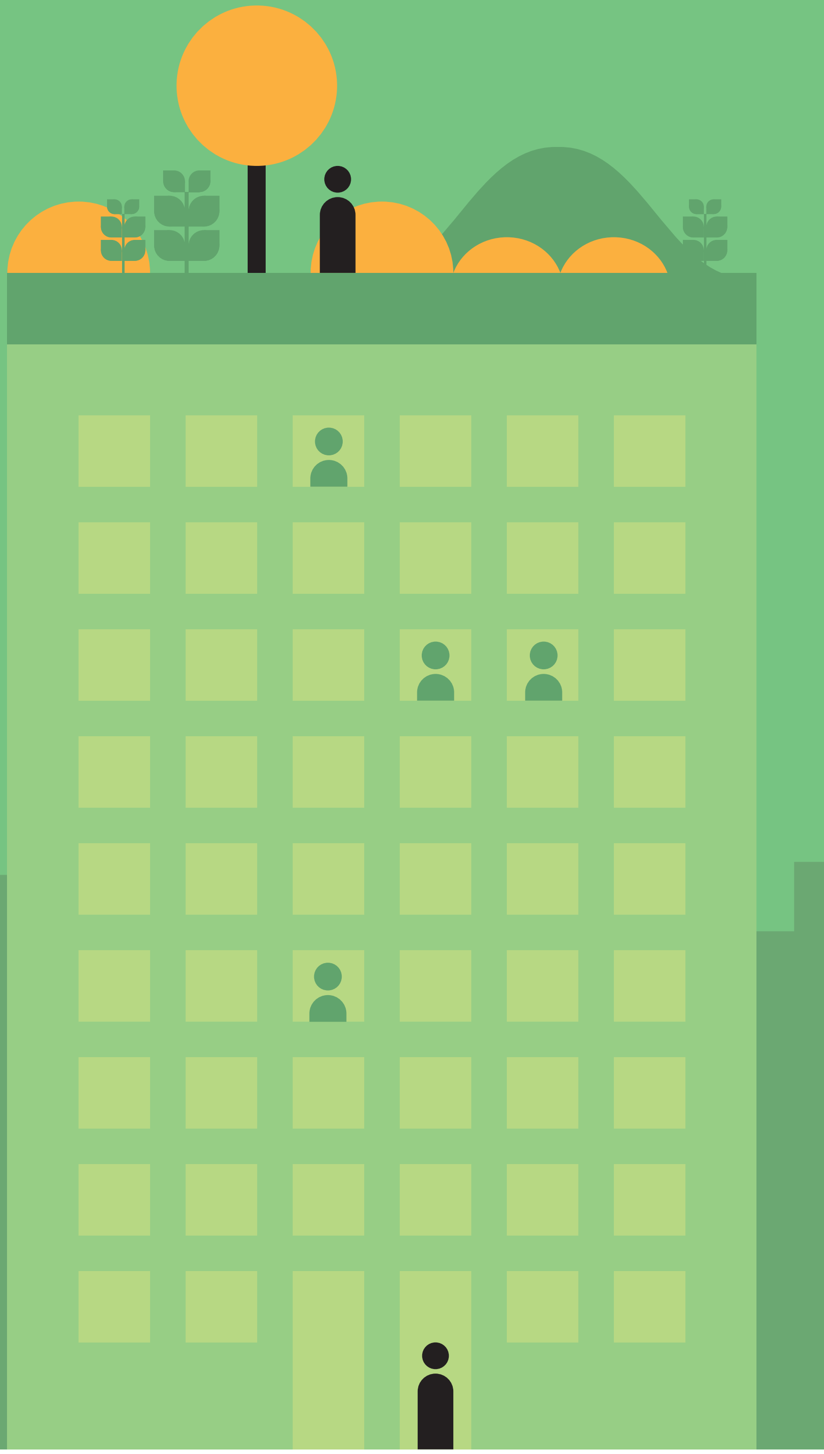
CLIMATE
EVERYONE'S
BUSINESS



# Climate Change: Implications for Buildings

Key Findings from the Intergovernmental Panel on Climate Change Fifth Assessment Report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# The **Physical Science** of Climate Change

## Rising temperatures:

The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) concludes that climate change is unequivocal, and that human activities, particularly emissions of carbon dioxide, are very likely to be the dominant cause. Changes are observed in all geographical regions: the atmosphere and oceans are warming, the extent and volume of snow and ice are diminishing, sea levels are rising and weather patterns are changing.

## Projections:

Computer models of the climate used by the IPCC indicate that changes will continue under a range of possible greenhouse gas emission scenarios over the 21st century. If emissions continue to rise at the current rate, impacts by the end of this century are projected to include a global average temperature 2.6–4.8 degrees Celsius (°C) higher than present, and sea levels 0.45–0.82 metres higher than present.

To prevent the most severe impacts of climate change, parties to the UN Framework Convention on Climate Change (UNFCCC) agreed a target of keeping the rise in average global temperature since pre-industrial times below 2°C, and to consider lowering the target to 1.5°C in the near future.

The first instalment of AR5 in 2013 (Working Group I on the physical science basis of climate change) concluded that by 2011, we had already emitted about two-thirds of the maximum cumulative amount of carbon dioxide that we can emit if we are to have a better than two-thirds chance of meeting the 2°C target.

## Impact of past emissions:

Even if emissions are stopped immediately, temperatures will remain elevated for centuries due to the effect of greenhouse gases from past human emissions already present in the atmosphere. Limiting temperature rise will require substantial and sustained reductions of greenhouse gas emissions.



