

DODGE DATA & ANALYTICS

World Green Building Trends 2018



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World Green Building Trends 2018 SmartMarket Report

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About Dodge Data & Analytics

Dodge Data & Analytics is North America's leading provider of analytics and software-based 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 and execute on those opportunities for enhanced business performance. Whether it's on a local, regional or national level, we make the hidden obvious, empowering our clients to better understand their markets, uncover key relationships, size growth opportunities and pursue those opportunities with success. Our construction project information is the most comprehensive and verified in the industry. We are leveraging our 100-year-old legacy of continuous innovation to help the industry meet the building challenges of the future.

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Introduction

Carrier, its parent company, United Technologies Corporation, and Dodge Data & Analytics (then known as McGraw Hill Construction) first began collaborating on this research program in 2008 because both companies believed green building was poised to transform construction on a global scale. This 2018 edition of the research demonstrates that their vision has been fulfilled, more than either could have imagined.

This report compares data from the latest study (2018) to previous ones in the series (2012 and 2015), analyzing the level of green activity, the benefits of building green, the triggers most likely to spur further green market growth and the challenges that may impede it.

One of the most encouraging trends is the increasing percentage of respondents who expect to do the majority of their projects (more than 60%) green in most of the 20 countries/regions included in this study. The global average for this group is expected to increase from 27% to 47% between 2018 and 2021, and in about half of the locations, the percentage who expect they will be doing the majority of their projects green by 2021 is expected to double. This trend analysis clearly demonstrates increasing global commitments to building green.

This year's study also features a deep look into the importance of healthier buildings as an element of green building.

Findings validate its importance globally, with particular strength in diverse markets like China, Colombia, India, Ireland and South Africa, as well as the US. This is an emerging priority that can be expected to gain increasing traction in future studies.

Consistent with previous studies, the top challenges and triggers vary strongly by market, and thus, each market is analyzed in regional/country sections. Some of these sections compare the 2018 responses to those from 2015, providing a unique vantage point into the priorities and drivers in some of the top green markets in the world.

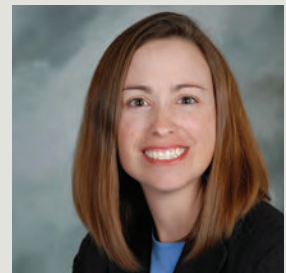
Among the most compelling elements of the data are the strong business benefits reported for both new green buildings and green renovations/retrofits of existing buildings. The findings since 2012 have clearly demonstrated the value of investing in green. For example, there has been a steady growth since 2012 in the number of owners who see a 10% or greater increase in asset value for new green buildings compared with traditional ones.

We would like to thank Carrier for their partnership on this research since 2008. We also thank the other organizations whose support made this SmartMarket Report possible, including the American Institute of Architects, Autodesk and the US Green Building Council, as well as the efforts of the World Green Building Council in advising on the study and promoting participation among its members.



Chris Nelson
President, Commercial
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Carrier

Chris Nelson leads the global commercial HVAC product and service portfolio for Carrier, part of UTC Climate, Controls & Security, a unit of United Technologies. He is responsible for driving continued product innovation with an unwavering focus on sustainability – from energy-efficient solutions that deliver comfortable, healthy and productive environments to green-certified manufacturing facilities, including the world's first LEED-certified HVAC factory.



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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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Left: Customer Experience Center at the UTC Center for Intelligent Buildings

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Executive Summary

WORLD GREEN BUILDING TRENDS 2018 SMARTMARKET REPORT

Green building activity continues to grow across the globe, with dramatic increases expected in 20 countries across five continents between now and 2021.

The latest in a series of studies, the findings show great consistency in the benefits derived from green with previous studies in 2012 and 2015, but they also demonstrate the increasing influence of social factors like creating a sense of community, encouraging sustainable business practices and especially improving occupant health and well-being.

Green Building Activity Is Increasing, But Is Not Always Certified

For the first time, global respondents were asked two questions about their level of green activity: the percentage of their projects considered green using a definition provided in the survey, and the percentage of their projects that are or will be certified under a recognized green building system. (See the Methodology on page 75 for the definition provided for green building.)

The chart at right reveals the total share of green projects reported by all global participants in the study currently, and the expected share in three years. **It demonstrates that green building activity will increase, and, even more important, it shows that most of the increase comes from a large percentage of respondents (47%) who believe that they will build the majority of their projects (more than 60%) green by 2021.**

The findings also reveal that some respondents who do the majority of their projects green are not certifying all of those projects. **More important, the gap among those doing the majority of their projects green and those who are actually seeking green certification on the majority of their projects is expected to grow between 2018 and 2021.** This indicates that green activity is expected to exceed certification activity and may suggest that those experienced with green are using certification more strategically.

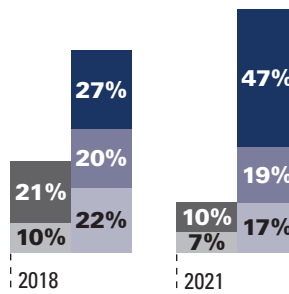
Growth in Green Driven by Ongoing Strong Business Benefits

The table at right shows the significant operating cost savings, short payback periods and asset value increases achieved from investments in new green buildings and green retrofit projects reported by respondents in the current study and the two previous ones in 2012 and 2015. The savings achieved, the payback periods and the increased asset values are strikingly consistent, despite changes in the number of respondents, in geographies and in global economic conditions over those years. These business benefits form the foundation that helps promote the growth of further green building activity.

Level of Green Building Activity (According to Global Respondents)

Dodge Data & Analytics, 2018

- 1% to 15% Green Projects
- Exploring (No Green Involvement)
- More Than 60% Green Projects
- 31% to 60% Green Projects
- 16% to 30% Green Projects



Business Benefits Expected From Green Building Investments

(Medians Reported in 2012, 2015 and 2018)

| | New Green Building | | |
|---|--------------------|---------|---------|
| | 2012 | 2015 | 2018 |
| Decreased 12-Month Operating Costs | 8% | 9% | 8% |
| Decreased 5-Year Operating Costs | 15% | 14% | 14% |
| Increased Asset Value (According to Owners) | 5% | 7% | 7% |
| Payback Time for Green Investments | 8 Years | 8 Years | 7 Years |

| | Green Retrofit | | |
|---|----------------|---------|---------|
| | 2012 | 2015 | 2018 |
| Decreased 12-Month Operating Costs | 9% | 9% | 9% |
| Decreased 5-Year Operating Costs | 13% | 13% | 13% |
| Increased Asset Value (According to Owners) | 4% | 7% | 5% |
| Payback Time for Green Investments | 7 Years | 6 Years | 6 Years |

Client Demands and Environmental Regulations Remain the Top Triggers for Building Green

The current findings, represented in the chart at right, closely echo those of the previous 2015 study. The top triggers demonstrate that the market is pulled by client demand and pushed by environmental regulations globally. However, the importance of these and other triggers vary significantly by country.

Creating Healthier Buildings Is a Priority for Green Building

Creating healthier buildings is also an important trigger for green building globally, especially in Brazil, China, India, South Africa and the US. In addition, improving occupant health ranks first among the social reasons for building green, and the percentage selecting it has jumped 5 points from the 2012 study.

Social Reasons for Building Green Gain in Importance Over Time

Consistent with the 2012 and 2015 studies, respondents in 2018 were asked to rank several social reasons for building green on a one to five scale, from not important to very important. The chart at right shows the percentage who consider several of the reasons provided to be important/very important.

In addition to demonstrating the importance of healthier buildings, the chart shows a general trend of ascribing increased importance to the social reasons for building green over time, especially increasing worker productivity, creating a sense of community and supporting the domestic economy.

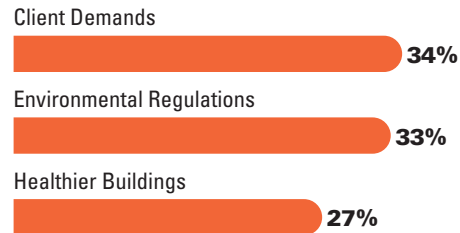
Obstacles to Building Green

Respondents citing higher first costs as a top obstacle has dropped from 76% in 2012 to only 49% in 2018. However, despite the drop, it still remains the top barrier in 2018.

Three additional barriers are selected by roughly one third of the respondents: lack of political support or incentives, affordability (green is for high-end projects only) and lack of public awareness. The degree to which each of these barriers is influential varies a great deal by country, suggesting different strategies are needed to promote green globally.

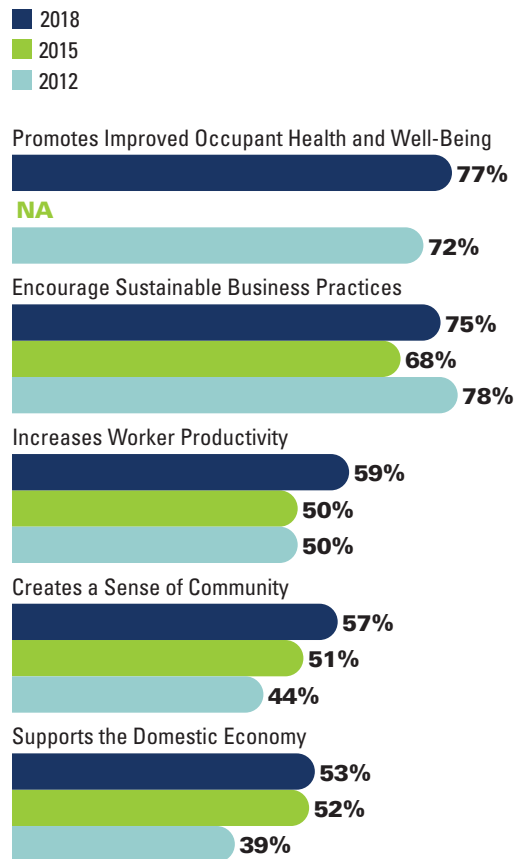
Top Triggers Driving Future Green Building Activity (According to All Global Respondents)

Dodge Data & Analytics, 2018



Top Social Reasons for Building Green (By Percentage of Global Respondents Rating Each Reason as Important)

Dodge Data & Analytics, 2018



Summary: Country Findings

Global Findings by Country

Each of the 19 countries featured in this report has different triggers and challenges, and different social and environmental priorities. For the share of respondents who are green building council members by country and for a more complete analysis by country and region, see pages 46 to 74.

Australia

Australia has a high share of GBC respondents (63%) and the highest percentage who report doing the majority (over 60%) of their projects green. Steep growth in that percentage is also expected by 2021.

Market factors drive new green activity, including **market demands** and **client demands** for green. **Improving occupant health and well-being** is the top social reason for building green.

Brazil

A moderate percentage in Brazil (21%) do the majority of their projects green now, but twice as many (42%) expect to do that share of green by 2021.

A wide range of triggers drive this green building market, including **market demands**, **market transformation**, **client demands** and **healthier buildings**.

Energy conservation and **protecting natural resources** are the top environmental reasons for building green in Brazil.

Canada

Over one third in Canada

currently do the majority of their projects green, and moderate growth in this level of green activity is expected in the future.

Client demands is the top trigger in Canada, selected by a much higher percentage (50%) than the global average (34%).

61% in Canada consider **improved occupant health and well-being** a top social reason for building green.

China

Only 9% in mainland China currently do the majority of their projects green, which is likely due to the low share of respondents who are members of a GBC (14%). However, three times as many expect to do a majority of green projects by 2021, even in this group.

In contrast, Hong Kong currently has the second highest percentage of those doing the majority of their projects green, and a relatively high share of respondents who are GBC members (46%), but little growth is expected in those doing a majority of green projects by 2021.

They also differ in terms of the top triggers for new green building activity. The

top ones in mainland China are **market demands**, **healthier buildings**, **right thing to do** and **branding/PR**, while **client demands** and **regulations** are the top triggers in Hong Kong.

Colombia

While the percentage currently doing the majority of their projects green in Colombia is relatively low at 19%, nearly half (46%) expect to do a majority of green projects by 2021.

Internal corporate commitments is one of the top triggers in Colombia and demonstrates the importance of private industry in promoting green in this country. Another top trigger is **lower operating costs**, which shows the importance of bottom-line business benefits. However, **regulations** are also an important trigger in this market.

Germany

A relatively modest percentage of German respondents say that they are building the majority of their projects green now, or that they expect to have that share of green

projects within three years.

The top triggers for new green building activity in Germany are **client demands** and **environmental regulations**, and its selection of **worker productivity** as the top social reason for building green is unique in this study.

India

The percentage of respondents doing the majority of their projects green in India is expected to nearly double by 2021, from 28% to 55%.

New green building in India is being driven most by **environmental regulations** and **healthier buildings**. The **need for more public awareness** about green is the top challenge faced in this country, and the **lack of educated green building professionals** is also an issue of note.

Ireland

Ireland has a relatively high percentage (40%) of those doing the majority of their projects green, perhaps due to the high share of GBC member participation in the study

(61%) in this country. 54% anticipate doing a majority of green projects by 2021.

Client demands is the most important trigger for new green building activity, selected by 71%, more than double the global average. **Environmental regulations** are the other notable trigger. Nearly half, though, find that the **lack of educated green building professionals** is a key obstacle to more green building, second only to **higher first costs**.

Mexico

Currently, slightly more than one quarter in Mexico (27%) do a majority of their

projects green, but that percentage is expected to double by 2021.

Mexican respondents regard a wide range of triggers as influential, including **environmental regulations, market transformation** and **lower operating costs**. **Higher first costs** is the top obstacle, but **lack of political support/incentives** is also an issue.

Norway

Those doing the majority of their projects green in Norway is expected to more than double from 30% in 2018 to 64% by 2021, suggesting a market in transition.

The biggest factors supporting that growth are **client and market demands**. However, cost is an issue: **higher first costs** and **affordability** are the top obstacles.

Poland

Poland has a relatively low percentage of respondents who are doing the majority of their projects green now or who expect to be doing a majority of green projects by 2021.

The key triggers that can drive growth in this market are **market transformation** and **improved 10-year costs**. On the other hand, **lack of public awareness** is the

top obstacle in this country.

Saudi Arabia

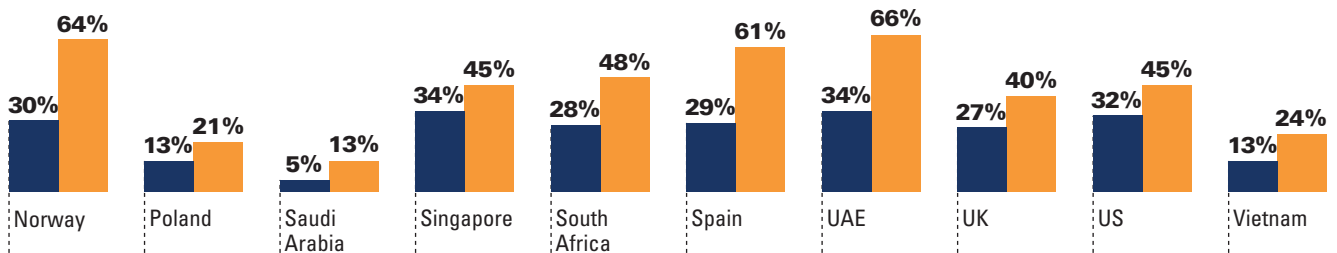
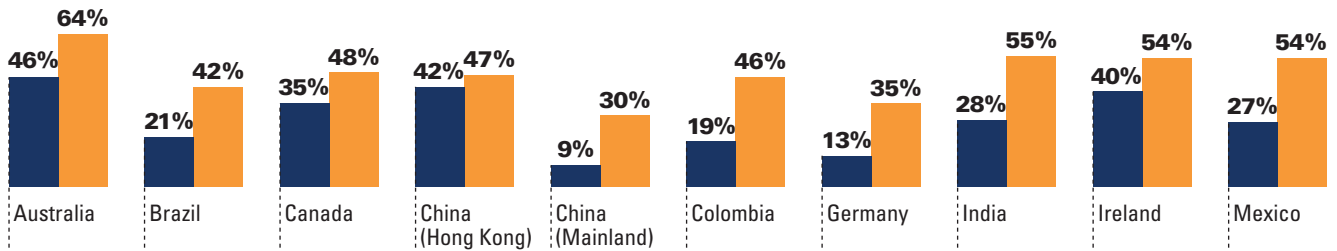
Saudi Arabia has the lowest percentage of respondents doing the majority of their projects green now (5%) or in three years (13%). This may be influenced by the fact that only 8% of Saudi respondents are GBC members.

There is little agreement on the top triggers to drive growth, with seven triggers selected by between 20% and 30% of respondents. **Perceived higher first costs** are the most widely recognized barrier to green in this market.

Percentage of Firms That Are Doing/Will Do More Than 60% Green Projects (2018 and Expected for 2021)

Dodge Data & Analytics, 2018

■ 2018 ■ 2021



Singapore

A green mandate has led to a high level of green building activity in Singapore, where environmental performance standards have been incorporated into building regulations.

Thus, it is not surprising that **environmental regulations** tops the lists of green building triggers in this market. However, **higher first costs** still continue to be the most widely recognized barrier to green building here. **Promoting sustainable business practices** is the most important social reason for building green.

South Africa

South Africa currently has a moderate percentage of those doing the majority of their projects green, but that percentage will grow considerably by 2021.

Lower operating costs is the top trigger driving future green building growth in this country, and **healthier buildings** is also an important driver. **Improved occupant health and well-being** is also one of the top two social reasons for building green in South Africa, along with **promoting sustainable business practices**.

Spain

A moderate percentage of Spanish respondents

do the majority of their projects green now, but by 2021, that percentage is expected to more than double, from 29% to 61%.

Financial and corporate benefits are driving this growth, with **internal corporate commitment** and **higher building values** all key triggers in Spain. **Improved occupant health and well-being** is also widely recognized as an important social reason for green building in Spain.

However, there is also a high degree of concern about the barriers to green building in Spain, with over 40% noting **higher first costs, lack of political support/incentives, lack of public awareness** and **lack of market demand** as barriers.

UAE

By 2021, two thirds of respondents from the United Arab Emirates (UAE) believe that they will do the majority of their projects green, nearly double the percentage of those with that share of green work now.

Environmental regulations are an important driver of that growth, selected by half as a top trigger. The key barriers that need to be overcome to encourage more green building in the UAE are **lack of public awareness** and **concerns**

about the affordability of green.

In addition to **energy conservation**, a top environmental reason to build green in the UAE is **water conservation**.

UK

The UK has a moderate level of green building activity (27% doing the majority of their projects green), and they still remain moderate by 2021 (40% expect the majority of their projects to be green).

Client demands is the most important trigger for future green building activity in the UK, and many also recognize the importance of **environmental regulations** to increase green activity. However, **lack of market demand** and **higher first costs** are barriers to additional growth in the green market.

In addition to **reducing energy consumption, lowering greenhouse gas emissions** is an important environmental reason for building green in the UK, one of the few countries to have this as a top reason.

US

A moderate level of growth in green activity is expected in the US by 2021, with those doing the majority of their projects green increasing from 32%

to 45%.

The top trigger driving the market by far in the US is **client demands**, demonstrating the degree to which green building is market driven in that country. Therefore, it is not surprising that the top barriers are **higher first costs** and **concerns about affordability**. **Encouraging occupant health and well-being** is widely recognized among US respondents (78%) as a top social reason for building green.

Vietnam

Vietnam has relatively few respondents (13%) who are doing the majority of their projects green. By 2021, that percentage is expected to nearly double, but it remains among the lowest in the study.

The most important triggers driving growth in green building in Vietnam are **market demands** and **higher building values**, which demonstrate the importance of owner engagement in green to help drive this market.

The top barrier to green market growth in Vietnam is **the lack of educated green professionals**, but other widely recognized barriers include the **lack of political support/incentives**, concerns about **higher first costs** and the **lack of public awareness about green building**.

Data: Introduction

Since 2008, Dodge Data & Analytics (formerly McGraw Hill Construction) has conducted global research on green building trends. The study evolved into its present form by 2012, and has been conducted every three years since then. The results are published in a series of *World Green Building Trends SmartMarket Reports*, which benefit from the ability to compare over time how the drivers, challenges and benefits of building green have (or have not) changed between 2012 and 2018.

The latest study in this series is the most broad-reaching yet, with over 2,000 participants from 87 countries that span five continents. This includes 19 countries with a large enough response to support statistically significant analyses of the findings. These countries are referenced both in the main data section and in the special data sections featuring a brief analysis of that country or region. All of the 13 countries included in the 2015 *World Green Building Trends SmartMarket Report* are featured, allowing for detailed analysis of changes in those markets since 2015 in the country/regional section. That section also features new additions like Canada, Ireland, Norway, Spain and Vietnam.

The profile of the respondents who participated in the study also differs from the earlier ones. In 2012, the majority of the respondents were members of a World Green Building Council (GBC). In 2015, a change in the way in which respondents were recruited led to only 33% of the total respondents being members of a GBC. In the current study, World GBC participation as a premier research partner, wide participation by various non-GBC partners and paid panels in selected markets led to a balanced 44% of participants who belong to a GBC.

In addition, this report features a special section on green technology, which includes data from a series of in-depth interviews with nine experts, along with two case studies on the use of technology to enhance green building and a feature article on converting existing cities to smart cities.

Notes About the Data

The data and analysis in this report are drawn from the 2,078 respondents to an online survey that was administered from April to June 2018. A minimum of 30 responses were received from the following countries, which are featured in the analysis of the report: Australia, Brazil, Canada, China (Mainland and Hong Kong), Colombia, Germany, India, Ireland, Mexico, Norway, Poland, Saudi Arabia, Singapore, South Africa, Spain, United Arab Emirates, United Kingdom, United States and Vietnam.

Due to the various means of recruiting respondents (discussed in the Methodology on page 75), the share of participation by respondents whose companies are members of a green building council (GBC) varies, which should be considered when comparing findings in the study.

- 60% or Greater Share of GBC Respondents: Australia, Canada, Ireland, Norway and Spain.
- 50% to 59% Share: India, South Africa, US
- 40% to 49% Share: China (Hong Kong), UAE
- 30% to 39% Share: Colombia, Poland, Vietnam
- 20% to 29% Share: Mexico, Singapore
- Less Than 20% Share: Brazil, China (Mainland), Germany, Saudi Arabia, UK

Respondents include the following:

- Architects/Designers (25%)
- Contractors/Builders (23%)
- Specialists/Consultants (21%)
- Owners/Developers (18%)
- Engineering Firms (12%)
- Investors (1%)

Statistically significant differences between architect/designers, contractors/builders, owners/developers and engineering firms are shown in the analysis. Also, where appropriate, longitudinal analysis is also conducted comparing the findings of this study to two previous ones: 2012 and 2015.

For more information on the study, including the definition of a green project, see the Methodology section on page 75.

Data: Green Building Market Activity

Level of Green Building Activity

Global study participants were asked about the share of their projects that are green in three time frames: three years ago (2015) currently (2018), and expected in three years (2021). They were asked to measure the share of green projects in two ways:

- The share of their work that was certified green by a recognized third-party system
- The share of their work that was green based on a specific definition of green: *The final building has efficient use of energy and water; it includes pollution and waste reduction measures; it has good indoor air quality; and a general consideration of the environment was done in design, construction and operation.* (Full definition used can be found in the Methodology on page 75.)

The findings discussed below demonstrate that the commitment to green building is still growing globally, and they reveal a slight shift toward doing green projects that are not certified by a third-party system.

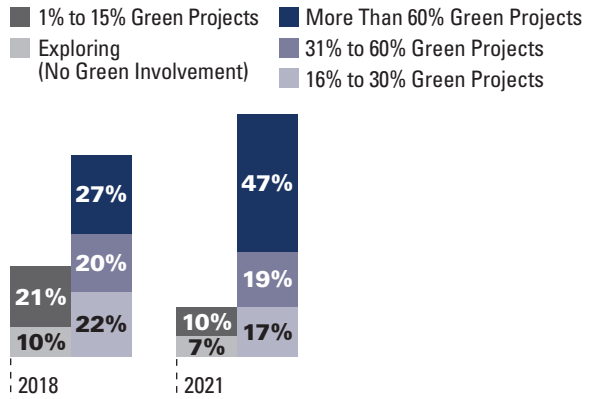
Total Share of Green Projects

The top chart at right shows the share of total green work—using the definition of a green project rather than third-party certification—for all study respondents reported for 2018 and expected by 2021.

- **Currently, over one quarter (27%) report that the majority (more than 60%) of their projects are green, and slightly more (31%) report little to no green involvement.**
- **Within three years, though, expectations for doing more green work are very high, with nearly half of respondents (47%) expecting to do the majority of their projects green, and very few (17%) who are still expecting little to no green involvement.**
- **Strikingly, owners are the most enthusiastic about the growth of green in the future, with 57% reporting that they expect to do the majority of their projects green by 2021.** Since owners typically make the final determination about whether a project will be green, this bodes well for future growth in green building.

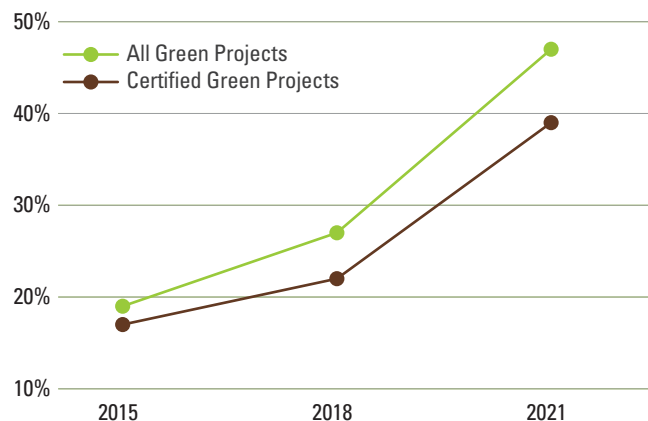
Level of Green Building Activity (According to Global Respondents)

Dodge Data & Analytics, 2018



Respondents Selecting Over 60% Green Projects Versus Those Selecting Over 60% Certified Green Projects (By Year)

Dodge Data & Analytics, 2018



Certified Versus Total Green Projects

The bottom chart on page 10 shows the growth in the percentage of those with certified green projects from 2015 to 2018 and anticipated in 2021, and the growth in total green projects over that same time frame. Two conclusions can be drawn from the data shown.

- **Most of those doing a high level of green projects are also certifying their projects.** This is true across the total respondents, but there is more variation by country, with the biggest gaps in Hong Kong, Ireland and Spain.
- **However, the gap between those doing the majority of green certified projects and total green projects is growing.** In 2015, there is little difference between the percentage with a majority of green projects (regardless of certification) and the percentage doing a majority of green certified projects. However, through 2018 and 2021, the percentage of those doing a majority of projects green regardless of certification is growing faster than those certifying the majority of their projects green. This suggests that those doing a majority of green projects (or those who expect to do so in the future) are becoming less reliant on green certification over time.

Green Activity by Country

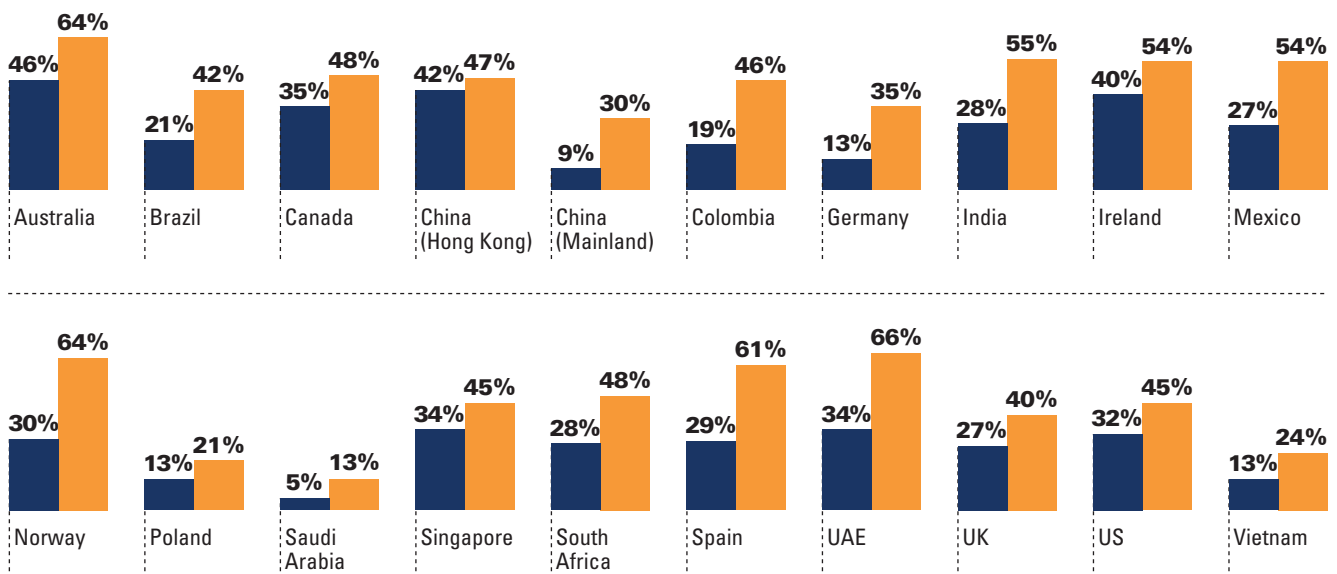
The chart below shows the percentage of those with a majority share of green projects currently and expected by 2021 in the 20 countries with a sufficient response level to be analyzed separately in this study.

