منتدى مستقبل العقار
Real Estate Future Forum

A Bolder Path to Net Zero

Decarbonizing Saudi Arabia's Built Environment

In collaboration with
Boston Consulting Group

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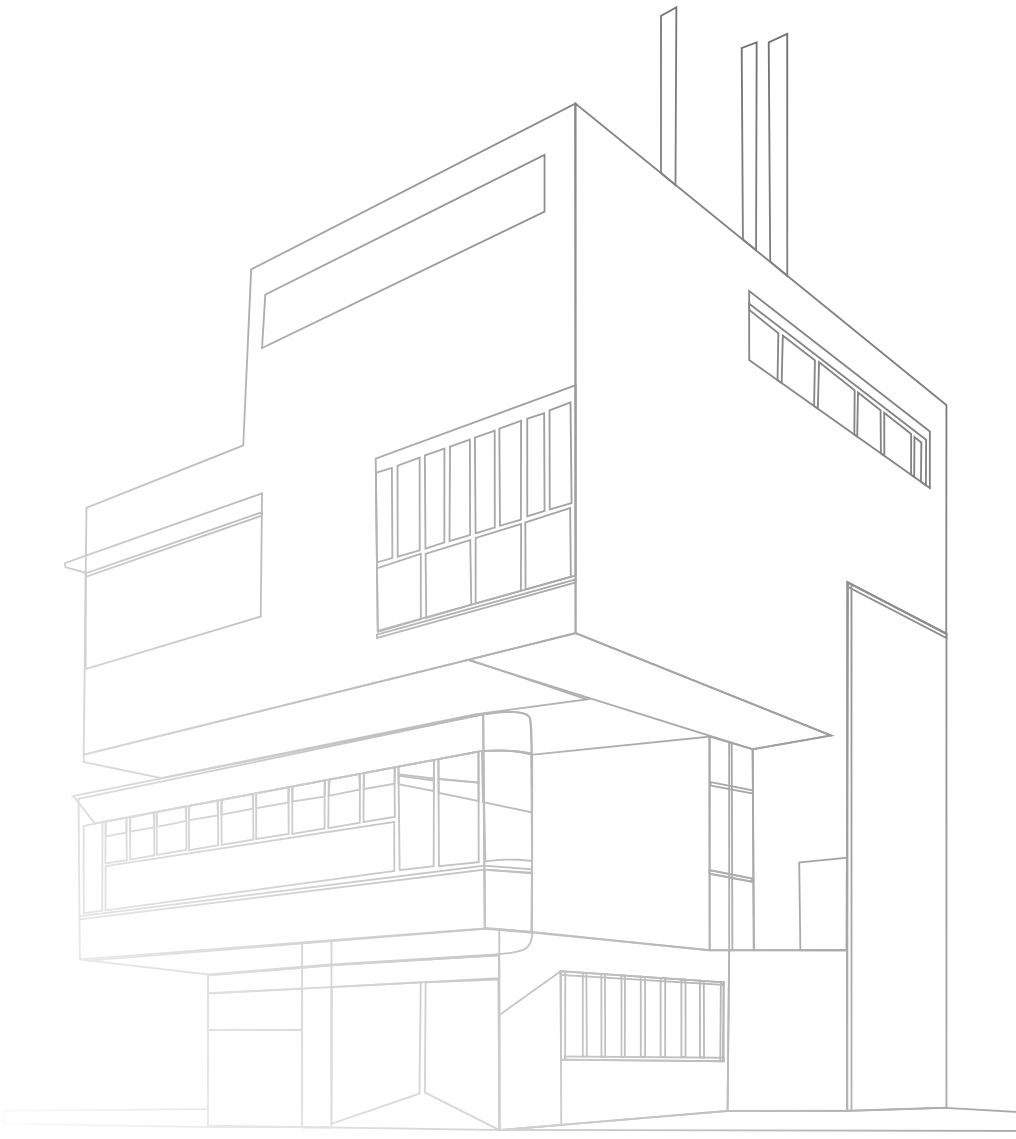
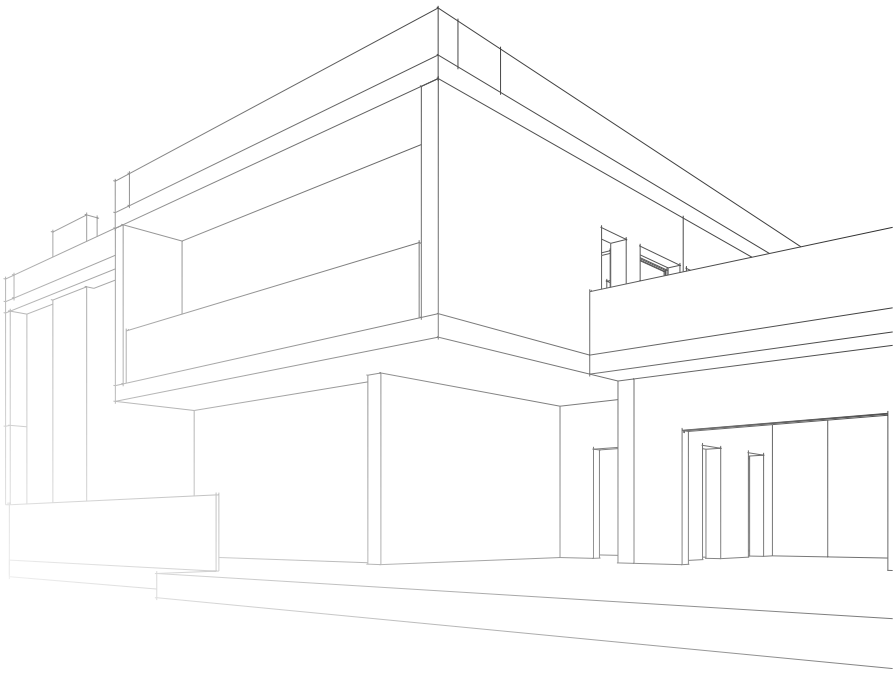
TABLE OF CONTENTS



FOREWORD

As the world grapples with the urgent need to limit global warming and combat environmental disasters, reducing our collective carbon emissions is essential to mitigate against worsening conditions. The built environment accounts for more than a third—roughly 35%—of total emissions globally; decarbonizing it emerges as our most essential lever for achieving overall net zero. Additionally, consumers are increasingly expecting more sustainable places to live and work, positioning sustainable innovations in the built environment not only as critical solutions, but key opportunities.

