



SmartMarket Brief



# Building Sustainably:

## The Drive to Reduce Embodied Carbon in Concrete Construction



# Introduction

## ABOUT THIS SMARTMARKET BRIEF

Building sustainably has always included creating high-performing buildings, but to truly address the building sector's contribution to greenhouse gas emissions, it is essential to reduce the embodied carbon footprint of every building during its design and construction.

This is particularly essential for buildings involving concrete, one of the most carbon-intensive materials. Fortunately, as the research findings in this report demonstrate, contractors and structural engineers are already rising to the challenge. Many are using the tools needed to measure it, and a substantial share are actively seeking to reduce embodied carbon on their projects.

The findings also show that project owners are increasingly calling for carbon reduction on their projects, which will help drive the industry to tackle this challenge. They also reveal both the current level of engagement with advanced concrete products on the market that help reduce a project's carbon footprint, and the strong potential for growth in their use.

Dodge wishes to thank CarbonCure and Biographene Solutions for sponsoring this important research.

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## A MESSAGE FROM CARBONCURE

The construction industry's future will be built on innovation. At CarbonCure, we're proudly innovating alongside our concrete producer partners and challenging the status quo. We've combined software and hardware with chemistry to flip a negative into a positive—transforming the world's most used building material from a climate challenge into a global solution. And we aren't done yet. Our partnership model deploys our technologies to the world's most innovative and driven concrete producers, enabling them to maximize profits while protecting our planet. Through our journey, we've seen the key role that data plays in innovation, both in the lab and at the job site. Knowing where we've been, where we are and where we could go are essential pieces for both large and small producers to seize opportunities for growth and to drive efficiencies across the construction value chain. A thorough awareness of changing trends and the growing need for sustainable construction are the foundation of a stronger, greener built environment. We're pleased to be able to provide this information, and we look forward to the new ideas and new directions our industry will take together.

# Key Findings

## Reducing Embodied Carbon in Concrete Construction

### TRACKING AND REDUCING EMBODIED CARBON IS GAINING GROUND

#### Engineers and contractors lead the way.

- 81% of engineers and 69% of contractors track embodied carbon on their projects.
- Reducing embodied carbon is still an emerging activity, though, with only 30% of engineers and 35% of contractors doing so on most of their projects.

#### Green commitments encourage greater engagement.

- Companies investing in staff dedicated to green activity or with formal commitments to reduce carbon are far more actively engaged in tracking and reducing embodied carbon.

#### Addressing the carbon in concrete is essential to achieving reduced emissions goals.

- 84% of contractors and 73% of engineers recognize the vital importance of reducing the embodied carbon of concrete to reduce the overall carbon in their concrete projects.

### ADVANCEMENTS IN CONCRETE THAT HELP REDUCE EMBODIED CARBON

#### Practitioners are seeking ways to reduce the carbon intensity of concrete.

- 84% of engineers and 76% of contractors would be highly influenced in their specification/purchase of concrete if it included green approaches that would reduce cementitious content.

#### Green advancements are taking hold in the market.

- Approaches like admixtures that replace diminishing materials/fly ash or that replace harmful chemicals are starting to emerge in the industry, and are being used by about one quarter of engineers and contractors.
- The use of carbon mineralization to reduce cement and associated carbon emissions is well established and in use by 41% of engineers and contractors.

# Key Findings

## Drivers for Increased Engagement With Carbon Reductions

### MEANS THAT HELP ADDRESS EMBODIED CARBON ARE WELL-ESTABLISHED IN THE INDUSTRY

#### Environmental Product Declarations (EPDs) are widely used.

- 98% of engineers and contractors use EPDs on at least some of their projects, and 55% of those using them currently do so on all projects, whenever available.
- 68% of all engineers and contractors using EPDs report that their use increased in the last year.
- 63% of engineers and contractors report that most or all of their clients ask for EPDs.

#### Lifecycle analysis is also broadly utilized, and performance-based specifications are on the rise.

- 78% of engineers and contractors have worked on a project on which a lifecycle assessment has been conducted, and the average share of projects on which they see it is 33%.
- 51% of engineers and contractors expect an increase in the use of performance-based specifications in the next three years.

