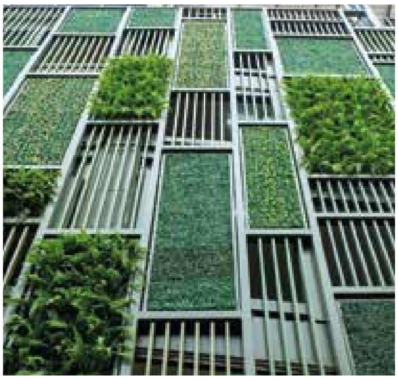
UN environment

Towards a zero-emission, efficient, and resilient buildings and construction sector

GLOBAL STATUS REPORT 2017






Global Alliance for Buildings and Construction

International Energy Agency
Secure Sustainable Together

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Towards a zero-emission, efficient, and resilient buildings and construction sector

GLOBAL STATUS REPORT 2017

Preface

The global buildings sector is growing at unprecedented rates, and it will continue to do so. Over the next 40 years, the world is expected to build 230 billion square metres in new construction – adding the equivalent of Paris to the planet *every single week*.

This rapid growth is not without consequences. While buildings sector energy intensity has improved in recent years, this has not been enough to offset rising energy demand. Buildings-related CO_2 emissions have continued to rise by around 1% er year since 2010, and more than four million deaths each year are attributable to illness from household air pollution.

Fortunately, many opportunities exist to deploy energy-efficient and low-carbon solutions for buildings and construction. These solutions will necessitate greater effort to implement strategic policies and market incentives that change the pace and scale of actions in the global buildings market.

This year's *Global Status Report* looks at the state of global buildings and construction since the historic Paris Agreement at the 21st Conference of Parties. It considers the numerous commitments and actions by countries, cities, industry and related stakeholders to help put the global buildings and construction sector on a sustainable trajectory.

The report makes clear that while global progress is advancing, there is a growing urgency to address energy demand and emissions from buildings and construction. Current policies and investments fall short of what is needed, and what is possible.

Ambitious action is needed without delay to avoid locking in long-lived, inefficient buildings assets for decades to come. Examples across the multitude of actions by Global Alliance for Buildings and Construction (GABC) countries and partners illustrate that this ambition is indeed possible.

It is our hope that this status report, along with continued international collaboration and best practice sharing, helps to raise awareness of the needs and opportunities to put global buildings and construction on a sustainable pathway.

Dr Fatih Birol
Executive Director
International Energy Agency

"We urgently need to move towards a pollution free planet, to tackle climate change and to drive sustainable development. We can only do that with decisive action in this sector. Technologically and commercially viable solutions exist, but we need stronger policies and partnerships to scale them up more rapidly. Many thanks to all the partners who work to produce this annual update on the progress made and the challenges ahead.

Erik Solheim
Executive Director
United Nations Environment Programme
Under-Secretary General, United Nations

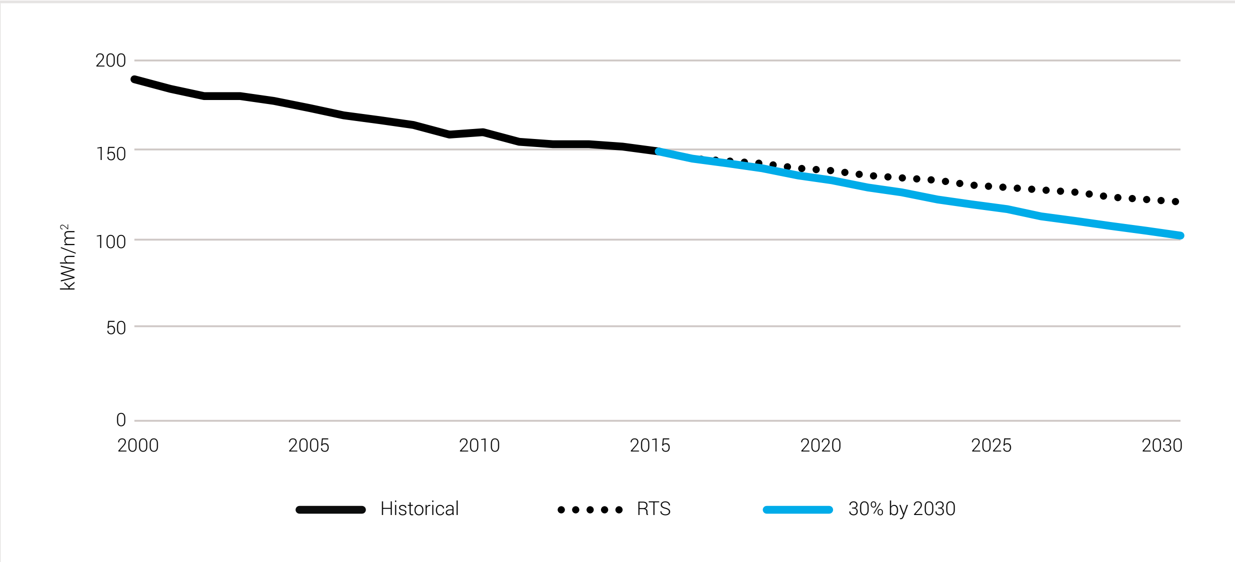
Table of Contents

Global Perspectives

Buildings and construction together account for 36% of global final energy use and 39% of energy-related carbon dioxide (CO_2) emissions when upstream power generation is included[1].

Progress towards sustainable buildings and construction is advancing, but improvements are still not keeping up with a growing buildings sector and rising demand for energy services. The energy intensity per square meter (m^2) of the global buildings sector needs to improve on average by 30% by 2030 (compared to 2015) to be on track to meet global climate ambitions set forth in the Paris Agreement.

FIGURE 1 Global final energy use per square meter



Notes: EJ = exajoules; kWh/m2 = kilowatt-hours per square metre: RTS = Reference Technology Scenario.
Source: IEA (2017), Energy Technology Perspectives 2017, IEA/OECD, Paris www.iea.org/etp/.

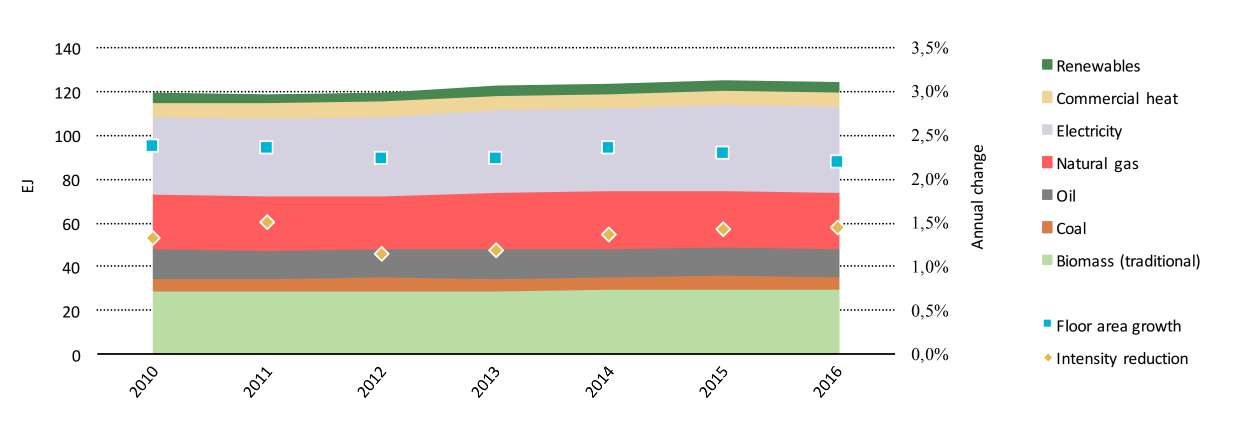
1 This data covers buildings and construction, including the manufacturing of materials and products for building construction that was not included in the Global Status Report 2016. More methodological details are available in the section "Global Status".

The global buildings sector continues to grow, with floor area reaching an estimated 235 billion m^2 in 2016. Final energy use by buildings grew from 119 exajoules (EJ) in 2010 to nearly 125 EJ in 2016. Fossil fuel use in buildings remained almost constant since 2010 at roughly 45 EJ (Figure 2).

On a positive note, global annual buildings-related carbon emissions appear to have peaked, at least temporarily, at around 9.5 gigatonnes of CO_2 ($GtCO_2$) in 2013, then decreasing to 9.0 $GtCO_2$ in 2016. However, that drop was largely due to progress in reducing the carbon intensity of power generation, with direct emissions from buildings stable at around 2.8 Gt CO_2. By contrast, CO_2 emissions from buildings construction grew steadily, from 3.1 $GtCO_2$ in 2010 to around 3.7 $GtCO_2$ in 2016.

Buildings sector energy intensity (in terms of energy use per m^2) continues to improve at an annual average rate of around 1.5%. Yet, global floor area continues to grow by about 2.3% per annum, offsetting those energy intensity improvements.[2] Continuing this trend in the coming decades will make it increasingly difficult to achieve ambitions for a 2 degree Celsius (°C) world or below.

FIGURE 2 Global buildings sector energy consumption by fuel type, 2010 - 2016



Source: derived with IEA (2017), World Energy Statistics and Balances, IEA/OECD, Paris, www.iea.org/statistics

KEY POINT

Buildings final energy demand increased by 5 EJ from 2010 to 2016 as energy-efficiency efforts have not kept up with rising floor area.

The Paris Agreement marked a turning point in the call to limit global warming. Seizing on that momentum, rapid deployment of energy-efficient and low-carbon solutions for buildings and construction can help put the world on a sustainable trajectory.

Multiple opportunities exist to mitigate greenhouse gas (GHG) emissions in the buildings and construction sector. The energy and emissions savings potential in buildings remains largely untapped due to continued use of less efficient technologies, alongside lack of effective policies and weak investments in sustainable buildings and construction in many countries. Consumer choices and behaviour also play a key role.

Yet, energy-efficient, low-carbon products are already available in most markets today. Upfront investments can represent a key barrier to adoption, but many high-performance technologies (e.g. light-emitting diodes [LEDs]) and technology packages (e.g. heat pumps combined with insulation) are typically cost-effective.

The establishment of a review-and-revise platform reflecting Parties' "highest possible ambitions" is already leading to positive developments with regards to end-use equipment efficiencies and building code implementation in several new countries.

2 IEA (2017), Tracking Clean Energy Progress 2017, IEA/OECD, Paris, www.iea.org/etp/tracking2017/

However, greater effort is needed to implement strategic policies and market incentives to encourage broad uptake of energy saving and sustainable solutions. The UNFCCC facilitative dialogue in 2018 and the formal collective review in 2023 are key milestones to bridge the gap between climate ambitions and policy action in buildings and construction.

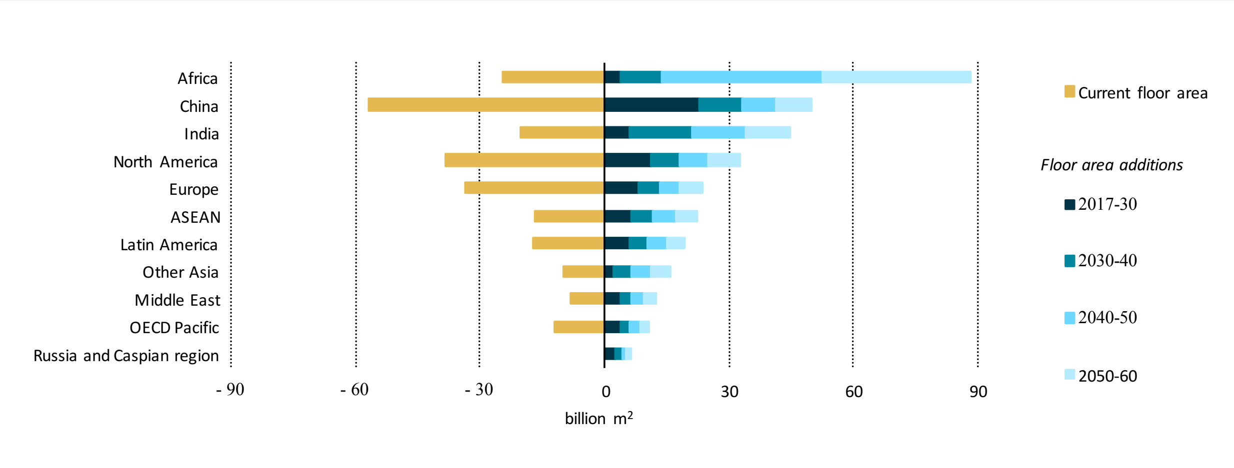
There is a growing urgency to address energy and emissions from buildings and construction if ambitions for a 2°C world or below are to be achieved. Over the next 20 years, more than half of new buildings expected to 2060 will be constructed. More alarmingly, two-thirds of those additions are expected to occur in countries that do not currently have mandatory building energy codes in place.[3]

Building growth will be particularly rapid in Asia and Africa (Figure 3). For instance, floor area in India is expected to double by 2035. Yet, only part of the sector is covered by mandatory building energy codes.

Deep energy renovations of existing buildings (e.g. 50% to 70% energy intensity improvements, with the objective of moving towards high-performance and low-carbon buildings, such as near-zero energy buildings [nZEBs]), are another priority over the coming decades. This is especially true for Organisation for Economic Co-operation and Development (OECD) countries, where roughly 65% of the total expected buildings stock in 2060 is already built today.

Achieving climate ambitions will require intensified policy response to drive change and scale up actions across the buildings and construction sector. This includes a sound balance of regulatory tools (e.g. building energy codes), incentives and financing tools, information and capacity building, and support for successful business models that attract private-sector investments and innovative solutions. It also will likely require changes in behaviour and social practices.[4]

FIGURE 3 Floor area additions to 2060 by key regions



Notes: OECD Pacific includes Australia, New Zealand, Japan and Korea; ASEAN = Association of Southeast Asian Nations.
Source: IEA (2017), Energy Technology Perspectives 2017, IEA/OECD, Paris, www.iea.org/etp

KEY POINT

There is urgent need to address rapid growth in inefficient and carbon-intensive buildings investments, especially in developing countries.

3 IEA (2017), Energy Technology Perspectives 2017, IEA/OECD, Paris, www.iea.org/etp

4 Lucon O. et al. (2014), Buildings in: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, http://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter9.pdf

Tracking progress

82% of final energy consumption in buildings was supplied by fossil fuels in 2015.

(including primary energy input for power generation; traditional use of biomass excluded)

193 countries have submitted nationally determined contributions (NDCs). 132 NDCs explicitly mention the buildings sector. Among them, 101 pointed to energy-efficiency opportunities to meet mitigation targets. 49 countries committed to use renewable sources of energy in buildings to improve access to clean energy and endorse adoption of low-carbon energy assets.

While building energy codes, certifications and high-efficiency technologies are crucial to achieve the transition to sustainable buildings, the majority of NDCs do not mention specific projects or targets relat ed to energy performance standards or efficient building technology deployment. This is the case even for some countries that have such policies in place.

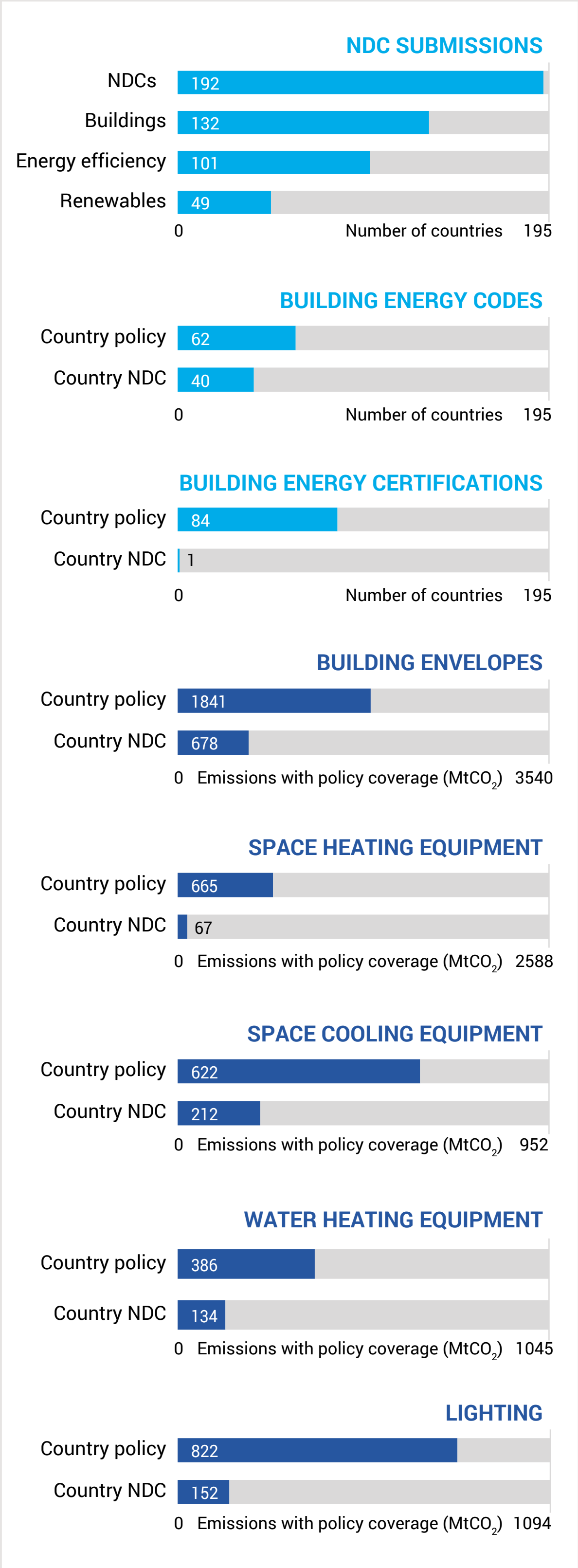
Of the buildings-specific actions, improving building envelope performance and enhancing cooling equipment efficiency cover the largest share of buildings-related emissions (Figure 4). Space heating is not mentioned explicitly in most NDCs, even though it accounts for nearly 30% of buildings-related carbon emissions.