- **Countries with the highest percentage doing a majority of green projects currently include Australia (46%), China (Hong Kong) (42%) and Ireland (40%).** Each of these countries also have a relatively high share of respondents whose companies are GBC members, which may influence these findings.
- **Countries with the highest percentage who expect to do a majority of their projects green by 2021 include the UAE (66%), Australia (64%), Norway (64%) and Spain (61%),** which again are countries with a high share of GBC respondents.
- **Norway, Spain and the UAE also expect to have the highest level of growth in the percentage doing 60% or more green projects in the next three years.** Other countries with high levels of growth include Mexico, India and Colombia. Thus, high growth in green is most common in emerging green markets, but also occurs in more established green countries like Norway.

Percentage of Respondents Whose Firms Have Done More Than 60% Green Projects (2018 and Expected for 2021)

Dodge Data & Analytics, 2018

■ 2018 ■ 2021



Sectors for Future Green Building Activity

Respondents were asked to select the building sectors in which they have planned green building projects in the next three years for the country in which they are located. The chart at right lists the global average of respondents for the six sectors included in the study and the top five countries with the highest percentage for each sector.

■ **New Commercial Construction:** New commercial construction is, by far, the sector most commonly selected globally. This corresponds to the findings in 2015 and shows that commercial construction is still the biggest driver of green building.

- Norway has the highest percentage (73%) of those doing new green commercial projects, and China, the UAE, Spain and Vietnam also have very high percentages, demonstrating that the popularity of green commercial projects are widespread globally.
- The lowest percentages of new commercial construction are found in the UK (30%) and Germany (31%).

■ **New Institutional Construction:** North America, China and the Middle East dominate this building type, while fewer than 20% in Brazil, Poland and South Africa report having green institutional projects in their pipeline.

■ **Retrofits of Existing Buildings:** Retrofits are reported in the pipeline by 50% or more respondents in Canada, Ireland, Spain, UAE and US, notably more than the 37% global average. They are least commonly reported in emerging markets like India (24%) and Brazil (21%), where the focus is on new buildings.

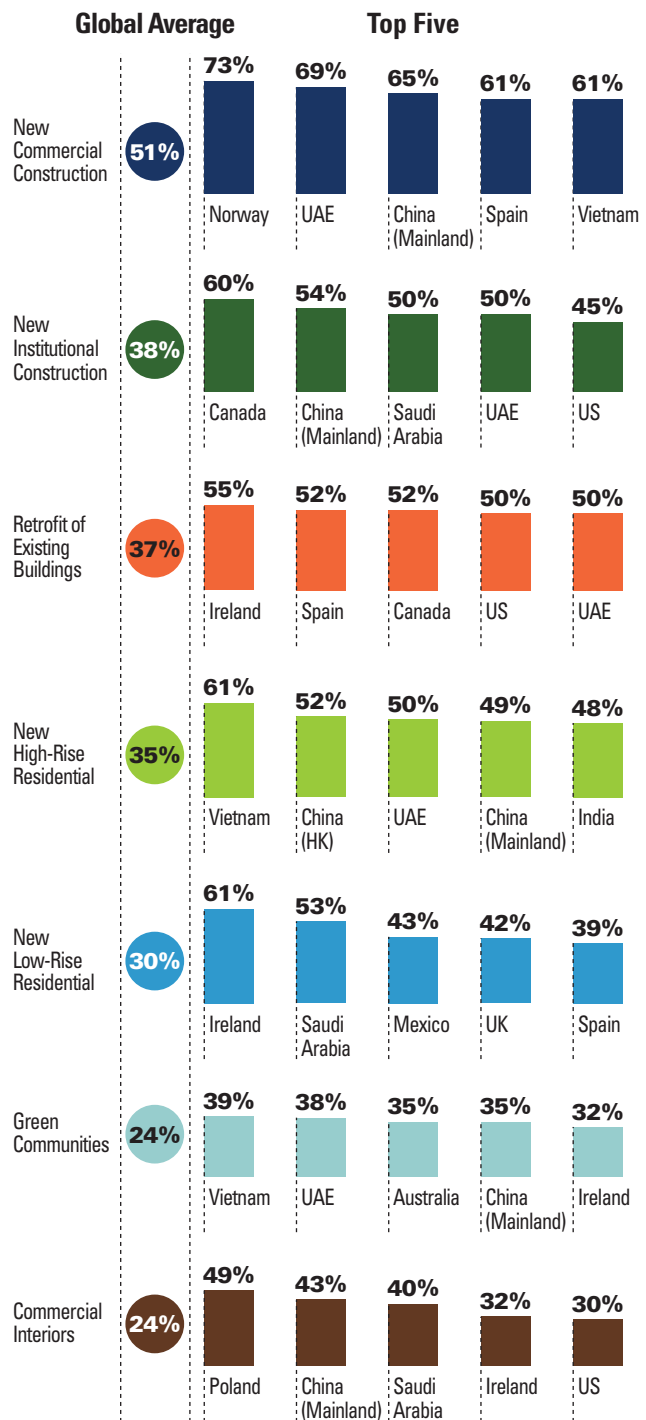
■ **New High-Rise and Low-Rise Residential:** Not surprisingly, there is no overlap in the countries with a high percentage with high-rise and low-rise residential projects in their pipeline. Vietnam (61%) has the highest percentage of high-rise residential, while Ireland (61%) has the highest percentage of low-rise.

■ **Other Sectors:** Green communities and green interiors are less commonly reported than the other project types overall, with less than one quarter globally reporting these types of projects in their pipeline.

- Nearly half the respondents in Poland (49%) are doing green interior projects in the next three years, a particularly robust finding.
- On the other hand, no country has more than 39% of respondents who report doing green communities.

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

Dodge Data & Analytics, 2018



Healthier Buildings

Even as interest in creating healthier buildings grows globally, the specific goals and priorities for those buildings vary based on local needs.

Over the past decade, benefits of green building—such as energy savings, water savings and reduced environmental impacts—have been well documented and quantified. More recently, health and well-being have emerged as key considerations in green building, but the movement is early in adoption, and data—and even definitions—have yet to be widely accepted.

Defining Health

Ratings and certification systems such as the Well Building Standard (WELL) and Fitwel are helping to provide building owners, developers and tenants with definitions and guidance on supporting health and well-being. Still, they are very early in adoption. As of May 1, 2018, WELL had 92 certifications globally with 737 in the pipeline. As of June 1, 2018, Fitwel had 95 certifications in the US with 620 pending.

“The word health was generally applied in green building 10 years ago but not well defined,” says Whitney Gray, senior vice president at Delos, which established the WELL Building Institute in 2013. “People in the building industry thought of health mostly within the LEED format, focusing on things like air quality, materials, acoustics and lighting. Now, we’re redefining health in buildings.”

Part of the issue is that definitions of health can vary greatly around the world. Gray notes that in places

like China, factors like air quality are important health considerations. By comparison, in Norway, air quality is less of a factor compared with availability of light and the effects on mental health. “There’s regional significance and a learned response,” she adds.

Who and how an employer should get involved in an individual’s health and well-being are also careful considerations. Gray says that, in the United States, responsibility for one’s healthcare is placed more on the individual, while many other countries have socialized healthcare systems. “It’s personal responsibility versus seeing it as everyone’s responsibility,” she adds. “In Norway, I don’t have to convince anyone about the importance of having healthy drinking water or why it’s important to have plants in the office. In the US, they might say, it’s not my responsibility.”

Benefits and Challenges

The World Green Building Council highlighted health benefits of green building in its April 2018 report *Better Places For People*, which focused on 11 case studies. For example, a net zero-carbon office in Australia had 94.5% staff satisfaction, while 72% of employees reported better health. A headquarters in El Salvador saw a 68% reduction in reported respiratory problems, and staff sick days were cut almost in half.

Catriona Brady, who heads the Better Places for People project, says that despite reporting

positive examples around the globe, she does see “huge disparity” in different parts of the world. “Among our members, who are in 33 countries, there are varying levels of development and various internal and external challenges in their buildings,” she says. “That brings a whole spectrum of opinions.” Brady notes that it is often the least developed countries that have the greatest need for healthier buildings, yet they often can’t make the commitment.

David Pogue, senior vice president at CBRE for Global Client Care—Sustainability, sees a direct connection between health and productivity. Pogue points to a 2015 Harvard study that reported that people working in green environments achieved cognitive scores that were double those of people working in conventional spaces.

He also sees companies focusing on the health benefits of green as a way to attract and retain employees. “You want to encourage not only their best work, but also to encourage them to stay,” he says. “It’s a strong recruitment and retention factor.”

A key challenge, however, is getting decision makers to make the direct connection. “Recruiting, retention and empowering employees—those are factors that live in human resources,” he says. “But real estate lives in finance. There’s often miscommunication and disconnect there.” ■

Data: Influences

on the Green Building Market

Top Barriers to Increased Green Building Activity

Respondents were asked to select the top three barriers to increased green building activity for their businesses. The chart at right shows the percentage in the current study who select each barrier as one of their top three, compared with those who selected it among their top three in previous studies in 2012 and 2015.

Barriers by Year

For the most part, the percentages concerned about the barriers in 2018 are very consistent with those from 2015. In both years, no single barrier is considered a top obstacle by more than half of the respondents. This suggests that there is no insuperable barrier to increasing green building growth globally, but it may also indicate that challenges are diffuse and more difficult to tackle on a global scale. To increase green building, attention to the most important barriers in specific markets is likely to be the most effective approach.

The chart reveals a few other notable trends.

- **Higher first costs have declined dramatically as a top concern since 2012.** In 2012, 76% considered this a top barrier, but by 2015, that percentage dropped to 50%, and now even fewer (49%) still select it as a top barrier in 2018. This demonstrates that the drop noted in the 2015 study may be a permanent shift in the perception about higher first costs as a negative influence on the green building market.
- **There is a small uptick in the percentage of those who find affordability (the association of green with high-end projects only) to be a concern.** Tracking this in future studies may be important to see if it is just a temporary increase or a growing concern moving forward.

Barriers by Country

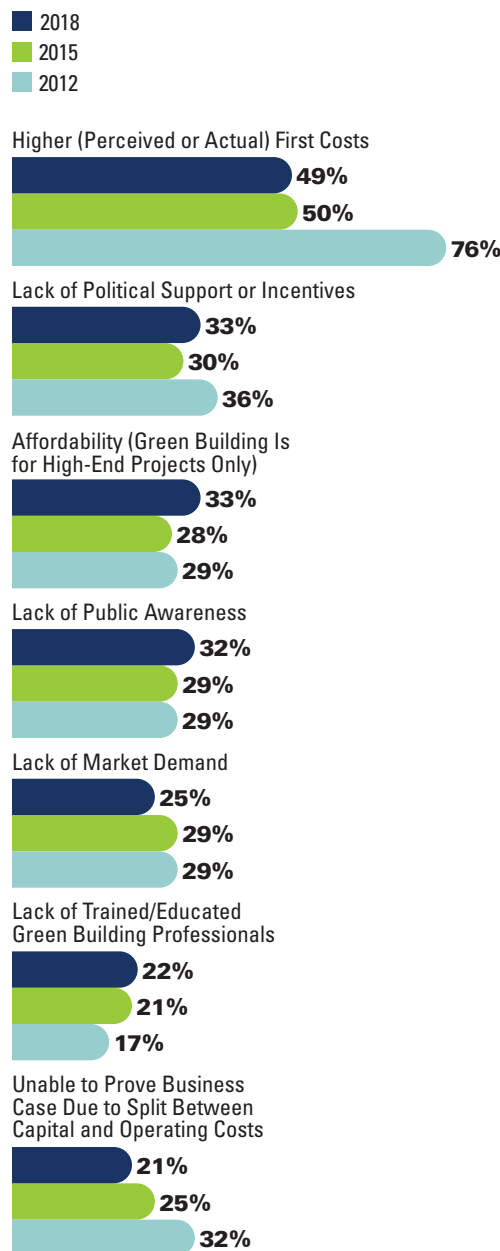
While no single barrier dominates globally, some are very influential in specific markets. The chart on the opposite page shows the countries in which the top five barriers globally are selected by the highest and lowest percentage of respondents.

Some conclusions that can be drawn from the findings include the following.

- **Higher first costs are a particular concern in the US and Ireland, surprising in such established green markets, but the US findings are also consistent with previous studies, revealing the persistence of this barrier in the US market.**

Top Barriers to Increased Green Building Activity (All Global Respondents by Year)

Dodge Data & Analytics, 2018

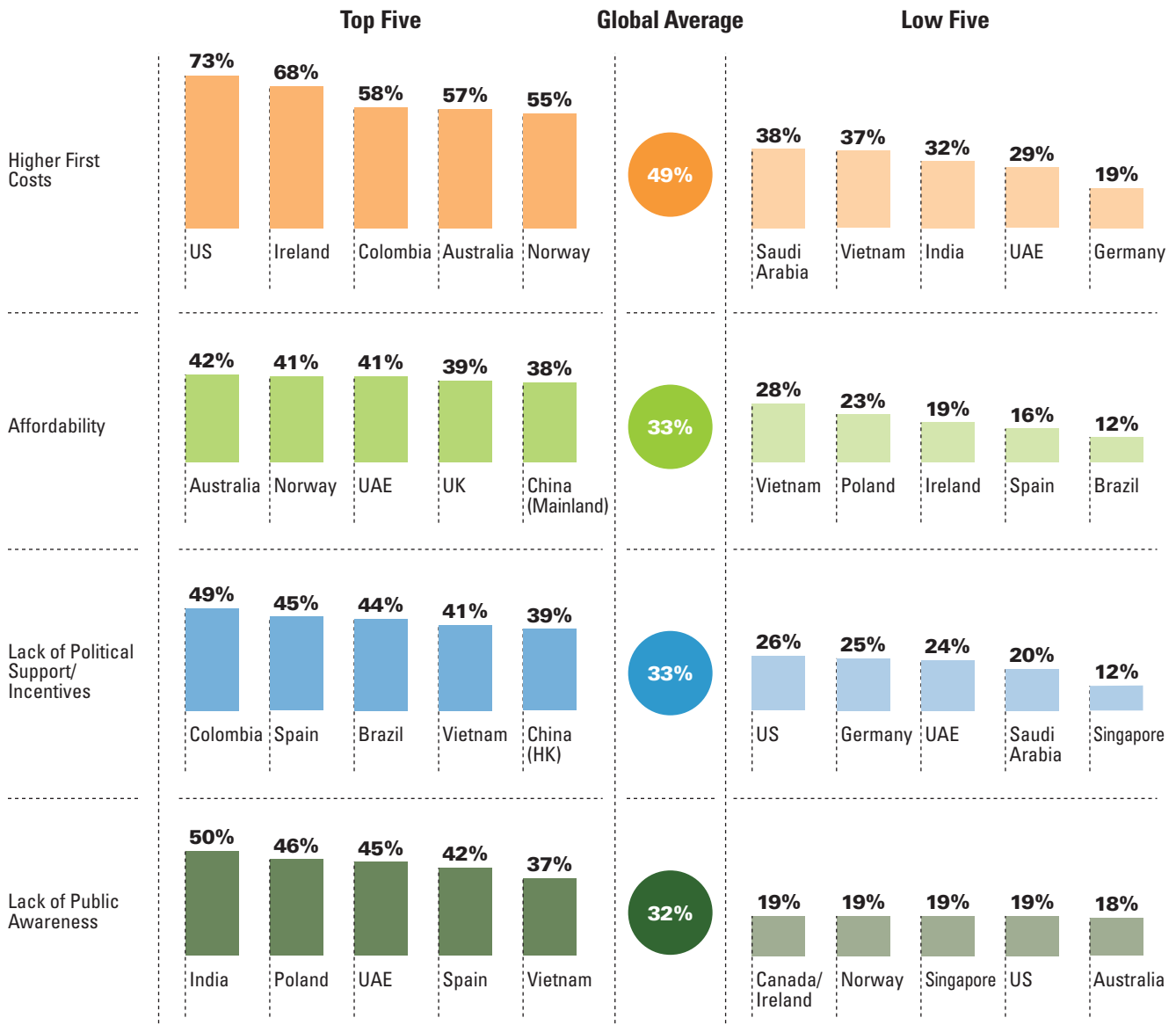


- The perception that green is associated with high-end projects only continues to be among the top issues in Australia, consistent with previous findings.
- Brazil, Colombia and Spain struggle with lack of political support or incentives as a barrier to green building.

- The need for greater public awareness of green building to help grow the market is most evident in India, Poland and the UAE.

Countries With the Highest and Lowest Percentages Selecting the Top Barriers to Green Building Activity

Dodge Data & Analytics, 2018



Triggers to Increased Levels of Green Building

Global study participants were asked to select their top three triggers from a list of 16, and the top 10 selections are indicated in the chart at right. The findings from previous years are not included on the chart because a new option (healthier buildings) was added this year, which prevents direct longitudinal comparisons, although notable changes in the importance of triggers compared with other years will still be discussed in the analysis below.

Most Influential Triggers

The top triggers in the current study are client demands and environmental regulations, consistent with the findings in 2015. This demonstrates that the green building market is equally influenced by the pull of the market and the push of regulations.

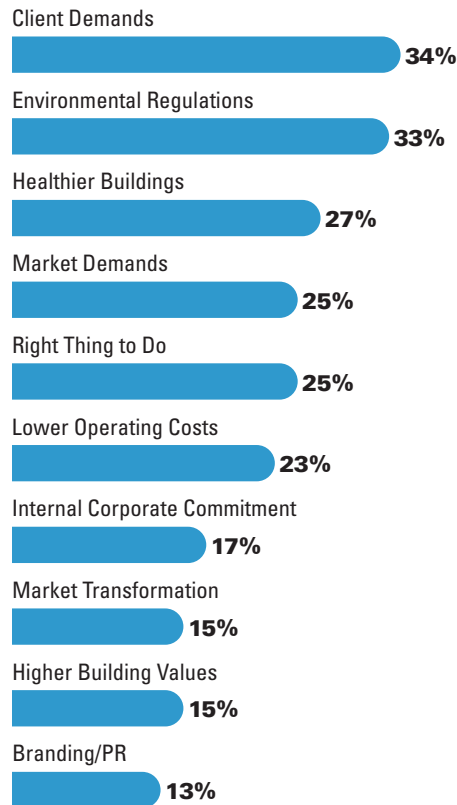
Moderately Influential Triggers

A cluster of four triggers are moderately influential, selected among the top three by between 23% and 27% of respondents.

- **Healthier Buildings:** This newly added trigger is the third most influential in the study, demonstrating that creating healthier buildings is a goal of building green.
 - More architects select this among their top three triggers than owners, engineers or contractors.
- **Market Demands:** The percentage selecting this trigger among their top three has dropped steadily since 2008, while the influence of client demands remains high, revealing that clients play a greater role in driving green building globally than does general market pressure.
 - This trigger is most influential with contractors.
- **Right Thing to Do:** After a precipitous drop between 2008 and 2012, the percentage who believe doing the right thing is a top trigger for future green building activity remains steady at about one quarter. While market factors have become more influential over time, the desire to build green to have a positive impact still remains an important driver.
 - This is especially true for architects and owners, who more frequently select this trigger than engineers and contractors.
- **Lower Operating Costs:** Roughly the same percentage in 2018 find this to be an important trigger as those in 2015, demonstrating the ongoing importance of lower operating costs to support a business case for green building investments.

Triggers Driving Future Green Building Activity (All Global Respondents)

Dodge Data & Analytics, 2018



- Like other triggers that impact the financial performance of the building like higher asset values, higher rents and higher occupancy rates, lower operating costs is most frequently selected as a top trigger by owners.

Less Influential Triggers

Corporate factors like internal corporate commitment, branding/PR and even higher building values are only top triggers for a relatively small percentage of respondents. In addition, while the percentages selecting market transformation and marketing/PR are quite consistent with the findings of 2015, they are significantly lower than those in 2012 and 2008.

This suggests a maturation of green building in most markets, where it has become more commonplace and therefore is no longer considered a transformational approach nor likely to directly boost marketing/PR efforts.

Influences on the Green Building Market

Triggers to Increased Levels of Green Building CONTINUED

WORLD GREEN BUILDING TRENDS 2018 SMARTMARKET REPORT DATA

It is worth noting that the two triggers selected by the fewest respondents—higher rents (5%) and higher occupancy rates (4%)—only apply to commercial real estate, which is likely to account for their low performance since many respondents may not work on those types of projects.

Variation by Country

As with challenges, the influence of the top triggers varies by country. The chart below reveals the countries in which each trigger has the greatest and least influence.

■ **Client demands are most influential in Northern Europe and North America**, although they have much less influence in Mexico than in Canada and the US.

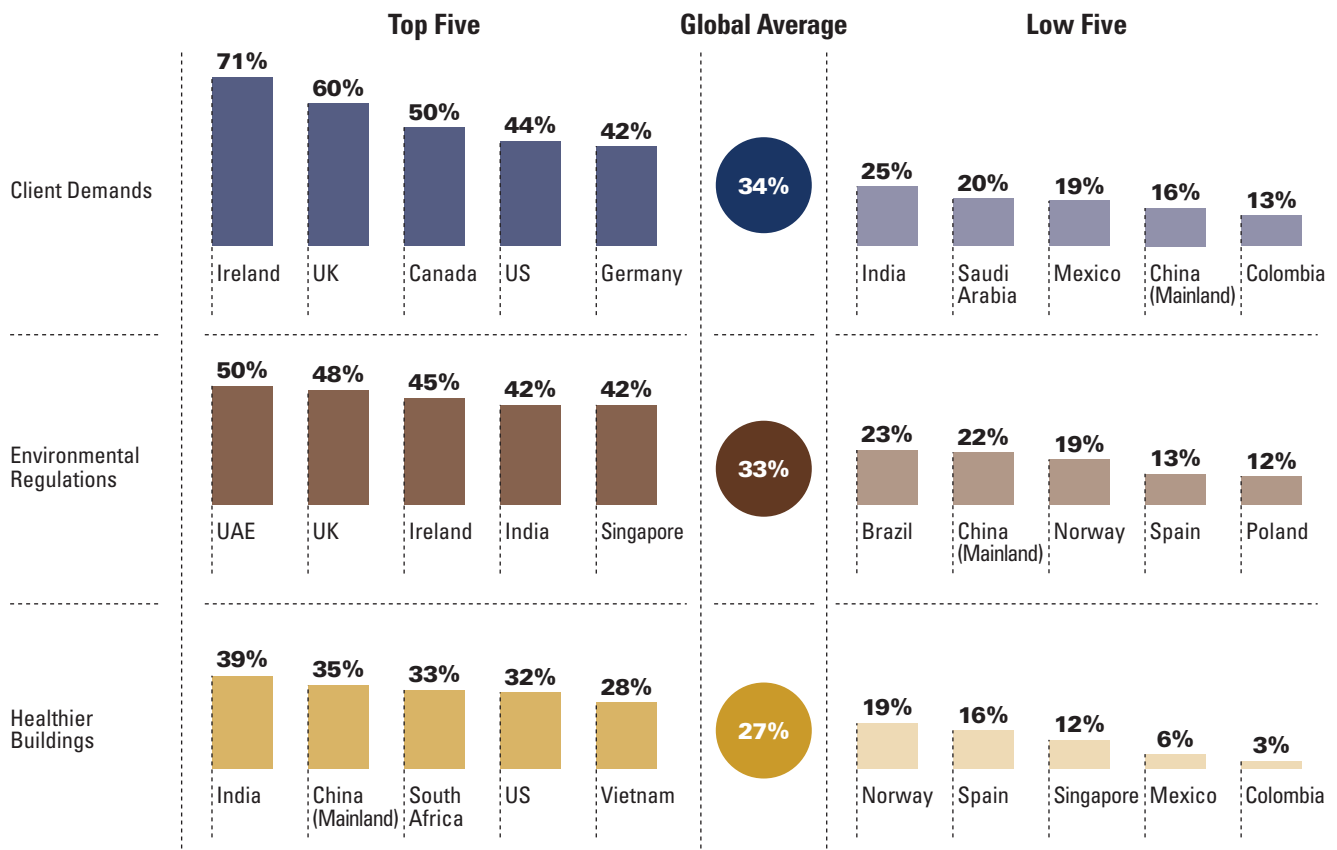
■ **Environmental regulations vary widely, within regions as well as across the globe.** Diverse countries like India, Ireland, Singapore, the UAE and the UK all consider regulations top triggers.

■ **Healthier Buildings: The top two markets interested in healthier buildings, India and China (Mainland), are those that also struggle with air quality issues.**

It is also notable that the US and India are among the highest percentages selecting this trigger. Because these two countries account for over one third of the total responses to the study, the high performance of healthier buildings in the overall findings is influenced by its popularity in the US and India. However, the global average, excluding the US and India, is still 23%, so the influence of healthier buildings is widely recognized globally, not just in those two countries.

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

Dodge Data & Analytics, 2018



Social Reasons for Building Green

Social Reasons Rated as Important

Overall, the findings of this study suggest a general tendency toward increased importance of many social reasons for building green. Respondents were asked to rate the importance of several social reasons for building green on a five-point scale, from unimportant to very important. The chart at right shows the percentage of those who rated each reason as important/highly important in the current study, and, where applicable, in the three previous studies.

VARIATION BY YEAR

- **The top two social reasons for building green, each rated as important by about three quarters of respondents, are that green building promotes improved occupant health and well-being, and that it encourages sustainable business practices.**
 - The impact of occupant health was added back into the study after being dropped in 2015, and this finding demonstrates the importance given to healthier buildings that is evident throughout the study.
 - After a slight decline in 2015, the ability of green buildings to encourage sustainable business practices is also highly influential in the current study.
- **Increasing worker productivity, creating a sense of community and being aesthetically pleasing are considered important in the current study by a higher percentage than in the two previous ones.** While this may have to do with the individual factors, it also suggests an evolving understanding that building sustainably should achieve other goals beyond just energy savings and resource conservation, indicating a more nuanced understanding of green building.

Two Most Important Social Reasons

Respondents were then asked to select the two most important social reasons for building green among the responses they rated as important. The chart on page 19 provides a listing of the global average for each reason, and show the countries with the highest percentage of respondents selecting each reason.

- **Improved Occupant Health and Well-Being:** This still ranks as the top reason globally, and it is selected among the top two reasons by a very high percentage of respondents from Colombia, Ireland and the United States. Conversely, less than one third of the respondents from Saudi Arabia (27%) consider this one of the top two reasons to build green.

Social Reasons for Building Green

(Respondents Who Rated Each as Important/Very Important)

Dodge Data & Analytics, 2018



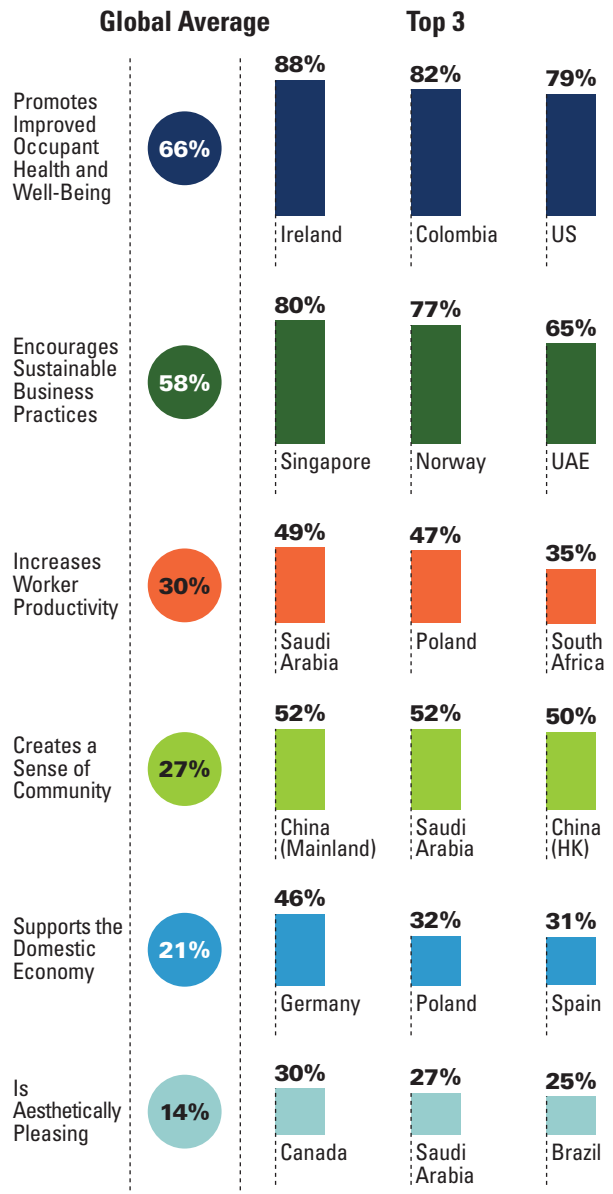
Influences on the Green Building Market

Social Reasons for Building Green CONTINUED

- Encourages Sustainable Business Practices:** Over three quarters of respondents from Singapore and Norway consider this a top social reason for building green. However, Saudi Arabia again has less than one third of respondents (24%) who rank it in the top two.
- Increases Worker Productivity:** Only about one third (30%) of respondents globally rate this among their top two reasons, but it has great influence in Saudi Arabia (49%) and Poland (47%).
- Creates a Sense of Community:** While only 27% of total global respondents consider this a top social reason for building green, about half of those from China (both Mainland and Hong Kong) and Saudi Arabia do.
- Supports the Domestic Economy:** Germany is notably more influenced by this factor than the other countries in the study, but globally, its influence is quite limited.
- Is Aesthetically Pleasing:** While nearly half rate this as an important factor in the previous question, very few of them (14%) select it as one of the top two social reasons for building green. Even when considering responses by country, fewer than one third of respondents from any country consider it among the most influential reasons.

