Building Performance Assurance Council

What is Required of Buildings

A review of UN and IPCC findings, global commitments and current progress

About BPAC

The Building Performance Assurance Council (BPAC) is a trusted international building performance hub dedicated to ensuring buildings meet targets aligned with the Paris Accord and the United Nations Sustainable Development Goals. With a commitment to measured and verified outcomes achieving local, national and international goals, it equips industry leaders, policy makers and the public with the knowledge and skills needed to enable success.

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What is Required of Buildings

Eight Easy Points

To achieve local, national and international sustainable development goals buildings must:

1. Advance climate change mitigation by:
    a) Achieving Passive House efficiency or better
    b) Operating on renewable energy
    c) Minimizing embodied carbon
    d) Delivering the above three outcomes as soon as possible
2. Reflect the SER Framework of Sufficiency, Efficiency and Renewables
3. Be grid interactive, smart buildings with measurement and verification of performance
4. Maintain a comfortable and healthy indoor environment during extreme weather and energy supply interruptions
5. Be resilient to the future climate, weather, and sea level
6. Mitigate impacts of weather events on people, infrastructure, and nature
7. Support biodiversity
8. In delivering the outcomes described above, contribute to all 17 UN Sustainable Development Goals with the exception of #14, Life Below Water.

1. Introduction

This paper organizes, summarizes and collates the findings, guidelines and recommendations of global agencies mandated to identify the outcomes buildings are to deliver for people, the planet and prosperity. The member nations of the UN have, almost without exception, through the Paris Agreement[1] and the adoption of the UN Sustainable Development Goals (SDG's)[2], committed to identified goals and signed, legally binding agreements. In this paper, buildings delivering the outcomes required to achieve those goals are referred to as 'Paris-aligned' – they deliver the outcomes the world has been informed are needed and agreed to pursue under the Paris Agreement.

This consolidated reference summarizes thousands of pages of formal reports and guidelines, making knowledge accessible to industry leaders, educators, policy makers and advocates. Those leading the transformation of buildings seek a deeper understanding regarding the goals the world has agreed to achieve and what is involved in doing so.

Within this framework, it becomes possible to evaluate the extent to which programs, policies, standards and green building labels achieve the outcomes the world has agreed to pursue – are they Paris-aligned?

An evaluation of whether or not we are achieving the needed outcomes is critical because buildings offer a unique opportunity to meet our climate and social goals. Happily, thousands of building industry leaders throughout the world are affordably delivering such outcomes today. How they are delivered varies with climate, culture and economic considerations, making local solutions the norm, but the outcomes themselves are universally achievable.

Delivering such outcomes sometimes appears to require an overwhelming degree of change in a limited time, particularly for those who are not actively involved in the design and construction of Paris-aligned buildings. The topic is complex and technical – as most subjects are. However, todays' industry leaders understand how the challenges can be overcome, and how readily industry could do so at scale.

As is the case in any market transformation, with the right mix of measures, the market can shift more rapidly than most believe possible.

Knowing the challenge is urgent and the needed outcomes are achievable, this paper summarizes the UN Sustainable Development Agenda with commentary on market transformation before delving into what is required of buildings and building regulations. With those requirements identified, it outlines the extent to which today's buildings are on track for Paris compliance.

This paper maintains a focus on buildings and does not attempt to address the critical array of benefits available through changes to the broader built environment or land use planning. The focus on buildings does not diminish the importance of making essential changes in the built environment through land use choices which so clearly enable the achievement of social and climate goals in relation to transportation, affordability, biodiversity, economic development, health, and resilience.

2. The UN Sustainable Development Agenda & Market Transformation

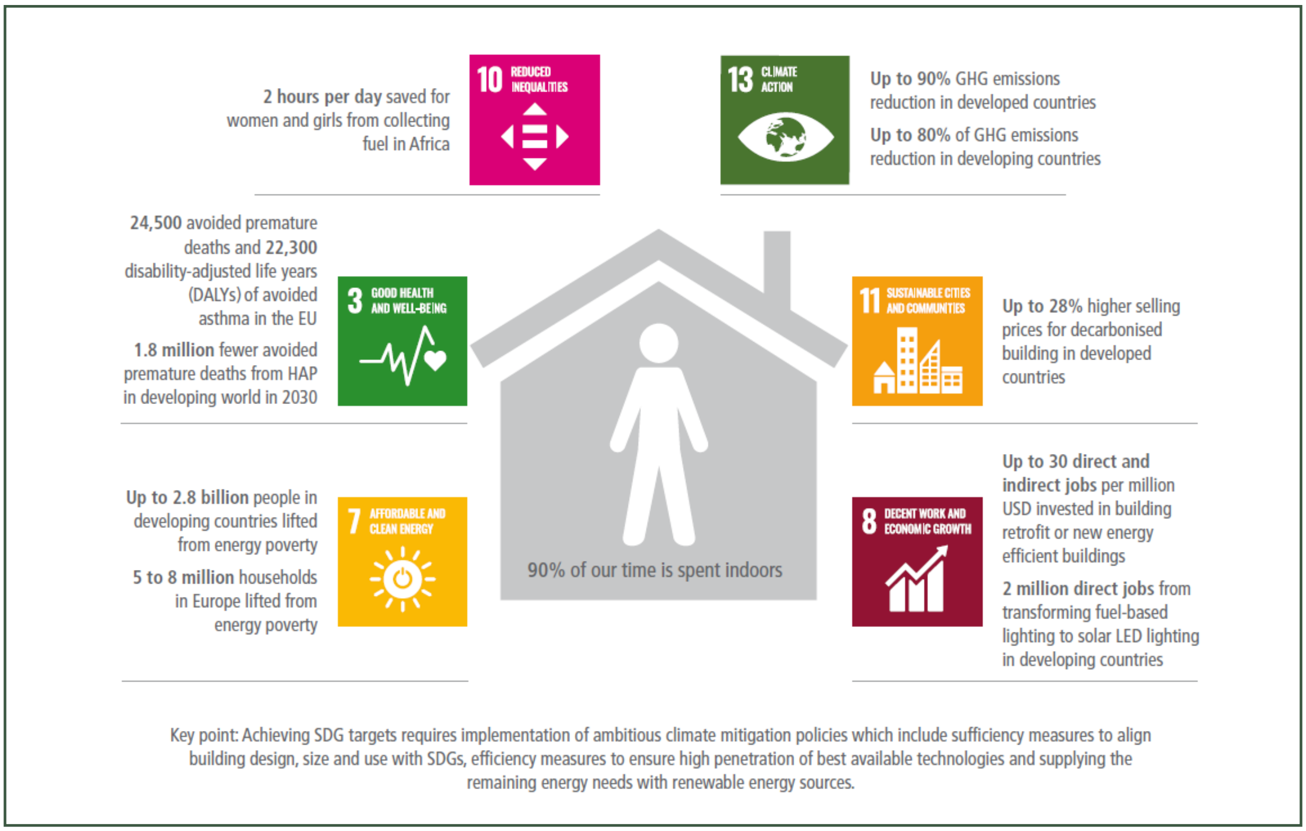
At the highest level, the UN Sustainable Development Agenda[3] describes a plan of action for people, planet and prosperity. It incorporates the 17 UN Sustainable Development Goals[4] (the SDG's), comprising a universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere. The SDG's were adopted by all UN Member States in 2015 and are part of the 2030 Agenda for Sustainable Development[5]. The Sustainable Development Agenda and the SDG's define a global direction of travel and form the foundation on which more specific guidance is based.

Of the 17 SDG's, the Intergovernmental Panel on Climate Change (IPCC) has found 16 are impacted by buildings[6]. The IPCC is the UN body for assessing the science related to climate change whose voluminous reports describe the global state of knowledge of climate change. Its flagship Assessment Reports are published periodically, with the 6th Assessment Report of Working Group III, released in April 2022, addressing mitigation.[7]

For the first time, the 6th Assessment report analyses more than scope 1 emissions from buildings. Emissions falling within Scope 1 are direct greenhouse gas emissions from the building, such as the combustion of fossil fuels within the building. Scope 2 emissions are indirect emissions associated with the offsite generation of energy, such as electrical generation. To the extent buildings consume such energy, Scope 2 attributes the resulting emissions to the buildings. Scope 3 emissions for buildings encompass all emissions not within Scopes 1 & 2, such as the emissions arising from the manufacture and delivery of materials from which the building is constructed. Typically, national emissions inventory reports are based on Scope 1 emissions, which attribute most of the impact of buildings to other sectors such as industry, energy generation, etc. Understating the impact of buildings in this manner can lead policy makers to consider buildings a low priority. The 6th Assessment report highlights this shortcoming and, for the first time, estimates the Scope 2 emissions from buildings and some Scope 3 impacts[8]. In broad terms, buildings are responsible for approximately 1/3 of global emissions and energy use, with the percentage being higher in urban areas[9].