The Kingdom of Saudi Arabia faces unique challenges and opportunities in this quest. A temperature rise expected to outpace the global average, coupled with ambitious real estate projects on the horizon, places the Kingdom at the heart of this global challenge and at the forefront of a transformative journey. Despite the challenges it poses, the need for decarbonization in Saudi Arabia's built environment also opens new avenues to lead in sustainable developments and trigger innovation across the construction value chain. The Kingdom has already put forward ambitious plans for new developments poised to transform its cities and society; it can take an equal lead in realizing a sustainably built future. The key levers and collaborative efforts required from all stakeholders to achieve the Net Zero target set for 2060 will spur state-of-the-art innovation and a bold reimagining of what built environments can enable for those who live in them.



01

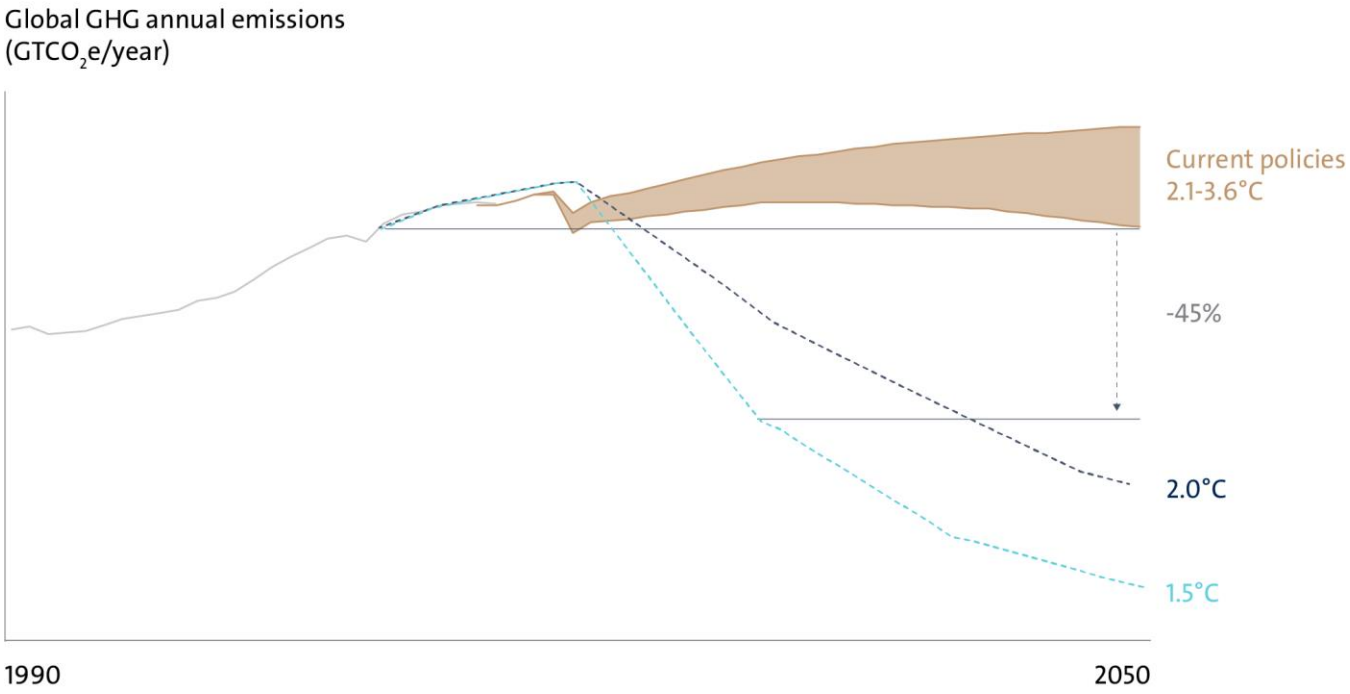
The Decarbonization Imperative and Opportunity in the Region's Built Environment

As shown in Exhibit 1, the world is not on track to limit global warming to 1.5 Celsius. Data from Berkeley Earth show that January-October 2023 was 1.55°C above the January-October average for 1850-1900; 2023 may prove to be the first calendar year to average more than 1.5°C warmer than the preindustrial benchmark[1]. Other environmental disasters, too, are on the rise. In September 2023, ten countries and territories saw severe flooding in just 12 days[2].

Saudi Arabia's temperature rise is expected to outpace the global average due to its unique landscape and land-sea warming contrast. For global warming levels of 1.5°C, 2°C, and 4°C, the projected average temperature increases across the Arabian Peninsula are approximately 2.2°C, 2.9°C, and 5.6°C, respectively[3]. To limit these scenarios as much as possible, urgent action is needed.

Exhibit 1: The world's path to limiting global warming

Based on current policies, 1.5°C scenario becomes increasingly difficult to attain...

