

# World Green Building Trends 2021



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## World Green Building Trends 2021

SmartMarket Report

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## About Dodge Construction Network

Dodge Construction Network is North America's leading provider of commercial construction project data, market forecasting & analytics services and workflow integration solutions for the construction industry. Building product manufacturers, architects, engineers, contractors, and service providers leverage Dodge to identify and pursue unseen growth opportunities that help them grow their business. On a local, regional or national level, Dodge empowers its customers to better understand their markets, uncover key relationships, seize growth opportunities, and pursue specific sales opportunities with success. The company's construction project information is the most comprehensive and verified in the industry.

As of April 15, 2021, Dodge Data & Analytics and The Blue Book—the largest, most active network in the US commercial construction industry—combined their businesses in a merger. The Blue Book Network delivers three unparalleled databases of companies, projects, and people.

Dodge and The Blue Book offer 10+ billion data elements, and 14+ million project and document searches. Together, they provide a unified approach for new business generation, business planning, research, and marketing services users can leverage to find the best partners to complete projects and to engage with customers and prospects to promote projects, products, and services.

To learn more, visit [www.construction.com](http://www.construction.com) and [www.thebluebook.com](http://www.thebluebook.com).

## Introduction

**D**odge Data & Analytics and Carrier have partnered on research on global green building trends since 2008, with this study in its current form first done in 2012. The current 2021 research, though, has occurred during a pivotal time across the globe. The COVID-19 pandemic has had a major impact that we are just beginning to understand on industry in general, and design and construction in particular.

In that atmosphere of change, it is particularly powerful to see the findings of this study. It demonstrates that despite the state of upheaval, many of the key findings of previous studies have not changed.

- Commitment to increasing green building efforts continues to remain strong. Respondents across the globe plan to intensify their green building engagement, with a 14-point growth in the share of those who intend to do the majority (more than 60%) of their projects green, from 28% doing so now in 2021 to 42% who plan to do so in the future.
- Respondents also expect to use more green building products and systems, with double-digit percentage point growth in six product categories, including building automation systems, thermal and moisture protection, waste management and the emerging use of mass timber structural systems.
- The findings also continue to demonstrate a compelling business case for building green:
  - The average reduction in operating costs in the first 12 months for new green buildings is 10.5% and five-year operating costs savings is 16.9%.
  - Green renovations and retrofits of existing buildings have even stronger performance globally at 11.5% and 17%, respectively.
  - Owners report that green new buildings and renovation/retrofit projects increase the asset value of buildings by more than 9%.

Social factors also continue to be important drivers, with improved occupant health and well-being, and encouraging sustainable

business practices rated as important/very important reasons for building green by over three quarters of respondents. Interestingly, these findings are highly consistent with those from the 2018 study, which suggests that the importance of creating healthier buildings is not a response to the pandemic but part of an ongoing commitment by green practitioners.

However, since 2018, there has been a significant increase in the share of those who report that doing the right thing is one of the top three triggers for increasing their green building efforts. It ranks second among owners/investors, and third among design and construction professionals, just below long-standing important drivers like lower operating costs and client demands, and it even outranks creating healthier buildings as a trigger for new green building efforts. This finding may be the strongest evidence of the impact of the times in which we live, in which evidence of the impact of climate change, such as extreme weather events, is already deeply felt, and in which the need to manage the risks associated with worsening effects, including increasing the risk of future pandemics, becomes more influential.

Another way in which the industry has changed since 2012 are the various means available to help improve buildings, from increasingly common net-zero/net-positive targets for buildings to controlling embodied carbon. For the first time the study explores the perceived importance and anticipated use of 10 of these new approaches, suggesting increasing ways for those engaged in design and construction to improve the performance of the built environment.

Dodge Data & Analytics thanks Carrier for their ongoing support of this critical research. We also thank our premier partner Autodesk for their support and engagement in this study, and our two contributing partners, the US Green Building Council and the American Institute of Architects. And we thank all the research partners who helped us reach out to the global design and construction industry, especially our premier research partner, the World Green Building Council.



**Jennifer Anderson**  
Chief Sustainability Officer  
Carrier

**Jennifer Anderson** leads Carrier's environmental, social and governance (ESG) priorities and the development of the company's associated strategic roadmap aligned with its vision to create solutions that matter for people and our planet. She is responsible for making progress against Carrier's ambitious 2030 ESG Goals, including reducing its customers' carbon footprint by more than one gigaton and investing over \$2 billion to develop healthy, safe, sustainable and intelligent building and cold chain solutions.



**Donna Laquidara-Carr, Ph.D., LEED AP**  
Industry Insights  
Research Director  
Dodge Data & Analytics

**Donna Laquidara-Carr** currently provides editorial direction, analysis and content to DD&A's *SmartMarket Reports*. Prior to this position, she worked for nearly 20 years with DD&A's Dodge division, where she gained detailed insight into the construction industry.

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**Above:** The Hotel Magdalena is the first mass timber boutique hotel in North America.

**Cover Photo:** Rendering for WILD, a new urban development on a human-made island. Its design has the capability to produce its own power, fresh water, food and heat as a closed biotope loop system.

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# Executive Summary

WORLD GREEN BUILDING TRENDS 2021

## Green Market Activity

The 2021 *World Green Building Trends Study* demonstrates the same commitment to increasing green building activity as have the previous studies in 2018, 2015 and 2012. As the chart at upper right shows, there is a high level of growth expected in the next three years among those who anticipate doing more than 60% of their projects green, and a corresponding reduction in those who plan on engaging in fewer than 15% green projects.

These findings show that green building continues to remain a global priority, likely driven by increasing extreme weather events and despite other rising concerns like the global pandemic.

### Use of Rating Systems

While the study reveals a slight decline in the share of green projects that use a rating system, especially in long-standing green markets, it also clearly demonstrates that the vast majority of green projects still employ one. The respondents using one report that they value it most for its ability to create better-performing buildings, provide third-party verification that a building is green and offer marketing and competitive advantages.

### Use of Green Products

Growth is expected in the use of green products and systems across nine different categories, with the top ones for anticipated use being electrical, mechanical, building automation systems, and thermal and moisture protection.

## Influences on Green Building Markets

### Environmental and Social Reasons for Building Green

Respondents to this study have been asked to rate the importance of the same set of environmental and social reasons for building green since 2012.

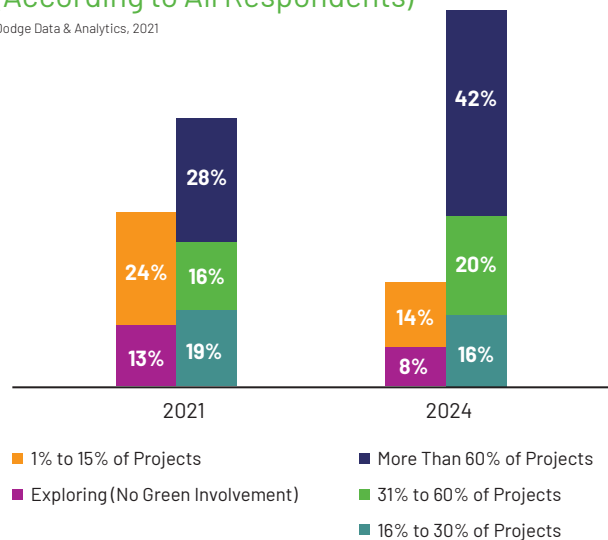
#### ENVIRONMENTAL REASONS

All of the environmental reasons for building green included in the study—reduce energy consumption, lower greenhouse gas emissions, improve indoor air quality, reduce water consumption and protect natural resources—are selected by over three quarters of the respondents as important, with reducing energy consumption topping the list at 87%.

- The environmental reason with the greatest and most consistent growth since 2012 is improved indoor air quality.

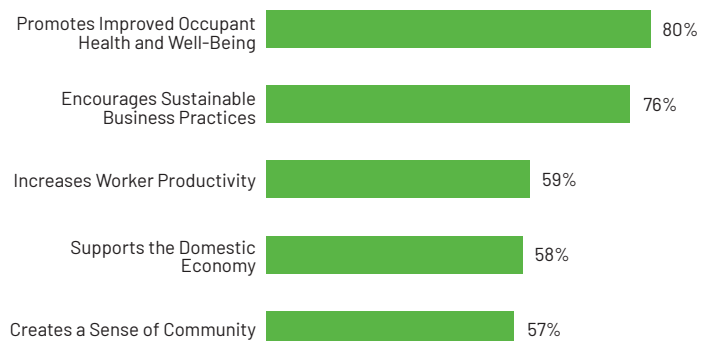
### Level of Green Building Activity (According to All Respondents)

Dodge Data & Analytics, 2021



### Social Reasons to Build Green Rated Important/Very Important

Dodge Data & Analytics, 2021



#### SOCIAL REASONS

As the chart at lower right reveals, green building also continues to be driven by social reasons as well as environmental ones, with improved occupant health and well-being, and encouraging sustainable business practices the most dominant factors. However, increased worker productivity, supporting the domestic economy and creating a sense of community are also considered important influences by over half of respondents.

# Executive Summary

WORLD GREEN BUILDING TRENDS 2021

## Influences on Green Building Markets CONTINUED

### Top Triggers for Increasing Green Building

The table at upper right shows that client demands are the top driver for construction industry practitioners, along with environmental regulations. Therefore, the triggers encouraging owners and investors to increase their green building efforts are critical to drive the industry forward. Lower operating costs is the top trigger for owners/investors, and it is also ranked first as the most important business benefit of building green globally.

In 2021, increasing green building because it is the right thing to do also increased compared with the findings in 2018, emerging in the top three for both practitioners and owners. This has no doubt been driven by greater concerns about the impacts of climate change and a more intense focus on healthier buildings driven by the pandemic. Creating healthier buildings also continues to be an important trigger, as it was in 2018, and improving occupant health and well-being remains one of the critical business benefits of green building, ranking nearly as high as operating cost savings.

### Financial Benefits of Building Green

As the table at lower right shows, average operating cost savings within the first 12 months exceed 10% and the five-year cost savings exceed 16%. Owners and investors report 9% growth in building asset value due to investments in both new green buildings and green renovations/retrofits. Clearly, green buildings are helping to drive the operating cost savings sought, and provide more value to the asset owners.

#### IMPACT OF HIGH GREEN INVOLVEMENT

Respondents who do more than 60% of their projects green benefit from their increased knowledge of and experience with green building and are able to achieve better results.

- Those with a high level of green involvement track operating costs more often, with 71% reporting doing so compared with the global average of 59%.
- Therefore, it is particularly notable that they report operational cost savings of over 16% on new green buildings and retrofits in the first year, and over 20% on green renovations/retrofits.

These findings suggest that as organizations intensify their green building involvement, it can help them achieve the top benefits sought, which can encourage even greater investment, reinforcing a virtuous cycle.

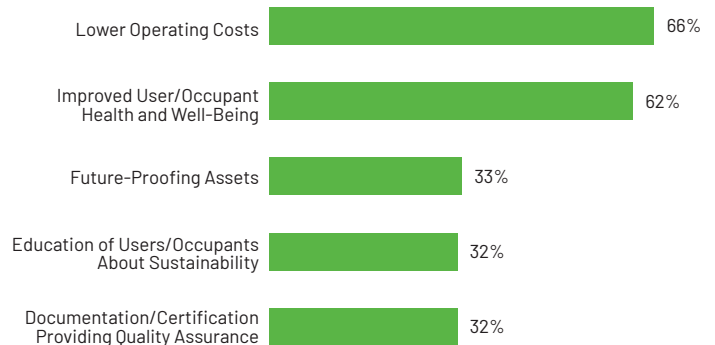
### Top Triggers for Increasing Green Building Selected by One Quarter or More Respondents

Dodge Data & Analytics, 2021

Owners/Investors	Architects/Engineers/Contractors
1. Lower Operating Costs	1. Client Demands
2. Right Thing to Do	2. Environmental Regulations
3. Healthier Buildings	3. Right Thing to Do
4. Internal Corporate Commitment	4. Healthier Buildings
5. Environmental Regulations	5. Lower Operating Costs

### Most Important Business Benefits of Green Building

Dodge Data & Analytics, 2021



### Financial Benefits of Building Green, Compared With Traditional Buildings

Dodge Data & Analytics, 2021

	New Green Buildings	Green Renovation/Retrofit
Average Reduction in Operating Costs in Next 12 Months	10.5%	11.5%
Average Reduction in Operating Costs in Next 5 Years	16.9%	17%
Average Increase in Asset Value (According to Owners/Investors)	9.2%	9.1%

# Executive Summary

## Emerging Approaches to Building Green

WORLD GREEN BUILDING TRENDS 2021

Many strategies to improve building performance and the construction of green projects have gained in prominence since the 2012 survey, so in the current study, new questions were added to examine some of these approaches. The chart at right shows those selected among the top three most important by global respondents and the share who believe they will use them in the next five years.

- Strategies for reducing energy use and radically altering the built environment’s carbon footprint top the list.
- New approaches for building, such as modular construction and design for disassembly and recovery, are also considered among the most important by at least one quarter, roughly the share that intend to employ them.

In addition, the study did a deeper dive on controlling embodied carbon, design for disassembly and recovery, and design for manufacturing and assembly.

### Embodied Carbon

With embodied carbon ranking second in both importance and anticipated future engagement, it is clear that efforts to track and reduce it should continue to grow in the next few years.

- Most of the respondents (72%) are at least familiar with the concept of embodied carbon, and 34% are tracking it on some of their projects, with two thirds of them also seeking to reduce it.
- The top factors that will drive more engagement with dealing with embodied carbon are more information about how to reduce it and more building products/materials on offer that can help to do so.

### Design for Disassembly and Recovery

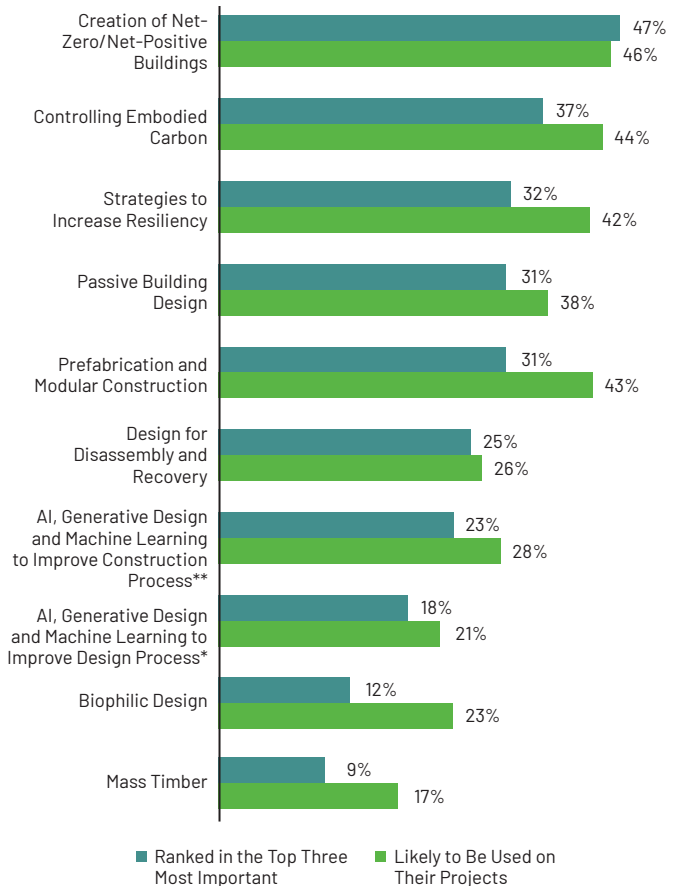
A critical way to reduce carbon and waste in the built environment is to have building products and buildings designed so that the various components can be reused when the building reaches the end of its lifecycle. Owners have the greatest influence in driving use of this approach, but fewer than half are currently familiar with it.

### Design for Manufacturing and Assembly

A little over half of the global respondents are familiar with design for manufacturing and assembly (DfMA), and about two thirds of those who are familiar with it have used it on projects. However, use is still emerging, currently limited to 10% or fewer projects for the majority of those deploying this approach.

### Most Important Approaches to Improve Sustainability in the Design and Construction Industry in the Next Five Years

Dodge Data & Analytics, 2021



\*According to Architects and Owners  
\*\*According to Contractors and Owners



# Data: Introduction

**T**he current study is the fourth in a series that has used the same questions to measure trending changes in green building over time. The studies have been conducted on a three-year cycle, beginning in 2012.

In the previous survey releases since then, questions have been slightly tweaked to reflect more current green building priorities, but this 2021 study included the most extensive reexamination of the questions since the start of this research.

This reconsideration of elements of the survey was done to help allow the study to expand into looking at approaches that are more widely considered for use currently than they were in 2012. This includes a few questions to benchmark engagement with tracking and reducing embodied carbon in buildings, use of design for disassembly and reuse, and use of design for manufacturing and assembly. In addition, two questions were added about a series of approaches to building green not previously included in the study, including most of the items shown above, along with the pursuit of net-zero/net-positive buildings, design for resiliency, the use of mass timber and several other approaches. One question asked respondents to select the top three most important to achieve future green building goals. The other asked them to identify which they plan to use in the next five years. These responses are instructive now and will serve as an important benchmark for future studies on the practices considered most valuable across the globe and within specific markets.

Despite this reconsideration, though, many questions still remained sufficiently the same to track green building trends. These include questions examining overall green building activity (although the definition of what qualifies as a green building was slightly modified this year), the top social and environmental factors for building green, the triggers and barriers for expanding green building efforts, the business benefits of green buildings and the use of green building products. These findings demonstrate a continued commitment to green building, well founded in the business benefits provided by these approaches.

Finally, given the pervasive influence of the pandemic globally and in every industry sector, this 2021 study included examining what changes in approaches brought about by the pandemic will be more widely adopted by the industry. The broad realization by the general public of the degree to which the built environment can impact their health will no doubt have lasting implications for green building efforts, so a better understanding of the changes brought about during this time will aid in better understanding the future of green building.

## Note About the Data

The data and analysis in this report are drawn from 1,207 respondents to an online survey that was administered from June to August 2021. Respondents include architects/designers, engineers, consultants, contractors, owners/developers and investors. The analysis of the responses by type of company focuses primarily on industry practitioners in the AEC community and on owners/developers and investors.

Overall, the types of participants are consistent with earlier studies conducted in 2012, 2015 and 2018, with one exception: Previously those doing more than 50% horizontal construction (e.g., roads, bridges, water treatment plants, etc.) were screened out, but in this study, they were included for all applicable questions. However, only 8% of respondents fell into this category.

The analysis also includes countries with a sufficient sample for statistical analysis. Typically, the minimum number has been 30 respondents. However, given the smaller size of the building market compared with many other countries, the decision was made to also include Cameroon, which had a total of 27 responses.

For more information on the study and the respondents, see the Methodology section on pages 75 and 76.

# Data: Green Building Market Activity

WORLD GREEN BUILDING TRENDS 2021 DATA

## Green Building Activity

All survey respondents were asked two questions about their level of green building activity:

- The overall share of current green projects and of green projects expected by 2024 for each respondent based on a definition of green building
- The current and expected future share of their projects registered and/or certified under a green building certification system

To determine the overall share, the following definition of a green project was provided in the survey:

*At a minimum, for a building project to be considered green, it must include the following:*

- Efficient use of energy, water and other resources
- Pollution and waste reduction measures, and the enabling of reuse and recycling
- Good indoor environmental air quality
- Consideration of the environment in design, construction and operation

*In addition, green building projects include as many of the following as possible:*

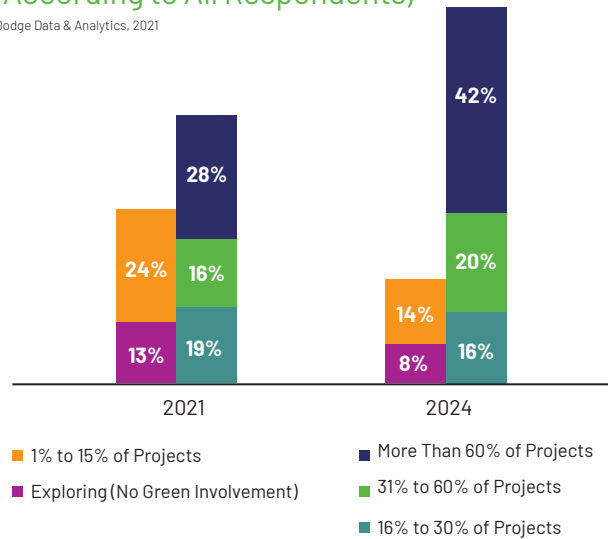
- Use of renewable energy, such as solar energy
- Use of materials that are nontoxic, ethical and sustainable
- A design that enables adaptation to a changing environment
- A commitment to net zero carbon emissions

The chart at the upper right shows the overall share of green projects reported by all respondents based on this definition.

- Notably, most respondents expect a larger share of their projects to be green by 2024 than their current share of projects, including steep growth in those who expect the majority of their projects to be green.
- In 2018, when the same question was asked, roughly the same percentage of respondents (27%) reported that the majority of their projects were green. However, there was a slightly smaller percentage (31%) who reported that they have 15% or fewer green projects than the share (37%) who currently report this.
  - One factor that may contribute to these findings is the inclusion in 2021 of organizations that largely do civil/horizontal projects, in addition to those who specialize in vertical projects.
  - Another factor that likely influences this finding is that there are fewer respondents from countries with historically high levels of green building, such as those in Western Europe and Scandinavia, in the current study than in 2018.

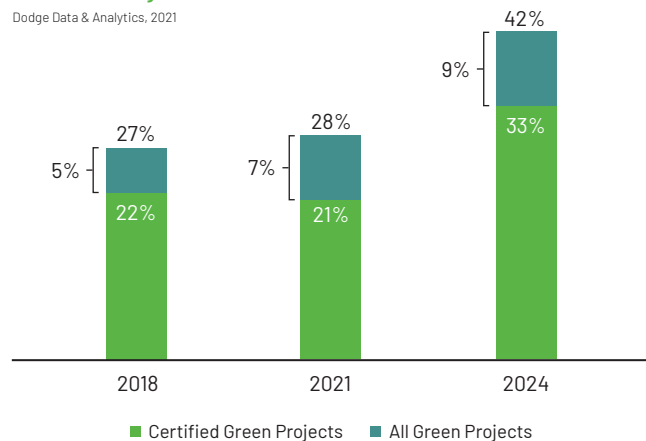
### Level of Green Building Activity (According to All Respondents)

Dodge Data & Analytics, 2021



### Share of Green Versus Certified Projects (According to Those With More Than 60% Green Projects)

Dodge Data & Analytics, 2021



### Variation in Overall Findings Between Green and Certified Projects

The chart above compares the responses of those who report that the majority of their projects meet the definition of green provided in the survey with those who have registered/certified projects with a green certification system. It includes the findings in 2018, the current share in 2021 and the expected share in 2024.

Notably, it confirms a trend first observed in 2018 that suggests a small shift away from using certification systems for green projects.

# Green Building Market Activity

## Green Building Activity CONTINUED

WORLD GREEN BUILDING TRENDS 2021 DATA

- In 2018, the difference between those reporting a majority of green projects using the definition and those reporting a majority of registered/certified projects was five percentage points.
- By 2021, that difference increased to seven points, and by 2024, it is expected to grow again to nine percentage points.

It is clear from these findings that it is still common for most organizations doing projects green enough to meet the rigorous definition provided in the survey to seek to certify most of those projects with a green rating system. However, as experience with green building continues to grow, it is clear that in a small but growing number of cases, companies are building green without seeking that external certification.

### Variation in High Green Building Activity by Country

The chart at upper right shows the share of those currently doing a majority of their projects green and those who expect to do so by 2024 in the 13 countries that had a sufficiently large enough response rate to analyze separately in the study.

- The highest levels of current activity are in Australia/New Zealand, Canada and the US.
- The highest levels of growth in those doing a majority of green projects are expected in Brazil, Colombia, Canada and Mexico.

The chart at lower right shows the countries with the greatest differences in the majority of green projects versus certified projects. Notably, the top three in this category are also the top three with the highest level of green projects overall, which again suggests that higher levels of experience with green may be a factor in the choice to build green without pursuing certification.

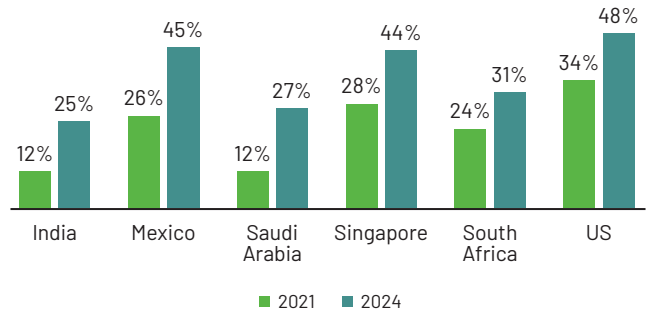
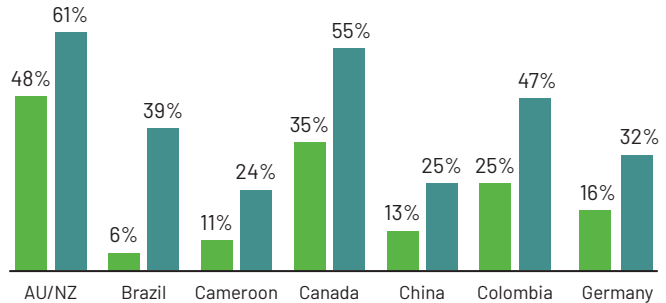
### Variation by Type of Organization

Owners most frequently report a majority share of green projects, with 37% stating that 60% or more of their projects are green.

On the other hand, general contractors (13%) and investors (14%) are least likely to report that the majority of their projects are green, with architects and engineers falling in the middle.

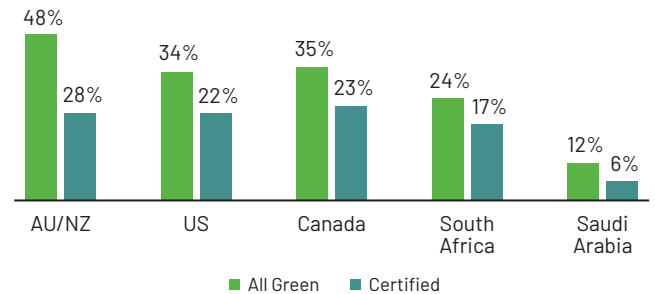
### Percentage of Respondents Whose Firms Have More Than 60% Green Projects

Dodge Data & Analytics, 2021



### Countries With Largest Difference Between Green and Certified Projects in 2021 (Difference of 5% or More)

Dodge Data & Analytics, 2021



# Green Building Market Activity

## Expected Future Green Activity by Sector

WORLD GREEN BUILDING TRENDS 2021 DATA

All respondents who plan to do green projects were asked in which sectors they expect to build green. The chart at right shows the total global average for each sector included in the study and the top five countries/regions in which those sectors were selected.

- No single sector is selected by more than half of the respondents, revealing a wide range of green project types expected globally.
- The top three sectors—new commercial construction, new institutional construction and existing buildings/retrofits—are also typically those with the greatest activity in general.
  - At 40%, the share reporting that they expect to do green retrofits may seem low compared with the volume of this type of work. However, it is challenging for many retrofits and small renovations to fit the rigorous definition of a green project provided earlier in the survey.
- Respondents in Cameroon most frequently select five of the seven types of building projects, and are in the top five for the other two. This may suggest less specialization among construction professionals in the Cameroon market than in some of the other markets, since one respondent may then select many building types.
- A large share of Indian respondents expect to engage in commercial construction.
- Many respondents from Saudi Arabia are also expecting to build green in the commercial, institutional and high-rise residential sectors.
- US, Canada and Brazil lead for existing building projects.
- The relatively low performance of green commercial interiors is likely due to the makeup of survey respondents, which did not include a large share of interior designers.

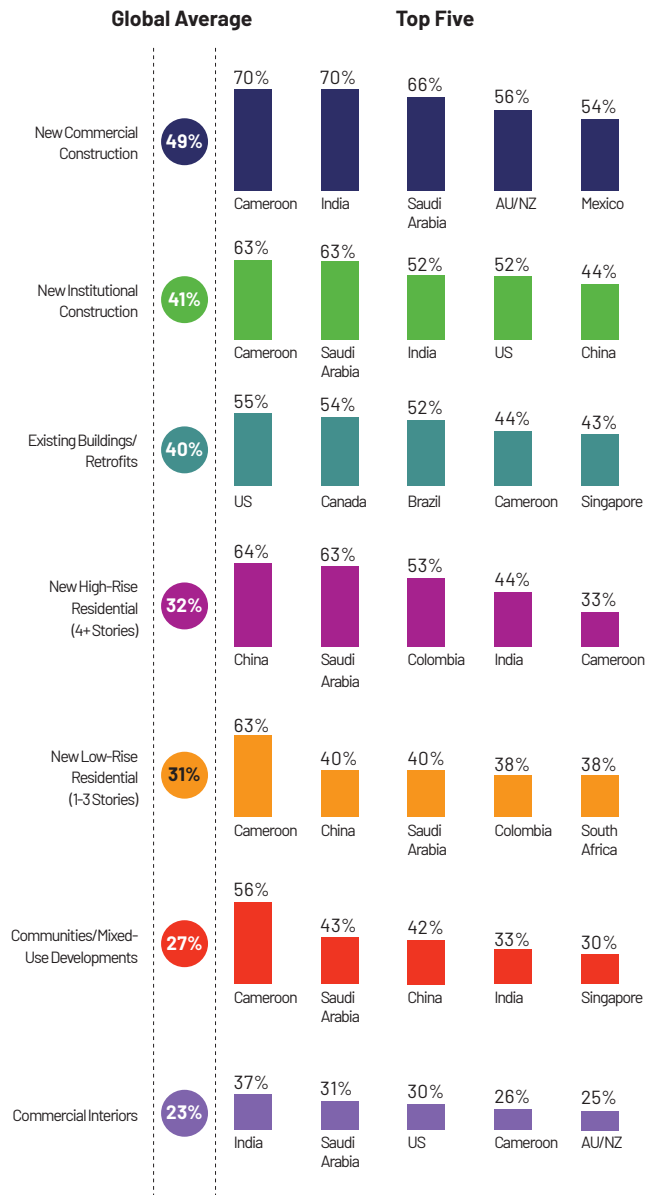
### Variation by Type of Organization

While generally the distribution of projects by organization is similar to the totals, there are a few exceptions.

- The top project type for architects is doing green existing building retrofits, selected by 46%. This is in contrast to all other types of organizations, where new green commercial construction is most frequently selected.
- Owners lag in most categories because a higher share of them tend to do just one kind of project. However, for them, existing buildings/retrofits is a close second behind commercial construction, lagging by just one percentage point (39% versus 38%). This is likely because many owners may be working on retrofits of existing buildings, regardless of the primary sector in which they build, so their total would be closer to the overall industry average here.

### Sectors With Planned Green Activity Over the Next Three Years (Global Average and Five Highest Averages by Country)

Dodge Data & Analytics, 2021



## Standards of Resilience

### Building codes and certification systems are adapting to climate change.

As the climate crisis unfolds, its impacts—more frequent and severe weather events, hotter temperatures and shifts in seasonal precipitation—are beginning to exceed the loads and conditions for which the built environment in many parts of the world was designed. With consequences ranging from reduced operational life to catastrophic failure, organizations worldwide are revisiting the codes, regulations and standards that govern design and construction. “It is pivotal that codes and standards incorporate climate models and science to adapt to the changing climate, safeguard communities and enhance overall sustainability and resilience,” says Judy Zakreski, vice president of global services at the International Code Council.

#### Climate Science and Codes

Advancing that work is the Global Resiliency Dialogue, a forum of building code developers and research organizations from Australia, Canada, New Zealand and the United States—including the Australian Building Codes Board, the National Research Council of Canada, the New Zealand Ministry of Business, Innovation and Employment, and the International Code Council. Established in 2019, the organization aims to inform the development of building codes that integrate both building science and climate science.

In February 2021, the Global Resiliency Dialogue published results from its first international survey, *The Use of Climate Data and Assessment of Extreme Weather Event Risks in Building Codes Around the World*. The survey found that when constructing hazard scenarios—such as flood maps,

wind maps and average temperature ranges—building codes and standards almost without exception rely on data that is historical rather than predictive. The results of a second global survey of regulators, design professionals, builders, climate scientists, researchers, standards organizations and the insurance industry are due to be released in early November. This second report will provide a definition for climate resilience in the context of building regulation, and will analyze comparative findings about the pathways to incorporating changing climate risks in building codes.

The Global Resiliency Dialogue is also in the process of developing international resilience guidelines through collaborative research efforts, stemming from takeaways from the two surveys, that will help jurisdictions around the globe in better preparing the building stock to withstand extreme weather events. “In adapting to the impacts of climate change, the Code Council recognizes that the risks the built environment will face in the future are different from those of the past,” says Ryan Colker, vice president of innovation at ICC. “Bringing together the latest research and modeling from climate scientists with the data and information needs of building scientists is essential.”

#### Resilience Certified

In addition to regulatory standards and codes, voluntary certification systems such as LEED can provide guidance for designing for resilience. The LEED Climate Resilience Screening Tool, for example, evaluates the corresponding potential of each LEED credit. In addition, the standard offers

three resilience-specific pilot credits: one that pertains to identification of risks, another to mitigating risks through design and the third to passive survivability (a building’s ability to remain habitable in the event of a power outage).

For project teams wanting to implement holistic best practices for this priority, USGBC is now piloting the RELi rating system, available to developments that are also seeking LEED certification. By selectively bundling existing sustainable and regenerative guidelines—including credits drawn from LEED—with credits for emergency preparedness, adaptation and community vitality, RELi offers a comprehensive paradigm for socially and environmentally resilient design and construction. Credit categories cover strategies in hazard preparedness, hazard mitigation and adaptation, energy and water, community vitality and more. “USGBC is prioritizing environmental, economic and social transformation in buildings and beyond,” says Taryn Holowka, senior vice president of communications at USGBC. “A key part of this work is advancing reliability and resilience strategies.”