Other countries only submitted economy-wide emissions reduction targets. Some of these coutries have policies in place but did not report nor complement them in their NDCs. Specifying intended actions in the buildings and construction sector would help clarify and track the important role the sector can play in meeting global GHG mitigation.

Despite progress, NDCs to date still fall short of tapping into the 4.9 $GtCO_2$ of potential annual emissions abatement that could be achieved if countries were to pursue strategic low-carbon and energy-efficient buildings technology deployment.[5] Globally, current policies cover roughly 47% of buildings-related CO_2 emissions. If NDC pledges are achieved in addition to those existing policies, coverage would only likely be extended to about 60%.

5 Further information on buildings sector carbon abatement potential and technology policy strategies can be found in the IEA's Energy Technology Perspectives 2017 (www.iea.org/etp).

FIGURE 4 Scope of NDCs and building policies by policy type and emissions coverage



Notes: MtCO2 = megatonnes of CO2. Indirect emissions from building envelopes are calculated based on the total carbon abatement potential related to heating and cooling in buildings.

Human factors

The human factor, including occupant choices and behaviour in buildings, significantly affects energy use in buildings. Building design and characteristics influence occupant feeling of comfort (and therefore energy demand). Occupant behaviour and needs equally influence building operations and performance.

Human factors can be addressed through a variety of measures, including but not limited to heating ventilation and air conditioning regulations (e.g. to ensure indoor air quality control), building design (e.g. to enable daylight harvesting, passive heating, passive cooling and optimised air flows) and construction materials (e.g. to enable greater thermal comfort).

A few countries have already started to promote occupant-friendly technologies and building attributes that could enable energy savings. For instance, human factors are explicitly mentioned in building codes in the People's Republic of China (hereafter, "China'"); some elements are even mandatory requirements. Other countries, such as the United States and Canada, have made documentation of best practices for building design and construction available. Many countries in the European Union have legislation in place for these issues.[6]

From an operational perspective, improved sensors and user controls can enable improved human-building interactions. IEA analysis on the role of digitalisation in buildings finds that smart contols and connected devices could save 230 EJ in cumulative energy savings to 2040, lowering buildings energy consumption by as much as 10% globally, while improving thermal comfort and delivering greater amenity to building occupants (Figure 5). Those savings would also help reduce the carbon intensity of the power sector, through better management of energy supply and demand across the grid.

Connected devices that can improve building-occupant interaction are taking off rapidly in many markets. For instance, smart thermostat adoption doubled from 3% in 2014 to 6% in 2016 in the United States.[7]

Smart building energy management can help to ensure that energy is consumed when and where it is needed, improving the responsiveness and efficiency of building energy services, while also accounting for user preferences and improving the overall quality of life in buildings. Smart buildings can also be at the forefront of decarbonising the broader energy system, providing flexibility through energy controls, storage and demand response.[8]

Real-time data collected through the controls and sensors can also potentially help governments, utilities and customers to predict, measure and monitor real-time buildings energy use and performance. That data could be used to assess where action is needed (e.g. for building maintenance), when investments are not performing as expected or where intervention could deliver on energy and emissions savings.

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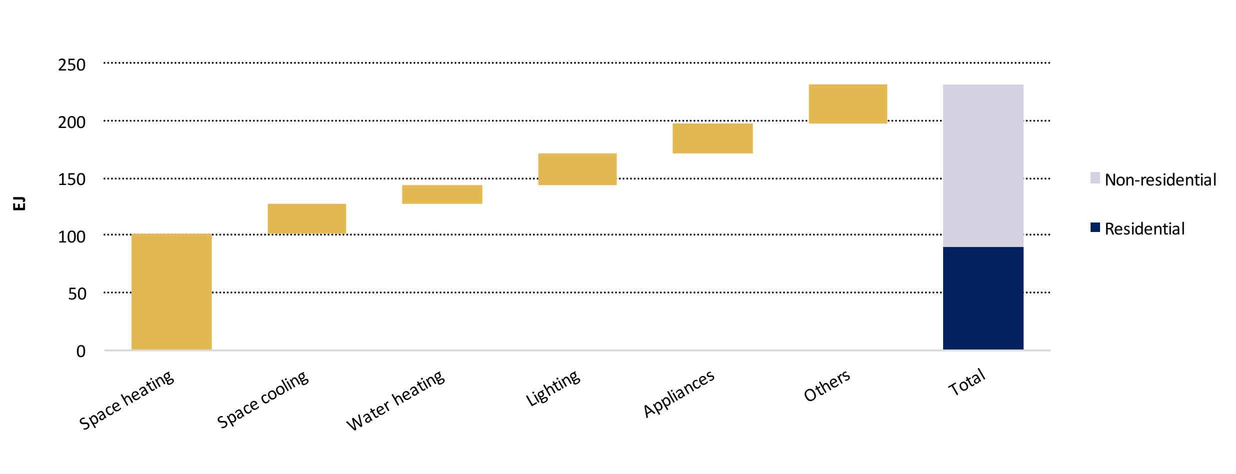
6 BPIE (Buildings Performance Institute Europe) (2015), Indoor Air Quality, Thermal comfort and Daylight: Analysis of Residential Building Regulations in Eight EU Member States, Brussels, http://bpie.eu/wp-content/uploads/2015/10/BPIE__IndoorAirQuality2015.pdf

7 Wilczynski, E. (2017). "Turning Up the Heat: The Rapid Surge in Smart Thermostat Programs", E Source, http://www.esource.com/Blog/ESource/ES-Blog-3-6-17-Smart-Thermostats

8 BPIE (Buildings Performance Institute Europe) (2017), Opening the door to Smart Buildings, Brussels, http://bpie.eu/publication/opening-the-door-to-smart-buildings/

FIGURE 5 Energy saving potential from digitalisation (cumulative, 2018-2040)



Source: IEA (2017), Digitalization and Energy, IEA/OECD, Paris, www.iea.org/digital/

KEY POINT

Active controls could save up to 230 EJ cumulatively to 2040, roughly twice the energy consumed by the entire buildings sector in 2017.

Transforming energy use in buildings and construction sector will require a better understanding of people's needs and expectations in buildings. Multiple examples already exist that demonstrate how better buildings and building design influence occupant experience, behaviour and energy demand. For instance, the World Green Building Council (WorldGBC) is working across countries and partners to build an evidence base on the intersection between the human factor and energy demand and emissions in buildings. This includes the link between key building elements, such as indoor air or lighting quality, with building energy use, employee sick days and even worker productivity.

Quantifying the benefits of sustainable buildings and construction is a key element to demonstrate the business value in accounting for human factors in buildings design and operation. For example, Skanska's renovated office in Bentley Works (United Kingdom) was certified as BREEAM Excellent, and data collected by the human resources team showed that employee sick days decreased by three days on average compared to other Skanska offices. The savings from that reduction were estimated at nearly USD 37 000 in 2015.[9]

BETTER PLACES FOR PEOPLE

In October 2016, the WorldGBC project Better Places for People released a report on Building the Business Case for health, wellbeing and productivity in energy-efficient and low-carbon buildings. The report features case studies illustrating how green buildings enhance occupant health, wellbeing and productivity, which deliver business value for building owners and investors. For instance, call-centre productivity in Saint-Gobain's North American headquarters saw a 97% increase in sales-generated leads and a doubling in leads per call after increasing daylighting by 25% and ensuring 90% of workspaces had a view to the outdoors. WorldGBC is planning to release a similar follow-up report with 15 additional case studies demonstrating the value of green buildings in March 2018.

9 WorldGBC (World Green Building Council) (2016), Building the Business Case: Health, Wellbeing and Productivity in Green Offices, London, http://www.worldgbc.org/sites/default/files/WGBC_BtBC_Dec2016_Digital_Low-MAY24_0.pdf

Data and measurement

The report Global Trends in Data Capture and Management in Real Estate and Construction found that while buildings data is often collected, the information is typically used by individual stakeholders and not shared for broader use.[10] The survey also found that the value of that data is not well understood, even within organisations that need better data, limiting ability to access and use better information. Transparency (e.g. through open databases and public disclosure) could remove many barriers regarding useful data for buildings.

There are several new initiatives dedicated to improving buildings data. The IEA technology collaboration programme on Energy in Buildings and Communities has created a programme of work (Annex 70) looking at actual building energy use and data across multiple countries.[11] Annex 70 has a three part research effort to:

1. Compare approaches to developing buildings stock data sets and models to identify and share lessons learned;
2. Establish best practice in methods used for gathering and analysing real building energy use data;
3. Evaluate the scope for using that data to inform policy making and support industry in the development of low energy solutions.

C40 Cities has similarly started a technical assistance programme to support private and municipal building efficiency networks with building energy data. The ICLEI – Local Governments for Sustainability carbon*n* Climate Registry (cCR) is another platform for cities, towns and regions that allows for exchange, learning and benchmarking among more than 1 000 registered entities while providing data that feeds into global climate negotiations.

In the European Union, many member states, such as Denmark, Ireland and the Netherlands, now have publically accessible databases about the energy performance of individual buildings or clusters of buildings. This type of publically accessible data, collected through Energy Performance Certificates in Europe for example, could be expanded across other countries to map and monitor building energy performance.[12]

In many countries, utility companies are now also using buildings energy data, such as electricity or gas consumption, to provide useful information to consumers about their energy consumption patterns and spending. For instance, EDF France provides users with an energy benchmark dashboard that displays information on monthly electricity and gas consumption relative to households with similar profiles. Links to information on energy-saving tips, tools and even certified professional contacts can also be found within the same dashboard tool.

TRACKING COOLING PROGRESS

The Kigali Cooling Efficiency Programme (K-CEP), established in 2017 to support the Kigali Amendment to the Montreal Protocol, will launch an online database and progress tracker in 2018. The data and tracker, hosted by the IEA Global Exchange Platform, will work across countries and with K-CEP partners to track information on cooling equipment energy efficiency, refrigerants, investments and policies. This data will be used to track progress towards high-performance cooling technologies and the phase-down of hydrofluorocarbons with climate-safe coolants.

UNITED STATES

The Bullitt center is the first net-zero energy building in Seattle. The building has exceeded its original goal and generated as much as 60% more energy than it actually consumes. The building also has an online dashboard that was developed to support energy-efficient behaviour and track how much energy the building is using in real time.

DATA FOR SMART BUILDINGS

The Smart Building Alliance (SBA) for smart cities, created in 2012, brings together 200 organisations in France and aims at converging the digital transition and energy transition of the buildings sector by promoting two quality charters, "Ready2Grid" and "Ready2Services" that will help deliver offers and solutions for active management of buildings through interoperable and smart data. The two labels will be certified and will indicate the readiness of a building or technology to deliver digital services, including ones related to energy. The SBA hopes the labels will unlock the potential for connected solutions that enable better data and management of energy use.

10 RICS (Royal Institution for Chartered Surveyors) (2017), Global Trends in Data Cature and Management in Real Estate and Construction, RICS Insights Paper, https://www.rics.org/be/knowledge/research

11 More information can be found at https://energyepidemiology.org/

12 BPIE (Buildings Performance Institute Europe) (2015), Energy Performance Certificates Across the EU: A Mapping of National Approaches, Brussels, http://bpie.eu/publication/energy-performance-certificates-across-the-eu/

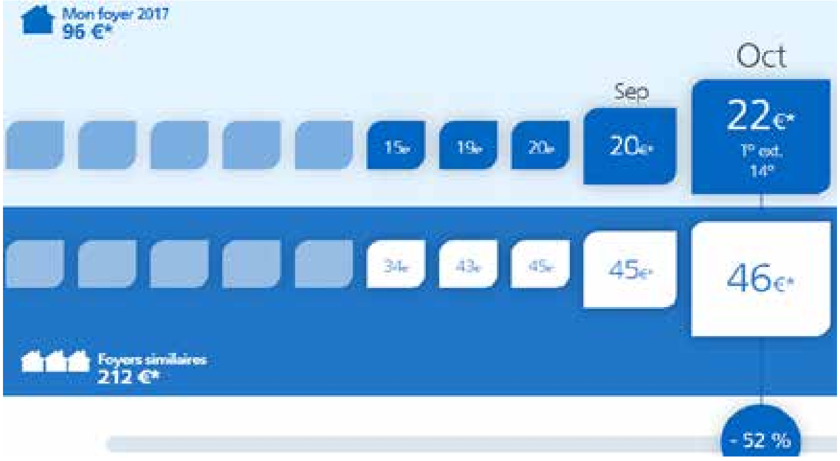


Image source: EDF France, https://equilibre.edf.fr

Priorities for action

A global transformation to a highly energy-efficient and low-carbon buildings and construction sector is key to ensure global ambitions for a 2°C world or below.

By 2060, buildings sector floor area will double, adding more than 230 billion m2 to the planet in new buildings construction. Those additions are equivalent to building the current floor area of Japan every single year from now until 2060.

There is a critical window of opportunity to address buildings and construction in the coming decade to avoid lock-in of inefficient buildings over the next 40 years. There is an equally critical need to address energy performance improvements and emissions reduction in the world's existing buildings stock. Swift and ambitious action is needed without delay to avoid locking in inefficient buildings assets for decades to come.

There are many strategies to reduce the energy and climate impact of buildings and construction. Key priorities identified by the GABC roadmap include:

1. URBAN PLANNING POLICIES FOR ENERGY EFFICIENCY AND RENEWABLES

Use urban planning policies to impact the form and compactness of buildings to enable reduced energy demand and increased renewable energy capacity.

2. IMPROVE THE PERFORMANCE OF EXISTING BUILDINGS

Increase the rate of building energy renovation and increase the level of energy efficiency in existing buildings.

3. ACHIEVE NET-ZERO OPERATING EMISSIONS

Increase uptake of net-zero operating emissions for new and existing buildings, including through system-level solutions such as zero-carbon district energy.

4. IMPROVE ENERGY MANAGEMENT OF ALL BUILDINGS

Reduce the operating energy and emissions through improved energy management tools and operational capacity building.

5. DECARBONISE BUILDING ENERGY

Integrate renewable energy and reduce the carbon footprint of energy demand in buildings.

6. REDUCE EMBODIED ENERGY AND EMISSIONS

Reduce the environmental impact of materials and equipment in the buildings & construction value chain by taking a life-cycle approach.

7. REDUCE ENERGY DEMAND FROM APPLIANCES

Collaborate with global initiatives to reduce the energy demand from appliances, lighting and cooking.

8. UPGRADE ADAPTATION

Reduce climate-change related risks of buildings by adapting building design and improving resilience.

9. INCREASE AWARENESS

Support training and capacity building including educational and informative tools to make the case for sustainable buildings and construction.

Global Status

The global buildings sector consumed nearly 125 EJ in 2016, or 30% of total final energy use. Buildings construction, including the manufacturing of materials for building such as steel and cement, accounted for an additional 26 EJ (nearly 6%) in estimated global final energy use (Figure 6).

Accounting for upstream power generation, buildings represented 28% of global energy-related CO_2 emissions, with direct emissions in buildings from fossil fuel combustion accounting for around one-third of the total. Buildings construction represented another 11% of energy sector CO_2 emissions (Figure 7).