Top Social Reasons for Building Green (Ranked Among the Top Two Reasons by Those Who Consider It Important)

Dodge Data & Analytics, 2018



Environmental Reasons for Building Green

In both 2015 and 2018, respondents were asked two questions about their environmental reasons for building green. First, they were asked to rate the importance of several reasons on a five-point scale from unimportant to very important. Next, respondents were shown the reasons they designated as important (4 or 5 in the scale) and asked to identify just their top two.

- Over three quarters of respondents rated all five of the environmental reasons offered in the survey as important (4 or 5).
- The chart at right shows the breakdown when they were asked to select just their top two most important.

Reducing energy consumption is still most frequently selected as a top environmental reason for building green, as it has been since 2008. As the chart shows, the same percentage selected it in 2018 as did in 2015. Reduced energy consumption remains the most tangible and financially significant benefit of green building, so this finding is not surprising.

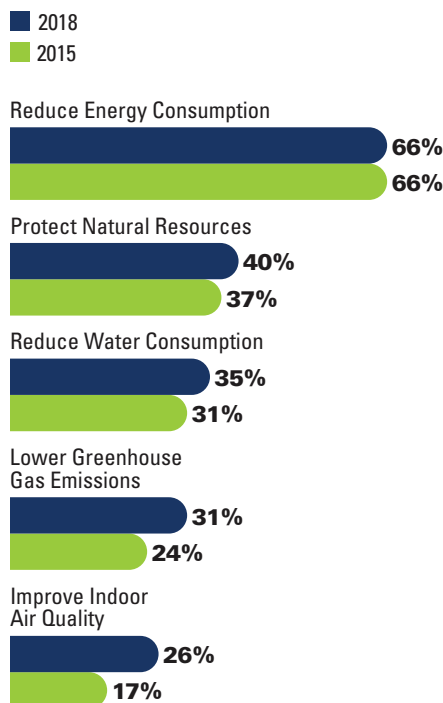
What is notable, though, is that **there is a significant increase since 2015 in those who consider reduced water consumption, lower greenhouse gas emissions and improved indoor air quality to be top reasons for building green.** This may indicate that a more holistic understanding of green building is becoming more common globally.

Variation by Country

- **Demonstrating its universal importance, reducing energy consumption is selected as one of the top two environmental reasons by more than half of respondents from all 20 countries in the survey.** It is selected by nearly all respondents from Saudi Arabia (91%) and China (Hong Kong) (86%).
- **Protecting natural resources is selected by nearly half of respondents in Vietnam (50%), Brazil (49%) and China (Mainland) (48%).** However, only 20% of respondents from Hong Kong and 8% from Ireland consider this one of their top two reasons.
- **Around half of respondents from Colombia (51%), South Africa (51%) and the UAE (50%) select reducing water consumption among their top two.** It is least important in Spain (9%) and Norway (8%), and all other countries in Western Europe have fewer than 20% of respondents who consider this a top reason, suggesting that it is generally not prioritized in this region.

Top Environmental Reasons for Building Green (Ranked Among the Top Two Reasons by Those Who Consider It Important)

Dodge Data & Analytics, 2018



- **Lowering greenhouse gas emissions is particularly important in Ireland (63%), and selected by at least half of respondents in Saudi Arabia (52%) and Hong Kong (50%).** However, less than 20% in the UAE (16%), Singapore (18%) or Brazil (18%) rate this highly.
- **No country has more than half of its respondents rating improved indoor air quality as one of the top two reasons.** This is surprising given the high level of interest in healthier buildings shown in the rest of the study.

Green Building Rating Systems

Three quarters (75%) of respondents report using one or more third-party green building rating system. Those using these systems were asked about the benefits they experienced from using them. All respondents were also asked why they chose not to use a rating system on green projects. Their answers to both questions are shown in the two charts at right.

Benefits of Using a Green Building Rating System

The top chart at right shows the benefits reported by more than 50% of respondents from their use of a rating system in the current study, and where applicable, also shows the percentage of respondents reporting these benefits in 2012 and 2015.

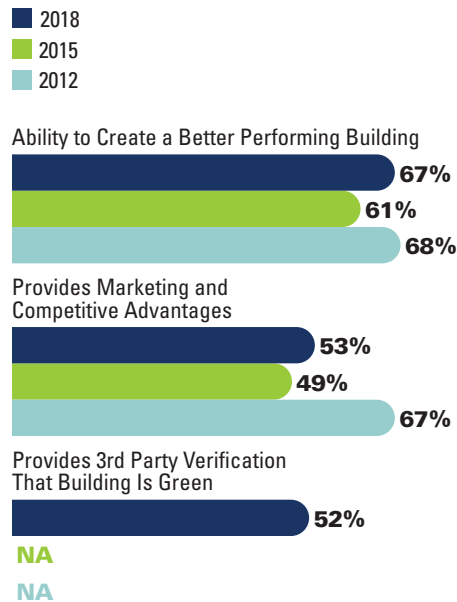
- **Two thirds (67%) report that using a rating system allows them to create better performing buildings.** This benefit declined slightly between 2012 and 2015, but the current study nearly restores the percentage back to the 2012 level. The frequency with which this has been consistently reported shows that respondents find that the rigor of a third-party system assists them in creating better performing buildings.
- **Marketing and competitive advantages are noted by more than half (53%), but the percentage experiencing this benefit declined since 2012.** In some markets, green building is becoming more common, making it less of a competitive advantage and more of a requirement to do business at all.
- **Over half (52%) of respondents also find that using a rating system provides third-party verification that their buildings are green.** This finding suggests that concerns about green washing are still prevalent in the industry.

Reasons Not to Use a Rating System

There is a notable increase of 26 percentage points between 2015 and 2018 in the number of respondents who don't use a rating system because of the cost. This is also the only concern selected by more than 20% in 2018, suggesting that the perception of the high costs may be the biggest hurdle needed to be overcome in order to encourage wider use of third-party rating systems. This increased concern may also contribute to the growing share of green projects that are not being certified in a system (see pages 10 and 11).

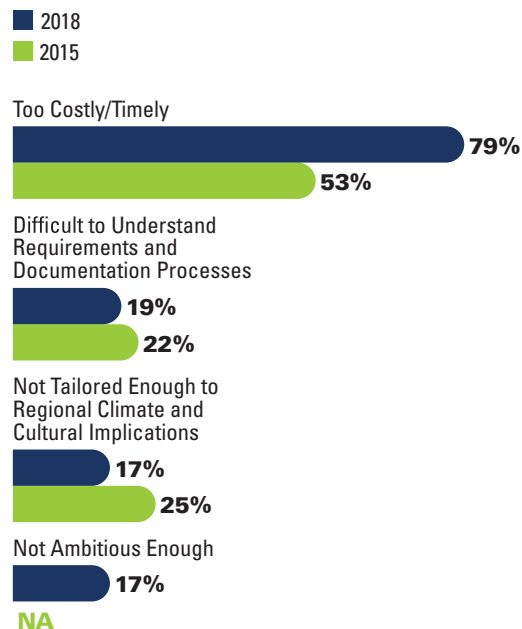
Benefits of Using a Green Building Rating System (According to Respondents Who Use Rating Systems)

Dodge Data & Analytics, 2018



Top Reasons for Not Using a Green Building Rating System (According to All Respondents)

Dodge Data & Analytics, 2018



Expert Insights on Green Technology

In July 2018, Dodge Data & Analytics conducted a series of interviews with experts from nine companies on using technology to improve building performance and achieve better sustainable outcomes in new and existing buildings.

Interviews on green technology were conducted with many experts from design firms recognized for their green projects, as well as experts from Johnson Controls and Siemens. For a full list of participants, see page 23.

No formal definition of green technology was provided to the participants, so their responses cover a wide spectrum of technologies, from advanced analytical capabilities in early design, to LED fixtures, to cloud-based systems gathering data from sensors.

In addition to insights about the technologies themselves, these discussions also highlighted critical trends and goals for green building that the industry is attempting to address through technology.

Key Sustainability Trends and Outcomes

During the interviews, participants were asked to discuss the technologies they currently use and anticipate using in the near future to accomplish their sustainability goals. Because specific goals were not included, this led to an interesting portrait of the top trends and outcomes driving sustainable activity among these experts. These trends and goals provide a framework for defining the technologies discussed as green.

- **Energy Performance:** Not surprisingly, improved energy performance in buildings is still a top outcome mentioned by all

“[Generative design] is going to augment our ability as designers to make better and more informed decisions early.”

Brendan Garrett, Dekker, Perich, Sabatini

participants. However, in some cases, ambitious energy goals were highlighted. Ilana Judah, former principal and director of sustainability at FXCollaborative, emphasizes achieving **net zero buildings**, and Clay Nesler, vice president of global sustainability and industry initiatives at Johnson Controls, reports that “this notion of net zero, near zero and energy positive buildings is clearly accelerating,” based on their 2017 global energy efficiency indicator study with building facility and energy executives in 12 countries.

Distributed energy production through renewables is also another ambitious trend observed by Tobias Huber, global head for business and project development at Siemens.

- **Building Occupant Impacts:** Attention to the health and well-being of building occupants is a primary concern of many of the respondents. In addition, ways to influence occupant behavior to improve building performance are also discussed by a few experts, largely by providing feedback to occupants about performance in an immediate, actionable way. Chris Nelson, President, Commercial HVAC, Carrier, states, “Building

developers and owners are expected to become increasingly sophisticated, taking a more holistic approach to address the pressing needs of lowering their carbon footprint, improving indoor air quality and offering a healthy occupant experience.”

- **Adaptable/Flexible Space:** Some experts report demand for spaces that can be flexible and adaptable. They discuss “address-less” offices, in which occupants choose spaces to work in that meet their immediate needs.
- **Transparency About Material Components and Lifecycle Impacts:** Several experts express interest in how technology can help address the challenges they face in understanding the makeup of the materials they choose and their likely health impacts. None of the experts has found a good technology solution to this challenge, but a few are hopeful about that potential.
- **Scaling Up:** A few experts are looking beyond the building envelope to understanding green performance on a neighborhood/city scale, and understanding how their buildings contribute. Aaron Ketner, intern architect/

energy specialist at Dekker, Perich, Sabatini, says, “[What] I am starting to find a passion for is, how does not only the individual building perform, but how does it influence the context. We are getting more interest in community-scale kind of impacts... we’re looking at an entire urban environment and how do we evaluate our design decisions based on a super-connected environment.”

Technologies

The experts were asked about the technologies that they have seen improve in the last five years and what they are seeing and most excited about on the horizon. In many cases, the answers to these two questions overlapped.

allowed them to “become part of the dialogue throughout the design process. And the biggest benefit is that, these technologies allow for an iterative process—a process for exploration.” His colleague Aaron Ketner also regards the speed with which these iterations can now be run as a major improvement over his experience in the past.

- **Ability to Conduct Analysis as Early as Possible in the Design Process:** Ellen Mitchell Kozack, principal and director of sustainability at HKS, sees the biggest benefit coming from “the shift toward more early phase analysis that can be done in-house by architecture and not solely relegated to our consultants. She points out that even though the limited parameters available in the

“I believe we should be making those early decisions that empower us to own the impact of the architecture.”

Margaret Montgomery, NBBJ

EARLY ANALYSIS TOOLS

By far, the most widely discussed technologies improving green building performance are the early analysis tools available for use with building information models (BIM). These include many aspects of building performance, with the most commonly mentioned uses being energy analysis and daylighting.

- **Integration Into the Model:** Brandon Garrett, associate/architect at Dekker, Perich, Sabatini, says that when they initially started using these tools for early analysis, they were part of a separate, optional process. However, their integration and increased ease of use has

very early design stages may not be able to yield completely accurate forecasts of energy consumption, they can be very valuable from a comparative perspective: “It allows us to look at the constraints and opportunities of the project in three dimensions instead of two.” Margaret Montgomery, principal and sustainable design leader at NBBJ, regards the decisions made before consultants typically join a project as critical to its ultimate performance. “When our designers start at day one, they probably don’t have the other disciplines sitting there with them as they are initiating their first design doodles,

Green Technology Experts Interviewed

- Chris Nelson, President, Commercial HVAC, Carrier
- Brandon Garrett, Associate/Architect, Dekker, Perich, Sabatini
- Aaron Ketner, Intern Architect/Energy Specialist, Dekker, Perich, Sabatini
- Ilana Judah, AIA, OAQ, LEED AP BD+C, CPHD, Institute for Resources Environment & Sustainability, University of British Columbia (former Principal and Director of Sustainability at FX Collaborative)
- Ellen Mitchell Kozack, Principal and Director of Sustainability, HKS
- Clay Nesler, Vice President, Global Sustainability and Industry Initiatives, Johnson Controls, Inc.
- Ryan Hess, Principal, Mills Group
- Margaret Montgomery, Principal and Sustainable Design Leader, NBBJ
- Tobias Huber, Global Head for Business and Product Development, Siemens
- Nirup Jayanth, Managing Director, Surbana Jurong SMEC
- Wang Ying, Director Assistant of Technology Development Department, TIAD China

but I want the software to be able to support them [at that stage]... I want us to have a good feedback loop when we're doing things that we tend to do quickly and early." She recognizes the importance of collaboration with other disciplines and embraces that approach, but sees these tools as valuable to improving performance at this early stage. She states, "I believe we should be making those early decisions that empower us to own the impact of the architecture."

- **Demonstrate Impact to Clients of Early Design Decisions:** Another important benefit of engaging in early energy analysis is the ability to show their clients the impacts of early, key design decisions, such as building placement and mapping. Ryan Hess, principal at Mills Group, says that being able to perform these functions "on the fly" in front of clients helps them to demonstrate the value of the choices being made and how they will impact final building performance. In fact, Aaron Ketner, from Dekker Perich Sabatini, describes how his team was iterating ideas with clients to demonstrate the impact of different basic design decisions, and the clients were very impressed, stating "Wait, you don't have to go do all this and come back?" Instead, in the course of their meeting they were able to continue to adapt the design and show the client the impact.
- **The Potential of Generative Design:** When asked about the technologies that they believe will have the greatest positive impact on sustainable outcomes in buildings in the next five years, many of the designers regard generative design

"..[A]s we move toward IoT, people are going to rely more on data to inform decisions, and once that comes, there is no going back."

Ellen Mitchell Kozack, HKS

as the most exciting development they anticipate. Brandon Garrett, from Dekker, Perich, Sabatini, describes it as goal-based tools, in which they could input their project goals and what they know about a project at an early stage (such as the site, the square feet, the number of buildings and the number of stories) into the system and have the software show them the top solutions to achieve those goals. He states that generative design "is going to further augment our ability as designers to make better and more informed decisions early." Excitement about computer aided design is not confined to designers. Chris Nelson regards a computer-aided design paradigm as an opportunity for Carrier to help their customers become more efficient. "When we take that [computer aided design technology] to the HVAC product level, it propels the design process forward and simplifies the way buildings are designed, constructed, commissioned and serviced."

- **Concerns About the Future of Design in an Age of Generative Design:** While many see automating this aspect of the design as a likely development in the future, some designers voice concerns. Ryan Hess, from Mills Group, argues that "it is important for the designer to have that hands-on understanding of the depth of the design to be able to make some critically informed

decisions. Every design is different, based on latitude, longitude, climate pattern ... it has to be very, very localized." Hess himself, though, caveats that "integration is key ... It is integration of all of that data [such as window placement and shading] in a simplified form that helps reveal a sound design process." Ellen Mitchell Kozack shares that concern while also sharing in the excitement of having this tool. She describes the possibility of having the computer generate simulations based on energy performance parameters that determine the optimal orientation, glazing, window treatments and other elements to improve energy performance as "pretty compelling," but also states that "it seems a little bit scary because in some ways it starts to take away our jobs as designers." However, on further consideration, she finds a balance in her expectation that "there are inherent things in terms of beauty and delight that a computer is not going to be as effective at simulating, but [the technical tasks of understanding how a structure performs] can be solved by a computer very easily."

- **Automating Design as it Progresses:** Brendan Garrett anticipates more automation of tools in the workflow of a designer. He anticipates, for example, "a dashboard that is sitting there as

we are working, and as you are designing and making decisions, performance is moving up or down. So it is no longer a second thought process to run the analysis, but rather, you get live feedback as you are designing.”

INTERNET OF THINGS

Sensors are now commonly deployed in building projects, to measure occupancy, air quality, temperature and other factors. However, use of the data being gathered is still an emerging trend, but one that directly impacts building performance. Tobias Huber, from Siemens, summarizes that impact well: “There is a clear trend from green to smart, and I believe in the near future, we will not be able to distinguish measures that make a building green or measures making a building smart.”

Ilana Judah considers the importance of the measurement and verification of data one of the most important technologies to emerge in the last five years, on par with the early analysis tools. She says, “We are starting to see more sophisticated building management systems, and that is helping us understand the actual performance of buildings once they’ve been built. It is the two ends of the spectrum: early design tools, and the measurement and verification tools.”

Ellen Mitchell Kozack believes **these tools are already having a fundamental impact on design.** “It is all about the shift to using data to inform decisions. I feel that is inevitable as we move toward IoT. People are going to be relying more and more on data to inform decision, and I think once that comes, there’s no going back.”

However, **the majority of owners do not share measurement and verification data currently with design firms.** Ilana Judah has found getting feedback from clients on the measurement and verification data of buildings they’ve designed to be exception rather than the norm. Ellen Mitchell Kozack agrees that sharing data has not entered the mainstream, but she sees creating a feedback loop as an opportunity. “I see [client use of the digital model] as a way to not only add value for the client but as a way to foster connections with the client beyond the design and construction of the building, through commissioning and post-occupancy work.”

Having data would directly impact design and building operations. Chris Nelson describes how their new headquarters in Florida features a “centralized security monitoring and management hub, [that] allows us to oversee systems and solutions throughout the building, respond rapidly to incidents, support remote sites as a backup and monitor the facility during off hours. Software platforms are integrated to help better protect the building and the people inside, while minimizing staff needs and enhancing operational efficiencies.” Clay Nesler states, “We are getting to the point where we can actually count people,” which allows for several benefits, including understanding space utilization and more proactive indoor air quality control to address carbon dioxide levels before they rise.

Brandon Garrett agrees. He believes this technology will change how they approach the layout of buildings because they can see how

people actually circulate around buildings, rather than relying on standard assumptions.

Major impacts are also expected on improving occupant well-being. Aaron Ketner explains that understanding how people circulate provides data on strategies designed to provide active routes and promote stair usage. Clay Nesler describes smart sensors that sense a broader range of indoor pollutants than just carbon dioxide. The use of this data will change based on location: In countries with acceptable outdoor air quality, this may call for more ventilation with outside air, but in buildings like their new headquarters building in Shanghai, it could lead to removing indoor air pollutants using filters and scrubbers instead.

Many are excited about the way in which the **data will help building operations and maintenance to become more predictive** rather than a reaction to issues that arise. Ryan Hess mentions the example of “a building having predictive forecasting” that can use the weather forecast to “precool the building [at night] instead of cooling it during peak hours.” Brandon Garrett imagines a future where a cloud system could track performance on all equipment of the same make and model installed into different buildings so that performance of a single unit could be compared with that of the others and addressed.

Nirup Jayanth, managing director at Surbana Jurong SMEC, anticipates the combination of data and artificial intelligence that will help dynamic systems perform on their own, maximizing the performance. He sees this trend largely merging in “laboratories and highly specialized

environments where you need a high level of control on the environmental conditions.”

The impact of this data ultimately, though, will depend on how usable they are. Clay Nesler compares these very technical buildings to modern cars today. The car itself is a combination of highly instrumented and complex systems, but because the user interface is still very simple, he states, “my 86-year-old mother drives her car just fine.” Buildings must be the same, according to Nesler. “Buildings are going to be more complex to design, more complex to construct, but through new user interfaces and automation technologies, we may be able to make them easier to operate and achieve peak performance.”

Still, in the current condition, **the challenge of the disparate nature of the data is significant.** Tobias Huber from Siemens describes the need to gather data from different systems together: “There is so much data existing in silos and not brought together for comprehensive analysis.” To maximize the operational impact of this data, systems need to be able to speak to each other. Wang Ying, director assistant of the technology development department at TIAD in China mentions that her firm is developing a protocol for different sensors for the operations phase that can allow the use of disparate data in one tool.

Wang Ying also explains that it is important that the sensors are demonstrated to help achieve the original design goals to be worth the investment, and not to just use technology for technology’s sake.

Digital twins, which marry the

building data to a digital model of building, also have the potential to help scale up the benefits of these technologies to the level of smart cities. Nirup Jayanth from Surbana Jurong, states, “When you look at the Internet of Things and sensors, this has primarily caught on at both the building level, having integrated BMS [building management systems] as well as a large scale city level of smart technology. What we are able to do today is to help provide command centers, providing monitors to manage these systems. Where we can go forward is potentially running simulations... to better double up with the artificial intelligence solutions and automated controls based on scenarios in the future.”

Ilana Judah also sees exciting applications in moving from the building scale to the city scale. She is interested in “how buildings talk to the greater infrastructure.” She pictures situations where an emergency management response team can use data to understand where people are in a building, where the temperature is very high and other data that can improve resilience.

LED LIGHTING

Several experts felt that LED lighting is still a critical technology for improving green building performance. Margaret Montgomery reports that LED lighting has tipped from being too expensive to being fairly ubiquitous. Tobias Huber regards LED lighting retrofit as an enabling technology to get smart IoT infrastructure in existing buildings, financed by the payback derived from energy savings.

PREFABRICATION

Margaret Montgomery is interested in the ways in which prefabrication is altering the design and construction process, which has strong sustainability implications. Wang Ying also mentions prefabrication as one of the technologies that has improved sustainable building outcomes in the last five years. Nirup Jayanth not only agrees, but he regards it as a factor that has helped reduce the air pollution caused by building construction in India.

OTHER TECHNOLOGIES

Other technologies mentioned briefly as desirable by the experts interviewed include better automation of green building certification requirements on projects, automation that helps support material selection, based on HPDs, EPDs and ratings that identify material components, and automation that provides better lifecycle analysis for materials.

Best Practices

A few best practices also emerged from the interviews with the experts.

- **A few are using their own offices as test beds in order to be able to advocate for the best new technologies with clients through their own experiences.** One example is the UTC Center for Intelligent Buildings, featured in a case study on page 30.
- **Meeting an overarching goal about performance (such as AIA 2030) can help to foster the will to experiment with new technologies.**
- **Recognize that people are the most critical element to improve building operational performance. Make tools simple, and use technology to guide occupant behavior.**

Existing Cities Get Smarter

For a growing number of the world's cities, data generated by sensing technologies is helping to orchestrate the functions of daily life—mobility, energy, water, waste, governance and citizen participation.

While a few cities are being built smart from the outset, the vast majority are created in quiet increments as existing cities undergo various rates of retrofit. But whether they are built all at once or piece by piece, a smart city comprises three layers.

The first is the data from sensors, meters and other collection points integrated into the urban fabric—in buildings, utilities, infrastructure, street furnishings, phones, wearables and elsewhere. The second is the middleware, analytics and apps that make sense of the volumes of data that the sensors produce. The third layer consists of decision making, in which a city's constituents—its citizens, businesses, utilities, agencies, governments and visitors—act on the data to make a better, more livable and more sustainable city.

Enhanced Mobility—Reduced Emissions

Many cities start with the mobility sector, which accounts for 14% of the world's greenhouse gas emissions (GHGs) and offers some of the most accessible gains. Singapore's Smart Urban Mobility project, for example, leverages data and digital technologies, including artificial intelligence and autonomous vehicles, to improve public transit and reduce the total number of cars on the road. Moscow has launched an intelligent transport system (ITS), which controls over 2,000 video

surveillance cameras, 3,700 road detectors and 6,000 traffic lights, to tackle its near-critical congestion and support a major public transit upgrade. London uses maps, apps and kiosks to allow people to compare transportation modes for a given route by price, time, calories burned and CO₂ emissions generated. And over 1,500 cities around the world are considering or have implemented bike sharing: using phone apps to find the nearest bike, unlock it and charge for time used.

Air quality monitoring can complement mobility improvements, or work as a stand-alone measure. Beijing, for example, reduced airborne pollutants by about 20% in less than a year by monitoring their sources and regulating traffic and construction accordingly.

Further reducing congestion and emissions, sensors on trash bins that send an alert when the bin is full are enabling garbage trucks to streamline their routes and eliminate runs for empty bins. The sensors also have the potential to improve waste management by signaling when inappropriate or hazardous material is deposited.

Distributing Energy, Saving Water

In the electricity and heat production sector, which accounts for 25% of global GHGs, smart technologies are supporting renewable energy initiatives. Copenhagen's Energy Block, for example, which positions

solar collectors on rooftop greenhouses (which also create jobs and contribute to urban food production), relies on smart meters to provide the real-time consumption data essential to stabilizing the electricity grid, and aggregated patterns to facilitate planning. With the combined gains from renewable production and smart-induced savings, Copenhagen's potential for energy optimization is estimated at 30%.

The water sector has been slower than others to implement smart technologies, but with utilities worldwide losing 25% to 35% of their water to leaks and bursts, early adopters are finding smart infrastructure can help stanch these losses. Following a major earthquake in 2011, the city of Christchurch, New Zealand, was able to use before-and-after data to locate ruptures and prioritize repairs. Not just for emergencies, smart water management systems increase network visibility, facilitate predictive maintenance and enable faster response times.

Priorities for smart initiatives vary from city to city. Regardless of which sectors a city emphasizes, however, sustainability rarely forms a stand-alone consideration, with solutions that integrate other quality-of-life indicators—economics, public health, social justice, to name a few—proving more likely to succeed. Ultimately, smart cities are thinking beyond technology to what a good city should be. ■

Affordable Housing With Sustainable Goals

Silver Star Apartments

LOS ANGELES, CALIFORNIA

Early energy modeling helped to ensure a passive design that had a major improvement on energy performance.



For anyone who thinks green building requires deep pockets, a nonprofit housing project for formerly homeless veterans will seem an unlikely poster child for ambitious sustainability goals and pioneering technologies. However, A Community of Friends (ACOF), a Los Angeles-based charity, aspires not only to build quality, permanent, supportive housing for its tenants, but to do so in a way that is environmentally responsible.

ACOF's Silver Star Apartments, a 49-unit, three-level, \$12 million development designed by FSY Architects, shows what is possible. Recognized as the 2017 Sustainable Innovation Awards Project of the Year by the L.A. chapter of the United States Green Building Council, the building has achieved platinum-level LEED for Homes and Energy Star Homes certifications, anticipates the 2030 Challenge for carbon-neutral operations, and is on track to comply with the zero net energy (ZNE) requirements of the Living Building Challenge.

Green building programs that recognize best-in-class sustainable

building practices inform ACOF's housing development strategy, says Ryan Lehman, the organization's senior project manager. Moreover, he says, "anything that can reduce the operating costs of the building benefits us directly."

One of the most significant operating costs Silver Star knocks down is energy. As the first ZNE affordable housing development in L.A., the project meets a predicted 105% of its annual energy needs with onsite renewably sourced electricity—an especially significant achievement for a tight urban site.

Aggressive on Passive

Producing a building's energy supply entirely within its property lines requires first minimizing demand, and Silver Star achieves a 54% reduction compared with baseline compliance with California's already progressive energy code. The biggest move in hitting that mark was to minimize heating and cooling demands.

The design team used building information modeling (BIM), three-dimensional design software, to optimize massing and facades for passive solar performance. Being

able to take a project from preliminary site and solar analysis through to construction documents in a single file makes continuity of design intent much easier to maintain, says Anuj Dua, an associate at FSY. "BIM can do a solar study at any stage," he says, "enabling continuous refinement and checking."

A C-shaped, courtyard building with its long axis running east-west, Silver Star varies its facade expression in response to BIM-based solar analysis. Windows on the exposed south face are protected with shade boxes. These provide horizontal shading against high midday rays, and faceted, vertical shading against lower sun angles either side of noon. The west facade minimizes exposure to afternoon rays by recessing windows in deep vertical slots. Facades facing into the shady courtyard need no additional protection. Behind the varied facades, apartment layouts are identical for cost-effective construction.

Passive solar performance is reinforced with a high performance building envelope in which quality-controlled air sealing and insulation installation minimize leaks, and all units enjoy cross-ventilation. Even with this optimized passive design, however, the project's energy demand was predicted to exceed the capacity of all the photovoltaic panels (PVs) that would fit on the roof.

Phase Change

To bring HVAC loads within supply limits, the building envelope, interior walls and ceilings incorporate an innovative phase change material (PCM). An organic compound derived from sustainably sourced, renewable, plant-based byproducts in

Silver Star Apartments LOS ANGELES, CALIFORNIA

quilt-like plastic sheets, the PCM takes advantage of diurnal temperature swings in L.A.'s desert climate. Overnight, the compound hardens as it cools; as daytime temperatures rise, it grows soft, absorbing heat as it melts. "If you would ordinarily turn on your air conditioner at 11:00 a.m., the coolness of the phase change material could make that 1:00 p.m.," says Dua. "Two hours a day, 200 days a year for 49 units over the 75-year life of the building: That's a huge savings."