As climate-related disasters pummel buildings and infrastructure year on year, “engaging in strategic collaborations to assist in aligning expectations for building durability and resilience with the projection of future hazards is increasingly important,” says Colker. “Codes, standards and the design process must adapt to recognize these changing risks.” ■

# Data: Influences on Green Building Markets

## Social Reasons for Building Green

The motivation to invest in green building is often complex, and can involve the societal benefits offered from green buildings as well as the environmental goals set forth for a project. Therefore, to better understand the factors that have encouraged respondents to engage with green building in their current practices, respondents were asked to rate a series of social reasons for building green. This question was also included in most of the previous *World Green Building Trends* studies, and the findings from 2012 to 2021 are shown in the chart at right. In addition, the table on the following page reveals the importance of each reason by country.

### Promotes Improved Occupant Health and Well-Being

The COVID-19 pandemic has raised the public profile of healthier buildings, but their growing importance to green building predates that among green building practitioners.

- The share of respondents who rate healthier buildings as an important/very important reason that they have built green projects has steadily increased from 72% in 2012 to 80% in 2021.
- Every country except Germany has 70% or more respondents who rate this as important/very important.
- Significantly fewer contractors (70%) rate this as important/very important than do architects (82%), engineers (80%), owners (82%) or investors (89%).
- 91% of those doing a majority of green projects consider this important/highly important.

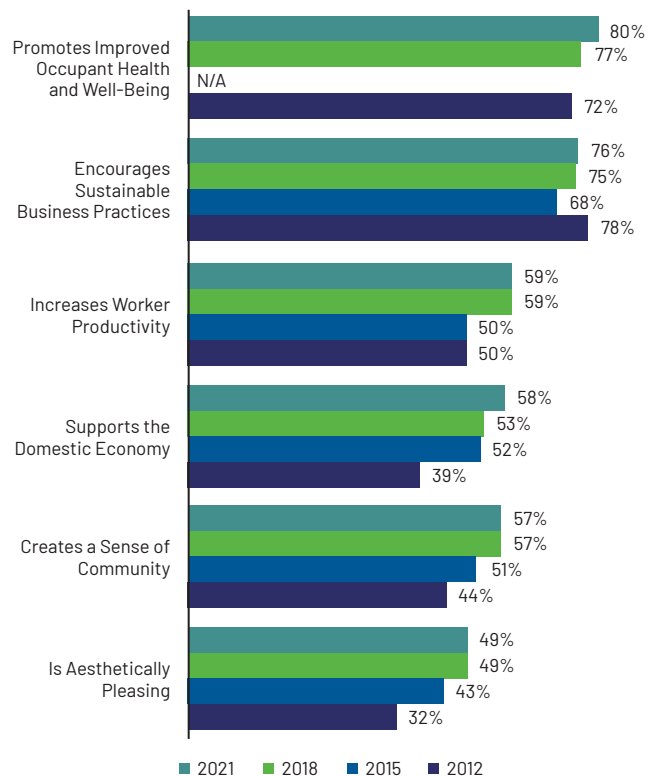
### Encourages Sustainable Business Practices

Green projects encourage sustainable business practices by example, and throughout the project team. A significant commitment to green buildings by large companies or by a large number of companies can also influence supply chain practices.

- Encouraging sustainable business practices has consistently been one of the top social reasons for building green since 2012, and 76% in the current study rate it as important/very important.
- As with healthier buildings, nearly all of the countries included in this analysis have 70% or more who rate this as important/very important, demonstrating its near universal influence. The only exception is Germany.
- Investors place the highest level of importance on this, with 92% who consider it important.
- 90% of those doing a majority of their projects green consider this important/highly important.

### Social Reasons for Building Green (Respondents Who Rated Each as Important/Very Important)

Dodge Data & Analytics, 2021



### Other Influential Reasons for Building Green

The survey included four other social reasons for building green, all of which are represented in the chart above and in the table on the following page. While not as broadly influential as creating healthier buildings or encouraging sustainable business practices, about half of respondents select each as influential reasons to build green.

#### INCREASES WORKER PRODUCTIVITY

Often considered a side benefit of having a healthier building, increased worker productivity is difficult to measure but can have a profound effect on the business performance of a company.

- The importance of productivity as a driver for green building increased between 2015 and 2018, and that increase is sustained in 2021.
- The top countries in which this is an influential factor include Cameroon, Saudi Arabia, India and Mexico. It is least

# Influences on Green Building Markets

## Social Reasons for Building Green CONTINUED

WORLD GREEN BUILDING TRENDS 2021 DATA

influential in Canada and Germany.

- There is no difference by type of company in how important this reason is for building green, but about two thirds of those doing at least 30% of their projects green consider it important, compared with just 54% of those doing 15% or fewer green projects.

### SUPPORTS THE DOMESTIC ECONOMY

Sufficient green building activity can support the shift to a greener economy, which may help position countries to have more sustainable growth in the near future.

- Only 39% considered this an important social reason to build green in 2012, but the current study has the highest share yet who do, at 58%.
- This factor is considered most important in Cameroon, China, India and Saudi Arabia and least important in Canada.
- Far more investors(81%) rate this as important/very important than do architects, engineers, contractors or owners.

### CREATES A SENSE OF COMMUNITY

Social spaces are often prioritized in green building projects, and responsiveness to the community is a fundamental part of a true green building practice.

- The 2021 findings sustain the growth in the importance of this factor first seen in 2018, suggesting a shift toward prioritizing a sense of community that is more long term.
- A high percentage of respondents from Cameroon, Saudi

Arabia, Brazil, China and India all rate this factor very highly, but it is less frequently considered important by respondents from Canada, Germany and the US.

- Owners(66%) and investors(73%) far more frequently rate this as important than do architects(53%), engineers(61%) or contractors (51%). This may reflect owner and investor engagement in the project throughout the building’s lifecycle, rather than just in the construction process. It may also be influenced by the benefit to owners and investors of a community embracing rather than resisting a new project.
- About two thirds of those doing over 30% of their projects green consider this important, compared with just 52% of those doing 15% or fewer green projects.

### IS AESTHETICALLY PLEASING

Some consider the aesthetic qualities of green buildings as highly important, for the building to improve the community, be a durable addition to the building stock and even for approaches like biophilia, which draws on the innate beauty of nature.

- While ranking lowest, nearly half still consider this important, and the share of those rating it as important has grown notably since 2015.
- It is widely ranked as important in Cameroon, China and Saudi Arabia, and less commonly in Australia/New Zealand, Canada, Colombia and the US.

## Top Social Reasons for Building Green (Rated as Important/Very Important)

Dodge Data & Analytics, 2021

	80% or More	70% to 79%	60% to 69%	50% to 59%	Fewer Than 50%
Promotes Improved Occupant Health & Well-Being	Cameroon, China, Colombia, India, Mexico, Saudi Arabia, South Africa	AU/NZ, Brazil, Canada, Singapore, US	None	Germany	None
Encourages Sustainable Business Practices	Brazil, Cameroon, Colombia, India, Mexico, Saudi Arabia, South Africa	AU/NZ, Canada, China, Singapore, US	Germany	None	None
Increases Worker Productivity	Cameroon, Saudi Arabia	India, Mexico	China, Colombia, South Africa	AU/NZ, Brazil, Singapore, US	Canada, Germany
Supports the Domestic Economy	Cameroon	China, India, Saudi Arabia	Brazil, Mexico, Singapore, South Africa	AU/NZ, Colombia, Germany, US	Canada
Creates a Sense of Community	Cameroon, Saudi Arabia	Brazil, China, India	Colombia, Mexico	AU/NZ, Singapore, South Africa	Canada, Germany, US
Is Aesthetically Pleasing	None	Cameroon, China, Saudi Arabia	Brazil, India	Germany, Mexico, Singapore, South Africa	AU/NZ, Canada, Colombia, US

# Influences on Green Building Markets

All respondents were asked to rate the importance of five environmental reasons for building green on a five-point scale, from not important to very important. Not surprisingly, the majority of respondents rate all five as important/very important, ranging from 79% who give that rating to protecting natural resources to 87% who rate reducing energy consumption that highly.

Therefore, in contrast with the analysis of the social reasons for building green (see page 12), this analysis focuses solely on those who rate each at the top of the scale as very important, in order to more clearly distinguish the respondents' top priorities. The chart at right and the table on the following page both show only those who selected very important.

However, it is important to note that nearly all respondents regard each of these factors as important reasons for their current level of engagement with green building.

## Reducing Energy Consumption

Reducing energy consumption continues to be the environmental reason most frequently rated as very important by respondents.

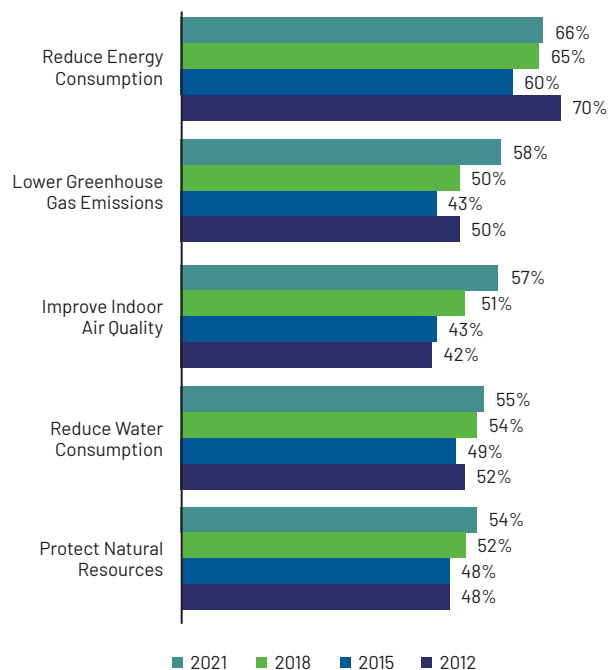
- Between 65% and 70% have consistently rated it as very important in the current and previous surveys, other than a brief drop to 60% in the 2015 study.
- The table on the following page shows a general pattern for those in Brazil, Cameroon, Colombia and Mexico to have a high percentage rating every environmental reason for building green as very important, and for those in China, Germany and Singapore to have the smallest share who do so. This may be due to cultural differences, degree of tenure with green building or other factors. Therefore, it is more productive to focus on other differences. In this case, all other countries roughly correspond to the global average for rating the importance of energy consumption, suggesting its widespread importance.
- There are no significant differences between architects, engineers, contractors, owners or investors in the share who rate reducing energy consumption as a very important reason for building green.
- However, 82% of those who do the majority of their projects (more than 60%) green and 79% of those who do over 30% to 60% green projects consider this a very important reason for building green, compared with around 60% of those doing a smaller share of green.

## Lower Greenhouse Gas Emissions

For many, lowering greenhouse gas emissions is a primary

## Top Environmental Reasons for Building Green (Rated Very Important by Respondents)

Dodge Data & Analytics, 2021



goal of many green projects in order to reduce the impact of climate change. For some, though, it is not as directly linked to cost savings as energy use reduction, and others believe that full net zero is a more impactful target. Still despite these factors, it ranks second in the share who rate it as very important.

- The share overall who rate it as highly important in 2021 is notably larger than in previous years. In fact, in 2015, it ranked fifth out of the five reasons for building green, so even in the last three years, it has gained in importance.
- The improved performance of this factor in the 2021 findings, though, may be related to fact that the US makes up a smaller share of the respondents in 2021 than in 2018. The US has consistently lagged behind many other countries in rating the importance of lower greenhouse gas emissions, and it continues to do so in the current study.
- Notably, Canada has one of the highest share who rate this as very important.
- Again there are no significant differences by type of organization in the share of those who rate lower greenhouse gas emissions as a very important reason for building green.



# Influences on Green Building Markets

## Environmental Reasons for Building Green CONTINUED

WORLD GREEN BUILDING TRENDS 2021 DATA

- However, 77% of those doing a majority of their projects green and 65% of those doing between 31% and 60% green projects consider it very important, compared with 51% doing fewer green projects.

### Improve Indoor Air Quality

The importance of healthier buildings (see page 12 for its ranking as the top social reason for building green) is often reflected in more focused attention on improving indoor air quality.

- Improving indoor air quality has seen steady growth in those who rate it as very important between 2012 and 2021.
- A high share of respondents in Saudi Arabia rate this as important, and Australia/New Zealand is below the global average for this green driver.
- As with energy consumption and greenhouse gas emissions, there is no notable difference by type of organization for this factor.
- 68% of those doing a majority of their projects green rate this as highly important, significantly more than those less engaged.

### Reduce Water Consumption

While reducing water consumption has always been a priority, it has also become an adaptation to climate change impacts that have already occurred, as many regions experience extended droughts that are likely to worsen in the future.

- Despite increasing concerns about water in certain regions, the share who rate reducing water consumption as highly important has remained remarkably consistent since 2012,

with only a slight uptick currently between 2018 and 2021.

- India, Saudi Arabia and South Africa are all above the global average in the share who rate reducing water consumption as a very important reason for building green, while Australia/New Zealand and Canada are below it.
- Again, there is no difference based on type of organization for reducing water consumption.
- 64% of those doing a majority of their projects green cite this as a very important reason.

### Protect Natural Resources

While protecting natural resources is ranked fifth out of the five environmental reasons for building green in the current study, the share selecting it as very important is only a few percentage points below most of the other options, demonstrating that it is very important to the building sector.

- As with water consumption, the share rating this as very important has stayed relatively consistent between 2012 and 2021.
- Respondents from South Africa are above the global average in the share rating this as very important, and those from Australia/New Zealand are below it.
- Fewer engineers (46%) rate this as a very important reason for building green than other types of organizations, with significant differences between them and architects (58%) and investors (68%).
- 62% of those doing a majority of green projects consider this a very important reason for building green.

## Top Environmental Reasons for Building Green (Rated as Very Important)

Dodge Data & Analytics, 2021

	70% or More	60% to 69%	50% to 59%	40% to 49%	Fewer Than 40%
Reduce Energy Consumption	Brazil, Cameroon, Colombia, Mexico	AU/NZ, Canada, India, Saudi Arabia, South Africa, US	Singapore	China, Germany	None
Lower Greenhouse Gas Emissions	Brazil, Cameroon, Canada	AU/NZ, Colombia, India, Mexico, Saudi Arabia, South Africa	US	Singapore	China, Germany
Improve Indoor Air Quality	Cameroon, Saudi Arabia	Brazil, Colombia, Mexico	Canada, India, South Africa, US	AU/NZ, China, Singapore	Germany
Reduce Water Consumption	Brazil, Cameroon, Colombia	India, Mexico, Saudi Arabia, South Africa	US	AU/NZ, Canada, China, Singapore	Germany
Protect Natural Resources	Brazil, Cameroon, Colombia, Mexico	South Africa	Canada, India, Saudi Arabia, US	AU/NZ, Singapore	China, Germany

# Influences on Green Building Markets

## Triggers to Increase Levels of Green Building

All respondents were asked to select the three most important triggers for increasing their organizations' involvement in green building projects. Architects, engineers, consultants and contractors were provided with a list of 12 options, and owners with a list of 15 options (including higher ROI, higher occupancy rates and higher rents). The two charts at right show the top responses from each group, with the investor results included in the owner chart.

The chart on the following page shows the global average for each option and the countries that most frequently and least frequently select it as a top trigger.

### Top Factors Influencing Architects, Engineers and Contractors

Notably, the top factors for designers and builders are very different from those for owners and investors.

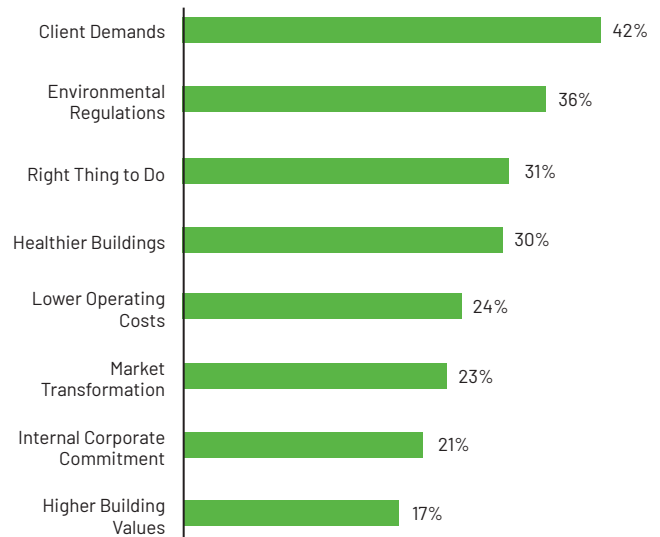
- Owners are still highly influential in determining green activity, with the highest percentage of designers and contractors identifying client demands as their top reason for building green. This is why understanding the top triggers for owners and investors is critical to encouraging more green building.
- The regulatory environment is also very influential for practitioners, with environmental regulations selected in their top three by over one third. Surprisingly, regulations are less influential for owners and investors, which may suggest that regulatory requirements can help fill the gaps in driving practitioners to engage in green building when their clients don't prioritize sustainable goals.
- Right thing to do ranks third for AEC practitioners. Notably, it has increased in importance since 2018, with a global average of 31% who place it in their top three now, compared with 25% in 2018. While this is likely due to many factors, including differences in the profile of the respondents, it may also be influenced by the high-profile climate concerns like severe weather that are getting more media focus.
- Healthier buildings ranks fourth for practitioners. On average, it has also seen a slight bump in the share who consider it important since 2018 (27%). However, the increase is small and its overall ranking remains the same as it did in 2018, which suggests that increased engagement with healthier buildings is not driven by pandemic concerns but is part of a more fundamental shift in prioritizing health that was already started in 2018.

### Top Factors Influencing Owners/Investors

There is only an eight percentage-point difference between the top four triggers for owners/investors, suggesting that all

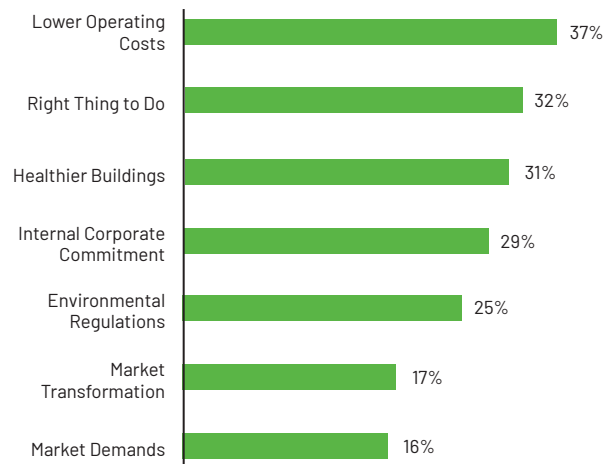
### Top Triggers for Green Building (Selected Among the Top Three by Architects, Engineers and Contractors)

Dodge Data & Analytics, 2021



### Top Triggers for Green Building (Selected in the Top Three by Owners and Investors)

Dodge Data & Analytics, 2021



# Influences on Green Building Markets

## Triggers to Increase Levels of Green Building CONTINUED

of these play a role in many owner/investor decisions to build green.

- Lowering operating costs is the top factor for owners, and it is far less influential for the AEC respondents.
- Right thing to do and healthier buildings rank second and third in close succession. The share of owners/investors who select each is about the same as the share of AEC respondents who do so.
- Notably, none of the triggers presented solely to owners—higher ROI, occupancy rates or rents—were selected by more than 11% of owners.

### Variation by Country

As the chart below reveals, the influence of specific triggers vary significantly by country. Thus efforts to encourage more green building globally must take place on the local level, with careful attention to the triggers and obstacles that matter most in individual regions.

### Countries With the Highest and Lowest Percentages Selecting the Top Triggers for Future Green Building

Dodge Data & Analytics, 2021



# Influences on Green Building Markets

In addition to being asked about the top triggers, all respondents were asked about the top three barriers to increasing their green activity from a list of 10 possible options. The chart at right shows the top seven overall, plus the regions in which they are most influential.

## Higher (Perceived or Actual) First Costs

Higher first costs continue to be the top barrier, as they have been consistently in previous surveys.

- A particularly high share report this as a barrier in Colombia.
- In the past, the US had this barrier dominate all others, but this study has a nine-point decline for US respondents.
- Investors are less concerned about this than other types of organizations, with only 30% who select it.

## Lack of Political Support or Incentives

The only other barrier selected by more than one third of respondents is lack of political support or incentives.

- Respondents from Cameroon find this much more challenging than other countries.
- There are no differences by type of organization in the share who select this option.

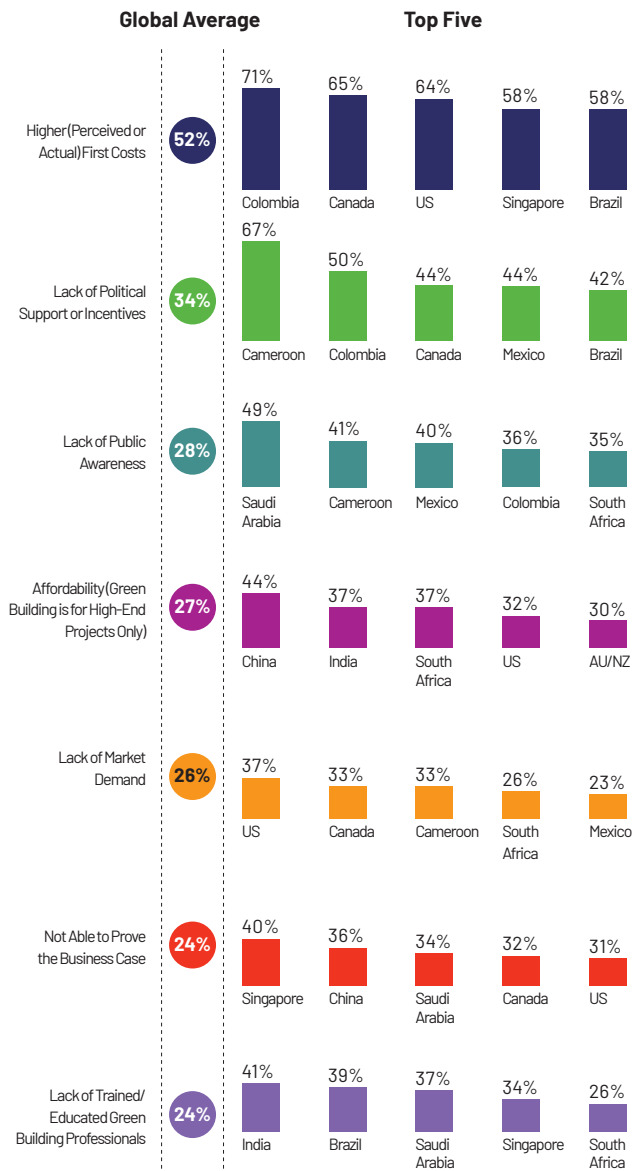
## Other Top Barriers

Five other barriers were all selected by around one quarter of total respondents, suggesting that each has some influence and should be addressed.

- Lack of public awareness is a particularly challenging issue in Saudi Arabia.
- The share selecting affordability has declined from 33% to 27% since 2018, with China, India and South Africa most challenged by this issue.
- Owners less frequently select lack of market demand as an obstacle to their building green than do the other types of organizations. Notably, their top triggers for green building are also not market driven. The findings reinforce, instead, the importance of financial considerations as the top drivers and obstacles for owners.
- However, it is notable that owners are on par with other types of organizations in their concerns about not being able to prove the business case, which suggests that many owners believe that the business case for green is relatively clear.
- Singapore struggles with being able to prove the business case more than other markets.
- India finds the lack of trained/educated green building professionals a particular challenge.

## Top Barriers to Increasing Green Building Activity (Overall and by Country)

Dodge Data & Analytics, 2021



# Influences on Green Building Markets

## Green Building Rating Systems

The findings of this study demonstrate that the majority of projects considered green by the respondents are also registered for certification under a recognized green building rating system. This is just one example of the ongoing influence of these systems on the green building market.

To better understand what drives use of these systems, respondents who reported using a certification system on their current projects were asked to select the top three benefits of the systems they use. In addition, all respondents were asked about the top three reasons they choose not to use a rating system on projects where they do not employ one.

### Benefits

As the chart at upper right shows, all eight benefits are selected by over one third of respondents as among the biggest they receive from their rating system, suggesting that the use of certification systems offers a wide range of benefits.

- Nearly two thirds agree that use of a certification system increases their ability to create better-performing buildings, which suggests that having a standard to reach and a set of goals is still useful for most doing green buildings.
- Over half also note the benefit they get from having third-party verification and that they find that using a rating system provides a marketing and competitive advantage.
- Notably, there are no significant differences by type of organization between architects, engineers, contractors, owners or investors for nearly all of these benefits.
- More of those doing the majority of their projects green report experiencing the top five benefits at a significantly higher level than the global average.

### Factors Influencing the Decision Not to Use a Green Rating System

Only 11% of respondents report that they always use a rating system. Therefore, it is also useful to understand why the rest choose not to do so on some projects.

- Cost is by far the most influential factor in that decision.
- The relatively low share of respondents selecting most of the other options suggests that they are not as influential.
- A notably high share of respondents selected the last option (other), and almost half of those that did so say that they didn't select a rating system because the owner was not interested or didn't require it. This reinforces the previous findings about the influence of the owner (see page 16) in the decision to build green.

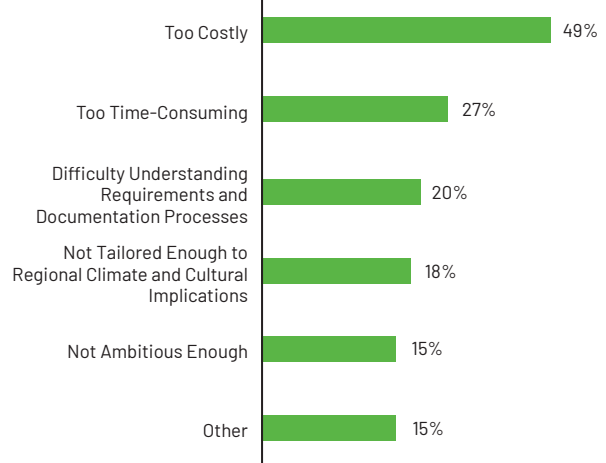
### Benefits of Using a Rating System (Percentage Selecting Each Among Their Top 3)

Dodge Data & Analytics, 2021



### Factors That Influence the Decision to Not Use a Rating System for a Green Project (Percentage Selecting Each Among Their Top 3)

Dodge Data & Analytics, 2021



# Influences on Green Building Markets

## United Nations' Sustainable Development Goals

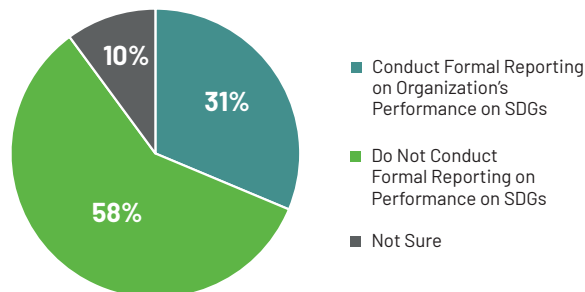
In 2015, the United Nations General Assembly adopted the 2030 Agenda for Sustainable Development, which contained 17 interrelated sustainable development goals (SDGs) that are intended as a blueprint for improving the world. The UN's website on this initiative describes the 17 goals as "an urgent call for action by all countries—developed and developing—in a global partnership. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality and spur economic growth—all while tackling climate change and working to preserve our oceans and forests." That description and a list of all 17 goals can be found at <https://sdgs.un.org/goals>.

To better understand the influence of this initiative on the green building market, all respondents were asked about SDGs, with options ranging from not being familiar with them to having them influence their green building strategy on all of their projects. As the chart below reveals:

- Over half (58%) report that SDGs do not have any influence at all, with nearly one third (32%) reporting that they are not familiar with them.
- Contractors and owners/investors are least frequently familiar with them.
- Those who find them influential are nearly evenly split between those who find them only influential on a few projects and those who report they are influential on many or all of their projects.

### Owners/Investors' Engagement With Formal Reporting on SDGs

Dodge Data & Analytics, 2021

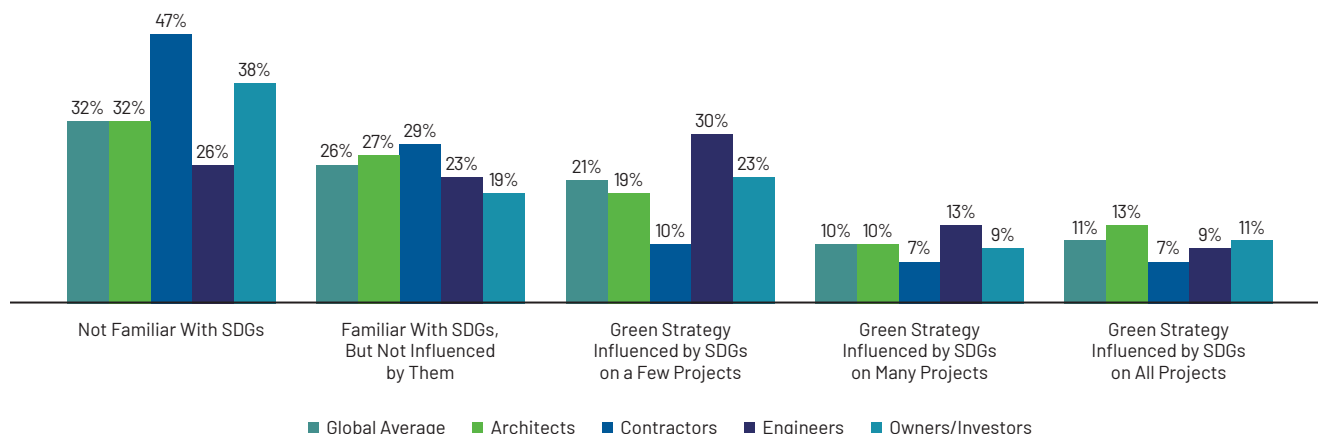


These findings suggest that the SDGs are having an impact, but that more awareness and engagement with them is also needed to help achieve them.

Owners and investors were also asked about whether they conduct formal reporting on their organizations' performance on SDGs, and as the pie chart above reveals, only 31% currently do so. This is another indicator that greater engagement by the building community is needed.

### Influence of the UN's Sustainable Development Goals

Dodge Data & Analytics, 2021



## Building Health: Rising Demand

### Greater awareness of building impacts on occupant health is changing priorities for the built environment.

If something good has come out of the pandemic, it's a surging awareness of the importance of the built environment in human health, and an increasing integration of health as a priority into building design, construction and operation. In early 2020, for example, the building area enrolled or certified under the WELL Building Standard (WELL) had surpassed 500 million square feet. Today, that number is well over 3 billion square feet across 30,000 projects in nearly 100 countries.

"COVID has significantly accelerated how we look at public health through the lens of buildings and communities," says Jason Hartke, executive vice president at the International WELL Building Institute (IWBI), which administers the standard. "From parents sending their children to school to workers making their commutes downtown, we now have a market that is knowledgeable about the role that buildings play in health—and in protecting health."

#### A Paradigm Shift

The heightened awareness among individuals who live, work and recreate in buildings is also manifesting among building owners. An international survey of real estate investors representing USD \$5.75 trillion in assets, conducted in 2021 by the Center for Active Design (CfAD) in partnership with BentallGreenOak and the United Nations Environment Programme Finance Initiative, found that 87% of respondents experienced increased demand for healthy buildings over the previous 12 to 24 months, 92% expect demand to grow over the next three years, and 89.5% plan to enhance their

company's health and wellness strategy in the coming year. (Assets included in the survey responses comprise primarily office, multifamily residential and diversified portfolios, with a majority located in North America, 18% in Europe, 10% in Asia and 13% geographically diverse.)

The business case is strong: for example, a 2020 study by the MIT Real Estate Innovation Lab found that across 10 US cities, effective rents for health-certified buildings transact between 4.4% and 7.7% more per square foot than for their nearby noncertified and nonregistered peers.

As healthy building advocates have sought to build demand over the last decade, they've relied on the business case, but more data is being gathered on the effects of the practices used by those seeking to improve building impacts on health. "Now, for the first time, we're talking about health outcomes directly," says Joanna Frank, executive director at CfAD, which administers Fitwel, a building certification system developed by the U.S. Centers for Disease Control and Prevention (CDC). Where previously investors thought in terms of companies with portfolios of assets, the pandemic has shifted their focus to individual buildings and their occupants, Frank says. As a result, "health has gone from being a positive, nice-to-have differentiator to a risk factor that can negatively affect a property's ability to attract and retain tenants," she says, "and the risk column gets attention."

#### A Measured Approach

With the real estate sector under pressure to act on the health priority,

both Frank and Hartke emphasize the importance of implementing evidence-based solutions. The survey of investors found that Fitwel and WELL are used by 47% and 39% of respondents, respectively, which compares with broader sustainability standards such as BOMA BEST at 37% of respondents, BREEAM at 29% and LEED at 68%.

Most recently, CfAD and the CDC have created an overlay certification for Fitwel specifically focused on infectious disease. IWBI is developing a new performance rating to foster building operations and management based on measurable and validated health-related metrics. And two code proposals now under consideration by the International Code Council would, if adopted, integrate indoor air quality standards into the 2024 iteration of the mechanical code.

As awareness of, and demand for, healthier buildings reaches new highs, there are challenges still to be met. These include:

- Supporting the health priority in countries and sectors where it has so far been underserved.
- Ensuring that the once-in-a-generation investments now being made, partly in response to the pandemic and its economic implications, are well spent.
- Making integrated progress on sustainability, resilience and health together.

"Now is the time to be pushing those boundaries," says Frank. ■

# Interview: Thought Leaders



**Cristina Gamboa**  
CEO, World Green Building Council

**An influential and inspirational leader in the field of sustainability, Cristina is passionate about radical cross-sector collaboration to bolster systemic change and make this the decade for net-zero emissions.**

## What are the biggest changes you have seen in the green building movement in the last three years?

**GAMBOA:** Sustainability has accelerated because of the pandemic. It forced the industry to drive forward all the best practices for a healthier world.

Also, when COP 26 was delayed, we had more time to engage in deep collaboration around the built environment. Through this work, we have been able to showcase the built environment in the official program of COP26 as a critical climate solution. This hasn't happened since COP21. For the green building movement, this is the moment in which it receives the importance it deserves. We have also collaborated with the COP26 High Level Climate Champions Team. They set out breakthrough efficiency targets for each participating sector, including building and construction, in what is called the Race to Zero ... This coalition represents tens of thousands of organizations, including GBCs in over 70 countries. There are two climate targets for the built environment: halving emissions by 2030 and decarbonizing by 2050.