FIGURE 6 Share of global final energy consumption by sector, 2015

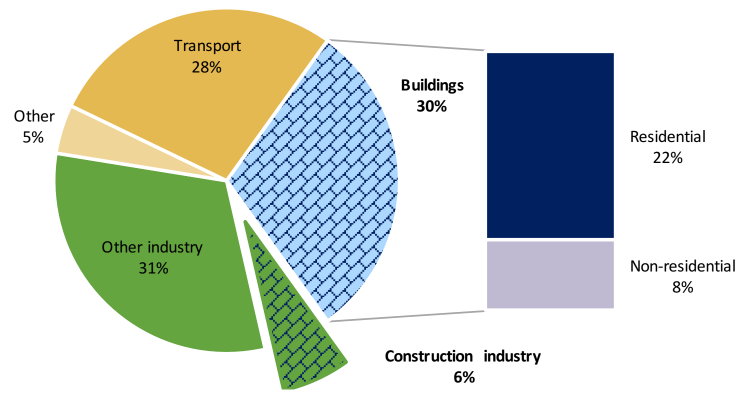
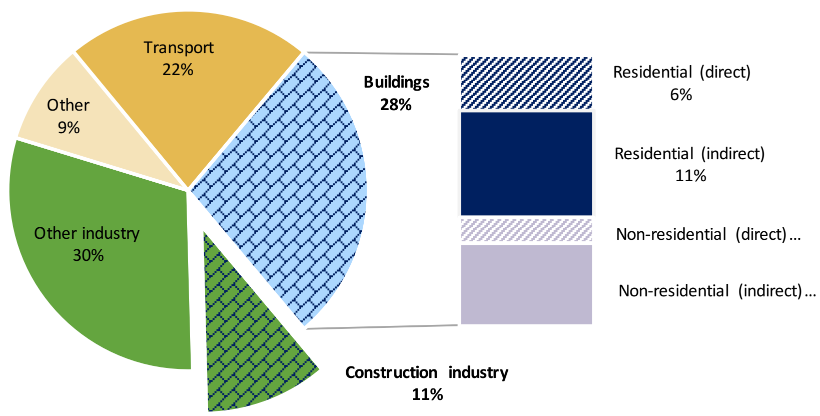


FIGURE 7 Share of global energy-related CO2 emissions by sector, 2015



Note: The "construction industry" is an estimate of the portion of the overall industry sector that applies to the manufacturing of materials for building construction, such as steel, cement and glass.
Source: derived with IEA (2017), World Energy Statistics and Balances, IEA/OECD, Paris, www.iea.org/statistics

KEY POINT

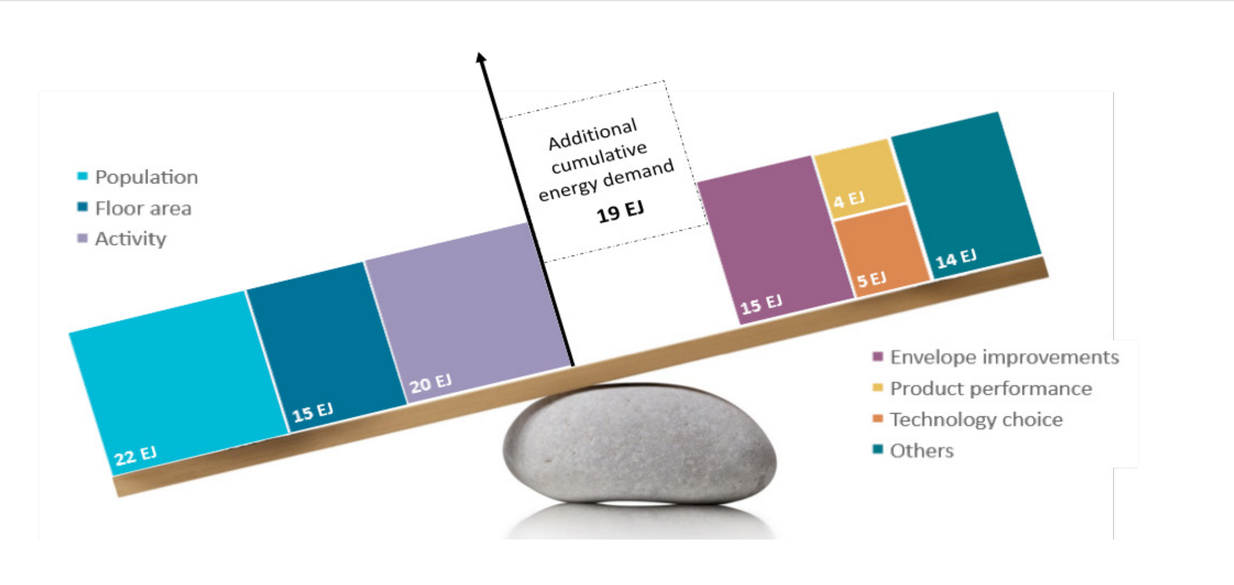
Buildings and construction account for more than 35% of global final energy use and nearly 40% of energy-related CO_2 emissions.

Globally, the buildings sector continues to fall short of its potential. CO2 emissions from buildings and construction rose by nearly 1% per year between 2010 and 2016, releasing 76 GtCO2 in cumulative emissions during that period.

A growing number of countries have put in place policies to improve buildings energy performance. However, a rapidly growing buildings sector, especially in developing countries, has offset those improvements.

Between 2010 and 2016, population growth, rising floor area per person and greater demand for energy services all contributed to an additional 57 EJ of cumulative growth over 2010 buildings energy consumption (Figure 8). This increase in new energy demand in buildings is equal to all the final energy consumed by Germany during that period.

FIGURE 8 Decomposition of buildings final energy consumption by key contributions, 2010-2016

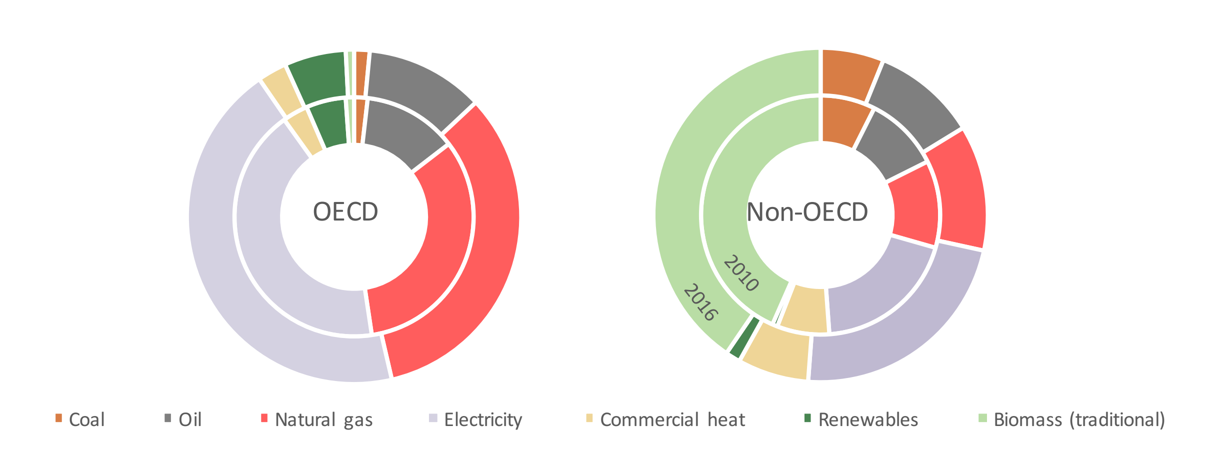


Notes: "Activity" represents changes in energy use per m^2 (which can be due to human factors, ownership of energy-consuming equipment or growth in services value added). "Envelope improvements" account for buildings measures that improve the energy intensity of the building envelope. "Product performance" represents energy technology efficiency improvements. "Technology choice" represents shifts from one type of equipment and/or fuel to another. "Others" includes greater access to electricity, changes in energy demand influences (e.g. annual cooling degree days) and any residual energy from the decomposition analysis.
Sources: Population: UN DESA (2015), World Population Prospects: The 2015 Revision, Medium Fertility Variant; services value added derived with IMF (2016), World Economic Outlook Database: April 2016; energy decomposition calculations derived with IEA (2017), World Energy Statistics and Balances (database), http://dx.doi.org/10.1787/enestats data en

KEY POINT

Despite progress, energy efficiency improvements since 2010 have not been enough to offset strong growth in energy demand from rising population, floor area and buildings sector activity.

FIGURE 9 **Buildings sector energy consumption by fuel shares, 2010 and 2016**



Source: IEA (2017), World Energy Statistics and Balances (database), http://dx.doi.org/10.1787/enestats-data-en

KEY POINT

Nearly two-thirds of global buildings sector energy consumption is supplied by fossil fuels for direct use or for upstream power generation.

By contrast, policy efforts, technology choice and energy efficiency measures all helped to avoid 24 EJ of final energy demand growth in buildings between 2010 and 2016. Those energy demand offsets are equivalent to the energy produced by more than 340 coal power plants during the same period.[13]

Other energy savings effects, including greater access to electricity in developing countries, helped to offset another 14 EJ of cumulative final energy growth since 2010.

The net result is that global buildings energy use increased (cumulatively) by 19 EJ between 2010 and 2016, equal to the total final energy used in Australia during that period.

Globally, fossil fuel use in buildings accounted for 36% of total final energy consumption in 2016, down slightly from 38% in 2010. Yet, that change does not tell the whole story: coal and oil use in buildings has remained practically constant since 2010. Natural gas use grew steadily by about 1% per year.

When fossil fuel input for electricity and commercial heat production is accounted for, this means that nearly two-thirds of buildings energy consumption was supplied by fossil fuels in 2016. Excluding for traditional use of biomass, that share rises to more than 80%.[14]

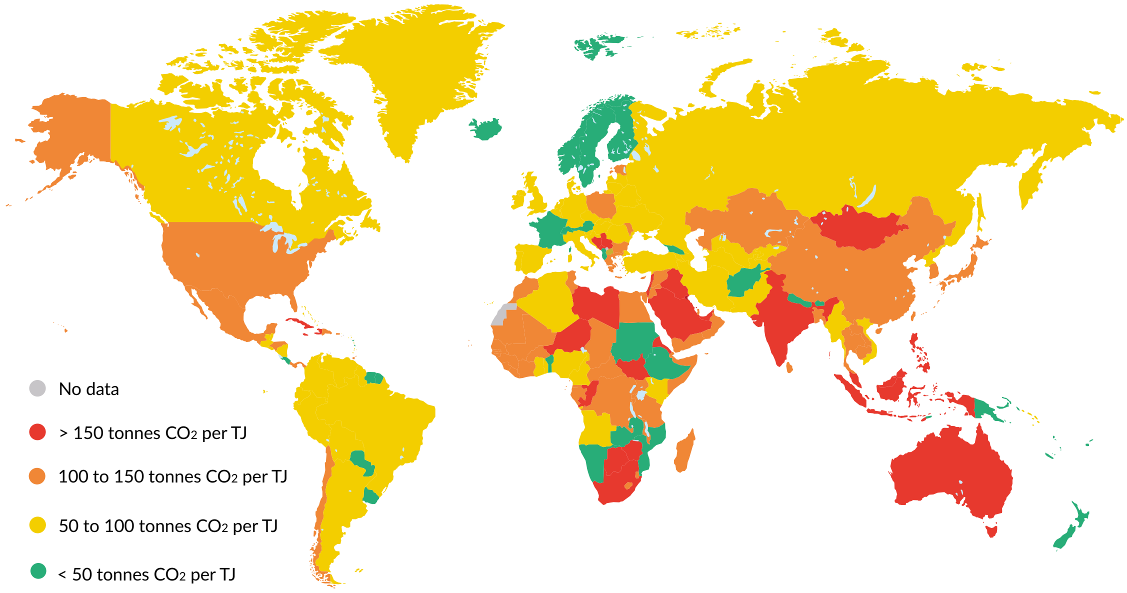
The share of fuels used in buildings continues to be very different between OECD and non-OECD countries (Figure 9). Many non-OECD countries still rely on traditional use of solid biomass (e.g. for cooking), which accounted for one-third of total final energy demand in buildings in those countries in 2016.

On a positive note, traditional use of biomass per person in non-OECD countries declined steadily by around 0.5% per year since 2010, due to a combination of factors, including urbanisation, increasing income and greater access to modern commercial fuels. Still, the improvement was not enough to offset strong population growth in those countries, which increased on average by 1.3% per year between 2010 and 2016.

13 A typical 500 megawatt coal power plant produces roughly 2.8 TWh per year running 5 600 hours per year at full capacity.

14 IEA (2017), World Energy Statistics and Balances (database), http://dx.doi.org/10.1787/enestats data en

FIGURE 10 Buildings sector energy-carbon intensities by country, 2015



Notes: 1 tonne CO_2 per terajoule = 3.6 grams CO_2 per kWh. Energy-carbon intensities represent the building-related CO_2 emissions (including direct emissions from fossil fuel combustion and indirect emissions from upstream power generation for electricity and commercial heat) per unit of final energy consumption in the buildings sector. These do not include primary energy for production of electricity of electricity and commercial heat. Final energy use in buildings excludes traditional use of biomass.
Sources: IEA, calculations derived from IEA World Energy Statistics and Balances 2017, www.iea.org/statistics; IEA (2017), Energy Technology Perspectives 2017, IEA/OECD, Paris, www.iea.org/etp

KEY POINT

Current buildings energy-carbon intensities are far from the 20 tonnes CO_2 per TJ or less needed by 2050 to meet ambitions for a 2°C world or below.

Global use of electricity in buildings grew on average by 2.5% per year since 2010, with electricity accounting for nearly 70% of the total growth in buildings final energy demand since 2010 and representing one-third of total energy use in buildings in 2016. In some rapidly emerging economies, such as India and Indonesia, electricity use in buildings increased by more than 500% since 2010.

By contrast, buildings electricity demand in OECD countries has remained relatively stable in recent years, largely due to energy efficiency improvements. At the same time, electricity use is still up 25% since 2000.

Overall, the buildings sector represents nearly 55% of global electricity demand. Buildings continue to place a growing demand on the power sector, whose average efficiency was only 43% in 2015.[15] Low-carbon power supply and renewables have helped improve the CO_2 intensity of electricity. However, when buildings sector electricity demand growth is accounted for, the net result is that buildings-related emissions from upstream power have remained practically constant since 2010.

When power sector carbon intensities are added to the overall fuel mix of the global buildings sector, the vast majority of countries today have buildings-related carbon intensities (in tonnes of CO_2 per terajoule [TJ][16]) that are far from the CO_2 intensities required to meet ambitions for 2°C or below (Figure 10). In order to meet those ambitions set forth in the Paris Agreement, buildings sector energy-carbon intensities need to decrease to less than 20 tonnes of CO_2 per TJ before 2050.[17]

15 This excludes electricity produced by co-generation (the combined production of heat and power), which accounted for roughly 9% of total global electricity production in 2015 and had an average global efficiency (main activity producers) of 60%

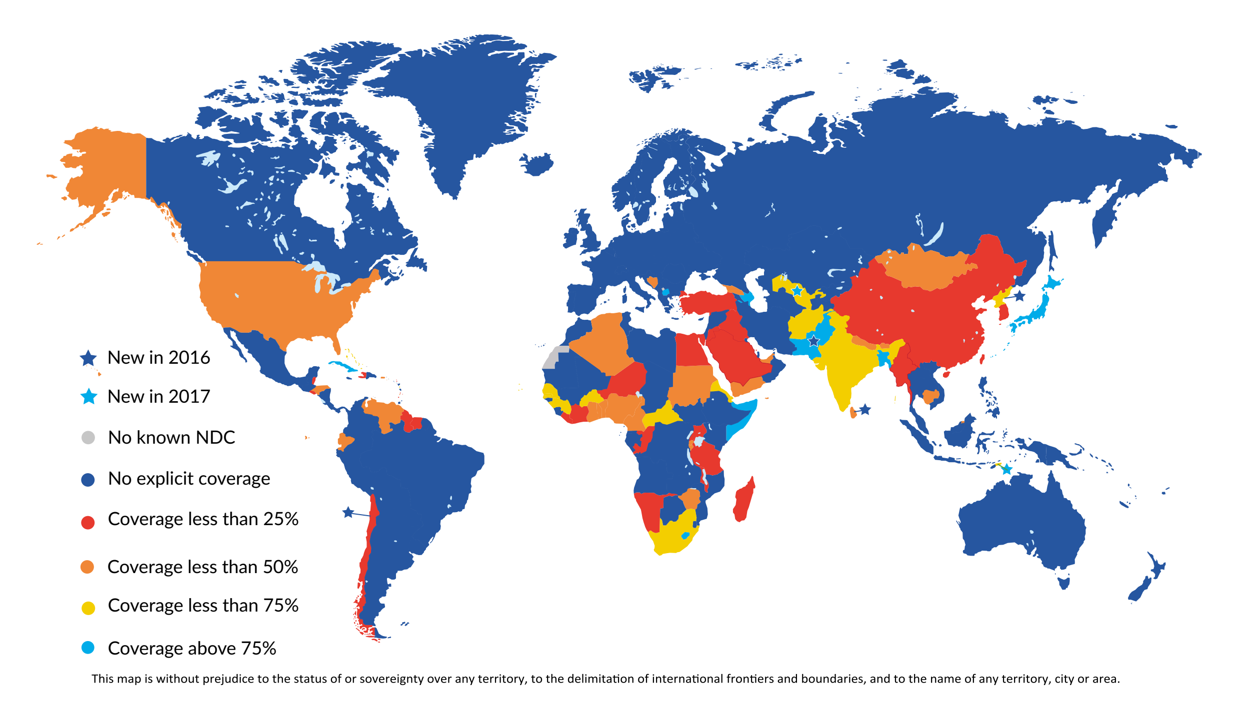
16 Energy-carbon intensities for the buildings sector have been estimated without energy demand from traditional use of biomass, as this is largely speaking an energy access and affordability issue in developing countries.

17 IEA (2017), Energy Technology Perspectives 2017, IEA/OECD, Paris, www.iea.org/etp.

Buildings-related climate commitments

Country commitments

FIGURE 11 Buildings sector emissions coverage as per explicit intended actions in country NDCs



Notes: Emissions coverage is estimated using specific mentions of measures related to the buildings sector, buildings end-use or technology with respect to 2016 buildings sector CO_2 emissions. Country NDCs that do not explicitly mention building measures or actions, for example in the case of economy-wide targets in the European Union, have not been counted in the emissions coverage. Additional information on country policy coverage can be found in other sections of this report (e.g. on building energy codes).
Sources: IEA estimated derived using IEA World Energy Statistics and Balances 2017, www.iea.org/statistics and IEA (2017), Energy Technology Perspectives 2017, IEA/OECD, Paris, www.iea.org/etp

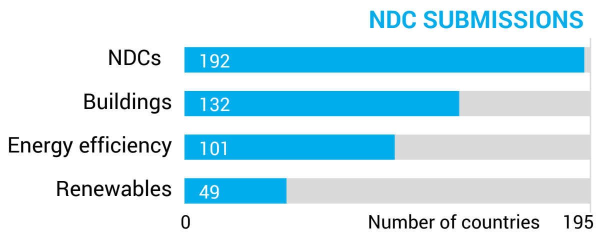
KEY POINT

Buildings-related NDCs only cover less than 15% of buildings sector emissions beyond existing country policies.

