and industrial plants that are less energy efficient. As a result, energy use in some of the most energy-intense segments of the economy increased in 2019, including 5% growth in cement and 7% in steel.

In India, Japan, Russia and the United States, savings from technical efficiency increased substantially in terms of gross primary energy. Europe's annual technical efficiency savings also increased from 2018 levels. In the United States, energy efficiency improvements were the largest contributor to a 2.9% improvement in energy intensity, following 2018 when energy intensity worsened, largely due to weather conditions.

Energy efficiency delivered a large share of energy sector emissions reductions in 2019

Energy efficiency improvements in 2019 avoided an increase of around 200 $MtCO_2$ in global emissions, almost equivalent to the energy-related CO_2 emissions of Spain. This was the second-largest source of avoided energy sector emissions, just behind renewables.

Figure 9.1 Change in global energy-related CO_2 emissions and avoided emissions, 2018 compared with 2019



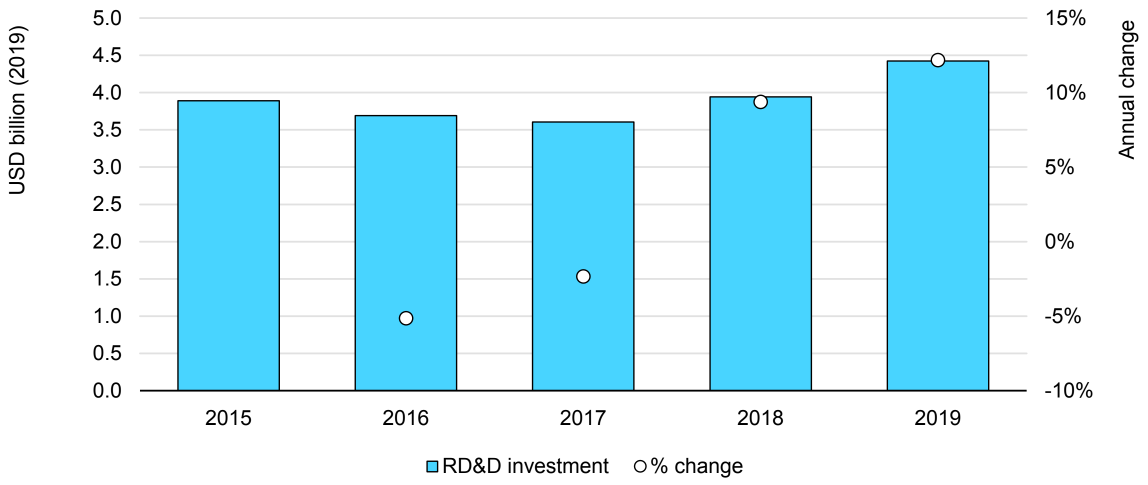
Notes: Y-axis starts at 31.5 Gt CO_2. Red columns are factors that increased energy-related greenhouse gas emissions, green columns are factors that reduced energy-related greenhouse gas emissions.
Source: IEA, Global Energy Review 2019.

Investments in future energy efficiency gains

A total of USD 250 billion was invested in energy efficiency across the buildings, transport and industry sectors in 2019, almost the same level as the previous year. While there were signs of new activity in some areas, annual changes for each sector remained moderate.

The outlook for new efficiency technologies was better, with inflation-adjusted public spending[20] on energy efficiency technology research and development (R&D) for new technologies growing 12% to USD 4.5 billion, surpassing the previous high of USD 4.4 billion set in 2009. Energy efficiency was one of the largest targets of total energy-related R&D investment.

Figure 9.2 IEA public energy efficiency technology R&D and demonstration spending, 2015-19