[These developments] are really important because it is not enough to do a little bit less harm; we have to do more. The climate change threshold has changed, the biodiversity threshold has changed. We have a much clearer call to action. Going into COP26, we are seeing more awareness, more action, and more leadership and deep collaboration that will allow our sector to accelerate to limit global heating to 1.5 degrees and reach the Paris Agreement.

## What trends in the pursuit of green are you most excited about?

**GAMBOA:** What excites me is that many leaders have already demonstrated that they can curb operational emissions ... And now, as we address embodied carbon, that means thinking about the building's entire lifecycle. Day after day, we see Race to Zero companies declaring their science-based targets and announcing new products and new innovations. I am also excited to see in the data in this *SmartMarket Report* that financial, ethical and sustainable drivers are still motivating green building. The multiple drivers for sustainability is also the core message behind the business case report that we are launching in parallel because it is going beyond the codes. Codes encourage people to take action, but there is also a realization that sustainability is one of the biggest business opportunities of this decade.

I think the new phase we are in is about regeneration. We see more and more about net positive spaces. We don't just try to reduce emissions and do less harm, but we also strive to restore biodiversity, embrace the circular economy and also enhance our economies and protect human health.

## What are the biggest challenges to achieving these goals?

**GAMBOA:** The policy gap is always important. We wish there could be a clear policy signal for every stakeholder in the industry to move in that direction. As the conversation of the overall framework of national commitments around measuring building evolves, it is a massive opportunity to encourage

performance-based energy codes for building, to continue to improve procurement, to continue to specify better materials that are using environmental product declarations, to embrace LCA [lifecycle analysis], all of that. Businesses have shown that they are ready for bolder, more ambitious regulation, right? Hopefully, we will see policy catch up.

## What do you recommend to design and construction practitioners interested in taking a more ethical approach?

**GAMBOA:** [We need] transparency and disclosure around everything the industry does. First, check if your company is aligned with sustainable development goals and work on your corporate, science-based target goals. Second, start treating carbon accounting the same way you treat your financial accounting. You need to know [your entire] footprint and what you can do about it. And finally, what you design today has to be a high-performance building in the future because those buildings will be around for 50 or 100 years. So if you are still designing today without thinking of climate changes or future-proofing your assets, you will be left with stranded assets and risky buildings.

## What is the one thing that needs to happen in the next three years?

**GAMBOA:** Engagement. [Committed companies] help others along the journey. They bring collaboration, momentum and create more demand and engagement. That's the way to have emissions become zero by 2050.



# Data: Business Benefits of Building Green

## Important Business Benefits of Green Building

All respondents were asked to select the most important business benefits of green building in their market from the list of 11 options shown in the chart at right. Given the importance of owners and investors in driving green building (see pages 16 and 18), their responses are shown in contrast to the global average to identify the greatest influences on them.

- The top two benefits by far according to all respondents are lower operating costs and improved/user occupant health and well-being. Owners are consistent with the overall averages for both, but investors select each of them far less frequently.
- Investors select a more diverse set of benefits as important. They include lower costs and improved health, but also future-proofing assets, user/occupant education about sustainability, higher value at point of sale, increased productivity for tenants and flexibility of design.
- Owners and investors more frequently select future-proofing assets as a top benefit than do the other types of organizations, although not as frequently as they select lower operating costs or improved health.

### Variation by Country

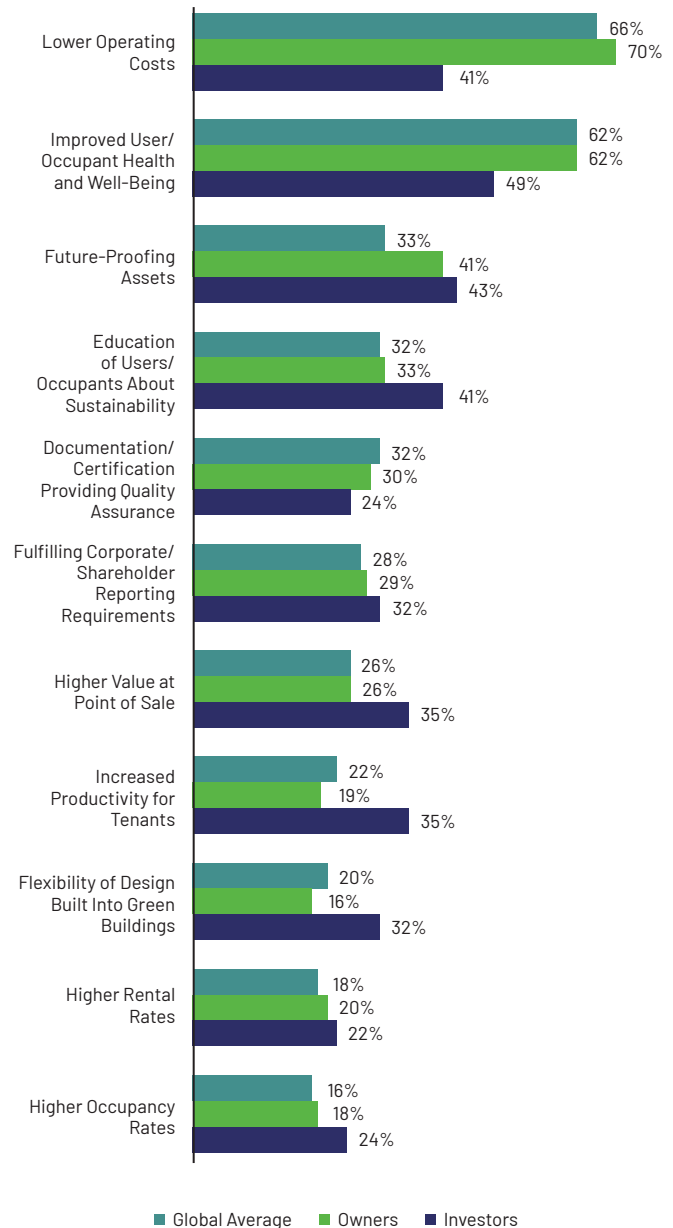
- Respondents from Australia/New Zealand more frequently select future-proofing assets(56%)and fulfilling corporate and/or shareholder reporting requirements(46%) than do most other countries.
- Respondents from Canada and the US more frequently select lower operating costs(87% and 80%, respectively) and improved user/occupant health and well-being(79% and 75%, respectively) than do others.
- Many from Singapore (75%)select lower operating costs.
- A relatively high share of respondents from India believe higher occupancy rates(33%)and increased productivity for tenants(39%)are top benefits in their market.
- Many respondents from Saudi Arabia also consider higher occupancy rates(34%)and increased productivity for tenants(40%)top benefits there, and nearly half(45%)also select flexibility of design built into green buildings.

### Variation by Green Involvement

- Those doing a majority of green projects more frequently select fulfilling corporate/shareholder reporting requirements(46%), documentation and certification(43%) and future-proofing assets(40%)than the global average.
- Those with moderate green involvement (30% to 60% green projects)also beat the global average for future-proofing assets(45%), and documentation and certification(42%).

## Most Important Business Benefits of Green Building

Dodge Data & Analytics, 2021



# Business Benefits of Building Green

## Metrics Used to Measure Benefits of Green Building

WORLD GREEN BUILDING TRENDS 2021 DATA

Measurement can be critical to fully achieving sustainable goals. Therefore respondents were asked what metrics they use to formally track performance on their green projects. They were also given the option to say they do not use metrics at all.

### Overall Use of Metrics

Globally, the vast majority (79%) of those building green use at least one metric to track green building performance. This is an increase of five points over the share who used formal metrics in 2018 (74%), which clearly demonstrates that the industry continues to recognize the importance of measurement.

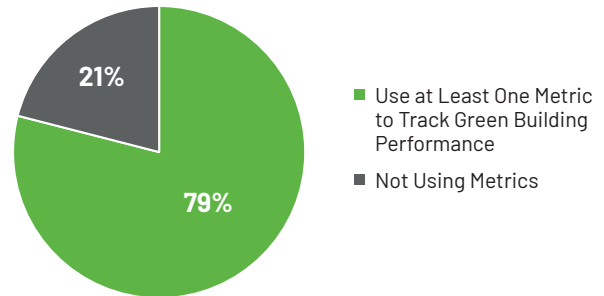
The table at bottom shows regional variations in metrics use, with four countries in which it is nearly ubiquitous, six in which it is very common and two that lag behind. However, even in Cameroon and the US, at least half of respondents report that they are formally measuring at least one aspect of building performance, so metric use is relatively common across the globe.

Surprisingly, architects less frequently use formal metrics than other types of organizations, with only 66% reporting that this occurs. Not surprisingly, owners (84%) and investors (91%) are among the most frequent users of metrics, given the importance of financial performance in their motivation to build green (see page 16).

Those doing very few green projects (15% or fewer) are less likely to use metrics to track their performance, with 70% reporting that they do so, and there is no significant difference between those with moderate and high levels of green involvement in the overall use of metrics.

### Global Use of Metrics to Track Green Project Performance

Dodge Data & Analytics, 2021



### Use of Metrics to Track Green Project Performance, by Country

Dodge Data & Analytics, 2021

90% or More Respondents Using Metrics	80% to 89% of Respondents Using Metrics	40% to 79% of Respondents Using Metrics
China, India, Mexico, Saudi Arabia	AU/NZ, Brazil, Colombia, Germany, Singapore, South Africa	Cameroon, Canada, US

# Business Benefits of Building Green

## Metrics Used to Measure Benefits of Green Building CONTINUED

WORLD GREEN BUILDING TRENDS 2021 DATA

### Use of Specific Metrics

The study asked respondents whether they use the six specific metrics for tracking green performance shown in the chart below.

#### USE BY TYPE OF ORGANIZATION

The chart shows the global average for the use of each metric, along with its use by type of organization.

- Lower operating costs are the most frequently used metric globally, and the only metric to be used by more than half of those who use metrics at all.
- Owners most frequently track lower operating costs, more than any other type of organization.
- Investors more frequently use documentation and certification providing quality assurance, higher value at point of sale and higher rental rates than the others.
- Contractors more frequently track improved occupant health and well-being than do architects, a surprising finding.
- Engineers and contractors are more frequently tracking increased productivity for tenants than other respondents.

#### VARIATION BY COUNTRY

- Metrics are widely used in China. They exceed nearly every other country included in the study in their use

of documentation and certification (60%), and they significantly exceed the global average for higher rental rates (28%) and improved occupant health and well-being (53%).

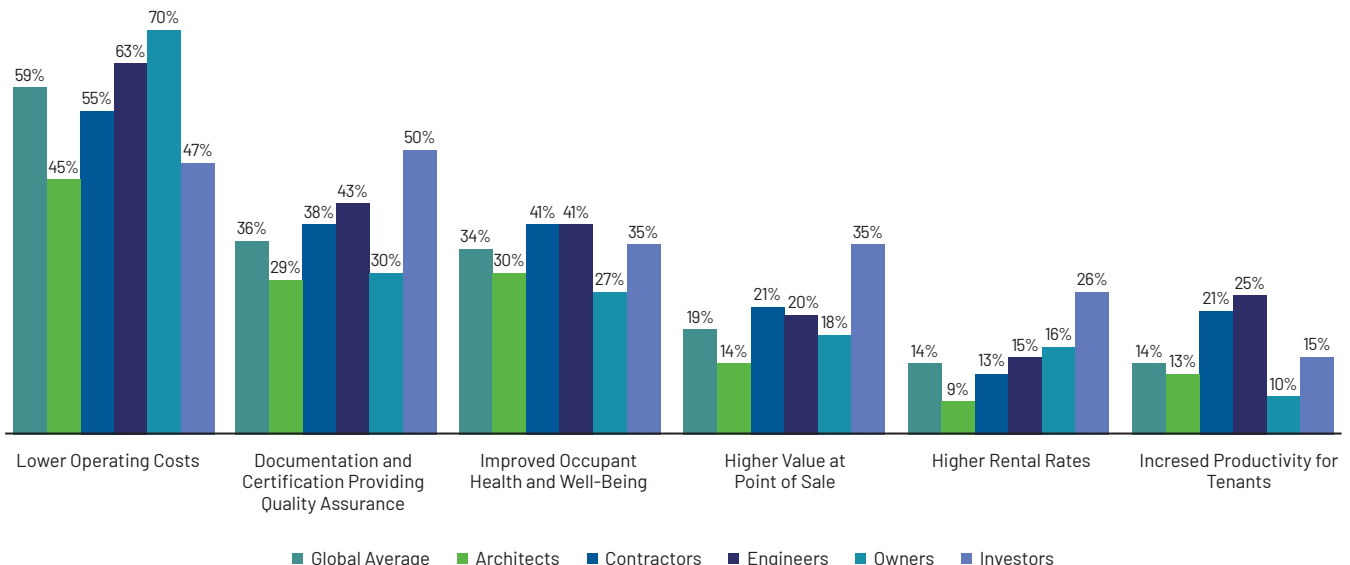
- India also more widely uses metrics than many of the other countries included in the study. They exceed the use of most other countries for tracking increased productivity for tenants (32%) and improved occupant health and well-being (58%) and also significantly exceed the global average for higher occupancy rates (28%).
- Saudi Arabia is a leader over most other countries in their use of documentation and certification (63%), higher value at point of sale (47%) and increased productivity for tenants (41%). They also exceed global averages for higher rental rates (34%), higher occupancy rates (41%) and improved occupant health and well-being (56%).
- Other countries that significantly exceed global averages for the use of specific metrics include Mexico for documentation and certification (56%), and Singapore for tracking lower operating costs (75%).

#### VARIATION BY GREEN INVOLVEMENT

Those doing a majority of green projects exceed global averages in their use of documentation and certification (48%), and metrics for lower operating costs (71%).

### Metrics Used to Track Green Building Performance

Dodge Data & Analytics, 2021



# Business Benefits of Building Green

## Impact of New Green Buildings on Operating Costs

Since 2012, the *World Green Building Trends* study has included a question on the expected impact of new green buildings on operating costs within the first 12 months and first five years of operation. The findings from the current study and the previous ones are shown in the charts at right.

Both charts clearly reveal how consistent the findings on these questions have remained between 2012 and 2021. They make a compelling case for the return on investment for green construction.

- The mean for overall savings in 2021 for the first 12 months of operation is 10.5%, and the mean for five years is 16.9%.
- There is an uptick between 2018 and 2021 in the share of those who report seeing cost decreases of 5% or less and a corresponding decline in those who report that the cost decreases fall between 6% and 10%. However, these findings are similar to those in 2012, so not out of bounds with previous findings.
- Over one third continue to report savings within the first year of over 10%, and over 60% report that level of savings in the next five years.

### Variation by Country

- About one quarter of respondents in Canada and the US report that they don't know the cost savings on their new green buildings over either time frame. This is consistent with the fact that fewer respondents in Canada and the US report tracking metrics on green building performance.
- However, those who are tracking performance in both countries report a higher average mean (12.8% and 12.3%, respectively) for one-year operational cost savings.
- Australia/New Zealand also reports a relatively high average level of savings in the first year (12.2%).
- The top countries for average five-year savings are Cameroon (21.5%), South Africa (19.6%) and Canada (19.3%).

### Variation by Type of Organization

Given the importance of operational cost savings in driving owner investment in green building, it is worth noting that owners report very similar averages to the ones reported by all respondents, with average savings of 10.6% over the first year and 16.2% over five years.

### Variation by Level of Green Involvement

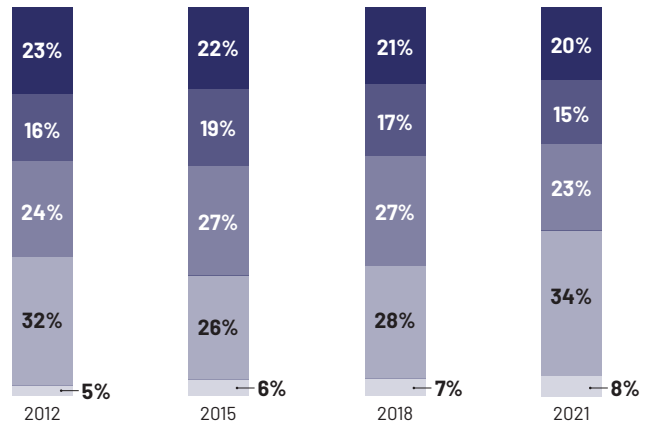
Higher green engagement leads to more savings. Those doing the majority of their projects green report an average operational cost savings of 16.7% in the first year and 20.7% in the first five years, significantly exceeding the global averages.

### Expected Operating Cost Decreases for New Green Buildings

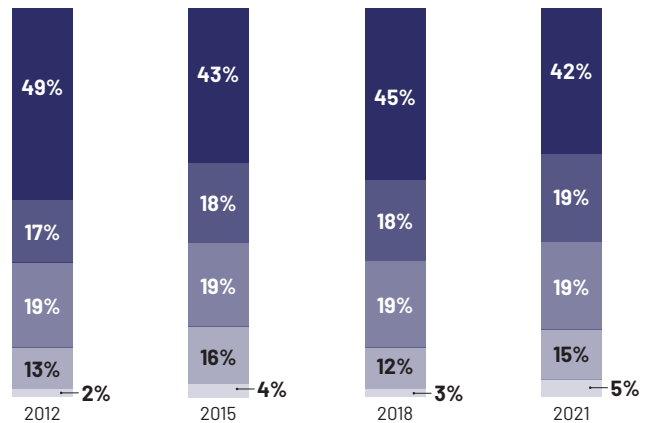
Dodge Data & Analytics, 2021

■ More Than 15% ■ 11%-15% ■ 6%-10% ■ 5% or Less ■ None

#### Within the First 12 Months of Operation



#### In the Next 5 Years



# Business Benefits of Building Green

## Asset Value Increase for New Green Buildings

WORLD GREEN BUILDING TRENDS 2021 DATA

Since 2012, the *World Green Building Trends* study has also included a question about the expected increase in asset value for new green buildings, asked of owners, investors, architects and engineers. The findings from the current study, along with the previous findings, are shown in the charts at right.

As the two charts show, architects and engineers were given an additional option of a new building retaining value better due to being green, while owners were only asked about increases in asset value.

Both charts, though, show that most of those doing new green buildings believe them to be a good investment.

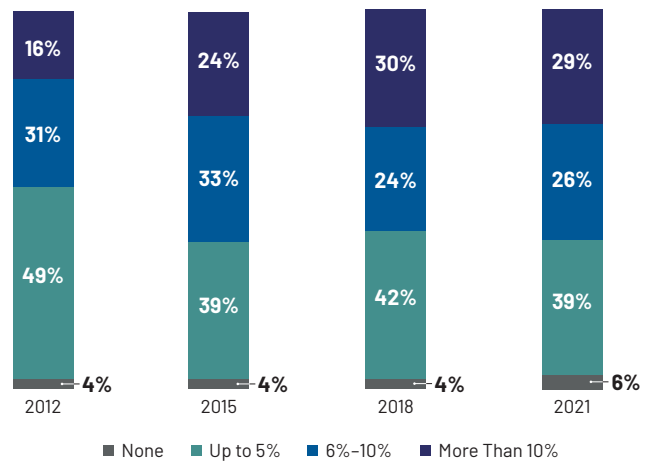
- Well over 90% of owners, investors, architects and engineers have consistently reported the belief that their new green buildings have higher asset values than traditional buildings.
- 2018 saw a notable increase in the share of owners/investors who reported that increase was for more than 10%, and the 2021 findings sustain that growth.
- The 2021 findings for architects and engineers are also consistent with those from 2018.
- Notably, there are no significant differences by country in the average increase in asset value reported in the survey. The only major difference reported by country is that around 40% of architects, engineers, owners or investors in the US are unsure about the increase in asset value for green buildings, compared with about 20% of architects and engineers and 15% of owners and investors from other countries.

### Variation by Level of Green Involvement

Over one third (34%) of architects and engineers with a majority of green projects more frequently report that they believe that asset values on their new green buildings increase by more than 10%.

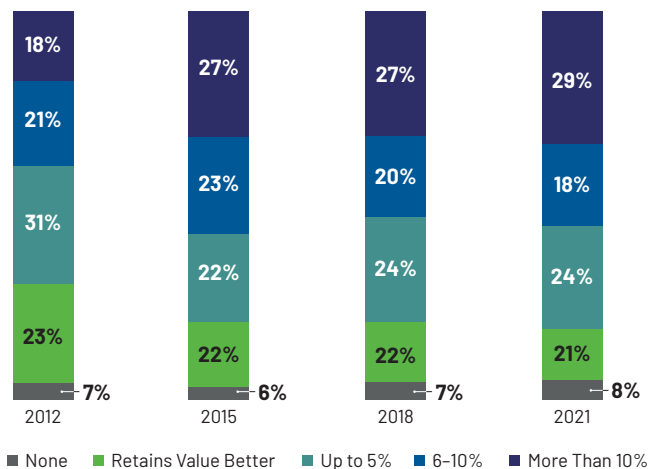
### Expected Increase in Asset Value for New Green Buildings (According to Owners and Investors)

Dodge Data & Analytics, 2021



### Expected Increase in Asset Value for New Green Buildings (According to Architects and Engineers)

Dodge Data & Analytics, 2021



# Business Benefits of Building Green

## Impact of Green Retrofit/Renovation on Operational Costs

To fully address the environmental impact of the buildings, it is essential to improve existing building stock. Therefore, all respondents were asked about whether they have done a green renovation/retrofit project in the last three years. Those who have were asked about their impact on operational costs, compared with traditional buildings.

The chart at top right shows the share of respondents by type of organization who have engaged in a green retrofit, and the chart at bottom right shows the operational cost savings they report in a one- and five-year time frame.

- About half of respondents engage in green renovation/retrofit projects, with most investors engaged in this work.
- The cost savings reported in the first 12 months and five years of operation are very consistent with those reported in the three previous studies, similar to the findings for new green buildings.
- On average, respondents report an 11.5% savings in the first 12 months and 17.0% within five years.

### Variation by Country

- 79% of respondents from Saudi Arabia engage in green renovation/retrofit projects.
- In contrast, only about one third of the respondents in Cameroon and Colombia do so.
- Nearly one quarter (21%) of US respondents don't know their operating cost decreases due to their green renovation/retrofit projects in the first year (21%), but those who do report their average costs are reduced by 13.5%, notably above the global average.

### Variation by Type of Organization

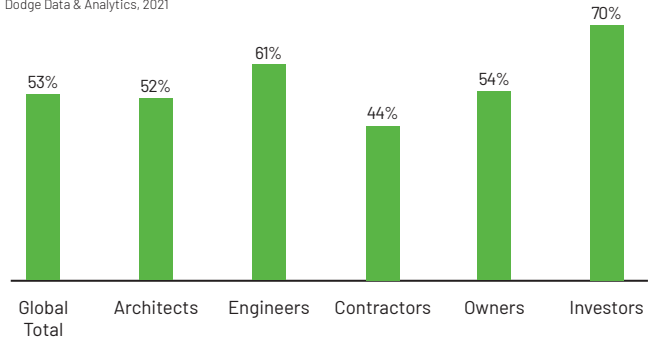
- Contractors are more conservative in the operating cost savings they report for the first year (average 8.8%) than are architects (13.2%) or engineers (13.0%). However, their five-year projections are not significantly different from the others.
- Since operating cost savings are an important driver for owners to engage in green building projects, it is worth noting that owners report average operating cost savings of 11.1% for one year and 14.6% for five years. The latter is significantly below the global average of 17.0%.

### Variation by Level of Green Involvement

Those doing a majority of green projects report operational cost savings on average of 16.35% in the first year and 20.1% over the next five years. These significantly exceed the global averages and demonstrate how more green experience can translate into improved performance.

### Involved in a Green Renovation/Retrofit Project in the Last 3 Years

Dodge Data & Analytics, 2021

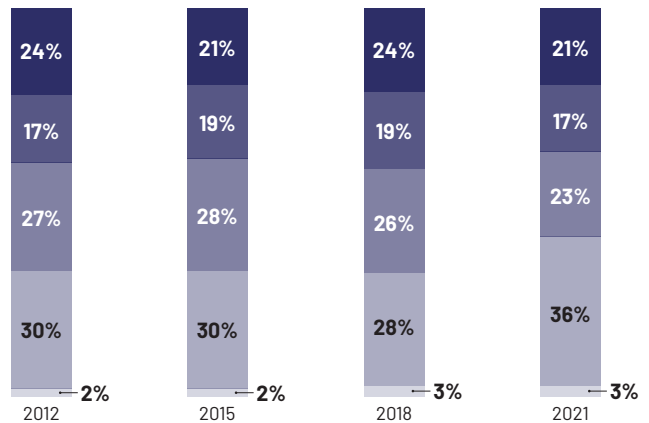


### Expected Operating Cost Decreases for Green Retrofits/Renovations

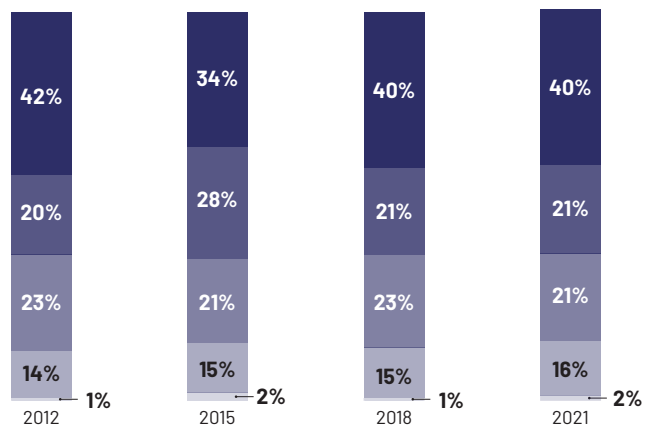
Dodge Data & Analytics, 2021

■ More Than 15% ■ 11%-15% ■ 6%-10% ■ 5% or Less ■ None

#### Within the First 12 Months of Operation



#### In the Next 5 Years



# Business Benefits of Building Green

## Asset Value Increase Due to Green Renovation/Retrofit Projects

WORLD GREEN BUILDING TRENDS 2021 DATA

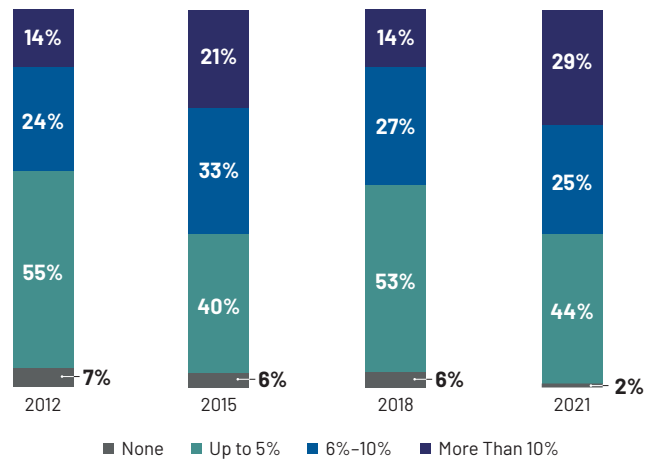
Owners, investors, architects and engineers were asked about the expected increase in the value of an asset due to a green renovation or retrofit. This same question has been asked of these four types of organizations in previous *World Green Building Trends* studies. The charts at right show the current and previous responses to this question.

- In 2021, 98% of owners/investors who have conducted a green renovation or retrofit project expect it to increase the value of their building/asset, and the share who expect that increase to be more than 10% is much higher than in any of three previous studies.
- The average increase in building value reported by owners and investors is 9.1%.
- Architects and engineers also have high expectations in the current study, with nearly all of them (97%) saying that the assets will retain or increase their value due to their green renovation/retrofit projects, and well over one third (36%) expecting an increase of over 10%.
- The average increase in building value reported by architects and engineers is 10.1%. Among those with a majority of green projects, it is 14.9%.

These findings powerfully reinforce the compelling business case for building green, with both lower operational costs and more valuable assets improving the financial performance of green building owners and developers.

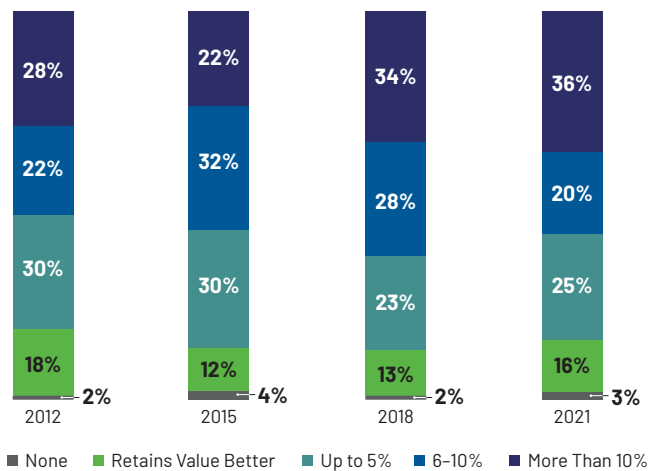
### Expected Increase in Asset Value for New Green Buildings (According to Owners and Investors)

Dodge Data & Analytics, 2021



### Expected Increase in Asset Value for New Green Buildings (According to Architects and Engineers)

Dodge Data & Analytics, 2021



# Prioritizing Healthier and More Efficient Buildings: HVAC Modernization at One Court Square

LONG ISLAND CITY, NEW YORK

Often the concept of creating a healthier building with greater tenant comfort and a highly energy-efficient one are considered to be at odds, with trade-offs on either side to achieve both goals. The HVAC modernization project at One Court Square, a landmark, 50 story, 1.5 million-square-foot building in Long Island City, New York, demonstrates that in fact, these goals can both be achieved very effectively.

## Strong Incentives for Better Performance

Savanna, the building owner, saw an opportunity with this property. "We wanted to address the building infrastructure as part of an overall repositioning of a 30-year-old asset, making it more competitive in the market. We wanted to make the building more energy efficient and obtain energy savings, while improving the occupant's comfort," says Peter Rosenthal, principal, director of development, Savanna. Part of the opportunity was also the utility and state incentives, which made the project appealing. He explains that this factored directly into the goals for the project: "We also wanted to take advantage of all the ConEd and NYSERDA rebate incentives, allowing us to reduce our out-of-pocket costs to the ownership of the building."

Those incentives, along with the potential energy savings, made it easy for him to get buy-in from his equity partners and lenders. He states, "This was a very easy story based on the amount of money that we were spending versus the amount of money we got back and versus the energy savings in terms of dollars that we received. This was a win-win-win for everybody."

## Making the Case

Rosenthal was also impressed with the team that did the work. He reports that

he was an "extremely active" partner in the process, explaining that the team put together a highly informative pitch for him, and their positive estimates were verified by the third-party engineering consultant. "I got as much information as possible, and they made it very easy to make an informed positive decision to move ahead with the project." Since the building is a short subway ride from his office on Park Avenue, he was easily able to stay engaged throughout the construction process. And when the project was complete, the team ended up beating the original positive estimates.

Carrier was brought into the mix by Cushman and Wakefield, the property managers. They presented Cushman and Wakefield with the goals of 20% energy savings, combined with improving air quality, comfort and temperature control as the main objectives. And while they were looking for annual kwh savings of over 4.4. million, they were also targeting 770 kw peak demand savings. As Terry Vanecek, director global lifecycle solutions, commercial HVAC aftermarket and service, Carrier, explains, "Those peak demand hours are usually when you are going to be tasked with more costs associated with your energy, so reducing energy consumed during that time is a significant money saver for the client."

## System Installed

The solution they devised to attain those goals involved multiple elements. Gary Bobb, VP of global services for commercial HVAC at Carrier, explains what it involved: "The first place we always look at is the big equipment piece, so we look at the chillers, and that's the muscle. Then we look at the brains, which is the control system." They saw an opportunity to improve

performance through use of a variable frequency drive, which, he explains, "allows you to use it on demand. When you're at peak demand, the chiller is running at full speed and when it's at low demand, it throttles down to a lower speed. And that's a really huge energy savings, and environmental savings as well." He explains that they then looked at additional ventilation and air quality solutions, but that the core element of the project was in the plant room. He states, "You have to get that right first, so that's where the new water cooled centrifugal chillers that Carrier put in really made a big difference."

## Project Facts and Figures

### Project Title:

One Court Square Tower HVAC Modernization Project

### Building Owner:

Savanna

### Engineer:

Smith Engineering

### Engineering Consultant:

MG Engineering, P.C.

### Property Manager:

Cushman & Wakefield

### HVAC System:

Carrier

### Construction Start:

February 2020

### Construction Completion:

November 2020

### Number of Stories:

50

### Total Building Square Feet:

1.5 million

### Project Energy Savings:

4.4. million kWh annually and 766.9 kW during peak demand

### Project Estimated Cost Savings:

20% in energy costs per year



## Prioritizing Healthier and More Efficient Buildings: HVAC Modernization at One Court Square

LONG ISLAND CITY, NEW YORK

When it comes to the air quality and healthier aspect of the building, Vanecek explains that the automation side is critical. He says that the system provides the customer and clients with accessibility and visual notifications on the current conditions in their facility. Those are easily identified and graphically represented. Sensors are also a critical part of the system for monitoring airflow and making sure the filters are functioning properly. He adds, "Having additional schedules and set points and trends built in is important, not just for the comfort of the tenants, but also for their health and their cognitive capabilities." He points out that this was particularly important throughout 2021 with building occupancy still being in flux due to the pandemic and describes it as "essential to making sure that the facility runs properly when you're partially occupied or occupied during different schedules."

### Dealing With the Pandemic

The project started construction in February 2020, and was quickly faced with challenges due to the pandemic. They did not change the delivery date or the target goals, but Bobb explains that they lost about two to three months initially on the schedule. They had to factor in how to complete the work while keeping their teams and their customers safe. One advantage that they had, though, according to both Bobb and Vanecek is that their team was highly experienced and could make up the ground they lost. In addition, Vanecek explains that they figured out a way to do much of the programming and building automation systems upgrades remotely, which they would normally do at the facility. He says, "That saved us some significant time, and I think that's one lesson that was learned: that you



One Court Square in Long Island City is a 50-story building that after opening in 1990, was the tallest building in New York state outside of Manhattan until 2019.

can do a lot of commissioning aspects remotely, as long as you have the right sensors in place and the right system design."