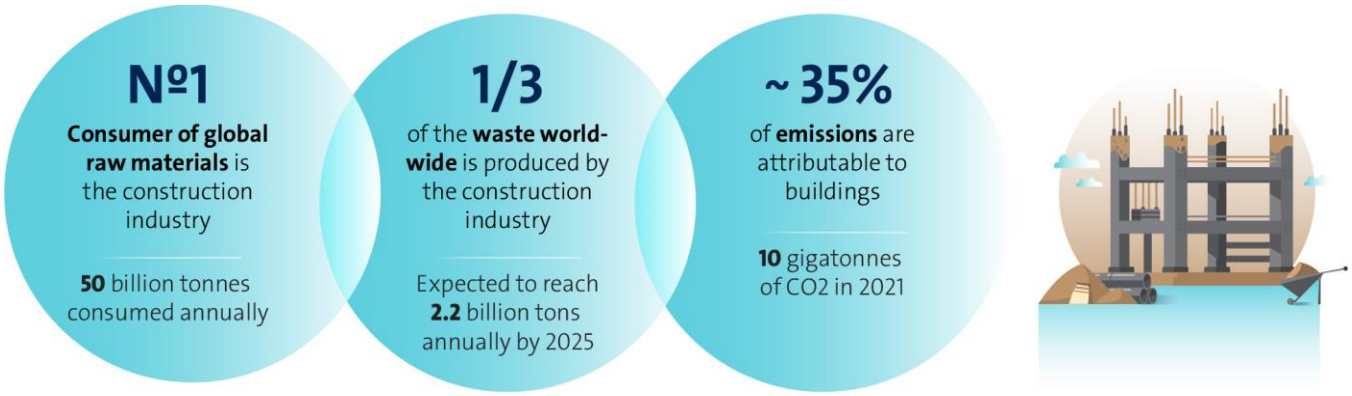


The Earth is now about 1.1°C warmer than it was in the 1800s. On the current path of carbon dioxide emissions, temperature could increase by as much as 3.6°C by the year 2050.

[1] Yale Climate Connections: Can we still avoid 1.5 degrees C of global warming?
[2] CNN: Is this the future of climate change?
[3] Climate Futures Report: Saudi Arabia In A 3-Degrees Warmer World

As summarized in Exhibit 2, the built environment is the biggest consumer of raw materials, and a significant producer of waste and greenhouse gas emissions, responsible for approximately 35% of global greenhouse gas emissions. Addressing this challenge becomes more complex when considering where the most pressing surges in real estate needs are.

Exhibit 2: The built environment's contribution to global emissions



A gigatonne is equivalent to one billion metric tons, 2.2 trillion pounds, or 10,000 fully-loaded U.S. aircraft carriers
Source: World Economic Forum; Press reports; BCG reports; WGBC, UNEP, BBC, Europa.eu

Yet it has been an unavoidable truth so far that increased development leads to increased emissions. China's development, for example, has led to emissions per head now greater than Europe. To accommodate anticipated population growth yet addressing this carbon emissions excess, the task will be to double the area of the built environment, while more than halving emissions per head.

However, every challenge is an opportunity, and the opportunity in the Middle East is unparalleled: $1 trillion USD worth of real estate projects are in the pipeline[4], with most projects at the maturity stage to integrate sustainability-focused decision-making. Additionally, regional governments that aspire to create better living standards for their people understand the role lower emissions play in creating a clean and hospitable environment. The projects in the region aim to lead real innovation in urban planning, placemaking, and experience design. The region additionally has the opportunity to position itself at the forefront of a burgeoning global movement, leading in creating greener, sustainable, and competitive value chains and establishing a legacy of progressive urban development.

[4] Morgan Stanley: The Future of Saudi Arabia: Emerging at 'Giga'speed

02

From Blueprint to Breakdown: The Key Opportunity Levers Across the Lifecycle

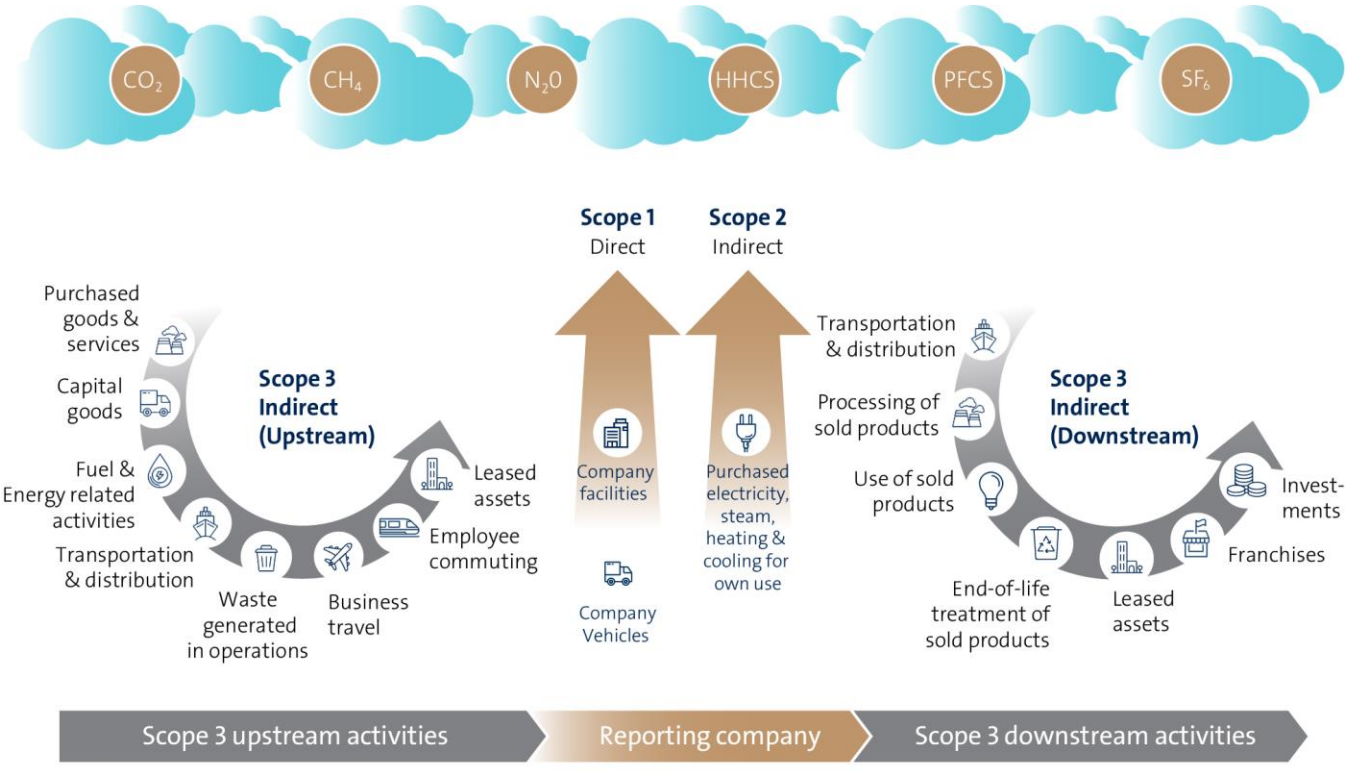
The categorization of emissions by scope is the first step to enhanced transparency and accountability. Exhibit 3 illustrates scope categories across industry.