Figure 1 below, from the 6th Assessment Report of Working Group III[10], illustrates some of the benefits of better buildings. With buildings having such a broad impact, society cannot achieve its objectives without a paradigm shift in how buildings are conceived, designed, constructed and operated.

FIGURE 1 – Contribution of mitigation policies of the building sector to meeting sustainable development goals.



The IPCC's findings on the interconnections between multiple SDG's align with findings in the 2021 UN Environment Program report, "Making Peace with Nature"[11]. It notes the interrelationships between social, environmental and economic goals and finds simultaneous, wholistic approaches are needed to enable transformative and systemic change. Without such change, humanity will not be able to fulfil international agreements and achieve the SDG's. Importantly, "Making Peace with Nature" highlights the challenge of overcoming systemic inertia. Change is always difficult, particularly, as the report notes, when individuals and organizations have ingrained habits, procedures and ways of doing business. Some also have substantial stakes in maintaining the status quo and may oppose change that disrupts their livelihoods, market share and future revenues.[12]

The key to avoiding exhaustion while overcoming systemic inertia is the implementation of measures simultaneously impacting multiple goals. For example, excellence in mitigation measures such as building efficiency simultaneously achieves social goals such as improving affordability, improved health and resilience during extreme weather. "Making Peace with Nature" also notes transformation does not necessarily entail changing everything massively and quickly. It can be a product of incremental but cumulative changes, especially if those changes affect key drivers or fundamental processes[13]. Transformative enablers may only be feasible after intervention via incremental enablers or the triggering of tipping points. The changes that appear most feasible may be those that do not contribute to, or even impede, transformative change, for instance by retaining or even consolidating the power of status quo interests[14]. These observations underscore the essential role of beginning with clearly-defined goals to enable proposed measures to be assessed for effectiveness.

The IPCC 6th Assessment Synthesis Report, released in March 2023, highlights urban systems, which are critical for achieving deep emissions reductions and advancing climate resilient development through integrated planning that incorporates physical, natural and social infrastructure[15]. An inclusive, equitable approach to integrating adaptation, mitigation and development can advance sustainable development in the long term. Integrated responses can harness synergies for sustainable development and reduce trade-offs[16]. The feasibility, effectiveness and benefits of mitigation and adaptation actions are increased when multi-sectoral solutions are undertaken that cut across systems, particularly if buildings are viewed within the broader context of the built environment.

When such options are combined with broader sustainable development objectives, they can yield greater benefits for human well-being, social equity, plus ecosystem and planetary health.

Climate resilient development strategies that treat climate, ecosystem biodiversity and human society as parts of an integrated system are the most effective[17]. UN agencies and related bodies apply these broad principles in developing more building-specific findings and recommendations.

The findings and recommendations of international agencies are based on many years of data. As a result, today's leaders exceed the minimum requirements identified in this paper. While few projects incorporate all elements of a Paris-aligned building, many tens of thousands of projects demonstrate how elements are affordably delivered with current knowledge and technology. While arguments have been made that required measures are not financially or practically feasible, successfully completed projects demonstrate otherwise.

In highlighting the need for immediate action, IPCC notes the importance of implementing change this decade[18]. Between 2020 and 2030, the knowledge and skills to reduce costs and remove constraints must be deployed at scale. Low ambition policies will lock in carbon and energy waste for decades, if not centuries[19]. The IPCC Synthesis Report released in March 2023 emphasises that the need for transformative action is more urgent than previously assessed, and any further delay will cause the world to miss a brief and rapidly closing window of opportunity to secure a livable and sustainable future[20].

The IPCC 6th Assessment Report strikes an optimistic note in explaining why their earlier Assessment Report #4 underestimated some aspects of the rate of change in buildings[21]. It notes that, by implementing measures available today, we can anticipate additional unforeseen opportunities will arise. The outcomes that industry can deliver are dynamic values, constantly changing as experience and technology improve[22]. By starting with clear goals, we can achieve more than currently appears feasible.

Today, innovative leaders have already delivered buildings which exceed the performance benchmarks established by international agencies.

Windows offering approximately double the thermal performance of Passive House windows are becoming available. Comfortable and healthy buildings without heating, cooling or mechanical ventilation exist in central Europe[23]. The Auroville Language Lab and Tomatis Therapy Centre operates effectively in the hot and humid climate of Tamil Nadu, southern India, without the use of dehumidification or mechanical cooling[24]. Inevitably, leading edge innovation becomes more widely deployed and, eventually, common.

3. The Outcomes Required of Buildings

The broad outlines of the SDG's and the principles outlined in Making Peace with Nature are assessed in relation to buildings by mandated agencies. The IPCC's 6th Assessment Report on Mitigation, published on April 4, 2022, provides the most detailed information available regarding what is required of buildings, the feasibility of specific measures, their impacts and a discussion of the interconnectedness of various goals. The UN Framework Guidelines for Energy Efficiency Standards in buildings and IEA reports provide further specific guidance.

The 6th Assessment Report is a wake-up call for both policy makers and 'green' building advocates. Emphasizing the fundamentals of mitigation, the report states that to realize the sector's mitigation potential, it is critical to exponentially accelerate workforce skills, reduce costs and remove systemic barriers[25].

Full and accelerated implementation is the only pathway aligned with Paris commitments. UN agencies, the IPCC and IEA clearly identify the need, as outlined in the UNEP report, "Making Peace with Nature," to implement measures achieving multiple social and environmental goals simultaneously. Given the extent to which achieving one goal delivers benefits in numerous areas, the implementation of half measures, which fail to deliver those multiple benefits, is counterproductive.

The IPCC identifies how effective mitigation and the SDG's are achieved through the application of the sufficiency (or SER, standing for Sufficiency, Efficiency, Renewables) framework and incorporating the following;

1) The four fundamentals of mitigation – efficiency, renewables, embodied carbon, and delivered as soon as possible.

2) Smart building systems enabling buildings to achieve intended outcomes.

3) Support achievement of 16 of the 17 SDG's.

4) Adaptation and resilience for the future climate.

5) An effective regulatory environment.

Each of these topics is discussed below.

The Sufficiency Framework

The sufficiency, or SER framework, is introduced by the IPCC's 6th Assessment Report on Mitigation as a critical approach. It places the full mitigation potential of buildings within grasp, while ensuring acceptable living standards for the global population. Sufficiency aligns consumption with planetary limits, recognizing that, at some point, the size of a home, for example, is sufficient. The concept is new in most policy circles, although the report describes its long history and identifies a number of jurisdictions in Germany where it has been introduced[26].

The three pillars of the SER framework include:

I. Sufficiency, which tackles the causes of the environmental impacts of human activities by avoiding the demand for energy and materials over the lifecycle of buildings and goods,

II. Efficiency, which tackles the symptoms of the environmental impacts of human activities by improving energy and material intensities, and

III. The renewables pillar, which tackles the consequences of the environmental impacts of human activities by reducing the carbon intensity of energy supply.

The SER framework introduces a hierarchical layering: sufficiency first, followed by efficiency and renewables which reduce the cost of constructing and using buildings without reducing the level of comfort of the occupant[27]. Sufficiency is defined as avoiding the demand for materials, energy, land, water and other natural resources while delivering a decent living standard for all within the planetary boundaries. As the IPCC notes:

> "Up to 17% of the mitigation potential of buildings could be captured by 2050 through sufficiency measures. Sufficiency interventions in buildings include the optimisation of the use of building, repurposing unused existing buildings, prioritising multi-family homes over single-family buildings, and adjusting the size of buildings to the evolving needs of households by downsizing dwellings. Sufficiency measures do not consume energy during the use phase of buildings[28]."

Wealthier suburbs often have an emissions footprint 15 times that of nearby neighbourhoods[29], making the concept important in most societies. It is equally important in the developing world in providing a means of addressing the inequity of insufficient resources. Expect this concept to gain traction as climate impacts increase.

The Four Fundamentals of Mitigation

There are four fundamental elements to effective climate mitigation in buildings. Maximization of efficiency, reliance on renewable energy, minimization of embodied carbon and achieving the first three things as soon as possible.