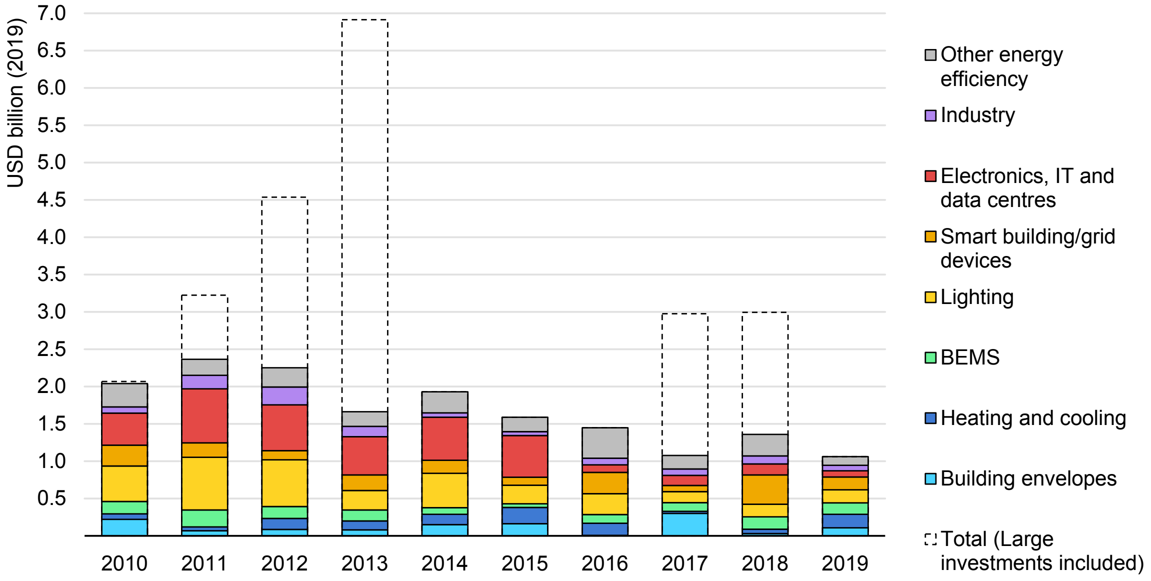


Source: IEA, Energy Technology RD&D Budgets.

In contrast to public investment in new technologies, private venture capital funding for startups developing new energy efficiency technologies was less than half of 2018 levels, although the decline was only slight when outlier investments of over USD 500 million are excluded. Most venture capital was allocated to the buildings sector, with investments spread fairly evenly across buildings technologies.

[20] This spending is additional to the USD 250 billion investment cited above.

Figure 9.3 Global venture capital investments in energy efficiency startups, by technology

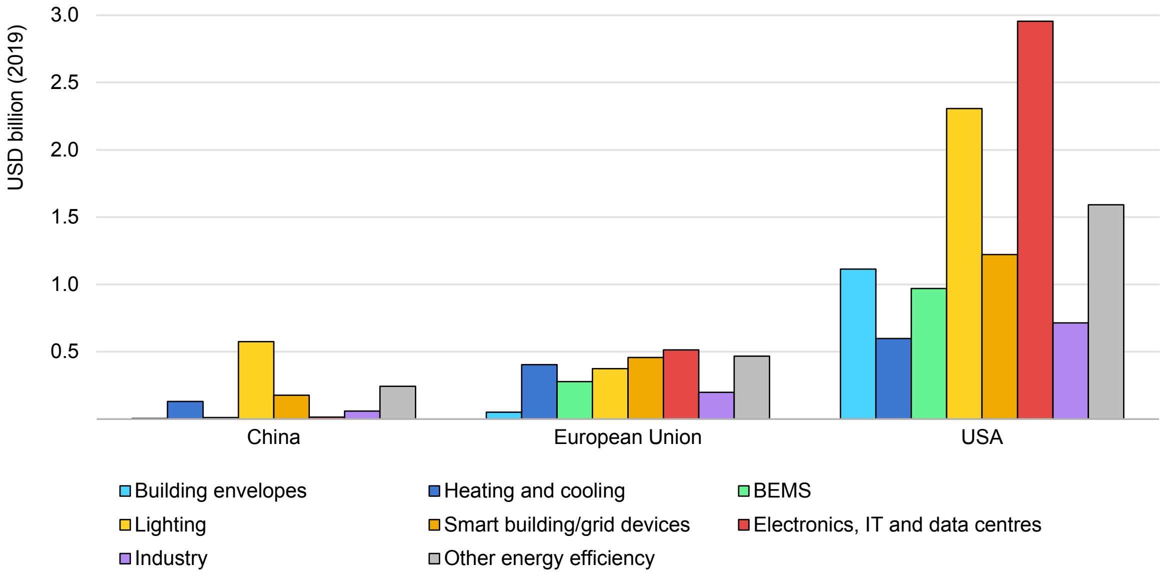


Note: Data in the coloured columns exclude outlier deals greater or equal to USD 500 million to avoid skewing the technology distribution. BEMS = building energy management system.

Startup investments in heating, ventilation and air-conditioning in 2019 that were under USD 500 million (i.e., excluding larger outlier deals to avoid skewing trends) were almost double 2018 levels, an encouraging sign after drops in investment in 2017 and 2018. Innovative cooling technologies targeted for investment in 2019 included technologies for converting waste heat to power refrigeration and air conditioning loops, solar storage cooling technologies, and intelligent devices for improving the efficiency of existing residential air conditioners.

Startups in the United States were the largest recipients for efficiency-related venture capital, receiving around 70% of investments. Businesses based in the European Union received around 16% of investments and Chinese businesses another 7%. Technologies targeted for investment in these three major regions partly reflect each region's comparative advantages. For example, in the United States, home to Silicon Valley, investments in IT and data centre energy efficiency were strong.

Figure 9.4 2019 energy efficiency venture capital investments by technology and region



Note: Data exclude deals greater or equal to USD 500 million to avoid skewing the technology distribution. BEMS = building energy management system.

Buildings

Efficient building technologies are still not being deployed fast enough

Under the IEA Sustainable Development Scenario, the energy used per square metre of building floor area decreases globally by at least 2.5% per year on average. This could be achieved by 2030 with more efficient new buildings, deep energy renovations of existing buildings, a tripling of heat pump uptake and a 50% improvement in the average seasonal performance of air conditioners, as well as other energy efficiency measures. Alongside these technologies, digital systems such as intelligent building energy management systems and smart controls continue to be deployed to great effect but have yet to achieve widespread adoption. Only lighting and data centres are currently on track.