NDCs have a large role to play in reporting upon and complementing existing policies to achieve country mitigation targets. Overall, country submissions have been positive, with 132 NDCs explicitly mentioning the buildings sector in their intended actions.

At the same time, nearly one-third of NDCs mentioning buildings do not indicate any specific actions on how they would achieve their ambitions, even if existing or planned national policy actions may address the buildings and construction sector. Hence emission coverage for country policies exceeds coverage of NDCs (Figure 4).

Assertive effort is needed to expand upon current commitments and ensure that NDCs translate into real investments that transform buildings and construction in line with a low-carbon transition. Current ambitions set forth in the NDCs only cover around 13% of global buildings sector CO2 emissions. Specifying buildings and construction actions in country NDCs would therefore help to clarify and track progress, while equally highlighting the global priority and importance of addressing emissions mitigation in the sector.



Local governments

In March 2017 in the United States, 383 Climate Mayors representing more than 20% of the United States population committed to act in support of the goals set forth in the Paris Agreement.

In June 2017, mayors of 140 of the world's largest cities expressed commitment to climate goals, along with support from United Cities and Local Governments (UCLG), C40 Cities Climate Leadership Group (C40) and ICLEI – Local governments for Sustainability.[18] All in all, more than 7 500 local authorities of all sizes are now involved in the Global Covenant of Mayors for Climate and Energy.

Private sector

In 2017, the World Business Council for Sustainable Development (WBCSD) called on its member companies to participate in Energy Efficiency in Buildings (EEB) Amplify project, launched at COP22 in Marrakesh. The project seeks to apply a business-led approach to develop and implement action plans leading to energy efficiency in buildings.[19] To date, EEB Amplify has already worked with stakeholders across the building value chain in 10 pilot markets and is working to increase this to 50 further interventions by 2020 in other regions.

In May 2017, the WorldGBC launched a call to businesses, governments and non-governmental organisations to dramatically increase ambitions and transform the global buildings sector. From Thousands to Billions- Coordinated Action towards 100% Net-Zero Carbon Buildings seeks to have all new buildings operate at net-zero carbon from 2030. It also calls for 100% of buildings meeting net- zero carbon by 2050.[20]

NEW NDCS SUBMITTED IN 2016 AND 2017

2 countries submitted NDCs in 2017

Timor-Leste promoted clean cook stoves to reach a target of 20 000 households. It also mentioned energy-efficient lamps and building codes as way to drive energy-efficiency in the buildings sector.

Uzbekistan announced its plan to improve energy efficiency in buildings through a programme of measures to transition to low-carbon development. The NDC specifies that the electricity, housing and utility sectors will be included in the programme.

6 countries submitted NDCs in 2016

Democratic People's Republic of Korea identified low-carbon products such as high-performance heat pumps and solar hot water heaters to replace coal-fired space heaters or hot water heaters in buildings. The NDC also mentions energy-efficient wood stoves to replace conventional wood and coal stoves, as well as energy-efficient air conditioners.

Sri Lanka announced its plan to use solar water heating technology combined with other renewable energy sources, such as wind and biomass, for tourism facilities. It also pledged to use building management systems to take advantage of demand side response in buildings.

Pakistan pledged to use energy standards and labelling (ESL) to deploy high-efficiency technologies for lighting, space heating, refrigerators and air conditioners. The NDC also notes efforts strengthen public sector capacity to promote, regulate and monitor ESL for manufacturers and importers.

Chile outlined its national construction strategy, setting forth guidelines to integrate the concept of sustainable development in the construction sector.

Panama and **Malaysia** submitted economy-wide targets, but without specific mention of buildings.

18 UNFCCC (2017), "Mayors of 140 of World's Largest Cities Express Commitment to Paris Goals", 23 June 2017, http://newsroom.unfccc.int/paris-agreement/the-cities-of-the-world-proclaim-the-montreal-declaration/

19 WBCSD (2016), "Energy Efficiency in Buildings: time to amplify action in 50 cities by 2020", 10 November 2016, http://www.wbcsd.org/Projects/Energy-Efficiency-in-Buildings/News/WBCSD-and-partners-launch-EEB-Amplify-at-COP22

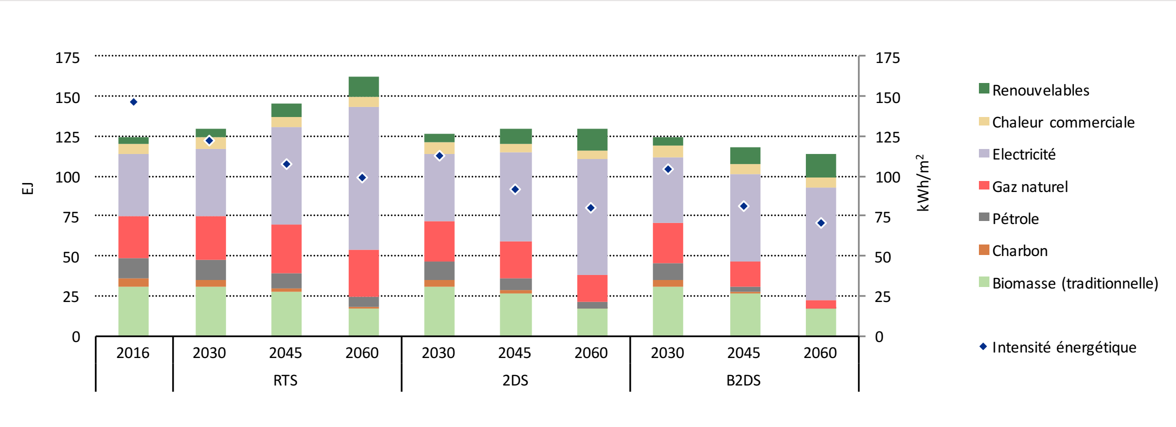
20 For more information, visit http://www.worldgbc.org/advancing-net-zero

Pathways to Sustainable Buildings and Construction

Today's critical challenge is to ensure the momentum around the transformation of buildings and construction and to speed up its progress. The current trajectory falls short. The IEA's **Reference Technology Scenario (RTS)**, which accounts for existing building energy policies and climate-related commitments, shows that final energy demand in the global buildings sector will increase by 30% by 2060 if more ambitious effort is not made to address low-carbon and energy-efficient solutions for buildings and construction (Figure 12). As a result, buildings-related CO_2 emissions would increase by another 10% by 2060, adding as much as 415 $GtCO_2$ to the atmosphere over the next 40 years – half of the remaining 2°C carbon budget and twice what buildings emitted between 1990 and 2016.

The **2°C Scenario (2DS)**, consistent with a 50% probability to limit the expected global average rise of temperatures below 2°C, reflects the need to deploy high-efficiency and low-carbon solutions for buildings and construction. Global buildings final energy demand in the 2DS stabilises around 130 EJ beyond 2030, with buildings-related CO_2 emissions dropping by 85% over current levels by 2060. Around 55% of those reductions are from low-carbon power generation, which is supported by energy-efficiency measures in buildings.

FIGURE 12 Buildings sector final energy consumption by scenario and fuel type, 2016 – 2060

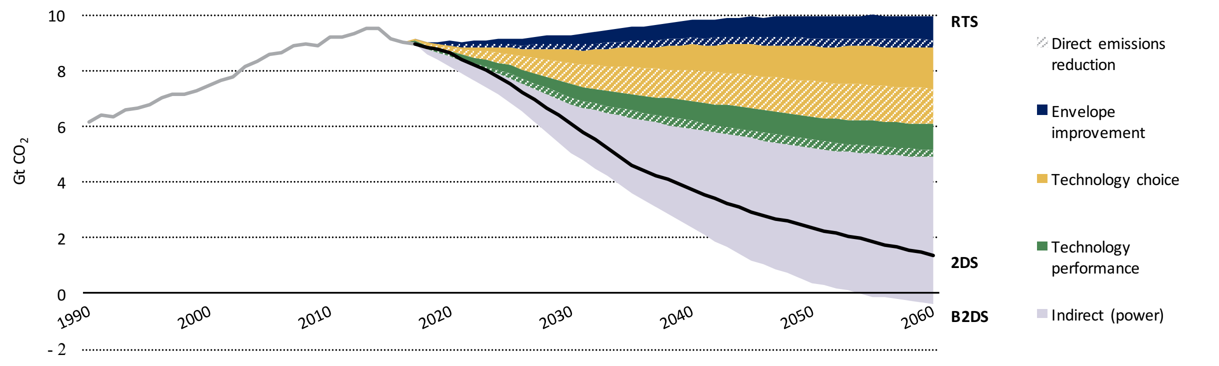


Source: IEA (2017), Energy Technology Perspectives 2017, IEA/OECD, Paris, www.iea.org/etp

KEY POINT

Achieving the 2DS or B2DS requires a major shift to put global buildings on a highly energy-efficient and net-zero carbon pathway to 2060.

FIGURE 13 Key contributions to CO_2 emissions reduction in the global buildings sector to 2060



Notes: "Direct emissions reduction" represents a decrease in emissions from reductions in direct fossil fuel consumption in the buildings sector. "Envelope improvements" include measures (including deep energy renovations) that improve the energy intensity of the building envelope. "Technology choice" represents shifts from one type of technology and/or fuel to another (e.g. incandescent lamps to LEDs or gas boilers to electric heat pumps). "Technology performance" represents energy technology efficiency improvements (e.g. higher operational performance for heat pumps). "Indirect (power)" emissions reduction is from improved carbon intensities of power generation, where negative emissions are from carbon capture and storage (CCS) technologies.
Source: IEA (2017), Energy Technology Perspectives 2017, IEA/OECD, Paris, www.iea.org/etp

KEY POINT

Accelerated energy-efficiency and a shift away from fossil fuels are needed to achieve net-zero emissions in the buildings sector before 2060.

The **Beyond 2°C Scenario (B2DS)** sets out a rapid decarbonisation pathway in line with goals set forth in the Paris Agreement to limit future temperature increases to well-below 2°C. The B2DS includes a rapid adoption of highly efficient, low-carbon solutions for buildings and construction, including: rigorous and widespread application of building energy codes, broad-scale renovation of the existing buildings stock, aggressive deployment of high-performance technologies and a strategic shift away from fossil fuel use in buildings. The B2DS reverses historical trends of increasing energy demand in buildings and results in a net decrease in energy demand below 115 EJ by 2060, reaching net-zero emissions in the buildings sector before 2060 (Figure 13).

The B2DS represents more than 275 GtCO2 of cumulative emissions reduction to 2060 compared with the RTS – more than all the carbon emissions produced by the global energy sector between 2006 to 2014. Shifts away from fossil fuels, alongside building envelope measures, technology choice (e.g. LED lamps) and continued improvements in product performance (e.g. higher efficiencies for heat pumps) all contribute to 140 $GtCO_2$ of total emissions reduction attributable to buildings. Those measures also play a key role in supporting decarbonisation of the power sector by 2060.

Capturing the enormous energy savings potential in the global buildings sector would deliver a broad range of benefits, including significant reductions in CO_2 emissions and other pollutants that pose a threat to human health. Achieving the 2DS already requires an unprecedented effort to develop and deploy energy-efficient and low-carbon technologies over the next 40 years, using a broad range of policy measures and market incentives. Going beyond the 2DS would require even swifter and more assertive policy action to drive innovation and move markets as quickly as possible over the next decade to best buildings practices and low-carbon, high-efficiency technology solutions.

Building envelope improvements

Building envelope design, materials and construction all have a large influence on heating and cooling loads in buildings, which represented nearly 3.5 $GtCO_2$ of emissions from buildings in 2015. More importantly, choices in building envelope investments can influence building energy demand and emissions for decades or more.

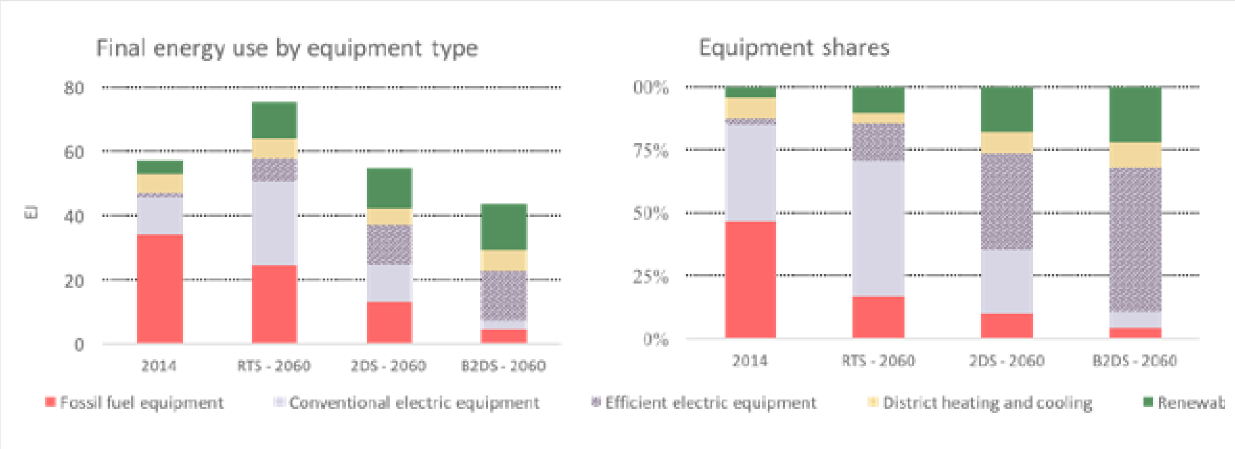
The energy savings potential from improved building envelope performance improvements is huge: globally, high-performance buildings construction and deep energy renovations of existing building envelopes represent a savings potential more than all the final energy consumed by the G20 countries in 2015, or around 330 EJ in cumulative energy savings to 2060.[21]

The transition to sustainable buildings needs assertive implementation and enforcement of building energy codes for new construction across all countries. It also requires an aggressive scaling up of deep building energy renovations of the existing global stock. Rapid progress is needed to double the average annual improvement in global building envelope performance (in kWh/m^2) from around 0.75% to more than 1.5% per year.

This would require enormous effort (including appropriate financing mechanisms) to ensure markets adopt best practices and high-performance envelope technology solutions, especially in rapidly emerging economies where new construction risks locking in less-than-optimal investments.

Technology choice

FIGURE 14 Heating and cooling final energy use and equipment stock shares by scenario to 2060



Notes: Excludes traditional use of solid biomass. Fossil fuel equipment includes coal boilers, oil boilers and all gas-powered technologies (e.g. gas condensing boilers). Conventional electric equipment includes electric resistance, instantaneous heaters and electric heat pumps with an efficiency below 300%. Efficient electric equipment includes electric heat pumps with efficiencies greater than 300%. Renewables include solar thermal equipment and efficient biofuels.
Source: IEA (2017), Energy Technology Perspectives 2017, IEA/OECD, Paris, www.iea.org/etp.

KEY POINT

Energy-efficient and low-carbon heating and cooling technology investments would reduce final energy demand in buildings by 25 % over current levels.

21 IEA, Energy Technology Perspectives 2017, www.iea.org/etp/

Technology choice has a ripple effect on the type of energy and the total energy consumed in buildings. Over the last 25 years, energy efficiency measures in buildings contributed to 450 EJ in cumulative energy savings – equivalent to all of global final energy demand in 2015. This includes nearly 90 EJ of energy savings from shifts away from traditional use of solid biomass in developing countries to more efficient end-use technologies, largely due to improved energy access.

Technology choice will play a key role in achieving the transition to sustainable buildings. For instance, the rapid shift to low-carbon and high-performance heating and cooling technology solutions under the B2DS would save 660 EJ in cumulative energy demand to 2060 (Figure 14). That savings is roughly equal to all the final energy consumed by China over the last decade.

Rapid adoption of the most efficient buildings end-use technologies underpins the energy savings and emissions reduction potential in the B2DS. For example, deployment of high-efficiency lighting, cooling and appliances over the next decade would save as much as 50 EJ in electricity demand between now and 2030 – equivalent to nearly three-quarters of global electricity demand today.

Technology choice is also an opportunity to improve clean energy access and local air quality, both of which are a key challenge for many developing countries. More than four million deaths annually are attributable to illness from household air pollution including cooking with solid fuels (wood, animal dung and crop waste) and burning gas in inefficient systems that result in higher risks of nitrogen oxide and carbon monoxide emissions.[22]

The accelerated uptake of high-efficiency and low-carbon technologies in buildings will require significant policy action, including wide-ranging energy performance standards to address continued availability of less efficient products. Policies also need to provide appropriate market incentives to address consumer decision-making, which often considers upfront costs over life-cycle cost-effectiveness. While those wide-ranging measures may be unprecedented in many countries, they would deliver on a range of multiple policy objectives. This includes improved buildings quality and comfort (e.g. humidity control in hot climates), reductions in local air pollution (e.g. from lesser need for peak power generation using coal) and greater capacity to provide affordable and improved energy services.