Although PCM's price is reportedly dropping, its cost to Silver Star was comparable to that of the photovoltaics it made redundant. Unlike the photovoltaics, however, PCM had no trouble fitting onsite. PCM also contributes to Silver Star's disaster resilience. If the power grid fails, electricity from the project's battery storage system will serve essential functions only, but the PCM, combined with shading and cross-ventilation, is expected to keep the building's tenants comfortable even after conventionally insulated buildings with fixed windows have become uninhabitable.

New technologies are not without risk, however. FSJ investigated the material with due diligence, says Dua, and reached a liability sharing arrangement with ACOF in case the product's performance falls short of its promise.

Solar Thermal

The other major power draw that Silver Star minimizes in order to achieve zero net energy is water heating. A 16-collector rooftop solar thermal array, combined with EPA WaterSense-compliant fixtures, reduces the energy consumption of high-efficiency heat pump water

heaters by up to 80%.

The cost of Silver Star's PV and solar thermal systems was \$350,000 and \$142,000, respectively. These costs were offset by a \$105,000 incentive from the Los Angeles Department of Water and Power, and \$65,000 in tax credits, bringing the net cost for both systems to \$322,000. Although this still represents a significant capital expense, the reduced operating costs from the two technologies enabled ACOF to take on an extra \$322,000 in permanent debt, bringing the real cost of the system to zero, says Lehman. That's based on a 15-year amortization, after which ACOF will enjoy free electricity and improved cash flow.

Coming Soon

Water is another significant conservation focus for the development, and Silver Star is dual-plumbed for gray water capture and reuse in toilets and irrigation, reducing potable water demand by 40%. The installation of the water treatment system is on hold, however, pending completion of the municipal permitting process. (So is the installation of the PV system's battery backup.) That regulatory delay is an aspect of green technology both developer and architect identify as a lesson learned. "Ideally you would only put in the technology that's approvable at the time you go out to bid on a project," says Lehman. "It's difficult to go back and add once everyone has moved on." That said, ACOF values its new understanding of these technologies, especially as L.A. now mandates projects of this type be gray water ready.

Will ACOF be pioneering green technologies on its future projects?

"Right now, with rising construction costs, it's a struggle just to get enough money for a basic building," says Lehman. Nonetheless, for a developer that prioritizes best building practices, and where incentives support innovation, he says, "it definitely makes sense to try." ■

Project Data

Owner
A Community of Friends

Location
South Los Angeles

Cost
\$12 million

Completed
2017

Number of units:
49

Certification
LEED for Homes—Platinum;
Energy Star Homes; Living
Building Challenge—Energy
Petal (pending)

Architect
FSJ Architects

General Contractor
Dreyfuss Construction

Sustainability Consultant
Green Dinosaur

Civil Engineer
SWCE Civil Engineering

Mechanical Engineer
JaycoCal Engineering

Electrical Engineer
Electrical Building Systems

Plumbing Engineer
JaycoCal Engineering

Landscape Architect
Yael Lir Landscape Architects

Photovoltaics
Promise Energy

stats

Smart for Green

The UTC Center for Intelligent Buildings

PALM BEACH GARDENS, FLORIDA

The UTC Center for Intelligent Buildings, a five-story office building completed in 2018 in Palm Beach Gardens, Florida, is on track to become the first building in the state to achieve LEED Platinum certification under the standard's stringent new version 4.

The 224,000 square foot building, which will serve as the global headquarters for UTC Climate, Controls & Security as well as members of the Otis America regional headquarters team, achieves a 60% reduction in energy use (6,240 MBtu/year)—obviating the production of 988 tons of greenhouses gases annually—a 36% reduction in water use inside the building and a 100% reduction in outdoor water use. The building also provides a standard of indoor air quality that Harvard-led studies correlate to a doubling of occupants' performance on cognitive tests assessing information usage, strategy, crisis response and other indicators.

In addition to its role as corporate headquarters, the building also serves as a showcase for UTC's products and systems and as a

living laboratory for the company's solutions, so the strategic use of building technologies played a central role in achieving the Center's green goals. Nonetheless, says Chris Pietrzykowski, Director of Technology at UTC, "an intelligent building is not about using technology for technology's sake." Instead, what the Center demonstrates, he says, is that "technology becomes the enabler of the vision for the building."

Cooling for Less

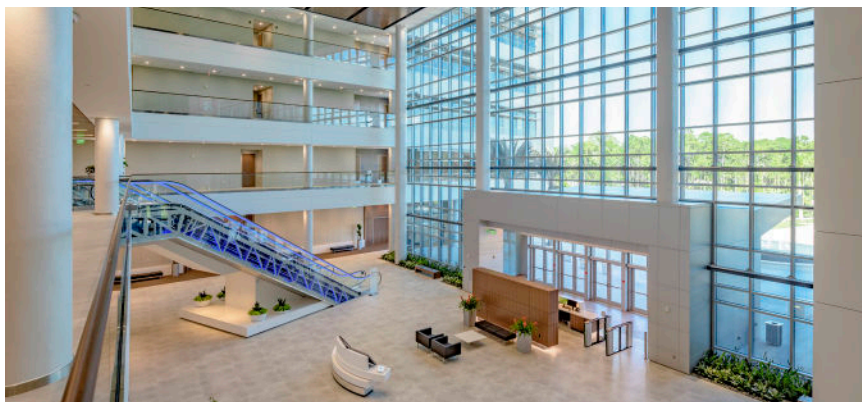
One of the most significant contributors to achieving the project's energy reduction goals, while providing a comfortable indoor environment in Florida's heat and humidity, is the building's advanced heating, ventilation and air conditioning (HVAC) system. High efficiency chillers in a series counterflow configuration (which reduces the work done by each compressor at both full and part load) reduce energy consumption for cooling by 42% compared to the industry standard.

Ceiling-mounted induction beams complement the chillers' efficiency with efficient air distribution.

Induction beams, also known as active beams, incorporate ventilation air distribution via a four-pipe terminal beam which can cool or heat the air as needed. The aerodynamics of a small amount of fresh air blown through a beam-integrated duct induces room air across the cooling (or heating) coil, where the air is mixed, tempered and delivered through linear diffusers. Based on the findings of the Harvard-led cognitive effects research, the UTC Center is designed to provide 40 cubic feet per minute of outdoor air per person, double the code-required ventilation rate.

Because the induction beams require only a small amount of air to be actively blown, fan noise and energy consumption are drastically reduced, drafts are eliminated, and spaces are evenly conditioned. Moreover, the reduced volume of forced air allows for shallower ceiling plenums and, therefore, reduced floor-to-ceiling heights. The Center is four feet shorter than conventional air conditioning would have required, resulting in considerable construction cost savings—in addition to the reduced embodied energy and associated greenhouse gases from using less material in the Center's structure and envelope.

Optimization through integration is a central feature of the project. Building on its HVAC efficiencies, one of the Center's most innovative achievements pertains to the LEED credit for occupant control of thermal comfort, which requires at least 50% of individual workspace occupants—including those in open areas—to be provided with controls. Typically, this granular level of occupant control entails a prohibitive



Low floor to ceiling heights in the Center allowed reduced embodied energy and associated greenhouse gases by using less material in the structure and envelope.

CONTINUED

The UTC Center for Intelligent Buildings

PALM BEACH GARDENS, FLORIDA

number of thermostats, says Luke Dorna, a systems engineer at United Technologies. But by capitalizing on the ability of the HVAC and security control systems to talk to each other through an underlying technology, and to interface with employees through a mobile phone app, the building is able to provide occupants with individualized thermal comfort without an army of thermostats.

Through the app, workers in a common area are able to register their thermal comfort preferences. The system then takes an average of the preferences of the employees it perceives in the space and sets the temperature accordingly. By corollary, if no one is present, the system puts the space into an energy conserving mode. In this way the technology achieves a balance that optimizes both occupant experience and energy savings.

Adapting to Change

Where a conventional building might undergo commissioning to optimize its systems shortly after construction, the Center for Intelligent Buildings is continuously self-commissioning. The data its control systems collect generate an evolving picture of how the building is actually used over time. The system then uses its security access data to automatically adapt such elements as HVAC temperatures, airflow and schedules to maintain comfort and efficiency even as use changes. "Users experience the building the way it's meant to be," says Dorna.

In addition to responding to changing usage, the Center's data analytics also identify operational anomalies that might otherwise

go undetected. For example, if a build-up of deposits is fouling a heat exchanger on one of the chillers, the monitor will alert maintenance staff to the reduced efficiency, enabling them to arrange a cleaning as needed rather than waiting for scheduled maintenance. The system can also prioritize faults according to pre-determined values and react either to maintain availability of the particular component, for example, or to conserve energy, depending on the value selected.

Thinking Things Through

Are there challenges specific to the use of smart technologies to support sustainability? "A lot of the advanced functionality takes advantage of information and data across multiple systems," says Pietrzykowski, "but if systems are too tightly integrated, you potentially have a more fragile building." To ensure a lighting fault, for example, will not affect the HVAC or security systems with which it communicates, the Center's building controls are designed for resilience to single failures.

For the project delivery team, the main challenge of integrating these innovative technologies centered on decision-making, says Londa Brady, senior vice president at JLL, project manager for the Center. With so many options to choose from, each product selection was put through a rigorous review to ensure both that it contributed effectively to the project's carefully articulated balance of priorities and that it would not result in unintended consequences for another system. In addition to clear project goals and methodical decision making, Brady also recommends the early

involvement of IT personnel to orchestrate the design implications of complex technologies.

"The smart building industry is evolving," says Brady. From what JLL sees UTC and other clients doing, she says, "a huge driver is to give building occupants the ability to optimize their experience of the space." Complementing the focus on occupant well-being, what the green achievements of the UTC Center for Intelligent Buildings demonstrate, adds Pietrzykowski, is that "technology can support the vision for the building in a sustainable way." ■

stats

Project Data

Owner:
United Technologies Corporation

Owner's Representation:
JLL

Architect/Interior Designer:
HuntonBrady

**Mechanical/Electrical/
Plumbing/Fire/LEED
Engineering Firm:**
EXP

Commissioning Firm (LEED):
NV5

General Contractor:
Whiting-Turner Contracting Company

Project type:
Office Building

Completed:
2018

Location:
Palm Beach Gardens, Florida

Square footage:
224,000

Certifications:
LEED Platinum (targeted)

Data: Business Benefits of Green Building

Important Benefits of Green Building

Respondents were asked to identify which green building benefits, from a list of 10, they feel are the most important ones. The percentage selecting each benefit is listed in the chart at right, both for the current 2018 study and the two previous ones, if it had been asked.

- **The top benefit identified by respondents is lower operating costs, selected by 65%.** This was also the top benefit in the two previous studies, although the percentage selecting it has steadily declined since 2012. Still, operating cost reductions remain central to the business case for green and are among the most tangible metrics for return on investment.

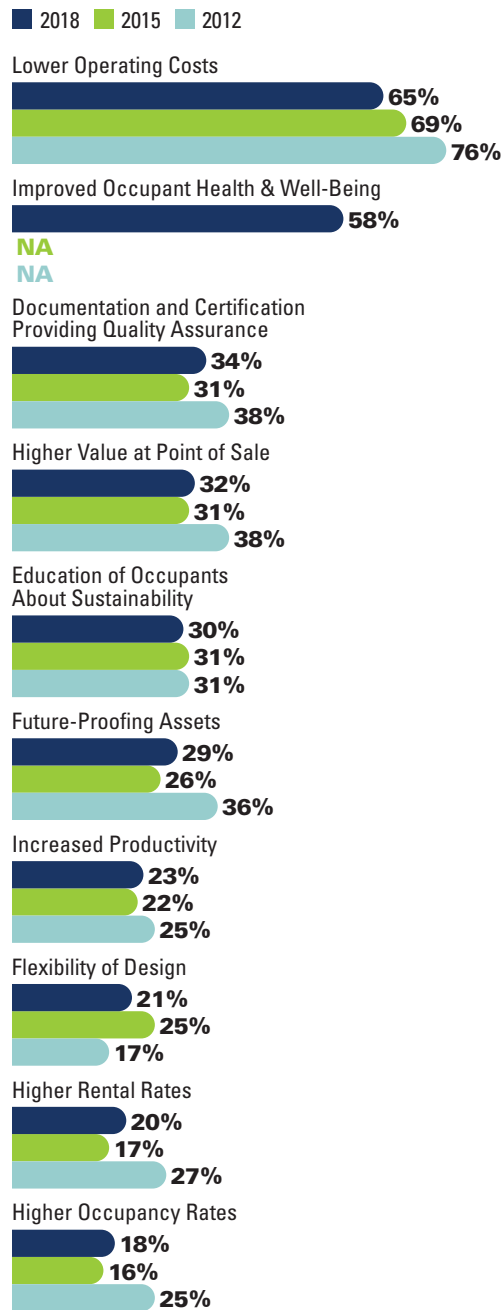
 - The US has the highest percentage of respondents (77%) who select higher operating costs as a top benefit.
 - Over 70% also select it in Colombia, Germany, Ireland, Singapore and the UAE.
 - Only one country (Poland at 24%) had fewer than 40% select this as an important benefit, reinforcing its broad influence.
- **The only other benefit selected by over half of all respondents is improved occupant health and well-being, a new option in this year's study and one that clearly is quite influential, with 58% selecting it as one of green building's most important benefits in their market.**

 - UAE (71%) and Ireland (71%) are most enthusiastic about it.
 - The fewest respondents who regard this as important are in Poland (31%) and Hong Kong (47%).
 - Between 50% and 65% of respondents from the remaining 16 countries consider this an important benefit for their markets, demonstrating its global importance as a green priority.
- **Five benefits are moderately popular, spanning a five-point range between 34% and 29%.**

 - **The assurance of quality that comes from certifying a project** tops the category of moderate benefits (34%), and an even higher percentage consider it an important benefit in Spain (52%), Norway (47%) Saudi Arabia (43%) and the UK (42%).
 - Two of the four moderate benefits—**higher value at point of sale** and **future proofing assets**—underscore the longer-term financial benefits of investing in green. Globally, though, there has been a notable drop in the popularity of these two benefits since 2012.

Most Important Benefits of Green Building (Respondents Who Selected Each Benefit as One of the Most Important in Their Market)

Dodge Data & Analytics, 2018



Business Benefits of Green Building

Important Benefits of Green Building CONTINUED

WORLD GREEN BUILDING TRENDS 2018 SMARTMARKET REPORT DATA

- **Higher value at point of sale** is considered an important green benefit by about half of respondents from Norway (53%), Saudi Arabia (53%), Vietnam (52%), Germany (50%) and Poland (48%).
- **Future-proofing assets is particularly influential in Ireland (68%),** but it is also considered important by a high percentage from mainland China (54%) and Australia (49%).
- **Future-proofing assets is also more frequently cited by owners** than by architects, engineers or contractors, which clearly shows that project teams underestimate the importance of this benefit to their clients.
- **Education of occupants about sustainability has consistently been selected by about 30% of respondents globally,** with the greatest support for this benefit found in Vietnam (41%) and Saudi Arabia (40%). In Norway, though, only 8% consider this a top benefit.
- **Several benefits are selected by fewer than one quarter of the respondents as important in their markets.**
- **Increased productivity** has been at this relatively low level since 2015, despite the focus on healthier buildings evident in the current study. This may reflect the difficulty in measuring and proving this benefit on individual projects, although there is a growing body of evidence in academic studies demonstrating that green buildings have a positive impact on productivity. Saudi Arabia has the highest percentage (43%) who rate this a top benefit.
- Saudi Arabia also has a much higher percentage (45%) than any other country who select **flexibility of design** as a top design factor.
- **Higher rental and higher occupancy rates** are not typically rated as strongly as some other factors, likely due to the fact that they only apply to commercial real estate. However, **higher rental rates** is considered an important benefit by above average percentages of respondents from Poland (42%) and Vietnam (39%), and **higher occupancy rates** scores best in Saudi Arabia (55%) and Poland (40%).
- Owners also place more importance on **higher occupancy rates** than architects, engineers or contractors.

Most Important Benefits of Green Building

(Top Five Countries in Which Each Benefit Is Most Frequently Selected)

70% and above 60% to 69% 50% to 59% 40% to 49% Below 40%

| | Global Average | Top 5 Countries | | | | |
|---|----------------|-----------------------|--------------------------------|----------------------------|----------------------------|------------------------------------|
| Lower Operating Costs | 65% | US 77% | Singapore 74% | UAE 74% | Colombia 74% | Germany 72% |
| Improved Occupant Health | 58% | UAE 71% | Ireland 71% | US 64% | Colombia 63% | India 63% |
| Documentation Providing Quality Assurance | 34% | Spain 52% | Norway 47% | Saudi Arabia 43% | UK 42% | Canada/Ireland (tie) 39% |
| Higher Value at Point of Sale | 32% | Norway 53% | Saudi Arabia 53% | Vietnam 52% | Germany 50% | Poland 48% |
| Education of Occupants About Sustainability | 30% | Vietnam 41% | Saudi Arabia 40% | Vietnam 42% | India 38% | UK 38% |
| Future-Proofing | 29% | Ireland 68% | China (Mainland) 54% | Australia 49% | Saudi Arabia 43% | South Africa 40% |

Metrics Used to Quantify Benefits of Green Building

Respondents were asked in 2015 and 2018 to select the metrics they use to quantify the business benefits of green buildings, including whether they use any metrics at all. The findings reveal consistent use of metrics between 2015 and 2018. In addition, in both studies, **most respondents (about three quarters) use metrics to quantify the benefits of their green building projects.** The findings also show that **lower operating costs is by far the most common metric tracked.**

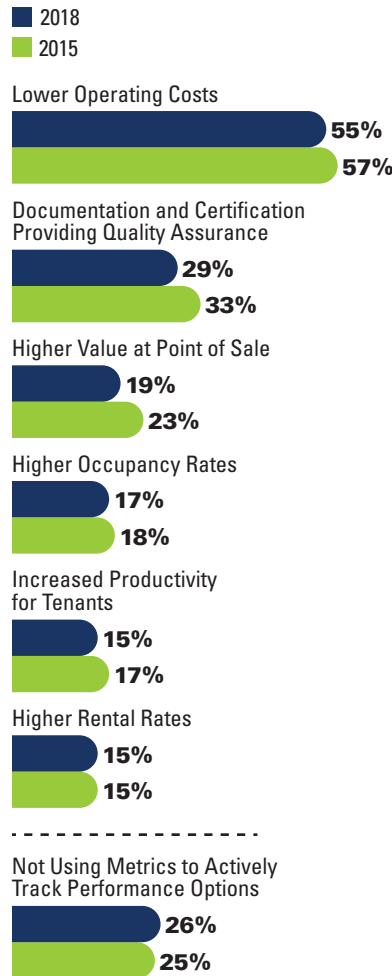
Variation by Country

In six countries—Mainland China, Mexico, Saudi Arabia, Singapore, UAE and Vietnam—nearly all respondents use metrics to quantify the benefits of green building. In many countries and regions where green building is well established, such as Australia, Europe and the US, metrics are far less commonly used. This may be due to the fact that the business case for green is already well known in these countries, while it still needs to be proven in emerging markets. The emphasis on technology in Asia may also account for wider use of metrics in that region.

The greatest variation among countries is in the use of metrics for improved occupant health and well-being. 60% of Chinese respondents report using these metrics, and they are used by nearly half of respondents in India, Hong Kong, Saudi Arabia and Vietnam. However, they are used by less than 20% of respondents in Canada, Norway, Poland and the US.

Metrics Used to Quantify the Benefits of Green Buildings

Dodge Data & Analytics, 2018



Use of Metrics to Quantify the Benefits of Green Buildings

(By Country)

| Very High Use (90% of Respondents or More) | High Use (80% to 89% of Respondents) | Moderate Use (70% to 79% of Respondents) | Low Use (69% or Fewer Respondents) |
|---|---|--|--|
| China (Mainland) Mexico Saudi Arabia Singapore UAE Vietnam | India China (Hong Kong) | Brazil Canada Colombia South Africa | Australia Germany Ireland Norway Poland Spain UK US |

Impact of Green Buildings on Reducing Operating Costs

As the green building movement has matured, the business benefits of operating cost savings, payback on investments and improved asset value have been important in driving green building activity. Since 2012, respondents to these surveys have been asked to quantify the benefits they have seen from their green projects. Owner responses have been particularly important since these benefits occur during building operations.

Lower Operating Costs in Green Buildings Compared With Traditional Buildings

Respondents were asked the percentage of expected operating cost decreases for new green buildings compared with those built with traditional methods, and they were asked to identify those percentages within two time frames: over the next 12 months and over the next five years.

The most striking finding is the consistency with which respondents have reported these cost savings since 2012. The stability of these findings, despite the number of additional countries included in the current study and the length of time between studies, suggests that owners understand and regularly find a certain level of operating cost savings on their green projects, and share these findings with their project teams.

In 2018, the median 12-month cost savings are 8% and the five-year savings are 14%, with the five-year savings holding steady and a small decline from 9% in 2015 for the 12-month period. There is no variability among owners, architects, engineers or contractors in the median savings.

VARIATION BY COUNTRY

While there is little variation by player, there is a wide range of variation by country. Countries reporting the greatest median savings for the 12-month period include Canada, Ireland and Spain, all with medians of 12%, and Mexico with a median of 11%. The lowest is Poland, at 3%, and Norway, China (Mainland and Hong Kong), Saudi Arabia and Germany, all at 5%.

VARIATION BY LEVEL OF GREEN INVOLVEMENT

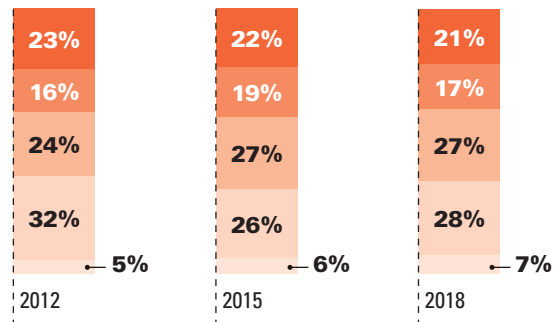
Respondents with high green involvement (doing more than 60% of their projects green) report higher median 12-month cost savings (13%) than those doing fewer green projects (8%). For five-year savings, it is

Expected Operating Cost Decreases for New Green Buildings Over 12 Months and Five Years

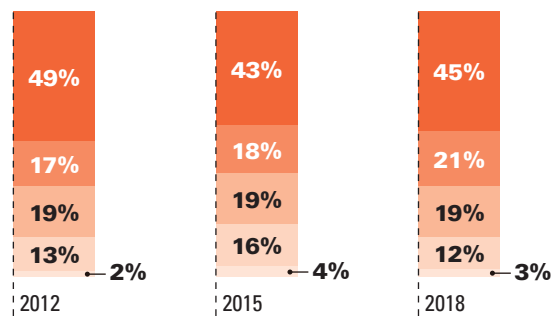
Dodge Data & Analytics, 2018

More Than 15% 11%–15% 6%–10% 5% or Less None

Within the First 12 Months of Operation



Within Five Years of Operation



more meaningful to compare the percentage getting a high level of savings (10% or more) because the relatively large percentage who select 15% savings or more skews the median figure. 78% of those with high green involvement expect 10% or greater operating cost savings in the next five years, compared with 60% of those doing 30% or less of their projects green.

These findings correspond to those of previous Dodge studies on green building and continue to support the inference that more experience with green building leads to better building performance.

In 2012, 2015 and 2018, respondents were asked whether they thought that new green buildings cost more than traditional buildings. **About three quarters of respondents in 2018 (74%) reported that they cost more,** roughly consistent with the findings from 2015 (73%) and 2012 (78%).

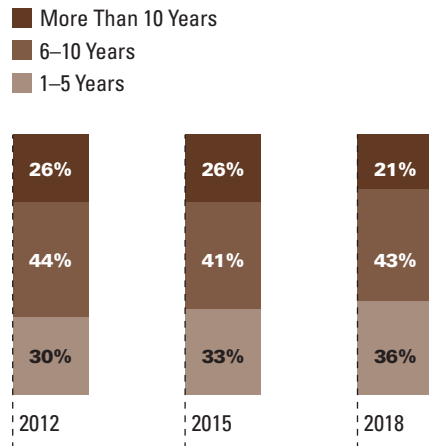
However, higher first costs are not major barriers to building green in many instances if green buildings can be demonstrated to save more than the incremental extra amount that they cost. In addition to the amount of savings, the time frame in which those savings can be achieved also frequently impacts owners' decisions about whether they should invest more to make their buildings green. Therefore, the respondents who reported that their buildings cost more were asked to estimate the average payback period for their new green building investments. The same questions were asked in the 2012 and 2015 studies as well.

The highest percentage of respondents (43%) find that payback periods for new green buildings are between six and 10 years. A relatively high percentage (36%) find that the payback period is between one and 5 years, and that percentage has kept growing steadily since 2012.

Shorter payback periods make it much easier to create a business case for green investments, regardless of sector. However, a short payback period is important for commercial real estate in particular, so the shift toward shorter payback periods evident across the three years may lead to wider investment in green building in the commercial sector.

Payback Period for Additional Cost of a New Green Building (According to Respondents Who Find That Green Buildings Cost More Than Traditional Buildings)

Dodge Data & Analytics, 2018



Asset Value Increase for New Green Buildings

Owners

As the impacts of green buildings on operating costs and the health of their occupants become more widely known and accepted, their value as an asset increases as well. Owners were asked about the increase in asset value they have experienced based on their green building investments, as they were in the two previous studies, and the results are shown in the chart at right.

The percentage of owners reporting that new green buildings have an asset value more than 10% greater than that of traditional buildings has nearly doubled since 2012. Around one third (30%) of owners report that much of an impact on asset value today, compared with 16% who did six years ago. This is also the first year in which that strongest impact level is greater than any of the four lower tiers.

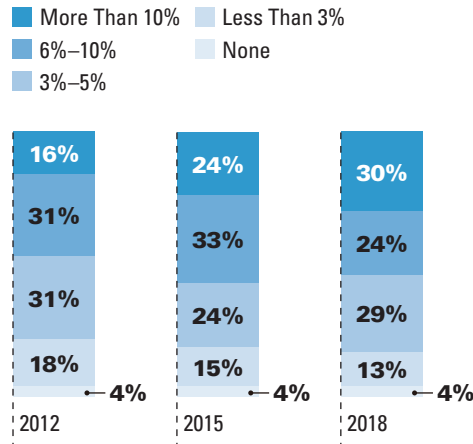
This dynamic demonstrates that while operating payback period is important, owners are likely to also benefit from the investments they make in green buildings at their point of sale, making the prospect of these investments more appealing in markets with short building ownership cycles.

Architects and Contractors

Most architects and contractors recognize that building green creates a higher asset value, and 27% of them believe that it adds more than 10% to the value, a similar percentage to the 30% of owners who find this to be true. The close correspondence between owners and their project teams on the value added by green is important, especially since motivated project teams can help influence more of their clients to invest in green if they fully understand and can communicate the financial benefits their clients can receive by doing so.

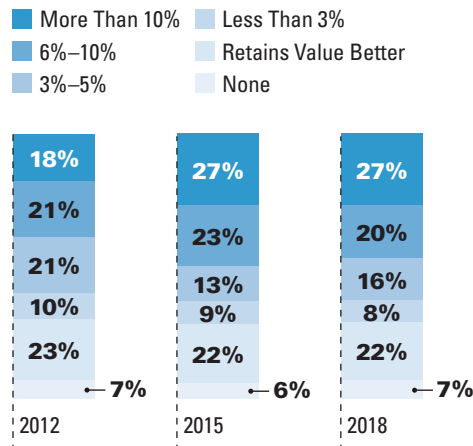
Expected Increase in Asset Value for a New Green Building (According to Owners and by Year)

Dodge Data & Analytics, 2018



Expected Increase in Asset Value for a New Green Building (According to Architects and Contractors, and by Year)

Dodge Data & Analytics, 2018



Impact of Green Retrofit and Renovation Projects on Operating Costs

Improving the performance of existing buildings is as critical, if not more so, to achieve the goals of green building as construction of new green buildings. Therefore, data on the business benefits generated by green retrofits or renovations is essential to encourage building owners to make those investments.

Nearly half (44%) of the study respondents have conducted green retrofit or renovation projects. Those respondents were asked about the degree of impact those retrofits/renovations are expected to have on 12-month and five-year building operations costs, as they were in the previous studies in 2012 and 2015.

The findings demonstrate a high level of consistency in the responses over the last six years. Currently, nearly half (43%) believe that they will see savings of more than 10% in the next year and almost two thirds (61%) expect to see that level of savings in the next five years.

Variation by Type of Company

While somewhat similar in their estimation of savings for green renovations/retrofits over a 12-month period, architects are more optimistic than owners about savings over five years of operations. 64% of architects expect savings of more than 10%, while only 54% of owners do.