Table 9.1 Clean energy technology progress for key buildings sector technologies

Technology	2019 Status	Status compared with 2018
Building envelopes	Red	-
Heating	Red	-
Heat pumps	Yellow	↑
Cooling	Yellow	-
Lighting	Green	-
Appliances and equipment	Yellow	-
Data centres and data transmission networks	Green	-

Note: Red = Not on track; Yellow = More efforts needed; Green = On track. Technologies such as building energy management systems are not represented on this table as data are not yet widely available for inclusion in the IEA Tracking Clean Energy Progress report.

Source: IEA, Tracking Clean Energy Progress.

Modular construction continued to improve building efficiency in developed economies.

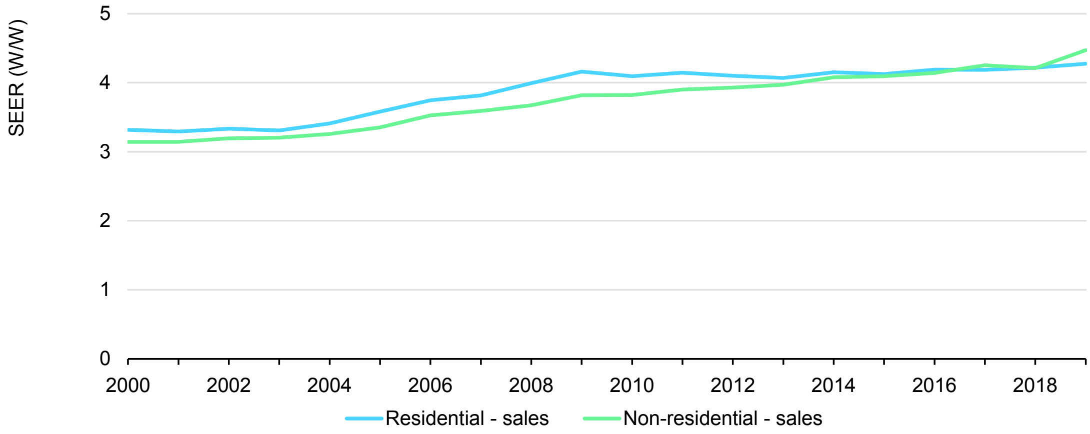
The use of modern methods of construction, such as prefabricated, offsite and modular construction, continue to be the major innovation area for energy-efficient building construction. Modern methods of construction more readily maintain construction quality and energy efficiency in their production process. The global value of modular building construction in 2019 was estimated at USD 70 million to USD 110 billion. The construction industry continues to invest in advanced design and manufacturing facilities for increasing bespoke building production for a range of building types, including multi-family, education and hospital buildings.

In 2019, for example, the United Kingdom announced that GBP 2.5 billion (USD 3.2 billion) of its Home Building Fund was allocated to modern methods of construction and that an additional GBP 170 million (USD 222 million) was being spent on research and development. However, the shift to modular construction has so far been led by heating dominated regions, such as the Baltic Region, Europe, North America and Northern China.

Global air conditioner efficiency continues to trail what is possible

Sales data indicate that on average, the seasonal energy efficiency ratio of air conditioners purchased in 2019 rose slightly in both the residential and non-residential sectors, to around 4 W/W (Watt of cooling output per Watt of electricity input). However, this is well below the best available technologies in most markets, which in developed economies such as Europe and the United States is 10 W/W to 12 W/W. In Africa, recent analysis suggests that 35% of air conditioners sold have a seasonal energy efficiency ratio of less than 3 W/W, raising fears that inefficient products are being dumped in the region.

Figure 9.5 Average seasonal efficiency of air conditioner equipment sold globally



Note: SEER = seasonal energy efficiency ratio.
Source: IEA, Tracking Clean Energy Progress.

Buildings efficiency investments reflected a two-speed market, driven mainly by new construction

The buildings sector is still the largest destination of efficiency spending. After faltering in 2018 in response to reduced government support in Europe, it grew 2% in 2019 to just over USD 150 billion, thanks mostly to increased investments in emerging economies. A two-speed market appears to be developing, with stronger activity in emerging economies where new construction is taking place, especially China, and weaker markets in Europe and North America, where a greater share of investment is driven by retrofits.