### Balancing Health and Efficiency

Both Bobb and Vanecek believe that this project in particular demonstrates that one does not need to make trade-offs to make a building highly efficient and healthier. In fact, Bobb states, "We see efficiency and healthy buildings coming together." The energy savings were a critical financial driver for the project, especially due to the incentives, but Bobb and Vanecek credit their indoor air quality efforts with helping to achieve greater energy savings, not undercutting them. According to Vanecek, "the more monitoring and the more sensing you do in a building helps you to operate it that much more effectively and efficiently. So, while

creating a much safer and healthier environment, you are also operating the system the way it is intended to operate." He believes that the process of creating a better understanding of an existing facility's indoor air quality may also reveal some "low-hanging fruit" to improve building operations, and perhaps even provide access to the kind of financial incentives that drove this project. When this synergy occurs, the overall upgrade, between the cost savings and the incentives, can be self-funding. For Bobb, the fact that a focus on creating a healthier building can actually lead to greater savings was one of the biggest lessons learned from this project. ■

# Data: Green Building Products and Services

## Current and Future Use of Green Building Products and Services

WORLD GREEN BUILDING TRENDS 2021 DATA

All respondents were asked about their current use of green products in the nine product/system categories listed in the chart at right. In addition, they were asked whether they intend to use green products in these categories in the next three years. This question has been asked on previous *World Green Building Trends* surveys, although mass timber systems was included in the survey for the first time this year.

Given the strict definition of green building projects provided at the beginning of the study, it is likely that many respondents are using green products on more traditional projects, but this can still help raise the overall level of building performance, even on projects that cannot fully be considered green.

### Use of Green Building Products/Systems Over Time

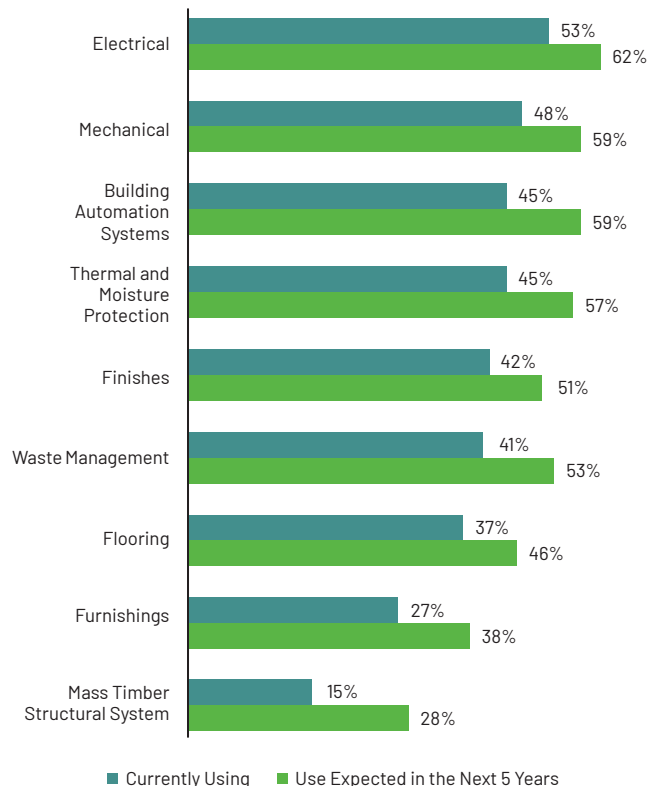
The chart clearly shows that many more respondents expect to use green building products and systems in the next three years. This shows their level of interest and commitment to green building, which bodes well for the future.

However, it should not be perceived as an accurate forecast of increased use of products in these categories, based on a comparison of these findings to those of previous surveys.

- Previous surveys also had a much larger share reporting intended use of green products/systems in the next three years for all categories than those currently using them now.
- However, when compared with the findings from 2015 and 2018, actual use has remained within three to five percentage points, plus and minus, in 2021 as it was previously.
- There is, however, some shifts in the ranking of the product categories.
  - Electrical is still the top green product category for use, as it was in 2015 and 2018.
  - However, mechanical now ranks second, but previously was tied for third. Given the focus on mechanical systems to help address concerns about preventing the spread of COVID-19 among building occupants, it is not surprising that these systems are more widely implemented.
  - Waste management ranks lower than it did in 2018, when it tied for third.
- It is clear that the use of mass timber is still emerging globally, with only 15% who report using it now. However, nearly twice as many (28%) expect to be using it within three years.

### Current and Expected Use of Green Building Products and Systems

Dodge Data & Analytics, 2021



# Green Building Products and Services

## Current and Future Use of Green Building Products and Services

CONTINUED

WORLD GREEN BUILDING TRENDS 2021 DATA

### Variation by Type of Organization

Not surprisingly, architects more frequently report use of the green products/systems that they themselves specify than most of the other organizations. These include thermal and moisture protection (60%), finishes (58%), furnishings (37%) and flooring (65%). Architects are likely to be more aware of the green nature of these products than many of the other project team members.

Owners exceed use by most of the other types of organizations in two categories, electrical and waste management.

### Variation by Country

There is also some variation in the share who report using green products/systems in each of these categories by country.

- The share of Canadian respondents who use green electrical, thermal and moisture protection, mechanical and building system automation products and systems significantly exceeds global averages.
- A higher share of those from Australia/New Zealand are also using electrical, mechanical, waste management and building automation systems products and systems.
- The share of US respondents above the global average

include those using green thermal and moisture protection, mechanical, finishes, flooring and furnishings products.

- Saudi Arabia has a high share reporting use of green thermal and moisture protection, waste management, building automation systems and green flooring products.
- South Africa exceeds the global average for use of green electrical products and waste management.
- Mexico exceeds the global average for use of building automation systems.

### Variation by Level of Green Building Involvement

Not surprisingly, a significantly higher share of those who do the majority of their projects green report using green products/systems in every category included in this study except thermal and moisture protection and furnishings. Particularly notable are the high levels of use of mechanical (67%), electrical (68%) and building automation products and systems (60%).

## Use of Green Building Products/Services, by Country

Dodge Data & Analytics, 2021

	Global Average	60% or More	50% to 59%	40% to 49%	30% to 39%	Less Than 30%
Electrical	53%	Canada, South Africa	AU/NZ, Colombia, India, Mexico, US	Singapore	Brazil, Germany, Saudi Arabia	China
Thermal & Moisture Protection	45%	Canada, China, Saudi Arabia	US	Mexico, South Africa	AU/NZ, Brazil, Germany, India, Singapore	Colombia
Mechanical	48%	Canada, US	AU/NZ, Singapore	None	India, Mexico, Saudi Arabia, South Africa	Brazil, China, Colombia, Germany
Waste Management	41%	India	AU/NZ, Colombia, Saudi Arabia, South Africa	Brazil	Canada, China, Mexico, Singapore, US	Germany
Building Automation Systems	45%	None	AU/NZ, Canada, Mexico, Saudi Arabia, Singapore	China, Colombia, India, US	Colombia	Brazil, Germany, South Africa
Finishes	42%	None	US	AU/NZ, Canada, Saudi Arabia	Brazil, China, Colombia, India, Mexico, Singapore	Germany, South Africa
Flooring	37%	None	Saudi Arabia, US	AU/NZ, Canada, India	China, Germany, South Africa	Brazil, Colombia, Mexico, Singapore
Furnishings	27%	None	None	China, India	AU/NZ, Mexico, US	Brazil, Canada, Colombia, Germany, Saudi Arabia, Singapore, South Africa

# Green Building Products and Services

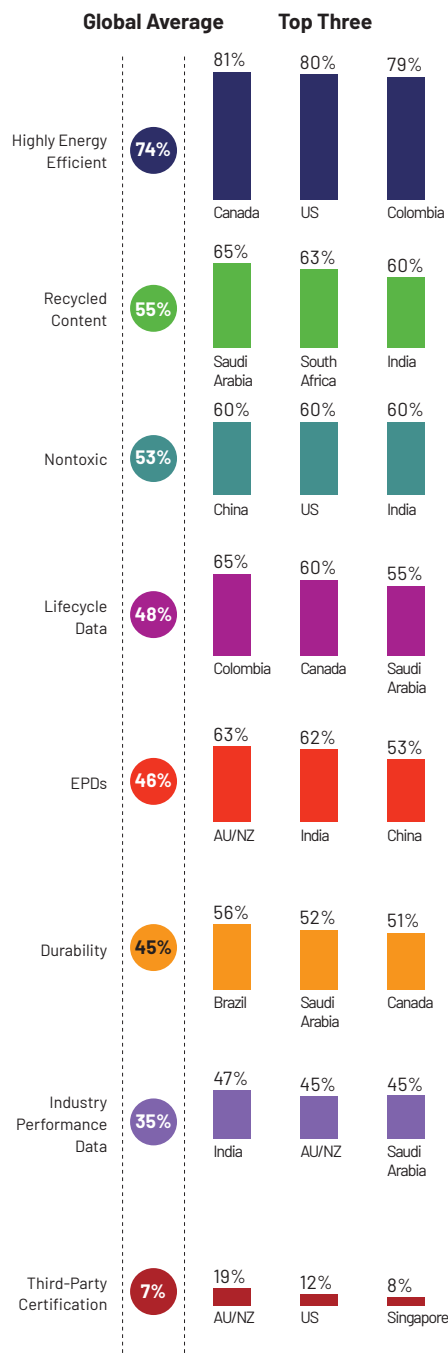
## Criteria for Identifying Green Products

The data on expected green product use clearly indicates that many respondents are interested in increasing their use of these products and systems (see page 32). However, to better understand what they are using now and what they intend to use in the future, it is critical to understand the criteria by which they gauge whether a product can be considered green or not. Therefore, respondents were asked to identify all the criteria they use for identifying green products. The chart at right shows the overall average of responses for each criterion, and the top three countries by share of respondents reporting use of that criterion.

- Being highly energy efficient is the most widely recognized criterion for green products, and the share selecting it is about the same as in 2018.
  - Notably, there are no significant differences between architects, engineers, contractors, owners or investors on the importance of energy efficiency as a criterion for green.
- Two other criteria are recognized by more than half of all respondents as critical for green products: recycled content and being nontoxic. These were also top criteria in 2018, although the share selecting each has increased a little in the current study.
  - Architects more frequently select both of these than most other types of organizations, with 70% of architects selecting nontoxic and 63% selecting recycled content as top criteria.
- Three additional criteria are selected by between 45% and 48%, so still influential for a wide swath of design and construction professionals. The performance of each of these in the current study is similar to their performance in 2018.
  - Lifecycle data and durability are again more widely considered by architects than the other types of organizations. Lifecycle data is also more widely used by those doing a majority of green projects (60%).
  - However, there is general agreement across all stakeholders on the importance of environmental product declarations (EPDs) as a criterion for selecting green products. The one group that exceeds the global average on this are those doing the majority of their projects green, with 62% who use this as a gauge.
- Industry performance data is selected by about one third, as it was in 2018. There are no differences by type of organization in the use of this criterion.
- The share selecting third-party certification for products has dropped from 16% in 2018 to 7% in 2021, and even among those doing a majority of green projects, it is just 14%.

### Criteria Used to Identify Green Products

Dodge Data & Analytics, 2021



## Green and Smart Buildings

### Green buildings increasingly need to also be smart buildings to achieve their performance goals.

**G**reen building and smart building are two separate trends in construction that seem to be converging. What is the relationship between green building and smart building, and can you have one without the other?

#### Green and Dumb?

Can a building be green and dumb? What does a building that's designed, built, renovated, operated or reused in a resource-friendly way have to do with smart technology to increase efficiency while maintaining a comfortable environment?

Although a green building is possible without smart technology, "It is behind the times," claims Chris Pyke, Ph.D., senior vice president for product, US Green Building Council (USGBC)-affiliated [ArcSkoru, Inc.](#), a platform that allows buildings to track performance data across five categories.

According to Pyke, after a long journey, green and smart converged. The wait is over. What pushed the convergence of green and smart to the next level?

The pandemic. "Post Covid, a smart green building is necessary," Pyke claims. The key reason is improving indoor air quality (IAQ). Occupants have become more aware of the issue. To get people to return to buildings and feel more comfortable, landlords must measure and, if necessary, improve IAQ. "This is what it takes to get — and keep — a Class A building into operation."

#### Smart Building Enables Green Building

Once a building is occupied, it must be smart to minimize energy use. Consider the heating and cooling of a multistory

office building. A smart building can manipulate its temperature in real time based on external and internal data. On the other hand, the heating/air conditioning in a traditional non-green building cycles on and off based on the time of day or schedule in particular limited zones.

Then, there's individual control. The expectation is that a smart building's operations can be tailored to occupant preferences. In a smart building, the occupant of each unit can often control the temperature of their space.

In theory, the ability to increase comfort could lead to increased energy use. However, in practice, this is not the case. "The highest performing buildings deliver superior comfort with lower energy intensity," calculates Pyke. And the numbers are significant, with 25% higher occupant satisfaction and a greater than 40% reduction in greenhouse gas emissions per occupant when moving from the lowest to the highest levels of green building certification. Green buildings achieve this by managing energy output on a granular level, which decreases the amount of energy used, and increases the overall efficiency level. "Being able to be smart about the charges to manage peak load, tracking use in real time, and selectively turning down heating and air conditioning leads to less energy use," Pyke concludes.

#### Can We Build It?

We already are.

Five years ago, the convergence of green and smart was primarily talk. Today, building owners can choose from multiple options for their smart green building.

Concerns regarding air quality have

grown greatly due to the pandemic and that's where Pyke speculates that the next big leap will be in terms of smart and green buildings. "The amount of measured air and what you can do with it will be significantly better in three to five years compared to now."

However, just because something can happen does not mean it will. Asking building owners to change the way they build and operate buildings is a big ask.

To get owner buy-in, there are a host of barriers to overcome. Cost is the first hurdle. A smart green building costs more to construct. According to a [2019 study](#), the price to construct a commercial green building project rises by about 1.58% as compared with a non-green building. However, the [USGBC](#) reports significant savings can be realized in operational costs. Note both sources focus only on green buildings.

Other barriers revolve around control. Owners, as well as tenants, want to control their space. Neither group is in control in a smart building—the technology is. This can be particularly challenging for owners for whom a building is an investment.

A particularly thorny topic is cybersecurity risks. Owners want to know if the Internet of Things is on their network, and if so, if it will intersect with enterprise security. This is a growing issue as both those looking to cause harm and those striving to protect a building's systems have become more sophisticated.

Green building and smart building have indeed converged. "To go where green building is going, a building has to be smart," predicts Pyke. Buildings that don't have both elements will be in lower demand. ■

# Data: Green Building Trends

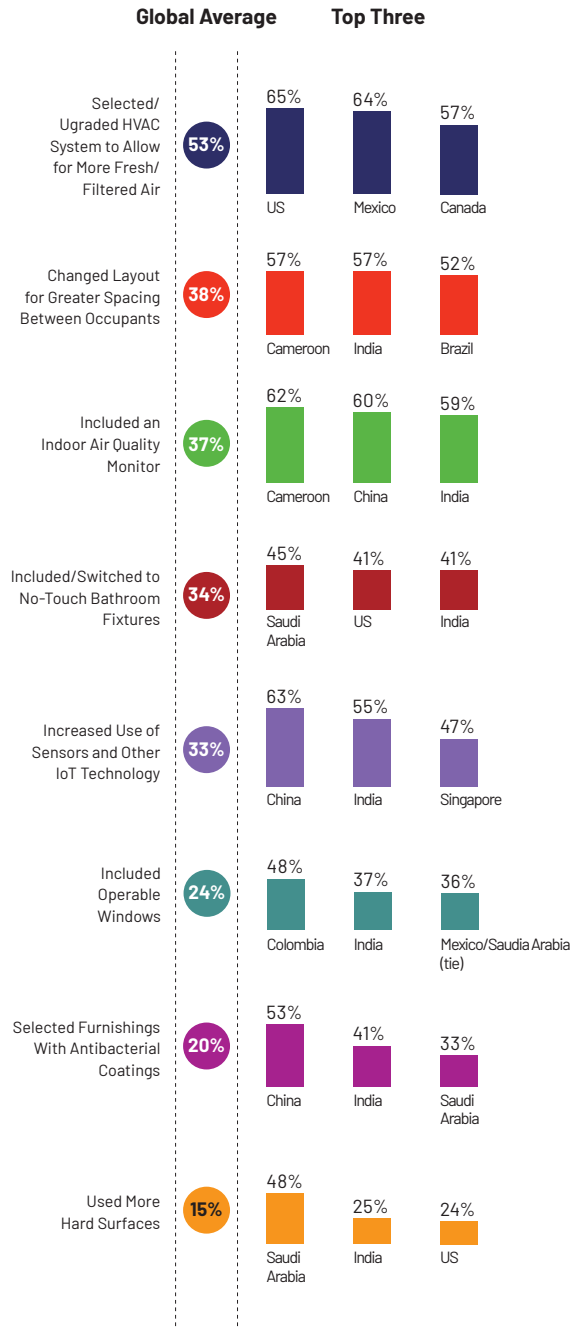
## Changes to Buildings in Response to COVID-19

The COVID-19 pandemic has called attention to the ways in which the built environment can encourage or discourage the spread of contagions. To better understand the degree to which the pandemic has influenced building design and construction, all respondents were asked how they have altered their building projects specifically in response to the pandemic, and their responses are shown in the chart at right.

- The public messaging about the importance of increasing fresh/filtered air exchange in buildings is clearly impactful, with 53% reporting that the pandemic has directly influenced their choice of HVAC system.
  - The countries in North America all lead in this area.
  - Nearly two thirds (64%) of those doing more than 30% green projects took this approach.
  - This mechanical solution was far more widely adopted than the inclusion of operable windows, although for many project types/locations, operable windows may already be a common practice and therefore not reflected in the responses to this question.
- Social distancing is also impacting building design, either through changes to the layout of a building (38%) or through the use of sensors and other IoT devices to track occupancy (as well as air quality and other factors) (33%).
  - The top three countries for use of IoT/sensors are all in Asia, whereas there is no geographical pattern for wide use of layout for social distancing.
- Over one third also included an indoor air quality monitor in their projects.
  - The top three countries are far above the global average, suggesting that this is very common in some markets and uncommon in others.
  - Nearly half (46%) of those who do over 30% of their projects green reported this, compared with just 30% of those with fewer than 15% of green projects.
- No-touch bathroom fixtures were also employed by over one third.
- Using furnishings and surfaces that help resist the spread of disease is a far less common response, used by 20% or fewer globally.
  - China and India are both double the global average in the share using furnishings with antibacterial coatings, and Saudi Arabia is more than double in the use of more hard surfaces.
  - Architects (23%) report the use of more hard surfaces significantly more than the global average, which may suggest that other types of organizations are not aware that those surfaces were being used in response to COVID-19.

### Changes Made to Building Projects in Response to COVID-19

Dodge Data & Analytics, 2021



## Reducing Embodied Carbon in the Built Environment

### Addressing embodied carbon is critical to achieve sustainable goals.

**B**y 2060, new construction is expected to add 2.5 trillion square feet of building area worldwide, doubling the existing footprint in just 40 years. In about the same period, between 2020 and 2050, half of all greenhouse gas emissions from new buildings will come from embodied carbon—emissions from the manufacture, transportation, installation, maintenance and disposal of building materials. “Embodied carbon is rapidly becoming the most important part of the conversation,” says Matthew Black, project coordinator for the World Green Building Council’s Advancing Net Zero (ANZ) initiative.

Unlike operational emissions, which accrue over the lifespan of the building, embodied carbon is front-end loaded. Because of that, the short- and medium-term ratio of emissions skews toward embodied. Over the next 10 years, embodied carbon will account for an estimated 72% of total building emissions. Coincidentally, 10 years is also about the amount of time that remains for preventing global heating from exceeding a critical 1.5C° increase. “It’s important to reduce both types of emissions,” says Black, “but the urgency of reductions makes the embodied cuts more valuable.”

#### Ambition Loops for Change

More and more businesses, organizations, cities, subnational and national governments are receiving that message. Since WorldGBC updated its Net Zero Carbon Buildings Commitment in 2018 to include action on embodied carbon (in addition to the 2030 net-zero operational emissions challenge), signatories have doubled year on year, a level of uptake that is fueling what the

Council’s 2021 ANZ Status Report refers to as an ambition loop: “When you see one set of stakeholders—private sector business, for example—taking action to go further and faster than existing building regulations, they highlight to policymakers at all levels that the market is ready for further policy and regulation,” says Black.

Denmark, for example, introduced embodied carbon targets into the country’s building regulations this year. The city of London now mandates whole lifecycle assessments for all new development. (Lifecycle assessments include both operational and embodied carbon emissions.) In the US, three states have passed low-carbon procurement policies, and the federal government, six other states, and numerous cities are considering or are in the process of implementing similar policies. Across Europe, 10 national green building councils have joined to help deliver the EU Green Deal, developing whole-life carbon road maps by which their respective countries can decarbonize the built environment across the entire lifecycle.

#### Measuring Embodied Carbon

At the project scale, a stumbling block for teams seeking to prioritize embodied carbon to date has been the difficulty of measuring it. To address this, the Carbon Leadership Forum has published a *Material Baseline Report* that estimates embodied carbon per product category (although individual products vary), and in Europe, Laudes Foundation and Ramboll are leading a similar benchmarking effort.

An initiative making progress on global transparency, product by product, is EC3, a free, open-source

database launched under the auspices of the nonprofit Building Transparency, with input from nearly 50 industry partners. EC3 draws on a rapidly growing database of embodied carbon emissions from thousands of third-party verified Environmental Product Declarations (EPDs), enabling teams to compare alternative products, and also to assess their project’s embodied emissions using building material quantities from construction estimates or BIM models. In another example of an ambition loop, in the state of Washington, where major industry players such as Microsoft, Amazon, and Skanska are piloting the tool in their bid processes, average emissions for major concrete suppliers (those disclosing their emissions) have dropped 20%. To foster wider uptake of the tool, work is now underway to increase the saturation of manufacturers providing data and to standardize reporting globally, says Stacy Smedley, executive director at Building Transparency.

Ultimately, bringing building-embodied carbon to net-zero will require deep collaboration across the entire value chain. “We’re going to need new business models to enable a circular economy of buildings and the materials that go into them,” says Black. “It’s going to require a radical transformation in the way that buildings are produced, used and reused.” ■

# Green Building Trends

## Embodied Carbon

Consideration of the impact of the built environment on climate change has often focused on the operational carbon footprint of those buildings. While that is a critical issue, the creation of built assets also involves some intensive CO<sup>2</sup> emissions in the manufacturing processes and transportation of materials. As the focus shifts from simply reducing emissions to achieving net-zero, attention to this embodied carbon in building, including how materials are treated at the end of life, becomes increasingly important.

Reducing embodied carbon is a major challenge in the industry. It requires a degree of transparency about product lifecycles that is often not currently available. It also requires unified action across the building sector, with manufacturers and suppliers, designers, contractors and owners/developers all playing a role in its reduction.

In order to understand the degree to which the design and construction industry is aware of and interested in tackling these challenges, respondents were asked three questions about embodied carbon:

- Do they try to reduced embodied carbon in their building projects through the selection of building products/ materials? The responses included the option of not being familiar with embodied carbon.
- Those familiar with embodied carbon but not yet actively trying to reduce it were asked what prevents them from doing so.
- Those who reported that they are trying to reduce embodied carbon were asked about the share of projects on which they are seeking to do so.

### Engaging With Embodied Carbon

#### AWARENESS

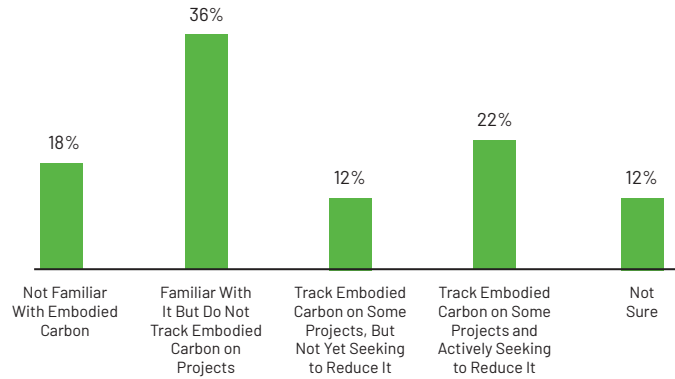
Most respondents (82%) are at least aware of the concept of embodied carbon.

- The highest levels of familiarity with embodied carbon are reported in Canada (95%) and Australia/New Zealand (91%).
- Contractors (71%) and owners (77%) are less familiar with embodied carbon than are architects (89%), engineers (80%) and investors (92%).
- As would be expected, those with a low level of green involvement (15% or fewer green projects) are less familiar with embodied carbon (76%) than those doing the majority (over 60%) of their projects green (92%).

It is notable, though, that awareness exceeds 70% even among the groups least familiar with it, so the concept is pretty well-known throughout the industry.

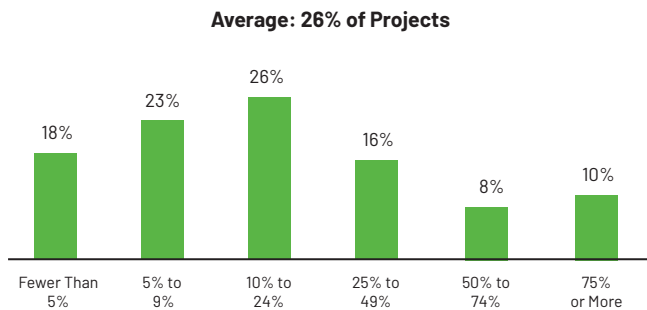
### Degree to Which Respondents Are Reducing Embodied Carbon

Dodge Data & Analytics, 2021



### Share of Projects on Which Carbon Is Reduced (According to Those Reducing Embodied Carbon)

Dodge Data & Analytics, 2021



#### RESPONSE TO EMBODIED CARBON

Awareness of embodied carbon is an important first step, but the findings reveal that most of the industry is not yet committed to reducing it.

- The largest share of global respondents (36%) do not track embodied carbon on their projects at all.
  - Half of the Canadian respondents (50%), fall into this group, and it is also common in the US (46%), India (43%) and Colombia (42%).
  - Architects (43%) report being familiar with it but not tracking it significantly more than the global average.
  - A large share (40%) of those doing very few green projects (fewer than 15%) also fall into this category.
- Notably, though, roughly the same percentage (34%) are tracking it, and about two thirds of them are seeking to reduce it.



# Green Building Trends

## Embodied Carbon CONTINUED

WORLD GREEN BUILDING TRENDS 2021 DATA

- One third or more respondents from Australia/New Zealand (34%), Cameroon (38%) and Saudi Arabia (33%) seek to reduce embodied carbon.
- Significantly fewer contractors (14%) report reducing embodied carbon than the global average. This is important, given the fact that contractors often are the ultimate purchaser of most building products and systems.
- 40% of those doing the majority of their projects green seek to reduce embodied carbon on their projects.
- On average, those attempting to reduce it do so on about one quarter (24%) of their projects, suggesting that it is still emerging as a common practice among this group.

### Factors Preventing Organizations From Reducing Embodied Carbon

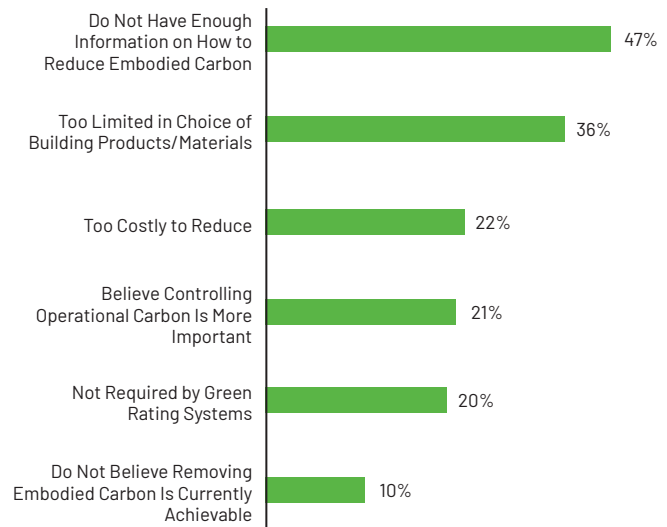
With only 22% reporting that they try to reduce embodied carbon, it is important to understand what prevents organizations from doing so. Therefore, respondents who are familiar with embodied carbon but not yet trying to reduce it were asked to select any of the six items in the chart at right that kept them from attempting to reduce embodied carbon.

Surprisingly, despite the fact that there was no limit on the options that could be selected, no single option was chosen by half or more of the respondents. This suggests that there is no small set of challenges that the industry needs to overcome, but that numerous issues will need to be tackled to see greater engagement with the reduction of embodied carbon.

- Not having enough information is the top reason, chosen by 47%. Notably, this is as big a challenge for those highly engaged in green projects as it is for those with low engagement, and there is no difference by type of company either, so this is an industrywide challenge.
- Limitations in the choice of building products was also selected by a relatively high percentage at 36%. Again, there was no difference by type of organization or level of green involvement.
- Around 20% select the next three options.
  - It is notable that concern about the cost of dealing with embodied carbon ranks far lower than lack of knowledge and limitations in product availability. This may bode well for addressing this issue in the future, as more information is available.
  - The findings suggest that including embodied carbon in prominent green rating systems could help to increase engagement with it. This is the only option selected by a significantly higher percentage of those with high green engagement than with low green engagement.

### Factors Preventing Organizations From Reducing Embodied Carbon (According to Those Familiar With It or Tracking It Who Do Not Reduce It)

Dodge Data & Analytics, 2021



- Fortunately, only 10% believe that removing embodied carbon from projects is not currently achievable, which could bode well for wider industry engagement with this issue in the future.

# Green Building Trends

## Design for Disassembly

Design for disassembly involves the selection of building products and construction of buildings done with the intent to easily reuse building products and systems at the end of the building's functional life. Currently, common practice is to assume that a building is demolished and its components disposed of, but design for disassembly seeks to create a circular economy, in which everything that can be reused on a building is.

### Familiarity With Design for Disassembly

Since a successful design for disassembly project begins in the early design phases, the intent to create a project like this relies on the decisions of the owners and architects, and is influenced by the investors.

Therefore, to better understand awareness of this approach in the industry, architects, owners and investors were asked whether or not they are familiar with the concept of design for disassembly and recovery.

- As the chart at upper right reveals, about two thirds of architects and investors are familiar with this approach, but only 51% of owners are. Since owners are a key decision-maker in taking this approach, it is clear that greater awareness is needed among building owners of this practice.
- Engagement with green building is directly correlated with familiarity with design for disassembly, with only about half of those doing 30% or fewer green projects aware of this approach, but about three quarters of those with more green involvement reporting that they are familiar with it.
- Because the question was only asked of architects, owners and investors, only Australia/New Zealand, Singapore, South Africa and the US had sufficient responses for a meaningful comparison with the global average. Of these four countries/regions, Australia/New Zealand stands out, with 83% of respondents who are familiar with this approach.

### Importance of Using Design for Disassembly

The same group of respondents was asked about the importance of design for disassembly after being presented with the following definition:

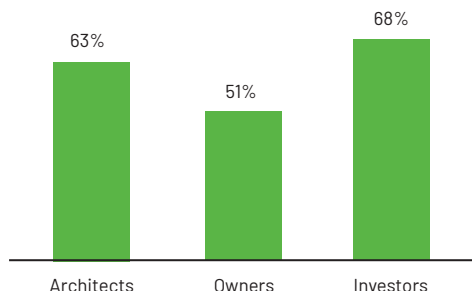
*Design for disassembly is defined as the process of considering how building projects can be designed so that all the parts and pieces of the building can be reused at the end of the building lifecycle.*

Thus its importance was rated by all architects, owners and investors, not just those who reported being familiar with it.

As the pie chart shows, most of them recognize that this

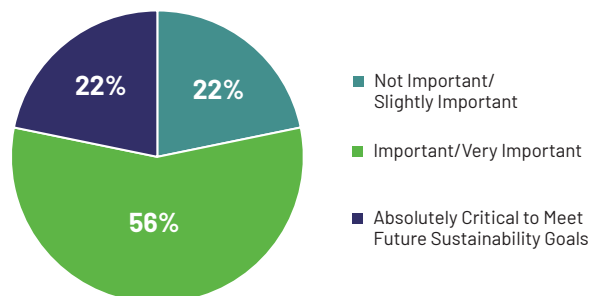
### Familiarity With the Concept of Design for Disassembly and Recovery

Dodge Data & Analytics, 2021



### Importance of Using Design for Disassembly (According to Architects, Owners and Investors)

Dodge Data & Analytics, 2021



# Green Building Trends

## Design for Disassembly CONTINUED

is either important or very important (56%). Interestingly, right now, the remainder is evenly split between those who assign this approach little or no importance and those who believe it is absolutely critical.

- There is no significant difference between architects, owners and investors in their responses to this question. This alignment may be helpful to encourage wider adoption of this approach in the future.
- Perhaps more surprisingly, those doing a majority of their projects green are not significantly different from the global average in their assignment of value to this approach.

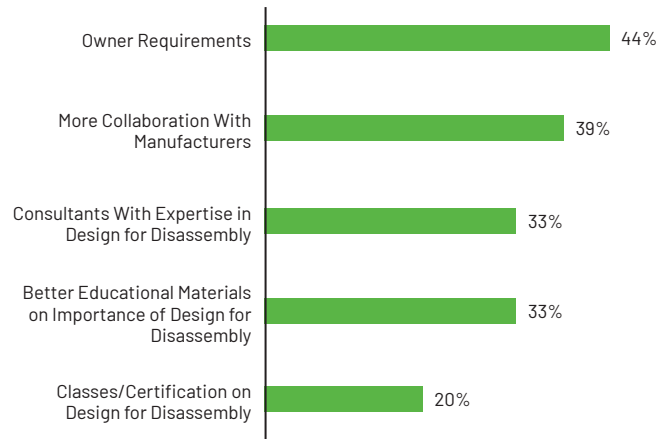
### Factors That Will Drive Wider Use

Architects, engineers, consultants, owners and investors were asked to select the top two factors that are most important to encourage the design industry to adopt design for disassembly as a regular practice. Their responses are shown in the chart at right.

- Owner requirements rank first. It makes sense that owners can drive this since it involves how to prioritize selection of building products and systems, and because it will influence the final design of the building.
  - Only 24% of investors consider this a top factor, but all other types of organizations are in agreement about the importance of the owner in driving wider use.
- More collaboration with manufacturers is also essential, since how the products and systems are made can influence the degree to which they can be reused. Therefore, it is not surprising that this ranks as the second most influential factor.
  - Nearly half (49%) of those who do the majority of their projects green believe this would be influential, far more than the global average.
- At this point, more respondents believe that consultants with expertise in this area can drive wider adoption than more classes or certification, suggesting a greater immediate need for outside help than internal expertise.
  - Only 24% of architects, however, select the availability of consultants with expertise, significantly fewer than the global average.
  - Respondents from China (39%) exceed the global average for selection of classes and certification.
- About one third clearly prioritize wider industry understanding of the importance of this issue, with their selection of better educational materials that explain why this approach is critical to greener building.
  - China (56%) and the US (42%) both exceed global averages for selection of this factor.