# **About** this document

The Fifth Assessment Report from the Intergovernmental Panel on Climate Change is the most comprehensive and relevant analysis of our changing climate. It provides the scientific fact base that will be used around the world to formulate climate policies in the coming years.

This document is one of a series synthesizing the most pertinent findings of AR5 for specific economic and business sectors. It was born of the belief that the building sector could make more use of AR5, which is long and highly technical, if it were distilled into an accurate, accessible, timely, relevant and readable summary.

Although the information presented here is a 'translation' of the key content relevant to this sector from AR5, this summary report adheres to the rigorous scientific basis of the original source material.

Grateful thanks are extended to all reviewers from both the science and business communities for their time, effort and invaluable feedback on this document.

The basis for information presented in this overview report can be found in the fully-referenced and peer-reviewed IPCC technical and scientific background reports at: **www.ipcc.ch**

**PUBLISHED:**
June 2014

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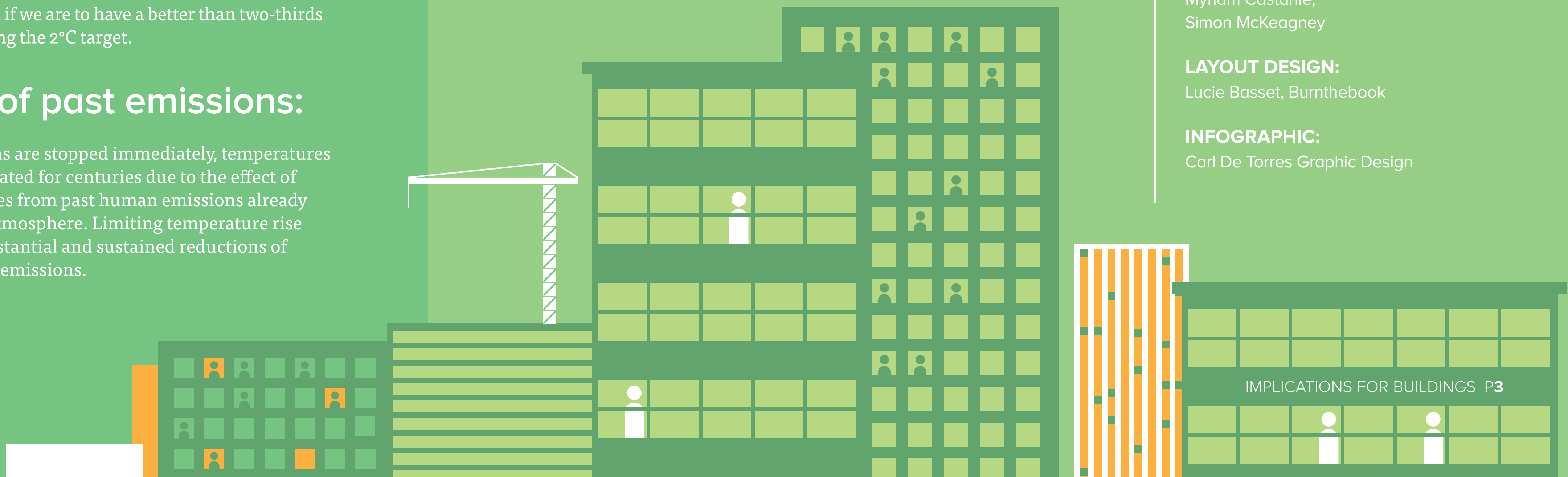


# Key Findings

1. **In 2010, the world's buildings accounted for 32% of global final energy use and 19% of all greenhouse gas (GHG) emissions.** Under business-as-usual projections, **use of energy in buildings globally could double or even triple by 2050.** Drivers include billions of people acquiring adequate housing and access to electricity.

2. **Widespread implementation of best practices and technologies could see energy use in buildings stabilise or even fall by 2050.** Many mitigation options promise multiple co-benefits.

3. **Many barriers exist to greater uptake of energy-saving opportunities,** including poor market transparency, limited access to capital and risk aversion. But know-how exists on retrofitting and how to build very low- and zero-energy buildings, often at little marginal investment cost; and there is a broad portfolio of effective policy instruments available to remove barriers to uptake.

4. **The very long life-cycles of buildings create risks of energy use 'lock-in'** with the effects of low ambition today playing out for decades. Using state-of-the-art standards immediately, for both new and retrofit buildings, would alleviate this hazard.

5. **Buildings face major risks of damage from the projected impacts of climate change,** having already experienced a big increase in extreme weather damage in recent decades. There is likely to be significant regional variation in the intensity and nature of such impacts.



# Executive Summary

The world's buildings account for just under a third of global final energy use and about a fifth of all GHG emissions, although energy use varies widely from region to region.

Buildings' energy use in developed countries is generally very wasteful and inefficient, although mounting evidence shows this need not be the case. Developing countries risk locking into the same pattern as their economies and populations grow – hence business-as-usual trends projecting two- or three-fold rises in global building final energy demand and associated emissions by 2050.

Yet buildings offer near-term, highly cost-effective opportunities to curb energy-demand growth rates, even to reverse them in developed economies. A few developed countries have already reversed growth in total energy use by using stricter building codes and appliance standards.

Exploiting this potential more widely requires sustained policies and actions that address all aspects of the design, construction, and operation of buildings and their equipment, as well as changing user behaviours and attitudes.

Within the buildings sector, both residential and commercial, early movers towards efficiency can reap multiple benefits. These include more valuable, resilient buildings that offer better living and working conditions for owners and tenants, associated improvements in health and productivity, and higher occupancy rates.