Technology performance

Improving technology performance is a key component of the transition to sustainable buildings. Efficiency improvements, including building envelope measures, represent nearly 2 400 EJ in cumulative energy offsets to 2060 – more than all the final energy consumed by the global buildings sector over the last 20 years. Those offsets are key to enabling greater services and comfort in buildings, using less energy at net-zero emissions.

Slightly less than one-third of the energy efficiency potential highlighted in the B2DS is due to enhanced technology performance. Market scale and greater value for energy efficiency (e.g. return on investment) can help deliver on high-performance technologies for buildings and construction. Yet, concerted effort is needed to support research and development, best practice sharing and international collaboration to accelerate the development of better buildings technologies and bring them to market at affordable prices.

Additional 2DS and B2DS technology strategies and innovation highlights for buildings and construction can be found in the IEA's Energy Technology Perspectives 2017.

22 IEA (2016), World Energy Outlook Special Report on Energy and Air Pollution, IEA/OECD, Paris, www.iea.org/publications/freepublications/publication/WorldEnergyOutlookSpecialReport2016EnergyandAirPollution.pdf

Key Sustainable Buildings Technology Solutions

Among 132 countries mentioning buildings in their NDCs, 87 supported their pledges with specific technology objectives. Some of the most commonly mentioned are building envelopes and energy codes, equipment performance, solar heating and cooling, and demand side management (Figure 15).

22 countries, mostly in sub-Saharan Africa (e.g. Niger, Somalia and Zimbabwe), the Middle East (e.g. Saudi Arabia and Yemen) and the Caribbean (e.g. Cuba and Dominica) mentioned solar energy as part of their sustainable energy actions in buildings.

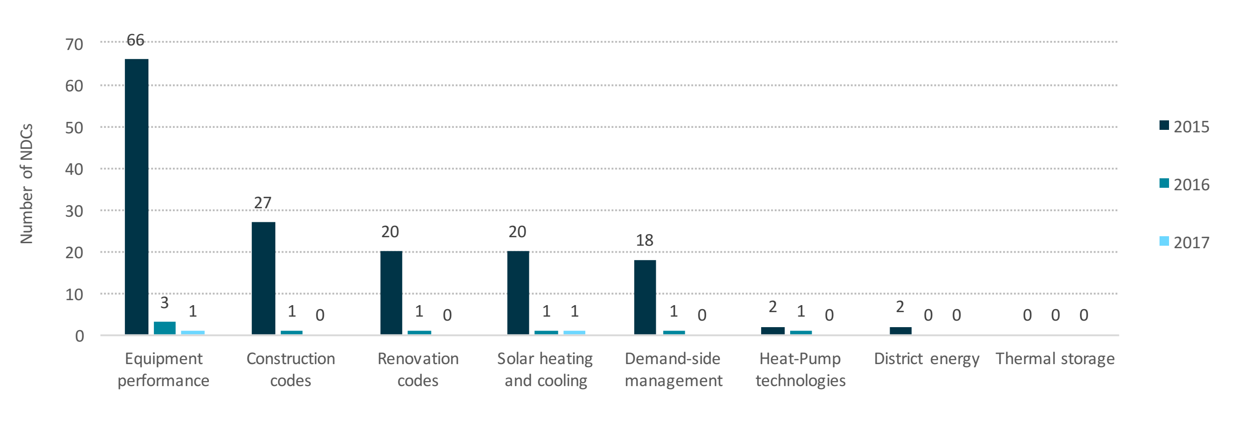
Heat pumps and district energy are only noted in five NDCs. Azerbaijan, Japan and the Democratic People's Republic of Korea all explicitly mentioned heat pumps for hot water heating in residential or commercial buildings.

The United Arab Emirates intend to undertake comprehensive infrastructure investments for district cooling, while Bosnia and Herzegovina plans to reconstruct and modernise its district heating grids, boilers and substations.

The NDC technology commitments are a positive step towards achieving global ambitions for low-carbon and energy-efficient buildings. Additional recommended steps can help advance specific strategies for the rollout of sustainable energy technologies for buildings and construction:

- Use guidance from a global strategy for the buildings sector for high-efficiency product deployment and fossil-fuel phase out, including the GABC Global Roadmap;
- Set specific technology policy pathways with quantified targets that can track deployment and progress;
- Engage with stakeholders and governance across all levels to ensure alignment of objectives and broad commitment to meeting targets;
- Work with GABC partners and stakeholders to provide a robust evidence base of sustainable buildings and construction solutions.

FIGURE 15 Number of specific technologies mentioned in NDCs



KEY POINT

87 of the buildings-specific NDCs mention key technologies that would improve buildings sector energy-efficiency and carbon intensity.

Global market trends

Building envelope technologies: in Europe, the share of nZEBs for new construction is gradually increasing, especially in large economies such as France, Italy, Germany, Poland and Austria. In France and Austria, zero-energy buildings (ZEBs), and even positive-energy houses, represent a significant share of new construction, reaching 8% and 25% in 2015, respectively.[23]

However, globally, and especially in rapidly emerging economies, building envelope performance is not improving fast enough to offset strong growth in buildings construction.

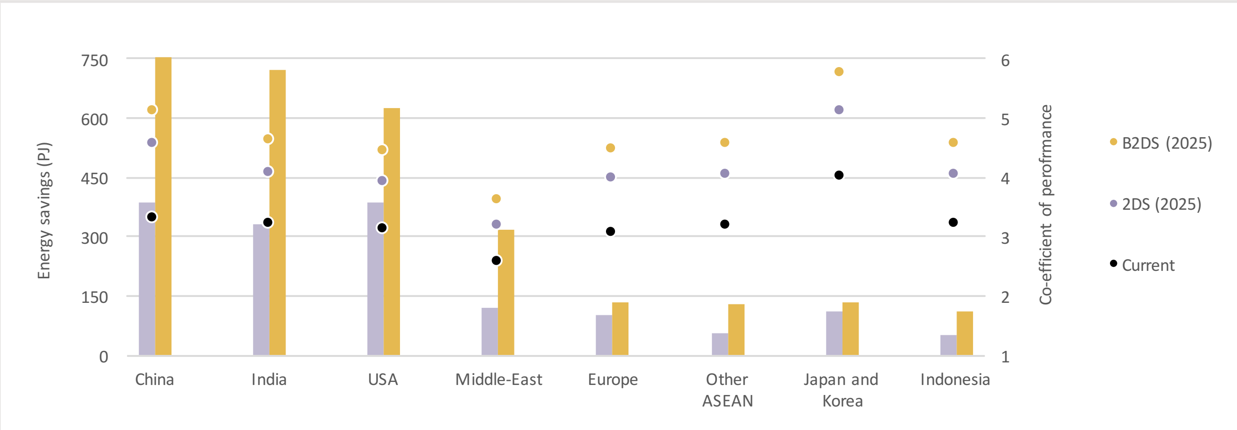
Space heating technologies: Fossil fuel and conventional electric equipment currently dominate the global market, accounting for more than 80% of the world's buildings equipment stock (see Figure 14). Condensing gas boilers, with efficiencies often higher than 95%, are gradually displacing coal, oil and conventional gas boilers, whose efficiencies are frequently less than 80%.

Heat pump sales are starting to increase across in many markets. In Europe, heat pump sales increased 20% in just two years, mainly driven by a growth in air-source heat pumps.[24]

Space cooling technologies: Typical air conditioner efficiency remains around 300% (a co-efficient of performance [COP] of 3) or less in most countries (Figure 16). That is far from best available technologies, whose efficiencies can be as high as 600%. In China, Japan and the United States, best available technologies for room air conditioners already exceed 600%. Other major markets such as India, Indonesia, Mexico and Brazil have access to cooling equipment with efficiencies higher than 400%.

Minimum energy performance standards would help drive markets towards higher efficiency cooling products.

FIGURE 16 **Energy savings from improved air conditioner performance in residential buildings, 2017-2025**



Source: IEA, Energy Technology Perspectives 2017, www.iea.org/etp/.

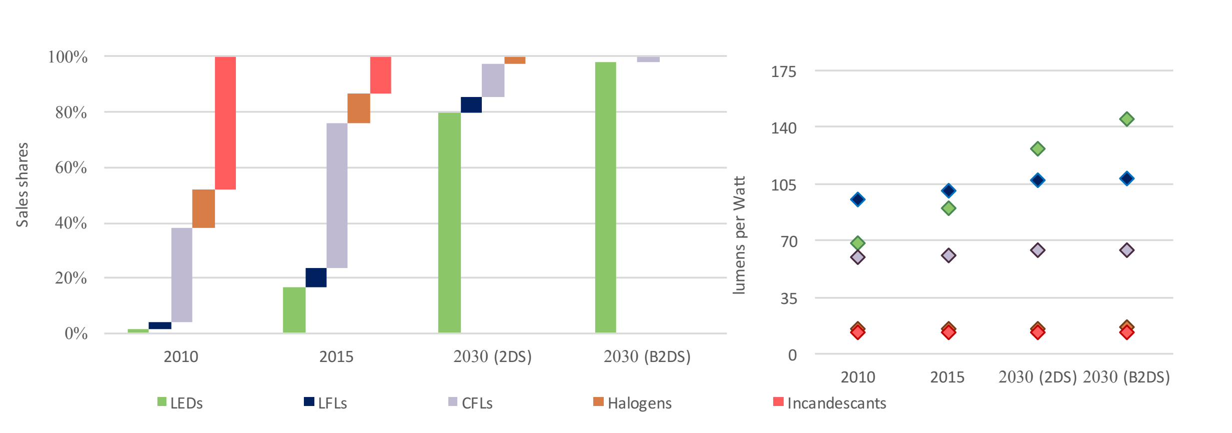
KEY POINT

Improving residential cooling equipment performance would save 3.5 EJ of energy to 2025 – slightly less than total electricity use in India in 2015.

23 Enerdata (2017), "Share of new dwellings built according to national nZEB definition or better than nZEB", ZEBRA2020 (database), www.zebra-monitoring.enerdata.eu/overall-building-activities/share-of-new-dwellings-built-according-to-national-nzeb-definition-or-better-than-nzeb.html

24 EHPA (European Heat Pump Association) (2016), Market data (database), www.ehpa.org/market-data/

FIGURE 17 Lighting sales shares and average lamp efficacy by technology type



Note: LFL = linear fluorescent lamp
Source: IEA, Energy Technology Perspectives 2017, www.iea.org/etp/

KEY POINT

LEDs sales ramped-up in 2015, but the residential lighting market is still dominated by less-efficient technologies.

Lighting technologies: LED sales exceeded 15% of global residential lighting sales in 2015 and are expected to have reached 30% in 2016. However, compact fluorescent lamps (CFLs) still make up the overwhelming majority of global residential lighting sales (Figure 17). Inefficient incandescent and halogen lamps still make up around 20%.

India is the world's largest LED market, as the domestic efficiency lighting programme having distributed more than 250 million LEDs by 2017.[25] The LED market is also growing quickly in Indonesia, where residential sales reached 120 million in 2016, compared to only 40 million just two years earlier.[26]

Controls: An increasing number of private sector companies, such as British gas, Siemens and Google, are proposing active controls to better adapt to occupant habits and energy needs. Yet globally, buildings are not bearing the fruits of the digital potential. The demand response market is often open to large industrial actors but is seldom commercially open to all consumers. Positive developments have occurred in Europe, with France making it possible for third-party aggregators to shift energy loads without the agreement of energy suppliers. Germany endorsed home-storage solutions, and Sweden and Finland fully deployed smart meters across their buildings sector.

AMSTERDAM'S EDGE

The Edge building in Amsterdam is an example of digital technologies at the service of energy efficiency. The zero-energy building was designed to maximise natural light intake as well as solar electricity production. Smart technologies such as intelligent ventilation systems and connected LEDs allow human-building interactions and are responsive to real-time data from sensors or occupant commands. This allows lighting levels, humidity and temperature, for example, to be adapted to end-user preferences, while also improving building energy performance.

25 UJALA (Unnat Jyoti by Affordable LEDs for All) (2017), National UJALA Dashboard, http://www.ujala.gov.in/

26 IEA (2017), Energy Efficiency Market Report 2017, IEA/OECD, Paris, www.iea.org/publications/freepublications/publication/Energy_Efficiency_2017.pdf

Recent achievements across countries

1 IN THE UNITED STATES

Sierra Crest development in California

The Sierra Crest development in Fontana, California has constructed 20 residential buildings that integrate high-efficiency building construction with solar generation to achieve the first zero net energy community in California, in support of the State's 2020 policy target for all newly constructed low-rise residential buildings to be net zero energy. The project is intended to provide evidence of the economics to consumers and developers, with additional mortgage costs for the measures more than offset by utility bill savings.[27]

2 IN FRANCE

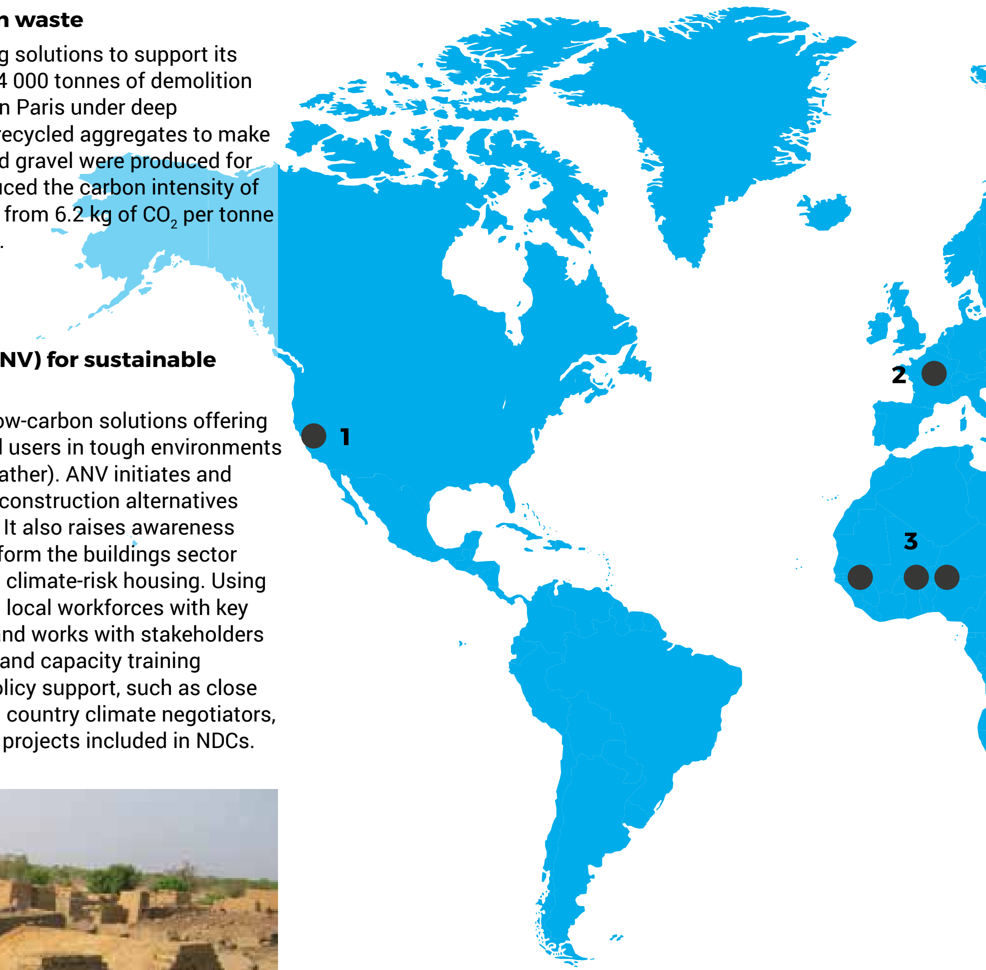
Recycling construction & demolition waste

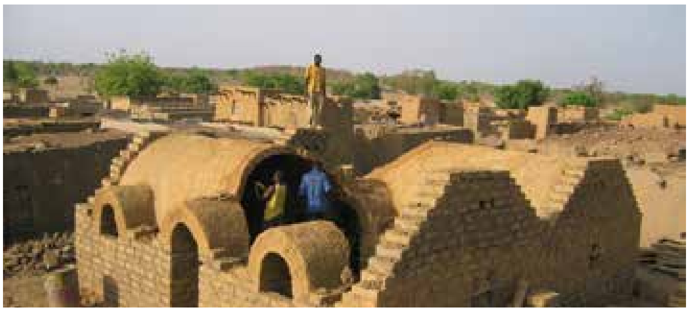
A waste sharing service proposes recycling solutions to support its clients in their circular economy projects. 4 000 tonnes of demolition waste from a 21 000 m^2 heritage building in Paris under deep renovation was turned into 720 tonnes of recycled aggregates to make new concrete, and 3 280 tonnes of recycled gravel were produced for road applications. Recycling concrete reduced the carbon intensity of concrete aggregate for the project by 16%, from 6.2 kg of CO_2 per tonne of aggregate produced to 5.2 $kgCO_2$/tonne.