Variation by Level of Green Involvement

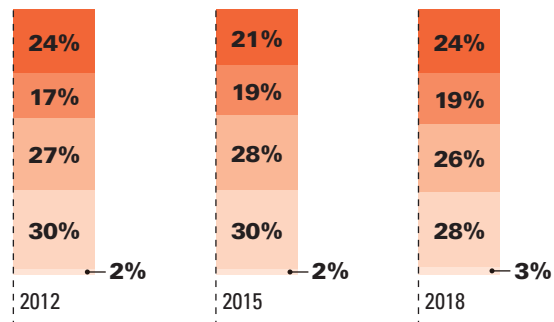
A higher percentage of those doing the majority of their projects green (more than 60% green projects) expect over 10% savings on operational costs than those doing fewer green projects (30% or less). This is true for the first 12 months of operation (51% versus 39%) and over the first five years (69% versus 57%).

Expected Operating Cost Decreases From Green Retrofits or Renovations (By Year)

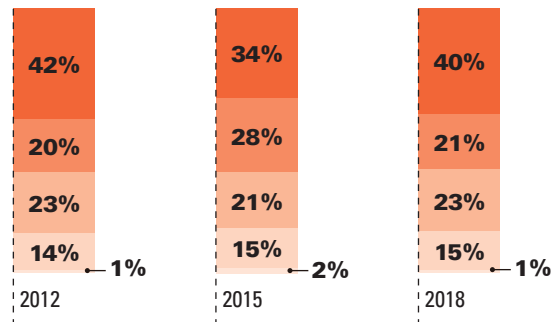
Dodge Data & Analytics, 2018

More Than 15% 11%–15% 6%–10% 5% or Less None

Within the First 12 Months of Operation



Within Five Years of Operation



Payback Period for Green Retrofit and Renovation Projects

Since 2012, study respondents have been asked to estimate the average payback period for their green retrofit/renovation projects. **The responses in 2012, 2015 and 2018 are all notably similar**, despite the changes in response rates, areas covered by the survey and green systems, technologies and products now available. This suggests that expected payback period is a critical factor in determining whether to undertake a green retrofit/renovation, or the degree to which investments are made to improve building performance.

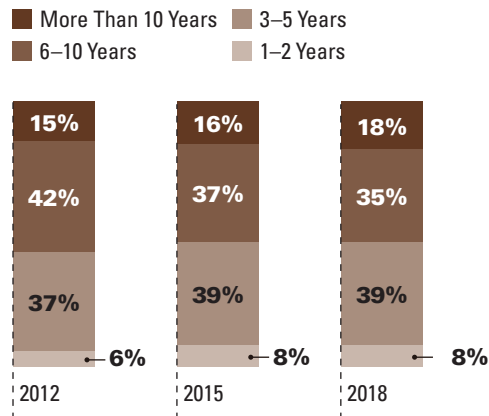
There are no significant differences between owners, architects, engineers and contractors on the payback periods for these projects. However, there is some variation by country.

- **The countries with the lowest median payback periods are the UAE and Saudi Arabia, at four years.** Brazil, Colombia, India, Singapore and South Africa also have short five-year payback periods.
- **The countries with the highest median payback periods are the UK (12 years) and Ireland (11 years).**

Respondents who do the majority (more than 60%) of their projects green also have a median of four years payback period for green renovations/retrofits, compared with a median of eight years reported by all doing fewer green projects.

Expected Average Payback Period for Green Retrofits/Renovations (By Year)

Dodge Data & Analytics, 2018



Impact of Green Retrofit and Renovation Projects on Building Asset Value

Owners, architects and contractors were asked about the impact of green retrofit and renovation projects on building asset value. The same question was asked in the 2012 and 2015 studies as well. The findings clearly demonstrate the widespread belief that green retrofits/renovations improve asset value, but there is some disagreement on the degree to which they do so.

Owners

Nearly all owners (94%) believe that their buildings are more valuable after conducting green retrofit/renovation projects, but most (53%) believe that asset value tends to increase moderately (by 5% or less).

Surprisingly, these findings in 2017 closely correspond to those in 2012, instead of reflecting the more optimistic expectations in 2015. There could be many causes for this change, including changing economic conditions favoring new construction over renovations, reducing the scale of green retrofit/renovations and thus their impact.

Architects and Contractors

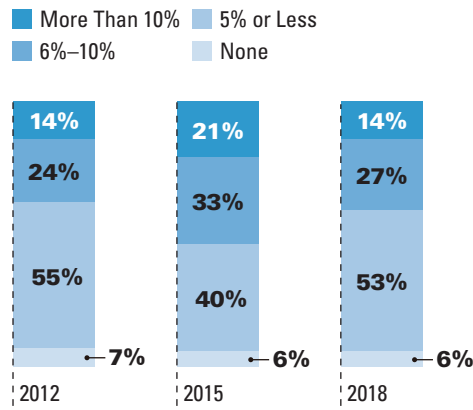
For new buildings, architects, contractors and owners are equally optimistic about the impact of green building on asset value. **For renovations, architects and contractors are more optimistic than owners. In 2018, the highest percentage (34%) believe that asset values are increased by more than 10% due to green retrofits and renovations.**

Interestingly, for architects and contractors, the findings in 2018 more closely mirror those in 2012 than those in 2015 as well. However, unlike with the owners, the findings in 2015 are less optimistic for architects and contractors about the impacts of green renovations/retrofits than those in 2012 or 2018.

One factor that could influence the higher estimates by architects/contractors are the types of projects they may be involved with. Owners may do a range of green retrofits/renovation projects, some of which may be small enough in scale to be handled by their operations team rather than designers or contractors. On the other hand, architects and contractors are more likely to be involved in more extensive green retrofit/renovation projects, which would have a bigger impact on building asset value.

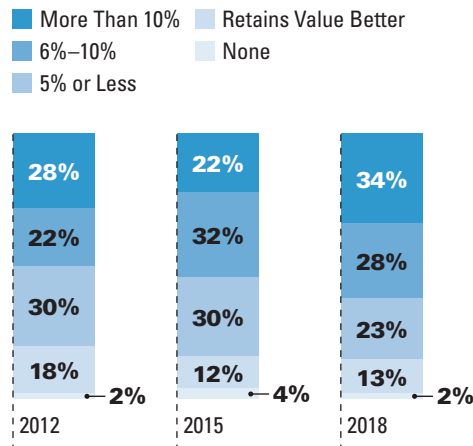
Expected Increase in Asset Value From a Green Retrofit or Renovation Project (According to Owners)

Dodge Data & Analytics, 2018



Expected Increase in Asset Value From a Green Retrofit or Renovation Project (According to Architects and Contractors)

Dodge Data & Analytics, 2018



Data: Green Building Products and Services

Use of Green Building Products and Services

Respondents in the current study were asked whether they specify or install eight categories of green products and services, and then asked whether they intend to specify or install products or services in those categories in the next five years. Respondents in the 2015 study were asked the same question. The chart at right shows the level of use in 2015, the current 2018 level of use and the anticipated use of these products in 2022.

Use of these green product/service categories has remained notably consistent between 2015 and 2018.

While there are a few percentage point changes, none rise to the level of statistical significance. Also, in 2015 and 2018, seven of the eight categories fall into the 40 to 50 percentile range for use, suggesting widespread but not ubiquitous use for any of these product categories.

A higher percentage of respondents in the current study believes that they will specify or install products in these categories in the next five years, with most now falling in the 50 to 60 percentile range. However, the 2015 estimations of product use were also quite similar, with highest levels of future use expected for electrical products, thermal and moisture protection products, and building automation systems, similar to the current finding. This demonstrates ongoing interest and commitment to these product/system categories.

It is notable, though, that in both studies, they were simply asked to indicate if they ever installed or specified products in these categories, not the frequency with which they do so. So while the percentage using each category may remain consistent, it is possible for use within each category to have changed.

Variation by Type of Firm

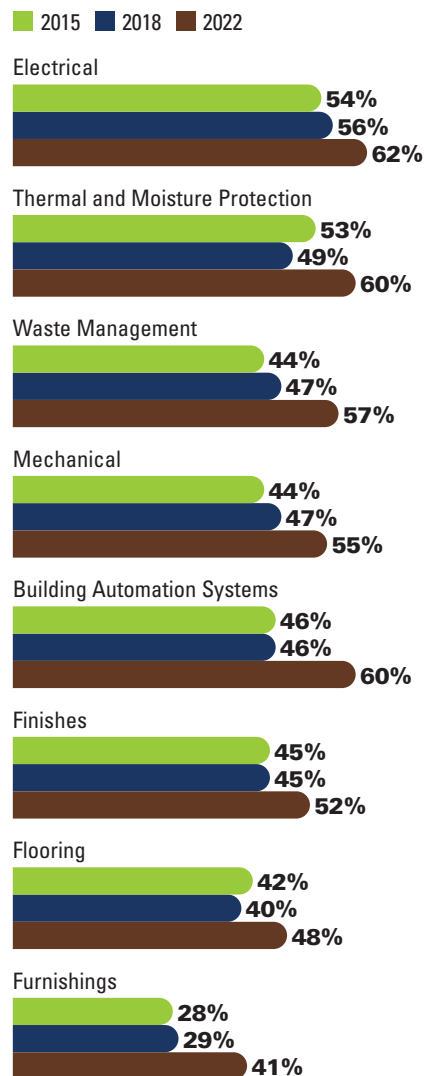
- **Architects:** Products more frequently used by architects than by engineers, contractors or owners include thermal and moisture protection, finishes, flooring and furnishings.
- **Owners:** Products/services more frequently specified or installed by owners than by the other major players fall into the categories of electrical and waste management. Owners and engineers also specify/install building automation systems more frequently than architects or contractors.

Variation by Location

The table on page 42 shows the countries with the highest level of specification/installation of products in each category.

Past, Current and Expected Future Use of Green Building Products/Services (Use Reported in 2015 and 2018 and Expected in 2022)

Dodge Data & Analytics, 2018



Countries With the Highest Percentage Reporting Use of Green Building Products/Services

| | 60% or More | 50% to 59% |
|--|---|--|
| Electrical | Australia, Norway, South Africa, UAE, Vietnam | Brazil, Canada, China (HK), Colombia, India, Ireland, Mexico, Saudi Arabia, South Africa, UK, US |
| Thermal & Moisture Protection | Spain, UAE, UK | Australia, Canada, China (HK), Ireland, Mexico, Poland, South Africa, US |
| Waste Management | India, Norway, Vietnam | Australia, Brazil, South Africa, UAE, UK |
| Mechanical | Canada, Ireland, UAE, US | Australia, UK, Vietnam |
| Building Systems Automation | Norway, UAE | Australia, China (Mainland), Poland, Singapore, Spain, Vietnam |
| Finishes | Spain | Australia, Canada, Colombia, UAE, US |
| Flooring | None | Australia, US |
| Furnishings | None | China (Mainland) |

Criteria for Identifying Green Products

Respondents were asked to identify the criteria they use to evaluate if a product is green. The chart on page 43 demonstrates that most respondents use multiple criteria.

■ **Highly Energy Efficient: This is by far the top category globally, the only one selected by almost three quarters (72%) of respondents.** Energy efficiency has consistently been the top criterion since the study was first conducted in 2008.

- **Owners** (77%) and **engineers** (78%) more frequently select this criterion than architects (70%) or contractors (69%).
- Nearly all the respondents in the **UAE** (91%) report that they use this criterion, and respondents from **Ireland** (85%) also use it more frequently than those from other countries.

■ **Made of Recycled Content: Over half (53%) consider this criterion when evaluating products, a finding consistent with the 2015 study.**

- Nearly two thirds of **architects** (61%) use this criterion, significantly more than owners or engineers.
- Over 60% of respondents from mainland **China, Spain** and **India** also use it.

■ **Nontoxic: Given the importance of healthier buildings in many of the findings in this study, it is not surprising that nearly half consider this when selecting green products.**

- 58% of **architects** use this criterion, far more than do owner or engineer respondents.
- This is a particularly important criterion in **Poland** and **Germany**, selected by 63% in both countries.

■ **Lifecycle Data: About half (46%) also consider lifecycle data important overall.**

- **Architects** (52%) most frequently consider this criterion.
- Nearly two thirds (62%) of respondents from **Norway** consider it as well.

■ **Durability: The importance of durability has declined notably from 2012, when 72% of global respondents regarded as a top criterion.**

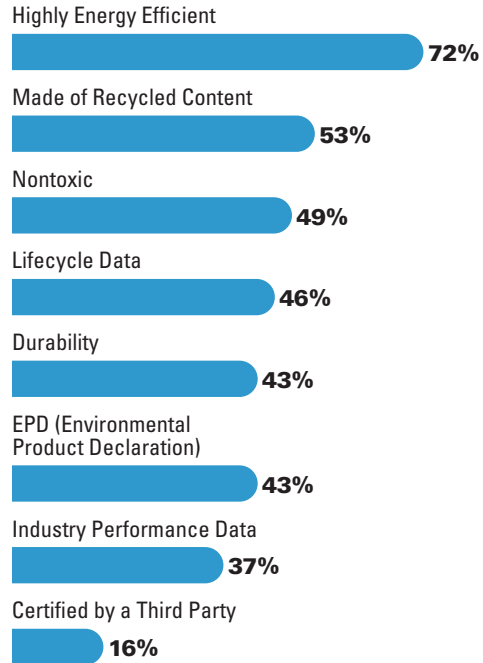
- The biggest market for this among the 20 countries included in the study is **Saudi Arabia**, where it was selected by 68% of respondents.

■ **EPDs: EPDs (Environmental Product Declarations) were first included in the study in 2015, when they were selected by 37%. The increase to 43% in 2018 is the largest of any of the criteria measured.**

- Nearly half of **architects** (48%) use this criterion, significantly more than contractors (37%) or owners (38%).
- A high percentage of respondents from **Spain** (79%), **Norway** (66%) and **Hong Kong** (56%) also select it.
- **Industry Performance Data: 37% also selected this in 2015, and the same percentage select it in the current study, demonstrating its ongoing importance in some markets.**
 - The top markets for relying in industry performance data are Hong Kong (63%) and the UK (53%).
- **Certification by a third party was selected by about one third of respondents in 2008 and 2012, but its influence has dwindled in 2015 (11%) and 2018 (16%).**
 - Even in the countries where it has the greatest influence, including Australia (28%) and the UAE (26%), the percentage who consider it is smaller than in 2008 and 2012.

Criteria Used to Evaluate If a Product Is Green (According to Global Respondents)

Dodge Data & Analytics, 2018



Sources of Information on Green Building

Respondents were asked to select the sources of information about green projects that they rely on the most. While the question specified that they should only select the most reliable sources of information, they were allowed to select as many from the list as they truly feel are reliable. The top nine most frequently selected are represented in the chart at right, which also shows the responses to the same question in 2015 and 2012.

Variation Over Time

In general, the relative ranking of each of these nine items remained comparable to the previous studies.

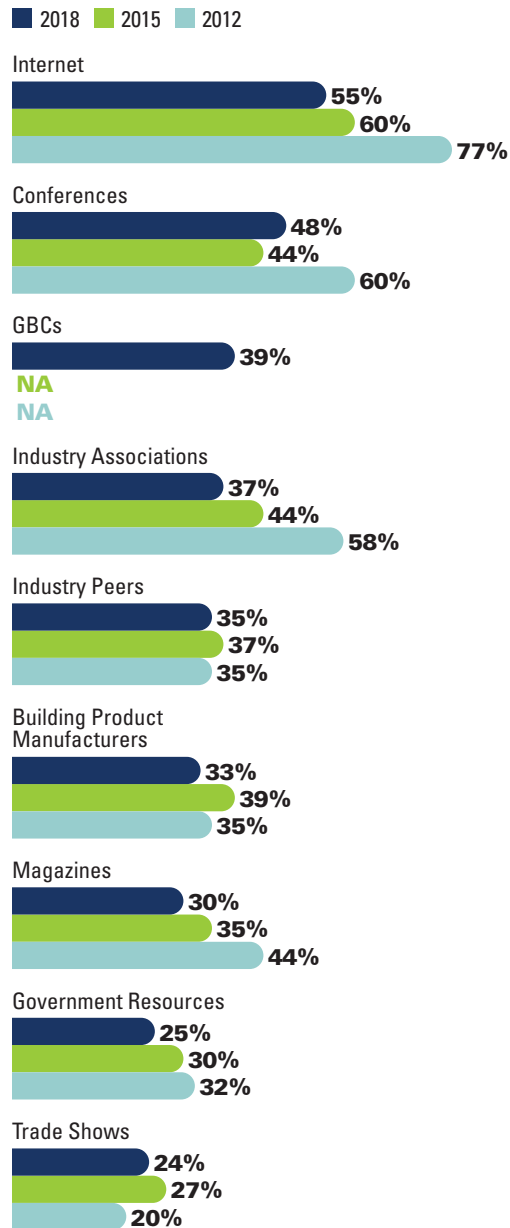
- The internet remains the most relied-upon source of information across all three years.
- While conferences have consistently ranked strongly, the gap between the internet and conferences narrowed considerably between 2015 and 2018.
- Peers and building product manufacturers remain in a virtual dead heat, as they have done in the previous studies.
- Magazines is one of the few options that declined notably in ranking from 2012, going from the fourth most relied-upon source of information in 2012 to the seventh currently.

Interestingly, the percentage selecting several options, including the internet, conferences, industry associations and magazines, has declined notably since 2012. It is likely that most respondents have more experience with green building now than they did in 2012, and that they have now determined the means they rely upon for finding information on green products, rather than seeking out information from multiple sources. Widespread availability of green products and more experience with using them have likely reduced the number of means respondents rely on to find out information about these products.

This year, the option of Green Building Councils (GBCs) as a source of information was added to the list. It is possible that the decline in industry associations may be due to people now selecting GBCs who may have selected the broader category in the past.

Most Relied-Upon Sources of Information About Green Projects (Reported in 2018, 2015 and 2012)

Dodge Data & Analytics, 2018



Variation by Firm Type

There is little variation across firm type for the number of people who rely on various sources of information. Two notable exceptions are magazines, which architects rely on more than engineers, contractors or owners, and conferences, which contractors rely on significantly less than architects, engineers or owners.

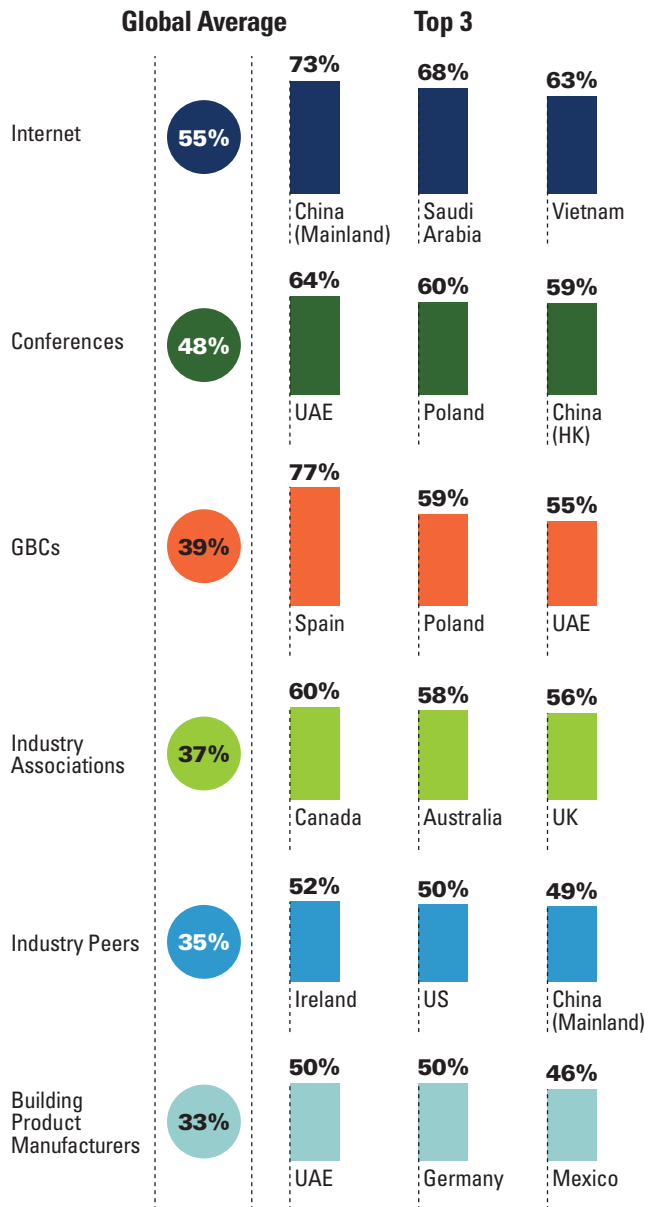
Variation by Country

On the other hand, there is significant variation by country for most sources of information. For those seeking to market products, choosing a strategy based on location will be more effective than a one-size-fits-all approach.

- The internet is selected by almost three quarters of respondents in Mainland China (73%), but by only 36% in Hong Kong or Germany.
- Nearly two thirds in the UAE (64%) rely on conferences for green product information, but only 8% in Germany do.
- Over three quarters in Spain (77%) select GBCs, but less than 20% in Brazil (16%), Germany (14%) and UK (7%) do.
- Over half of respondents from Canada (60%), Australia (58%) and the UK (56%) rely on industry associations, but less than 20% do in Spain (19%), Colombia (19%), Saudi Arabia (18%) or Poland (12%).
- Peers are influential in Ireland (52%), the US (50%) and Mainland China (49%), but are not relied upon in Germany (19%), Saudi Arabia (18%) or Vietnam (11%).
- Half of respondents in Germany (50%) and the UAE (50%) rely on building product manufacturers for green product information, but few do in Poland (19%), Vietnam (19%) or Mainland China (16%).

Most Relied-Upon Sources of Information About Green Projects (By Countries With Highest Percentage That Rely Upon Each)

Dodge Data & Analytics, 2018



Green Building Activity and Trends in Australia

Australia currently has one of the most active green building markets in the study, and the level of activity is expected to grow in three years. However, concerns about cost continue to nag this market.

Green Building Market Activity

Australia has a relatively mature green building market currently. Nearly all (94%) of survey respondents do at least some green building projects, and the majority (67%) report at least a moderate level of green activity, with a 30% share or more of their work being green. In fact, nearly half (46%) report that they are doing the majority of their projects (60% or more) green now, the highest of any country included in the survey. This finding may be influenced, however, by the fact that 63% of survey respondents work at companies that are green building council (GBC) members, well above the average for the study.

Respondents are also very enthusiastic about doing even more green projects in the future, with nearly two thirds (64%) who expect by 2021 that they will be doing the majority of their projects green, an 18 percentage point jump from 2018.

Overall, the findings suggest that Australia has a mature, robust and growing market for green buildings.

SECTORS WITH EXPECTED GROWTH

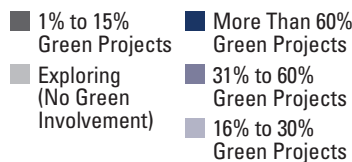
Australian responses to the sectors in which they intend to build green projects in the next few years are consistent with the overall global findings, with all categories within a few percentage points of the global averages.

- **The top sector is new commercial buildings, with 54% of respondents.** The percentage of Australians who expect to do green commercial work far exceeds those for any other sector included in the study, and it is double the percentage (27%) who expected to do green commercial projects in 2015.
 - When asked about their overall work, a higher percentage of respondents in 2018 report doing commercial office projects in general in the current study (75%) than in the 2015 one (50%), but this may not entirely account for the increase between 2015 and 2018 of those intending to do green projects in this sector.

- **Over one third expect to do green institutional projects (39%) and existing building renovations (37%).** Both percentages are higher than those reported in 2015 (30% and 33%, respectively).
- **A lower percentage of respondents in 2018 (25%) report that they will do green low-rise residential projects than in 2015 (39%).** This is despite the fact that the same percentage of respondents in 2015 and 2018 report having done low-rise residential projects in the last three years (57%).
- **One third (33%) of Australian respondents expect to do green high-rise residential projects.** A much higher percentage of the 2018 respondents from Australia (63%) work in this sector than in 2015 (20%), so it is not surprising that this percentage is much higher than the one from 2015 (24%).

Levels of Green Building Activity for Respondents in Australia (2018 and 2021 Expected)

Dodge Data & Analytics, 2018



Influence Factors for Future Green Building Activity

TRIGGERS

The market has a stronger influence in Australia than other factors, with the top two triggers for future green building being **client and market demands**. Australia is also notably higher than the global average for each of these factors, demonstrating the sway they have on encouraging the green building market in this country.

Australia is slightly lower than the global average for the influence

of **environmental regulations**, not surprising in a country where market factors are so important. However, it still ranks third in the overall triggers in Australia, demonstrating that regulatory influence still plays a role in helping to drive the market.

The other top triggers, selected by about one quarter, are **doing the right thing** and **healthier buildings**. Both of these are on par with global averages.

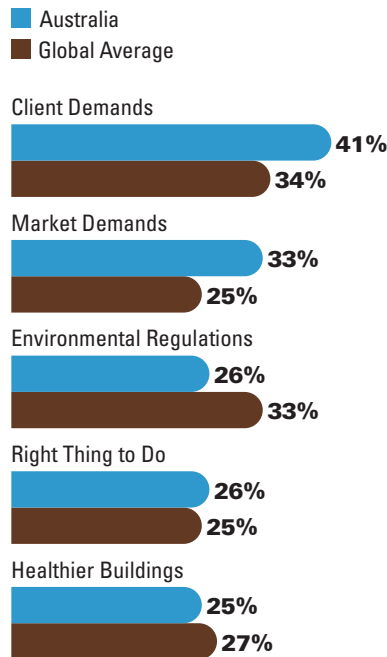
CHALLENGES

Cost concerns continue to be the biggest challenges for building green in Australia.

- **The top challenge, ranked in the top three by 57% of Australian respondents, is higher perceived first costs.** Australia is above the global average in the percentage who rank this a top concern. The persistence of this issue in a country with a mature green market is surprising.
- **Affordability (perception that green is for higher-end projects only) is another top challenge, according to 42% of Australian respondents.** Australia is also the country with the highest level of concern over this issue, as it was in 2015, suggesting that this has been a persistent obstacle to green building for Australians.
- **Other challenges ranked in the top three by one quarter or more Australian respondents are lack of market demand (28%), lack of political support/incentives (28%) and the inability to prove the business case because of the split between capital and operating costs.** All of these align with the overriding concern about the premium cost of building green and the challenge to pay for it.

Top Triggers Driving Future Green Building Activity in Australia

Dodge Data & Analytics, 2018



Social and Environmental Reasons for Building Green

SOCIAL REASONS

Improving occupant health and well-being (75%), sustainable business practices (70%), increasing worker productivity (59%) and creating a sense of community (58%) are all considered important social reasons for building green by over half of Australian respondents.

When asked to select their top reasons, though, the majority select **improving occupant health and well-being (79%), and sustainable business practices (59%).**

ENVIRONMENTAL REASONS

Lowering green house gas emissions is rated as important by the highest percentage of Australian respondents (75%) among all the environmental reasons for building green. However, when those rating multiple items as important were asked to select their top two, the highest percentage select **reducing energy consumption (57%),** with greenhouse gas reductions a distant second (48%).

Business Benefits

An average of 9% operating cost reductions in the first 12 months for a new green building and 11% for a green retrofit are expected from Australian respondents. The figure for the five-year cost reductions for new green buildings is skewed by the high percentage reporting that they expect more than 15% in that time range. It is notable, though, that the average payback period is lower than in the last study, which may ultimately impact the perception of higher costs.

Expected Business Benefits of Green Building in Australia

| | New Green Building | | Green Retrofit | |
|--|--------------------|------|----------------|------|
| | 2015 | 2018 | 2015 | 2018 |
| Decreased Operating Costs Over One Year | 11% | 9% | 7% | 11% |
| Decreased Operating Costs Over Five Years | 13% | 27% | 13% | 15% |
| Payback Time for Green Investments (Years) | 8 | 7 | 9 | 6 |

Green Building Activity and Trends in China

China contains at least two distinctly different markets: Mainland China, an emerging market with the potential for explosive green growth and Hong Kong, a mature green market that is largely driven by client demand.

Respondents from China are divided into two groups for this analysis: those from Mainland China and those from Hong Kong. This is done to give a more specific portrait of these two very different markets. Also, the makeup of respondents in each of these groups is also different. Almost half (46%) of respondents from Hong Kong report that their company is a member of a green building council (GBC), while only 14% of respondents of Mainland China report that their companies are members. The low participation of members of green building councils may be reflected in the low share of green activity shown in the data from Mainland China.

Green Building Market Activity

The current levels of green activity in Hong Kong are much higher than those reported in Mainland China, with 53% of those in Hong Kong currently doing more than 30% of their projects green, compared with 35% in Mainland China.

Expectations about the level of green work by 2021 on Mainland China suggest the possibility of strong growth, with the percentage expecting to do more than 30% of their projects green almost doubling to 67%. However, the highest percentage fall in the moderate level of green building category between 31% and 60%.