Lack of access to capital presents a significant hurdle to progress, not least for resource-poor countries. Yet energy efficiency helps other development goals, including better health from improved indoor air quality, poverty alleviation and improved energy security.

The longevity of buildings presents the risk of energy performance 'lock-in' whereby today's sluggish ambition confers a legacy of less than optimal buildings to future generations. Avoiding lock-in requires the urgent adoption of state-of-the-art performance standards in all buildings.

Buildings face multiple climate change impacts including more frequent strong wind, increased heat, particularly in cities (Urban Heat Island effect), and the floods and wildfires that accompany some extreme weather events. Buildings have already experienced big increases in damage over recent decades.

# Mitigation Potential

There is major potential for energy savings of up to 50–90% in existing and new buildings. Many mitigation options are immediately available and highly cost-effective. Although well-documented solutions exist, there are barriers indicating a need for effective policy instruments. Different modelling approaches project different energy-use trends and suggest alternative emphases for mitigation. Top-down, integrated models that optimise across sectors suggest that building emissions will further rise in the future. On the other hand, bottom-up models that cover mitigation options for the building sector in far greater detail project scenarios in which emissions may be cost-effectively stabilised or even reduced by 2050.

The primary mitigation strategies comprise carbon efficiency, energy efficiency of technology, system and infrastructure efficiency, and service demand reduction via behavioural and lifestyle changes.

## Carbon efficiency

At present, electricity is the main energy used for cooling and appliances in buildings, while most countries use fossil fuels for heating. Both energy carriers are causing significant carbon emissions. More than 2 billion people presently have no access to electricity or clean energy for cooking. If their energy provision shifts to electricity, this may shift trends in building-related emissions.

Integrated models suggest that electricity sector decarbonisation offers lower cost mitigation gains than direct emission cuts in energy end-use sectors. That contrasts with sectoral model projections, which suggest targeting big cuts in both primary fuel and electricity use before exploring low- and zero-carbon electricity options. Switching to advanced biomass stoves would save cooking energy use and its associated emissions. The long lifetimes of buildings mean that life cycle cost calculations are key to deciding optimal choices.

Barriers to progress include sub-optimal technology and the disincentive effects of conventional fuel subsidies. Feed-in tariffs, carbon taxes and soft loans for small-scale renewables can help overcome such barriers.

The Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) is the most detailed assessment of climate change ever.

Recent advances in technologies, know-how and policies provide opportunities to stabilise or reduce global buildings sector energy use by 2050.

## Energy efficient technology

There are many mitigation options specifically applicable to buildings.

- High-performance building envelopes. Typically, these have high-performance insulation and windows, avoiding thermal bridges and maintaining air tightness while using mechanical ventilation with or without heat recovery to maintain high indoor air quality
- Energy-efficient appliances, efficient lighting, and Heating, Ventilation and Air-Conditioning (HVAC)
- Evaporative cooling and solar-powered desiccant dehumidification, as locally appropriate.
- Improved building automation and control systems that respond to changing conditions
- ‘Daylighting’ – designing buildings for controlled admission of natural light, adjustable through the day using solar shading
- Using smart meters and grids to modulate supply in real time.

Total life-cycle energy use in low-energy buildings is less than for conventional buildings. Larger amounts of energy may be embodied in their materials and energy-efficiency features, but this is outweighed by in-use energy savings. Swedish research estimates that a low-energy house would require 40% less total energy over a 50-year period. Barriers to such technologies include fragmented market and institutional structures, the lack of user feedback loops, transaction costs and principal-agent problems (when building owners or operators derive no direct benefits from improvements). Key policies to cut through these barriers include public procurement, appliance standards, tax exemptions, and soft loans.

## System or infrastructure efficiency

Taking an infrastructure efficiency approach improves the prospects of significant savings. Integrated design processes prioritise energy performance-and-use factors throughout design, construction and commissioning.

Passive building designs – those that minimise or even eliminate the need for mechanical heating, cooling and ventilation – offer potential for both cost savings and carbon dioxide ($CO_2$) mitigation. Active designs can also achieve low energy use and related emissions, while adjusting to suit conditions and user needs.

Individual retrofits can produce big savings versus baseline business-as-usual energy use, depending on the building type. Existing examples include:

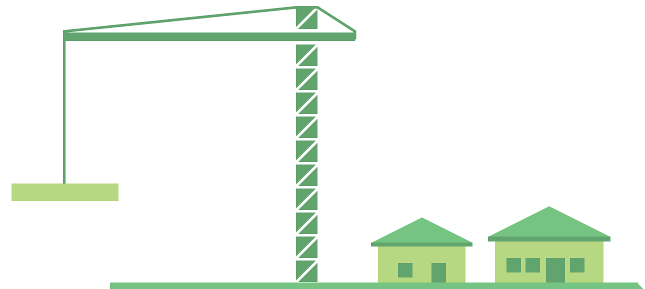
- Detached single-family homes cutting total energy use by 50–75%
- Multi-family housing reducing space heating requirements by 80–90% and, in developing countries, cutting cooling energy use by 30% and heating energy by 60%
- Commercial building HVAC energy use reduced by 25–50% and by 30–60% for lighting.

Policies to encourage these types of retrofit include tighter building codes, preferential loans, grants, subsidised finance, use of Energy Performance Certificates (EPCs), energy supplier efficiency obligations and tradeable white certificates.

Energy Service Companies (ESCOs) can aid mitigation efforts by striking performance-based contracts with end users, investing in efficiencies, then profiting from savings. Pushing ESCOs to pursue long-term, ambitious savings is essential to avoid locking-in sub-optimal contracts. Other possibilities include utility-provided energy services, on-bill financing or the US Property Assessed Clean Energy (PACE) finance mechanism.