### Most Influential Factors to Encourage Adoption of Design for Disassembly as a Regular Practice (Selected in the Top Two by Architects, Engineers, Consultants, Owners and Investors)

Dodge Data & Analytics, 2021



## How Green Is Additive Manufacturing?

**The ability to recycle the materials it uses may be key to its sustainability.**

A 40-foot additive manufactured stainless steel bridge opened across a canal in Amsterdam this year. In New York, additive manufactured polymer molds made possible hundreds of complex faceted precast concrete components in the award-winning facade of One South First (2019), part of the Domino Sugar redevelopment.

Both projects claim environmental advantages from the use of additive manufacturing. For the bridge, the designer highlights the technology's capacity to reduce the weight of metal structures and their associated material impacts. For the facade components, the manufacturer cites hundreds of pours for the carbon-fiber ABS forms, compared with the 15 to 20 typical for wood. But for project teams prioritizing sustainability, there's an overall shortage of data on how various methods of additive manufacturing compare with conventional construction, or with each other.

"This is an area of interest and growth," says Sherry Handel, executive director of the Additive Manufacturer Green Trade Association, an organization founded in 2019 in part to generate lifecycle assessment (LCA)-based data comparing additive and conventional processes.

Additive manufacturing (AM), also known as 3D printing (3DP), is the process of joining materials, usually layer upon layer, to make objects from 3D model data. The process lends itself to a wide range of materials. A 2020 review of the literature on the sustainability of AM found that polymers, ceramics, metals and

composites are now the focus of intensive research to improve their use, but despite progress on a number of issues, using materials optimization to minimize energy and waste is still "far from a global solution" in this sector.<sup>1</sup>

### Reducing Metal Waste

Compared with conventional manufacturing, metal AM can enable more complex shapes and therefore more structurally efficient structures using less material. Metals' high recyclability and cost also makes them good candidates for recovery and reuse, and a number of established and start-up companies are now working to create circular economies for AM metal powders. For example, a compact recycling foundry invented by the start-up MolyWorks Materials Corporation upcycles scrap metals to AM-grade powder in a single step onsite, generating 89% fewer greenhouse gas emissions (using the example of titanium) than the traditional powder. From a circular economy perspective, "I think metal will work itself out," says Handel.

### The Polymer Challenge

Recycling polymers is more problematic. "There's a tremendous amount of AM polymer waste, just as in plastics as a whole," says Handel, and she highlights failed builds and single-use rapid prototypes as the main sources. Technical challenges, such as degradation and inconsistency in the polymer with iterative cycles of use, as well as the sheer size of some of the manufactured components to be broken down, hinder the development

of commercial processes for recovery and reuse. And because polymers are relatively cheap, the business case for solving these issues is harder to make.

Nonetheless, in Denmark the Academy for Plastic Recycling, CIRKLA, is pioneering the processing of waste polymers into inputs for the AM industry, receiving an award in 2021 from the Danish Plastic Federation for a 100% recycled 3D-printing filament.

In the US, material design company Techmer and the Saudi Arabian multinational chemical manufacturing company Sabic, with the support of Oak Ridge National Labs, are developing ways to regrind AM polymers and blend them in new filament. Meanwhile, more sustainable substitutes for the carbon or glass fibers typically used in polymer AM, such as hemp or bamboo fibers and wood dust, are becoming available. "It's starting to hit the inflection point where we're going to see commercial products," says Kyle Davidson, sales engineer in the AM division of equipment manufacturer Cincinnati Inc.

While LCA data and widespread circular economies may not be imminent, an increasing number of scientific publications on issues of sustainability in AM indicates that researchers are paying attention, and solutions for the reuse and recycling of materials and the environmental impacts of processes are a growing priority. In accelerating change, consumer demand and investor focus are key factors, says Handel, as are public sector leadership, policy and research funding. "Everybody's trying to figure out how to do this," she says. "The more we talk about it, the better." ■

<sup>1</sup> Colorado, H. A., Velásquez, E. I. G., & Monteiro, S. N. (2020, June 9). Sustainability of additive manufacturing: The circular economy of materials and environmental perspectives. *Journal of Materials Research and Technology*. <https://www.sciencedirect.com/science/article/pii/S2238785420312278>.

# Green Building Trends

## Design for Manufacturing and Assembly (DfMA)

Design for manufacturing and assembly (DfMA) allows for offsite construction of building components with assembly onsite. As an approach, it is well documented to offer greater certainty in time and schedule, safer working conditions and reduced waste. It can also lead to better energy performance of buildings if that is prioritized by the design team. It can be a valuable system for supporting other sustainable goals as well, as long as those goals are well established at the start of the project.

Respondents were asked about their use of this approach, and their responses are shown in the two charts on this page.

### Familiarity

The chart below rolls up the responses into three groups: those unfamiliar or not sure about their use of DfMA, those who are familiar with it but not using it, and those who use it.

- About half of the respondents are not familiar with this approach.
- The majority of those who are, though, have also tended to deploy it on projects.
- Lack of familiarity is high among those doing fewer than 15% of their projects green (54%) and among contractors (49%).
- The share of those who are not familiar with/not sure about DfMA in Colombia (72%) and the US (60%) is significantly higher than the global average.

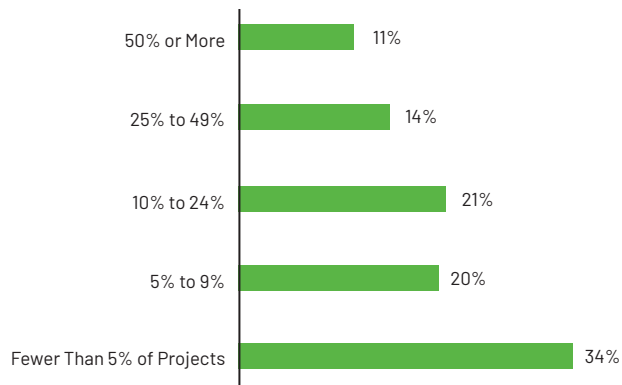
### Use

Three quarters (75%) of those currently using DfMA tend to do so on 10% of their projects or less, demonstrating that it is still an emerging practice, even among those currently using it.

- Engineers and contractors have the highest average percentage of use of DfMA, on 16.2% of projects and 14.9% of

### Share of Total Projects That Use DfMA (Among Those Who Use DfMA)

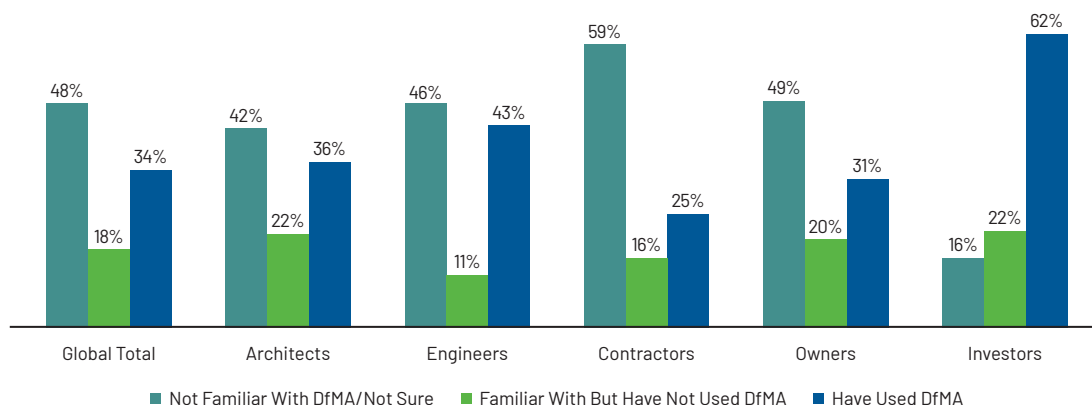
Dodge Data & Analytics, 2021



- projects, respectively.
- Those with a majority of green projects who use DfMA do so, on average, on 16.2% of their projects, while DfMA users with fewer than 15% green projects on average use DfMA on only 6.9% of their projects.
- The average share of DfMA projects among users in Singapore (18.9%) is significantly higher than the global average.

### Familiarity With and Use of Design for Manufacturing and Assembly (DfMA)

Dodge Data & Analytics, 2021



## The Advantages of Design for Manufacturing and Assembly

### DfMA helps reduce waste and creates flexibility across the building's lifecycle.

The story has been the same for years: Construction is inefficient—projects run over budget and take longer than expected. Whether through integrating technology or new design and construction methods, the industry is striving to change the narrative and become more efficient. One new methodology is Design for Manufacturing and Assembly (DfMA).

#### What Is DfMA and Why Now?

An engineering methodology, DfMA focuses on elements of a building that can be designed for ease of manufacturing and assembly; allowing for offsite manufacturing and construction. It offers standardization and leads to a quicker, more efficient, and more sustainable construction process.

The standardization inherent in DfMA means certain elements of a building are scalable and swappable. Instead of each element constructed from a bespoke design, a building is designed around standardized components. Building things custom or bespoke every time like we do now in the traditional construction design process increases risk and waste. DfMA, informed by productization and standardization, for lots of complex elements in areas of the building like MEP assemblies and systems, allows designers to spend more time on custom areas and elements.

To some degree, DfMA has been around for years. "This [DfMA] has been happening behind the walls, ceilings, and underground—the MEP [mechanical, electrical, and plumbing] for 20 years," says Amy Marks, VP industrialized construction strategy &

evangelism for Autodesk.

But the real gains come when going beyond MEP as "more people are recognizing that the processes and business models have converged and it's more efficient to make something in a factory than onsite," Marks says.

#### Benefits

DfMA puts less strain on the already stretched construction industry workforce. Building in a factory rather than onsite is more efficient and requires less labor.

There is also a green element to DfMA because it helps eliminate waste. The machinery in a factory is more suitable for scalability and creating products with exactitude. Creating customized elements on a jobsite involves a level of trial and error that is time consuming, costly and wasteful.

The benefits of DfMA are also evident after a building is complete, as reuse and disassembly have been considered, leading to a building that is more maintainable. If a design element of a building needs to be replaced, it can simply be swapped out for a new one. Since components are made as a standard and at scale, they are presumably easier to get and more reasonably priced.

DfMA means less reliance on the local supply chain. Building customized design elements requires many specific parts ordered for each project. However, when elements are standardized, parts can be ordered from global supply chain partners rather than a new order for each element to only a few suppliers. Aggregating these parts into an assembly also means fewer shipments of parts, with less carbon footprint and more certainty of logistics.

When construction happens onsite, raw elements involved in the construction such as steel, wood, etc., need to be onsite before construction can begin. While there, they may be damaged. On the other hand, manufactured elements can be brought to a site when they are to be installed. Less time onsite means less chance that damage will occur.

#### Challenges in Implementing

Every change in processes and mindset, including DfMA, comes with challenges.

Marks acknowledges that changing mindset may be the biggest challenge, since the technology and tools will advance to assist with these projects.

Another challenge, according to Marks, is related to data. "Designers need to have manufacturing data if we expect them to design around manufactured elements." Having the data and understanding the parameters of manufacturing is a related challenge. "We haven't enabled [designers] with the necessary information" about the data of the thousands of interdependent elements in a building."

How can we expect designers to know all this information? We can't. That's why Marks believes there needs to be a technology breakthrough that enables artificial intelligence and machine learning to assist in the design process.

The implementation of DfMA will not lead to cookie-cutter designs. It will impact design elements such as fire stairs that do not distinguish buildings. Using productized, scalable construction elements when designing buildings will lead to lower construction costs, more sustainability and shorter construction schedules. ■

# Green Building Trends

One goal from the start of the launch of the World Green Building trends study has been to gather longitudinal data on green building to understand how the business case, drivers and challenges have evolved. This goal has meant that large sections of the survey remain relatively unchanged since it was designed in 2012.

However, in the last nine years, there has also been many approaches and strategies for building green that were not top-of-mind in 2012, but that now have or are poised to have a major influence on the performance of the built environment.

In order to better understand these topics, new questions have been added. The first asks respondents to select the top three most important ways to improve sustainability from the list of 10 topics at right. Then, respondents were presented with the same list and asked which are most likely to be used on their projects in the next five years. The findings for both questions for all respondents is shown in the chart at right.

- Generally, the chart shows a strong correspondence between the approaches considered most important to improve sustainability and the expectation of future use.
- It also shows that there is no single approach regarded by a majority of respondents as the top way to make the industry more sustainable, with six out of 10 selected by between one quarter to one half of respondents in their top three.

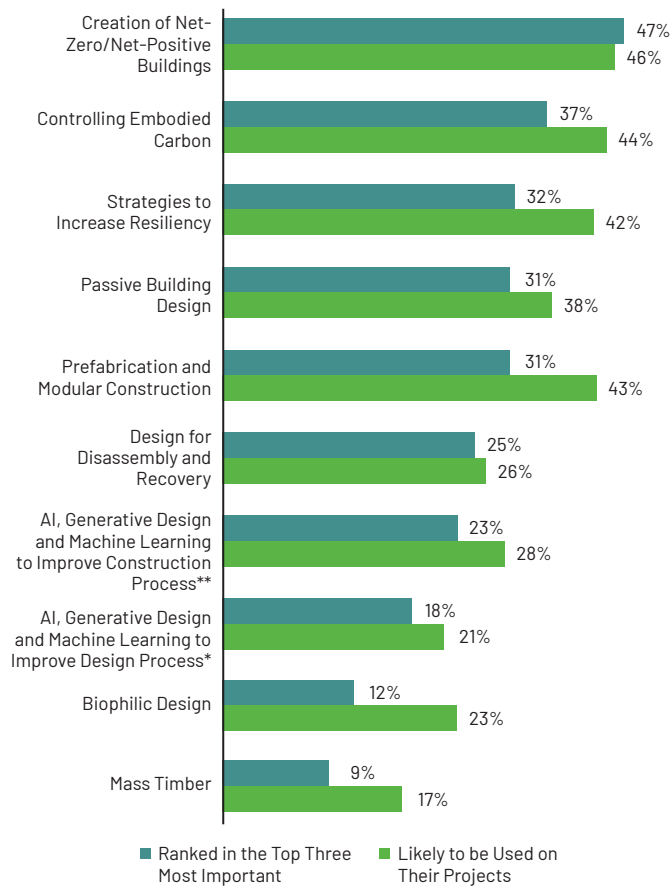
## Carbon/Energy-Related Approaches

Three of the top five most important approaches specifically address means to reduce energy consumption and/or the carbon footprint of building projects.

- The top ranked option for both importance and future use is the creation of net-zero/net-positive buildings. This reflects the recognition that only by making the built environment carbon-neutral can the goals to minimize the impacts of climate change be achieved.
  - As the table on the following page shows, this is the top approach selected by architects, engineers and owners, and it ranks second for contractors. In expected use in five years, though, none of the different types of organizations exceed the global average.
  - Canada (67%) and the US (54%) are significantly above the global average for the importance of this approach. An even higher percentage in Canada (68%) plan to make at least some of their projects net-zero in the next five years, but those in the US planning to do net-zero projects lags behind those who identified it as important.
  - This is not only the top selection for importance by those doing the majority of their projects green, but the share

## Most Important Approaches to Improve Sustainability in the Design and Construction Industry in the Next 5 Years

Dodge Data & Analytics, 2021



\*According to Architects and Owners  
\*\*According to Contractors and Owners

- who select it as important (61%) significantly exceeds the global average. They also exceed the global average in expected use (68%).
- Controlling embodied carbon ranks second. For more information on engagement with controlling embodied carbon, see pages 38–39.
  - Architects, engineers, owners and investors all have the importance of controlling embodied carbon in their top three approaches, but contractors do not. However, similar to net-zero, no type of organization exceeds the global average in anticipated use.
  - Australia/New Zealand (43%) is the only location to significantly exceed the global average in selection of this as important.

# Green Building Trends

## Most Important Green Building Approaches CONTINUED

- However, both Australia and New Zealand (58%) and Canada (57%) exceed the average for anticipated use.
- It ranks second for those with a majority of green projects, and it is the only other approach besides net-zero selected by a significantly higher percentage (52%) of them than the global average.
- Passive Building Design is not a new strategy, but it has received increased interest as organizations look for ways to improve their energy and carbon performance.
- Architects are the only ones for whom this is ranked in the top three in terms of importance, and they are the only type of organization to exceed the global average in expected use in five years (46%).

### Strategies to Increase Resiliency

With the impacts of climate change already evident, resiliency is recognized as an important sustainable approach by about one third of the total respondents. Given the widespread nature of the challenge, it is not surprising that there are no significant differences by the type of organization nor by country in the share of those who recognize increasing resiliency as important. It is notable, though, that the importance of resiliency is viewed roughly equally regardless of the level of green involvement by companies.

However, expected use of strategies to increase resiliency do vary by the level of green involvement, with over half (52%) of those doing a majority of green projects planning to incorporate these strategies into their projects in the next five years.

### Additional Alternative Design and Construction Approaches

In addition to passive building design, there are two other approaches to design and construction that can potentially

disrupt standard practices that are selected by between one quarter and one third of respondents.

- Prefabrication and modular construction are cited by 31% as important, and they are selected as the third highest for expected use in the next five years.
  - Prefabrication/modular is the top approach among contractors, both in importance (see below) and in expected use (55%).
  - Only Colombia (55%) significantly exceeds the global average in its selection of this as important, but Brazil (64%) and India (57%) are the only two countries in the study to exceed the average of expected use.
- Design for disassembly requires a different set of priorities in building design and in the specification of products and systems to be used. For more information, see pages 40–41.
  - Owners and investors have this ranked among their top most important approaches. However, only architects have a share expecting to use it in the future that exceeds the global average (33%).
  - Respondents from Brazil (45%) select this among the most important at a higher rate than the global average. Over half (52%) from Brazil also expect to use it in the next five years. High use of this approach is also expected in Saudi Arabia (54%).

### Other Approaches

Currently, fewer than 25% consider AI and other tools to improve the design and construction processes, biophilic design or mass timber to be among the top two most important ways to improve the sustainability of design and construction. However, the share intending to use all of these except mass timber in the next five years is over 20%, suggesting that they may be emerging items for more general use in the future.

## Most Important Approaches to Improve Sustainability in the Design and Construction Industry in the Next Five Years, by Company Type

Dodge Data & Analytics, 2021

Architects	Engineers	Contractors	Owners	Investors
1. Creation of Net-Zero/Net-Positive Buildings (52%)	1. Creation of Net-Zero/Net-Positive Buildings (46%)	1. Prefabrication and Modular Construction (45%)	1. Creation of Net-Zero/Net-Positive Buildings (48%)	1. Design for Disassembly and Recovery (57%)
2. Controlling Embodied Carbon (42%)	2. Controlling Embodied Carbon (36%)	2. Creation of Net-Zero/Net-Positive Buildings (35%)	2. Strategies to Increase Resiliency (31%)	2. Controlling Embodied Carbon (35%)
3. Passive Building Design (40%)	3. Strategies to Increase Resiliency (36%)	3. Strategies to Increase Resiliency (32%)	3. (Tie) Controlling Embodied Carbon & Use of Design for Disassembly and Recovery (29%)	3. Strategies to Increase Resiliency (33%)



# Data: Australia and New Zealand

## Green Building Activity and Trends in Australia and New Zealand

110 responses were received from Australia and New Zealand, with the vast majority (108) coming from Australia. This analysis will compare those responses to the global averages and examine trends in this region, including any changes since the previous study in 2018. Since nearly all responses are from Australia, in the write-up of the analysis below, for simplicity's sake, all findings will be attributed to Australia.

### Green Building Market Activity

#### CURRENT AND FUTURE ACTIVITY

Australia has the highest percentage of those currently doing the majority (more than 60%) of their projects green. As the table at right shows, the average is 20 points higher than the global average. They remain consistent with the levels of green building reported in 2018 in this region.

The study also shows a high level of commitment to increased green building activity in the next three years in Australia, with 61% who anticipate doing the majority of their projects green by 2024. Again, this is significantly above the global average for those with the same future expectations.

#### TOP PROJECT TYPES FOR BUILDING GREEN IN AUSTRALIA

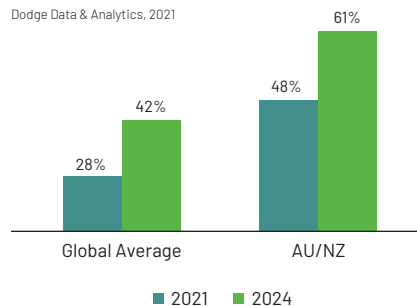
Respondents in Australia select the following as the top types of green building projects they expect to design and construct over the next three years.

- New Commercial Construction: 56%
- Existing Buildings /Retrofits: 35%
- New Institutional Construction: 33%
- New High-Rise Residential: 33%

Except for slightly more focus on existing building/retrofits, these findings are largely consistent with the top green building types expected globally and with the expectations reported in Australia in 2018.

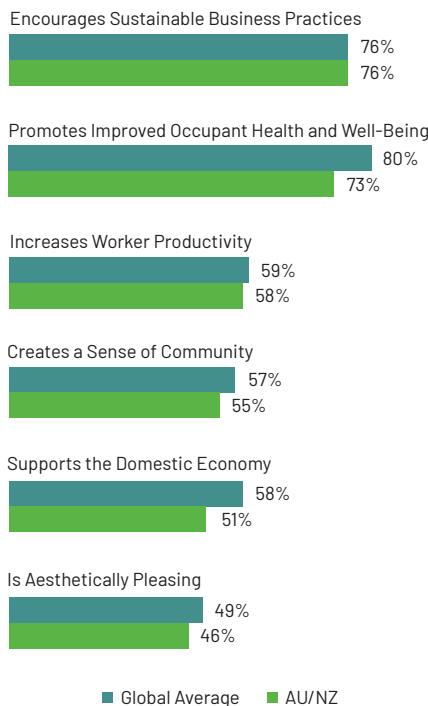
### Organizations Doing More Than 60% of Their Projects Green (Currently and in Three Years)

Dodge Data & Analytics, 2021



### Social Reasons for Building Green (Respondents Who Rated Each as Important/Very Important)

Dodge Data & Analytics, 2021



### Influences

#### SOCIAL REASONS FOR BUILDING GREEN

The chart at lower left contrasts the global average of those rating six social reasons for building green as important/very important with the responses from Australia. It reveals a high level of consistency between the priority of the social reasons globally and in Australia.

In 2018, the top two social reasons for building green in Australia were also encouraging sustainable business practices and promoting improved occupant health and well-being. However, perhaps surprisingly, in 2018, slightly more respondents selected improved occupant health and well-being (75%), and slightly fewer selected encouraging sustainable business practices (70%). While the differences are very small, and these are clearly the top two social drivers for green building in Australia, it is still surprising to see healthier buildings reduced in emphasis during the global pandemic. It is possible that, because Australia did a better job avoiding a dramatic surge in COVID cases in 2020 than many other global regions, it blunted the focus on how the built environment can help reduce the spread of illness in that region.

Three other social drivers were also rated as important/very important by over half of the respondents: increasing worker productivity, creating a sense of community and supporting the domestic economy. Each of these had similar scores in 2018. Overall, the findings suggest consistent attention to many social reasons for building green in this region.

#### ENVIRONMENTAL REASONS FOR BUILDING GREEN

More than 70% of respondents from Australia rate all five of the environmental reasons for building

# Data: Australia and New Zealand

## Green Building Activity and Trends in Australia/New Zealand CONTINUED

green important/very important, with energy conservation selected by 85%, lower greenhouse gas emissions by 84%, conservation of water and natural resources by 74% and improved indoor air quality by 71%.

- There is no significant difference between these findings and the global averages for each.
- While the general rank of each item has not changed since 2018, the share who consider several of them important/very important has grown:
  - Those rating greenhouse gas emissions as important grew by nine points, from 75% to 84%.
  - The share selecting conserving natural resources grew by six points, from 68% to 74%.
  - Those rating water conservation as important grew by five points from 69% to 74%.

These findings suggest increased influence for several environmental factors in the current decision to build green.

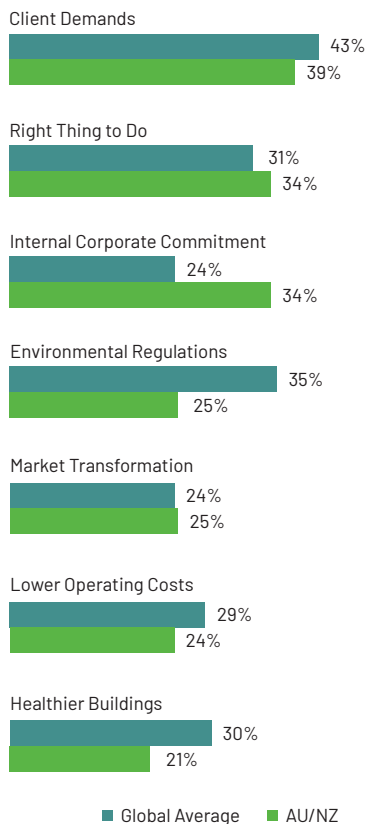
### TOP TRIGGERS FOR MORE GREEN BUILDING PROJECTS

Respondents were also asked about the top triggers that would encourage them to do more green building projects. The chart in the middle column compares the responses from Australia with the global averages for the top triggers in Australia.

- Client demands is the top trigger for future green projects both globally and in Australia.
- Right thing to do and internal corporate commitments tie for the second most important triggers in Australia. While the share selecting right thing to do in Australia is consistent with the global average, the share influenced by internal corporate commitments is much higher.
- Respondents from Australia are less influenced by environmental

### Top Triggers for New Green Building in Australia/New Zealand

Dodge Data & Analytics, 2021



regulations or healthier buildings as a trigger to increase their new green building efforts.

- Since 2018, the importance of client demands in Australia as a trigger has remained about the same, the importance of doing the right thing and internal corporate commitments have increased, and the influence of market transformation has declined.

### TOP BARRIERS TO THE GROWTH OF GREEN BUILDING

The top barriers to increased green building in Australia are:

- Higher (perceived or actual) First Costs: 41%
- Lack of Political Support or Incentives: 36%
- Affordability, Green Is for High End Projects: 30%

### Benefits of Green Building

#### USE OF METRICS

Most (82%) respondents in Australia report that they are using metrics to track critical benefits of green buildings, roughly consistent with the global average.

The top metrics tracked in Australia are lower operating costs (58%), documentation and certification providing quality assurance (36%) and improved occupant health and well-being (33%).

# Data: Australia and New Zealand

## Green Building Activity and Trends in Australia and New Zealand CONTINUED

### TOP BENEFITS IN THEIR MARKETS

Respondents were asked to identify the top business benefits of building green in their markets. The chart at right compares the responses from Australia with the global averages.

- The top three benefits in Australia are lower operating costs, future-proofing assets and improved occupant health and well-being. Of these, only future-proofing assets differs notably from the global average, with a much higher share selecting it in Australia.
- Also exceeding global averages in Australia are the benefits of fulfilling corporate/shareholder reporting requirements.

### FINANCIAL BENEFITS OF BUILDING GREEN

The table below shows the average reductions in operating costs reported for new green buildings and green renovations/retrofits by respondents in Australia, as well as owners' average anticipated increases in asset value from new green buildings by owners.

- Respondents from Australia report a greater operating cost reduction on new green buildings and green renovations than the global average, but they are more conservative about the impact on asset value.

### Use of Green Products

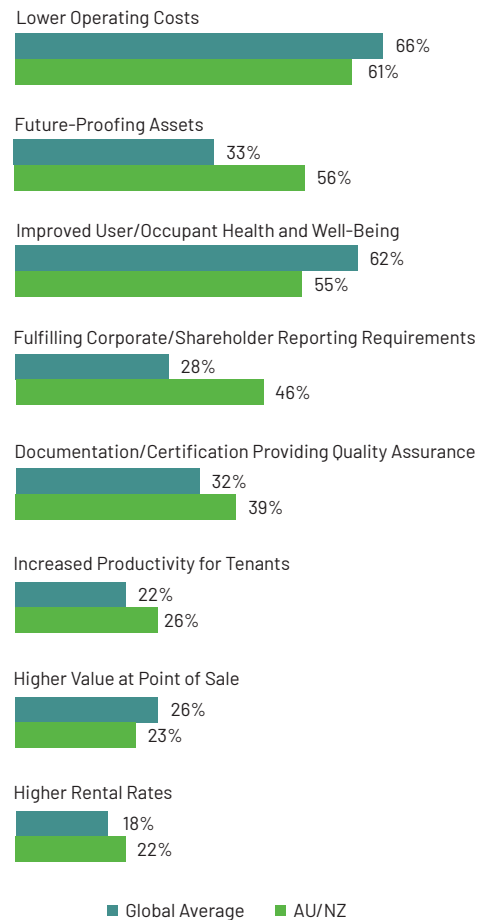
Over half of respondents from Australia report that they have specified or installed green products and systems in the following categories:

- Electrical: 59%
- Waste Management: 57%
- Mechanical: 56%
- Building Automation Systems: 53%

They exceed the global use of products for waste management (listed above), green flooring (47%) and furnishings (39%).

### Most Important Business Benefits of Green Building in Australia/New Zealand

Dodge Data & Analytics, 2021



### Financial Benefits of Building Green, Compared With Traditional Buildings

Dodge Data & Analytics, 2021

New Green Buildings	Global Average	AU/NZ
Average Reduction in Operating Costs in Next 12 Months	10.5%	12.2%
Average Reduction in Operating Costs in Next 5 Years	16.9%	17.8%
Average Increase in Asset Value (According to Owners/Investors)	9.2%	6.3%
Green Renovations/Retrofits	Global Average	AU/NZ
Average Reduction in Operating Costs in Next 12 Months	11.5%	12.7%
Average Reduction in Operating Costs in Next 5 Years	17.0%	18.8%

# Data: Australia and New Zealand

## Green Building Activity and Trends in Australia/New Zealand CONTINUED

### New Approaches to Improving Sustainability

#### TOP APPROACHES

The chart at right shows the top most important approaches to improving sustainability and their anticipated use in the next five years, according to the respondents from Australia.

- Creation of net-zero/net-positive buildings and controlling embodied carbon are the most important means, according to Australian respondents.
  - There is a wide, 16-point gap between Australians and the global average for the importance of controlling embodied carbon.
  - Over half in Australia also expect to engage with each of these in the next five years, at least 10 points more than those who anticipate doing so in the global responses.
- Australians are slightly under the share of global responses in terms of those who rank many of the remaining items as important, with the exception of mass timber.
- However, the share who intend to engage in passive building design, strategies to increase resiliency, prefabrication and modular construction, and design for disassembly and recovery either match or slightly exceed the global averages, revealing a rigorous engagement with most of these approaches.
- The share who expect to use mass timber is double the global average of 17%.

#### EMBODIED CARBON

Nearly all (91%) of respondents from Australia are familiar with embodied carbon, and 48% are tracking it on some of their projects, with over one third (34%) reporting that they are also actively seeking to reduce it. This is far more than are seeking to address embodied carbon globally (22%), putting Australia at the forefront of this effort.

#### DESIGN FOR DISASSEMBLY

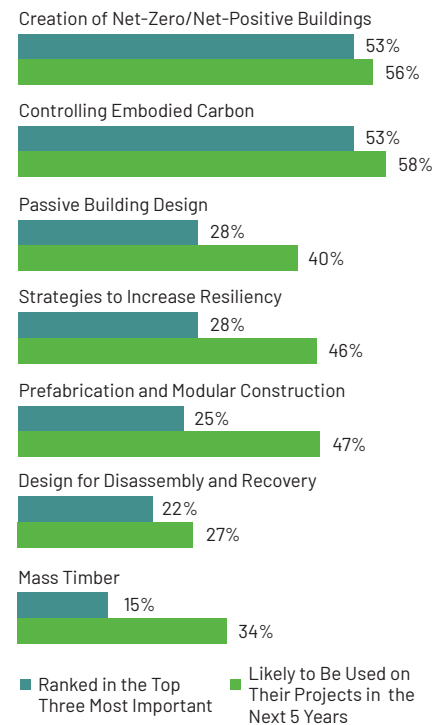
When presented with a definition of design for disassembly, half of the Australian respondents (other than contractors) state that it is either very important or absolutely critical to meet future sustainability needs. They also agree with the global consensus that the best ways to encourage the design industry to adopt this approach as a regular practice is to increase collaboration with manufacturers (41%) and for owners to require it on their projects (38%).

#### DESIGN FOR MANUFACTURING AND ASSEMBLY

A relatively high share of respondents in Australia (72%) are familiar with design for manufacturing and assembly (DfMA). 38% report actually using it on projects but almost two thirds of them only use it on fewer than 10% of their projects.

### Most Important Approaches to Improve Sustainability (According to Respondents in Australia/New Zealand)

Dodge Data & Analytics, 2021



## Green Building Activity and Trends in Asia

In total, 248 responses were received from 16 countries in Asia, including Bangladesh, Brunei, China, India, Japan, the Republic of Korea, Malaysia, Pakistan, the Philippines, Russia, Singapore, Sri Lanka, Thailand, Turkey and Vietnam. Of these, three countries had sufficient responses to support a statistical analysis: China, India and Singapore. Please note that the China data shown in the charts and included in the findings are from mainland China only and exclude responses received from Hong Kong, due to the very different nature of the green market in Hong Kong compared with the mainland.

This section examines the top findings from Asia and from China, India and Singapore.

### Green Building Market Activity

#### CURRENT AND FUTURE ACTIVITY

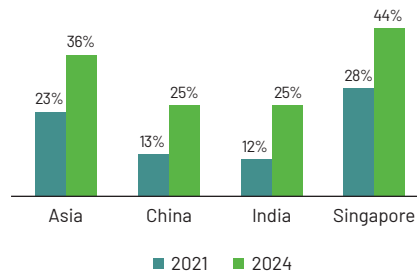
Overall, fewer respondents from Asia (23%) report that they engage in a high level of green building (more than 60% green projects) than the global average of 28%. Of the three countries featured, Singapore has the highest percentage of those doing a majority of their projects green currently, at 28%.