In Hong Kong, the shift is less dramatic, in part due to the high level of green building already happening in this market. Those expecting to

do more than 60% of their projects green by 2021 grows by 5 percentage points over the current figure, with a corresponding shift down among those doing fewer than 15% of their projects green. **This steadier, moderate level of growth suggests that the Hong Kong green market is in a relatively mature state, while the explosive growth anticipated on the Mainland points to an emerging green market.**

SECTORS WITH EXPECTED GROWTH

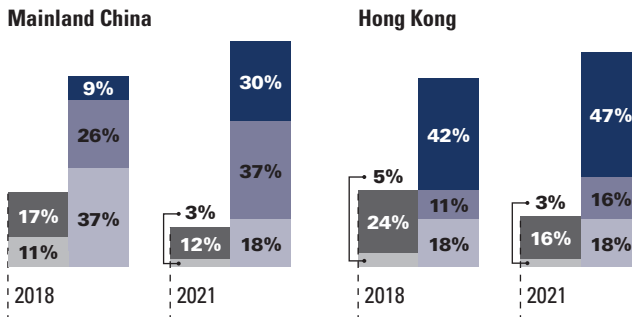
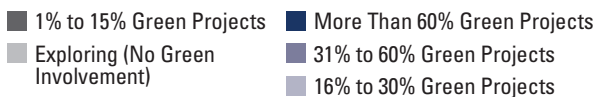
Respondents from Mainland China expect to be engaged in green in multiple sectors, with relatively high percentages reported for several sectors, compared both to the global averages and to the percentages from Hong Kong. The percentages of Mainland China respondents

are significantly higher than those in Hong Kong for two sectors (new institutional construction and commercial interiors) and directionally higher for three (new commercial construction, new low-rise residential construction and communities). Since the previous finding shows a higher level of green activity in Hong Kong than in Mainland China, this may suggest more specialization by sector-type for green projects among Hong Kong respondents than among those from the Mainland.

- Mainland China:** The sectors reported by the highest percentage in Mainland China are **new commercial construction (65%), new institutional construction (54%), new high-rise residential (49%) and commercial interiors (43%).**

Levels of Green Building Activity for Respondents in China (2018 and 2021 Expected)

Dodge Data & Analytics, 2018



■ **Hong Kong: New commercial construction** also tops the sectors for Hong Kong at 59%, but close behind is new **high-rise residential** at 52%. The percentage expecting to do green high-rise residential work in Hong Kong is not only higher than that on Mainland China but is the second highest among the countries included in the study, with only Vietnam (61%) with a higher percentage expecting to work in this sector.

Influence Factors for Future Green Building Activity

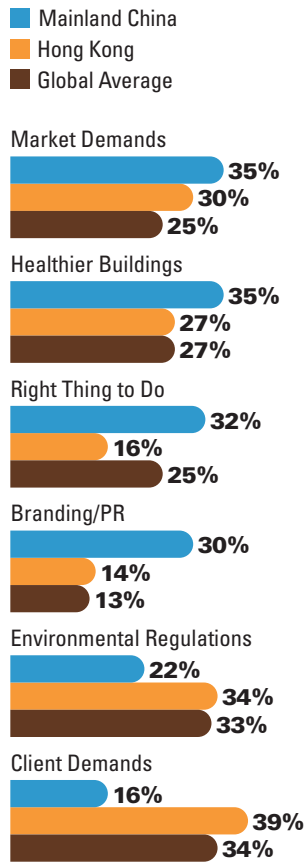
TRIGGERS

The most important triggers for new green building activity vary widely between Mainland China and Hong Kong.

- **Mainland China: The top triggers are market demands and healthier buildings. Doing the right thing and branding/PR** are also important drivers for this market.
 - Mainland China has the highest percentage of respondents who consider **branding/PR** a top trigger of all the countries included in the study. This is likely because green building activity is still relatively low, which means that firms can still distinguish themselves through the efforts to build green, unlike in more mature green markets like Hong Kong.
 - **Doing the right thing** also is more important on the Mainland than in Hong Kong. Again, this is often a bigger driver in emerging green markets than in more established ones.

Top Triggers Driving Future Green Building Activity in China

Dodge Data & Analytics, 2018



■ **Hong Kong: The top two triggers in Hong Kong are client demands and environmental regulations.** Both factors that are not highly rated in Mainland China. In general, the top triggers in Hong Kong more closely mirror global averages than in Mainland China, with the exception of **doing the right thing**, which has less sway in Hong Kong than in most of the countries included in the study.

CHALLENGES

While the triggers for green projects differ, the top three challenges to more green building are the same for the Mainland China and Hong Kong respondents.

- **Higher First Costs: This challenge is selected by 49% of Mainland respondents and 43% of those from Hong Kong.**
- **Affordability (perception that green is for higher-end projects only): 38% of Mainland respondents and 32% from Hong Kong select this challenge.**
- **Lack of Political Support/ Incentives: 30% of Mainland respondents and 39% of Hong Kong respondents select this one.**

Social and Environmental Reasons for Building Green

SOCIAL REASONS

When asked to rate the importance of the six social reasons for building green included in the study, about three quarters of respondents from Mainland China rate five of the reasons as important: **creates a sense of community (78%), supports the domestic economy (78%), improved occupant health and well-being (76%), promotes**

sustainable business practices (73%) and **is aesthetically pleasing** (70%). Respondents from Hong Kong are more tempered in their responses. The highest percentage from Hong Kong are the 68% who rate **improved occupant health and well-being** as an important reason, followed by 61% for **sustainable business practices**.

However, when those who rated several items as important were asked to select their top two reasons, there is much greater parity in the responses between Mainland China and Hong Kong.

- The top reason for both is also the one with the greatest disparity: 77% of respondents from Hong Kong select **improved occupant health and well-being** among their top two, compared with only 54% of those from Mainland China.
- The second most important social reason for both is **creates a sense of community**, with around half of the respondents from both locations placing it among their top two.
- The third most important social reason for building green, selected by 48% from Mainland China and 41% from Hong Kong, is **promoting sustainable business practices**.

ENVIRONMENTAL REASONS

As with the social reasons, the Mainland respondents tend to rate most of the environmental reasons for building green higher than those from Hong Kong.

- Both have a high percentage who consider **reducing energy consumption** important (89% in Mainland China and 80% in Hong Kong).
- The biggest gap falls in their estimation of the importance of **improving indoor air quality**, which is rated as important by 87% in Mainland China and 64% in Hong Kong.
- The only environmental reason rated as important by a higher percentage in Hong Kong (84%) than in Mainland China (73%) is **lowering greenhouse gas emissions**.

When those who rated several environmental reasons were asked to select their most important, 86% of those in Hong Kong who consider **reducing energy consumption** important selected it as one of the top two factors, compared with 70% of those from Mainland China. A higher percentage of Hong Kong respondents (34%) also consider **lowering greenhouse gas emissions** a top environmental reason than those from Mainland China (19%).

Conversely, 48% of those in Mainland China who consider **protecting natural resources** important selected it as one of their top two reasons, compared to just 20% from Hong Kong. Mainland respondents also more frequently select **improving indoor air quality** (34%) as a top environmental reason for building green than do respondents from Hong Kong (21%).

Business Benefits

Respondents from Mainland China and Hong Kong are conservative about the percentage of operating cost savings they can expect for new green buildings. Both their one year (5%) and their five-year (9%) estimated savings are well below the global averages of 8% and 14%, respectively. However, respondents from Mainland China expect to see payback in five years, notably under the global average of seven years, while the average payback in Hong Kong is nine years.

The same holds true for green retrofits and renovations, which are also notably under the global averages of 9% savings in one year and 13% savings in five years. Payback time reported on Mainland China, though, matches the global average of six years, while payback in Hong Kong is expected to take nine years.

Expected Business Benefits of Green Building in China

| | New Green Building | | Green Retrofit | |
|--|--------------------|-----------|----------------|-----------|
| | Mainland | Hong Kong | Mainland | Hong Kong |
| Decreased Operating Costs Over One Year | 5% | 5% | 7% | 5% |
| Decreased Operating Costs Over Five Years | 9% | 9% | 12% | 6% |
| Payback Time for Green Investments (Years) | 5 | 9 | 6 | 9 |

Green Building Activity and Trends in Europe

The most notable aspect of the findings from Europe is the degree to which individual countries vary, from their levels of activity, to the reasons they build green to the savings they report experiencing from their green investments.

The data from six countries in Europe—Germany, Ireland, Norway, Poland, Spain and UK—are featured in the study, but 59 responses were also received from 17 other countries across Europe.

The level of green building council (GBC) participation also differs across the respondents. 40% of all European respondents work for companies that are GBC members, but well more than half of the respondents from Norway (73%), Spain (65%) and Ireland (61%) work for GBC member companies, which may influence the level of activity and awareness of green in these markets. In contrast, only 39% of respondents from Poland, 13% in the UK and 8% in Germany work for GBC member companies.

Green Building Market Activity

Levels of activity reported by the individual countries vary widely across Europe.

- Ireland has the highest percentage of those currently doing the majority (more than 60%) of their projects green at 40%.
- Spain has the highest percentage of high and moderate levels of green work, with 65% reporting that they do more than 30% of their projects green.
- Poland currently has the lowest level of green activity reported by survey respondents.

All of the European countries expect to see a higher level of green activity by 2021 than they have currently.

- In all but one country (Poland), the growth in green building comes largely in an increase in those who expect to do the majority of their projects green. Norway and Spain have the most dramatic increases in this category.
- Poland is still emerging in green activity. Even by 2021, the highest percentage expect to be doing a relatively low level of green (16% to 30%) of projects.

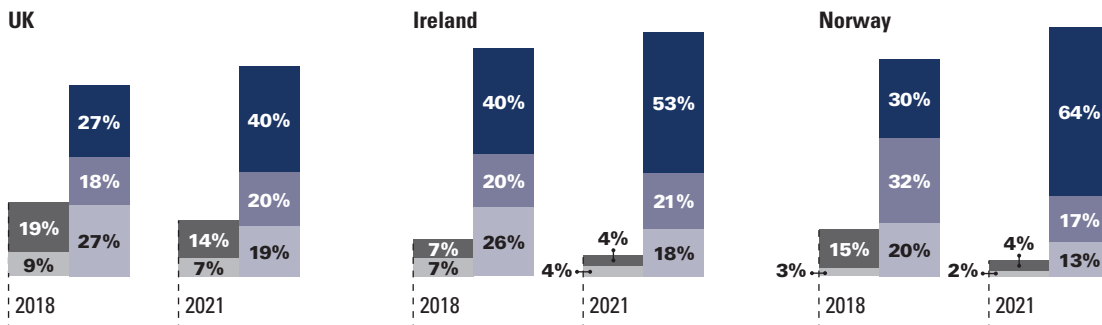
SECTORS WITH EXPECTED GROWTH

The top sectors across Europe for green buildings in the next three years are new commercial construction (48%), existing buildings/retrofits (38%) and low-rise residential (32%). There is some variation among the countries included in the study.

Levels of Green Building Activity for Respondents in the UK, Ireland and Norway (2018 and 2021 Expected)

Dodge Data & Analytics, 2018

- 1% to 15% Green Projects
- Exploring (No Green Involvement)
- More Than 60% Green Projects
- 31% to 60% Green Projects
- 16% to 30% Green Projects



- Nearly two thirds (61%) of Irish respondents anticipate doing green low-rise residential buildings in the next three years.
- Ireland is also higher than the European average for new commercial construction and existing buildings/retrofits (both at 55%).
- Germany is lower than the European average for new commercial construction (31%) and higher for low-rise residential (42%).
- Almost three quarters (73%) of Norwegian respondents plan to do new green commercial construction projects.
- With 45% who will be doing institutional projects, Norway also exceeds the other five countries included in the study and the overall European average (31%) for this sector.
- Commercial construction is a focus for the Polish respondents, with 48% reporting that they expect to do a new green commercial project

- and 49% new commercial interiors in the next three years.
- Over half of the Spanish respondents expect to do new green commercial projects (61%) and green existing building/retrofit projects (52%) in the next three years.
- Low-rise residential projects top the list among the UK respondents, with 42% reporting they will be doing green projects in this sector.

- Client demands are widely influential in Europe, with the greatest influence in Ireland, the UK, Germany and Norway. Even the countries least influenced are close to the global average for this trigger.
- Environmental regulations are influential triggers in the UK, Ireland and Germany as well. The other three European countries in the study fall well below the global average for this trigger.
- Market transformation is one of the most influential triggers in Poland. A higher percentage in Spain than the global average also favor this trigger.
- Spain and Norway both exceed global averages for the percentage selecting higher building value.
- Spain is influenced more than most by internal corporate commitments.
- Almost one third of Norwegian respondents (32%) consider improved 10-year costs an influential trigger.

Influence Factors for Future Green Building Activity

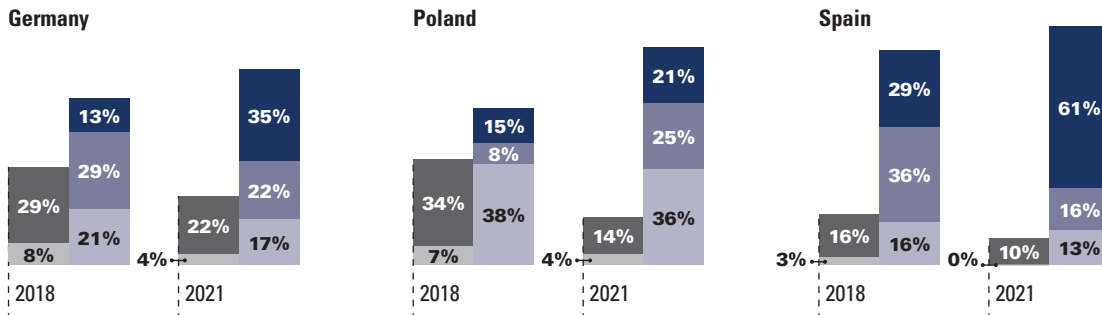
TRIGGERS

The importance of specific green triggers vary by country in Europe. Some of the most dramatic variations include the response to client demands, environmental regulations, market transformation, higher building values, internal corporate culture and improved 10-year costs.

Levels of Green Building Activity for Respondents in Germany, Poland and Spain (2018 and 2021 Expected)

Dodge Data & Analytics, 2018

- 1% to 15% Green Projects
- Exploring (No Green Involvement)
- More Than 60% Green Projects
- 31% to 60% Green Projects
- 16% to 30% Green Projects



CHALLENGES

The top challenges for all European respondents are higher (perceived or actual) first costs (48%), lack of market demand (33%) and lack of political support/incentives (32%). As with the triggers, though, there is wide variation by country.

- The second most important challenge in Ireland, selected by almost half of Irish respondents (41%), is the lack of trained/educated green building professionals. This is much higher than the European (17%) or global (22%) average.
- One third of German respondents select lack of market demand and affordability (green is for high-end projects only) as top challenges, the most for any of the challenges included in the study.

- Cost is a big concern in Norway, with the perception of higher first cost selected by more than half (55%) and affordability selected by 41%.
- Lack of public awareness is the top challenge in Poland, selected by 46%.
- In Spain, over 40% not only select higher first costs (49%), but also lack of political support/incentives (45%), lack of public awareness (42%) and lack of market demands (42%), suggesting a high level of concern about challenges in the market in general.
- Higher first costs and lack of market demand top the list of UK challenges, both with over 40% expressing concerns.

Social and Environmental Reasons for Building Green

SOCIAL REASONS

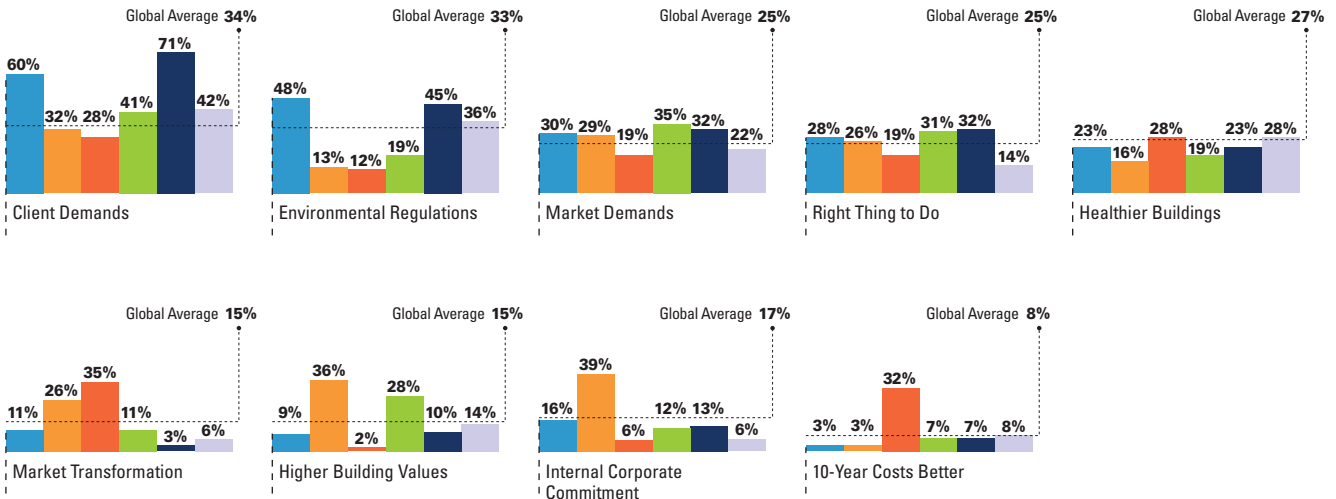
Three of the six social reasons for building green included in the study appear to resonate most with European respondents: **improving occupant health and well-being, encouraging sustainable business practices and increasing worker productivity.** The percentages below are the share of those who rated this social reason as important in a previous question, and then selected it as one of the two most important reasons to build green.

- Improving occupant health and well-being is selected as one of the two most important social reasons for building green by 60% of European respondents.

Top Triggers Driving Future Green Building Activity in the UK, Spain, Poland, Norway, Ireland and Germany

Dodge Data & Analytics, 2018

UK Spain Poland Norway Ireland Germany



- It is selected by the highest percentage of Irish (88%) and Spanish (71%) respondents.
- The only one of the six European countries featured in this study where less than half selected this as a top social reason for building green is Poland (31%).

■ **Encouraging sustainable business practices is considered one of the top two social reasons by 58% of European respondents.**

- Over three quarters (77%) of respondents from Norway who consider this reason important ranked it in their top two.
- The only country in which it was selected by fewer than 50% is Germany (36%).

■ **Increasing worker productivity is selected as one of the top two social reasons for building green by 42% of European respondents.**

- There is a wider range of response for this reason than for the other two: It is highly ranked in the UK (50%) and Poland (47%), moderately ranked in Ireland (31%) and Germany (30%), and relatively low ranked in Norway and Spain (both 26%).

Expected Business Benefits of Green Buildings in Europe
(Including Ireland, Germany, Norway, Poland, Spain, the UK and the Average of all European Countries in the Study)

| | New Green Building | | | | | | |
|--|--------------------|---------|---------|--------|--------|-------|-----|
| | Europe | Ireland | Germany | Norway | Poland | Spain | UK |
| Decreased Operating Costs Over One Year | 7% | 12% | 5% | 5% | 3% | 12% | 7% |
| Decreased Operating Costs Over Five Years | 13% | 22% | 8% | 12% | 10% | 31% | 12% |
| Payback Time for Green Investments (Years) | 9 | 9 | 8 | 8 | 9 | 5 | 10 |

| | Green Retrofit | | | | | | |
|--|----------------|---------|---------|--------|--------|-------|-----|
| | Europe | Ireland | Germany | Norway | Poland | Spain | UK |
| Decreased Operating Costs Over One Year | 10% | 16% | 13% | 6% | 9% | 13% | 8% |
| Decreased Operating Costs Over Five Years | 13% | 34% | 13% | 9% | 14% | 15% | 13% |
| Payback Time for Green Investments (Years) | 8 | 11 | 7 | 8 | 8 | 8 | 12 |

ENVIRONMENTAL REASONS
Reducing energy consumption is the top priority for all European countries included in the study.

- It is rated as important by over 90% in Ireland, Germany, Norway and Spain, and 70% or more in Poland and the UK.
- It is selected among the top two environmental reasons for building green by the highest percentage of respondents for any reason from the six European countries included.

The other important environmental reasons for building green vary more by country.

- **Lowering greenhouse gas emissions is one of the top reasons cited in Ireland, Norway and the UK.**
- **Protecting natural and material resources is a top reason in Germany and Poland.**
- **Improving indoor air quality is a top reason in Spain.**

Business Benefits

NEW GREEN BUILDING

Ireland and Spain report the highest average operating cost savings from green buildings when compared with traditional ones for both a one-year and five-year time frame. (Please note that the five-year average median savings is a little high due to the number that selected 15% or more as their highest category.)

On the other hand, Germany, Norway and Poland are all quite conservative in their estimates of operating cost savings due to new green buildings.

Spanish respondents report the shortest payback periods for the investments they make in new green

building. The UK reports the highest, but it is relatively consistent with the other four countries included, which are all slightly above the global average of seven years.

GREEN RETROFITS

Ireland, Germany and Spain expect the biggest percentage of operating cost savings due to their green retrofits within 12 months. However, only Ireland has notably larger expectations than average for the five-year operating cost savings.

Despite their optimism about the level of savings experienced, payback periods for Ireland are the longest of the six countries tracked, with the UK close behind.

Norway is by far the most conservative about the savings they see from green retrofits. However, their estimation of the payback period for their investments is pretty much on par with the European and global averages.

Green Building Activity and Trends in India

Indian respondents anticipate steep growth in their green activity in the next three years, driven by environmental regulations and the drive for healthier buildings. Many of the challenges they face are typical of an emerging market, including the need for more public awareness of green and more green-educated professionals.

Around half (51%) of the survey respondents in India work for companies that are members of a green building council. This is above the average for participation in the study overall, and should be taken into account when comparing responses from India to other countries or to global averages.

Green Building Market Activity

Most Indian respondents (90%) have at least some level of green building experience, but the majority report that less than 60% of their projects are green currently, with a relatively even distribution between those doing less than 16%, those doing between 16% and 30%, and those doing 31% to 60% of their projects green.

Their expectations about the share of green projects they expect to undertake by 2021, however, is very optimistic and shows strong expectations for growth in the market. Those expecting to do more than 60% of their projects green nearly doubles to 55%.

SECTORS WITH EXPECTED GROWTH

Around half of the Indian respondents expect to do green projects in the next three years in two sectors: new commercial construction (54%) and new high-rise residential (48%). These are the same sectors that were expected in the 2015 study by the highest

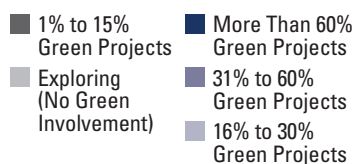
percentage of Indian respondents. This consistency demonstrates the importance of these sectors to this market.

While the percentage expecting to do new green commercial construction is on par with the global average (51%), the percentage doing new high-rise residential is significantly higher in India than globally (35%).

The one sector where India is significantly below the global average is for existing buildings/retrofits. Only 24% of Indian respondents expect to do a green retrofit project in the next three years, compared with the global average of 37%. This suggests an emphasis on green for new buildings in the Indian market.

Levels of Green Building Activity for Respondents in India (2018 and 2021 Expected)

Dodge Data & Analytics, 2018



Influence Factors for Future Green Building Activity

TRIGGERS

The two most important triggers for future green building activity in India are environmental regulations and healthier buildings. India notably exceeds the global average for each of these triggers.

The strong performance of environmental regulations and relatively low performance of client demands, along with the data on the green market activity, suggest that India is still an emerging green market overall. Right now, it is the pull of regulations rather than the expectation of the market driving activity.

However, the strong emphasis on healthier buildings suggests that those doing green buildings in India are tied into larger global trends, where health has emerged as a top concern. Given the importance of work in which productivity is actively measured, such as call centers, in India, it is not surprising to see healthier buildings as a strong trigger. Also, many countries that struggle with air quality issues place emphasis on the indoor environment as part of their green projects.

CHALLENGES

Lack of public awareness is selected as a top challenge to expanding green building efforts by half of Indian respondents. The relatively low performance of client demand

corresponds to this finding, and together, they both suggest the need for greater education of Indian developers and consumers to create a demand for green.

Other challenges reported by a higher percentage of respondents from India than the global average are **lack of trained/educated green building professionals** (27%) and **lack of availability of green products** in their market (21%). Again, both of these suggest that India is still an emerging market for green building.

However, one challenge that is highlighted by fewer Indian respondents than the global average is **higher (real or perceived) first costs**. 49% report that this is a challenge globally, but only 32% find it to be a challenge in India. It will be interesting to see if this remains at a relatively low level as the market matures since it was a commonly reported issue in the early days of green building in many more developed markets.

Social and Environmental Reasons for Building Green

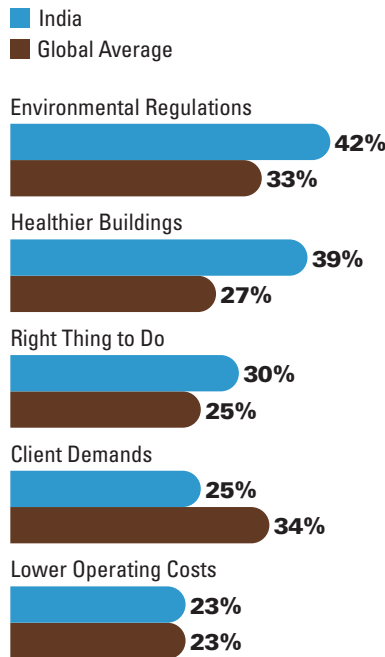
SOCIAL REASONS

Most Indian respondents tend to rate each of the social reasons included in the study as important, far more than respondents tend to do globally. However, when asked to select their top two most important, two clear reasons emerge.

- **65% consider improving occupant health and well-being a top environmental reason for building green (among those who rated it as important).**
- **62% consider encouraging sustainable business practices one of the top social reasons for building green.**

Top Triggers Driving Future Green Building Activity in India

Dodge Data & Analytics, 2018



These findings are consistent with the global averages, but they again reinforce the importance of healthier buildings in this market.

ENVIRONMENTAL REASONS

Over 80% of Indian respondents consider all five environmental reasons for building green important.

When asked to select their top two, though, **reducing energy consumption** is selected by the highest percentage (62%), as it is in most green markets. The second most important environmental reason is **reducing water consumption**, ranked in the top two by 48%, followed closely by **protecting natural resources**, which is ranked in the top two by 43%.

Business Benefits

Indian respondents are more conservative about their expectations for one-year operating cost savings for new green and retrofit projects than they were in the 2015 study, bringing them closer in line with global averages. Their five-year expectations are more consistent for new green projects, but have also shifted down slightly for green retrofits.

On the other hand, they are more conservative about payback periods on new projects than they are on green retrofits, perhaps because that market is still relatively small among these respondents.

Expected Business Benefits of Green Building in India

| | New Green Building | | Green Retrofit | |
|--|--------------------|------|----------------|------|
| | 2015 | 2018 | 2015 | 2018 |
| Decreased Operating Costs Over One Year | 10% | 8% | 11% | 8% |
| Decreased Operating Costs Over Five Years | 15% | 15% | 16% | 12% |
| Payback Time for Green Investments (Years) | 4 | 7 | 5 | 5 |

Data: Middle East/North Africa

Green Building Activity and Trends in the Middle East and North Africa

Two of the largest markets in MENA, Saudi Arabia and the United Arab Emirates, reveal how two countries in the same region can be different from each other, in terms of green activity, triggers and challenges to increased green building, and the social and environmental reasons for building green.

Respondents from the Middle East and North Africa (MENA) region came from 12 countries. Two of them, Saudi Arabia and the United Arab Emirates (UAE), had sufficient responses to be analyzed separately, but data from the region as a whole is also included in this section.

Saudi Arabia and UAE had different levels of participation from respondents whose companies are members of a green building council (GBC). In Saudi Arabia, only 8% of the respondents are GBC members, while in UAE, nearly half (48%) are. The disparity in the makeup of the respondents should be kept in mind when reviewing the responses.

Green Building Market Activity

The UAE has a relatively active green building market, with over half of the respondents from that country (56%) reporting that more than 30% of their projects are green. In contrast, Saudi Arabia is still an emerging green market, with only one quarter (25%) doing more than 30% of their projects green. The MENA region is closer to the levels reported in the UAE, with nearly half (49%) doing more than 30% green projects.

Growth is expected in the levels of green activity by 2021, in both countries and throughout the region.

■ **In the UAE, this growth largely comes in those expecting to do the majority of their projects (more than 60%) green, with the percentage at that level of green**

activity anticipated to nearly double from 34% to 66%.

- **In Saudi Arabia, the largest increase is also expected among those doing a majority of their projects green**, although those doing a relatively low (16% to 30%) and moderate (31% to 60%) level of green building will also increase. The biggest shift, in fact, is the decrease in doing no green currently (21%) and those expecting to do no green work by 2021 (10%), suggesting a steady, but still early, shift toward green in this market.
- **Across the MENA region as a whole, the highest level of growth is also among those doing the majority of their projects green**, nearly doubling from 19% to 37%.

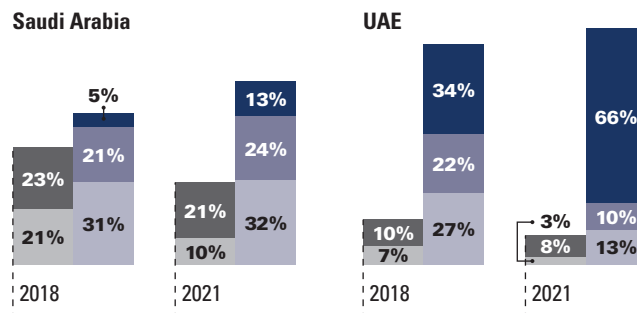
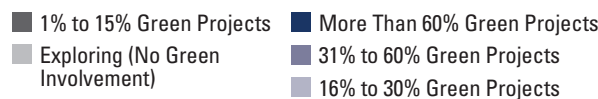
SECTORS WITH EXPECTED GROWTH

The top project sectors for green building in MENA are new commercial construction (62%), new institutional construction (49%) and high-rise residential (40%). While new green commercial construction is also the top sector in Saudi Arabia and the UAE, there are some notable differences by sector between the two countries.