## Service demand reduction

Energy use increases projected for buildings relate mainly to higher demand for energy services, driven by people moving out of poverty and changing patterns of consumption. Potential instruments that can deliver demand reduction in the context of these social trends include carbon pricing, personal carbon trading, property taxation related to building $CO_2$ emissions, progressive appliance standards and building codes with absolute consumption limits. More intense or frequent extreme weather events will affect property insurance. Insurability can be preserved through risk-reducing measures, although not without limit.



### Multiple co-benefits of cutting $CO_2$ emissions

Mitigation offers many co-benefits that can substantially exceed climate and energy benefits. Yet they are rarely recognised as doing so, still less internalised in policies. Among these co-benefits are reduced mortality and morbidity from improved indoor and outdoor air quality – particularly in developing countries – and reduced energy and fuel poverty.

Economic benefits include:

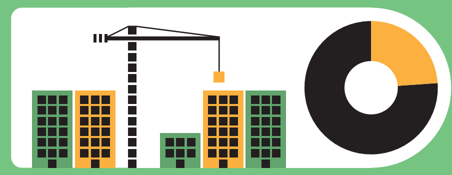
- **Higher asset values**
- **Lower energy bills**
- **More jobs**
- **Improved energy security**
- **Improved productivity of commercial building occupants.**

Reducing overall energy demand also eases peak pressure on grids and cuts energy transmission and distribution losses, as well as improving energy security, lessening human impact on ecosystems and lessening the building sector's overall contribution to climate change.

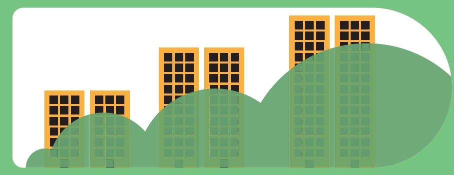
# Building for a low-carbon future

Effective policies can lead to buildings and wider settlements that are climate resilient and use energy efficiently, so curbing the rise in greenhouse gas (GHG) emissions. There is potential for energy savings of 50–90% in existing and new buildings.

**In 2010, buildings accounted for 32% of global final energy use.**



**In 2010, buildings accounted for 19% of all GHG emissions.**



**$CO_2$ emissions in the building sector could double or triple by 2050.**

## BUILDING-AS-USUAL

Buildings' energy use in developed countries is generally wasteful and inefficient. Developing countries risk locking into the same pattern as their economies and populations grow richer.

### Demand Pressures

Under business-as-usual projections, use of energy in buildings globally could double or even triple by 2050. Drivers include billions of people acquiring adequate housing and access to electricity. More wealth, more urban dwellers and a higher global population will also raise demand.

### Impacts and Risks

Many buildings are vulnerable to impacts of climate change. These include increased precipitation, thawing permafrost, and extreme weather-related events such as wildfires, severe storms and floods. Without investment in improved resilience, this vulnerability is destined to increase.

### Warming and Energy Demand

Higher temperatures will drive changes in climate-related energy demand. In low-income countries, rising wealth will be the main driver of increasing energy demand, principally for air conditioning and transport.

### Energy in the Home

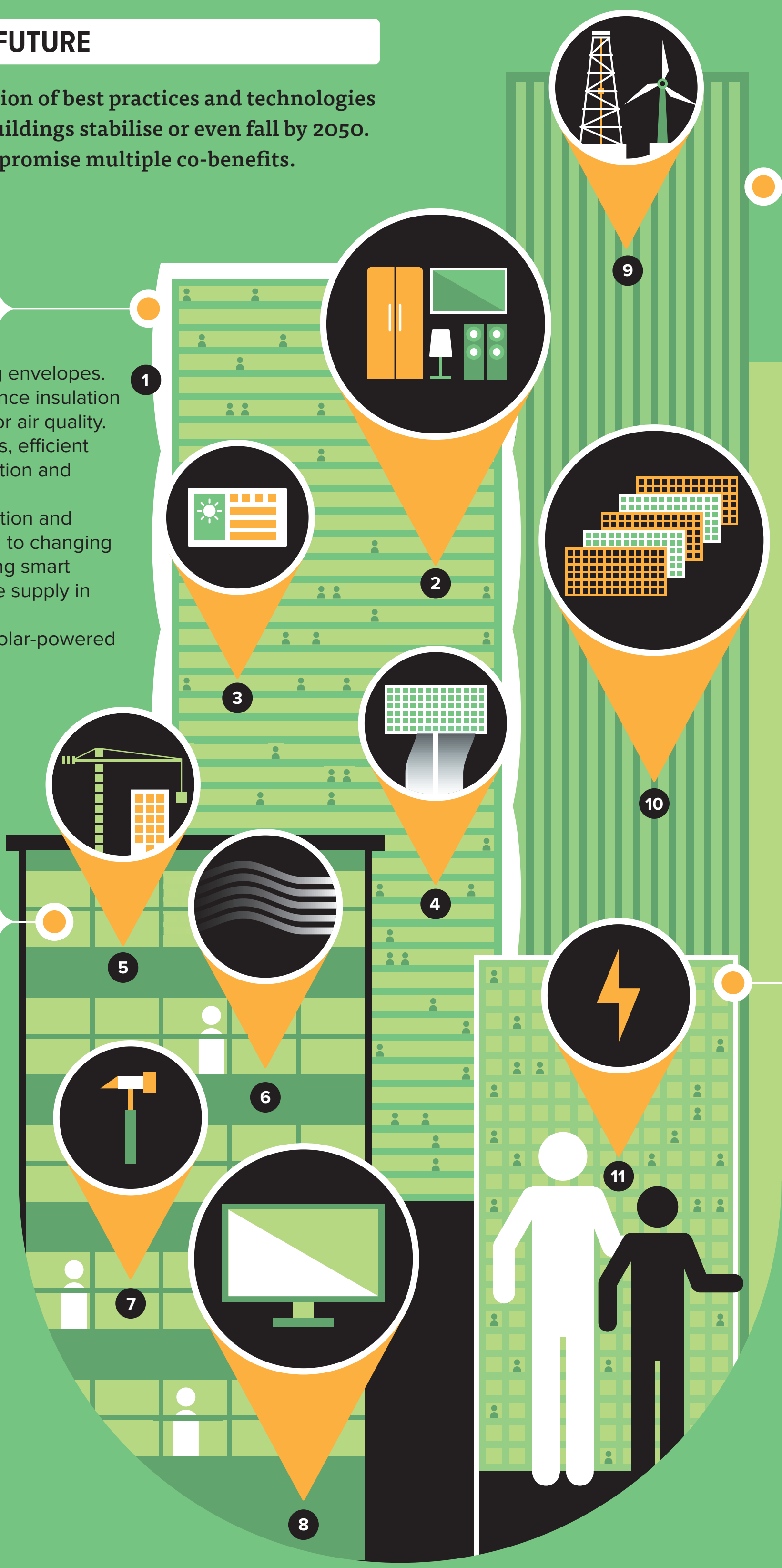
Traditional large appliances account for most household electricity consumption, yet their share is falling fast. Electronic entertainment and communications equipment now account for more than 20% of residential electricity use in most countries.