3 IN SUB-SAHARAN AFRICA

The Association of Nubian Vaults (ANV) for sustainable housing

Nubian vaults are low-tech, low-cost and low-carbon solutions offering better living and working conditions to end users in tough environments (e.g. extreme temperatures and violent weather). ANV initiates and grows a local market, embedding building construction alternatives in social, economic and cultural practices. It also raises awareness among local populations on ways to transform the buildings sector and move away from carbon-intensive and climate-risk housing. Using only locally available materials, ANV trains local workforces with key skillsets (around 8 000 persons per year) and works with stakeholders on awareness raising, knowledge building and capacity training within the local community. Continuous policy support, such as close co-operation with national institutions and country climate negotiators, has helped develop relevant country-scale projects included in NDCs.





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27 Stankorb, S. (2017), "Lessons from California Community to Inform Large-Scale Deployment of Super-Efficient Homes", EPRI Journal, 19 September 2017, http://eprijournal.com/zero-net-energy-for-the-masses/.

4 IN VIET NAM

Palm Tree eco-development in Hanoi

The Palm Tree residential housing development in Hanoi has been designed as an energy-efficient ecopark development. The buildings have been designed with passive design strategies to take advantage of daylighting and natural ventilation while avoiding the need for mechanical air-conditioning.

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5 IN JAPAN

Higashi-Matsushima smart eco-town with micro-grid

An independent and resilient energy system became operational for 85 housing units (including four hospitals and a school) deprived of reliable electricity access after the 2011 Tohoku earthquake and tsunami. 460 kilowatts of solar photovoltaics are connected to a 480 kWh battery that can supply electricity steadily through the micro grid. The system operates without feed-in-tariffs and does not create any cost liability for the society. An emergency biodiesel power generator also guarantees the autonomy of the micro-grid for three days.

6 IN INDIA

Energy Management Centre (EMC) energy positive campus

The EMC energy positive campus in Kerala was developed to allow natural cross-ventilation from building forms and openings. The campus has a 30 kilowatt grid-connected solar capacity that exports around 50 kWh per day on average, with a doubling of the capacity under implementation. The EMC campus also uses daylighting controls, chlorofluorocarbon and hydrochlorofluorocarbon free heating, ventilation and cooling systems, along with a halogen-free fire-fighting system. Solar reflectance index coating combined with high-albedo paintings and turbo-vents for passive cooling have been used on the buildings, and tropical rainforest trees help create cool and shaded surroundings. For the construction process, certified green construction materials, recycled wood boards, low-emitting paints and adhesives, and green-plus certified carpets have been used. Building envelope intensities are less than 10 kWh/m²/year.

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Key Sustainable Buildings Policy Developments

A wide array of sustainable building policy packages were introduced in 2016 and 2017, spanning local jurisdictions, regional authorities and national governments. This includes introductions or updates of building energy codes in a handful of countries, as well as building energy certification and incentive programmes in several countries.

One notable development in the last year has been the expansion of the Energiesprong (Dutch for Energy Leap) programme, which is an innovative building deep energy renovation initiative seeking to achieve affordable zero-energy building retrofits. The programme is now present in 4 countries – Netherlands, France, Germany and the United Kingdom – and has also been recently adopted in New York State in the United States.

NEW POLICIES ANNOUNCED OR INTRODUCED IN 2016 OR 2017

AUSTRALIA

In October 2017, the Australian Federal Government launched a National Carbon Offset Standard for Buildings. The Standard was developed in close collaboration with Green Building Council Australia and provides best-practice guidance on how to measure, reduce, offset, report and audit emissions from building operations. It uses well-established rating programmes such as Green Star and the National Australian Built Environment Rating System as pathways to demonstrate compliance and sets rigorous requirements for achieving carbon neutrality by reducing energy demand in buildings, procuring renewable energy and purchasing carbon credits to offset any remaining emissions.

CHINA

The Ministry of Housing and Urban-Rural Development released the Standard for Energy Consumption of Buildings in December 2016. The national standard includes prescriptive indicators of actual energy use for various types of buildings and seeks to limit the total energy consumption of the buildings sector in China. It covers both existing and new buildings (excluding rural residential buildings) and adopts two indicators for each building type: a mandatory upper limit for annual building energy intensity and a voluntary leading value, which will set a target for energy-efficient buildings. Both values will be measured in annual energy consumption per m^2. The standard does not currently include enforcement provisions, although local authorities already have the duty to authorise, inspect and enforce building energy codes.

INDIA

Commercial buildings have been introduced in the Perform, Achieve and Trade (PAT) programme. PAT falls into the Energy Conservation Act of 2001, which notifies Designated Consumers (DCs). The first cycle (PAT-I) was completed in 2016 and is estimated to have saved nearly 9 million tonnes of oil equivalent (Mtoe) of final energy, reducing annual emissions by about 23 $MtCO_2$. A second cycle was launched in 2016, and commercial buildings can be designated as DCs. Energy saving targets were drafted and DCs were notified in early 2017. Currently, 150 to 200 hotels consuming around 1 000 Mtoe have already been appointed as DCs.

NIGERIA

The Nigerian Federal Ministry of Power, Works and Housing launched the country's first building energy code in September 2017 in a partnership with the German Development Agency (GIZ) and the Nigerian Energy Support Programme. The new code is a set of minimum standards for energy efficient building construction in Nigeria and includes guidelines for professionals on how to design, construct and operate energy-efficient buildings.

CANADA

In December 2016, Natural Resources Canada published tighter energy performance standards for 20 energy-using product categories, ranging from lighting and appliances, to water heaters, to chillers and electric motors. As part of the Pan-Canadian Framework on Clean Growth and Climate Change, new building energy codes will also be introduced by 2022 alongside federal measures to increase energy efficiency in existing buildings.

RWANDA

A mandatory green building certificate policy passed in 2017 will be required of all buildings occupied by more than 100 people as of January 2018. The certificate will serve as an instrument of the Rwanda Green Building Minimum Compliance building code that was passed earlier in 2017.

SWEDEN

In late 2016, the Swedish government introduced a support programme of roughly EUR 100 million for building renovations and energy efficiency measures. The energy consumption of the building must be reduced (and verified) by at least 20% in order to receive the support. A Cwentre for Sustainable Construction was also created to promote energy-efficient renovations and the use of sustainable materials through knowledge gathering and dissemination.

EUROPEAN UNION

In November 2016, the European Commission published a "Clean Energy for all Europeans" policy package, setting out plans for European Union energy policy to 2030 and beyond. It contains a wide range of proposals on energy efficiency, energy markets, renewable energy and climate issues, including plans to revise the Energy Performance of Buildings Directive (EPBD). Other proposals related to buildings include potential energy efficiency targets for 2030.

The discussions within European Institutions on revising the EPBD progressed quickly in 2017. In June, the European Council agreed a general approach to the revision, and the European Parliament Industry Committee agreed its position in October. The initial proposal aimed at streamlining existing provisions and ensuring consistency with other policies, while introducing a smartness indicator to ensure buildings are ready to connect and interact with the grid. The Industry Committee position strengthened these provisions and introduced new concepts and tools, including a building renovation passport that could be used to encourage and support building owners in renovating buildings. The final agreement is now being negotiated, with the final revised EPBD expected in early 2018.

BRAZIL

41 and 60 Watt incandescent bulbs were banned in Brazil in June 2016. The National Institute for Standardisation also published a law for mandatory certification of public lighting using LEDs and other efficient lamps.

The examples listed here are non-exhaustive and illustrative of new building energy policies and programmes from various regions.

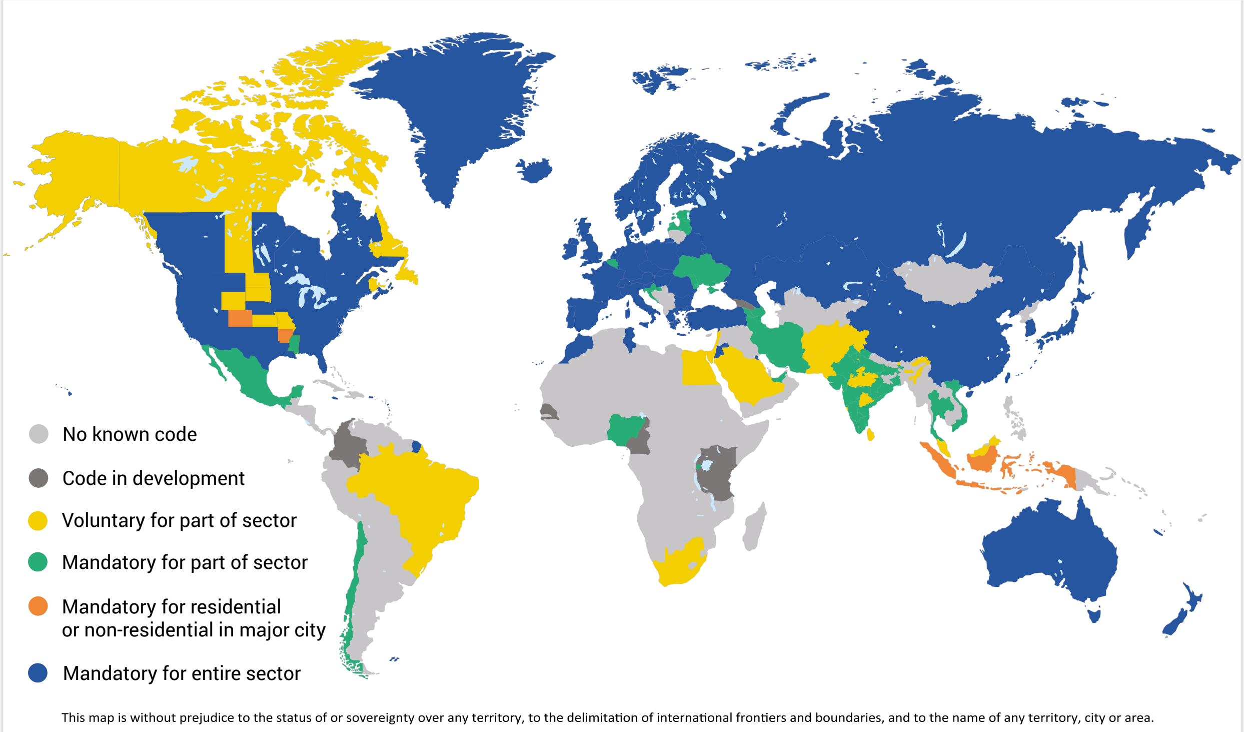
Building energy codes

Building energy codes and standards are regulatory instruments that set minimum requirements for energy efficiency and/or use of resources in buildings (e.g. requirements for energy sufficiency and renewable energy sources). Currently, both mandatory and voluntary building energy codes exist in more than 60 countries worldwide (Figure 18).

There is a critical need to implement and enforce mandatory building energy codes for new construction in developing countries. More than 100 billion m^2 are expected to be built by 2060 in countries that currently have no mandatory building energy codes in place.

Building energy codes can also play a role in improving the energy performance of existing buildings. The International Partnership for Energy Efficiency Cooperation (IPEEC) Building Energy Efficiency Taskgroup conducted research in 2017 identifying countries with regulations for existing buildings. The group found that there are a range of policy options and instruments currently addressing existing buildings. Energy codes are part of the solution, although comprehensive approaches include finance and performance disclosure needed to make significant changes to the world's existing building stock.

FIGURE 18 **Building energy codes by country, state and province, 2016**



Source: IEA (2017), Building Energy Efficiency Policies (Database), https://www.iea.org/beep/

KEY POINT

Nearly two-thirds of countries do not have mandatory building energy codes in place today.

BUILDING ENERGY CODES UPDATED OR IMPLEMENTED IN 2016 OR 2017

MEXICO

Mexico published in March 2017 a roadmap to guide future building energy codes and standards development, with a goal toward zero energy and emissions buildings.

NORWAY

In January 2016, the Planning and Buildings Act set energy performance requirements by building category in terms of annual energy intensity, ranging from 95 kWh/m2/year for apartment buildings to 225 kWh/m^2/year for hospitals. For new construction, building envelope component energy performance must comply with stricter requirements for outer walls, ceilings, floors, windows, doors, ventilation, air leakage and cold bridges.

ALABAMA

The International Energy Conservation Code of Alabama is applicable to insulation materials, mechanical systems, water heaters, lighting and cooling equipment, controls, pipes and air sealing techniques. The code has been amended to allow changes during construction provided that construction documents will be resubmitted to the code official as an amended set of construction documents.

ONTARIO

Additions built after 31 December 2017 will require a heat recovery ventilator and a shower drain water heat recovery system. Additions will also require radon testing and mitigation measures to determine whether remedial action, such as installing a soil gas control system is feasible. The code provides an annex with guidelines regarding measurement devices, device placement, measurement duration and results interpretation.

SINGAPORE

The Code on Environmental Sustainability Measures for Existing Buildings released in 2016 set forth minimum sustainability measures, including energy efficiency, and administrative requirements for existing buildings within Singapore's Building Control Regulations. The code applies to nearly all non-residential buildings.

INDIA

The Energy Conservation Building Code (ECBC) 2017 is an update to the 2007 ECBC for commercial buildings. ECBC 2017 is one of the first building energy codes to recognize improvements beyond code performance and has defined incremental, voluntary energy efficiency performance levels. There are now three levels of energy performance standards in the code: ECBC compliant building, ECBC+ building and Super ECBC building. Passive design strategies such as daylight, shading, low energy comfort systems and natural ventilation are given emphasis in ECBC 2017. Providing arrangements for use of renewable energy systems is now mandatory in the code. ECBC 2017 will also encourage building designs that can be adapted to installation of renewable energy systems with ease.

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ROMANIA

An April 2017 order requires both new construction and renovations in Romania to comply with minimum energy performance standards (MEPS) and achieve less than 153 kWh/m2 per year for buildings with less than three floors and 117 kWh/m2 per year for larger buildings. The order also includes MEPS for building envelope components for different subsectors (e.g. residential, commercial and hospitality) and for different climate zones. It also notes a maximum allowed primary energy consumption using non-renewable energy sources.

SOUTH AFRICA

South Africa has started updating its building energy code SANS 10400 XA, which considers energy use in buildings under the National Buildings Regulations published in 2011. The code update will take into account a new detailed climate zone map finalised in 2016 and is expected to be published for comment by the end of the year.

CALIFORNIA

The 2016 California Building Standards Code (California Code of Regulations, Title 24) went into effect 1 January 2017. It serves as the basis for the design and construction of buildings in California and includes improved safety, sustainability, technology and construction method guidelines.

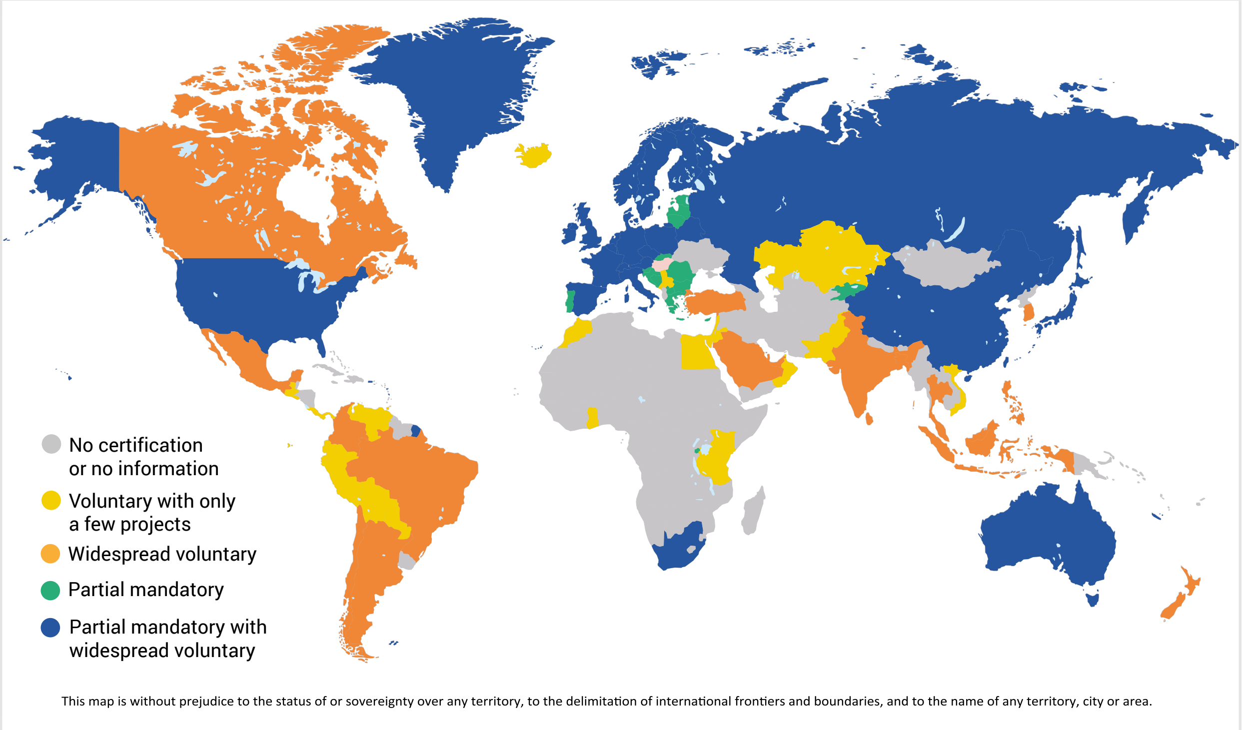
Building energy certifications

Building energy certification efforts includes a range of mandatory policies and voluntary programmes that are created by both governments and organisations, such as green building councils. Examples include ENERGY STAR in the United States, Green Mark by the Buildings and Construction Authority (BCA) of Singapore, and building energy performance certificates used in the European Union.