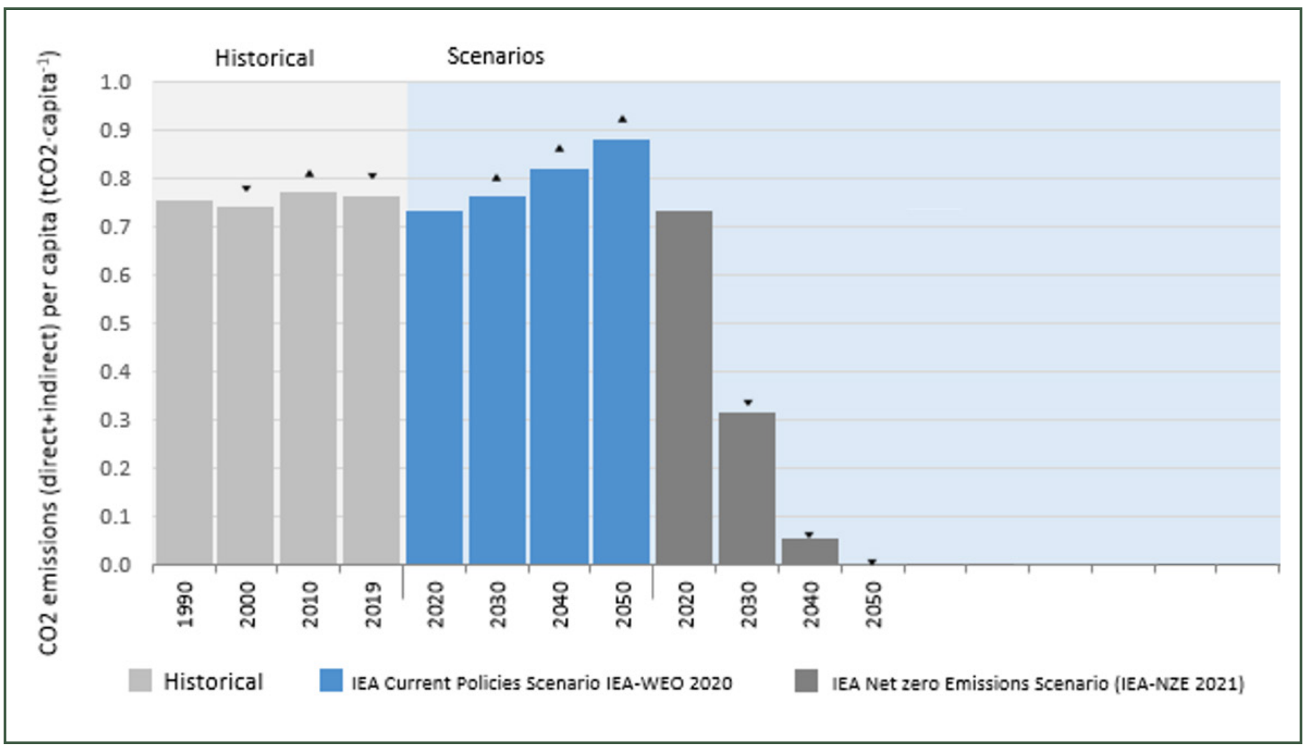
I. Maximize Energy Efficiency

Operating energy efficiency is typically the first element addressed by policy makers because it is the largest source of building emissions and enables the achievement of multiple social goals. Given its central role, and the fact it is usually the first area to encounter systemic inertia, it is important to begin with a clear understanding of what is to be achieved, and why. Without leaders having a clear commitment to the necessary outcomes, systemic inertia will undermine efficiency outcomes, setting the stage for a failure to achieve goals in addressing the other elements such as embodied carbon, smart building systems and grid integrated renewable energy systems. Drastically reducing embodied emissions and successfully implementing smart building strategies also requires disruption of status quo thinking, making it important to begin the task of transforming buildings with an openness to change and commitment to excellence.

The critical and multifaceted role of efficiency is re-enforced by the Net Zero by 2050, A Roadmap for the Global Energy Sector, a report published by the International Energy Agency (IEA) in 2021[30]. The Net Zero scenario requires both new and existing buildings be transformed, including retrofitting half of existing buildings in developed countries and a third of existing buildings in developing countries to net zero by 2030[31]. Efficiency must be maximized, the sale of new fossil fuel-fired boilers banned. Heat pumps and very efficient appliances must become the norm. Unfortunately, the necessary commitments, planning and policies of most nations are not aligned with that scenario[32].

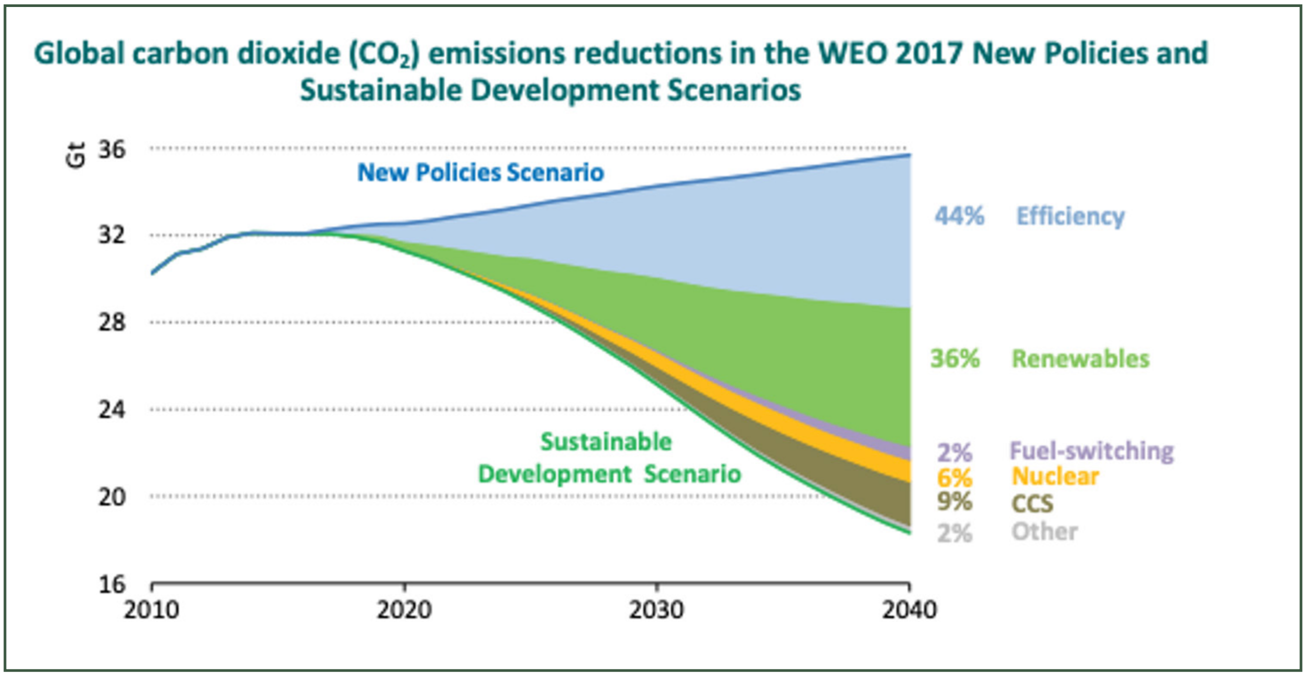
Figure 2 below contrasts the emissions path current policies place buildings on with what is required by the IEA Net Zero by 2050 scenario.[33]

FIGURE 2



The critical role of energy efficiency in reducing emissions is often underestimated. In some circles, fuel switching without maximizing efficiency is put forward as a viable path, particularly in jurisdictions rich in hydroelectricity or other renewables[34]. Figure 3 below, from the 2018 IEA Energy Efficiency Market Report[35], illustrates how efficiency is responsible for slightly more emissions reductions than fuel switching. Both are essential. Trading one of the four fundamentals of mitigation in place of another is not a viable path; each element must be pursued with equal vigour. Debating the relative importance of efficiency, embodied carbon, renewable energy and speed of implementation is not useful when all are essential.

FIGURE 3



The IPCC undertook an independent assessment of emissions reductions potential of buildings, arriving at somewhat different numbers than the IEA. Nevertheless, the story remains the same. Globally, efficiency has more than double the potential to reduce emissions than the combined impact of sufficiency measures plus on-site renewables. In North America, sufficiency can have a greater impact (responsible for 25% of emissions reductions), but efficiency remains responsible for about half of total emissions reductions[36].