Slowing construction in 2019 curbed efficiency investment

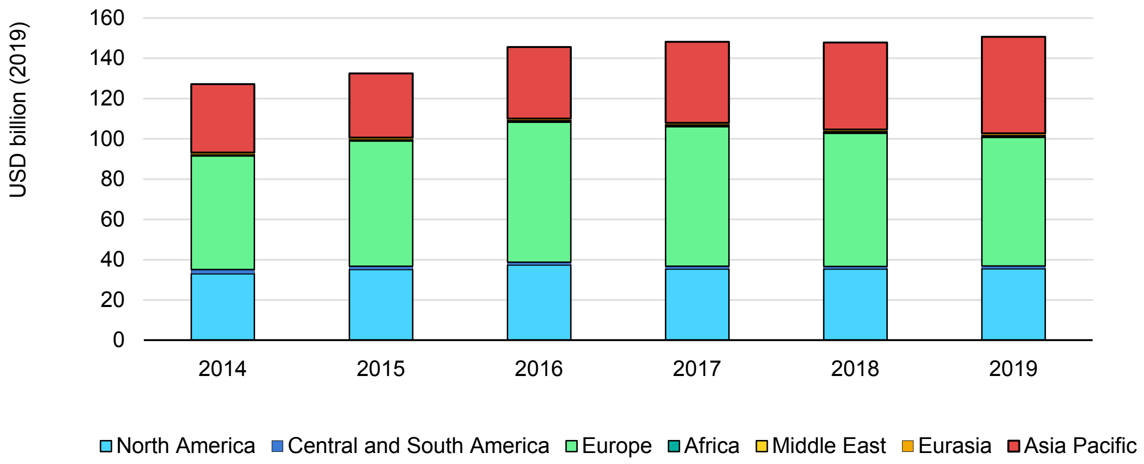
Global construction– which includes construction of buildings that exceed minimum energy performance standards in building codes, increasing the proportion of more efficient building stock – was the primary driver of energy efficiency investment in most major economies. In 2019, construction investment was valued at around USD 5.9 trillion, a rise of 4.9% from 2018.

Although overall construction investment in 2019 was higher than in 2018, construction activity began to slow towards the end of 2019 in several key regions including China, the Middle East, the United States and Western Europe. There was also a considerable slowdown in Australia. This decline would have had a knock-on effect, reducing market-driven energy efficiency investment. It would also have increased the share of government programmes – primarily for building retrofits –in overall efficiency spending.

Energy efficiency activity in buildings was concentrated in fast-growing economies such as China, where investment increased by 10% to USD 30 billion (overall construction investment grew at 13%), or economies where energy efficiency policies began to have an impact. The latter included Canada, which allocated an additional CAD 600 million to buildings sector efficiency in the 2019 budget, 20% more than 2018.

In Europe, public investment in energy efficiency, which represented 40% of overall energy efficiency investment, outpaced construction activity, meaning that renovation, rather than new builds, was the major focus. In the United Kingdom, for example, public energy efficiency investment increased by 8% from 2018, while construction investment growth was minor. This trend of growth in publicly funded efficiency improvements outpacing construction was also shown in Italy and Switzerland. By comparison, in Germany public energy efficiency investment fell by 12% in real terms from 2018, but construction investment grew modestly.

Figure 9.6 Annual investment in building energy efficiency by world region, 2014-19



Buildings sector policies in 2019

Few buildings sector policies appeared to be announced in 2019, but China made a major announcement that will have a significant impact for efficiency trends. A growing number of jurisdictions have also opted to adopt mandatory standards for existing buildings. Buildings sector policy updates in 2019 included:

- Australian energy ministers agreed the *Trajectory for Low Energy Buildings,* a new multi-year strategy for low-energy (and low-carbon) residential and commercial buildings for Australia. The strategy proposes a suite of initiatives to improve the energy efficiency of existing buildings in Australia including minimum energy performance standards for rental properties, improved heating, ventilation and air conditioning in government buildings, and new information and data collection tools.
- In August 2019, China updated its Assessment Standard for Green Buildings (GB/T 50378-2019). Under the standard, energy efficiency is one of the criteria used to specify if building materials are classified as being "green".
- Korea introduced a subsidy scheme for efficient appliances. The government will provide a 10% rebate to reduce the cost of grade 1 efficient appliances across seven appliance types.
- Turkey introduced an innovative incentive system for residential building efficiency whereby homeowners can borrow against the value of their homes at differentiated levels based on the building's energy efficiency rating. The policies include an obligation for public buildings to achieve energy savings of 15% from 2020 to 2023, alongside the mandatory use of solar energy for hot water in non-residential buildings with an area of greater than 2 000 m^2.
- In March, Estonia adopted new regulations requiring that 46% of the proceeds from auctioning greenhouse gas allowances are used for improving the energy efficiency and use of renewable energy in central government buildings.
- In 2019 Spain published a review of its minimum standards for energy efficiency and renewable energy for new and refurbished buildings. Buildings built to the new standards are estimated to save up to 40% of energy consumed compared with those built with the previous standards. Improvements include more ambitious requirements on thermal enclosures and more efficient technologies to ensure thermal comfort in buildings.

Transport

Efficiency improves in electric vehicles and rail while other modes lag

Growth is robust in efficient electric car markets but appetite for larger vehicles persists

Electric car sales reached 2.1 million in 2019, securing their highest ever share – 2.6% – of the global car sales market. The number of electric cars on the world's roads exceeded 7 million in 2019. Fleets of electric buses and trucks are also being procured in more and more cities around the world.

The global appetite for larger vehicles like SUVs continued, however. This trend is common to all vehicle markets and has led to a slackening – or in some cases even reversal – of national rates of fuel consumption improvements, as reported in *Energy Efficiency 2019*.