**KEY ISSUES**

- ENERGY INSECURITY
- EXTREME WEATHER
- DROUGHT
- GLOBAL WARMING
- HUMAN BEHAVIOUR

## BUILDING FOR THE FUTURE

Widespread implementation of best practices and technologies could see energy use in buildings stabilise or even fall by 2050. Many mitigation options promise multiple co-benefits.




### Energy-Efficient Technology

**1** High-performance building envelopes. Typically, with high-performance insulation and windows, and high indoor air quality.
**2** Energy-efficient appliances, efficient lighting, and Heating, Ventilation and Air-Conditioning (HVAC).
**3** Improved building automation and control systems that respond to changing conditions. 'Daylighting'. Using smart meters and grids to modulate supply in real time.
**4** Evaporative cooling and solar-powered desiccant dehumidification.

**Average $CO_2$ reduction potential: 20–45% of baseline**

### System Infrastructure Efficiency

**5** Know-how exists on retrofitting and how to build very low-and zero-energy buildings, often at little marginal investment cost or manageable payback times.
**6** Passive building designs that minimise or eliminate the need for mechanical heating, cooling and ventilation.
**7** Deep retrofits of existing buildings have brought 50–90% energy savings.
**8** Integrated Design Processes prioritise energy performance-and-use factors through building design, construction and commissioning.

**Average $CO_2$ reduction potential: 30–70% of baseline**

### Carbon Efficiency

**9** At present, electricity is the main form of energy used for cooling and appliances, while fossil fuels are used for heating. Changing fuels and energy supply infrastructure to buildings will be needed to deliver large emissions cuts even if end-use demand falls.
**10** More than 2 billion people currently lack access to modern energy carriers. The evolution of their energy provision will drive trends in buildings-related emissions.

**Average $CO_2$ reduction potential: 20–45% of baseline**

### Service Demand Reduction

**11** Energy use increases projected for buildings relate mainly to higher demand for energy services, driven by people moving out of poverty and changing patterns of consumption. Potential means to deliver demand reduction include carbon pricing, personal carbon trading, property taxation related to building $CO_2$ emissions, progressive appliance standards and building codes with absolute consumption limits.

**Average $CO_2$ reduction potential: 20–40% of baseline**

# Impacts of Climate Change

Climate change is projected to have profound impacts on the built environment, although the precise extent of these impacts is uncertain and will vary significantly between and within regions.

Many buildings are vulnerable to progressive changes in climate and to extreme events. Impacts include increased precipitation, thawing permafrost, more frequent wildfires, severe storms and floods. Without investment in improved resilience, this vulnerability is destined to increase. The location of the built assets is key to their vulnerability.