Scope 1
emissions include direct emissions from developer-owned or -controlled sources such as onsite fossil fuel combustion for cooling.

Scope 2
emissions cover indirect emissions from the generation of purchased electricity used in real estate, such as servers in occupied office buildings.

Scope 3
emissions encompass other indirect emissions outside of the development, such as those produced from the extraction and production of purchased materials and fuels, transportation of materials, and end-of-life disposal or recycling of the built environment.

Exhibit 3: The corporate carbon footprint covers all value chain activities



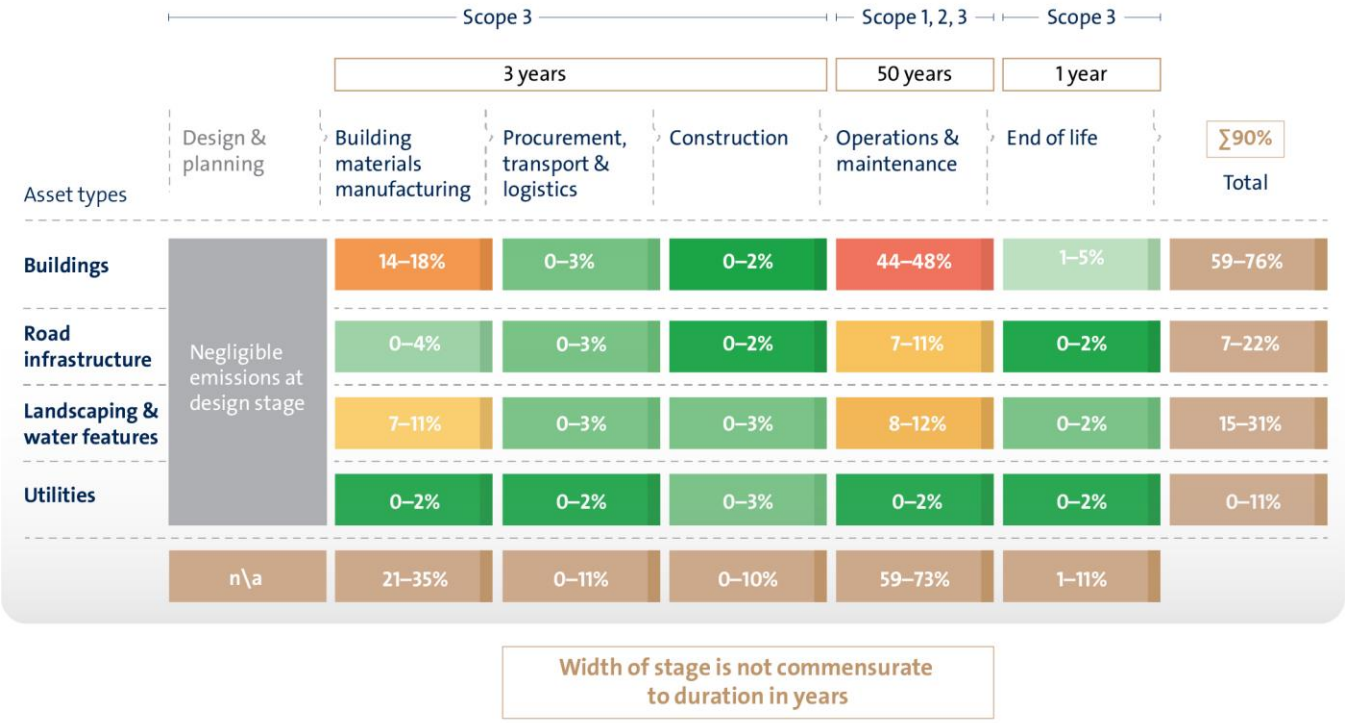
CO2, Carbon dioxide; CH4, methane; N2O, Nitrous oxide; HCFs, Hydrofluorocarbons; PFCs, Perfluorocarbons; SF6, Sulfur hexafluoride
Source: GHG Protocol

Next, understanding the real estate value chain is fundamental to pinpointing where emissions occur. This spans design, materials manufacturing, procurement and transportation, construction, building operations and maintenance, and end-of-life phases.

Exhibit 4: Materials Manufacturing and Operations and Maintenance as main drivers of emissions

Heatmap of lifecycle CO_2 equivalent emissions [50 years, % of total emissions]

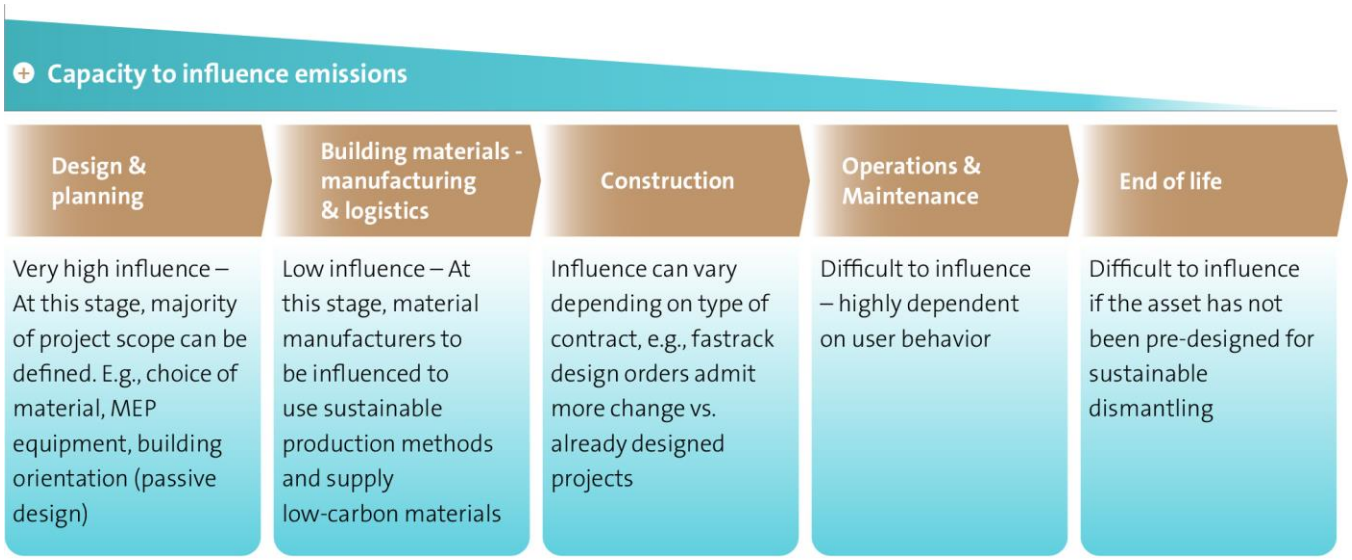
Example of a typical GCC urban development project