China led the rapid roll-out of high speed rail

Globally, high-speed rail continues to grow strongly. Almost two out of three high-speed rail lines are in China: starting from virtually none only a decade ago, the country now has over 24 000 km. In 2019 alone, China National Railways opened two more high-speed rail corridors totalling 750 km of lines, and added more than 3 000 km of new lines. The rapidity of this rollout makes it one of the largest infrastructure projects in recent history. Total high-speed rail activity in China is catching up with domestic passenger aviation. This is significantly boosting transport energy efficiency, because rail is more energy efficient than road and air travel.

Figure 9.7 Clean energy technology progress for key transport sub-sectors

Transport sub-sector	2019 status	Status compared with 2018
Electric vehicles	Green	-
Rail	Green	-
Fuel consumption of cars and vans	Red	-
Trucks and buses	Yellow	-
Aviation	Yellow	-
International shipping	Yellow	-

Note: Red = Not on track; Yellow = More efforts needed; Green = On track.
Source: IEA, Tracking Clean Energy Progress.

Transport investments stayed flat

Transport efficiency investment fell slightly in 2019 (by nearly 4%), as global car sales fell and sales of the most efficient cars trailed the wider market. Spending on more efficient road freight vehicles stabilised despite a drop in the overall market – including a decline in total sales in China – as fuel economy standards began to make an impact. Freight vehicles generally have higher upfront costs, making purchases hard to justify for smaller enterprises, despite lower lifetime fuel costs.

Investments in electric vehicles increased by less in 2019, but their share of the global car fleet rose

Global spending on electric cars grew 13% from 2018 to reach USD 90 billion in 2019. Of this, USD 60 billion was on battery-electric cars and the remainder on plug-in hybrids. The rise in spending was lower than in 2018, when around USD 35 billion was added to the global electric car market in just one year, but higher than the growth in numbers of cars sold.

Electric car sales grew by 100 000 in in 2019 while passenger car sales growth as a whole contracted by around 4 million sales worldwide, or 5%.

Transport policy updates in 2019

- In October 2019, Australia introduced new fuel quality standards for cars and vans. The new petrol standard will improve petrol quality by setting a lower pool average for aromatics from 2022 and lowering sulphur limits from 2027. This will support the introduction of more fuel-efficient light vehicles to the Australian market.
- In June 2019, Japan launched new fuel economy standards for cars, which will apply from 2030. The standards represent a 32% improvement over the fleet average fuel economy for fiscal year 2016. They followed updates to heavy-duty vehicle standards in March 2019, which will come into force in 2025.
- In August, Europe introduced its first CO_2 emissions standards for heavy-duty vehicles, requiring vehicle manufacturers to reduce the average CO_2 emissions intensity of the heavy-duty vehicle fleet by an average of 15% (after 2025) and 30% (after 2030) compared with a reference period of 1 July 2019 to 30 June 2030.
- Italy introduced a new “bonus malus” programme to encourage the rollout of electric vehicles. The “bonus” is a subsidy of up to EUR 6 000 for the purchase of vehicles that emit 90 grammes of CO_2 or less per kilometre. The “malus” is a

tax on vehicles that emit more than 160 grammes of CO_2 or more per kilometre, starting at EUR 1 100 and rising to more than EUR 2 500 for high emitting vehicles.

- Spain developed a EUR 50 million programme to support electric vehicle research and innovation, the purchase of electric vehicles, the installation of charging points, deployment of electric bicycle hire schemes and the implementation of business transport plans.

Industry

Across all industries, efficient technology deployment continues to lag

As rapid urbanisation continued, demand for construction materials such as steel and cement remained strong in 2019. These two sectors alone represented almost 30% of industrial energy use and more than 41% of industrial sector greenhouse gas emissions.

In these and other energy-intensive industrial sub-sectors, energy efficiency technologies are not being deployed at levels modelled in the IEA Sustainable Development Scenario. In 2019 there were no major technological changes in the status of clean energy technology progress within major energy-consuming industries.

Figure 9.8 Summary of clean energy technology progress for key industry sub-sectors

Industry sub-sector	2019 status	Status compared with 2018
Chemicals	○ (Yellow)	-
Iron and steel	○ (Yellow)	-
Cement	○ (Yellow)	-
Pulp and paper	○ (Yellow)	-
Aluminium	○ (Yellow)	-

Note: Red = Not on track; Yellow = More efforts needed; Green = On track.
Source: IEA, Tracking Clean Energy Progress.

Metals production energy efficiency stayed flat, with some improvements in China

The use of scrap steel in either electric arc furnaces or induction furnaces is one of the most effective ways of reducing the energy intensity of steel production. To meet the Sustainable Development Scenario, scrap inputs should account for over 40% of total crude steel production by 2030. In 2018, the rate of scrap-based production was only about 20%. It is unlikely that scrap use increased in 2019, as the share of crude steel produced by electric arc furnaces (which use scrap as a primary feedstock) declined from 28.8% in 2018 to 27.7% in 2019.