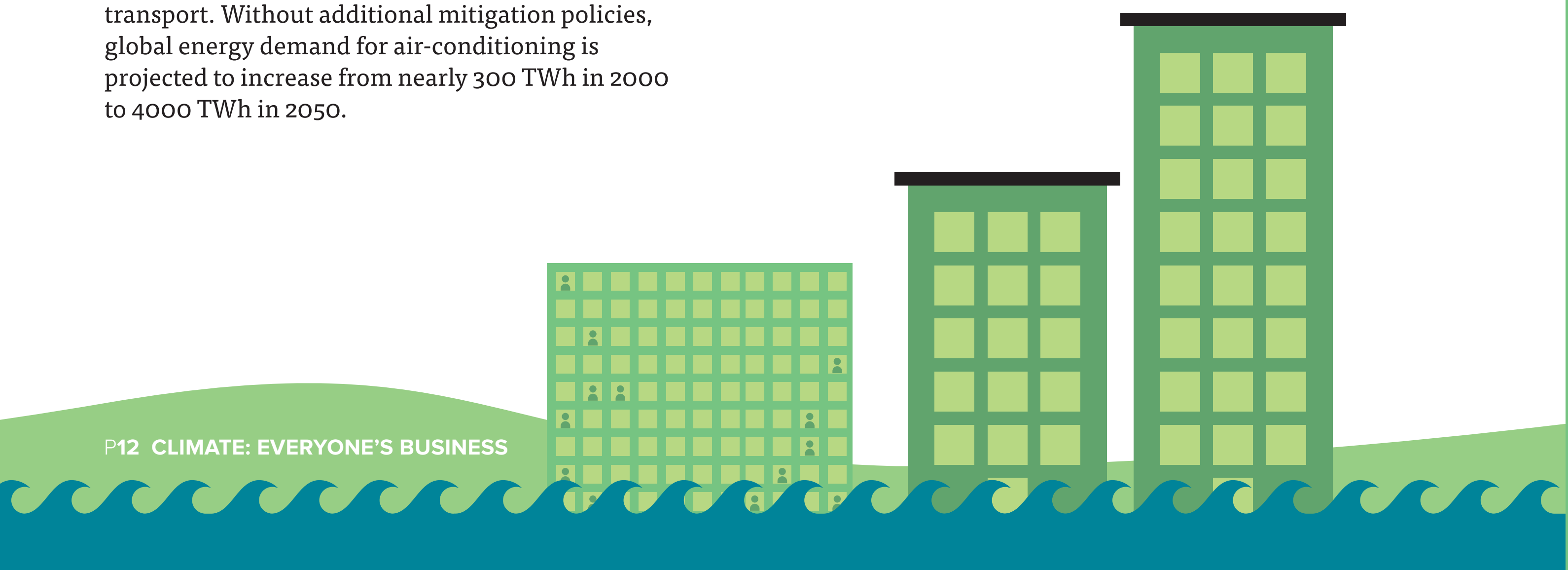
The construction sector itself faces direct impacts. Precipitation extremes could increase construction delays and thus costs. Climate change also risks changing the length of building seasons. The changing patterns of extreme weather events imply more rebuilding and repair work.

The increased incidence and severity of heat waves has implications for building design, potentially implying the need to move away from current architectural designs towards different approaches for new builds.

Higher temperatures will drive changes in climate-related energy demand. In low-income countries, usually with warmer climates, increased wealth will be the main driver of increasing energy demand, principally for air conditioning and transport. Without additional mitigation policies, global energy demand for air-conditioning is projected to increase from nearly 300 TWh in 2000 to 4000 TWh in 2050.

Energy demand for winter heating is also projected to rise, although much less rapidly, as regions with the highest need for heating are generally already rich enough to afford it, with some exceptions. Developed country heating energy demand is seen as flat through to 2030 while developing countries will consume significantly more.

Climate-related hazards affect poor people directly through impacts that include the total destruction of their homes, which tend to be relatively vulnerable. Damage to physical assets from extreme weather events is well documented for poor urban settlements, often built on risk-prone floodplains and hillsides susceptible to erosion and landslides. Richer households in high-risk areas may get relief with insurance or by lobbying for protective policies, in contrast to poor residents.





# Resilience and Adaptation

There is a lack of private investment into adaptation 'best practices' in design and construction of existing buildings, putting those structures in the front line for projected increases in climate damage risk. Protecting new buildings from the same climate change impacts would mean incorporating adaptation responses into their design and construction.

Factors affecting any location's capacity for adaptation include the quality of local government and risk-reducing infrastructure and services. The extent of housing built to suitable health and safety standards, and local levels of risk from climate change impacts, are also significant.

Governments are key to crafting and coordinating building sector responses and can identify and encourage synergies between adapting buildings to climate change and mitigating their GHG emissions, recognising potential for multiple benefits. Governments might, for example, encourage gardens or reflective materials to be installed on roofs to cut solar heat gain and cool the surrounding air. Taken together, a package of measures might aim to reduce building energy use to the minimum possible, which could be zero or even net negative.

Technology can reduce or exacerbate risk of damage during extreme weather events. An example of the latter is Hurricane Katrina in New Orleans, where flood defences enabling construction on a floodplain then suffered catastrophic failure in the face of an extreme event.

Insurance providers can encourage policy holders to cut risk exposure by giving resilience ratings to buildings, feeding into lower premiums. They can also support work to improve building codes and communicate best practices to property owners, governments and others. Yet insurers can also constrain action – for instance when 'like-for-like' replacement clauses prevent improvements being made.

Adaptation challenges facing developing countries also present many opportunities, as economic inequality generally translates into poor housing. More than half the urban areas projected for developing countries by 2030 have yet to be built, offering great potential for integrated adaptation planning. A first step toward adaptation would be to reduce vulnerability to existing climate risks.

Research in the Metropolitan Region of São Paulo suggests that knowledge of observed and projected environmental changes, coupled with an understanding of population vulnerabilities, is critical for defining adaptation policies. Its lessons could help buildings-resilience thinking in other developing country megacities.

In Bangladesh, authorities concentrated shelter construction around primary and secondary schools just as primary school attendance became compulsory. The result was new buildings for shelter and schooling designed to meet projected climate impacts.

Traditional construction methods can cut vulnerability to cyclones and floods in rural areas. Solomon Islanders use elevated floors to stay dry during heavy rains and construct low, aerodynamic houses with sago palm leaves as roofing material.

# Regional Perspectives

Building codes and appliance standards, if well designed and implemented, have been among the most environmentally and cost effective instruments for emission reductions.

Big regional variations exist in climate change risks and capacities to meet them. Some of the perspectives highlighted here for individual regions apply equally elsewhere. Huge variability also exists within regions.