■ **New commercial construction is by far the top green sector in the UAE, selected by 69%.** In fact, there is at least a 19 percentage point gap between new commercial construction and any other sector, demonstrating the importance of commercial construction in that market.

Levels of Green Building Activity for Respondents in MENA (2018 and 2021 Expected)

Dodge Data & Analytics, 2018



- While new commercial construction is also the top green sector in Saudi Arabia, selected by 55%, it is followed closely by low-rise residential (53%) and new institutional construction (50%), suggesting less of a concentration on new commercial construction in Saudi Arabia than in the UAE. This also places Saudi Arabia well above the global average for respondents expecting to do green low-rise residential projects in the next three years.
- However, Saudi Arabia has a higher percentage (40%) expecting to work on green commercial interiors than the UAE (21%). This may be due to the mix of respondents who participated in the study in Saudi Arabia.
- With 50% of the respondents in both Saudi Arabia and the UAE expected to do new commercial construction, both countries are well above the global average (38%) for that sector.
- After new commercial construction, three sectors have a high percentage of UAE

respondents for anticipated green projects: new institutional projects, high-rise residential and existing buildings/retrofits, all with 50% of respondents reporting expected green work in the next three years in these sectors. This puts the UAE well above Saudi Arabia and the global average for all three sectors, and above the MENA average for high-rise residential and existing buildings/retrofits.

Influence Factors for Future Green Building Activity

TRIGGERS

Saudi Arabia and the UAE differ from each other notably when it comes to the influence of various triggers to encourage more green building.

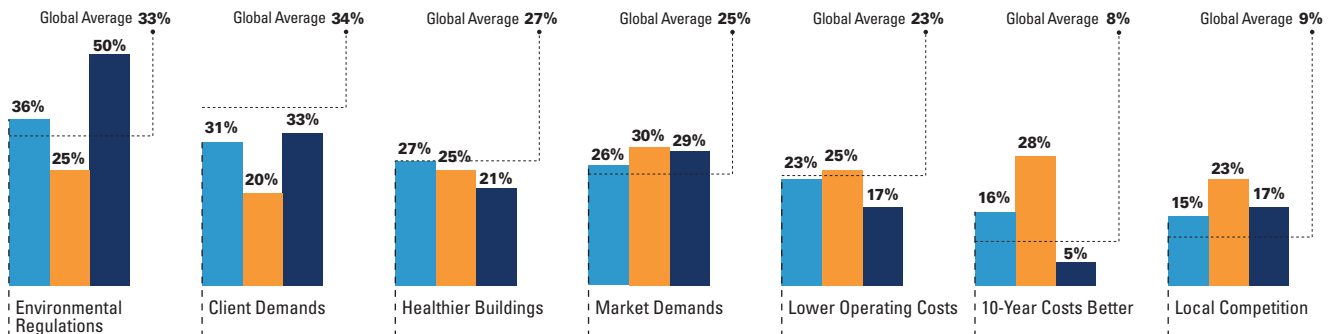
- Saudi Arabia: No single trigger dominates the responses from Saudi Arabia. Instead the top six triggers are a tight grouping, nearly equally influential among the Saudi respondents.

- Market demands is the top trigger at 30%, a percentage roughly typical for the region and in line with the global finding.
- It is closely followed by improved 10-year costs at 28%, which is notably higher than the regional or global averages.
- Creating healthier buildings, lower operating costs, environmental regulations and local competition all hover at around one quarter of the respondents. While this puts Saudi Arabia on par with global averages for healthier buildings and lower operating costs, and slightly under for environmental regulations, the percentages for local competition are much higher than the regional or global averages.
- UAE: The top trigger in the UAE is environmental regulations. Half (50%) of the UAE respondents select this, well above the global average or any market factor. Correspondingly, the remainder of the UAE responses for other triggers are around or below global averages.

Top Triggers Driving Future Green Building Activity in the Middle East/North Africa, Saudi Arabia and the UAE

Dodge Data & Analytics, 2018

■ MENA Average ■ Saudi Arabia ■ UAE



CHALLENGES

The top barriers to green growth in the MENA region overall are lack of public awareness (42%), higher first costs (real or perceived) (40%), lack of market demand and lack of political support or incentives (both 32%). However, the most significant challenges differ between Saudi Arabia and the UAE.

- Perceived higher first costs is the top challenge in Saudi Arabia, selected by 38%. Other influential challenges in this market include lack of market demand (30%), affordability (the perception that green is for high-end projects only) (30%), lack of public awareness (28%) and lack of trained/educated green building professionals (28%). This suggests that the market still needs to overcome several challenges to fully mature.
- The top challenge in the UAE is lack of public awareness, selected by 45%. This is notably above the global average but consistent with other MENA findings, suggesting that this region in particular struggles with creating public awareness to create demand.
- The perception that green is for high-end projects only is also a widely reported obstacle in the UAE, by 41%. This is well above both the regional and global averages for this issue, making it particular to this market.
- 38% of respondents from the UAE also consider the lack of trained/educated green building professionals to be a major challenge facing the growth of green work in this country. Again, this is much higher than the regional or global averages for this obstacle.

Social and Environmental Reasons for Building Green

SOCIAL REASONS

When asked to rate the importance of the six social reasons for building green included in the study, at least three quarters of respondents from Saudi Arabia rate all six as important, including supporting the domestic economy, improving worker productivity, improving occupant health and well-being, supporting sustainable business practices, creating a sense of community and being aesthetically pleasing.

In contrast, the highest percentage to rate any of the social reasons as important in the UAE is 74%. The two factors rated by that percentage as important are

promoting sustainable business practices and improving occupant health and well-being.

When those who rated several items as important were asked to select their top two reasons, respondents from the UAE still clustered around promoting sustainable business practices and improving occupant health and well-being.

The Saudis, on the other hand, most frequently selected creating a sense of community and improving worker productivity as their top two social reasons for building green.

ENVIRONMENTAL REASONS

Reducing energy consumption is the top environmental reason for building green in Saudi Arabia and the UAE. It is recognized by most

Expected Business Benefits of Green Buildings in the Middle East/North Africa (Including Saudi Arabia and the Average of 11 Other Countries)

| | New Green Building | | |
|--|--------------------|--------------|-----|
| | MENA | Saudi Arabia | UAE |
| Decreased Operating Costs Over One Year | 8% | 5% | 9% |
| Decreased Operating Costs Over Five Years | 14% | 9% | 38% |
| Payback Time for Green Investments (Years) | 7 | 6 | 5 |

| | Green Retrofit | | |
|--|----------------|--------------|-----|
| | MENA | Saudi Arabia | UAE |
| Decreased Operating Costs Over One Year | 8% | 4% | 9% |
| Decreased Operating Costs Over Five Years | 14% | 11% | 15% |
| Payback Time for Green Investments (Years) | 5 | 4 | 4 |

respondents in Saudi Arabia (85%) and the UAE (93%) as important, and it is considered one of the top two most important reasons by nearly all those in Saudi Arabia who consider it important (91%), and by over three quarters (77%) in the UAE.

Nearly all respondents from the UAE (91%) rate reducing water consumption as important, and it is selected as one of the top two reasons by half of them. On the other hand, while three quarters of the Saudis rate reducing water consumption as important, only 27% of them consider it one of the top reasons for building green.

Protecting natural resources is also considered one of the top environmental reasons for building green by 36% of the respondents who consider it important from both Saudi Arabia and the UAE.

Business Benefits

NEW GREEN BUILDING PROJECTS

Respondents across MENA believe on average that a new green building will save 8% in operating costs over the first 12-month period of operation compared with a traditional building. The respondents from UAE largely align with those findings, which are consistent with the global findings, but Saudi respondents are more conservative.

However, **68% of respondents in the UAE reported that they expect 15% or higher savings in their green building operating costs over five years**. Since this was the highest category, it skews the median to be a very high number, but even though that figure may be skewed, it still represents a great deal of optimism about the long-term performance of

green buildings. In contrast, only 18% of Saudis and 45% globally expect operating cost savings of 15% or more in five years for their green buildings.

Given the high level of savings expected, it is not surprising that the UAE respondents also expect a low payback time frame (five years) for their green investments.

GREEN RETROFIT PROJECTS

Respondents from Saudi Arabia are notably conservative in their expectations for operating cost savings over the first 12 months due to their green retrofits of existing buildings.

The 4% median savings expected is well below the regional or global averages. Some of the difference between Saudi Arabia and the regional responses could be due to energy subsidies available to some members of the Gulf Cooperation Council (GCC).

They also are a little below the regional and global averages for five-year median cost savings.

The region as a whole expects relatively short payback periods of five years, and the respondents from Saudi Arabia and UAE fall even a little below that at four years. A short payback period can support the business case for investing in these retrofits.

Green Building Activity and Trends in North America

North America is comprised of three active green markets, although the Canada and US market is more mature than that of Mexico. Costs are a particular concern for this region, although Canada and Mexico both report strong business benefits from their green building projects.

When comparing the findings of Canada, Mexico and the US, it is important to consider the percentage of participants in the survey who are members of green building councils (GBCs). Canada has the second highest percentage in the study as a whole, at 63%, the US is slightly above average at 53%, and Mexico is well below average at 20%. These percentages may influence the relative levels of activity reported in these markets.

Green Building Market Activity

All of the three major markets in North America—Canada, Mexico and the US—currently have relatively high levels of green building activity. Over 85% of respondents from all three countries do at least some green building, and for over two

thirds, green projects account for more than 15% of their work.

However, there are also some notable differences in the level of green activity by country.

- **Canada has the highest percentage (35%) of those doing the majority (over 60%) of their projects green, and the US is close behind at 32%.**
- **While Mexico lags in terms of those doing a majority of green projects, a higher percentage of those respondents currently report a moderate (31% to 60% green projects) and low (15% to 30%) level of green activity than in the US and Canada.** Thus, although Mexico has fewer respondents who report a high level of green activity, they have a higher percentage who are engaged with green projects at some level than Canada and the US.

By 2021, a higher percentage of respondents from all three countries expect to see their levels of green building activity increase.

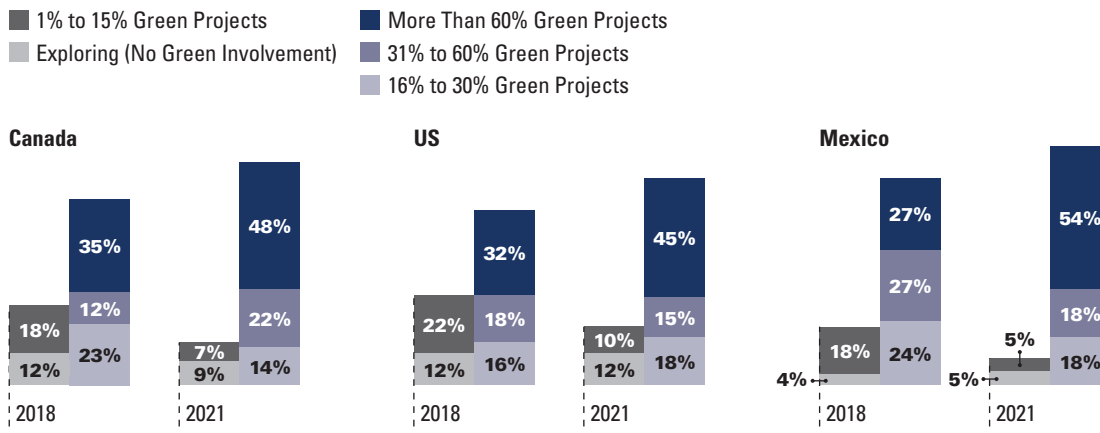
- **Canada and the US report the same 13 percentage point uptick in those expecting to do the majority of their projects green.** This level of growth reveals highly active, growing markets in both countries.
- **Mexican respondents are very enthusiastic about the percentage of green projects they will be doing by 2021, with those expecting to do a majority of green projects doubling from 27% in 2019 to 54% by 2021.**

SECTORS WITH EXPECTED GROWTH

The top sectors for green projects in Canada, Mexico and the US vary. The analysis includes comparisons to the 2015 study for the US and Mexico,

Levels of Green Building Activity for Respondents in North America (2018 and 2021 Expected)

Dodge Data & Analytics, 2018

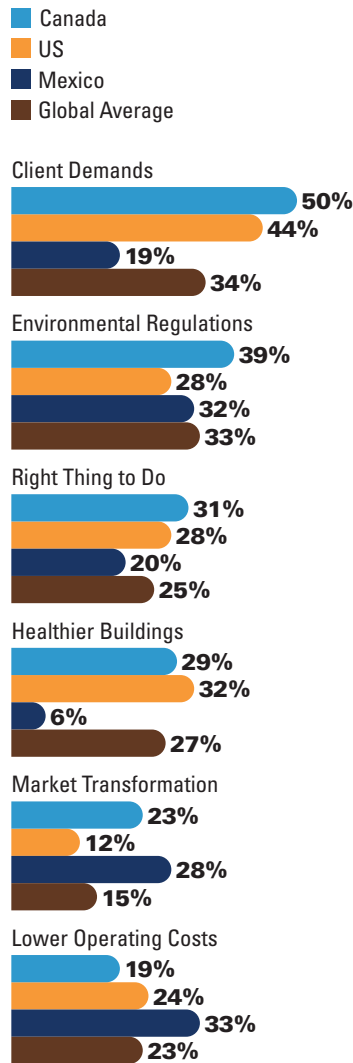


but not for Canada, since Canada did not have a sufficiently large level of participation in the previous study.

- **The top sector for green building in Canada is new institutional construction, selected by 60%.**
- **45% also anticipate doing green institutional construction in the US,** a figure substantially above the percentage in Mexico (32%) and the global average (37%). This percentage is also consistent with the findings from the 2015 study for US engagement in green institutional construction.
- **The top sector for green building in the US is green existing buildings/retrofits, selected by 50%.** This is higher than the percentage (43%) who reported that they expected to do work in this sector in 2015.
- **Green existing buildings/retrofits is also an active sector in the Canadian green building market,** with 52% expecting to be engaged in these projects.
- **Mexico at 32% lags considerably behind the US and Canada in expectations for green existing buildings/retrofits,** but Mexico is also more in line with the global average (37%), which the US and Canada far exceed. However, this is a drop from the findings in 2015, when nearly half (48%) of respondents from Mexico expected to do green retrofit projects.
- **The top sector for green building in Mexico is new commercial construction, selected by 52%.** However, it is notable that this is a drop from the 65% who expected to do new green commercial construction in 2015.
- **A relatively high percentage in Canada (44%) and the US (45%) also expect to do these projects,** but

Top Triggers Driving Future Green Building Activity in North America

Dodge Data & Analytics, 2018



both are below the global average of 51%. In the US, this is also on par with the findings from the 2015 study.

- **Low-rise residential construction is also selected by a high percentage of Mexican respondents (43%).** The percentage anticipating doing this work in Canada (37%) is also above the global average of 30%, but the US (25%) is notably below that average for this sector. This was not one of the top three sectors in Mexico in 2015, though, which suggests that it has gained in importance in this market.

Influence Factors for Future Green Building Activity

TRIGGERS

- While there are some overlaps, there are also some significant differences in the percentages who identify their top triggers for new green building activity in Canada, Mexico and the US.
- **Client demands is the top trigger in Canada and the US, particularly in Canada, where it is selected by 50%.** Client demands was also the top trigger in the US in the 2015 study, selected by an even higher percentage (52%) than in the current study.
 - **Environmental regulations are an important trigger for green building in Canada and Mexico.** In Mexico, this is a big change from 2015, when environmental regulations were not even included among the top five triggers.
 - **In addition to environmental regulations, the other top trigger in Mexico is lower operating costs, selected by one third (33%).** This

has also increased in importance since the 2015 study, when 25% of Mexican respondents considered it a top trigger.

- **Healthier buildings is an important trigger in the US and a moderately important one in Canada, but few in Mexico consider it an important trigger for building green.** Since it was not included in the 2015 study, no comparison is possible for the US or Mexico.
- **Doing the right thing also continues to be an important trigger for green building in Canada, and a moderately important one in the US.**

CHALLENGES

The top challenge to increased green building reported in Canada, Mexico and the US is higher first costs (perceived or actual). 73% of US respondents in the current study select this as a top challenge, far more than the 53% in Canada, and the 41% in Mexico or the 49% global average for this factor. In the US, the finding is consistent with the 2015 study, in which 70% regarded higher costs as a top challenge. However, in Mexico, the percentage has reduced considerably since 2015, down 13 points from 54%.

In the US and Canada, affordability (the perception that green is for high-end projects only) is the second biggest obstacle, selected by 37% in the US and 36% in Canada. It is notable that the third most commonly noted obstacle in the US (30%) and the fourth in Canada (31%) is the challenge in making the business case due to the split between operational and capital costs. The combined importance of all these obstacles suggests

that costs in general are the major obstacle to building green.

In Mexico, the lack of political support or incentives for green is considered a top obstacle by 39%, the second highest for this country and consistent with the findings from 2015. It is the third highest obstacle in Canada at 32%, but only 26% in the US select it.

It is also notable that 30% select high levels of corruption in the industry/government in Mexico, three times the global average for that factor.

Social and Environmental Reasons for Building Green

SOCIAL REASONS

Respondents were first asked to rate the importance of six social reasons for building green, including creating a sense of community, improved worker productivity, improved aesthetics, supporting the domestic economy, encouraging sustainable business practices and improving occupant health and well-being. Then those who rated each as

important were asked to select their top two social reasons for building green.

For Canadian, Mexican and US respondents alike, two factors emerged as the top two: improving occupant health and well-being, and encouraging sustainable business practices.

- A much higher percentage of respondents from the US (78%) select improved occupant health and well-being as one of the top two social reasons for building green than any of the other reasons, or than respondents from Canada (61%) or Mexico (54%).
- Encouraging sustainable business practices is selected among the top two by the highest percentage in Mexico (61%), and by relatively high percentages in Canada (59%) and the US (59%) as well.
- Aesthetics ranks higher in Canada than in most countries, with 30% of respondents selecting it among their top two social reasons for building green.

Expected Business Benefits of Green Building in North America

| | New Green Building | | |
|--|--------------------|--------|-----|
| | Canada | Mexico | US |
| Decreased Operating Costs Over One Year | 12% | 11% | 8% |
| Decreased Operating Costs Over Five Years | 21% | 23% | 13% |
| Payback Time for Green Investments (Years) | 8 | 5 | 8 |

| | Green Retrofits | | |
|--|-----------------|--------|-----|
| | Canada | Mexico | US |
| Decreased Operating Costs Over One Year | 12% | 12% | 11% |
| Decreased Operating Costs Over Five Years | 14% | 30% | 13% |
| Payback Time for Green Investments (Years) | 7 | 6 | 7 |

ENVIRONMENTAL REASONS

The respondents had a similar set of questions for their top environmental reasons for building green to those they had for their top social reasons. The following considers the choices of the top two among all the environmental reasons rated as important.

- **The most frequently selected environmental reason for building green in the US, Canada and Mexico is to reduce energy consumption.** Roughly two thirds of the respondents in each country who considered this important selected it among their top two. This is consistent with other findings in the study and the findings of previous studies for the US and Mexico.
- **Protecting natural resources was also selected by a high percentage from each country,** including 46% from Mexico, 38% from the US and 37% from Canada.
- **Reducing water consumption ranks high for Mexican respondents as well,** with 47% selecting it among the top two environmental reasons for building green. That is far more than respondents from the US (28%) or Canada (21%). This factor has increased in importance in Mexico since 2015, when it did not rank among the top three environmental reasons for building green.
- **Lowering greenhouse gas emissions is a high priority in Canada,** with 48% of respondents selecting it as one of their top two environmental reasons. A moderate percentage in the US (36%) and Mexico (31%) also consider this important.

- **Surprisingly, relatively few select improved indoor air quality as an environmental reason for building green,** despite the importance of healthier buildings as a social reason. It is possible that most view the environment as an external factor outside of the building, and therefore are less likely to choose indoor conditions as an environmental priority.

Business Benefits

NEW GREEN BUILDINGS

Respondents from Canada and Mexico are more optimistic about 12-month operating cost savings in their new green buildings than those in the US, and than the global average, with median average savings of 12% and 11%, respectively, compared with the US and global average of 8%.

That pattern continues in their estimation of five-year operating costs savings, with median savings boosted for both Canada and Mexico by the high percentage of those who select the highest category included in the study of 15% savings or more (53% selecting that range in Canada and 55% in Mexico). In contrast, the US expectation of 13% savings is on par with global averages.

Mexico also has a shorter payback period for investment in new green buildings than do Canada or the US, probably due to less expensive labor costs.

GREEN RETROFITS

The US estimates for operating cost savings on green retrofits in a 12-month period more closely align to those from Canada and Mexico, with all reporting a relatively high percentage.

Five-year estimates, though, are far more optimistic in Mexico, with 61% selecting the category of 15% or more.

Payback periods for retrofit projects are one year shorter than those expected for new green projects in Canada and the US, and one year longer than for new green projects in Mexico.

Green Building Activity and Trends in South Africa

Within three years, South Africans anticipate that they will be doing a much higher level of green building activity than they are now, driven by the desire for lower operating costs and healthier buildings. Right now, retrofits of existing buildings is the biggest building sector for green in this country.

Around half (52%) of the survey participants from South Africa work for companies that are members of a green building council. When comparing the findings to the ones from 2015, it is worth noting that only 31% of respondents to that survey were from companies that are green building council members.

Green Building Market Activity

Most South African respondents (94%) have at least some level of green building experience. The level of activity varies across the market, with an almost even distribution between those reporting very low (less than 15% green projects), low (15% to 30% green projects), moderate (31% to 60% green projects) and high (more than 60%) levels of green building activity.

By 2021, though, the largest percentage (48%) expect to be doing a high level of green activity, with dramatic shifts downward in the other three categories.

SECTORS WITH EXPECTED GROWTH

Around half of the South African respondents (49%) expect to do green retrofit projects, the biggest sector reported by these respondents. This is well above the global average for green retrofits (37%), and it is consistent with the top sector reported in the 2015 study. The drop in new building construction in South Africa and the need for building owners to fully leverage

their assets, retain tenants and building values is closely linked to the expectation that renovations of existing buildings will be the top sector for green building in this market.

The second highest sector for South Africa is new green commercial buildings, but the 39% who expect to work in this sector in South Africa is significantly smaller than the 51% who will be working in this sector globally.

New green residential buildings, both low-rise (28%) and high-rise (26%), are only other sectors selected by more than a quarter of South African respondents.

Influence Factors for Future Green Building Activity

TRIGGERS

Lowering operating costs is an important trigger for future green building activity in South Africa. It is selected by 38%, well above the global average of 23%. In fact, South Africa is the only country in the study where lower operating costs are the top trigger. The predominance of retrofit work is likely to be directly correlated to this finding.

Another important trigger for green building activity in South Africa is creating healthier buildings, selected by 33%. Again, this exceeds the global average for this trigger.

Three other triggers are selected by more than one quarter of South African respondents: **client demands, right thing to do and environmental regulations.** These are a diverse set of triggers that demonstrate that the pull of the market, the push of regulations and the desire to do the right thing all carry sway within this market, rather than being driven by a few key triggers.

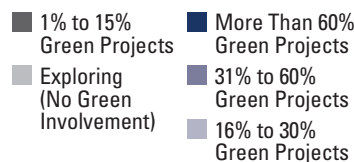
CHALLENGES

The top challenge reported by South Africans is higher (real or perceived) first costs, selected by 43%. However, it is notable that this percentage is lower than the global average of 49%.

The challenge of affordability that comes with the perception that

Levels of Green Building Activity for Respondents in South Africa (2018 and 2021 Expected)

Dodge Data & Analytics, 2018



green is for high-end projects only is the second most commonly selected challenge by South Africans, chosen by 37%. This is higher than the global average of 33%.

Two other challenges were selected by 28% of South African respondents: the difficulty in making the business case due to the split between capital and operating cost expenses, and the lack of political support/incentives. The combination of all these factors suggests that addressing the issue of the cost of building green would help to grow this market.

Social and Environmental Reasons for Building Green

SOCIAL REASONS

Encouraging sustainable business practices is the top social reason for building green in South Africa in the current study, as it was in 2015. It is rated as important by 84% of the 2018 respondents, well above the global average of 75%.

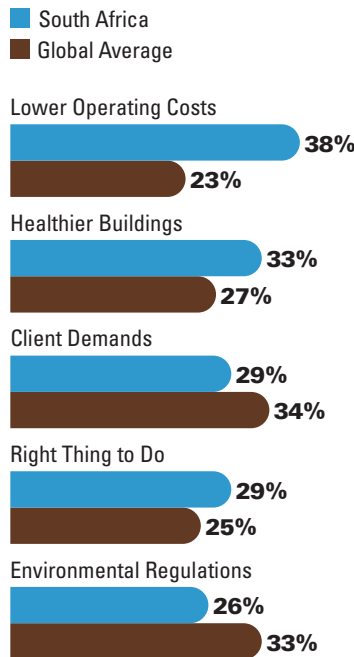
The other top social reason for building green in South Africa is to improve occupant health and well-being, rated as important by 83% of respondents. This finding is consistent with global findings and the priorities in many countries included in this study.

ENVIRONMENTAL REASONS

Most South African respondents (79% or more) consider all five environmental reasons for building green important. When asked to select their top two, though, reducing energy consumption is selected by the highest percentage (55%), as it is in most green markets, although by a lower percentage in South Africa

Top Triggers Driving Future Green Building Activity in South Africa

Dodge Data & Analytics, 2018



than in many other countries.

Close behind energy for South Africans is reducing water consumption, ranked in the top two by 51%. A high percentage (47%) also selected protecting natural resources among their top two environmental reasons for building green.

Business Benefits

The medians for anticipated 12-month operating cost savings reported in 2018 in new green buildings and green retrofit projects are similar to global averages. There is a relatively high percentage (55%) who select the 15% or higher category for their expected five-year savings, which may skew the median savings up a little for that five-year period for both new buildings and retrofits. The global average for that category is 45%.

The South African respondents expect shorter payback periods for their investments than they did in 2015, a strong driver for the business case for making those investments.

Expected Business Benefits of Green Building in South Africa

| | New Green Building | | Green Retrofit | |
|--|--------------------|------|----------------|------|
| | 2015 | 2018 | 2015 | 2018 |
| Decreased Operating Costs Over One Year | 18% | 8% | 9% | 8% |
| Decreased Operating Costs Over Five Years | 19% | 23% | 29% | 22% |
| Payback Time for Green Investments (Years) | 8 | 7 | 6 | 5 |

Data: South America, Central America and the Caribbean

Green Building Activity and Trends in South America, Central America and the Caribbean

The markets in the South American, Central American, Caribbean region all expect strong growth in levels of green activity. There is an emphasis on new green commercial and high-rise residential projects in this region, with a relatively few green institutional projects expected.

Respondents from South America, Central America and the Caribbean came from 15 countries. Two of them, Brazil and Colombia, had sufficient responses to be analyzed separately, but data from the region as a whole is also included in this section for regional analysis and comparison.

About one third of the respondents from Colombia (32%) work at companies that are members of a green building council, compared with just 12% of the respondents from Brazil. This disparity should be kept in mind when comparing the findings from the two countries.

Green Building Market Activity

Currently, 95% of respondents from Brazil and 87% from Colombia are doing at least some green projects. Among respondents from other countries in this region, that percentage drops to 82%.

- The highest percentage in Brazil (31%) of those doing green building report 16% to 30% of their projects are green.
- About one third of the respondents from Colombia (30%) report that they are doing between 1% and 15% of their projects green.
- In both countries the remainder of those doing green projects are split nearly evenly between the other categories with only around one fifth (21% in Brazil and 19% in Colombia) reporting that they do

the majority (more than 60%) of their projects green.

Respondents were also asked about the share of green projects they expect to be doing by 2021. **Both Brazilian and Colombian respondents expect to be doing a much larger share of green in three years**, with 42% of those in Brazil and 46% of those in Colombia expecting to do the majority of their projects green by 2021. The remaining countries in this region report a similar level of growth, with 46% reporting that they expect the majority of their projects to be green by 2021.

SECTORS WITH EXPECTED GROWTH

New commercial construction is the sector across the region in which the

highest percentage of respondents (52%) plan to do green projects.

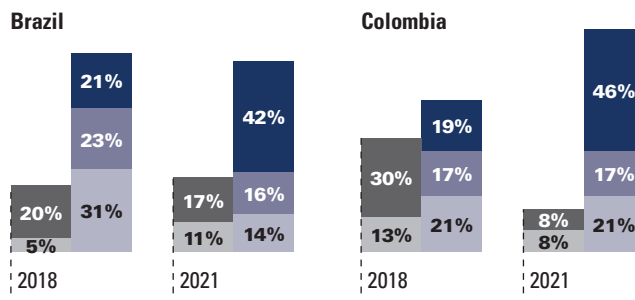
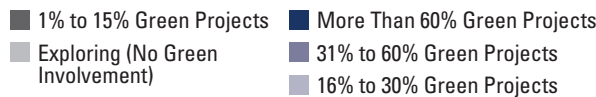
- **47% in Brazil expect to do new green commercial construction projects and 48% in Colombia.** This is notably below the 62% from the rest of the region, although the difference is directional rather than statistically significant.
- **The percentage expecting to do green commercial construction in Colombia has fallen 11 points since the 2015 study.** On the other hand, the percentage from Brazil has remained consistent.