As of 2017, there are more than 80 countries with building energy certifications, including 36 countries with mandatory building energy certification policies and another 20 countries with widespread voluntary building energy certification policies or programmes.

Notable in 2017 is the publication of the International Organization for Standarization (ISO) 52000-1 energy performance of buildings standard, which establishes a systematic and comprehensive structure for assessing building energy performance.

FIGURE 19 **Building energy certification by country, 2016**



Source: IEA (2017), Building Energy Efficiency Policies (Database), https://www.iea.org/beep/

KEY POINT

While common in in an increasing number of countries, building energy certifications are typically voluntary.

CERTIFICATIONS UPDATED OR IMPLEMENTED IN 2016 OR 2017

BRAZIL

In August 2017, Green Building Council Brasil launched a Zero Energy Standard. A program of 11 pilot projects will evaluate the standard across five different states. Two projects have already received certification for demonstrating a net-zero energy balance for one year of operation: the Sebrae Centre for Sustainability in the city of Cuiabá and the Geo Thermal Energy Headquarters in Tamboará.

CHINA

The Leading Efficiency Programme (LEP), a national energy labelling initiative focused on promoting energy efficient products, was launched in China in June 2016.

GHANA

In March 2017, the Eco-Communities and Cities National Framework was launched to become integral part of the National Housing Policy. The aim of this framework is to create a platform, provide inspiration and contribute to national development on planning, design, construction, operation maintenance and renewal of sustainable communities in Ghana. This is part of the Eco-Communities rating tool being developed in two stages. The first is a framework with best practice principles to guide community development (either new development or revitalisation). The second is the development of a rating tool.

SPAIN

In March 2016, the Spanish Association for Standardisation and Certification (AENOR) published an energy efficiency specification. It classifies, categorises and certifies energy service providers. The specification, transferred to the Spanish Legal System after having been approved by a Royal Decree, ensures the quality and reliability of energy services provided by big companies through mandatory energy audits.

UKRAINE

On 22 June 2017, Ukrainian parliament passed the law on "Energy Efficiency of Buildings" law, aligning Ukrainian legislation with the European Union's Directive on Energy Performance of Buildings. Minimal energy efficiency requirements as well as mandatory certification programmes will be applicable to public buildings in 2018. The law also predetermines the development of a national plan to increase the number of nZEBs in the future. In addition, the Ukrainian Parliament passed laws in 2017 on commercial metering of heat supply and establishing a national energy efficiency fund. The later will focus mainly on building energy renovations.

CANADA

In May 2017, Canada Green Building Council (CaGBC) launched a dedicated Zero Carbon Building Standard, making carbon emissions the key indicator for building performance. This was developed through extensive consultation with representatives from over 50 industry organisations, governments, utilities and companies across Canada. CaGBC is also working with 16 of Canada's most sustainable projects in the Zero Carbon Building Pilot Program, which will inform further development of the standard as well as accompanying resources and education.

FRANCE

In November 2016, Alliance HQE-GBC launched a voluntary labelling system E+C- (energy plus and low-carbon buildings) in conjunction with the French Government to promote buildings and construction as part of the strategy to meet climate change ambitions. The certified E+C- label covers all energy uses during building operation, including energy consumed by equipment owned by occupants, as well as on-site production of renewable energy and emissions linked to building energy demand (both operational and embodied carbon from construction and buildings equipment). The label also provides results in terms of a life cycle assessment of environmental indicators and also includes GHG emissions due to leaks of refrigerants. The first seven labels were delivered to successful projects in France in July 2017.

EUROPE

The United Nations Economic Commission for Europe (UNECE) adopted new guidelines in September 2017 that support development of standards to improve energy efficiency in buildings. A joint task force will work with countries to promote Framework Guidelines on Energy Efficiency Standards in Buildings, helping to improve sustainability in the conception, design, construction and maintenance of buildings. The guidelines reflect lessons learned and best practices from around the world and are intended to inform the development of standards to support planners, builders and the building delivery and management chain. The joint task force will also seek to enhance the market harmonisation for building products and technologies that increase energy efficiency in buildings in the 56 UNECE member States.

SOUTH AFRICA

The largest listed Real Estate Investment Trust (REIT) in South Africa launched a dual-certified property portfolio called Thrive Portfolio in 2017. The portfolio consists of 71 buildings that have a Green Star South Africa certification, and the building's energy and water performance will be disclosed to prospective tenants before they move into property. The Green Building Council of South Africa has also launched a labelling system designed to complement the ratings under the Green Star South Africa tool, recognising buildings that completely neutralise or positively redress their carbon emissions, water consumption, solid waste and/or other negative ecological impacts. Four projects to date have achieved certification for one or more of the criteria.

EUROPEAN UNION

The European Union started testing a new voluntary reporting framework called Level(s) in late 2017. Using existing standards, Level(s) seeks to improve the sustainability of buildings through a common framework of indicators and metrics that can be used to measure the environmental performance of a building. The tool will encourage life cycle planning from the design stage through to building operation and occupation. It will also take into account other aspects related to building energy and environmental performance, ranging from health and comfort to life cycle costs and potential future risks association with a building's performance. The framework has been developed for both existing and new buildings as well as for various types of residential and commercial buildings. It is targeted for professionals that play a critical role in buildings development and management, including design teams, construction firms, property owners and facility managers. Initial testing of the framework is planned for the next two years.

The examples listed here are non-exhaustive and illustrative of building energy certifications from various regions.

Investments and Finance to Enable Transformation

Global investments

Energy efficiency investments in the buildings sector have continued to increase steadily in recent years, growing by 12% in 2016.[28] Total spending on energy-efficient products and services in buildings was USD 406 billion in 2016. Incremental efficiency investments in buildings, including appliances and lighting, were USD 133 billion.

Only a small share of the spending on new buildings is considered energy efficiency investment, as the majority is considered as autonomous improvement. However, three-quarters of spending on existing building renovations was considered energy efficiency investment in 2016.

Total spending on energy efficiency in the global buildings sector was less than 9% of the more than USD 4.6 trillion spent on buildings and construction (including renovations) globally. The building envelope, primarily with insulation and windows, accounted for the largest share of total energy efficiency spending at roughly USD 250 billion.

Investor confidence

While buildings sector investment in energy efficiency is relatively low compared to total spending on buildings and construction, efforts to improve investor confidence are beginning to solidify. The Investor Confidence Project has developed a new procedure and certification with Green Buildings Certification Inc. (GCBI). This Investor Ready Energy Efficiency certification enables investment through the use of industry best practices and standards for baselining energy usage, savings calculations, commissioning, operations and maintenance, and buildings measurement and verification.

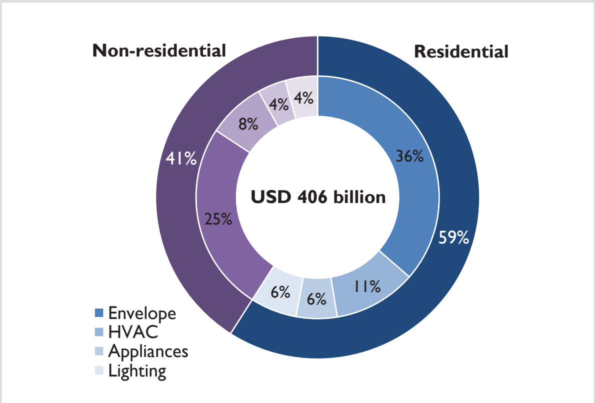
The Transformative Actions Program (TAP) aims to catalyse and improve capital flows to cities, towns and regions to strengthen the capacity of local and subnational governments to access climate finance and attract investment. TAP is equally working with partners and participants to communicate the value of those projects and attract additional investments for local and regional governments.

In Europe, the Energy-efficient Mortgages Action Plan (EeMAP) initiative aims to create a standardised "energy efficient mortgage" to improve the energy efficiency of buildings or to acquire an already energy efficient property by way of preferential financing conditions linked to the mortgage.

KEY POINT

Energy efficiency investments still represent a small portion of global buildings spending.

FIGURE 20 Energy efficiency investments in buildings globally, 2016



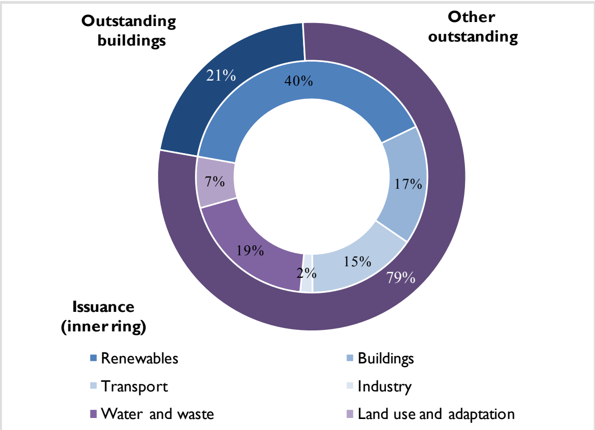
Source: IEA (2017), Energy Efficiency Market Report 2017, IEA/OECD, Paris.

Green bonds

KEY POINT

Buildings-related issuance represented around 17% of the green bonds market globally.

FIGURE 21 Labelled green bonds (issuance and outstanding) in 2016



Source: Climate Bonds Initiative, 2017.

28 IEA (2017), Energy Efficiency Market Report 2017, IEA/OECD, Paris, www.iea.org/publications/freepublications/publication/Energy_Efficiency_2017.pdf

Annual issuance of labelled green bonds was over USD 80 billion in 2016, and the Climate Bonds Initiative expects issuance to reach at least USD 130 billion in 2017, with emerging economies making strong contributions.29, 30

Buildings-related bonds accounted for around 17% of the labelled green bond universe in 2016 and 21% of the USD 277 billion in total outstanding labelled green bonds (Figure 21). Within the larger bond universe that is not labelled, buildings only represented 2% (about USD 20 billion) in total outstanding bonds that are climate-aligned. This includes bonds issued by real estate developers and operators as well as those by the financial sector (e.g. issuing bonds against a portfolio of green buildings loans). The average size of a green buildings bond issue is USD 125 million - half the green bond market average in 2016.

The largest issuers within the buildings sectors include European property managers, with French and Swedish issuers having particularly strong presence. The largest green bond for buildings was the USD 1.6 billion bond issued by Unibail-Rodamco in France in 2016, followed by the USD 1.2 billion green bond issued by Vasakronan in Sweden in 2016.

On the financial services side, Dutch mortgage provider Obvion NV issued the first green residential mortgage-backed security (RMBS) called Green Storm for EUR 500 million in June 2016. A second Green Storm bond was issued in June 2017 for EUR 550 million. The assets backing those bonds are a mix of energy-efficient homes and houses that have been refurbished to improve energy performance.

The World Economic Forum and the IEA note that the buildings sector requires upwards of USD 4 trillion between now and 2030 to meet climate ambitions.[31] Compared to current investments in the sector (estimated at USD 358 billion annually), an additional USD 300 billion in yearly investments are needed. Much of this could be provided through the issuance of green bonds.

One key challenge for the buildings sector and green bonds investors is determining 'what is green enough'. Most green real estate bond issuances have been linked to certification programmes (e.g. LEED and BREEAM), while some are linked to energy performance and direct emissions tracking.

Various practices have emerged to strengthen this part of the green bond issuance process. Green Bond Principles provide a broad overview of categories that are potentially eligible, although they do not provide details for building beyond "green buildings which meet regional, national or internationally recognised standards or certifications."

The Climate Bonds Standard goes further and provides detailed sector-specific criteria for what qualifies as green for real estate assets. This includes proxy indicators for carbon thresholds, such as LEED gold or platinum certified and ASHRAE 90.1 compliant. Only buildings which comply with the criteria are eligible for inclusion in a Certified Green Bond.

Positively, harmonisation of standards looks increasingly likely. High-level conversations convened by the Green Bonds Principles, the European High-Level Expert Group and others in 2017 seek to strengthen harmonisation between standards, external reviews and certification programmes. This offers the buildings sector strong prospects for growth in green bonds issuance.

GERMANY

Germany launched an Individual Building Renovation Roadmap energy audit and planning tool designed to help owners prepare and implement deep energy renovation of buildings. The tool takes into account user preferences and financing to point to renovation opportunities and strategies (e.g. sequence and coordination of renovation works). This can be used by energy advisors and providers to proposes solutions and establish a tailored plan with building owners, such as a stepwise or a one-time deep energy renovation. The EU-funded project iBRoad is now testing and implementing the concept in Poland, Bulgaria and Portugal. Similar initiatives are underway in Belgium and France.[32]

29 Data from the Climate Bonds Initiative.

30 Kidney, S. (2017, January 31). Summary – A record-breaking year for climate bonds. Renewables Now. Retrieved from: https://renewablesnow.com/news/summary-a-record-breaking-year-for-climate-bonds-556202/

31 IEA, Energy Technology Perspectives 2017, www.iea.org/etp/

32 BPIE (Buildings Performance Institute Europe) (2016), Building Renovation Passports: customised roadmaps towards deep renovation and better homes, Brussels, http://bpie.eu/publication/renovation-passports/

UKRAINE

Investments in building energy efficiency via the warm loan program reached Euro 130 million. From 2014 to 2017, more than 230 000 loans were issued by four state banks. The programme allows preferable purchasing of high-performance windows, doors, insulation and other energy efficiency materials or equipment for the renovation of private houses, apartments and multi-apartment buildings. The State Energy Efficiency Agency of Ukraine estimates that the programme allowed savings of 107 million cubic meters in natural gas equivalent during 2014-2016.

EUROPEAN UNION

The Abracadabra project is a European Union funded project that aims to increase investments in deep energy renovations of existing buildings. The project aims to demonstrate to key stakeholders in the buildings and financial sectors the value of deep energy renovations, with the goal to reduce payback times for renovation projects and accelerate progress towards nearly zero energy buildings. Financial, technical and regulatory toolkits are also being put together to provide knowledge and practical guidance for stakeholders.

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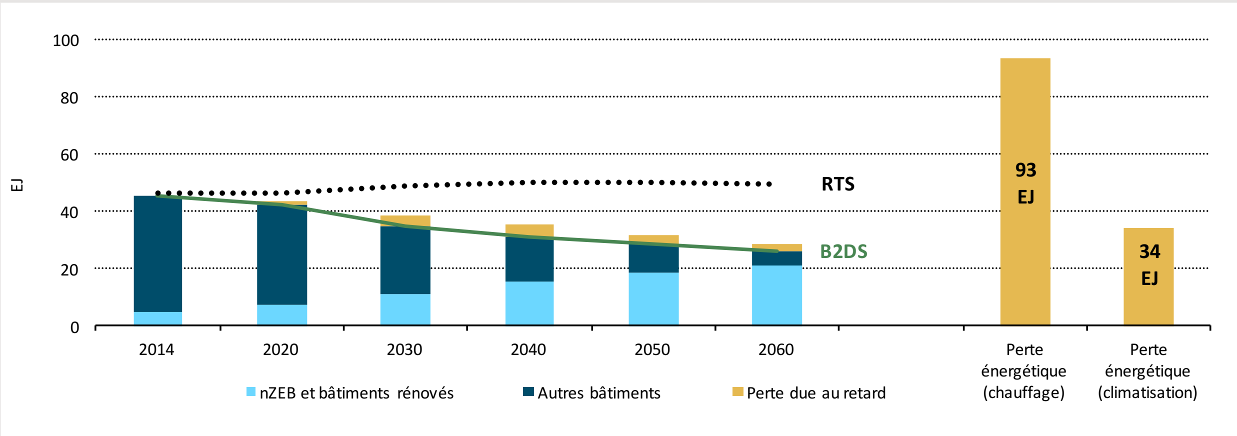
Locking in Better Buildings for Tomorrow, Today

Urgent need for implementation of mandatory building energy codes

The consequences of delaying action to address global building envelope performance are considerable. If envelope performance outlined in the B2DS were delayed another 10 years, the result would be an additional 127 EJ of final energy demand to 2060 in the global buildings sector – the equivalent of another three years of heating and cooling energy consumption by buildings (Figure 22). That additional energy represents as much energy as the total energy consumed by buildings in India during the last 16 years.

An urgent focus on building envelope performance and design is needed, including the policy levers and financing tools that enable affordable and sustainable buildings construction and renovations. Continuing the current pace of global action would create a longstanding lock-in of buildings sector energy demand and subsequent emissions. Setting forth a "build it right from the start" approach (including building energy renovations) will help avoid unnecessary energy demand, as well as costly renovations later to improve underperforming buildings assets.

FIGURE 22 Consequences of a ten-year delay in deploying B2DS building envelope measures



Source: IEA, Energy Technology Perspectives 2017, www.iea.org/etp/

KEY POINT

Delaying action by ten years would result in three years' worth of additional heating and cooling energy demand in the buildings sector certifications are typically voluntary.

Regions whose floor area is expected to soar in the coming years have the most at stake. In China, where 45% of floor area additions to 2060 will likely be completed by 2030, a 10-year delay would mean 50 EJ of additional final energy demand. India and Indonesia would experience similar additional energy need if rapidly rising floor area and a growing appetite for cooling energy services are not properly addressed through high-performance buildings and construction.