At 44%, Singapore also exceeds China and India in the share who expect to be building the majority of their projects green in three years, as well as surpassing the global average of 42%.

China and India are also expecting a much larger percentage to be building the majority of their projects green by 2024, with the share of those expecting to build green at that level in three years just about doubling the share of those doing so now. However, even with that growth, they are still below the global average of 42%.

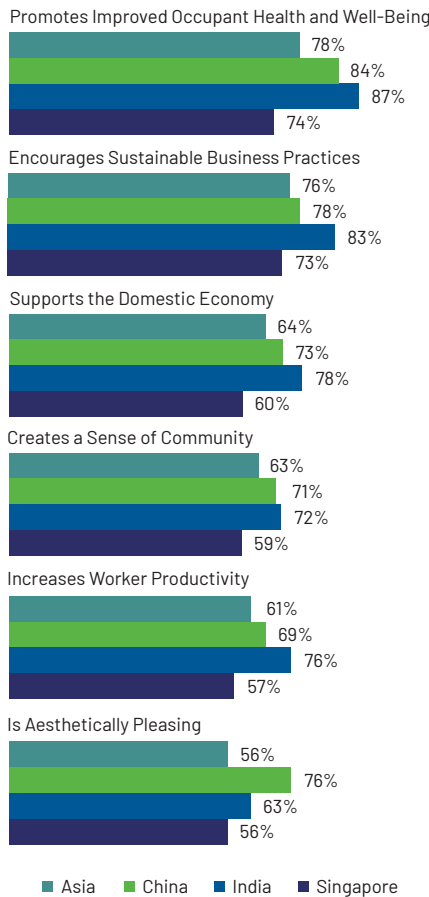
### Organizations Doing More Than 60% of Their Projects Green (Currently and in Three Years)

Dodge Data & Analytics, 2021



### Social Reasons for Building Green (Respondents Who Rated Each as Important/Very Important)

Dodge Data & Analytics, 2021



### TOP PROJECT TYPES FOR BUILDING GREEN IN ASIA

- New commercial construction is the top sector for expected new green building projects in three years in Asia (55%), followed by new institutional (45%) and high-rise residential (43%) projects. A far lower share (35%) expect to do green existing building renovation/retrofit projects.
- New commercial construction is also the top sector in India (70%) and Singapore (40%).
- While a high percentage (41%) of Chinese respondents also expect to do new green commercial buildings, even more (64%) expect to engage in new green high-rise residential projects.

### Influences

#### SOCIAL REASONS FOR BUILDING GREEN

The top two social reasons for building green among Asian respondents is to promote improved occupant health and well-being and to encourage sustainable business practices, both rated as important/very important by over three quarters.

- Respondents from Singapore generally tend to rate all the social reasons for building green lower than do those from China and India, with only a small gap for encouraging sustainable business practices but notable differences for most of the other measures.
- Over 70% of respondents from India rate all the social factors highly, except aesthetics.

#### ENVIRONMENTAL REASONS FOR BUILDING GREEN

75% or more of respondents from Asia consider all five environmental reasons for building green important/very important, with reducing energy consumption (83%) and improving indoor air quality (80%) topping the list.

# Data: Asia

## Green Building Activity and Trends in Asia CONTINUED

- As with the social factors, respondents from India are the most enthusiastic, with 90% or more rating each environmental reason for building green as important or very important.
  - Protecting natural resources ranks first in India, selected by 98%.
  - All other factors have 93% rating them highly, except improving indoor air quality, with just 90%.
- In China, reducing energy consumption most frequently receives an important/very important rating (82%), followed by improving indoor air quality (80%) and reducing greenhouse gas emissions (73%).
- Reducing energy and water consumption tie for first place in Singapore, with 76% rating each as important/very important. Improving indoor air quality is next, rated highly by 71%.

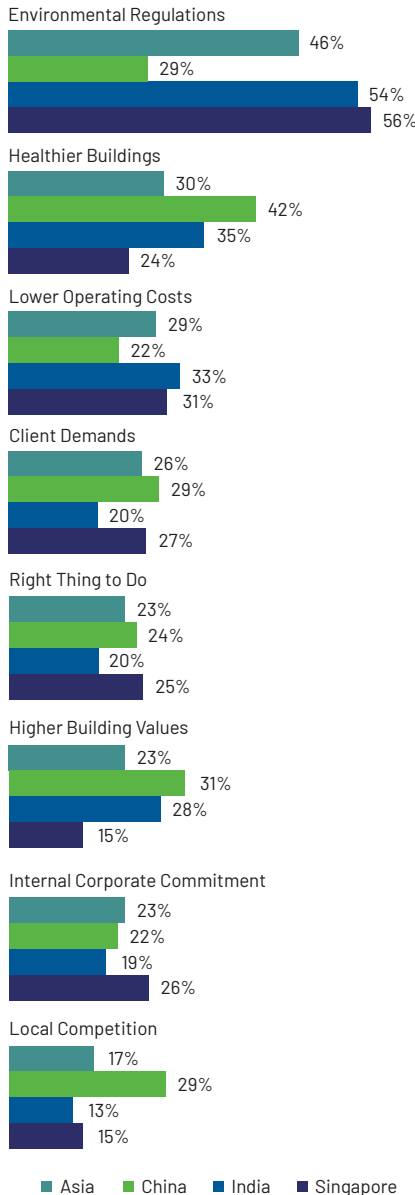
### TOP TRIGGERS FOR MORE GREEN BUILDING PROJECTS

As the chart in the middle column reveals, there is notable variation in the top triggers for future new green building projects in the responses of those from Asia.

- Overall, the top trigger in Asia is environmental regulations, but it is selected in the top three far less frequently by respondents from China than by those from India or Singapore.
- Healthier buildings ranks first by far in China, which corresponds to the high emphasis placed there on improving indoor air quality. Chinese respondents also more frequently select local competition as a trigger than do others in Asia.
- Other than environmental regulations, respondents from India also rank healthier buildings and lower operating costs among the top triggers for future green building.
- In Singapore, the only other trigger besides environmental regulations selected in the top three by over 30% is lowering operating costs.

### Top Triggers for New Green Building

Dodge Data & Analytics, 2021



### TOP BARRIERS TO THE GROWTH OF GREEN BUILDING

The top three barriers in Asia to the growth of green building activity are higher perceived first costs (46%), affordability (33%), inability to prove the business case (31%) and lack of trained/educated green building professionals (31%).

- In China, the top barriers are higher first costs (53%), affordability (44%) and inability to prove the business case (35%).
- In India, they are lack of trained/educated green building professionals (41%), affordability (37%) and high levels of corruption in the industry (33%).
- In Singapore, they are higher first costs (58%), inability to prove the business case (40%) and lack of trained/educated green building professionals (34%).

### Benefits of Green Building

#### USE OF METRICS

Nearly all (91%) of the respondents in Asia report that they are using metrics to track the critical benefits of green building, with no significant differences between the respondents from China, India or Singapore.

- The top metrics being used in Asia overall are lower operating costs (70%), improved occupant health and well-being (48%), and documentation and certification providing quality assurance (46%).
  - China reports very high use of documentation and certification (60%).
  - India has a high percentage who track tenant productivity (32%).

# Data: Asia

## Green Building Activity and Trends in Asia CONTINUED

### TOP BENEFITS IN THEIR MARKETS

Respondents were asked to identify the top business benefits of building green in their markets.

- Overall respondents in Asia select improved occupant health and well-being as the top business benefit in their markets. This is in contrast to the global findings, in which lower operating costs rank first, although improved health and well-being are also highly ranked.
- While improved health and well-being also tops the list in China and India, lower operating costs is the top benefit reported in Singapore, selected by 75%. This percentage is notably higher than the global average for lower operating costs, which is 66%.
- China and India fall far below the global average in the share of those who consider lower operating costs one of the top benefits.
- A notably high share of Indian respondents (52%) select future-proofing assets, far more than the average in Asia of 39% or the global average of 33%.
- The remainder of the top benefits of green building reported in Asia—documentation/certification providing quality assurance, education of users/

occupants about sustainability and fulfilling corporate/shareholder reporting requirements, are all several percentage points higher than the global average for each.

### FINANCIAL BENEFITS OF BUILDING GREEN

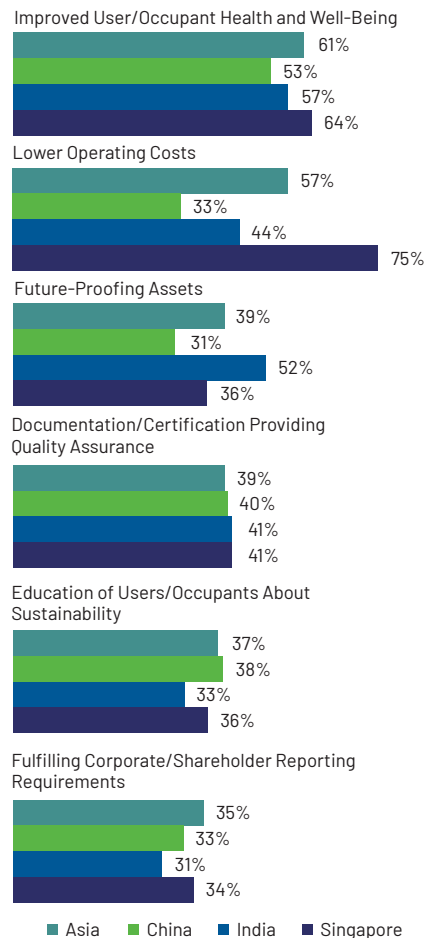
The table below shows the average reductions in operating costs reported for new green buildings and green renovations/retrofits, as well as average increases for the asset value of new green buildings by respondents in Asia.

### Use of Green Products

- Top categories for green building products and systems used in the last five years in Asia are building automation systems (51%), electrical (47%), waste management (45%), mechanical (43%), and thermal and moisture protection (40%).
  - Respondents from China report a very high use of green thermal and moisture protection products (76%).
  - India reports a high level of use of green waste management (69%) and green furnishings (47%).
  - Singapore reports high levels of use of green mechanical products and systems (55%).

### Top Benefits of Green Building in Asia

Dodge Data & Analytics, 2021



### Financial Benefits of Building Green, Compared With Traditional Buildings

Dodge Data & Analytics, 2021

New Green Buildings	Asia	China	India	Singapore
Average Reduction in Operating Costs in Next 12 Months	10.0%	7.4%	9.8%	10.8%
Average Reduction in Operating Costs in Next 5 Years	15.8%	11.3%	17.8%	16.3%
Average Increase in Asset Value (According to Owners/Investors)	9.0%	9.0%	9.5%	8.2%
Green Renovations/Retrofits	Asia	China	India	Singapore
Average Reduction in Operating Costs in Next 12 Months	10.4%	7.6%	11.9%	10.7%
Average Reduction in Operating Costs in Next 5 Years	15.4%	12.6%	17.4%	14.6%

## New Approaches to Improving Sustainability

### TOP APPROACHES

The charts at right show the most important approaches to improving sustainability according to respondents from Asia, and the share who expect to use these approaches in the next five years.

- Creation of net-zero/net-positive buildings and controlling embodied carbon are top approaches in the region overall and in all three countries.
- Prefabrication and modular construction is expected to be widely used across Asia in general, and in China and Singapore.
- Strategies to increase resiliency are also expected to be widely used across this region, but especially in India.
- Design for disassembly and recovery ranks particularly high in importance in India and Singapore.
- Indians also rank the importance of biophilic design higher than the other respondents from Asia, and have a higher share who intend to use it in the next five years.

### EMBODIED CARBON

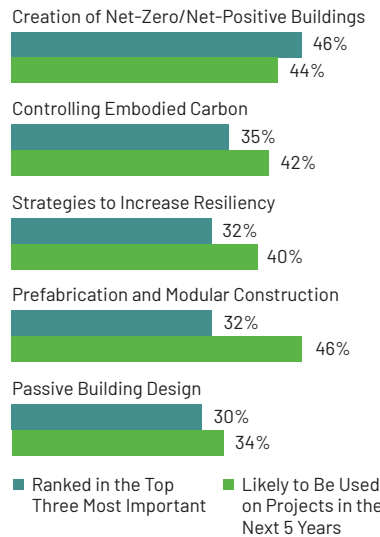
About three quarters (76%) of respondents from Asia are familiar with embodied carbon, with a particularly high share reporting this in China (82%) and India (90%). Over 40% of respondents from China and India say that they are tracking embodied carbon, and about one quarter say that they are actively seeking to reduce it.

### DESIGN FOR DISASSEMBLY

All respondents from Asia report similar findings for this approach, with nearly half (47%), when provided with a definition of it, who believe it is very important/absolutely critical to achieve sustainable goals.

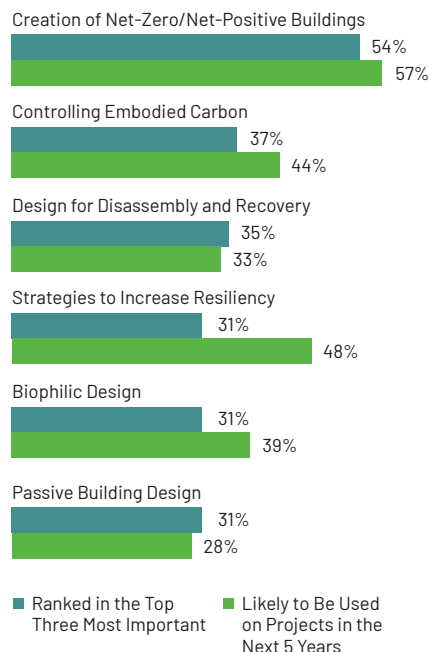
## Most Important Approaches to Improve Sustainability (According to Respondents From Asia)

Dodge Data & Analytics, 2021



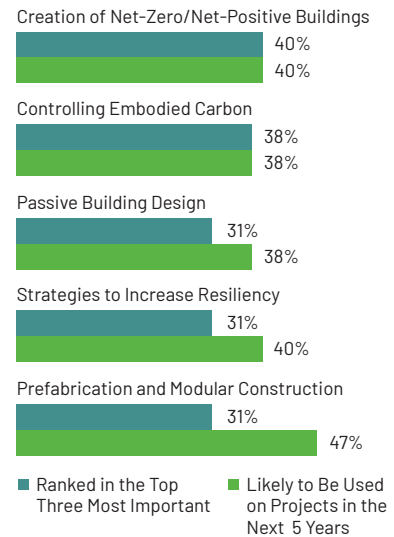
## Most Important Approaches to Improve Sustainability (According to Respondents From India)

Dodge Data & Analytics, 2021



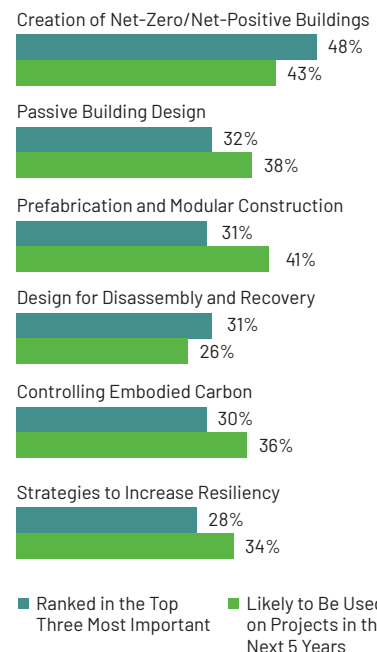
## Most Important Approaches to Improve Sustainability (According to Respondents From China)

Dodge Data & Analytics, 2021



## Most Important Approaches to Improve Sustainability (According to Respondents From Singapore)

Dodge Data & Analytics, 2021





# Data: Europe

In total, 111 responses were received from 21 countries in Europe, including Albania, Austria, Belgium, Croatia, Czech Republic, France, Germany, Greece, Hungary, Ireland, Italy, Liechtenstein, Netherlands, Poland, Portugal, Serbia, Spain, Sweden, Switzerland, Ukraine and the United Kingdom. Of these, only Germany had sufficient responses to be analyzed independently, so this section will look at responses from Europe as a whole and from Germany in particular.

In general, the findings from Germany are more conservative than those in the rest of Europe and the global averages. While many factors could contribute to the differences between Germany and the responses in Europe in general, one factor that should be considered is that owners comprise 39% of the total responses in Germany. This is significantly higher than the total in Europe (16%, including Germany, only 6% if Germany is excluded) and the average share of the total global responses of 17%. In addition, the share in Germany of responses from architects is only 9%, compared with 31% of the other European responses. Owners are generally more conservative than architects in their response to green, and this likely contributes to the lower responses in many areas for Germany.

## Green Building Market Activity

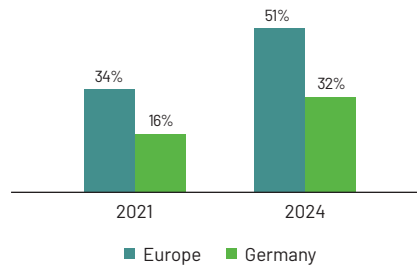
### CURRENT AND FUTURE ACTIVITY

34% of respondents from Europe currently report that the majority (over 60%) of their projects are green, higher than the global average of 28%. However, German respondents are significantly below, with only 16% reporting that they are building green at that level.

The respondents from Europe also exceed the global average of 48% who intend to do the majority of their projects green in the next three years, with 51% reporting that. While Germany again has

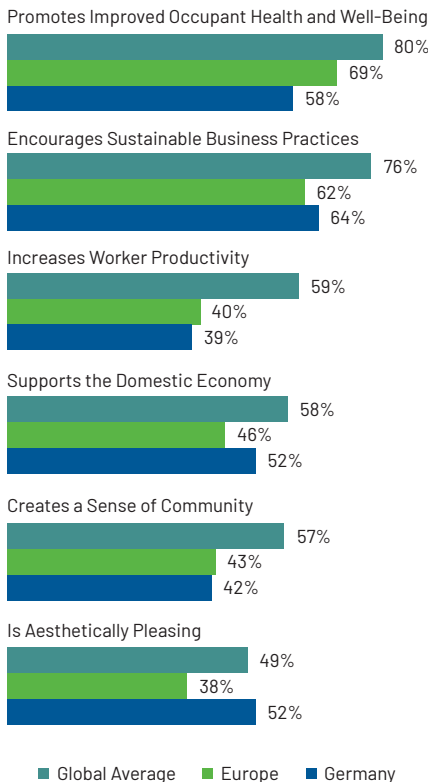
### Organizations Doing More than 60% of Their Projects Green (Currently and in Three Years)

Dodge Data & Analytics, 2021



### Social Reasons for Building Green (Respondents Who Rated Each as Important/Very Important)

Dodge Data & Analytics, 2021



a lower percentage, it is notable that the share of those doing a majority of green projects is expected to double in Germany within three years, suggesting a commitment to green building in the future.

### TOP PROJECT TYPES FOR BUILDING GREEN IN EUROPE

Respondents in Europe select the following as the top three types of green building projects they expect to design and construct over the next three years.

- New Commercial Construction: 44%
- New Institutional Construction: 34%
- Existing Buildings/Retrofits: 34%

Despite being the top choices in Europe, all three are lower than the global averages selecting each. This may suggest a higher level of specialization in Europe, leading many respondents to select fewer project types overall. As the previous findings demonstrate, it does not represent a lower share of overall green projects.

## Influences

### SOCIAL REASONS FOR BUILDING GREEN

The chart at right contrasts the global average of those rating six social reasons for building green as important/very important with the responses from Europe and Germany.

- The top two social reasons for building green globally are also the top two in Europe and German—promotes improved occupant health and well-being, and encourages sustainable business practices.
- In Europe, these are the only social reasons rated as important/very important by more than 50% of respondents. The next two most important are supports the domestic economy (46%) and creates a sense of community (43%).

# Data: Europe

## Green Building Activity and Trends in Europe CONTINUED

- Over half of German respondents also consider supporting the domestic economy and the aesthetic quality of green buildings to be important/very important reasons for building green.

### ENVIRONMENTAL REASONS FOR BUILDING GREEN

European respondents less frequently select all the environmental reasons for building green than do their global counterparts.

- Reducing Energy Consumption: 79% in Europe rate it as important/very important versus 87% globally
- Lower Greenhouse Gas Emissions: 76% versus 81%
- Reduce Water Consumption: 70% versus 80%
- Improve Indoor Air Quality: 70% versus 81%
- Protect Natural Resources: 69% versus 79%

There are no significant differences between the share of responses in Europe as a whole and those in Germany selecting each of the five factors.

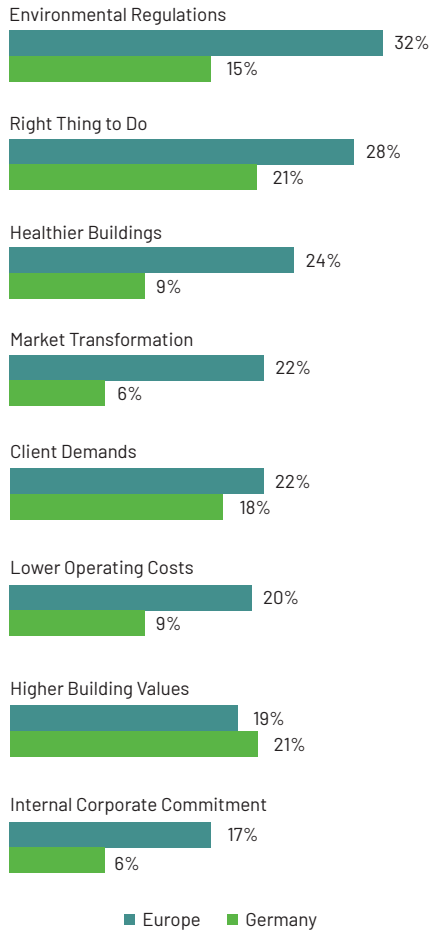
### TOP TRIGGERS FOR MORE GREEN BUILDING PROJECTS

Respondents were also asked to select the top three triggers that would encourage them to do more green building projects. The top findings for Europe and Germany are shown in the chart in the middle column.

- No single trigger for Europe as a whole or Germany specifically is selected by one third or more respondents. The tight distribution of several triggers demonstrates that there are multiple factors that can encourage the growth of green building in this region, rather than one or two key factors.
- The top two triggers in Europe are environmental regulations and right thing to do.
- Right thing to do is also one of the top

### Top Triggers for New Green Building

Dodge Data & Analytics, 2021



triggers in Germany, tied with higher building values.

### TOP BARRIERS TO THE GROWTH OF GREEN BUILDING

Respondents were asked to select the top three barriers facing the growth of green building in their business.

- The top response for Europe overall, and by a wide margin, is higher (perceived or actual) first costs, selected in the top three by 53%. In contrast, the next most widely selected barrier in Europe is the lack of trained/educated green building professionals, selected by 30%.
- Higher first costs is also the top barrier in Germany, but it is selected by only 27%.
- No other barrier is selected by more than one quarter of German respondents. Instead, 33% of them say that there are no barriers to the growth of green building.

### Benefits of Green Building

#### USE OF METRICS

Over three quarters (78%) of respondents in Europe report that they are using metrics to track critical benefits of green buildings.

- By far, the top metric tracked is lower operating costs, with 55% reporting that they do so.
- The only other two metrics tracked by more than one quarter of respondents from Europe are documentation and certification providing quality assurance (26%) and improved occupant health and well-being (26%).
- There are no significant differences between the responses from Germany and the rest of Europe.

# Data: Europe

## TOP BENEFITS IN THEIR MARKETS

Respondents were asked to identify the top business benefits of building green in their markets. The chart at right compares the top responses from Europe and Germany with the global averages.

- The top two benefits in Europe are also the top global benefits: lower operating costs and improved user/occupant health and well-being.
- Lower operating costs are also a top benefit in Germany. Improved health and well-being is a distant fourth among the top benefits in Germany.
- A relatively high share in Europe select future-proofing assets and higher rental rates among their top business benefits of building green, more than those selecting each globally or in Germany.

## FINANCIAL BENEFITS OF BUILDING GREEN

The table below shows the average reductions in operating costs and average increases in asset value reported for new green buildings and green renovations/retrofits by respondents in Europe and Germany.

German respondents report much lower operating cost decreases for both

new buildings and green retrofits than do the respondents in Europe overall. However, both German and overall European respondents expect new green assets to gain in value by over 9%.

## Use of Green Products

The top three product categories in which European respondents have specified or installed green products in the last five years are:

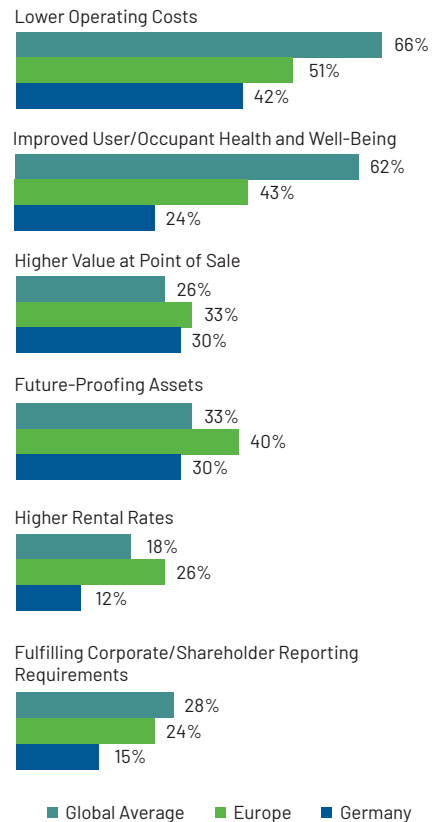
- Thermal and Moisture Protection: 52%
- Electrical: 45%
- Mechanical: 39%
  - Reported use in Germany of green mechanical products/systems is much lower (17%) than outside of Germany (49%). This is likely due to the difference in sample noted at the beginning of this section.

A relatively high share (22%) in Europe also use mass timber, compared with just 15% globally. Use of mass timber is less widely reported within Germany (7%) than outside of it (28%).

Very few German respondents also report using green furnishings (3%), especially compared with European respondents outside of Germany (31%).

## Most Important Business Benefits of Green Building in Europe

Dodge Data & Analytics, 2021



## Financial Benefits of Building Green, Compared With Traditional Buildings

Dodge Data & Analytics, 2021

New Green Buildings		Europe	Germany
Average Reduction in Operating Costs in Next 12 Months		8.6%	4.2%
Average Reduction in Operating Costs in Next 5 Years		13.2%	8.3%
Green Renovations/Retrofits		Europe	Germany
Average Reduction in Operating Costs in Next 12 Months		12.3%	6.9%
Average Reduction in Operating Costs in Next 5 Years		17.0%	10.7%

# Data: Europe

## New Approaches to Improving Sustainability

### TOP APPROACHES

The charts at right show the top most important approaches to improving sustainability according to the respondents from Europe (excluding Germany) and those from Germany.

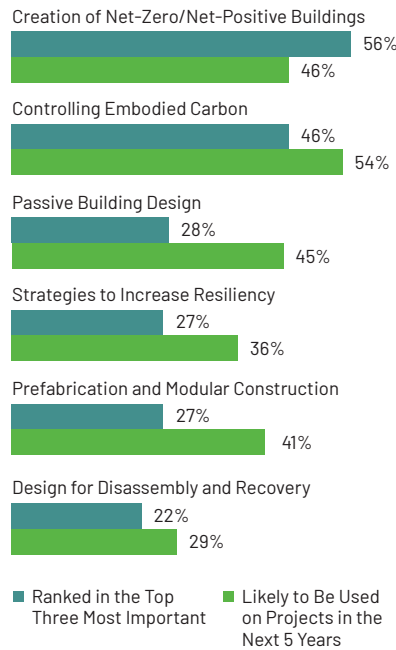
- The top two most important approaches to improving sustainability in Europe outside of Germany are the creation of net-zero/net-positive buildings and controlling embodied carbon. Notably, an even greater share expect to control embodied carbon on some of their projects in the next five years than those who rank it as important. The share who select each as important and the share who anticipate controlling embodied carbon are also much higher than the global averages.
- In addition to wide use of both of these approaches, a high share of respondents from Europe also expect to use passive building design, prefabrication and modular construction, and strategies to increase resiliency.
- The top approach to improve sustainability according to the German respondents is design for disassembly and recovery, with over one third selecting it among their top three and one third expecting to use this approach.

### EMBODIED CARBON

Most respondents (80%) in Europe are familiar with embodied carbon, and nearly 40% are tracking it on at least some of their projects. Nearly two thirds of those tracking it are also actively attempting to reduce it. Those who are reducing it report doing so on nearly one third (31.3%) of their projects. These findings suggest that Europe is further advanced than many other regions globally in addressing the issue of embodied carbon.

## Most Important Approaches to Improve Sustainability (According to Respondents in Europe, Excluding Germany)

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### DESIGN FOR DISASSEMBLY AND RECOVERY

When presented with a definition of this approach, over half (54%) of European respondents consider it very important or absolutely critical to meet future sustainable goals.

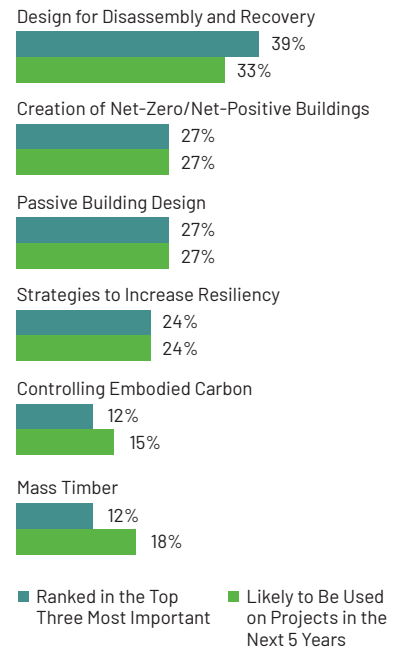
Consistent with the overall global findings, European respondents believe that owner requirements and more collaboration with manufacturers are the top means to encourage the design industry to adopt this as a regular practice.

### DESIGN FOR MANUFACTURING AND ASSEMBLY

Over half (59%) of the respondents from Europe are familiar with design for manufacturing and assembly, and 30% have done at least some projects with

## Most Important Approaches to Improve Sustainability (According to Respondents in Germany)

Dodge Data & Analytics, 2021



this approach. Over half of them, though, have done so on fewer than 10% of their projects, suggesting that this is still an emerging building approach in Europe.

# Data: Latin America

## Green Building Activity and Trends in Latin America

In total, 218 responses were received from 15 countries in Latin America, including Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, El Salvador, Guatemala, Mexico, Panama, Peru, Saint Kitts and Nevis, Trinidad and Tobago, Turks and Caicos Islands, and Venezuela. Of these, three countries had sufficient responses to support a statistical analysis: Brazil, Colombia and Mexico.

This section examines the top findings from Latin America.

### Green Building Market Activity

#### CURRENT AND FUTURE ACTIVITY

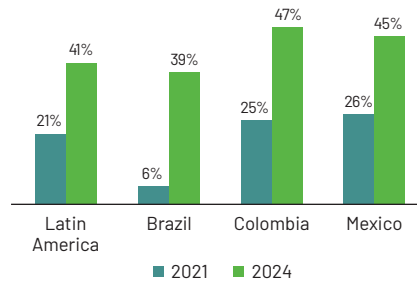
Currently, the share of those doing the majority (more than 60%) of their projects green among all the Latin America respondents is 21%, less than the global average of 28%. Far fewer report building green at that level in Brazil currently, while Colombia and Mexico are slightly above the regional average, and Mexico matches the global one.

However, dramatic growth is expected in those doing the majority of green in this region in the next three years. The regional percentage almost doubles, from 21% currently to 41% who expect to do the majority of their projects green by 2024, essentially closing the gap with the global average of 42%.

- Brazil has the most dramatic growth in the share of those expecting to do a majority of green projects by 2024, even if it still falls short of the global average.
- Colombia and Mexico, though, both have a high level of growth as well, with both substantially exceeding the global average in their three-year outlook.

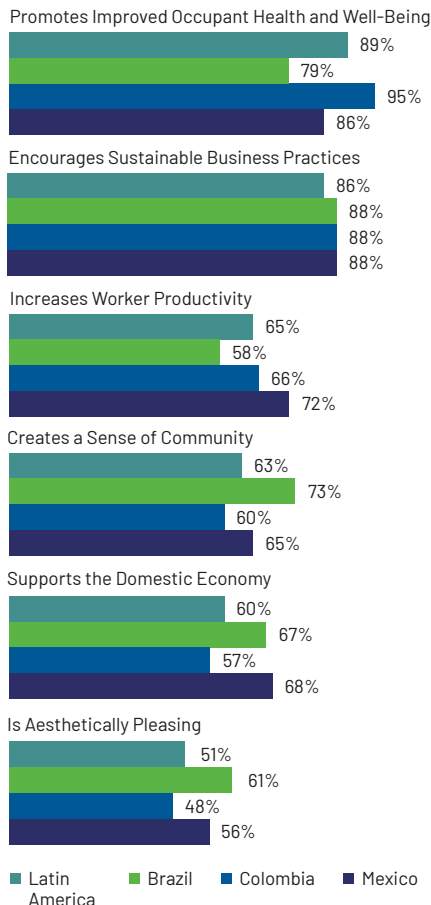
### Organizations Doing More Than 60% of Their Projects Green (Currently and in Three Years)

Dodge Data & Analytics, 2021



### Social Reasons for Building Green (Respondents Who Rated Each as Important/Very Important)

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### TOP PROJECT TYPES FOR BUILDING GREEN IN LATIN AMERICA

The top types of green projects that Latin American respondents anticipate doing in the next three years are new commercial construction (50%), new high-rise residential construction (35%), existing buildings/retrofits (32%) and new low-rise residential construction (32%).

- Far more respondents from Colombia (40%) report that they expect to do new green institutional projects than in Brazil (15%), with Mexico much closer to the regional average.
- New green high-rise residential projects are also more commonly expected in Colombia (53%) than in the region (35%), or in Brazil (21%) or Mexico (32%).

### Influences

#### SOCIAL REASONS FOR BUILDING GREEN

The top two social reasons for building green overall among Latin American respondents are to promote improved occupant health and well-being, and to encourage sustainable business practices, both rated as important/very important by over 85% of respondents.

- Promoting occupant health and well-being is particularly influential in Colombia, but also highly influential in Mexico and Brazil.
- In addition to encouraging sustainable business practices, the ability of green projects to increase worker productivity is particularly influential in Mexico, and generally influential in the region.
- Creating a sense of community is particularly influential in Brazil and also generally influential in the region.