The IPCC's 6th Assessment Report finds energy use in buildings contributed 82% to global CO2 emissions from buildings, while embodied emissions contributed 18%[37]. The central role efficiency plays in reducing emissions underlies longstanding efficiency policies. It is always cheaper and more sustainable to reduce than to generate. The IEA's doctrine, "Energy Efficiency Is the First Fuel," is a clear illustration of this well-established principal.[38]

Recognizing such facts, the updated Framework Guidelines for Energy Efficiency Standards in Buildings[39] offer principles-based performance guidance for building energy standards that is outcome-based and projects a vision of holistically-designed, efficient buildings operating as part of an integrated energy system. The Guidelines state that it is possible, with the technology available in 2020, to transform buildings to align with the highest standards of health, comfort, well-being and sustainability including energy productivity and reducing carbon dioxide emissions at costs equal or close to those of traditional buildings:

> "Limiting building heating and cooling requirements to 15 kWh/m^2a in new builds and to 25 kWh/m^2a for retrofit projects (final energy in conditioned space) each reduces energy needs sufficiently to permit renewable energy or zero carbon sources to meet most or all of the remaining space conditioning energy requirements. Total primary energy use in buildings' conditioned spaces, including heating, ventilation, cooling and hot water, can be limited to 45 kWh/m^2a or, including plug-in loads (appliances), to 90 kWh/m^2a. Over time with improvements in technology and materials and with enhanced connections to the built environment, these targets could be improved further. In addition, a viable indicator for primary renewable energy use should be introduced."

Those familiar with Passive House will recognize the energy use intensity levels identified in the Framework Guidelines as being the benchmarks identified in the Passive House standard. Essentially, the UN Framework Guidelines understand that performance level can be achieved without materially impacting costs. In the Framework Guidelines and this paper, a reference to Passive House performance levels is a brand neutral reference to the suite of outcomes that level of performance achieves. It is not a reference to the specific quality assurance process used by the Passive House Institute in certifying buildings. From a policy perspective, it is the outcomes which matter, rather than the tools employed to achieve them.

The foundation of this understanding is not only the tens of thousands of such buildings constructed internationally, but longstanding policy guidance such as found in the 2008 International Energy Agency (IEA) information paper, "Energy Efficiency Requirements in Building Codes[40]." After reviewing the cost effectiveness and feasibility of numerous public policies and building standards existing prior to 2008, the authors state:

"In the long term, buildings need to have an energy consumption which is ultra low (Passive House level) or even Zero Energy Building level to be sustainable. Some countries have taken initiatives and have defined this as the target for building codes already in 10 years from now [2018][41]."

The report finds that energy consumption in American buildings can be reduced by 75% without additional costs to the owners, and that Zero Net Energy Buildings (defined as being more efficient than Passive House) can be built in 2008 with only relatively small additional total costs. In Europe, the amount by which efficiency could be improved was found to be dependent on existing building regulations, but is 70–75% in many countries. In Europe, 70–75% reduction in energy consumption will often correspond to a Passive House[42]. The report concluded that, in 2008, a Passive House was already feasible, while zero net energy buildings would increase costs, with zero net energy buildings becoming feasible in the following one or two decades.

The report concludes with a series of recommendations, including that: "Passive Houses and Zero Energy Buildings should be the target for future buildings codes. A path should be set up to reach this target no later than 2030." (80–82).

These findings from the IEA ring as true today as when they were written. As anticipated, the efficiency levels the reports recommends have become both easier and less expensive to achieve.

The IPCC has long recognized the fundamental importance of efficiency, renewable energy, embodied carbon and rapid deployment in relation to buildings. Their 6th Assessment Report on Mitigation offers increasing detail and specificity to those four fundamentals. It highlights what industry leaders have understood for years: thousands of projects demonstrate nearly zero energy buildings are possible in all climates, for both for new and existing buildings. The data and references in the report make it clear buildings can achieve at least Passive House levels of efficiency.

> "Nearly zero energy (NZE) buildings or low-energy buildings are possible in all world relevant climate zones.[...] Moreover, they are possible both for new and retrofitted buildings. Different envelope design and technologies are needed, depending on the climate and the building shape and orientation. For example, using the Passive House standard, an annual heating and cooling energy demand decrease between 75% and 95% compared to conventional values can be achieved[43]."

While there is some room for debate about how efficient buildings should be, particularly in relation to retrofits, no reasonable interpretation places the level below Passive House. Arguments for higher levels of efficiency can readily be made, and today's leading projects do so.

All authorities say higher levels of efficiency should become cost effective, with improvements anticipated for four main reasons. First, technology such as more efficient and affordable windows, ventilation systems and heat pumps reduce both energy loads and costs. Second, specialized building components become available as market penetration increases, enabling designers to better meet specific needs, thereby delivering better performance. Third, as designers gain experience, they develop more efficient and cost-effective design solutions. Finally, regulatory barriers to efficient buildings get reduced or removed as such buildings become more common. For example, municipal set back requirements are adjusted to permit additional insulation or the installation of air admittance valves become permitted, minimizing thermal bridging from plumbing vent stacks.

Critically, the implementation of half measures fails to trigger the innovation described above -- preventing continual improvements, because status quo solutions remain adequate. It is critical to ensure that efficiency, as the usual first element, succeeds by setting the bar high, changing the culture of status quo and setting the stage for success in other areas.

II. Use Renewable Energy

The fact that buildings must be powered by renewable energy is presented as self-evident in the 6th Assessment Report, which identifies how advances in heat pump and other technologies make it viable to do so. The IEA and the UN Framework Guidelines align with the IPCC in underlining the need to rapidly move buildings away from fossil fuels. The IPCC highlights the importance of efficiency in enabling a renewable energy future and recognizes the inclusion of energy generation in buildings as a step toward distributed energy systems. Buildings can be prosumers[44].

Electrification is expected to increase the demand for electricity in buildings, dramatically so if efficiency is not maximized. On the other hand, the 6th Assessment Report finds highly efficient buildings can help manage that increase by keeping interior temperatures stable and enabling load shifting to off-peak periods. The combination of smart grid infrastructure, distributed generation and efficiency are seen as ways to minimize system losses and investments in energy generation[45].

> While a significant proportion of the world's population is not connected to fossil fuel energy sources, we have an opportunity to distribute renewable power generation through micro-grid systems, enabling peer-to-peer energy exchanges.

This will have the co-benefit of improving energy security for rural populations and, with extreme weather events on the rise, such energy system resiliency benefits everyone:

> "The integration of energy generation on-site means further contribution of buildings towards decarbonization (Ürge-Vorsatz et al. 2020). Integration of renewables in buildings should always come after maximizing the reduction in the demand for energy services through sufficiency measures and maximizing efficiency improvement to reduce energy consumption, but the inclusion of energy generation would mean a step forward to distributed energy systems with high contribution from buildings, becoming prosumers[46]."

The IPCC's commentary on distributed generation, smart grid integration of buildings and the resiliency they offer applies equally to developed nations facing increasing energy supply disruption due to weather and geopolitical events.

III. Minimize Embodied Carbon

For the first time in an Assessment Report, the IPCC takes a close look at embodied carbon, stressing the need for new materials, reliable Environmental Product Declarations, and ambitious targets. Embodied carbon will form an increasing share of building life cycle emissions as building efficiency improves and fossil fuels are eliminated[47]. For example, a review of 650 life cycle assessment case studies estimated that the contribution of embodied emissions to building lifetime emissions is 42-50% for highly efficient buildings, surpassing 90% in extreme cases[48].

Achieving the necessary ambitious embodied carbon reductions will require innovation and disruption of status quo practices similar in extent to those required to achieve efficiency goals. Both building design and construction will be impacted as buildings become designed to use less carbon intensive products, to be more efficient or economical in the use of material and are designed for deconstruction and re-use. Advances in material science such as low carbon glass, concrete or steel must continue, with such products becoming the norm.

Additionally, synergies with seemingly unrelated goals must be captured. For example, achieving transportation mode shifts can greatly reduce embodied carbon in buildings by reducing or eliminating the need for parking infrastructure, both surface and underground. Underground parkades are responsible for a disproportionate amount of the embodied carbon of many buildings. Landscaping plans which enhance biodiversity can also reduce embodied carbon from shading devices, cooling equipment and refrigerants.

In the LED + 2°C policy scenario cited by the IPCC, 2050 embodied emissions are 86% lower than the baseline. That comes from slower floor area growth leading to less floor area of new construction per capita (sufficiency), reductions in the mass of materials required for each unit of newly built floor area (material efficiency), and reduction in the GHG intensity of material production, from material substitution to lower carbon materials, and faster transition of energy supply[49].

Ultimately, embodied carbon targets will need to be lower than commonly thought to be feasible today. The 86% reduction mentioned above still misses the 1.5° target. New approaches are required and the SER framework may support measuring the carbon on a per capita basis (based on design occupancy), rather than based on a per square metre of floor area.