Source: BCG analysis for an urban mega-development in Riyadh

Among these phases, the building operations and maintenance phase is the largest source of emissions, given the long lifetime of buildings and their resulting long-term energy consumption. As shown in Exhibit 4, in new construction, it accounts for around 65% of all lifecycle emissions when considering a 50-year lifetime cycle. Materials manufacturing comes second, accounting for an additional approximately 25% of lifecycle emissions; cement, steel, and aluminum manufacturing is particularly energy-intensive and fossil-fuel-dependent. Therefore, when it comes to real estate decarbonization, the key focus areas are the materials used and building operations. The highest ability to influence decisions is during the design and planning stage, illustrated in Exhibit 5 — there are critical benefits to starting early.

Exhibit 5: The decreasing capacity to influence emissions over time



Source: BCG analysis

Design & Planning: The majority of potential impact can be obtained in the design phase[5]. Often in the construction industry, the initial investment in sustainable design can be higher, deterring stakeholders whose focus is on immediate budget constraints over long-term savings and environmental impact. Strategic planning and design are essential for energy-efficient buildings. Better planned and designed buildings are easier to manage, and Building Information Modeling and Building Management Systems can help smoothen this transition.

One notable example of sustainable planning is the state-of-the-art design of King Abdullah University of Science and Technology (KAUST), completed by HOK architects in 2009. Through a combination of solar energy, water conservation, and strategic shading principles, the development is the first establishment in Saudi Arabia to attain the distinguished LEED Platinum certification[6].

Building Materials: Cement, steel, and aluminum pose significant emissions reduction challenges. These three materials comprise up to 80% of emissions from building materials according to a BCG study on a megaproject in the region. Cement production emits CO_2 during the calcination of limestone, steel production uses fossil fuels in the blast furnace process, and aluminum smelting involves the consumption of carbon anodes, leading to CO_2 release. The distinctive characteristics of each material make emissions reduction a complex task, underscoring the importance of understanding these challenges to identify the most effective technologies for successful emissions abatement.

[5] Hindawi: Early Stage Design Decisions - The Way to Achieve Sustainable Buildings at Lower Costs (hindawi.com)
[6] Construction Week Online: The Middle East's five best green buildings

Nevertheless, players along the supply chain are responding to the need to lower CO_2 emissions. As one example, in 2019, building materials company Holcim (formerly LafargeHolcim) announced a breakthrough low-carbon cement, Solidia Concrete, which "reduces the overall carbon footprint in precast concrete by 70%[7]". In 2020, Holcim joined the Science Based Targets initiative (SBTi) Business Ambition for 1.5°C, becoming the first global building materials company to sign the pledge with intermediate targets for 2030, validated by SBTi[8]. In another example, UK academia and industry came together to establish a "low carbon concrete routemap" to 2030[9]. The plan's seven steps span concrete usage and production to decarbonize the complete concrete supply chain.

Construction: The construction phase is rife with inefficiencies, from material waste and excessive energy consumption to fossil fuel-powered machinery. Moreover, traditional construction methods are labor-intensive and time-consuming, extending the duration over which emissions are generated. Increasing the pre-fabrication of components off-site, the electrification of localized transport, heavy machinery at construction sites, and the use of technologies that reduce inefficiencies and improve logistics in the construction process can all abate emissions. Construction sites implementing these strategies are being piloted today, such as the Net Zero carbon road in Oslo, which sources local materials and uses electricity- and biogas-powered equipment.

Regional construction is also making strides toward greater efficiency. ICD Brookfield Place, located in the Dubai International Financial Centre (DIFC), is the tallest and largest office building in the EMEA region to achieve the prestigious LEED Platinum certification. During construction, more than 87% of waste was recycled, and more than 30% of construction materials originated from recycled sources, including steel and concrete, and were sourced locally to reduce environmental impact from transport[10].

Operations and Maintenance: Operations are a critical part of the decarbonization roadmap for both new buildings and existing stock, accounting for approximately 65%[11] of all lifecycle emissions. Operational emissions primarily emanate from energy consumption for cooling, lighting, and other building systems. Lack of efficient building systems and inadequate maintenance further exacerbate the problem. However, solutions exist today that reduce both emissions and operational and maintenance costs.

In Saudi Arabia, the need for cooling is the most significant source of emissions. District cooling can save nearly 40%[12] of HVAC emissions compared to the use of single-unit air conditioners. District cooling is a feasible option for large-scale developments. It has already been

[7] Global Construction Review: Solidia, LafargeHolcim in commercial breakthrough for low-carbon cement
[8] Holcim website: Holcim Upgrades Its 2030 Climate Targets in Line with SBTi 1.5°C Framework
[9] Institution of Civil Engineers, UK: Low Carbon Concrete Routemap
[10] Brookfield Properties: EMEA LEED Project Case Study
[11] BCG Publication: Decarbonizing Mega Projects in the Middle East
[12] Abu Dhabi Department of Energy: DoE Issues District Cooling Regulations for the Emirate of Abu Dhabi

used in many master-planned developments in the region, including Business Bay, Dubai Downtown, Festival City in Dubai, and The Pearl Qatar. The use of LEDs and smart lighting controls can abate nearly half of lighting-related emissions[13]. According to BCG research, 55% of emissions of large-scale developments in the operational phase can be addressed with established technologies and design principles at zero to no cost[14]. Other operational levers relevant to the region's unique climate and energy needs include smart cooling and lighting controls, solar thermal, better insulated building envelopes, and cooling recovery. Integrating these levers, the region can harness a comprehensive approach to energy efficiency to ensure cutting-edge, sustainable, and energy-efficient real estate.