## Africa

Africa's urban population is projected to triple by 2050, increasing by 0.8 billion. Many of the continent's evolving cities are unplanned, with informal settlements of inadequate housing. Cities and towns are highly vulnerable to climate change impacts, typically lacking provisions to cut flood risks or manage floods when they arise. Climate change itself could affect Africa's rural and urban human settlements, being a determinant of the scale and type of rural-urban migration. The continent's urgent adaptation needs stem from its sensitivity and vulnerability to climate change, coupled with poor adaptive capacity. Yet adaptation strategies can generate significant development co-benefits, boosting the chances of their adoption. Softer measures, such as building codes and zone planning, are being implemented. These are needed to complement and inform hard, infrastructural climate proofing. An example is Madagascar's code for cyclone-resistant public buildings.

## Europe

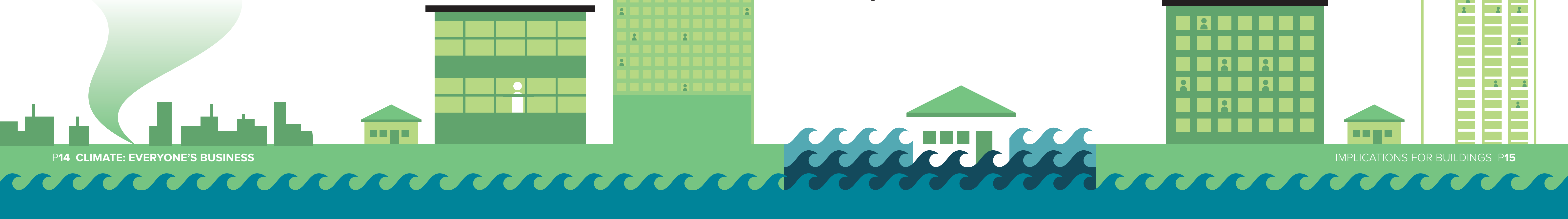
Climate change is very likely to increase the frequency and intensity of heat waves, particularly in southern Europe. Adaptive strategies, not exclusive to the region, include using thermal mass, ventilative cooling and solar shading to moderate extremes. There may also be more frequent, and severe, drought-induced soil subsidence and associated damage to buildings. Sea-level rise and increases in extreme rainfall are projected to further increase coastal- and river-flood risks in Europe. Adapting homes and commercial buildings to occasional flooding is possible, although in extreme cases, 'managed retreat' is the likely policy response. Climate change will affect the region's many culturally valued buildings, through extreme events and chronic damage to materials. Europe's capacity to adapt is relatively high, although there are important differences in impacts, and capacity to respond, between and within its sub-regions.

## Asia

Climate change will compound Asia's multiple stresses from rapid urbanisation, industrialisation and economic development. By 2050, its urban population is projected to rise by 1.4 billion. At the same time, extreme weather events will have increasing impacts across the continent, of varying type and magnitude depending on location. Half to two-thirds of Asian cities with a million or more inhabitants are exposed to one or multiple climate-related hazards, with floods and cyclones the most important. Three of the world's five most populated cities (Tokyo, Delhi, Shanghai) lie in areas with high flood risk. Such risks, and associated human and material losses, are heavily concentrated in India, Bangladesh, and China. Urban heat-island effects have risen, with local adaptation of the built environment and urban planning determining the public health impacts. Populations in much of Asia cannot afford mechanical cooling – especially for domestic housing – making it essential to consider low-energy designs to keep people cool. Their adoption could reduce later pressures to install energy-intensive cooling such as air conditioners. Such principles are embedded in traditional or so-called vernacular designs throughout the world, not exclusively in Asia. These could be incorporated with modern technologies to optimise cooling and resilience, using ventilative cooling as an alternative to mechanical cooling where possible.

## Oceania

Projected impacts in Australia include more frequent hot extremes, with associated wildfires, fewer cold extremes and more extreme rainfall events causing increased flood risks in many parts. All of these affect buildings. In Australia, a sea-level rise of 1.1 m would affect AUD226 billion of assets, including up to 274 000 residential and 8600 commercial buildings, with other intangible costs due to stress, health effects and service disruption. For Oceania's small islands, current and future risk drivers include sea-level rise, tropical and extra-tropical cyclones, increasing air and sea surface temperatures, and changing rainfall patterns. All of these have implications for buildings. The dangers presented mirror those faced by low-lying islands around the world. Planning, building design, early warning systems and public education could help adaptation, as they can elsewhere. Such measures are being implemented in places that have experienced extreme weather events.



## North America

Recent changes in climate and individual extreme weather events in North America have shown both the impacts of climate-related stresses and the vulnerabilities of exposed systems. On the Gulf Coast, change is underway in the design and construction of new homes in response to hurricanes over the past decade. Nevertheless, most North American markets have seen little change. Many jurisdictions are engaged in climate assessment and planning processes. The costs of adaptation, combined with limited long-term liability for future buildings, have led some builders to take a wait-and-see attitude. Exploratory work is underway to consider building codes focused both on historic weather experience and expected future risks. The housing and construction industries have made advances toward climate change mitigation by incorporating energy efficiency in building design. Less progress has been made in addressing the risk of damage to buildings from extreme weather events. Leadership in adaptation is far more evident municipally than at other levels of government.

## Central and South America

Central and South America collectively have the second highest proportion of population in urban areas (79%), behind North America (82%), and well above the world average (50%). These populations face diverse social, political, economic and environmental risks in daily life. Climate change could add another layer. The still high and persistent levels of poverty in most Central and South American countries translate into high vulnerability to climate change. Economic inequality means unequal access to water, sanitation and adequate housing, particularly for the most vulnerable groups, and low adaptive capacities to climate change.