The IPCC Assessment Report strikes a cautionary note for those looking for simple solutions to minimizing embodied carbon. Wood is often promoted as a low carbon material – which it is, relative to some. However, the global supply of timber may only be able to meet 36% of world-wide demand between 2020 and 2050. Much more forest areas will be required in, for example, China, Russia, India and the Americas. A similar detailed analysis for Europe concluded that current European forest areas and wheat plantations are sufficient to provide timber and straw for the domestic construction sector:

> "The increased use of timber and other bio-based materials in buildings brings not only benefits, but also risks. The increased use of timber can accelerate degradation through poor management and the pressure for deforestation, as already recorded in the Amazon and Siberia forests, and the competition for land and resources [...] promoting the use of more timber in buildings requires the parallel strengthening of legislation for sustainable forest management [...].[50]"

The report lays a solid policy foundation for ambitious policies and building code provisions to minimize embodied carbon. To meet targets, such measures must roll out quickly. Because the impact of embodied carbon is determined, and mostly occurs, at the time of construction, ensuring early implementation is particularly important. Improved designs, new materials, better ways to use traditional materials and better sourcing of materials can drastically reduce embodied carbon. Those factors, combined with advances in life cycle assessments tools and materials databases, plus a growing number of practitioners skilled in using them, are enabling dramatic reductions.

IV. Achieve the First Three Fundamentals of Mitigation as Rapidly as Possible

The 6th Assessment Report is even clearer than its predecessors in high-lighting the importance of ensuring all new buildings and all retrofits deliver the four fundamentals of mitigation. Once built, buildings lock in carbon and energy impacts for decades, if not centuries, making it critical to ensure each new building or retrofit is highly efficient, operates on renewable energy and minimizes embodied carbon.

Buildings failing to deliver Paris-aligned outcomes represent a retrofit liability, the cost which ought to be considered when planning a project. While retrofitting is possible, it will not be undertaken for decades at the very least, and cannot address embodied carbon. It is always easier, cheaper and better to build properly at the outset.

> “These include bringing new buildings and existing buildings to near zero, with a half of existing buildings in developed countries and a third of existing buildings in developing countries being retrofitted by 2030. These also mean banning the sale of new fossil fuel-fired boilers, as well as making heat pumps and very efficient appliances standard technologies. The Net Zero Emissions by 2050 Scenario achieves almost fully to decarbonize the sector by 2050, with such commitments reflected neither in the planning and modelling efforts (Section 9.9) nor in policies and commitments [...].[51]“

The retrofit of existing buildings offers a unique opportunity to practice the four imperatives by delivering whole building deep energy retrofits. The need to replace existing component-based retrofit practices with whole building plans is clear, given the limited emissions reductions typically achieved by simply replacing components in the absence of an deep energy retrofit plan for the building[52].

Too many retrofit programs target ineffective incremental improvement, thereby locking in emissions and energy waste while failing to transform the market. The IPCC authors state low renovation rates and shallow retrofits have hindered the achievement of climate goals. Without strong policies to support true deep energy retrofits (defined by one study as those achieving at least 80% whole building energy savings[53]), we will not achieve our Paris goals. Half measures, whether in new or existing buildings, impede mitigation by locking in poor performance. This finding is key, and one of the most ignored realities in retrofit programs. It is far more effective, from a mitigation perspective, to undertake deep retrofits on a small number of buildings, than shallow retrofits on many.

The 6th Assessment Report finds that while cost effective retrofit solutions are often elusive, innovation in project delivery and climate finance have enabled successful projects and programs around the world. Cost barriers remain and require some form of climate finance incentive to drive costs down through market transformation. The Energiesprong program in the Netherlands is cited as a successful example. It has already reduced the total cost of retrofitting by over 50% and is targeting further cost savings[54]. Other retrofit programs are targeting lower levels of cost savings, understanding a significantly smaller reduction in costs aligns the cost of a deep energy retrofit with the historical cost of building renewal[55].

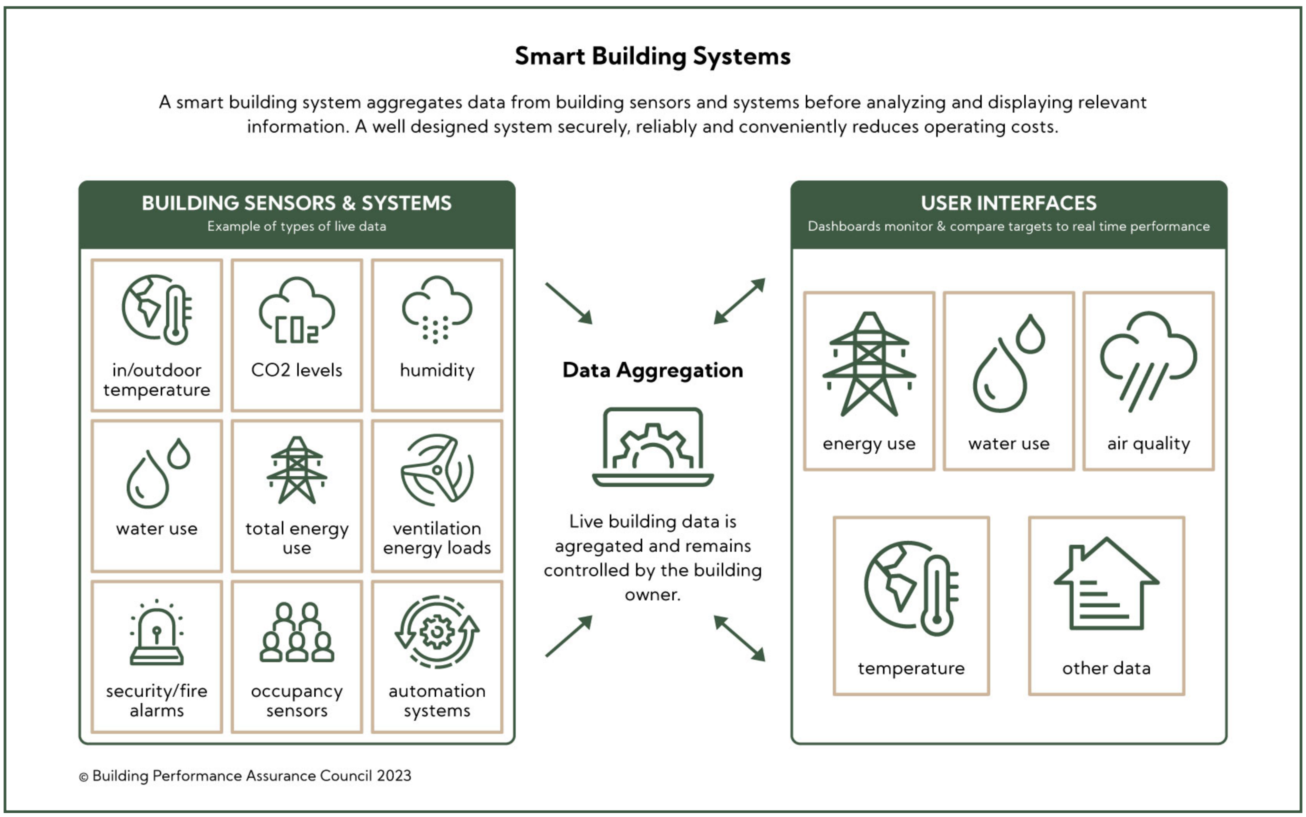
Smart Buildings

Smart buildings are those which, through meters, sensors, and operating technologies, are able to gather building performance data to enable effective building management and system optimization. References throughout the 6th Assessment Report to the need for distributed energy generation, building/grid integration, buildings being prosumers of energy and post occupancy measurement and verification all require what is commonly referred to as smart building infrastructure.

An integrated, brand neutral approach to the design and installation of sensors, data management and data display is key to the successful implementation of smart building systems. Recent advances in technology offer cost effective solutions supporting management and operation buildings in addition to providing the performance data building owners, regulators and funders require for Paris alignment. By combining building science with data science, it becomes possible to assure buildings deliver the broad range of outcomes anticipated during their design and is a key element of affordable Paris compliance[56]. Increasingly, cost effective, integrated solutions are being developed for the consumer and small building market[57].

Figure 4 below illustrates the basic elements of an integrated smart building system, applicable at any scale of building.

FIGURE 4



Despite the increasing availability of solutions, achieving broad market penetration of smart building systems requires overcoming the inertia inherent in any change. Technical solutions alone are insufficient. Building owners and managers must take the time to understand how the technology can improve their lives or profitability and be prepared to invest time in gaining that understanding. With funding sources and regulators increasingly demanding credible data of in use building performance, such systems are becoming more common. A wholistic approach recognizing the multiple benefits such systems offer has proven most effective in over-coming resistance.

Achievement of multiple SDG's

An area of increased focus in the 6th Assessment Report (AR6) is how mitigation measures outlined above support the attainment of 16 of the 17 UN SDG's[58]. Only SDG #14, Life Below Water, is not advanced by better buildings. Triggering numerous co-benefits by delivering the full mitigation potential of buildings is an example of synergies available through effective actions as identified in the "Making Peace with Nature" and the IPCC 6th Assessment Synthesis Report.