OECD countries equally stand to lose from delayed building energy performance improvements. Advancement of deep energy renovations of existing buildings is critical to meeting 2DS and B2DS targets. Yet, progress continues to be sluggish in most OECD countries.[33]

A call to action

A 30% improvement in global average building energy intensity (in terms of energy use per m^2) is necessary by 2030 in order to meet ambition set forth in the Paris Agreement to limit global average temperature rise to 2°C or below. This means a near-doubling of current buildings energy performance improvements to more than 2% each year to 2030.

Building envelope performance will play a key role in meeting those 30 by 30 targets. The number of high-performance and low-carbon buildings (e.g.nZEBs) needed to achieve the 2DS or below increases six-fold compared to the current global trajectory. This means near-zero energy, zero-emissions buildings need to become the construction standard globally within the next decade.

Similarly, the rate of building energy renovations needs to improve considerably, from rates of 1% to 2% of existing stock today to more than 2% to 3% per year in the coming decade.

In order to achieve these ambitions, concerted effort is needed across all stakeholders to put in place the priority actions outlined in this report and by the GABC Global Roadmap.

Implications beyond energy savings and emission mitigation

Multiple risks are associated with delaying building energy performance measures. Inefficient and carbon-efficient use of energy in buildings touch upon a multitude of important issues, ranging from local air pollution, health, energy access, energy affordability and energy poverty. Improved building energy performance, including better buildings envelopes, can help address multiple policy objectives, such as reducing outdoor pollution from inefficient and energy-intensive coal use in buildings.

Building performance also goes beyond the direct energy and emissions implications from building design and operation. Building design and controls can affect temperature variation and ventilation to improve pollutant removal, such as mould or radon. Moisture flows also contributes to keeping building elements dry, preventing potential structural damage and ensuring sound building “health”.

Building material choices for construction and renovation are likewise crucial to keep indoor environments safe and healthy (e.g. products may contain formaldehyde). Other elements, such as natural lighting, can influence occupant behaviour and sense of wellness beyond direct energy demand.

ADVANCING NET ZERO

The WorldGBC’s Advancing Net Zero project is a global campaign to accelerate uptake of net zero carbon buildings to 100% by 2050. Those buildings have high energy efficiency levels that significantly reduce their energy consumption, with remaining operational energy supplied from renewable energy sources. As of October 2017, five Green Building Councils (France, Canada, Brazil, Australia and South Africa) have launched net zero building certification programmes using performance metrics and actual energy consumption data. This rating approach to advancing the net zero movement is significant and has been strongly welcomed by industry.

33 IEA, Energy Technology Perspectives 2017, www.iea.org/etp/

Key Findings

This Global Status Report 2017 reconfirms the significance of the buildings and construction sector in global energy consumption and related emissions. It also shows that efforts to decarbonise the sector are progressing, thanks to implementation of comprehensive policy frameworks, deployment of low-carbon and energy-efficient technologies, better building design approaches and solutions, and an improving investment market. While the pace and scale of improvement is still not enough to meet global climate ambitions, noteworthy examples highlighted in this report nevertheless show that increased effort can still deliver on those objectives, while also bringing forward multiple positive economic, social, health and environmental benefits.

Realising the potential of the global buildings and construction sector requires all hands on deck, ranging from policy, technology and financing tools to increased international cooperation, greater education and awareness, and better training and capacity building across the buildings value chain. Key ingredients to achieve a successful shift to sustainable buildings and construction include:

1. AMBITIOUS AND TRANSPARENT COMMITMENT

Effort is needed to bring forward strategic policies and market incentives that signal the vital role of buildings and construction in meeting sustainable development goals. This includes clearer communication on intended country actions to address energy efficiency and emissions mitigation in buildings and construction, as well as greater engagement of stakeholders across all levels of the value chain to ensure consistency of messaging.

2. BUILDING ENERGY CODES AND CERTIFICATION

Deployment of improved building energy codes and policies, including certification, labelling and incentive programmes, are needed in all countries. Clear and consistent signals, including effort to update and enforce existing policies, are needed to drive markets towards sustainable buildings and construction investments.

3. ENERGY-EFFICIENT, LOW-CARBON AND AFFORDABLE TECHNOLOGIES

Wide-scale adoption and investment in high-performance, low-carbon solutions are key to sustainable buildings and construction. To ensure markets adopt best practice technology solutions, a greater focus is needed on the human factor, including the value of sustainability beyond energy and emissions savings.

4. COMMUNICATION AND CAPACITY BUILDING

Engagement of stakeholders and governance leadership is needed to ensure alignment and commitment to sustainable buildings and construction. Best practice sharing, training and capacity building can help ensure wide-spread uptake of sustainable practices and high-performance, low-carbon technology solutions for buildings.

5. DATA CAPTURE AND MANAGEMENT

Accessible and reliable data are needed to improve understanding of progress and performance in the buildings and construction sector. Data are key to enable informed decision making by stakeholders, ranging from governments and public authorities to the finance community, developers, professionals and final consumers.

6. INVESTMENTS AND FINANCE

Transforming buildings and construction will require a major shift in financing and investments. This includes building the business case for investors, while providing information and financing tools that remove risks and uncertainties for decision makers.

Global Alliance for Buildings and Construction Work Areas

The GABC aims to bring together the building and construction industry, countries and stakeholders to raise awareness and facilitate the global transition towards for low-emission, energy-efficient buildings. The GABC works on a voluntary collaboration basis through a series of five Work Areas.

WORK AREA 1

Awareness and Education

The focus of the working group is to develop common narratives and key messages as well as to support capacity building. Topics include: importance of targets; the need to raise the level of ambition; how to make the case for finance/policies; bringing out multiple benefits; how to increase demand for energy-efficient buildings; and training building professionals.

WORK AREA 2

Public Policies

The focus of the working group is to be a platform for countries to showcase their policies and enable peer-to-peer learning; to enable capacity support through match-making of on-going partner activities and the development of new activities where priorities of partners align; and to enable cities and subnational engagement. A new cities and regions public policies group was created in 2017 to identify opportunities, facilitate community-level climate and energy strategies, and foster cooperation between national and sub-national levels of government.

WORK AREA 3

Market Transformation

The focus of the working group is to enable multiple partnerships and the shared culture between private and public sectors as well as to facilitate market transformation. This includes the development of voluntary arrangements to prepare regulation and enable innovation in the market. It also includes developing guidance on science-based targets that can be used to help transform the buildings and construction sector.

WORK AREA 4

Finance and Data Analysis

The focus of the working group is to reinforce the need for access to funding and innovative finance tools. This includes: improving access to climate finance; enabling reliable information for investors to reduce risk and create value of more efficient buildings; and enabling funding for policies and engineering to conceive and implement energy efficiency in buildings.

WORK AREA 5

Measurement, Data and Accountability

The focus of the working group is to close the information gap and to support policy and investment with Measurable, Reportable and Verifiable (MRV) data. This includes: raising awareness of the importance of MRV amongst all stakeholders; collecting commitments and tracking progress made by governments and the building sector towards below 2 degrees Celsius targets; promoting data transparency, consistency and information exchange; providing guidance to enhance policy and tracking investments in the building sector; and facilitating accessibility, transparency, understanding and comparability of energy usage through the development of international data, measurements and standards in the land, construction, built environment and investment industry sectors.

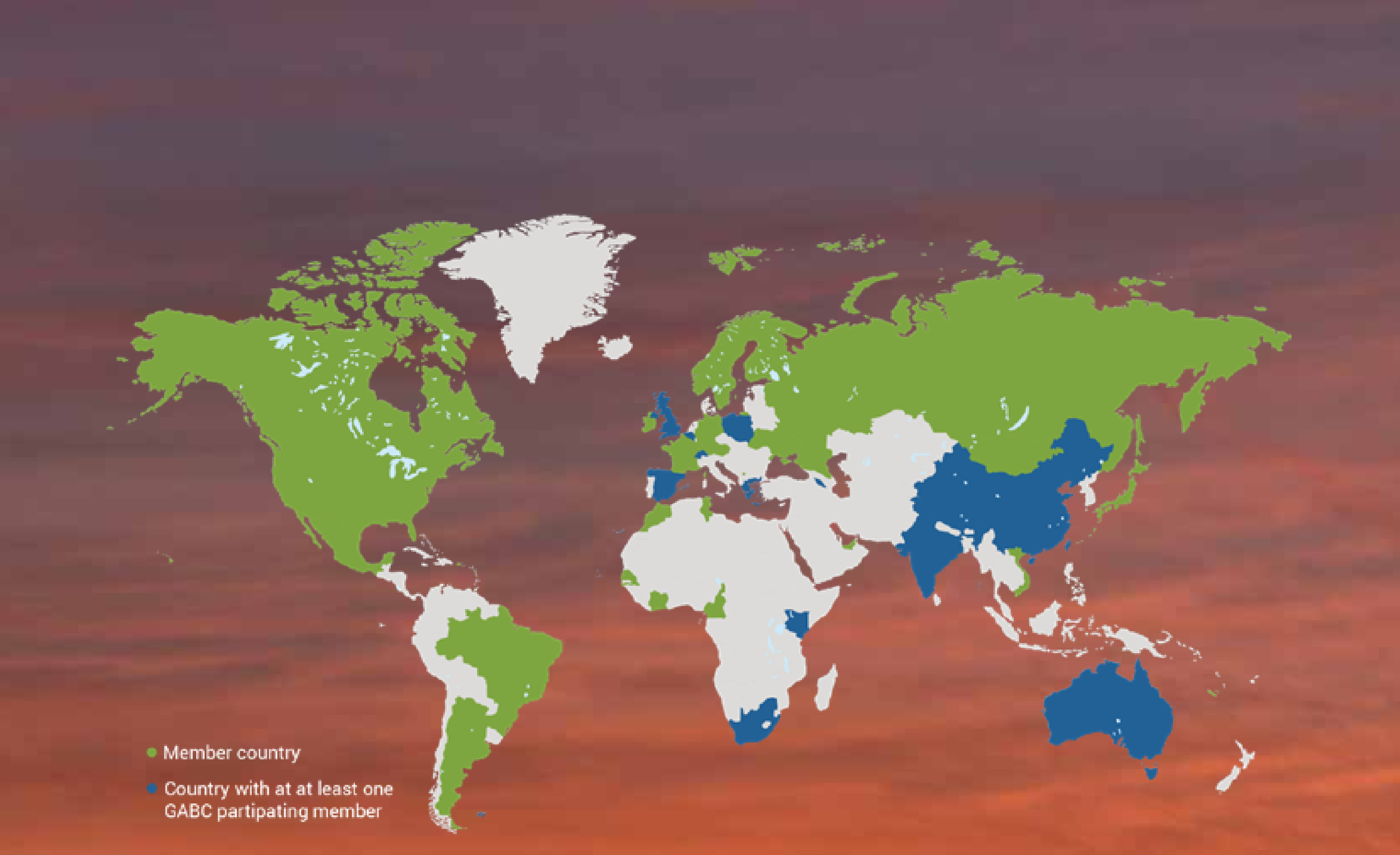
All working groups as well as the GABC overall welcome new participants. Please contact the GABC secretariat (global.abc@un.org) for more information.

All GABC members

GABC members include 25 countries/Ministries/National Agencies, 9 local governments and -networks, 42 civil-society organization, 11 intergovernmental organizations, and 15 private sector companies and -networks

Country name / abbreviation	Institution / full name
Countries/Ministries/National Agencies	
ADEME	The French Environment & Energy Management Agency
Argentine Republic	Ministry of Environment and Sustainable Development
Republic of Armenia	Ministry of Urban Development
Republic of Austria	Federal Ministry of Agriculture, Forestry, Environment and Water Management
Federative Republic of Brazil	Ministry of the Environment
Republic of Cameroon	Ministry of Housing and Urban Development
Canada	Environment and Climate Change Canada
Republic of Finland	Ministry of the Environment
French Republic	Ministry of Ecological & Inclusive Transition (METS) & Ministry of Territorial Cohesion (MCT)
Federal Republic of Germany	Federal Ministry for Economic Affairs and Energy
GIZ	German Corporation for International Cooperation GmbH
Japan	Ministry of Land, Infrastructure, Transport and Tourism
Mongolia	Ministry of Road, Transportation, Construction and Urban Development
Kingdom of Morocco	Ministry of National Territory Development, Urban Planning, Habitat and Urban Policy
Kingdom of Norway	Ministry of Climate and Environment
Russian Federation	Ministry of Construction, Housing, and Utilities
Republic of Senegal	Ministry of Environment and Sustainable Development
Republic of Singapore	Building and Construction Authority
Kingdom of Sweden	Ministry of Enterprise and Innovation, Department for Housing and Transport
Republic of Tunisia	Ministry of Housing and Spatial Planning
Ukraine	State Agency on Energy Efficiency and Energy Saving
United Arab Emirates	Dubai Land Department
United Mexican States	Secretariat of Agrarian, Land, and Urban Development & Secretariat of Energy
United States of America	United States Department of Energy
Socialist Republic of Vietnam	Ministry of Natural Resources and Environment & Ministry of Construction
Sub-National Governments/Provinces/Cities/City Networks	
State of California	State of California
ICLEI - Local Governments for Sustainability	ICLEI - Local Governments for Sustainability
Energy Cities - Local Authorities in Energy Transition	Energy Cities - Local Authorities in Energy Transition
Mexico City	Mexico City
Province of Ontario	Province of Ontario
Tokyo Metropolitan Government	Tokyo Metropolitan Government
City of Vancouver	City of Vancouver
Capital City of Warsaw	Capital City of Warsaw
World Resources Institute	World Resources Institute
Civil Society Organisations/Civil Society Networks, & Think Tanks	
10YFP SBC	10-Year Framework of Programmes on Sustainable Consumption and Production Patterns - Sustainable Buildings and Construction Programme
ACE	Architects' Council of Europe
AFD	French Development Agency
Architecture 2030	Architecture 2030
AVN	Nubian Vault Association / La Voute Nubienne
BPIE	Buildings Performance Institute Europe
C2E2	Copenhagen Centre on Energy Efficiency
CBCS	Brazilian Sustainable Construction Council
CICA	Confederation of International Contractors Association
Climate-KIC	Climate-KIC
Construction21	Construction21
CRCLCL	Cooperative Research Council for Low Carbon Living
CSTB	Centre Scientifique et Technique du Bâtiment
CTCN	Climate Technology Centre and Network
ECREEE	Centre for Renewable Energy and Energy Efficiency
ENERGIES 2050	ENERGIES 2050
EuroAce	EuroAce
FFB	Federation Française du Batiment
Fibrenergie	Fibrenergie
FIDIC	International Federation of Consulting Engineers
FIEC	European Construction Industry Federation
GBPN	Global Buildings Performance Network
GFHS	Global Forum on Human Settlements
Global District Energy in Cities Initiative	Global District Energy in Cities Initiative
Housing Europe	Housing Europe
HUDCO	Housing and Urban Development Corporation Ltd. (A Government of India Enterprise)
iiSBE	International Initiative for a Sustainable Built Environment
INTA	International Urban Development Association
IPHA	International Passive House Association
ICP	Investor Confidence Project
OID	Observatoire de l'Immobilier Durable
Plan Bâtiment Durable	Plan Bâtiment Durable

R20 Regions of Climate Action	R20 Regions of Climate Action
Renovate Europe	Renovate Europe
RHF	Réseau Habitat et Francophonie
RIBA	Royal Institute of British Architects
RICS	Royal Institution of Chartered Surveyors
SEforALL	Sustainable Energy for All
TERI	The Energy and Resources Institute
The Prince of Wales's Corporate Leaders Group	The Prince of Wales's Corporate Leaders Group
ULI	Urban Land Institute
UIA	International Union of Architects
Intergovernmental Organizations/Agencies	
GEF	The Global Environment Facility
IEA	International Energy Agency
IFC	The International Finance Corporation
IFDD	Institut de la Francophonie pour le Développement Durable
IPEEC	International Partnership for Energy Efficiency Cooperation
IRENA	The International Renewable Energy Agency
UN ECE	United Nations Economic Commission for Europe
UN Environment	United Nations Environment Programme
UNEP FI	United Nations Environment Programme Finance Initiative
UN-Habitat	United Nations Human Settlements Programme
The World Bank ESMAP	The World Bank / Energy Sector Management Assistance Program
Private Sector Enterprises/Private Sector Networks	
Autodesk	Autodesk
Broad Group	Broad Group
Consolidated Contractors Company	Consolidated Contractors Company
Danfoss	Danfoss
GBCSA	Green Building Council of South Africa
LafargeHolcim	LafargeHolcim
Saint-Gobain	Saint-Gobain
Sekisui House	Sekisui House
Suez Environment	Suez Environment
GBCI	Green Business Certification Inc.
Thermaflex	Thermaflex International B.V
Velux	Velux
Veolia	Veolia
WBCSD	World Business Council for Sustainable Development
WorldGBC	World Green Building Council



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

UN environment
United Nations Environment Programme

ADEME
French Environment & Energy Management Agency

Liberté • Égalité • Fraternité
République Française
Ministère de la Transition Écologique et Solidaire
Ministère de la Cohésion des Territoires

Global Alliance for Buildings and Construction

iea International Energy Agency
Secure Sustainable Together