# Data: Latin America

## Green Building Activity and Trends in Latin America CONTINUED

WORLD GREEN BUILDING TRENDS 2021 DATA

### ENVIRONMENTAL REASONS FOR BUILDING GREEN

87% or more of respondents from Latin America consider all the environmental reasons for building green important/very important, with only small differences between those most frequently rated the highest—reducing energy (94%) and water (91%) consumption—and the remainder—protecting natural resources (89%), improving indoor air quality (89%) and reducing greenhouse gas emissions (87%). There are also no significant differences between Brazil, Colombia or Mexico in these ratings, suggesting that the five environmental factors are all top drivers for green in this region.

### TOP TRIGGERS FOR MORE GREEN BUILDING PROJECTS

As the chart in the middle column reveals, there is notable variation in the top triggers for future new green building projects in the responses of those from Latin America.

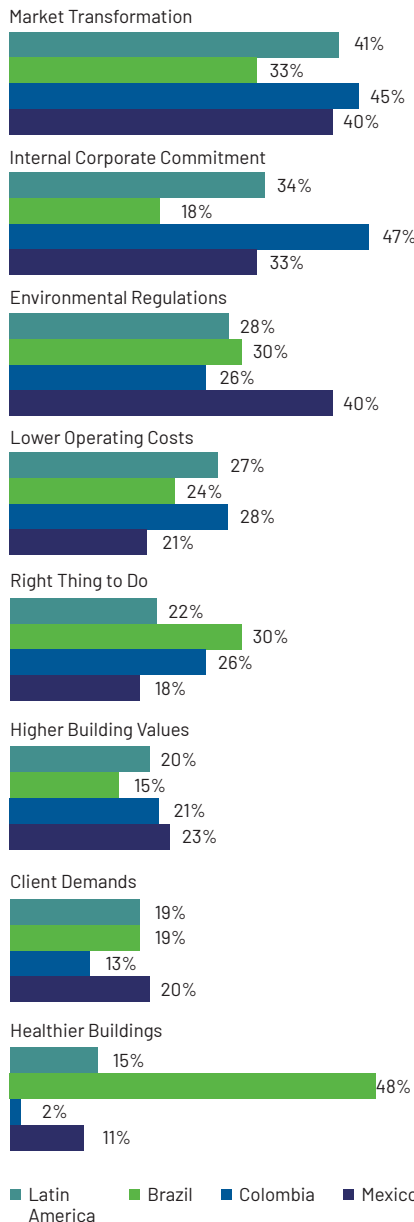
- Overall, the top trigger in Latin America is market transformation, and this also ranks in the top three for all three countries.
- The top trigger in Brazil is healthier buildings, and this is in sharp contrast to the other findings in Latin America.
- The top trigger in Colombia is internal corporate commitment, followed closely by market transformation.
- The top triggers in Mexico are market transformation and environmental regulations. Regulations are far less important in the rest of the region than they are in Mexico.

### TOP BARRIERS TO GREEN BUILDING IN LATIN AMERICA

The top three barriers to the growth of green building activity in Latin America are higher perceived first costs (59%), lack of political support or incentives (49%) and lack of public awareness (34%).

### Top Triggers for New Green Building in Latin America

Dodge Data & Analytics, 2021



In Colombia, far more respondents (71%) select higher perceived first costs, but the Colombian findings generally correspond to the regional findings in the ranking of the top three obstacles. These also rank as the top three in this order in Brazil and Mexico.

### Benefits of Green Building

#### USE OF METRICS

Most (83%) respondents in Latin America report that they are using metrics to track critical benefits of green building, with no significant differences between respondents from Brazil, Colombia or Mexico.

- Over half (57%) report tracking lower operating costs as a performance measure on their green projects.
- Improved occupant health (37%), and documentation and certification providing quality assurance (36%) are also used by over one third.
- Over half (56%) in Mexico report using documentation and certification.

# Data: Latin America

## Green Building Activity and Trends in Latin America CONTINUED

### TOP BENEFITS IN THEIR MARKETS

Respondents were asked to identify the most important benefits of building green in their markets. The chart at right lists the findings for Latin America and for the three countries.

- The top benefit, both regionally and in each country, is lower operating costs. However, those in Colombia select this as a top benefit more frequently than those in Brazil or Mexico.
- The other major benefit reported in Colombia is improved occupant health and well-being. It is also influential regionally and in Brazil, but less influential in Mexico.
- Education of users/occupants about sustainability is a top benefit in Brazil.
- Higher value at point of sale is a top benefit in Mexico.

### FINANCIAL BENEFITS OF BUILDING GREEN

The table below shows the average reductions in operating costs reported for new green buildings and green renovations/retrofits by respondents in Latin America, Brazil, Colombia and Mexico.

- Respondents from Mexico report higher average operating cost savings for new green buildings than the average regionally. The findings from Brazil and Colombia are more consistent with the overall regional findings for this.

- For green retrofits, the differences vary based on the length of time.
  - Respondents from Colombia report the greatest operational cost savings in the first year.
  - Those from Brazil report the greatest savings in five years.

### Use of Green Products

When asked in which product categories they have specified or installed green products in the last five years, the respondents from Latin America most frequently selected the following categories:

- Electrical: 55%
- Building Automation Systems: 43%
- Waste Management: 41%

There are two types of green products more widely used in Mexico than in Colombia: thermal and moisture protection (45% versus 25%, respectively) and furnishings (31% versus 8%).

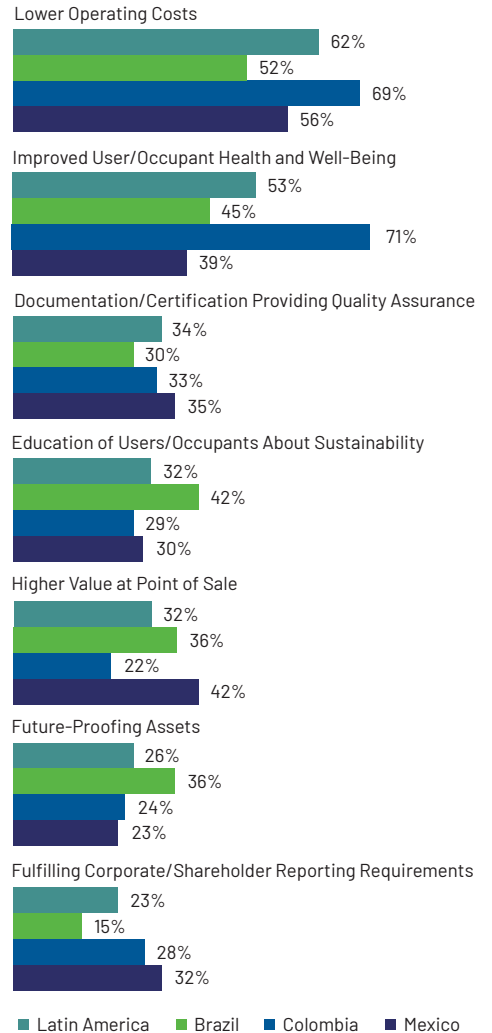
### New Approaches to Improving Sustainability

#### TOP APPROACHES

The charts on the following page show the top most important approaches to improving sustainability according to all the respondents from Latin America and those from Brazil, Colombia and Mexico, and the share who expect to use those

### Top Benefits of Green Building in Latin America

Dodge Data & Analytics, 2021



### Financial Benefits of Building Green, Compared With Traditional Buildings

Dodge Data & Analytics, 2021

New Green Buildings	Latin America	Brazil	Colombia	Mexico
Average Reduction in Operating Costs in Next 12 Months	8.5%	7.0%	8.5%	10.2%
Average Reduction in Operating Costs in Next 5 Years	15.7%	15.5%	15.5%	17.5%
Green Renovations/Retrofits	Latin America	Brazil	Colombia	Mexico
Average Reduction in Operating Costs in Next 12 Months	10.9%	7.0%	13.6%	12.0%
Average Reduction in Operating Costs in Next 5 Years	18.5%	21.3%	18.4%	18.4%

# Data: Latin America

approaches in the next five years.

- Generally, in Latin America, the range in percentages of those selecting the top six approaches is quite small, suggesting that many approaches are considered important across the region.
- Controlling embodied carbon and the use of prefabrication/modular construction are tied as the most important strategies regionally, with more expecting to use prefabrication and modular construction in the next five years.
- Design for disassembly is the most important strategy in Brazil, along with controlling embodied carbon. Brazil is also unique in that mass timber and biophilic design are among the top six most important approaches. A large share of respondents from Brazil also intend to use biophilic design and prefabrication and modular construction in the next five years.
- In Colombia and Mexico, the same six approaches that are on top regionally are also on top here.
  - Colombia has a particularly high percentage who consider prefabrication and modular construction important.
  - Mexico has a relatively high share who intend to control embodied carbon on their projects in the next five years.

## EMBODIED CARBON

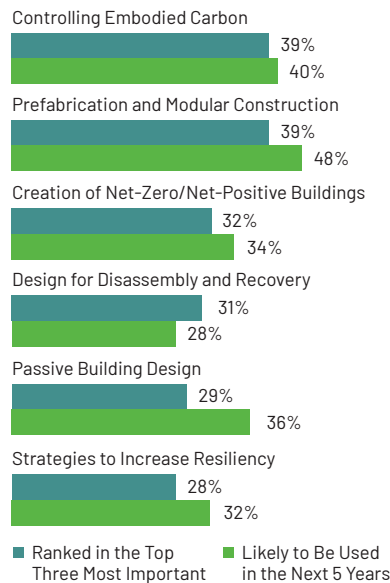
Most respondents (81%) from Latin America are familiar with embodied carbon, and 34% report that they are tracking it. 19% are attempting to reduce it currently.

## DESIGN FOR DISASSEMBLY

When presented with a definition of design for disassembly, 60% believe it is either very important or absolutely critical to meet future sustainability goals.

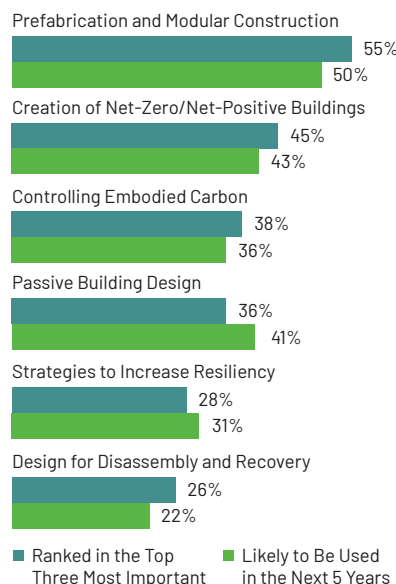
## Most Important Approaches to Improve Sustainability (According to Respondents From Latin America)

Dodge Data & Analytics, 2021



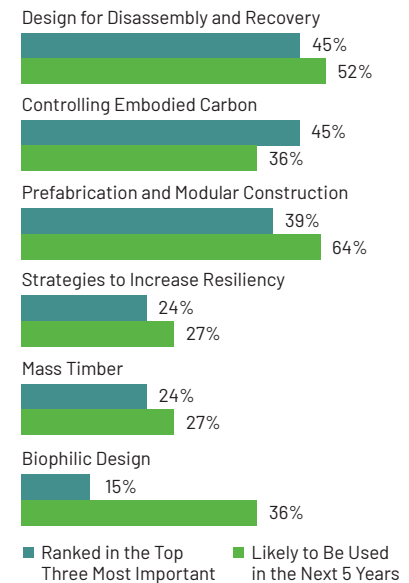
## Most Important Approaches to Improve Sustainability (According to Respondents From Colombia)

Dodge Data & Analytics, 2021



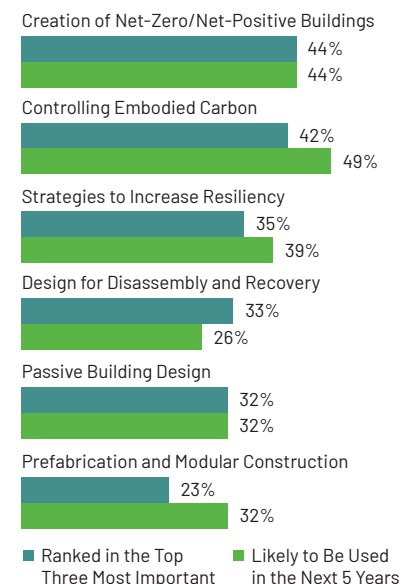
## Most Important Approaches to Improve Sustainability (According to Respondents From Brazil)

Dodge Data & Analytics, 2021



## Most Important Approaches to Improve Sustainability (According to Respondents From Mexico)

Dodge Data & Analytics, 2021





# Data: Middle East and North Africa

## Green Building Activity and Trends in the MENA Region

In total, 88 responses were received from 12 countries in the Middle East and North Africa (MENA), including Algeria, Bahrain, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Tunisia and the United Arab Emirates. Of these, only Saudi Arabia had sufficient responses to be analyzed independently, so this section will look at responses from the whole region and from Saudi Arabia in particular.

### Green Building Market Activity

#### CURRENT AND FUTURE ACTIVITY

Currently, the level of green building in the MENA region is lower than the global average for those doing the majority (more than 60%) of their projects green. Only 11% from the MENA region as a whole, and 12% from Saudi Arabia, report engaging in green building to that degree, significantly less than the 28% global average for that level of engagement.

In both the region as a whole and in Saudi Arabia, the share who report expecting to be that engaged with green in three years is more than double those who are doing so now. While this still falls short of the 42% global average who expect to be doing the majority of their projects green, it demonstrates a growing commitment to green building in this region.

#### TOP PROJECT TYPES FOR BUILDING GREEN IN MENA

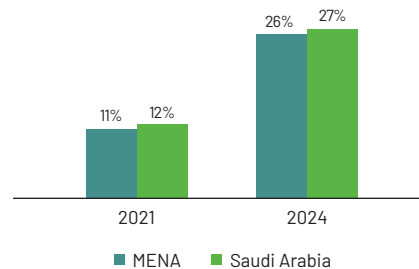
Respondents in the MENA region select the following as the top types of green building projects they expect to design and construct over the next three years.

- New Commercial Construction: 61%
- New Institutional Construction: 51%
- New High-Rise Residential: 49%
- Communities (Mixed-Use Development): 40%

Respondents from Saudi Arabia have a slightly different ranking, with new

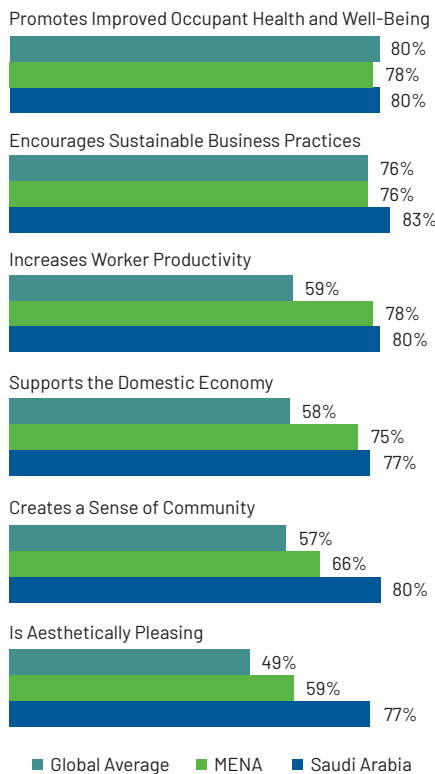
### Organizations Doing More Than 60% of Their Projects Green (Currently and in Three Years)

Dodge Data & Analytics, 2021



### Social Reasons for Building Green (Respondents Who Rated Each as Important/Very Important)

Dodge Data & Analytics, 2021



commercial green projects still the top category, but with the share expecting to do new green high-rise residential work (63%) equal to those who anticipate doing new institutional construction.

In both the MENA region as a whole and in Saudi Arabia in particular, existing building retrofits is selected by fewer than the overall global average of 37% (33% and 31%, respectively), suggesting a greater focus on new green building construction in this region.

### Influences

#### SOCIAL REASONS FOR BUILDING GREEN

The chart at right contrasts the global average of those rating six social reasons for building green as important/very important with the responses from the MENA region as a whole and Saudi Arabia in particular.

- The top two—promotes improved occupant health and well-being and encourages sustainable business practices—are selected by about the same percentage in the MENA region as they are on average globally.
  - Encourages sustainable business practices is the top social driver for green building in Saudi Arabia, but improving occupant health and well-being is also very important there.
- The share of respondents who rate the other four social reasons for building green highly in the MENA region and in Saudi Arabia all significantly exceed the global averages.
  - In Saudi Arabia, the ability of green buildings to create a sense of community and to be aesthetically pleasing are particularly important.

#### ENVIRONMENTAL REASONS FOR BUILDING GREEN

77% or more of respondents from the MENA region consider all five of the

# Data: MENA

## Green Building Activity and Trends in MENA CONTINUED

environmental reasons for building green important/very important, with reducing energy consumption (89%) and improving indoor air quality (87%) topping the list. Surprisingly, reducing water consumption finishes fourth out of five, but it is still selected as important/very important by 82%.

There are no significant differences between the responses from the respondents from Saudi Arabia and the rest of the region on these factors.

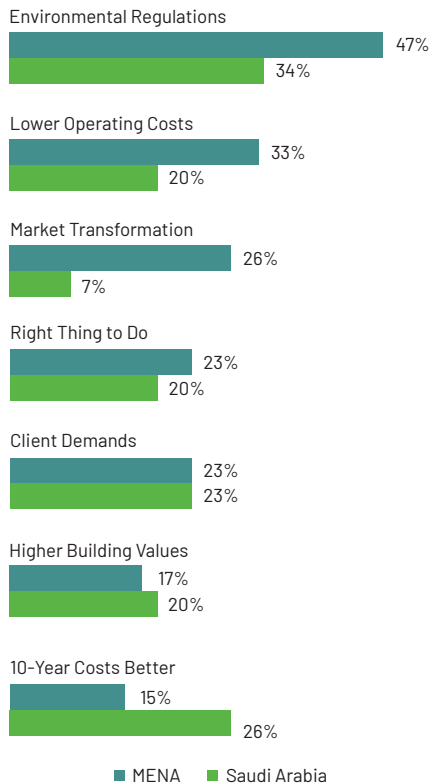
### TOP TRIGGERS FOR MORE GREEN BUILDING PROJECTS

Respondents were asked about the top triggers that would encourage them to do more green building projects. As the chart in the middle column reveals, respondents from Saudi Arabia have a different perspective on many of the triggers from others in the MENA region.

- The top trigger in the MENA region as a whole and in Saudi Arabia is the same—environmental regulations.
  - Environmental regulations are selected by fewer respondents in Saudi Arabia than in the region as a whole.
- The second most important trigger regionally is lower operating costs, and the third is market transformation. However, these are selected by far fewer respondents from Saudi Arabia than from the rest of the region.
- In Saudi Arabia, the second most important trigger is better 10-year costs (26%). In contrast, only 15% think this is one of the top three triggers regionally. The higher rating for 10-year costs over lower operating costs may suggest that owner/operators are driving the market for green in Saudi Arabia more than building developers, leading to different priorities for triggering new work.

### Top Triggers for New Green Building

Dodge Data & Analytics, 2021



### TOP BARRIERS TO THE GROWTH OF GREEN BUILDING

The three top barriers to growth in the MENA region are higher (perceived or actual) first costs (39%), lack of public awareness (39%) and lack of trained/educated green building professionals (33%).

In Saudi Arabia, the top barrier by far is lack of public awareness (49%) and the second is the lack of trained/educated green building professionals (37%).

### Benefits of Green Building

#### USE OF METRICS

Nearly all (92%) of respondents in the MENA region report that they are using metrics to track critical benefits of green buildings. All of the respondents from Saudi Arabia report this.

- The most frequently tracked metric in the region is lower operating costs, reported by 63%. A slightly smaller share track this data in Saudi Arabia (56%), where it is still widely used.
- The top metric used in Saudi Arabia is documentation and certification providing quality assurance (63%). This is nearly double the global average (36%), demonstrating its particular importance to this market.
- Saudi Arabia exceeds global averages for several other metrics, including:
  - Improved Occupant Health and Well-Being (56% versus 34%)
  - Higher Value at Point of Sale (47% versus 19%)
  - Increased Tenant Productivity (41% versus 14%)
  - Higher Rental Rates (34% versus 14%)

# Data: MENA

## Green Building Activity and Trends in MENA CONTINUED

### TOP BENEFITS IN THEIR MARKETS

Respondents were asked to identify the top business benefits of building green in their markets. The chart at right compares the top benefits of the MENA region and Saudi Arabia with the global averages.

- The percentage selecting the top two business benefits in MENA—lower operating costs and improved user/occupant health and well-being—are nearly the same as the global averages.
- However, the share selecting each in Saudi Arabia is much lower.
- In contrast, the share from Saudi Arabia selecting many other benefits is much higher than the global or regional averages, including documentation/certification providing quality assurance, future-proofing assets, and increased productivity for tenants. These benefits are also more widely tracked in Saudi Arabia than they are globally or regionally.
- The Saudis also consider flexibility of design built into green buildings to be a top benefit far more frequently than do regional or global respondents.
- Education of users/occupants about sustainability is more widely selected in the MENA region than in Saudi Arabia.

### FINANCIAL BENEFITS OF BUILDING GREEN

The table below shows the average reductions in operating costs reported for new green buildings and green renovations/retrofits by respondents in the MENA region and in Saudi Arabia.

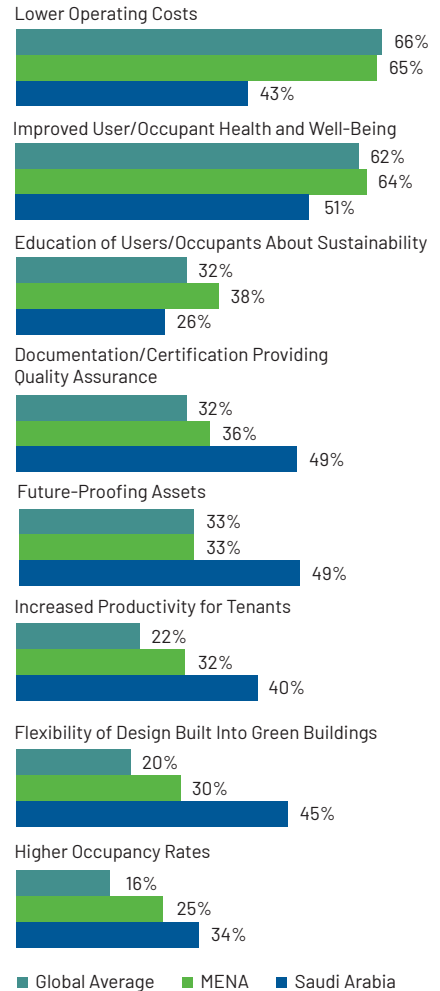
### Use of Green Products

The top categories for green building products and systems used in the last five years in the MENA region are thermal and moisture protection (55%) and mechanical (51%). A relatively high share also used green building automation systems (48%), electrical products and systems (43%) and waste management systems (43%).

For the most part, there are no significant differences in the use of green products by category between Saudi Arabia and the rest of the region, except flooring (50% in Saudi Arabia versus 33% in MENA) and mass timber systems (40% in Saudi Arabia versus 17% in MENA).

### Top Business Benefits in MENA

Dodge Data & Analytics, 2021



### Financial Benefits of Building Green, Compared With Traditional Buildings

Dodge Data & Analytics, 2021

New Green Buildings	MENA	Saudi Arabia
Average Reduction in Operating Costs in Next 12 Months	11.3%	9.9%
Average Reduction in Operating Costs in Next 5 Years	17.7%	15.4%
Green Renovations/Retrofits	MENA	Saudi Arabia
Average Reduction in Operating Costs in Next 12 Months	8.2%	7.9%
Average Reduction in Operating Costs in Next 5 Years	14.5%	12.2%

# Data: MENA

## New Approaches to Improving Sustainability

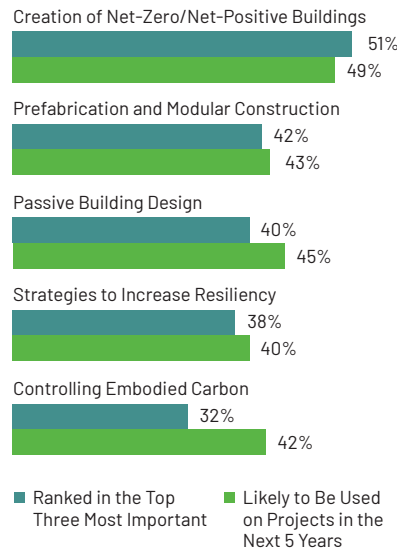
### TOP APPROACHES

The charts at right show the top most important approaches to improving sustainability according to the respondents from the MENA region, not including Saudi Arabia, and the respondents from Saudi Arabia. Please note that this is the only chart in which the Saudi responses have been removed from the overall MENA ones.

- The Saudi respondents and those from the larger region agree on the importance of the creation of net-zero/net-positive buildings. However, a much greater share of respondents in the larger region think they will be creating these projects than in Saudi Arabia.
- Priorities then diverge between the larger region and those in Saudi Arabia.
  - Prefabrication and modular construction and passive building design are the second and third most frequently selected approaches in the MENA region, with the share who plan to use them roughly the same as those who think they are a priority.
  - Biophilic design ranks second in Saudi Arabia, and far more respondents think it is important than those who plan to incorporate it on their projects.
  - Design for disassembly and recovery ranks third in Saudi Arabia, and in this case, far more think that they will be engaged with these kinds of projects in the next five years than selected it among the top three approaches.
- Controlling embodied carbon and strategies to increase resiliency both rank lower in MENA and Saudi Arabia than they do globally. However, the share planning to use these

## Most Important Approaches to Improve Sustainability (According to Respondents in MENA, Excluding Saudi Arabia)

Dodge Data & Analytics, 2021



approaches is very similar to the global share, suggesting that they are still considered important by many, even if they did not select them in their top three.

### EMBODIED CARBON

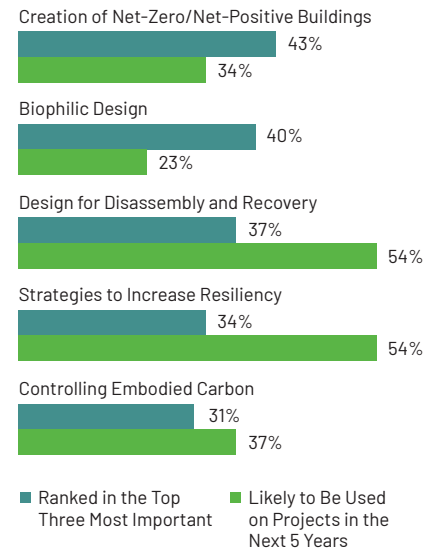
Most respondents (85%) from the MENA region are familiar with embodied carbon, and Saudi Arabia has roughly the same share reporting this. Over 40% of respondents from this region say they are tracking embodied carbon, and about half of them are actively attempting to reduce it.

### DESIGN FOR MANUFACTURING AND ASSEMBLY

Far more respondents in Saudi Arabia (85%) than in the MENA region as a whole (68%) report that they are familiar with design for manufacturing and assembly (DfMA).

## Most Important Approaches to Improve Sustainability (According to Respondents in Saudi Arabia)

Dodge Data & Analytics, 2021



Among those who are actually using it, it is still used on a relatively small share of projects (14.6% across the region), suggesting that the use of this approach is still emerging in this region, as it is globally.

# Data: Canada/US

## Green Building Activity and Trends in Canada/US

In total, 309 responses were received from Canada (63) and the United States (246). This section compares these responses to each other and to the global averages to better understand green building trends in these two markets.

### Green Building Market Activity

#### CURRENT AND FUTURE ACTIVITY

The share of those doing the majority (more than 60%) of their projects green in Canada and the US currently is roughly the same, as the chart at right shows. They both exceed the global average of 28%, suggesting that these long-standing green building markets have a relatively high level of activity.

There is also a large increase expected in three years in the share of those expecting to engage in that level of green building. The increase is larger in Canada than in the US, but for both countries, these findings demonstrate that many respondents expect their engagement with green building to grow. The US findings are only slightly above the global average of 42%, but the Canada findings are notably above that.

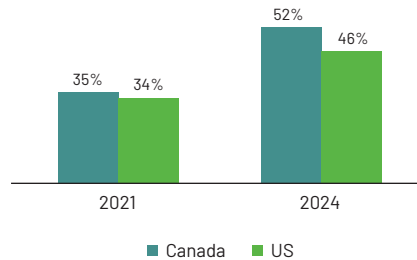
#### TOP PROJECT TYPES FOR BUILDING GREEN IN CANADA AND THE US

Respondents in Canada and the US select the following as the top types of green building projects they will design and construct over the next three years.

- Canada
  - Existing Buildings/Retrofits: 54%
  - New Institutional Construction: 40%
  - New Commercial Construction: 33%
- US
  - Existing Buildings/Retrofits: 55%
  - New Institutional Construction: 52%
  - New Commercial Construction: 40%

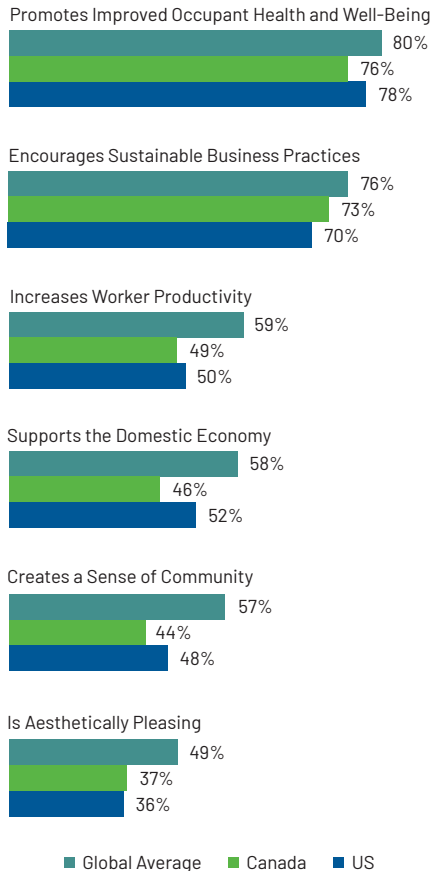
### Organizations Doing More Than 60% of Their Projects Green (Currently and in Three Years)

Dodge Data & Analytics, 2021



### Social Reasons for Building Green (Respondents Who Rated Each as Important/Very Important)

Dodge Data & Analytics, 2021



Both markets are notably above the global average for green existing buildings/retrofits and below average for new commercial construction. It is possible that the low performance for commercial construction is influenced by the sectors hit hardest by the pandemic in both countries.

### Influences

#### SOCIAL REASONS FOR BUILDING GREEN

The chart at lower left contrasts the global average of those rating six social reasons for building green as important/very important with the responses from Canada and the US.

- Promoting improved occupant health and well-being is the top choice globally, in Canada and in the US.
- Encouraging sustainable business practices is a top factor for all three groups.
- Fewer respondents in both Canada and the US consider increasing worker productivity, supporting the domestic economy, creating a sense of community and being aesthetically pleasing to be important/very important reasons for building green than do respondents globally. However, all of these except aesthetics are considered important by about/just under half of respondents from Canada and the US, suggesting that they still should be considered influential.

#### ENVIRONMENTAL REASONS FOR BUILDING GREEN

Respondents from Canada and the US also rated the importance of five environmental reasons for building green. Over 70% of Canadian and 75% of US respondents rated all five as important/very important, with energy conservation ranked first for both at 88% and 87%, respectively.

- While there were no differences

# Data: Canada/US

## Green Building Activity and Trends in Canada/US CONTINUED

that rise to the level of statistical significance between Canada and the US for any of the environmental factors, for three out of the four remaining ones, the share of Canadian respondents rating each as important/very important is at least five points lower than the US respondents.

- Improve Indoor Air Quality: 78% Canada versus 83% US
- Reducing Water Consumption: 73% Canada versus 79% US
- Protect Natural Resources: 71% Canada versus 76% US

• However, a higher share of Canadians (86%) rate reducing greenhouse gas emissions as important/very important, compared with US respondents (78%).

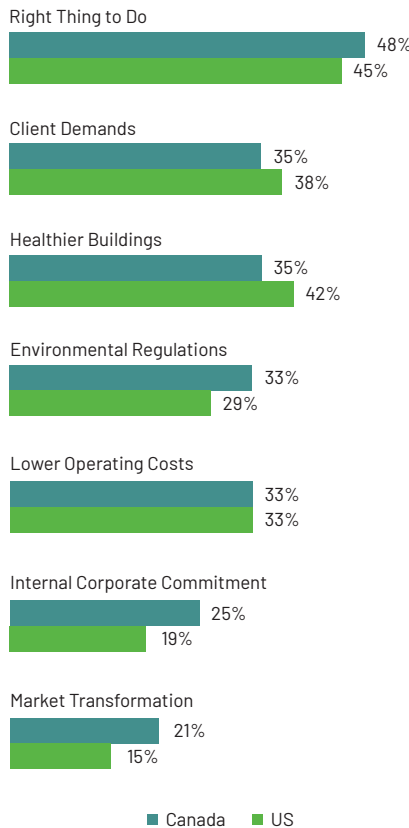
### TOP TRIGGERS FOR MORE GREEN BUILDING PROJECTS

Respondents were also asked about the top triggers that would encourage them to do more green building projects. The chart in the middle column shows the top triggers for Canada and the US.

- Similar triggers apply to both markets. Even where differences are shown in the chart, none rise to the level of statistical significance.
- Doing the right thing is the top trigger in both markets. This is a departure from 2018:
  - In 2018, client demands was the top driver in both markets.
  - Environmental regulations scored higher in Canada in 2018.
  - Healthier buildings scored higher in the US in 2018.
- The spread of percentages for the next four triggers—client demands, healthier buildings, environmental regulations and lower operating costs—is quite narrow, suggesting that each of these is an important influence on the markets in these two countries.

### Top Triggers for New Green Building in Canada and the US

Dodge Data & Analytics, 2021



### TOP BARRIERS TO THE GROWTH OF GREEN BUILDING

The top barrier to building green in both Canada and the US is higher (perceived or actual) first cost, selected by about two thirds (65% and 64%, respectively).

The second most influential barrier in Canada is lack of political support or incentives, selected by 44%. This is less of a barrier in the US, where only 28% select it among their top choices.