AR6 identifies the following co-benefits of buildings offering effective mitigation:

1) Reducing poverty by reducing energy and other operating costs without materially increasing construction costs.

2) Reducing hunger and improving nutrition through improved cook stoves, reduced food spoilage and increasing food production opportunities. Paris-aligned buildings avoid indoor combustion and offer better conditions for food storage and production.

3) Ensuring healthy lives and promoting well-being for all. The health gains through improved indoor air quality and thermal comfort are well documented. Superior thermal envelopes avoid the growth of molds and mildews and include high quality, filtered fresh air supply. The absence of fossil fuels improves both health and safety, reducing risks from indoor air pollution, explosions and fire. Additionally, a high quality building envelope with mechanical ventilation provides a quiet indoor environment, sheltered from exterior noise. The economic costs imposed by today's average buildings on healthcare systems and workforce productivity due to absenteeism have been studied and

tools developed to measure them. Such costs measure in the billions of dollars annually, even in smaller nations[59].

The 6th Assessment Report notes that the COVID-19 pandemic emphasised the importance of buildings for human wellbeing. However, the lockdown measures implemented also highlighted the inequalities in access to suitable and healthy buildings.

4) Advancing inclusive and equitable quality education.

5) Supporting gender equity, empowering women & girls given gender roles within homes, particularly in developing nations. The adverse health impacts of, for example, indoor combustion and need for fuel gathering disproportionately impact women.

6) Improving availability and sustainable management of water and sanitation.

7) Improving access to affordable, reliable, sustainable and modern energy, particularly with distributed generation and storage. Such buildings also facilitate smart grid integration, demand pricing and load shifting to minimize grid infrastructure investments.

8) Improving sustained, productive, decent, sustainable work and economic growth through macro- and micro-economic effects such as increased productivity of labour, job creation and reduced poverty. Economic development is advanced by the action of transforming of buildings. Additionally improvement in asset values is demonstrated by data showing market does value better buildings.

9) Building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation.

10) Reducing inequalities within and among countries.

11) Enabling sustainable cities and communities to become safe, resilient & sustainable. For example, by viewing the buildings within the built environment as part of the integrated infrastructure, biological and resilience systems which support them, a broader array of cost effective solutions emerge.

12) Supporting sustainable consumption and production patterns, including reduced consumption of natural resources & energy. Labour savings from reduced fuel gathering and work required to maintain comfort is another factor.

13) Taking urgent action to combat climate change and its impacts.

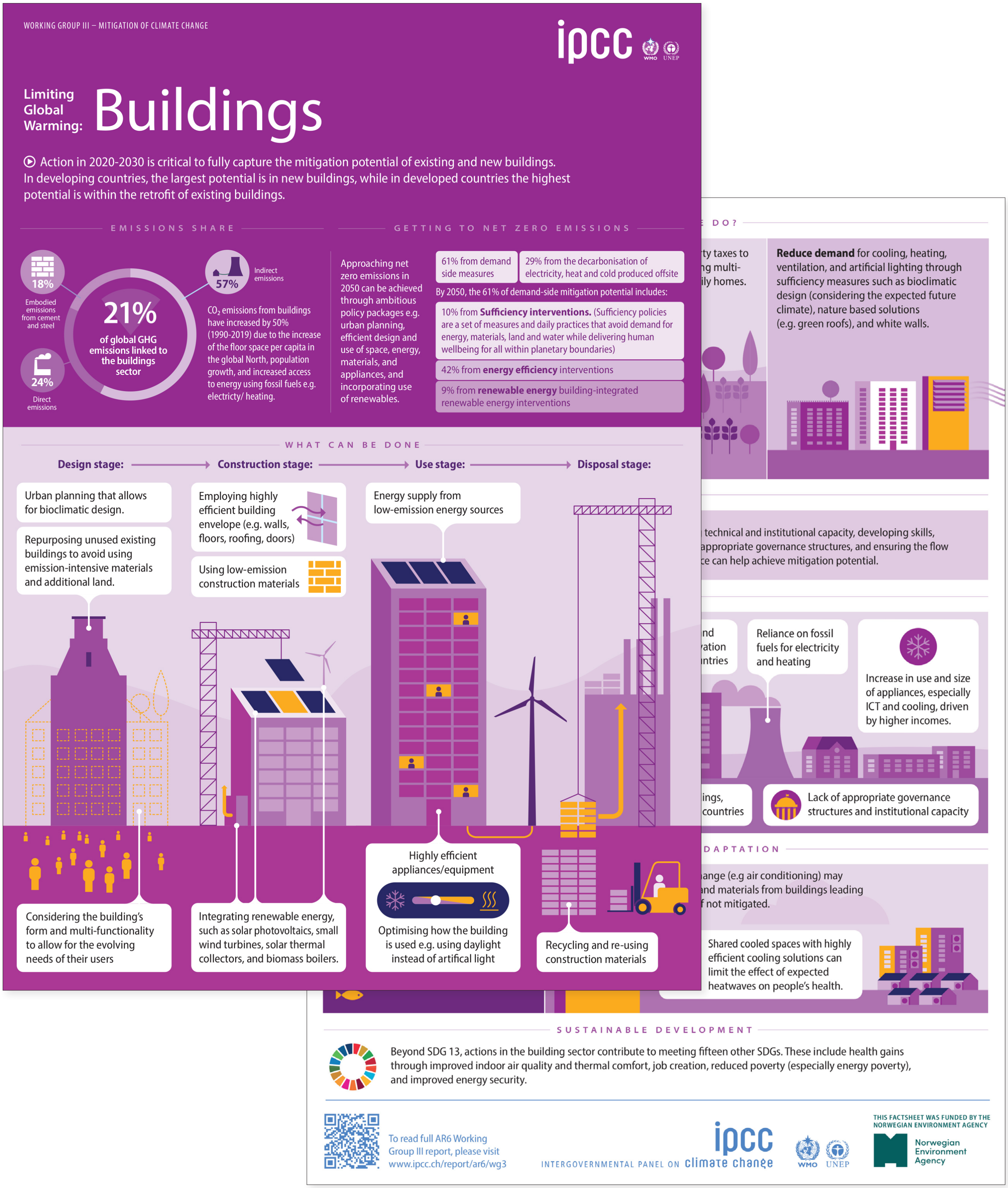
14) Protecting, restoring and promoting sustainable use of terrestrial ecosystems. Given the extent of built up areas, the built environment must play an important role in providing plant & animal habit, improving food production, mitigating the impacts of rain events, drought, heat events and forest degradation.

    While the IPCC does not specify solutions to implement or standards to apply, a thoughtful and deliberate approach to the restoration of nature is important for all buildings. As with point number 11 above, this issue is most effectively addressed in the planning context of the built environment, but each building should do its part in fulfilling regional and national ecological goals. Plans such as water management, native habitat restoration, fire mitigation, urban heat island mitigation, urban tree canopies and storm safety all impact buildings and their landscape plans.

15) Promoting peaceful and inclusive societies for sustainable development and building effective, accountable and inclusive institutions at all levels.

16) Strengthening the means of implementation and revitalize the Global Partnership for Sustainable Development.

An excellent fact sheet from the IPCC highlights some of the points mentioned above[60].