Box 9.1 Benchmarking industrial energy intensity in G20 countries

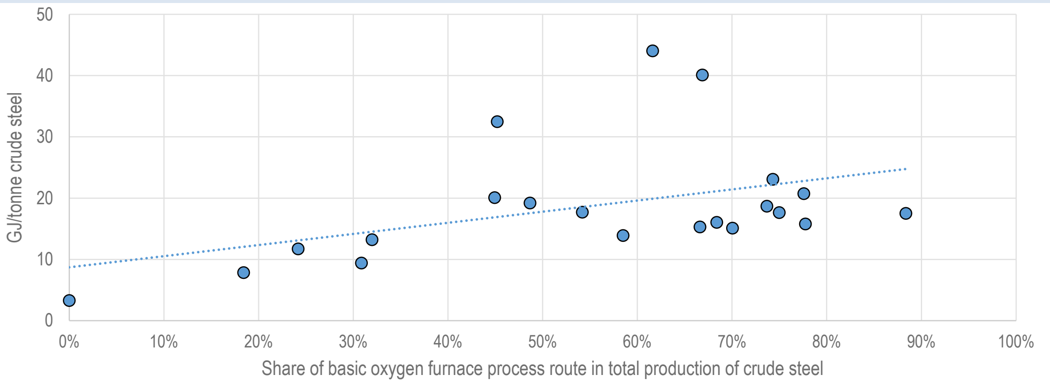
The IEA continues to support G20 countries with industrial energy efficiency benchmarking, an initiative launched by Japan during its G20 presidency. This work is of interest to several countries. In Brazil, for example, this year's *Atlas of Energy Efficiency* included a chapter on the topic. India is examining international industry sector benchmarks for various sectors to inform the next cycle of its Perform Achieve and Trade programme.

In addition to high-level indicators such as energy used per tonne of product, other indicators can be useful in international industry sector benchmarking, to provide more detail on the factors influencing energy intensity.

For example, a useful indicator of steel sector energy intensity in a country is the share of blast furnace production routes (more energy intensive) compared with electric-arc furnace production routes (less energy intensive).

While countries with a higher proportion of blast furnace steel production tend to have slightly higher energy use per tonne of steel, the relationship is not always clear, as other factors also contribute, such as plant age, and technology differences and differences in data collection methodologies.

Average iron and steel sector final energy consumption in G20 countries vs. production share of basic oxygen furnaces, 2018

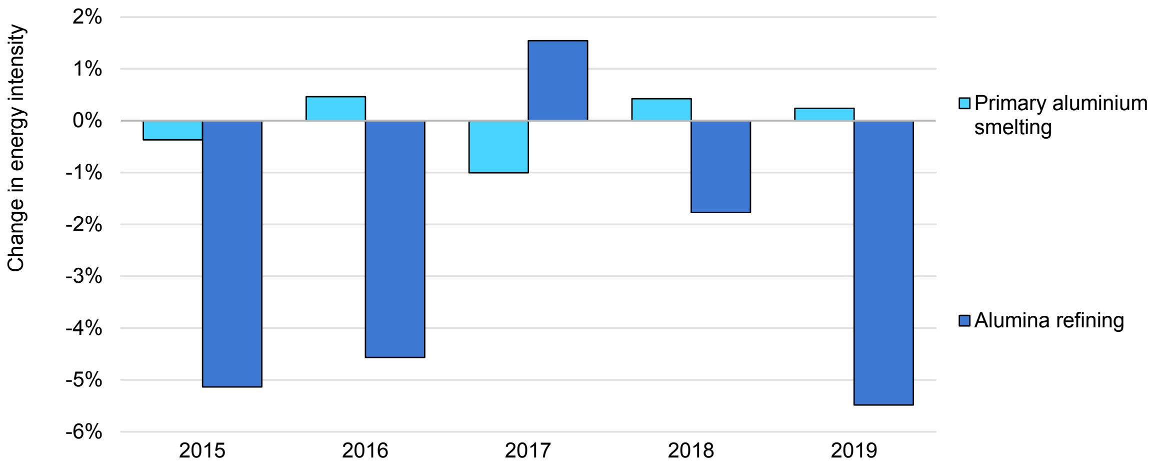


Note: Dots represent the average for the iron and steel sector within countries and not specific facilities.

Sources: IEA, World Energy Balances; Worldsteel Steel Statistical Yearbook, 2019.

Energy efficiency improvements in global aluminium production differed by region and stage in the production process. Globally, the energy intensity of aluminium smelting stayed almost flat, at just over 14 000 kWh per tonne of aluminium. In contrast, global alumina refining (the process of refining bauxite ore into alumina) was over 5% less energy intensive, mainly due to Chinese producers adopting best available technologies.

Figure 9.9 Annual change in the global energy intensity of primary aluminium smelting and alumina refining, 2015-19



Note: Energy intensity is calculated using final energy.
Source: World Aluminium Institute.

Energy management systems growth down in Europe, up in Asia

Energy management systems are among the most cost effective ways to promote energy efficiency across industrial sub-sectors. Each year, the number of industrial facilities certified by the International Organization for Standardization (ISO) as complying with the international standard for energy management (ISO 50001) provides an indicator of the prevalence of such systems globally. Key drivers have been government incentives or regulations, changing values and sustainability goals of companies and non-energy benefits, which can be crucial for small and medium-sized enterprises. However, barriers to wider uptake still exist, such as firms lacking a culture of energy management, a fear of extra administrative complexity, and skills shortages.