# Conclusion

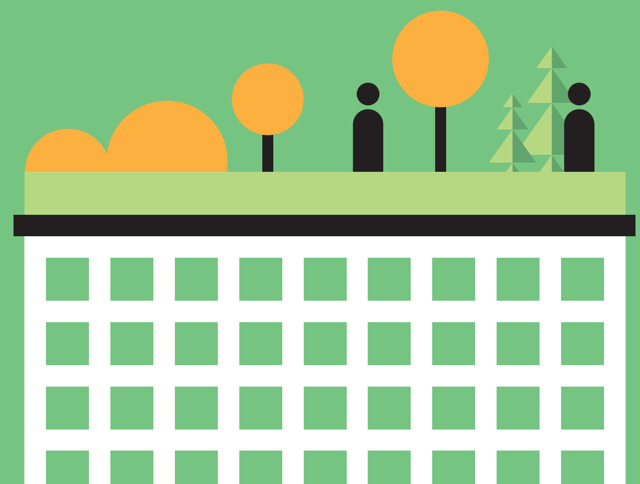
Buildings represent a critical piece of any global low-carbon future. Yet in many developing countries there is also a substantial need for shelter and basic services. Effective policies in these countries can lead to buildings, and wider settlements, that are climate resilient and use energy very efficiently, thus curbing the rise in GHG emissions. Opportunities for major energy savings also exist in the often wasteful and inefficient buildings of developed countries and emerging economies.

Impacts of climate change such as heat stress, extreme precipitation, inland and coastal flooding, landslides, air pollution, drought, and water scarcity pose risks in urban areas that are amplified by a lack of essential infrastructure and services or by living in poor-quality housing and exposed areas. Improving housing and resilient infrastructure systems could significantly reduce vulnerability and exposure in urban areas.

Radical change within the building sector requires aggressive and sustained policies and actions across the design, construction, and operation of buildings and their equipment, and will benefit from market and policy incentives. Advances in technologies, know-how and policy provide opportunities to stabilize or reduce energy use from buildings by mid-century. Recent large improvements in performance and costs make very low energy construction and retrofits economically attractive, sometimes even at net negative costs.

Building codes and appliance standards, if well designed and implemented, have been among the most environmentally and cost effective instruments for emission reductions. Substantially strengthening these codes, adopting them in further jurisdictions, and extending them to more building and appliance types will be key factors in reaching ambitious climate goals and in helping adapt to the changing climate.

For developed countries, scenarios indicate that lifestyle and behavioural changes could reduce energy demand by up to 20% in the short term and by up to 50% of present levels by 2050.



# Glossary

## ADAPTATION

The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects.

## BUILDING ENVELOPE

All of the elements of the outer shell of a building that maintain a dry, heated or cooled indoor environment and facilitate its climate control.

## CLIMATE CHANGE

Any significant change in climate that persists for an extended period, typically decades or longer.

## CLIMATE IMPACT

The effects of climate change on natural and human systems.

## CO-BENEFITS

The positive effects that a policy or measure aimed at one objective might have on other objectives.

## DECARBONISATION

The process by which countries or other entities aim to achieve a low-carbon economy, or by which individuals aim to reduce their carbon emissions.

## EMERGING ECONOMIES

Those economies in the low- to middle-income category that are advancing rapidly and are integrating with global capital and product markets.

## FINAL ENERGY USE

Energy that has been cleaned or refined or converted to electricity or heat, and delivered to end-use facilities, where it becomes usable energy in supplying energy services.

## GREENHOUSE GAS

A gas in the atmosphere, of natural and human origin, that absorbs and emits thermal infrared radiation. Water vapour, carbon dioxide, nitrous oxide, methane and ozone are the main greenhouse gases in the Earth's atmosphere. Their net impact is to trap heat within the climate system.

## MITIGATION

A human intervention to reduce the sources or enhance the sinks of greenhouse gases.

## PROJECTION

A potential future evolution of a quantity or set of quantities, often computed by a model. Projections involve assumptions that may or may not be realized, and are therefore subject to substantial uncertainty; they are not predictions.

## RENEWABLE ENERGY

Any form of energy from solar, geophysical or biological sources that is replenished by natural processes at a rate that equals or exceeds its rate of use.

## RESILIENCE

The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure.

*"Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions."*

IPCC, 2013

**About us:**

CISL brings together business, government and academia to find solutions to critical sustainability challenges.

CJBS is in the business of transformation. Many of our academics are leaders in their field, creating new insight and applying the latest thinking to real-world issues.

BPIE is a European not-for-profit think-tank with a focus on independent analysis and knowledge dissemination, supporting evidence-based policy making in the field of energy performance in buildings. It delivers policy analysis, policy advice and implementation support.

GBPN provides decision makers with policy expertise and technical assistance to advance building energy performance and realise sustainable built environments for all. We are a globally organised and regionally focused non-profit organisation active in China, Europe, India, South East Asia and the United States.

WBCSD is a CEO-led organisation of forward-thinking companies that galvanises the global business community to create a sustainable future for business, society and the environment.

**Disclaimer:**

This publication has been developed and released by the European Climate Foundation (ECF), the Buildings Performance Institute Europe (BPIE), the Global Buildings Performance Network (GBPN), the World Business Council for Sustainable Development (WBCSD) and the University of Cambridge's Judge Business School (CJBS) and Institute for Sustainability Leadership (CISL).

This project was initiated and financed by ECF and endorsed by CJBS and CISL.

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