WORKING GROUP III – MITIGATION OF CLIMATE CHANGE
ipcc
WMO UNEP
Limiting Global Warming:
Buildings
Action in 2020-2030 is critical to fully capture the mitigation potential of existing and new buildings. In developing countries, the largest potential is in new buildings, while in developed countries the highest potential is within the retrofit of existing buildings.
EMISSIONS SHARE
18%
Embodied emissions from cement and steel
21%
of global GHG emissions linked to the buildings sector
24%
Direct emissions
57%
Indirect emissions
CO_2 emissions from buildings have increased by 50% (1990-2019) due to the increase of the floor space per capita in the global North, population growth, and increased access to energy using fossil fuels e.g. electricity/ heating.
GETTING TO NET ZERO EMISSIONS
Approaching net zero emissions in 2050 can be achieved through ambitious policy packages e.g. urban planning, efficient design and use of space, energy, materials, and appliances, and incorporating use of renewables.
61% from demand side measures
29% from the decarbonisation of electricity, heat and cold produced offsite
By 2050, the 61% of demand-side mitigation potential includes:
10% from Sufficiency interventions. (Sufficiency policies are a set of measures and daily practices that avoid demand for energy, materials, land and water while delivering human wellbeing for all within planetary boundaries)
42% from energy efficiency interventions
9% from renewable energy building-integrated renewable energy interventions
WHAT CAN BE DONE
Design stage:
Construction stage:
Use stage:
Disposal stage:
Urban planning that allows for bioclimatic design.
Repurposing unused existing buildings to avoid using emission-intensive materials and additional land.
Employing highly efficient building envelope (e.g. walls, floors, roofing, doors)
Using low-emission construction materials
Energy supply from low-emission energy sources
Considering the building's form and multi-functionality to allow for the evolving needs of their users
Integrating renewable energy, such as solar photovoltaics, small wind turbines, solar thermal collectors, and biomass boilers.
Highly efficient appliances/equipment
Optimising how the building is used e.g. using daylight instead of artifical light
Recycling and re-using construction materials
E DO?
ty taxes to
ng multi-
ily homes.
Reduce demand for cooling, heating, ventilation, and artificial lighting through sufficiency measures such as bioclimatic design (considering the expected future climate), nature based solutions (e.g. green roofs), and white walls.
technical and institutional capacity, developing skills, appropriate governance structures, and ensuring the flow
ce can help achieve mitigation potential.
Reliance on fossil fuels for electricity and heating
Increase in use and size of appliances, especially ICT and cooling, driven by higher incomes.
ings,
countries
Lack of appropriate governance structures and institutional capacity
DAPTATION
ange (e.g air conditioning) may
nd materials from buildings leading
f not mitigated.
Shared cooled spaces with highly efficient cooling solutions can limit the effect of expected heatwaves on people's health.
SUSTAINABLE DEVELOPMENT
Beyond SDG 13, actions in the building sector contribute to meeting fifteen other SDGs. These include health gains through improved indoor air quality and thermal comfort, job creation, reduced poverty (especially energy poverty), and improved energy security.
To read full AR6 Working Group III report, please visit www.ipcc.ch/report/ar6/wg3
ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP
THIS FACTSHEET WAS FUNDED BY THE NORWEGIAN ENVIRONMENT AGENCY
Norwegian Environment Agency

Adaption and Resilience

The 6th Assessment Report identifies the need for buildings to not only meet our needs today, but also be fit for the climate of tomorrow. Modern energy models and available future climate data enable building design models to anticipate future cooling needs, resilience during power outages, and susceptibility to severe weather events. While components such as larger cooling equipment may not be required at the time of construction, building design should accommodate the easy installation of additional components to address conditions anticipated in the future.

Adaptation and resilience includes more than thermal comfort. For example, adequate ventilation is essential during power interruptions, periods of severe air pollution and fire smoke events, to filter outdoor pollutants or allergens plus remove internally generated gasses such as CO2 or combustion gasses. Such resilience and adaptation measures also support the achievement of SDG's discussed above.

An Effective Regulatory Environment

Another useful addition to the 6th Assessment Report is a more detailed commentary on regulatory instruments. Regulatory instruments for both new and existing buildings are identified as key to reducing emissions and achieving the SDG's[61].

Building energy codes and minimum energy performance requirements have proven to be both effective and cost-effective when well implemented. The following elements are identified as important for an effective regulatory system:

1. Be outcome based, identifying the outcomes buildings are to deliver rather than prescribing design and component specifications. Outcome codes are increasingly important in overcoming limitations of prescriptive building energy codes.

2. Include all energy used by the buildings, including plug and process loads. Plug and process loads account for an increasing share of total energy use as efficiency improves.

3. In addition to efficiency outcomes, progressive building codes incorporate:

    a. sufficiency principles;

    b. renewable energy requirements; and

    c. embodied emissions.

4. Post occupancy compliance including:

    a. Measurement and verification of in-use energy performance to ensure to ensure estimated energy and emissions savings are realized.

    b. Elimination of the performance gap between estimated and actual performance.

5. Mandatory commissioning and re-commissioning.

6. Institutional capacity and resources for enforcement of regulations.

7. Accurate and trusted mandatory building labels and energy performance certificates.

8. Regulation of retrofits to deliver Paris-aligned outcomes.

9. Require buildings to be designed for the future climate. The changing climate may impact the performance, durability and safety of buildings, especially historical and coastal ones. The failure to plan for the future climate may increase GHG emissions by requiring expensive retrofits or rebuilding to address changing conditions.

10. Mandatory energy audits to overcome information barriers to efficiency investments, particularly for those owned or occupied by small companies. To be effective, auditors must be adequately trained and provide quality audits.

11. Minimum energy performance standards for building equipment such as HVAC systems and other components plus consumer appliances. Such standards must, of course, enable the targeted building performance outcomes.

12. Appliance energy labelling to enable the market to compare the efficiency of equipment and appliances. It is not enough to have standards, it must also be easy for the market to compare performance, triggering competition to exceed minimum standards.

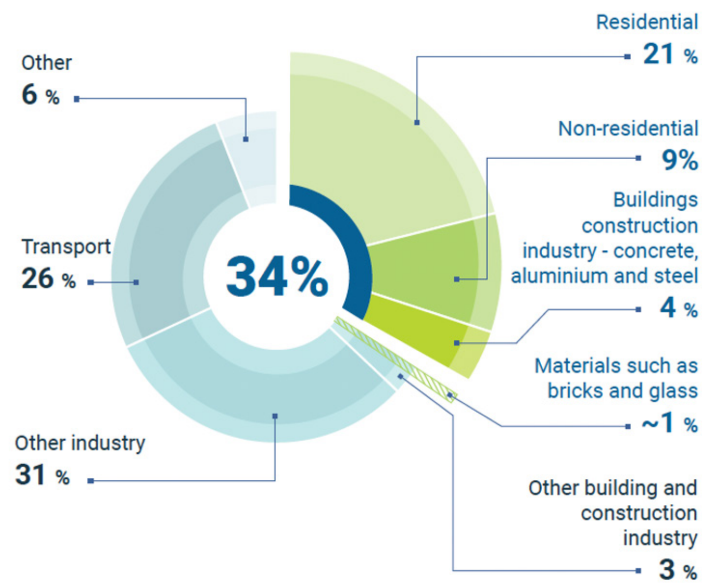
13. A communications strategy which informs the public and changes end-user behavior. Energy audits are an important element of communicating performance and are most effective when individuals can compare their energy use to that of their peers by incorporating social norms. Energy consumption feedback with smart meters, smart billing and dedicated devices and aps is another instrument. Energy cost savings alone are typically insufficient to effectively engaging consumers, requiring a more wholistic approach based on social practice theories. Smart building systems, for example, can monitor many aspects of health and comfort within a home, providing real time feedback on mobile devices and consumers must be informed of and able to value the multiple benefits they receive from better buildings.

4. The Status of Buildings Today

Where do today's buildings sit relative to where they need to be? The Global Alliance for Buildings and Construction, a UN Environment Program launched at COP 21 in Paris, issues a Global Status Report providing an annual snapshot of the progress of the buildings and construction sector in meeting the Paris Accord goals. The excerpts which follow are taken from the 2022 Global Status Report[62]. To be aligned with reaching net zero carbon emissions by 2050, emissions from both operations and those embodied in materials, need to fall by over 98% from 2020 levels[63].

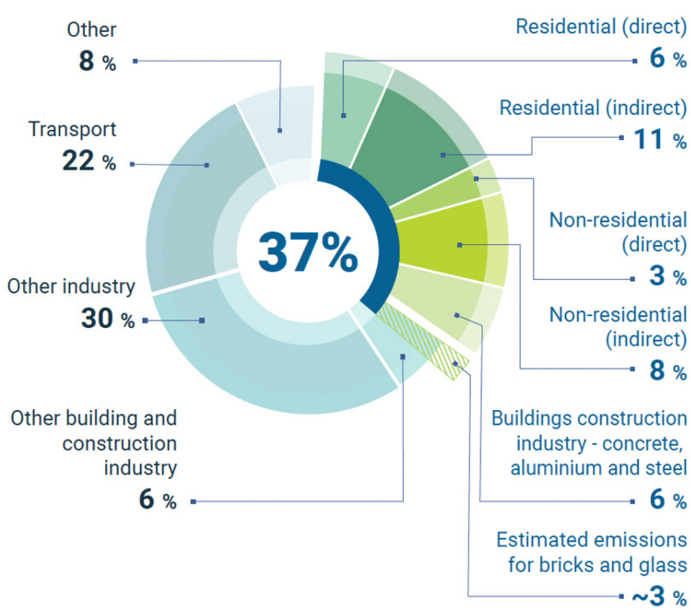
In 2021, buildings were responsible for 34% of final energy consumption (see figure 5 below). Of that, operational energy accounted for 30% while embodied energy represented 4%.

FIGURE 5 – Share of buildings in total final energy consumptions in 2021



In 2021, buildings were responsible for 37% of global energy and process emissions (Figure 6). Of that 37%, building operations accounted for 28% while embodied emissions represented 9%.