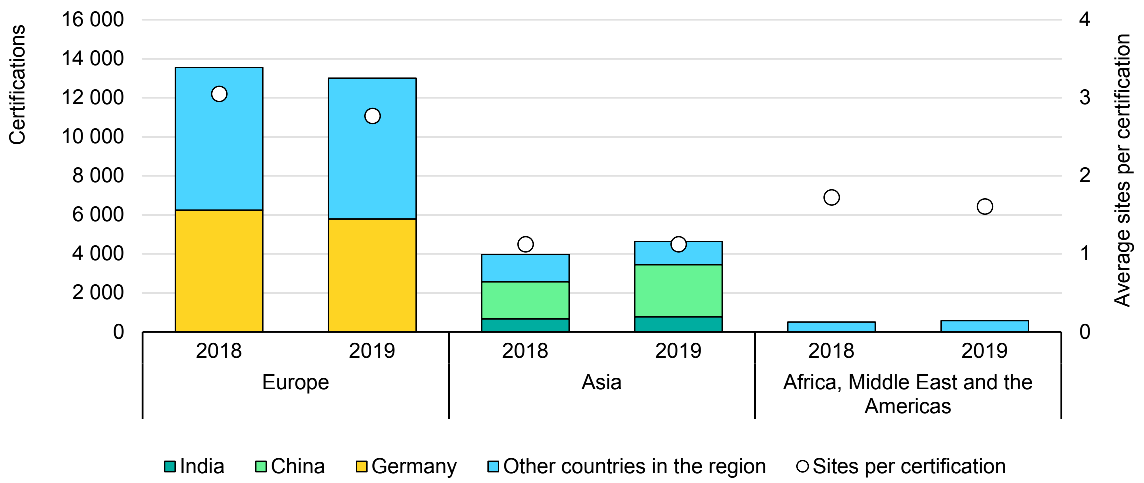
The number of ISO 50001 certifications decreased in Germany in 2019 and stayed almost flat in France, Italy, Spain and the United Kingdom. The number of certifications and certified sites increased in emerging economies such as China and

India, but the total number of certifications in these regions is still less than half that of Europe. The net result is that globally, the number of ISO 50001 certifications has stagnated in the last two years.

Certificates in Africa are dominated by Egypt (with almost two-thirds of certifications, mostly in light industry). In the Americas, Brazil and Mexico represent almost half of certifications, while China and India represent almost 90% of certificates in Asia.

In Europe, the trend is a preference for multi-site certifications, with on average almost three sites per certification in Germany and four in France, Italy, Spain and the United Kingdom. The trend does not appear to be growing China and India, however. Opting for multi-site certifications may be a way to reduce the administrative burden[21] while still complying with regulations and accessing incentives.

Figure 9.10 ISO 50001 certifications in selected regions 2018-19



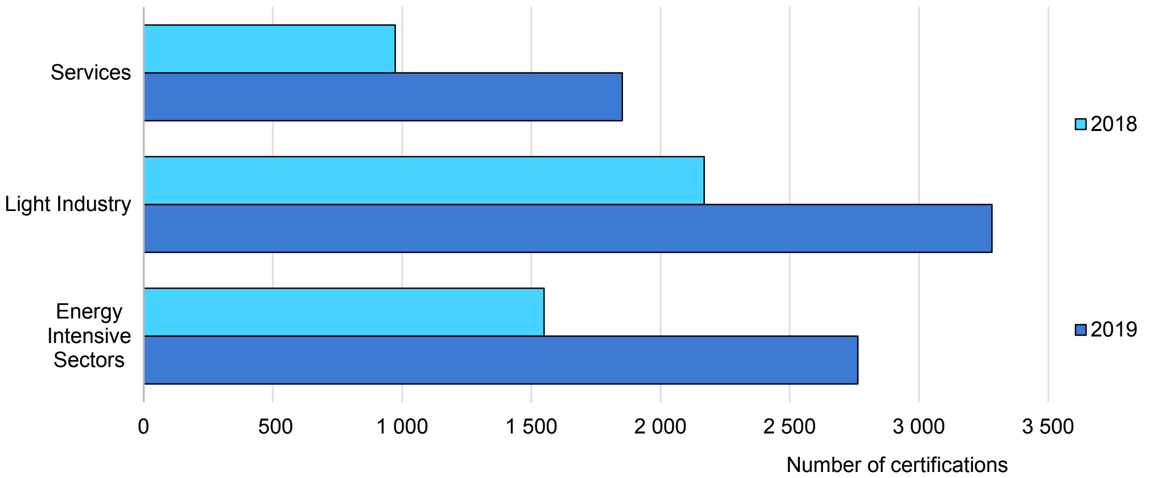
Note: 2018 and 2019 data differ from previous years' data due to changes in the methodology used in the ISO survey and are not comparable with data presented in previous years' reports.
Source: International Organisation for Standardization, ISO Survey 2019.