End-of-life: The end-of-life phase of buildings is often overlooked, yet it has significant environmental implications. The traditional 'take-make-dispose' model leads to a massive waste of resources and disposal challenges—lack of planning for building deconstruction and material reuse or recycling further compounds the problem. "Design for disassembly" is one approach that uses modular building techniques to allow for the reuse of materials after deconstruction.

A prime example of deconstruction was Expo 2020 Dubai. When the doors of the global, 6-month event closed in April 2022, the Expo team documented the deconstruction process of several pavilions to compare their subsequent waste. The Netherlands Pavilion, shown in Exhibit 6, used sheet piles as walls, which can be reused after deconstruction. Floors were built using sand, gravel, and stabilization mats, which can be removed to serve as a new surface somewhere else in the city. All installations, lighting, and even the elevator was leased to other firms for further use. The foundation of the pavilion was also designed to be removed again, using steel plates instead of concrete[15].

Exhibit 6: The Netherlands Pavilion at Expo 2020 Dubai was designed to be deconstructed sustainably

[13] Facilities Net: Lighting Controls Strategies Can Save Money
[14] BCG Publication: Decarbonizing Mega Projects in the Middle East
[15] Construction Week: Building to Unbuild

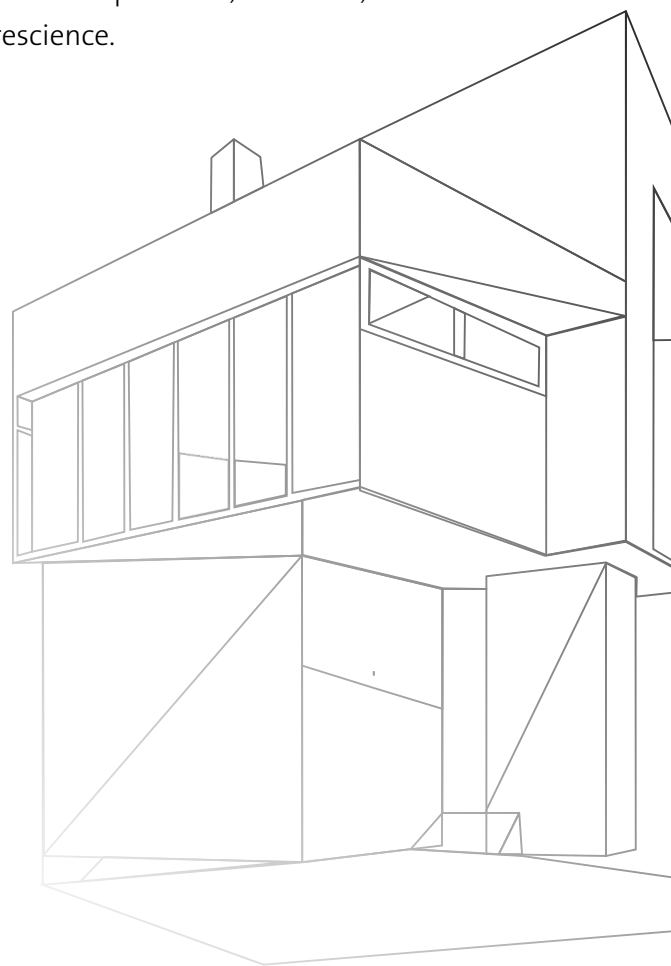
03

Retrofitting Today's Built Environment for Tomorrow

For existing real estate stock, retrofits focused on efficiency improvement are crucial to decarbonizing. Levers include improving the insulation of the building envelope, upgrading to high-performance HVAC components, and installing energy-efficient lighting devices and equipment. Overall, lighting and HVAC measures provide the most substantial impact on energy savings at the lowest average cost. To reduce whole-life carbon, retrofit strategies should limit demolitions and reuse or recycle materials as much as possible. Employing locally sourced, low-carbon, and bio-based construction materials can generate significant value both environmentally and for the local economy.

Retrofits should also increase buildings' use intensity and efficiency to ensure the greatest benefit to their communities for the energy consumed. For example, office amenities and parking lots, typically empty at night, might be retrofitted to facilitate community activities. Technology such as sensors and predictive building management tools can help target space optimization opportunities to create places that better serve users, maximizing the use of existing building stock.

Further, the built environment should enable lower carbon lifestyles, including facilitating active travel, lower energy use, and improved recycling and reuse of waste fluids and solids. This will require a pivot of major infrastructure systems—mode shifting transport and energy systems—to fundamentally lower carbon ways of living. To avoid the worst effects of climate change, this transition will need to happen with unprecedented speed and, therefore, with far more prescience.



04

Overcoming Obstacles: The Key Challenges in Real Estate Decarbonization

Understanding challenges is, of course, key to overcoming them; it is also useful in mapping stakeholders and their unique roles in the landscape. Therefore, a closer look at the key challenges in real estate decarbonization is required. The ten identified as most significant are outlined below.

A fragmented value chain: One of the significant hurdles in achieving decarbonization in the built environment is the fragmented nature of the industry. Various stakeholders, including architects, engineers, contractors, material suppliers, and building owners, often work in silos. Further challenges include siloed contracting and procurement, absence of ESG scoring for suppliers, and inadequate waste management and recycling infrastructure, all of which exacerbate the industry's fragmented approach to decarbonization.

Limited transparency on material origins and supply chain: The lack of transparency concerning building materials is another challenge. It's often difficult to trace their origin, manufacturing process, and associated carbon footprint.

Fragmented and slow to change regulatory frameworks: The absence or fragmentation of regulatory frameworks supporting sustainable building can deter stakeholders from investing in building green. For instance, the absence of building standards often restricts the adoption of new environmentally-friendly materials and technologies, despite the intent to use them. The situation is further complicated by unclear standards and guidelines, coupled with a lack of specific, binding regulations for green financing, thereby adding to the regulatory uncertainty.