FIGURE 6 – Share of buildings in global energy and process emissions in 2021

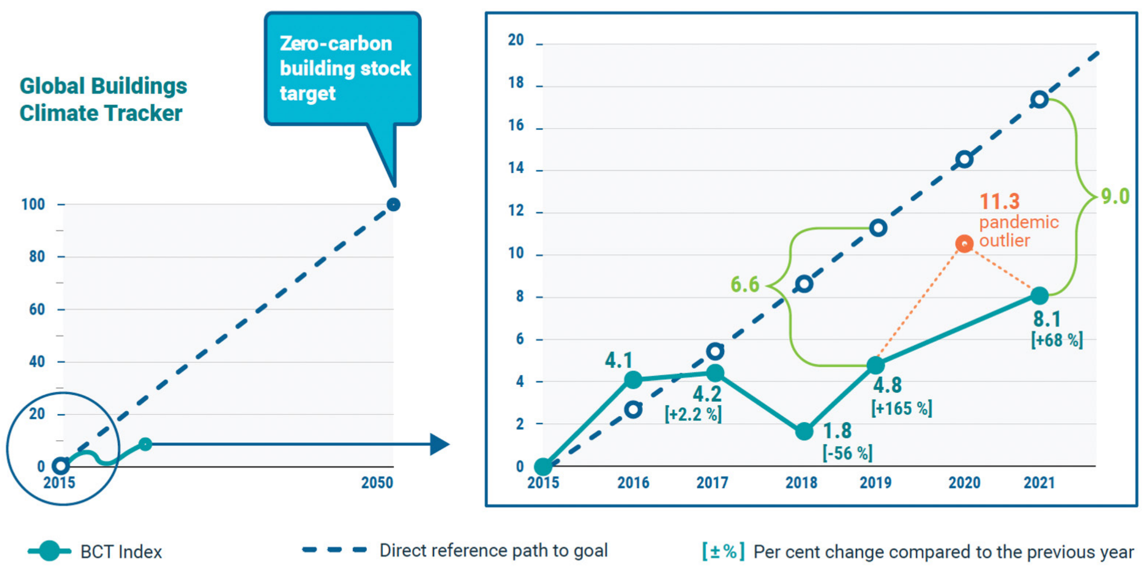


The 2022 Global Status Report reveals energy use intensity is, however, stable and emissions intensity is barely declining, while floor area is increasing, resulting in a 4% increase in energy use from 2020, exceeding the previous 2019 peak by over 3%[64]. Operational emissions are similarly increasing, growing by about 5% from 2020, exceeding the pre-pandemic all time high by 2%[65].

One of the tools used to track decarbonization progress is a tool developed by the Building Performance Institute Europe[66] called the Global Buildings Climate Tracker[67]. It illustrates how, since the pandemic, building decar-bonization activities have reverted to their previous, inadequate, rate of change. Figure 7 below is from the Global Status Report and illustrates the extent to which buildings are off track.

FIGURE 7

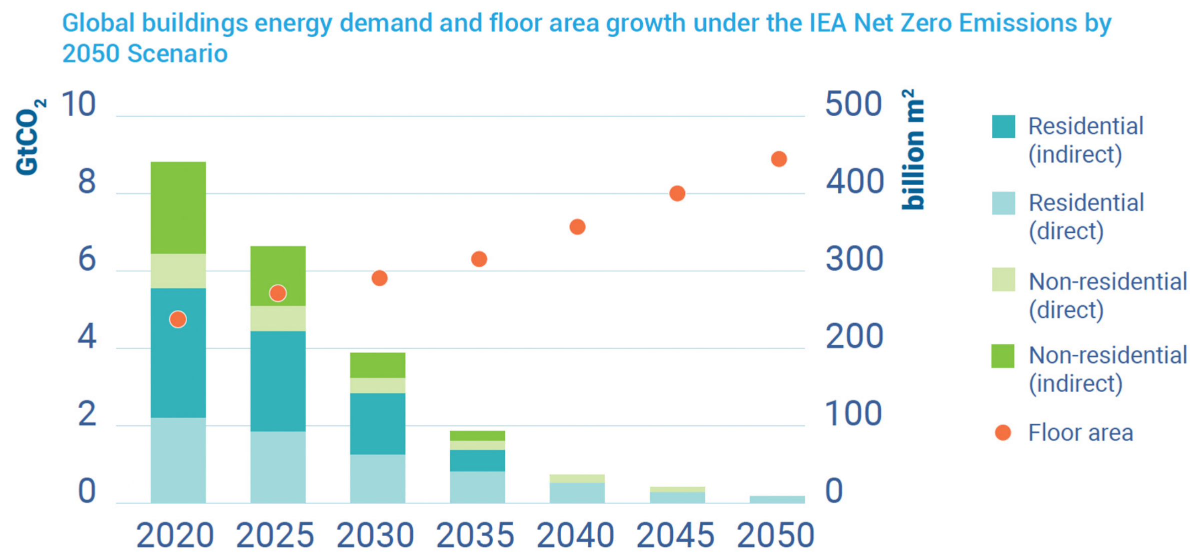
Direct reference path to a zero-carbon building stock target in 2050 (left); zoom into the period between 2015 and 2021, comparing the observed Global Buildings Climate Tracker to the reference path (right)



Source: Figure 2, Global ABC, 2022 Global Status Report

Figure 8, also from the Global Status Report, illustrates the rate of progress required by our Paris commitments. As is obvious, the sector is not on track and incremental measures reflecting modest ambition are incompatible with a sustainable future.

FIGURE 8



Source: Figure 7, Global ABC, 2022 Global Status Report

5. What Does This Mean For Us?

Given the cautious and solid foundation on which the findings and recommendations described above rest, advocating for less ambitious outcomes is incompatible with local, national and international goals. The thousands of pages of reports presenting data, exemplary projects & policy examples summarized in this paper represent a well-researched, data driven consensus endorsed by essentially every nation. It is past time to be looking for reasons to achieve less.

Engaging with the local industry leaders currently delivering Paris-aligned buildings can generate desired results. As identified in “Making Peace with Nature” and the IPCC 6th Assessment Synthesis Report, simultaneously pursuing multiple goals is often key. Strategies and implementation will vary, but a clear and public commitment to identified outcomes catalyzing market transformation is essential. Clear definitions of necessary outcomes is commonly avoided out of concern about triggering resistance. The result is policies and goals using undefined or inadequately defined terms such as ‘high-performance’, ‘low-carbon’, zero-carbon’, ‘net-zero’, ‘green building’, etc. Without giving such terms specific, Paris-aligned definitions, they lack meaning and communicate the absence of commitment to change. The time has come for clarity. Without being clear about our destination, it is impossible to get there.

Today, thousands of industry leaders are delivering millions of square metres of buildings that achieve various elements of Paris-alignment in most developed nations. Developing nations face greater challenges and require more support, but pathways exist there as well. Today's innovators are achieving more than the base levels described in this paper. While few buildings deliver all of the outcomes outlined in this paper, many tens of thousands deliver key elements, particularly energy efficiency. The gap between where we are today and where we need to be, while large, is not insurmountable. Most industry members, with motivation and a small amount of training, are capable of bridging the gap.

Governments and policy makers are in a unique position to catalyze market transformation through public sector leadership. Ensuring all public buildings and all buildings receiving public funding are Paris-aligned, triggers transformation in much of the market, creating consumer demand for such buildings and laying a foundation for regulations.

"Climate promises and plans must be turned into reality and action, now."

There remains much work to be done. With the exception of energy efficiency, international agencies have not yet developed clear specifications and metrics for many elements of Paris-aligned buildings. In most cases, the data that such agencies need to support specifications and metrics is lacking. That data will become available over time. In the interim, our responsibility is to do as much as possible, and track the results to generate needed data. Further international guidance, perhaps in the form of a UN protocol or another instrument, could provide valuable guidance for consumers, government and industry.

Those who understand the climate emergency are alarmed. The UN, its agencies, the IEA and the IPCC could not have been more clear about what is required to safeguard life as we know it. It is up to us and our leaders to make the necessary choices. In his remarks during the release of the IPCC's 6th Assessment Report on Mitigation, the UN Secretary General António Guterres put the issue succinctly: "Climate promises and plans must be turned into reality and action, now."[67]

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About the Author

Rob Bernhardt built, and still lives in, the first Passive House on Vancouver Island, Canada and then developed the first market Passive House strata units in Canada before becoming the founding CEO of Passive House Canada until 2019. He has been actively involved in the development of building strategies, policies and regulations at the local, national and international level. His work has included authoring, co-authoring or contributing to papers, articles and reports on building performance and compliance.

Rob currently leads the development of the Building Performance Assurance Council, an international industry-based initiative to ensure buildings meet targets aligned with the Paris Agreement and the UN Sustainable Development Goals.

BPAC

Building Performance Assurance Council

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