In the US, the second greatest barrier is lack of market demand (37%), and this is also influential in Canada, selected by 33%.

The only other barrier selected by more than 30% in Canada is inability to prove the business case (32%). This is also another top barrier in the US (31%), along with concerns about affordability/green is just for high-end projects (32%).

### Benefits of Green Building

#### USE OF METRICS

70% of respondents in Canada and 63% in the US use metrics to track green building performance. In both cases, this share is lower than in many other countries included in the study.

- The most frequently tracked metric in Canada and the US is lower operating costs, tracked by about half in each country.
- Only two other metrics are used by 20% or more respondents in Canada and the US.
  - Documentation and Certification Providing Quality Assurance: 35% in Canada and 25% in the US
  - Improved Occupant Health and Well-Being : 23% in Canada and 20% in the US

# Data: Canada/US

## Green Building Activity and Trends in Canada/US CONTINUED

### TOP BENEFITS IN THEIR MARKETS

Respondents were asked to identify the most important business benefits of building green in their markets. The chart at right compares the responses from Canada and the US with the global averages for each benefit.

- The top two benefits of building green in Canada and the US are lower operating costs and improved user/occupant health and well-being.
  - The percentage of Canadian and US respondents selecting each is much higher than the global average.
  - These benefits are also selected by more than twice the percentage of any other benefit included in the study, suggesting their importance in these two markets.
- Canadian respondents more frequently select future-proofing assets as a top benefit in their market than do respondents in the US.
- US respondents more frequently consider education of users/occupants about sustainability a top benefit than do those in Canada.

### FINANCIAL BENEFITS OF BUILDING GREEN

The table below shows the average reductions in operating costs reported for new green buildings and green

renovations/retrofits, and average increases in the asset value of new green buildings.

- Canadians generally expect to see better returns from their green investments on new green buildings, with expectations of lower operating costs and bigger increases in asset value than in the US.
- However, the US respondents expect to see better returns on their investments in green renovations/retrofits.

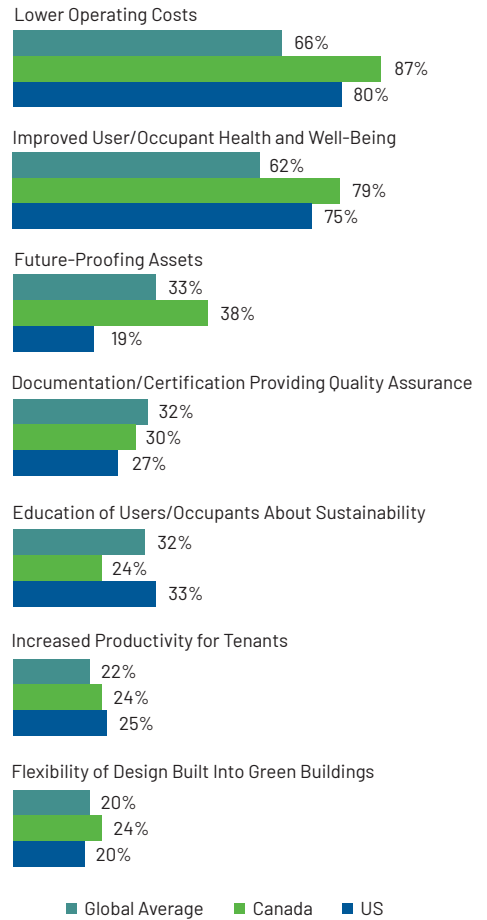
### Use of Green Products

Respondents were asked about the top product categories for which they specified or installed green products in the last five years.

- The top category for both is mechanical, but Canadian respondents (82%) far more frequently used green products/systems in this category than did those from the US (66%).
- The other top categories for each include electrical products, thermal and moisture protection, finishes and flooring, with no significant differences in their responses for each.
- 38% of Canadians expect to use mass timber structural systems in the next five years, compared with 25% in the US and 28% globally.

### Top Benefits of Green Building in Canada and the US

Dodge Data & Analytics, 2021



### Financial Benefits of Building Green, Compared With Traditional Buildings

Dodge Data & Analytics, 2021

New Green Buildings	Canada	US
Average Reduction in Operating Costs in Next 12 Months	12.8%	12.3%
Average Reduction in Operating Costs in Next 5 Years	19.3%	17.9%
Average Increase in Asset Value (According to Owners/Investors)	8.2%	6.7%
Green Renovations/Retrofits	Canada	US
Average Reduction in Operating Costs in Next 12 Months	10.4%	13.5%
Average Reduction in Operating Costs in Next 5 Years	15.1%	17.9%

# Data: Canada/US

## Green Building Activity and Trends in Canada/US CONTINUED

### New Approaches to Improving Sustainability

#### TOP APPROACHES

The charts at right show the top most important approaches to improving sustainability according to respondents from Canada and the US.

- The same six approaches are selected by the highest percentage of respondents from Canada and the US.
- Both agree that the top approach is the creation of net-zero/net-positive buildings.
- Controlling embodied carbon ranks second in Canada and fourth in the US.
- Strategies to increase resiliency rank second in the US and fourth in Canada.
- More Canadian respondents (57%) anticipate that they will seek to control embodied carbon on projects and create more net-zero/net-positive buildings (68%) the next five years than those in the US (40% and 50%, respectively), but otherwise, there are no significant differences between Canada and the US in expected use of these top six approaches.

#### EMBODIED CARBON

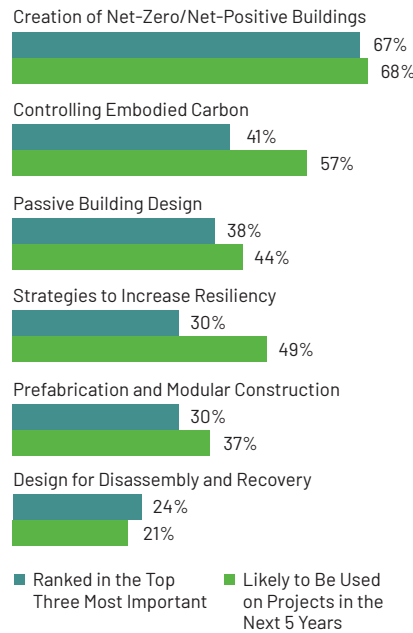
Nearly all Canadians (95%) state that they are familiar with embodied carbon, far more than in the US (84%). More Canadians also report tracking it on their projects (37%) than do those in the US (26%). However, over three quarters (78%) of those who are tracking embodied carbon in the US are also attempting to reduce it, compared with 68% of those tracking it in Canada.

#### DESIGN FOR DISASSEMBLY

When presented with a definition of design for disassembly, more Canadian respondents (56%) consider it very important or absolutely critical to meet future sustainability goals than do those in the US (35%).

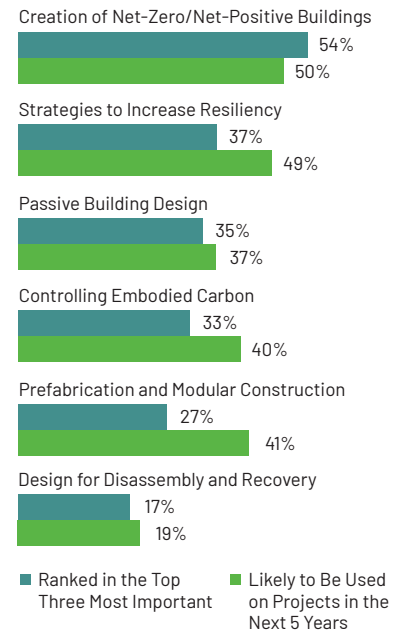
### Most Important Approaches to Improve Sustainability (According to Respondents in Canada)

Dodge Data & Analytics, 2021



### Most Important Approaches to Improve Sustainability (According to Respondents in the US)

Dodge Data & Analytics, 2021



Respondents from both countries agree that owners requiring design for disassembly on their projects and better education materials on its importance are critical to help it become a more common design practice. However, more US respondents (44%) than Canadians (28%) also see the value of more collaboration with manufacturers, and more Canadian respondents (34%) than those in the US (21%) regard consultants with expertise in this area as important.



# Data: Sub-Saharan Africa

## Green Building Activity and Trends in Sub-Saharan Africa

In total, 123 responses were received from 11 countries in Sub-Saharan Africa, including Botswana, Cameroon, Kenya, Mauritius, Namibia, Nigeria, Rwanda, South Africa, Tanzania, Uganda and Zimbabwe. Of these, only Cameroon and South Africa had sufficient responses to be analyzed independently, so this section will look at responses from the whole region and from those countries in particular.

### Green Building Market Activity

#### CURRENT AND FUTURE ACTIVITY

Currently, the share of respondents from Sub-Saharan Africa who do a majority of green projects (over 60%) is 21%, lower than the global average of 28%. In Cameroon, that share is only 11% and in South Africa, it is 24%.

The share of those who expect to do a majority of their projects green in the future is expected to grow in the region at a moderate level, and Cameroon in particular has the biggest gain in this area, more than double those currently engaged at that level in green building. South Africa still expects to have the largest share in the region with that high level of green involvement, but even their level of engagement is below that of the global average (48%).

#### TOP PROJECT TYPES FOR BUILDING GREEN IN SUB-SAHARAN AFRICA

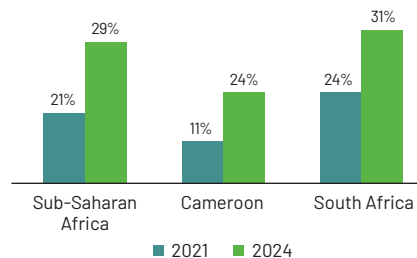
Respondents in Sub-Saharan Africa select the following as the top types of green building projects they plan to design and construct over the next three years.

- New Commercial Construction: 52%
- New Low-Rise Residential: 45%
- New Institutional Construction: 43%
- Existing Buildings/Retrofits: 41%

The focus on new green low-rise residential is more prominent in this region than in most of the other regions included in this study.

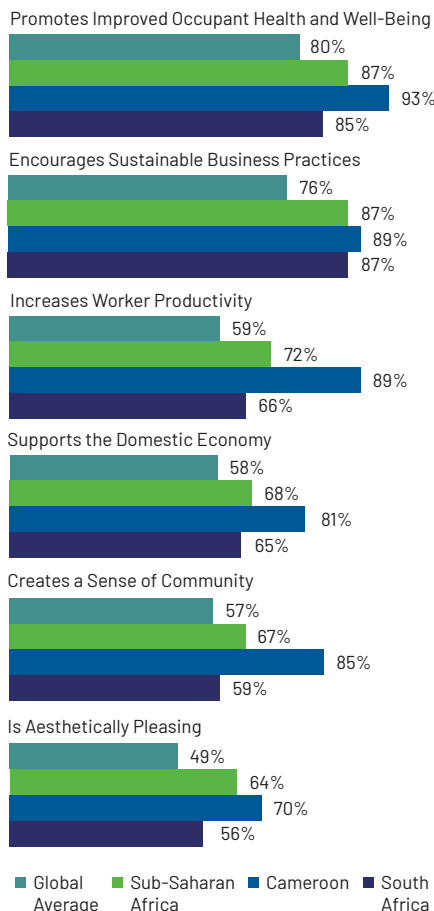
### Organizations Doing More Than 60% of Their Projects Green (Currently and in Three Years)

Dodge Data & Analytics, 2021



### Social Reasons for Building Green (Respondents Who Rated Each as Important/Very Important)

Dodge Data & Analytics, 2021



There are no significant differences in the share who expect to do any type of green projects in the next three years between the overall region, Cameroon and South Africa.

### Influences

#### SOCIAL REASONS FOR BUILDING GREEN

The chart at lower left contrasts the global average of those rating six social reasons for building green as important/very important with the responses from Sub-Saharan Africa, Cameroon and South Africa.

- The top two social reasons for building green in the Sub-Saharan region as a whole are also the top two globally: promotes improved occupant health and well-being and encourages sustainable business practices. In this region, though, each is rated important/very important by 87%, notably more than the global average.
- The top three social reasons for building green in Cameroon are improved occupant health and well-being, encouraging sustainable business practices and increasing worker productivity.
- In South Africa, encouraging sustainable business practices ranks slightly higher than promotes improved occupant health and well-being.
  - The other two notable social reasons for building green in South Africa are increasing worker productivity and supporting the domestic economy.
- Aesthetics is a more important driver in this region than it is globally.

#### ENVIRONMENTAL REASONS FOR BUILDING GREEN

86% or more of respondents from Sub-Saharan Africa consider all five of the environmental reasons for building green important/very important, with

# Data: Sub-Saharan Africa

## Green Building Activity and Trends in Sub-Saharan Africa CONTINUED

reducing energy consumption and protecting natural resources (both 91%) ranking first, reducing water consumption close behind at 90% and improving indoor air quality and lower greenhouse gas emissions both at 86%. Similar to the social reasons for building green, these tend to be higher rated in this region than in many other regions included in the study.

There are no significant differences between the countries and the regional ratings for any of these environmental factors.

### TOP TRIGGERS FOR MORE GREEN BUILDING PROJECTS

Respondents were also asked about the top triggers that would encourage them to do more green building projects and their responses are shown in the chart in the middle column.

- Regionally, the top triggers are environmental regulations and healthier buildings. Doing the right thing and lowering operating costs are clearly influential as well.
- Environmental regulations is the top trigger in Cameroon, followed closely by right thing to do and market transformation.
- Right thing to do is the top trigger in South Africa, with environmental regulations and healthier buildings a close second and third, and lower operating costs also selected by a significant share of respondents.

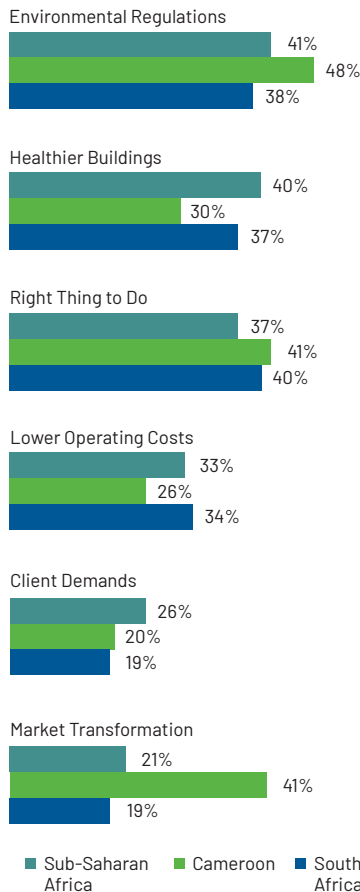
### TOP BARRIERS TO THE GROWTH OF GREEN BUILDING

For the most part, the top barriers to green building are common across the Sub-Saharan region, with no statistically significant differences in the percentages who report them in Cameroon or South Africa.

- The top barrier to the growth of green building in Sub-Saharan Africa is lack of public awareness, reported by 43%.

### Top Triggers for New Green Building in Sub-Saharan Africa

Dodge Data & Analytics, 2021



- Other important barriers include lack of political support or incentives (39%), lack of trained/educated green building professionals (30%) and higher first costs (29%).

### Benefits of Green Building

#### USE OF METRICS

Three quarters of respondents in Sub-Saharan Africa report that they are using metrics to track critical benefits of green buildings. These findings are relatively consistent with the global average of 79%.

- The share doing so in Cameroon (57%) is lower than the regional average.
- The share doing so in South Africa (84%) is higher.

The most common metric tracked in the Sub-Saharan region is lower operating costs, which is used by 60%, roughly the same as the global average (59%).

The second most common metric is documentation and certification providing quality assurance, which is only used by 33%. Again, the percentage using this metric in Sub-Saharan Africa is close to the global share, which is 36%.

There are no significant differences in the use of specific metrics in Cameroon or South Africa.

#### TOP BENEFITS IN THEIR MARKETS

Respondents were asked to identify the top business benefits of building green in their markets. The chart on the following page compares the responses from the region as a whole, Cameroon and South Africa, contrasted with the global average for each benefit.

- The top two benefits in the region are also the top two globally: lower operating costs and improved occupant health and well-being.

# Data: Sub-Saharan Africa

WORLD GREEN BUILDING TRENDS 2021 DATA

## Green Building Activity and Trends in Sub-Saharan Africa CONTINUED

- Also highly important in Cameroon are improved health and well-being, and education of occupants about sustainability. In fact, the share selecting occupant education in their top three in Cameroon is more than double the global average.
- The top benefit in South Africa is improved occupant health and well-being, followed closely by lower operating costs.
- Future-proofing assets is selected by a higher share of respondents in South Africa than in Cameroon, regionally or globally.

### FINANCIAL BENEFITS OF BUILDING GREEN

The table below shows the average reductions in operating costs reported for new green buildings and green renovations/retrofits by respondents in Sub-Saharan Africa, Cameroon and South Africa. For some of the data, the sample size from Cameroon is too small for comparison with the others.

- South Africa is slightly more conservative than the region in general and Cameroon in particular in its expectations for one-year and five-year operational cost savings from new green buildings.

- It is also more conservative in its estimation of one-year operational cost savings from green renovations/retrofits, but the five-year estimation corresponds to the regional one.

The operational cost savings and asset value increases expected from green building make a compelling business case in this region.

### Use of Green Products

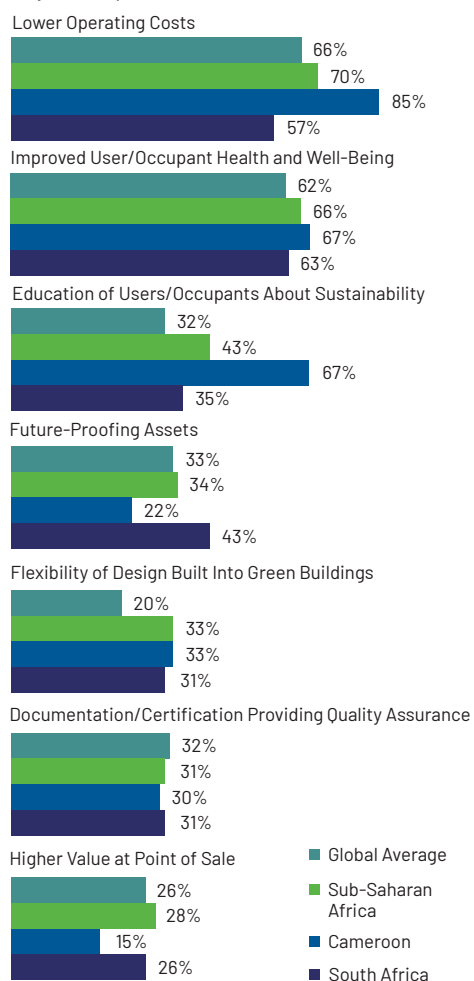
The top categories for green building products and systems used in the last five years in Sub-Saharan Africa are electrical (selected by 59%) and waste management (51%). Other product categories are selected by one third or fewer, and there are no significant differences in the use of these product categories between Cameroon, South Africa and the larger region.

Most of the regional respondents expect to use each category more broadly in the next five years.

- Over 60% plan to use green electrical and waste management products.
- Over 50% plan to use green mechanical products and systems.
- Over 40% plan to use green thermal and moisture protection, finishes, flooring, and building automation systems.

### Top Benefits of Green Building in Sub-Saharan Africa

Dodge Data & Analytics, 2021



### Financial Benefits of Building Green, Compared With Traditional Buildings

Dodge Data & Analytics, 2021

New Green Buildings	Sub-Saharan Africa	Cameroon	South Africa
Average Reduction in Operating Costs in Next 12 Months	10.7%	11.5%	10.4%
Average Reduction in Operating Costs in Next 5 Years	20.4%	21.5%	19.6%
Average Increase in Asset Value (According to Owners/Investors)	11.3%	N/A	11.8%
Green Renovations/Retrofits	Sub-Saharan Africa	Cameroon	South Africa
Average Reduction in Operating Costs in Next 12 Months	11.5%	N/A	10.0%
Average Reduction in Operating Costs in Next 5 Years	17.3%	N/A	17.0%

# Data: Sub-Saharan Africa

## Green Building Activity and Trends in Sub-Saharan Africa CONTINUED

### New Approaches to Improving Sustainability

#### TOP APPROACHES

The charts at bottom show the top six most important approaches to improving sustainability according to the respondents from Sub-Saharan Africa, Cameroon and South Africa.

One overall characteristic of all three charts is that the percentage of those intending to use each approach in the next three years exceeds those who placed it in their top three most important. This suggests an overall regional commitment to a range of these approaches, rather than to just the three they selected as most important.

- There is general agreement about the importance of the creation of net-zero/net-positive buildings and reducing embodied carbon, although for South

Africa, embodied carbon ranks lower than it does regionally.

- Strategies for increasing resiliency are particularly important in the region as a whole and in Cameroon in particular. They are also very important in South Africa, but to a slightly lesser degree.
- The reverse is true of passive design, which is important in all three, but slightly more important in South Africa than regionally or in Cameroon.

#### EMBODIED CARBON

About three quarters (77%) of respondents from Sub-Saharan Africa report that they are familiar with embodied carbon. One third of the respondents report that they are currently tracking it on their projects, and two thirds of them are actively seeking to reduce it.

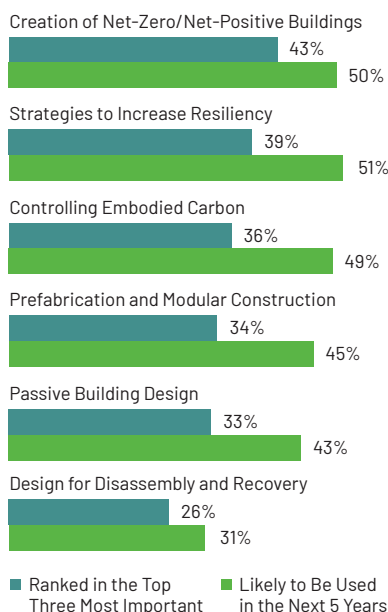
#### DESIGN FOR DISASSEMBLY

Over half of the respondents in Sub-Saharan Africa (58%) consider using design for disassembly very important or absolutely critical to meet future sustainability goals.

They have a slightly different perspective than the global averages on what is most important to encourage the design industry to adopt this as a regular practice. While a large share (40%) select owners requiring this on their projects as a top driver, even more find that collaboration with manufacturers (43%) and better educational materials on the importance of this approach (42%) are top factors, and a notable percentage (35%) also believe consultants with expertise in this area would be influential.

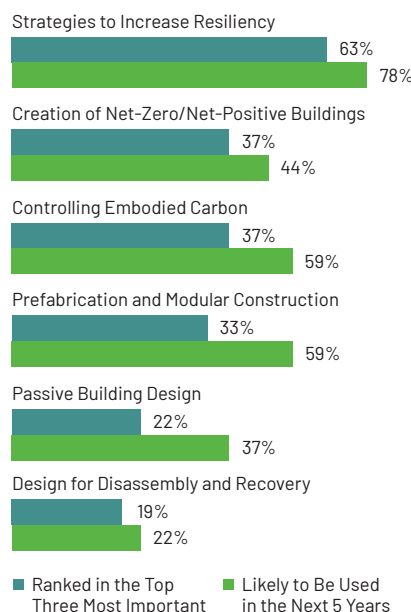
### Most Important Approaches to Improve Sustainability (According to Respondents in Sub-Saharan Africa)

Dodge Data & Analytics, 2021



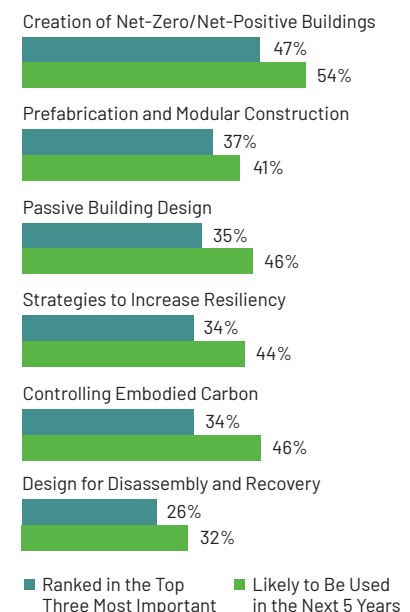
### Most Important Approaches to Improve Sustainability (According to Respondents in Cameroon)

Dodge Data & Analytics, 2021



### Most Important Approaches to Improve Sustainability (According to Respondents in South Africa)

Dodge Data & Analytics, 2021



# Methodology

Dodge Data & Analytics conducted the 2021 *World Green Building Trends Study* among the global AEC and building owner community to achieve the following objectives:

- Identify triggers, obstacles and reasons for adopting green
- Measure current and future levels of green building activity
- Measure the impact of green building practices on business operations
- Profile the use of green building products
- Better understand the current engagement with new or emerging approaches to green building.

Many questions in the study remained the same or similar to questions in the previous studies conducted in 2012, 2015 and 2018 in order to better understand global trends.

The research was conducted through an online survey from June to August 2021. It was fielded using panel providers, sent to the Dodge database list of industry professionals and offered through outreach by various partner organizations. These include:

- Many green building councils worldwide, with responses from green building council members coming from the following countries: Argentina, Australia, Austria, Bahrain, Bolivia, Brazil, Cameroon, Canada, China, Colombia, Costa Rica, Egypt, El Salvador, Germany, Greece, Guatemala, Hong Kong, Hungary, India, Ireland, Italy, Jordan, Kenya, Lebanon, Malaysia, Mexico, Netherlands, New Zealand, Panama, Peru, Philippines, Poland, Qatar, Serbia, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Turkey, United Arab Emirates, UK, US and Zambia.
- Industry associations
  - The American Institute of Architects (AIA)
  - Architects' Council of Europe (ACE)

- The Chartered Institute of Building
- Latin-American Federation of Contractors' Associations (FIIC)
- Instituto Mexicano Del Edificio Inteligente (IMEI)
- Royal Institution of Chartered Surveyors (RICS)
- US Green Building Council (USGBC)

## Survey Respondents

A total of 1,207 industry professionals responded to the survey. The breakdown of responses is as follows:

- Architects/Designers: 23%
- Engineers: 15%
- Specialists/Consultants: 23%
- Contractors/Builders: 15%
- Owners/Developers: 20%
- Investors: 3%

42% of respondents are members of a national GBC.

For the first time, those who do a majority of non-building (horizontal) projects, such as roads, tunnels and bridges, were included in the study. Those who fell into that category made up 8% of the total responses. Previously, those doing a majority of non-building (horizontal) projects were screened out.

Respondents are located in 79 countries, with a full list on the following page. The report includes detailed analysis of responses from 13 countries/regions with a sufficient level of response to support statistical significance: Australia/New Zealand, Brazil, Cameroon, Canada, China (mainland China only), Colombia, Germany, India, Mexico, Saudi Arabia, Singapore, South Africa and the US. These detailed findings, along with the larger regional findings, can be found on pages 47 through 74.

## Definition of Green Building

When asked to identify their total green building activity, the following definition was provided to the respondents.

At a minimum, for a building project to be considered green, it must include the following:

- Efficient use of energy, water and other resources
- Pollution and waste reduction measures, and the enabling of reuse and recycling
- Good indoor environmental air quality
- Consideration of the environment in design, construction and operation

In addition, green building projects include as many of the following as possible:

- Use of renewable energy, such as solar energy
- Use of materials that are nontoxic, ethical and sustainable
- Consideration of the quality of life of occupants in design, construction and operation
- A design that enables adaptation to a changing environment
- A commitment to net-zero carbon emissions

The final part of the definition, a commitment to net-zero carbon emissions, was a new addition in 2021 and not part of the definition in the previous study in 2018.

# Methodology

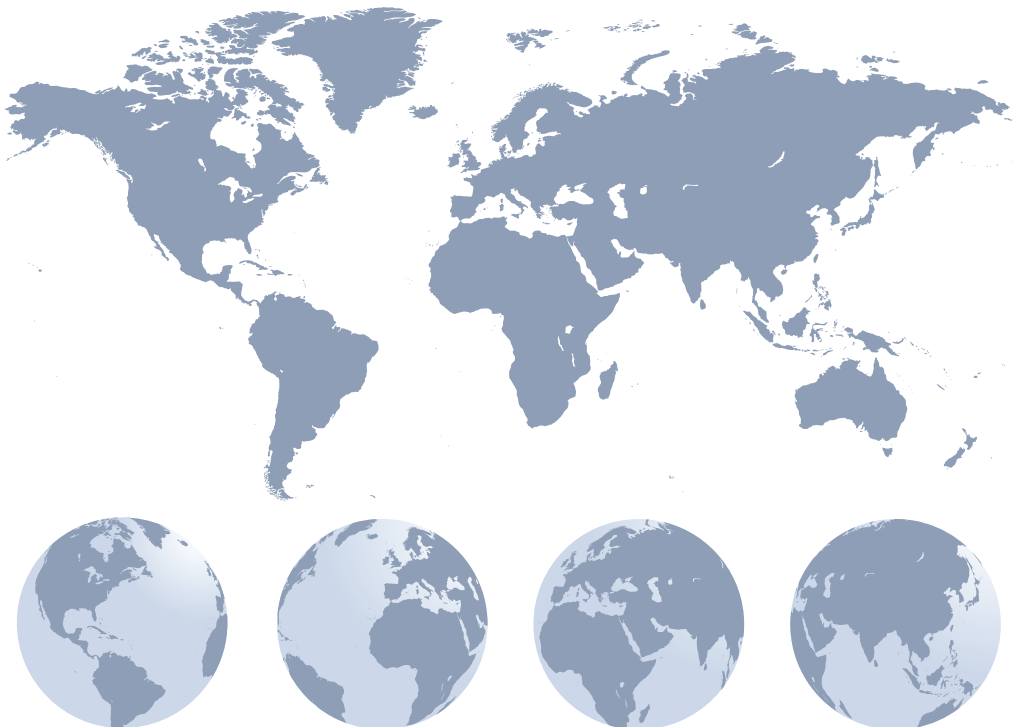
The results in this report are drawn from survey respondents from the following 79 countries. See region/country-specific results on pages 47-74.

Afghanistan  
Albania  
Algeria  
Argentina  
Australia  
Austria  
Bahrain  
Bangladesh  
Belgium  
Bolivia  
Botswana  
Brazil  
Brunei  
Cameroon  
Canada  
Chile  
China (mainland and Hong Kong)  
Colombia  
Costa Rica

Croatia  
Czech Republic  
El Salvador  
France  
Germany  
Greece  
Guatemala  
Hungary  
India  
Ireland  
Israel  
Italy  
Japan  
Jordan  
Kenya  
Kuwait  
Lebanon  
Liechtenstein  
Malaysia  
Mauritius

Mexico  
Namibia  
Netherlands  
New Zealand  
Nigeria  
Oman  
Pakistan  
Palestine  
Panama  
Peru  
Philippines  
Poland  
Portugal  
Qatar  
Republic of Korea  
Russia  
Rwanda  
Saint Kitts & Nevis  
Saudi Arabia  
Serbia

Singapore  
South Africa  
Spain  
Sri Lanka  
Sweden  
Switzerland  
Tanzania  
Thailand  
Trinidad and Tobago  
Tunisia  
Turkey  
Turks and Caicos Islands  
Uganda  
Ukraine  
United Arab Emirates  
United Kingdom  
United States  
Venezuela  
Vietnam  
Zimbabwe



# Resources

**Organizations, websites and publications to help you get smarter about global green building trends.**



## **Dodge Construction Network**

Main Website:

**[www.construction.com](http://www.construction.com)**

Dodge Construction Central:

**[www.construction.com/products](http://www.construction.com/products)**

Market & Competitive Intelligence:

**[www.construction.com/products/construction-market-data](http://www.construction.com/products/construction-market-data)**

Sweets:

**[www.construction.com/products/sweets](http://www.construction.com/products/sweets)**

SmartMarket Reports:

**[www.construction.com/toolkit/reports](http://www.construction.com/toolkit/reports)**

## **ACKNOWLEDGEMENTS:**

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We thank the World Green Building Council, our Premier Research Partner, and we appreciate the efforts of all the green building councils who shared the survey with their members. In particular, we would like to call out the green building councils in Australia, Cameroon, Colombia and Singapore for the high level of response they were able to get from their members.

Our other research partners were essential to the research process as well, so we thank the Architects' Council of Europe (ACE), The Chartered Institute of Building (CIOB), the Latin-American Federation of Contractors' Associations (FIIC), the Instituto Mexicano Del Edificio Inteligente (IMEI), and the Royal Institution of Chartered Surveyors (RICS).

We also thank all the individuals who shared their insights and expertise in the interview, case study or feature articles.



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Autodesk: **[www.autodesk.com](http://www.autodesk.com)**

## **Contributing Partners**

American Institute of Architects (AIA): **[www.aia.org](http://www.aia.org)**

US Green Building Council (USGBC): **[www.usgbc.org](http://www.usgbc.org)**

## **Premier Research Partners**

World Green Building Council: **[www.worldgbc.org](http://www.worldgbc.org)**

## **Research Partners**

Architects' Council of Europe (ACE): **[www.ace-cae.eu](http://www.ace-cae.eu)**

Chartered Institute of Building (CIOB): **[www.ciob.org](http://www.ciob.org)**

Consejo Colombiano de Construcción Sostenible (CCCS): **[www.cccs.org.co/wp](http://www.cccs.org.co/wp)**

Green Building Council Australia: **<https://new.gbca.org.au>**

Green Building Council Cameroon: **[www.gbccam.org](http://www.gbccam.org)**

Instituto Mexicano Del Edificio Inteligente

(IMEI): **<https://imei.org.mx>**

Latin-American Federation of Contractors'

Associations (FIIC): **[www.fiic.la](http://www.fiic.la)**

Royal Institution of Chartered Surveyors: **[www.rics.org](http://www.rics.org)**

Singapore Green Building Council: **[www.sgbc.sg](http://www.sgbc.sg)**

## **Other Resources:**

Additive Manufacturer Green Trade

Association: **<https://amgta.org>**

Architecture 2030: **[www.architecture2030.org](http://www.architecture2030.org)**

Carbon Leadership Forum: **<https://carbonleadershipforum.org>**

Fitwel: **[www.fitwel.org](http://www.fitwel.org)**

International Code Council: **[www.iccsafe.org](http://www.iccsafe.org)**

International Well Building Institute:

**[www.wellcertified.com](http://www.wellcertified.com)**

RELI Rating System: **<https://gbci.org/reli>**

United Nations Climate Change: **<https://unfccc.int>**

United Nations Sustainable Development Goals:

**<https://sdgs.un.org/goals>**

■ Design and Construction Intelligence

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