Among industrial sectors, the largest growth in certifications was in facilities producing basic metals, where certifications doubled between 2018 and 2019, adding 700 certifications. Certifications of food products, beverage and tobacco facilities increased from over 500 to almost 900. Finally, chemicals, chemical products and fibres, and rubber and plastic products increased by 50%, to reach 1 500 certifications in 2019. However, compared with older standards such as

[21] Multi-site certifications are based on a sample of sites that are audited, thereby reducing the number of audit days for a company.

ISO 9001 (launched in 1987) and ISO 14001 (launched in 1996) the number of ISO 50001 certifications in these sectors remains very low, indicating a large potential for development. For instance, in 2019 there were almost 27 000 ISO 14001 certifications in the basic metals sector but just 1 000 for ISO 50001.

Figure 9.11 ISO 50001 certifications by industry sector, 2018 and 2019



Note: Energy intensive sectors includes: Pulp, paper and paper products, Chemicals, chemical products and fibres, Non-metallic mineral products, Concrete, cement, lime, plaster etc., Basic metal and fabricated metal products. Light Industry includes: Food products, beverage and tobacco, Textiles and textile products, Leather and leather products, Manufacture of wood and wood products, Publishing companies, Printing companies, Pharmaceuticals, Rubber and plastic products, Machinery and equipment, Electrical and optical equipment, Shipbuilding, Aerospace, Other transport equipment, Manufacturing not elsewhere classified. Services includes: Wholesale & retail trade, repairs of motor vehicles, motorcycles and personal and household goods, Hotels and restaurants, Transport, storage and communication, Financial intermediation, real estate, renting, Information technology, Engineering services, Other Services, Public administration, Education, Health and social work, Other social services.
Source: International Organization for Standardization, ISO Survey 2019.

Industry investments were flat

Industry investments in energy efficiency are estimated to have remained roughly at business-as-usual levels, at around USD 35 billion in 2019.

Global industry investment in energy efficiency is primarily driven by:

- policies, in particular those implemented by large industrial producers, such as China, Europe, India and the United States
- payback periods, energy efficiency investment competing with other investments.

There have been no major policy changes in recent years and energy prices reached record lows in 2019, lowering financial benefits. These two elements have combined to maintain investment levels at around the same level for the last few years, with a slight decrease in 2019.

Industry policy updates in 2019

- The Netherlands introduced an energy efficiency reporting obligation that requires industrial facilities consuming over 50 000 kWh of electricity or 25 000 m^3 of gas to report energy efficiency actions taken.
- Poland introduced Energy Plus, an incentive programme combining loans and grants for industry that will run from 2019 to 2025. The programme aims to reduce the wastage of primary raw materials through improved production processes that minimise or utilise downstream waste and waste heat.
- Brazil commenced the third cycle of its Strategic Alliance Program for Energy Efficiency, in which the government will fund up to 40% of the cost of energy efficiency consulting services for industrial plants. The programme will target measures to decrease electricity consumption.
- The Philippines set in place a comprehensive Energy Efficiency and Conservation law in April 2019. The new law includes obligations for commercial, industrial and transport large energy users and incentives for energy efficiency investments. It also strengthens the government's energy management programme and expands minimum energy performance ratings to more appliances and vehicles.
- In Spain, the Program of Energy Efficiency Actions in SMEs and large companies in the industrial sector was approved with a contribution of EUR 307 million. The objective is to encourage energy efficiency actions in the industrial sector that reduce CO_2 emissions and final energy consumption, to help achieve energy savings targets established by EU Directive 2012/27/EU.

Policies for motors began to strengthen

Improving electric motors is the first step to increasing the efficiency of wider electric motor-driven systems such as compressors, pumps and fans. In 2019 stronger minimum energy performance standards for motors were implemented and updates were proposed in several key regions. Policy changes expected to significantly improve the energy efficiency of motors in coming years included:

- Brazil implemented new minimum energy performance standards for motors. The standard, legislated in 2017, came into force in August 2019 and requires motors between 0.2 kW and 370 kW to reach IE3 levels (the International Electrotechnical Commission classifies motor efficiency from IE1 to IE4).

- The European Union expanded the coverage of its regulation on electric motors and variable speed drives on October 2019 through Regulation (EU) 2019/1781, requiring IE3 levels for motors with output power between 0.75 kW and 1 000 kW by July 2021, and IE4 levels for motors between 75 kW and 200 kW by July 2023.
- China presented a draft update to its standard for motors (GB 18613), which sets IE3 requirements for motors between 0.12 kW and 1 000 kW.

Table 9.2 Minimum energy performance standard levels for motors by country

Motors MEPS levels	Country/Jurisdiction
IE3	Brazil, Canada, European Union, Japan, Korea, Mexico, Saudi Arabia, Singapore, Switzerland, Chinese Taipei, Turkey, United States
IE2	Australia, Chile, China, Colombia, Ecuador, India, New Zealand

INTERNATIONAL ENERGY AGENCY

The IEA examines the full spectrum of energy issues including oil, gas and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand side management and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability and sustainability of energy in its 30 member countries, 8 association countries and beyond.

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Estonia
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Greece
Hungary
Ireland
Italy
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Mexico
Netherlands
New Zealand
Norway
Poland
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