Rapid technological advancements: Rapid technological advancements can be both an opportunity and a challenge. Keeping up with the evolving technology landscape, understanding the implications of new materials and construction technologies, and ensuring they are employed effectively requires continual learning and adaptation.

Baselining challenges: The absence of a standardized baselining methodology and consistent analytical tools poses significant challenges. Complications are heightened by data collection issues and data quality concerns. The limited availability of KSA specific data like emission factors and environmental product declarations further impedes precise environmental assessments and tailored decarbonization strategies.

The green premium: The higher cost of green materials and practices, real or perceived, can be a deterrent to developers and investors. This issue is compounded by the absence of standards for certifying green materials and the lack of mechanisms for fast-track testing of new materials. Furthermore, the market demand for green solutions is scattered, and supplier readiness is low, with a limited supply of green materials available, intensifying the green premium challenge.

Aging building stock: Many existing buildings require substantial renovations to integrate modern sustainability measures such as insulation and advanced HVAC technology,

posing a challenge especially when these buildings are continually in use.

End-user awareness and habits: Regardless of technological advancements, gaps in energy conservation awareness and behaviors such as leaving lights and air conditioning on while not in use counteract energy-saving measures.

Change management: Professionals in the field, including engineers and architects, often lean toward familiar materials, suppliers, and technologies. Transitioning to eco-friendly alternatives entails upskilling and risk-taking, which can be a deterrent, indicating a need for robust change management strategies.

Organizational and governance challenges: Key challenges include limited platforms for sharing best practices, such as a lack of peer forums. Organizational ambiguity, especially in the delegation of authority and the positioning of ESG teams at lower hierarchical levels (N-3/4), further limits their influence and effectiveness in driving sustainable initiatives.

05

Unifying Stakeholders Around the Net Zero Ambition

Saudi Arabia's Net Zero target for 2060, which lays out a clear ambition towards a sustainable future, is underscored by the decarbonization of its built environment. The current fragmentation of this ecosystem presents a significant hurdle to achieving the necessary rate of emissions reduction. The complexity and scope of this green transition call for a unified effort that goes beyond the conventional boundaries of governmental bodies, real estate developers, construction firms, and material manufacturers. The envisioned transformation is not merely a change in operational methodologies, but a complete overhaul of the entire ecosystem encompassing policy formulation, research, industrial technologies, supply chains, and societal awareness toward sustainability.

Therefore, the urgency of this task calls for a cohesive framework where each player aligns its capabilities and resources into a harmonized blueprint aimed at a common objective: a decarbonized built environment. Expectations from each stakeholder are outlined below.

Government:

- Update national codes and standards that allow the use of low-carbon materials, following best global practices and leading them in time.
- Foster financial mechanisms such as green bonds, grants, and subsidies.
- Enact more ambitious regulatory targets within the building sector, such as advancing specific decarbonization goals, mandating green technologies in new construction, and exclusively utilizing green materials in the medium and long-term.
- Offer guaranteed purchase agreements to green material providers, mitigating the risk associated with producing eco-friendly materials like green steel and ensuring a stable demand.
- Implement training and education programs to develop a skilled workforce capable of supporting green industries and creating sustainable firms and jobs in the region.
- Empower Saudi universities to research green transition topics and new materials, and become regional leaders in accelerating the knowledge base that will underpin it.
- Support a centralized testing mechanism for new materials, coupled with research partnerships, particularly with universities focusing on material innovation.
- Introduce standards and a fast-track process for certifying green materials, ensuring they meet global best practices.
- Mandate decarbonization analyses, such as lifecycle assessments (LCA), as part of the mandatory processes for real estate stakeholders, aligning with international best practices.
- Implement an ESG scoring system for contractors and suppliers, with minimum requirements set by authorities to encourage sustainable practices.
- Invest in infrastructure development crucial for decarbonization, like advanced waste management and recycling facilities, to bolster sustainable practices in the building sector.
- Foster an industrialization plan to establish local businesses that can operationalize the capabilities needed.
- Establish green public procurement programs to capitalize on the above.

- Enhance awareness of energy conservation and emission reduction among end-users.

Real estate developers:

- Develop clear decarbonization roadmaps.
- Set requirements and targets that incentivize the prioritization of carbon abatement.
- Experiment with new decarbonization technologies and scale those with high impact.
- Build capabilities in-house for green design and building.
- Evaluate the complete life cycle costs of low-carbon materials.
- Discount community management fees for green units.
- Build stronger collaborative relationships across the value chain.
- Push for green procurement across the value chain.
- Introduce low-carbon-focused design like walkable/car-free neighborhoods.
- Install energy efficiency devices in units, like smart sensors.
- Adopt green procurement and develop a sustainable supply chain.
- Consolidate demand for green materials by coordinating with other developers and expand sustainable partnerships.
- Allocate a dedicated carbon budget at the project concept stage to prioritize decarbonization from the outset.

Design and construction firms:

- Build strong supply networks of green and low-carbon materials.
- Measure and report material and project emissions, using the data to inform design and material choices.
- Execute eco-conscious, reduced-emission construction techniques and waste reduction strategies and mechanisms.
- Publicize and disseminate material and project data in a structured way so there is a dynamic knowledge base to spur further innovation.
- Collaborate with regulators to expedite approvals for new technologies and materials, or revise standards to facilitate their adoption.

Building materials and technology manufacturers:

- Maximize the production of green materials to meet demand and commercialize green products, capturing a green premium.
- Implement systems to trace the origin of raw materials throughout the supply chain. This could involve blockchain technology or other digital solutions, detailed product declarations, eco-labels or certifications.
- Create partnerships for decarbonization technologies such as those related to carbon capture, utilization, and storage and green hydrogen.
- Adopt creative approaches to finance capital-intensive projects, such as innovation incentives and small business support funds. For example, the Dubai Future Foundation has created a $100M business development fund for regional 3D printing startups.