The second biggest sector in this region is new green high-rise residential buildings, selected by 40%.

- **47% expect to do new green high-rise residential projects**

Levels of Green Building Activity for Respondents in South America, Central America and the Caribbean (2018 and 2021 Expected)

Dodge Data & Analytics, 2018



in Colombia. This is a dramatic increase over the percentage in Colombia (36%) who expected to do this work in 2015.

- Only 30% expect to do new green high-rise residential buildings in Brazil. This is not only significantly fewer than those in Colombia, but it is also a drop of 13 points from the findings in 2015.

Other sectors chosen by more than 30% across the region include new green low-rise residential (36%) and green retrofits of existing buildings (34%).

- The percentages who anticipate doing new green low-rise residential work in Brazil (37%) and Colombia (35%) hover around the average reported for the region.

While it has stayed relatively consistent for Brazil since 2015, the percentage from Colombia has increased by 9 percentage points in that period, suggesting that green is becoming more widely adopted in this sector.

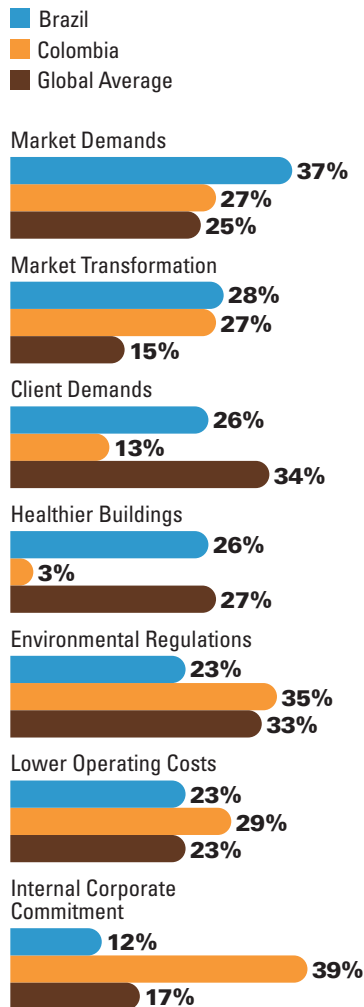
- Fewer respondents from Brazil (21%) expect to do green retrofits than those in Colombia (33%) or in the rest of the region (46%). This is a significant drop of 16 percentage points for Brazil from the 2015 findings as well.

30% of respondents across the region expect to do new green institutional projects, lower than the global average of 38%.

- Few in Brazil in particular (16%) are expecting to work in this sector. Colombia at 32% and the rest of the region at 35% are both much closer to the global average.

Top Triggers Driving Future Green Building Activity in Brazil and Colombia

Dodge Data & Analytics, 2018



Influence Factors for Future Green Building Activity

TRIGGERS

The triggers for new green building activity are very country specific, with different factors driving the green building markets in Brazil and Colombia.

- Brazil: A wide range of triggers help drive green building in Brazil, suggesting market influences, economic and social interests, and concerns about occupants are all important in this market.

- Market demands is selected by the highest percentage and is more influential in Brazil than in Colombia or globally. This is a notable change from 2015, when market demands were only selected as a top trigger by 12% of respondents from Brazil. Publication of data demonstrating the business benefits of green building, along with strong media attention to green projects, have created market demand for green in the commercial real estate sector in Brazil.
- Market transformation is also considered a key trigger in Brazil, with a much higher percentage (28%) selecting it than the global average (15%) or than selected it in 2015 (12%), and supports the high level of optimism reported for green building in the next three years.
- Client demands are also important in Brazil, although they are selected by a lower percentage there (26%) than the global average (34%). The findings are roughly consistent with those in 2015 when it was selected by

29%, although at that time, client demands was the top trigger for Brazil.

- **Healthier buildings** is the final top trigger for Brazil. While the percentage of respondents for this trigger is on par with the global average, it is much higher than in Colombia, where very few see this as a top driver. This trigger was not included in the 2015 study.
- **Colombia: Corporate culture and regulations help drive green building in Colombia, with an emphasis on fulfilling green goals and improving the bottom line.**
 - 39% of Colombian respondents find **internal corporate commitments** to be a top trigger for green building in their market, far more than those in Brazil (12%) or the global average (17%). This was also the top trigger in 2015 for Colombia, selected by 33%.
 - **Environmental regulations** are also an important driver here, selected by 35%, which is similar to the global average. This is also similar to the finding in 2015, when this trigger was selected by 31%.
 - **Lower operating costs** is the third most frequently selected trigger in Colombia, demonstrating the importance of a good business case for green in this market. It was selected by 22% in 2015, and ranked fifth at that time.
 - It is notable that 27% in Colombia consider **market transformation** a top trigger, similar to the percentage in Brazil and slightly below the 31% who selected it in 2015.

CHALLENGES

Unlike the triggers, whose importance varies by country, there is general agreement across the region about the top barriers to increased green building.

- **Higher First Costs (Real or Perceived): Over half (56%) across the region believe this is one of the top barriers to green building in their markets.**
 - The percentage of Brazilian respondents selecting this challenge (47%) is on par with the global average of 49%.
 - A relatively high percentage in Colombia (58%) select higher costs as a top obstacle, although it has dropped notably since 2015 when it was selected by 67%.
- **Lack of Political Support or Incentives: Regionally, this is considered a top barrier by nearly half (49%) of respondents.** Both Brazil (44%) and Colombia (49%) far exceed the global average (33%) for this challenge, suggesting that this is a particular issue in this region that needs to be addressed. However, it is notable that this challenge is selected by a much higher percentage currently than in 2015 (39%) in Brazil and a much lower percentage currently than in 2015 (60%) in Colombia.
- **Lack of Public Awareness: About one third (32%) of the respondents regionally report that this is a top barrier,** and Brazil (33%) and Colombia (30%) have a similar percentage of respondents to each other and to the global average (32%). This factor has dropped notably in both Brazil and Colombia from the percentage of respondents who selected it in 2015 (41% and 45%, respectively).

Social and Environmental Reasons for Building Green

SOCIAL REASONS

The top social reason for building green in this region is improved occupant health and well-being.

It was not only rated as important on a scale of one to five by 87% of respondents, but over three quarters (76%) of those who consider it important rate it among their top two social reasons for building green.

The other major social reason for building green according to respondents from this region is that it promotes sustainable business practices. However, there are differences by country for this factor.

- In Brazil, 70% rate this as important, but only 33% of those respondents place it among the top two social reasons for building green.
- In Colombia, 81% rate it as important, and 58% of those consider it one of their top two reasons.

At least half of the respondents in Brazil and Colombia rate the other four social reasons for building green, including **creating a sense of community, increasing worker productivity, improving the domestic economy and being aesthetically pleasing**, as important, suggesting that all these reasons influence the market.

ENVIRONMENTAL REASONS

All five environmental reasons for building green included in the study—**reduce energy consumption, reduce water consumption, preserve natural resources, improve indoor air quality and lower greenhouse**

gas emissions—are rated as important by more than 80% of respondents across the region and in Colombia, and by more than 75% of respondents in Brazil. It is clear that all of these are widely recognized as essential components of green building in these two countries.

When asked to select their top two among these environmental reasons, reducing energy consumption is most frequently chosen, both regionally and in Brazil and Mexico. However, it is notable that it is only selected as a top reason by 61% in Brazil and 56% in Colombia, relatively low for this factor, and that a couple of other reasons are selected by a relatively high percentage.

- 51% in Colombia consider **water conservation** a top environmental reason for building green.
- Almost half in Brazil (49%) and Colombia (48%) also consider **preserving natural resources** a top reason.

Business Benefits

NEW GREEN BUILDING PROJECTS

Respondents from Brazil and Colombia are slightly more conservative than their regional counterparts in the one-year operating cost savings they expect in green buildings compared with traditional ones. They are also much closer to the global median of 8%.

Expectations about five-year operating cost savings in Brazil are the same as the global median (14%), but they are high regionally and in Colombia.

The payback period for the additional cost of a new green building in Brazil is the same as the global median of seven years. In Colombia, though, a five-year payback is expected.

GREEN RETROFIT PROJECTS

Estimations of the one-year operating cost savings regionally and in Brazil are just slightly under the global average of 9%, but respondents in Colombia only expect about 5%.

Their five-year estimates are larger, though, than the global average of 13%, with Colombia close to that average at 14%, and Brazil and the region notably higher.

The median payback period expected in this region is five years, just slightly under the global average of six years.

Expected Business Benefits of Green Building in South America, Central America and the Caribbean

| | New Green Building | | |
|--|--|--------|----------|
| | South America, Central America and the Caribbean | Brazil | Colombia |
| Decreased Operating Costs Over One Year | 11% | 9% | 10% |
| Decreased Operating Costs Over Five Years | 22% | 14% | 18% |
| Payback Time for Green Investments (Years) | 6 | 7 | 5 |

| | Green Retrofits | | |
|--|--|--------|----------|
| | South America, Central America and the Caribbean | Brazil | Colombia |
| Decreased Operating Costs Over One Year | 8% | 8% | 5% |
| Decreased Operating Costs Over Five Years | 18% | 20% | 14% |
| Payback Time for Green Investments (Years) | 5 | 5 | 5 |

Green Building Activity and Trends in Southeast Asia

The green mandates in Singapore have led to a high level of green activity already, and it is expected to grow even more in the three years. Vietnam's market is driven by the priorities of commercial construction, including market demand, higher building values and healthier buildings.

Respondents from Southeast Asia came from seven countries. Two of them, Singapore and Vietnam, had sufficient responses to be analyzed separately, but data from the region as a whole is also included in this section.

Over one third of the respondents from Vietnam (39%) work at companies that are members of a green building council, and a lower percentage work for green building council members in Singapore (28%). This disparity should be kept in mind when comparing the findings from the two countries, and when comparing their levels of green building activity to other countries, since the global average is 44% for green building council membership.

Green Building Market Activity

A high percentage of respondents from Southeast Asia (94%) have done at least some green building projects, revealing a robust market for green building.

Singapore, in particular, already has a very high level of green building activity. Over one third (34%) report that the majority of their projects (over 60%) are green, a notable level of growth over the findings from the 2015 study, in which 23% were engaged at that level in green building. This high level of activity is no doubt due to the mandates for green in place in Singapore.

In contrast, **only 13% of respondents in Vietnam are currently doing the majority of their projects green.** In contrast, nearly one third (32%) of Vietnamese respondents are doing between 1% to 30% of their projects green.

Singapore is also expecting to see increased levels of green building in the next three years. By 2021, 45% of those in Singapore expect to do the majority of their projects green.

Vietnam is also expecting to see a significant increase in the level of green activity. The percentage expecting to do fewer than 16% green projects shrinks from 40% to 22% with commensurate growth in those doing more green building, especially in those doing the majority of their projects green, which nearly doubles from 13% to 24%.

SECTORS WITH EXPECTED GROWTH

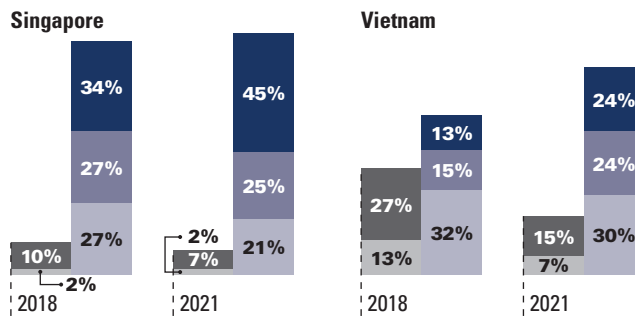
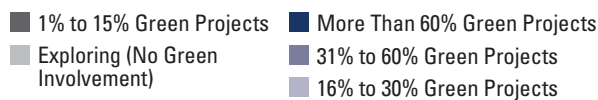
The top project sectors for green building in Southeast Asia are new commercial construction (57%), high-rise residential (41%) and communities (36%). All three are above the global average for percentage expecting to do work in these sector, with the most notable gap in communities, which is only selected by 24% of global respondents.

There are a few notable differences by country.

- **61% of respondents from Vietnam expect to do new green commercial construction in the next three years.** While this is not a statistically significant increase above the 48% in Singapore

Levels of Green Building Activity for Respondents in Southeast Asia (2018 and 2021 Expected)

Dodge Data & Analytics, 2018



expecting to work in this sector, it is still directionally notable and above the global average of 51%.

- **61% of respondents from Vietnam also expect to do new green high-rise residential work**, significantly more than those in Singapore (25%) and again well above the global average (35%).
- **Nearly half (49%) of Singapore respondents anticipate working on green existing building/retrofit projects**, more than the 37% global average and far more than the 13% who expect to do work in this sector in Vietnam.

Influence Factors for Future Green Building Activity

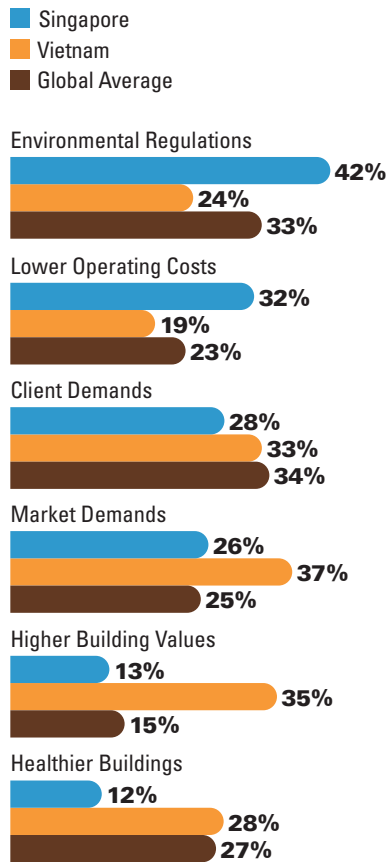
TRIGGERS

The two triggers for new green building activity most frequently selected by Southeast Asia respondents are environmental regulations (42%) and creating healthier buildings (39%). However, differences emerge by country.

- **Singapore: The green mandate drives green building in this market, but lower operating costs are also influential.**
 - **Environmental regulations** are considered an important trigger by 42% of respondents in Singapore, far more than the 24% influenced by them in Vietnam and notably more than the global average of 33%.
 - **Lower operating costs** are selected by 33% of respondents from Singapore as an important trigger. This demonstrates that a good business case is also an important driver in Singapore, in addition to the government mandate.

Top Triggers Driving Future Green Building Activity in Southeast Asia

Dodge Data & Analytics, 2018



- **Vietnam: The influence of the commercial real estate market is evident in the triggers driving green building in Vietnam.**
 - **Market demands** is the top trigger, selected by 37%, notably higher than the global average.
 - **Higher building values** is selected by 35% as a top trigger, an unusually high percentage which is likely linked to the robust green commercial building market.
 - **Client demands** are also an important trigger in Vietnam,

selected by a slightly higher percentage than in Singapore, and consistent with the global average.

- The percentage in Vietnam selecting **healthier buildings** as a top trigger (28%) is in line with the global average. It is likely that the commercial building market is influencing its rank among the Vietnamese respondents, since healthier buildings have been widely promoted in this segment and currently provide a competitive advantage for attracting and retaining tenants.

CHALLENGES

The top barriers to green growth in Southeast Asia overall are **higher (real or perceived) first costs (48%), lack of trained/educated green building professionals (34%) and affordability/the perception that green is for high-end projects only (32%)**. Similar to the triggers, though, the critical barriers also vary by country.

- **Singapore: By far the biggest barrier to green building in Singapore is higher first costs.** This is likely related to operating cost savings being an important trigger for green since long payback periods on these investments can cause challenges to those promoting the benefits of building green.
 - The other top barriers are selected by about one third of respondents: **affordability/perception green is for high-end projects only (32%)** and **the lack of trained/educated green building professionals (30%)**.
- **Vietnam: Vietnam has a wide range of important barriers that need to be addressed.**

- The top barrier to green building for Vietnamese respondents is the **lack of trained/educated green building professionals**, selected by 43%. In emerging markets with a high level of green growth expected, this can be an issue since experienced green professionals can be rare in those markets.
- 41% select the **lack of political support or incentives** as a top obstacle in Vietnam.
- Other obstacles selected by more than one third of Vietnamese respondents include **higher first costs** (37%) and **lack of public awareness about green building** (37%).

Social and Environmental Reasons for Building Green

SOCIAL REASONS

Respondents were asked two questions about the social reasons for building green: First, they were asked to rate the importance of six reasons provided in the study on a scale of one to five. Then, those who rated more than one reason as important were asked to select the top two reasons.

Promoting sustainable business practices and improving occupant health and well-being were the top two social reasons for building green selected by respondents from Singapore and Vietnam.

- **Promoting sustainable business practices was selected as one of the top two social reasons by 80% of those who consider it important in Singapore.** It was selected by the second highest percentage (63%) of Vietnamese respondents.

- **Improving occupant health and well-being was selected as one of the top two reasons by 71% of Vietnamese respondents.** 59% in Singapore selected it among their top two as well.

ENVIRONMENTAL REASONS

Reducing energy consumption is rated as important on a five-point scale by 89% of respondents from Singapore and 87% of respondents from Vietnam, the highest for any of the environmental reasons for building green included in the study. It is also selected as one of the top two environmental reasons for building green by those who considered it important by 77% of respondents from Singapore and 68% from Vietnam, the highest as well.

About half of those who rate **protecting natural resources** as important in Singapore (42%) and Vietnam (50%) consider it one of the top two reasons for building green.

In Singapore, **water conservation** is also highly regarded (43% consider

it one of the top two reasons), while in Vietnam, 42% of those who consider **improved indoor air quality** important choose it as one of their top two reasons.

Business Benefits

NEW GREEN BUILDING PROJECTS

Respondents from Southeast Asia are generally optimistic about the business benefits they get from new green building projects. While the Vietnamese respondents are slightly lower than the global average for operating cost savings for one year, their five-year projections are far above the global average.

The payback period of seven years is consistent with other findings across the globe.

GREEN RETROFIT PROJECTS

The operating cost savings and payback period for retrofits are also fairly consistent with the general global findings.

Expected Business Benefits of Green Building in Southeast Asia

| | New Green Building | | |
|--|--------------------|-----------|---------|
| | Southeast Asia | Singapore | Vietnam |
| Decreased Operating Costs Over One Year | 9% | 9% | 7% |
| Decreased Operating Costs Over Five Years | 14% | 12% | 22% |
| Payback Time for Green Investments (Years) | 7 | 7 | 7 |

| | Green Retrofits | | |
|--|-----------------|-----------|---------|
| | Southeast Asia | Singapore | Vietnam |
| Decreased Operating Costs Over One Year | 8% | 7% | 7% |
| Decreased Operating Costs Over Five Years | 11% | 9% | 12% |
| Payback Time for Green Investments (Years) | 5 | 5 | 7 |

Methodology:

World Green Building Trends Research

The World Green Building Trends Study was conducted to achieve the following objectives: 1) identify triggers, obstacles and reasons for adopting green building in the domestic marketplace; 2) measure past, current and future levels of activity in green building; 3) identify important construction sectors for growth in green building; 4) measure the impact of green building practices on business operations; 5) profile the use of green building products and/or methods; and 6) uncover trends in the industry through comparison with relevant findings from the 2012 and 2015 Global Trends in Green Building Studies.

The study was conducted between April and June 2018. It was fielded using panel providers, email blasts and association broadcast to members, or by forwarding the link to other groups as follows: 1) multiple Green Building Councils across the world sent email invitations to their members; 2) several associations (AIA, ACE, CIOB, IMEI and USGBC) sent the survey link to members; and 3) the survey was sent to a Dodge Data & Analytics database of industry professionals.

Study Participants

2,078 architects, engineers, contractors, owners, specialists/consultants and investors responded to the survey. All respondents were required to be employed construction professionals and to have non-building projects account for no more than 50% of their office's revenue.

The distribution of respondent is as follows:

- Architect/Design Firm: 25%
- Contractor/Builder: 23%
- Specialist/Consultant: 21%
- Owner/Developer: 18%
- Engineering Firm: 12%
- Investor: 1%

Respondents were located in 86 countries, listed on page 76. Sufficient responses were provided for statistically significant analysis to be conducted for 19 countries, also listed on page 76.

COUNTRIES FEATURED

The percentage of respondents by the countries featured in report are as follows, along with the percentage of respondents from that country who are members of a green building council (GBC):

- Australia: 5% of total; 63% GBC respondents
- Brazil: 2% of total; 12% GBC
- Canada: 3% of total; 68% GBC
- China Mainland: 2% of total; 14% GBC
- China Hong Kong: 2% of total; 46% GBC
- Colombia: 6% of total; 32% GBC
- Germany: 2% of total; 8% GBC
- India: 19% of total; 51% GBC
- Ireland: 1% of total; 61% GBC
- Mexico: 3% of total; 20% GBC
- Norway: 4% of total; 73% GBC
- Poland: 3% of total; 39% GBC
- Saudi Arabia: 2% of total; 8% GBC
- Singapore: 3% to total; 28% GBC
- South Africa: 4% of total; 52% GBC
- Spain: 1% of total; 65% GBC
- UAE: 2% of total; 48% GBC
- UK: 4% of total; 13% GBC
- US: 16% of total; 53% GBC
- Vietnam: 3% of total; 39% GBC

Benchmark of Accuracy

The total sample size of 2,078 benchmarks at a high degree of accuracy: 95% confidence interval with a margin of error of 2%.

Definition of Green Building

Respondents were asked about their company's level of green activity in two ways: by the share of green certified projects out of their overall work, and by the share of total green projects. For the determination of what qualified as a green building, the following definition was provided:

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

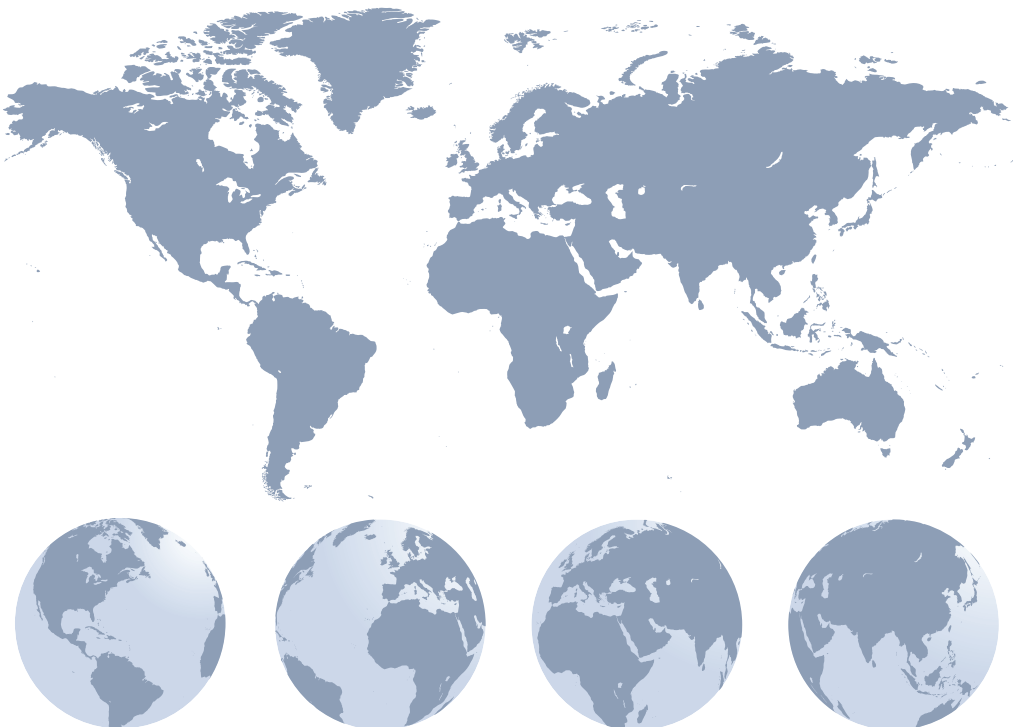
- Efficient use of energy, water and other resources
- Pollution and waste reduction measures, and the enabling of reuse and recycling
- Good indoor environmental air quality
- Consideration of the environment in design, construction and operation

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 non-toxic, 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

The results in this report are drawn from survey respondents from the following 86 countries, with statistically significant results on the highlighted 19 countries. See region/country-specific results on pages 46–74.

- | | | | |
|---------------------------------------|--------------------|-------------------|-----------------------------|
| Afghanistan | Dominican Republic | Lesotho | Saudi Arabia |
| Albania | El Salvador | Malaysia | Sierra Leone |
| Argentina | Finland | Malta | Singapore |
| Australia | France | Mexico | Slovakia |
| Austria | Germany | Moldova | Slovenia |
| The Bahamas | Ghana | Morocco | South Africa |
| Bahrain | Gibraltar | Namibia | Spain |
| Bangladesh | Greece | New Zealand | Sri Lanka |
| Belgium | Guatemala | Nicaragua | Sweden |
| Bermuda | Guyana | Nigeria | Switzerland |
| Botswana | Hungary | Norway | Trinidad and Tobago |
| Brazil | India | Oman | Turkey |
| British Indian Ocean | Indonesia | Palestine | Ukraine |
| Brunei | Iran | Pakistan | United Arab Emirates |
| Cambodia | Ireland | Panama | United Kingdom |
| Canada | Israel | Peru | United States |
| China (Mainland and Hong Kong) | Italy | Philippines | Uruguay |
| Colombia | Japan | Poland | US Virgin Islands |
| Costa Rica | Jordan | Portugal | Vietnam |
| Czech Republic | Kenya | Puerto Rico | |
| Democratic People's | Kuwait | Qatar | |
| Republic of Korea | Latvia | Republic of Korea | |
| | Lebanon | Romania | |



Resources

Organizations and websites that can help you get smarter about global green building trends.



Dodge Data & Analytics

Main Website: www.construction.com

Dodge Global Network:

www.construction.com/products/dodge-global-network

Research & Analytics:

www.construction.com/products/dodge-research-analytics

Sweets: www.construction.com/products/sweets

SmartMarket Reports:

www.construction.com/toolkit/reports

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We also thank our other research partners, ACE, CIOB and IMEI, for their efforts to broaden the reach of our survey and variety of responses.

Finally, we thank all the individuals and organizations who contributed their experiences, data and images for publication in the case studies, along with those who agreed to provide their insights in our feature articles.



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Contributing Partner

US Green Building Council:
<https://new.usgbc.org>

Premier Research Partner

World Green Building Council:
www.worldgbc.org

Research Partners

Architects' Council of Europe:
www.ace-cae.eu

Chartered Institute of Buildings:
www.ciob.org

La Asociación Mexicana del Edificio
Inteligente y Sustentable A.C.
(IMEI): <https://imei.org.mx/imei>

Other Resources

Architecture 2030: https://architecture2030.org/2030_challenges/2030-challenge

ASHRAE: www.ashrae.org

Building Owners and Managers
Association International
(BOMA): www.boma.org

C40 Cities: www.c40.org

The Global ESG Benchmark
for Real Assets Requirements
(GRESB): <https://gresb.com>

International WELL Building
Institute: www.wellcertified.com

mindful MATERIALS
Collabortative:
www.mindfulmaterials.com

National Institute of Building
Sciences: www.nibs.org

Organization for Economic
Development and Cooperation
(OECD): www.oecd.org

Resilient Design Institute:
www.resilientdesign.org

United Nations Framework
Convention on Climate
Change: <https://unfccc.int>

■ Design and Construction Intelligence

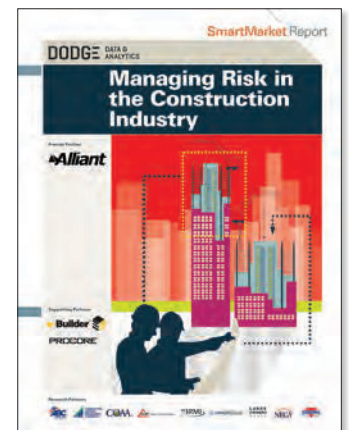
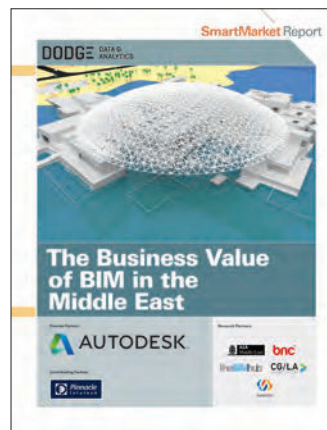
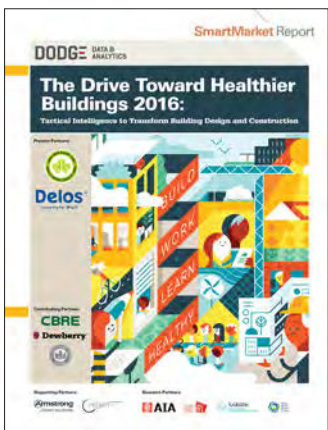
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