These efforts will not only position Saudi Arabia as a vanguard in sustainable building practices but also significantly contribute to altering the global perception regarding its commitment to combating climate change. The Kingdom is already utilizing the following tools to boost the progress of the construction sector:

Code, policies, and processes

- The New Government Tenders and Procurement Law, which introduced a competition mechanism for government entities to more actively source and contract innovative ideas, came into force in December 2019.[16]
- The Saudi Building Code 2018 harmonized focus on ensuring buildings' efficiency, safety, strength, and sustainability. It can be further enhanced to include more detailed decarbonization considerations, such as the application of greener materials.

Innovation promotion and funding

- The King Abdulaziz City for Science and Technology (KACST)[17] is a scientific government institution that conducts research and development in building and construction and grants programs for universities and research centers.
- Since 2010, the Saudi Green Building Forum (SGBF) has been positioning the Kingdom at the forefront of global sustainable development, fostering dialogue amongst key stakeholders, and enabling partnerships.

New efforts to build local talent

- Four Saudi universities are in the top 10 ranking of the Best Arab Region Universities for Engineering: KAUST, King Saud University, King Abdulaziz University, and King Fahd University of Petroleum and Minerals.[18]
- National transformation initiatives, such as improving the Kingdom's international ranking in attracting international students, bring global talent to the local economy to be employed in green jobs.

The imperative now is to build off this momentum. It will take the intention and effort of every stakeholder to reach the ambition of a decarbonized built environment. Still, with a clear roadmap and aligned priorities, it is possible—and the benefits for Saudi communities and the world will be lasting and priceless.

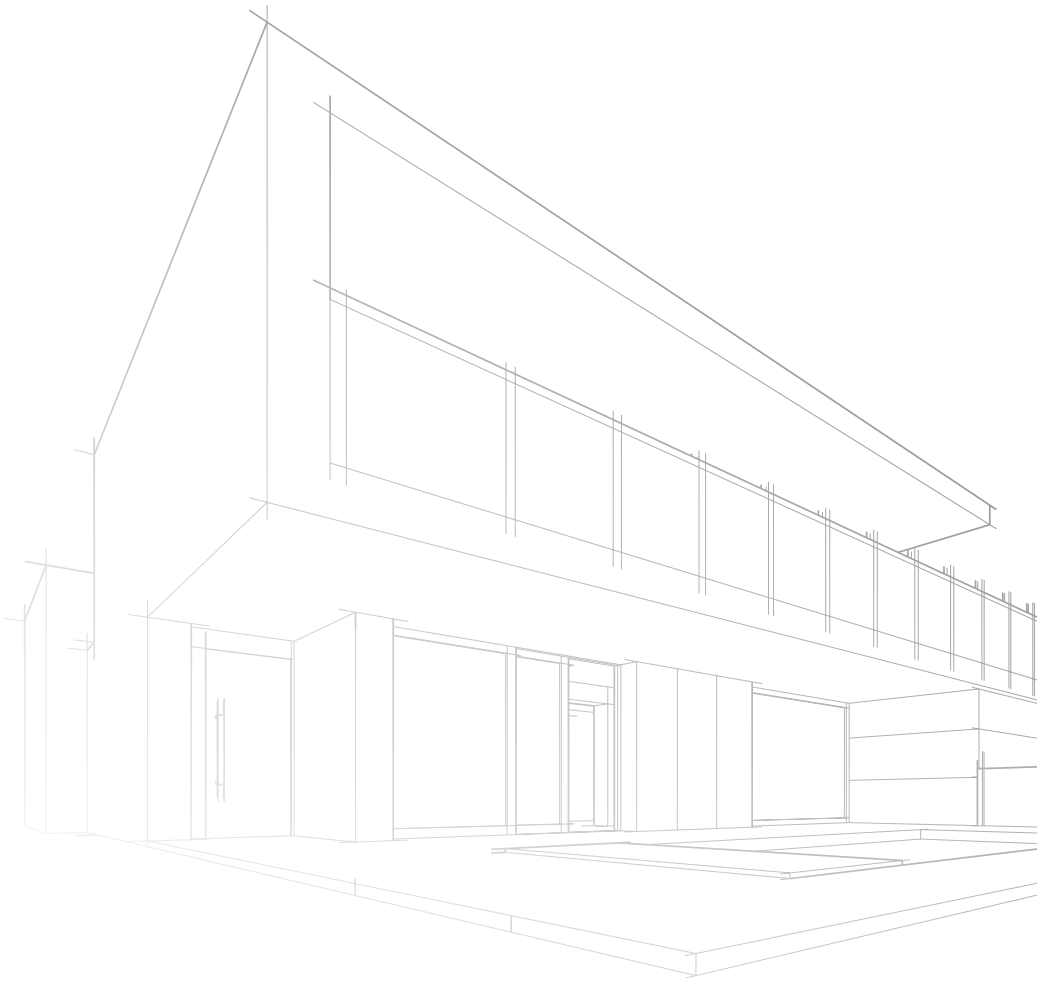
[16] Reed Smith: The New KSA Government Tenders and Procurement Law
[17] King Abdulaziz City for Science and Technology website
[18] Scimago Insitutions Rankings

06

Conclusion: The Kingdom's Urgent Opportunity

With a large portion of its Vision 2030 real estate in the construction stage, Saudi Arabia has an unparalleled potential advantage to deliver greener buildings at scale and pioneer the sustainable development of the built environment. This opportunity extends beyond merely mitigating the environmental impact of projects. It also positions the Kingdom to establish leadership in innovative technological solutions, build new industries that are highly competitive, and build knowledge and expertise that can be exported across the world.

This is a pivotal moment in the Kingdom's journey to Net Zero. Collaborative efforts between the public and private sectors can accelerate the adoption of green technologies and set a global benchmark for sustainability. Leveraging its strategic vision and robust investment capabilities, the Kingdom has the potential to serve as a beacon for other nations in the pursuit of environmental stewardship. Demonstrating success in sustainable real estate not only holds environmental benefits for Saudi Arabia but also promises economic advantages by attracting global partners and investors. To achieve all of this, the government, developers, and the entire real estate ecosystem must work together with unprecedented alignment and focus—and the opportunity must be seized now.



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