### OWNERS ARE ONE OF THE TOP DRIVERS FOR ENGAGEMENT

#### The number of owners asking for embodied carbon to be reduced on their projects is growing.

- 94% of engineers and contractors have client requests to reduce embodied carbon on projects and 27% report that this happens on 50% or more of their projects.

#### The influence of ESG (Environmental, Social, Governance) disclosure on financial ratings provides owners with a direct incentive to address reducing carbon in their capital planning as well as their operations.

- 56% of engineers and contractors work with owners with ESG commitments, and 73% of them say that the number of owners with those commitments have increased in the last year.

# Introduction

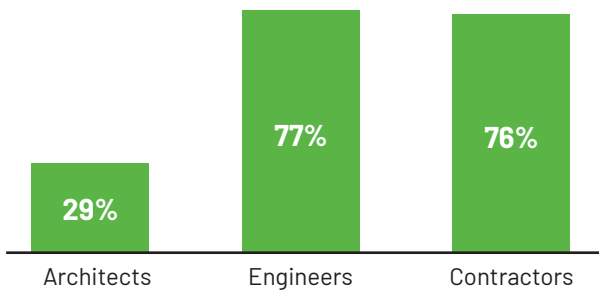
## INTRODUCTION: PROFILES OF RESPONDENTS

This study examines the degree to which key project stakeholders who handle the specification and purchase of concrete prioritize reducing embodied carbon and how they do so. The profiles of the participants is critical to understanding their responses.

- **Architects:** Architects have a higher share of green projects, compared with those of the engineers and contractors, but are less likely to have dedicated green staff or formal commitments to reduce carbon. Nearly half (42%) also report that they do work on a national/international scale.
- **Engineers:** Engineers have the highest share of firms with national/international projects. While they lag behind architects

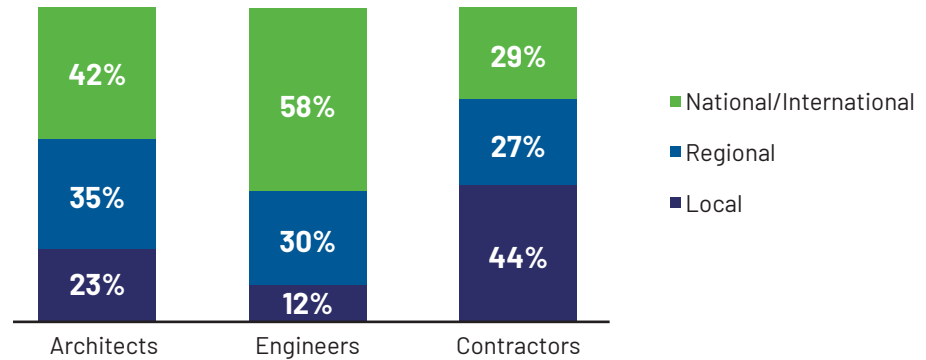
## Has Dedicated Staff for Sustainable Activities

Dodge Data & Analytics, 2022



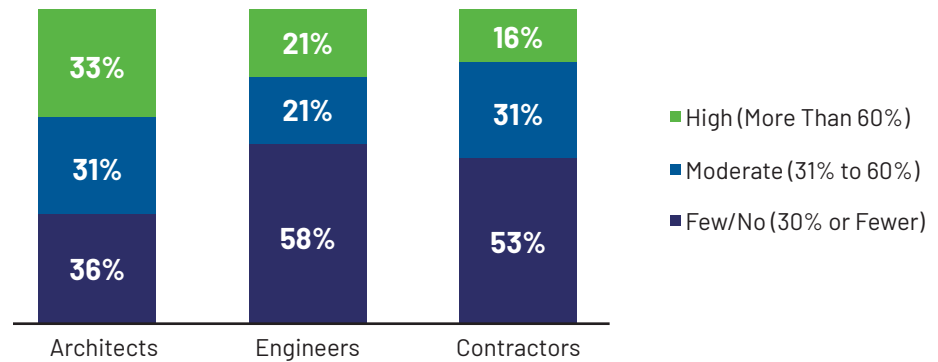
## Breadth of Projects

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## Share of Green Projects

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# Introduction (CONTINUED)

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

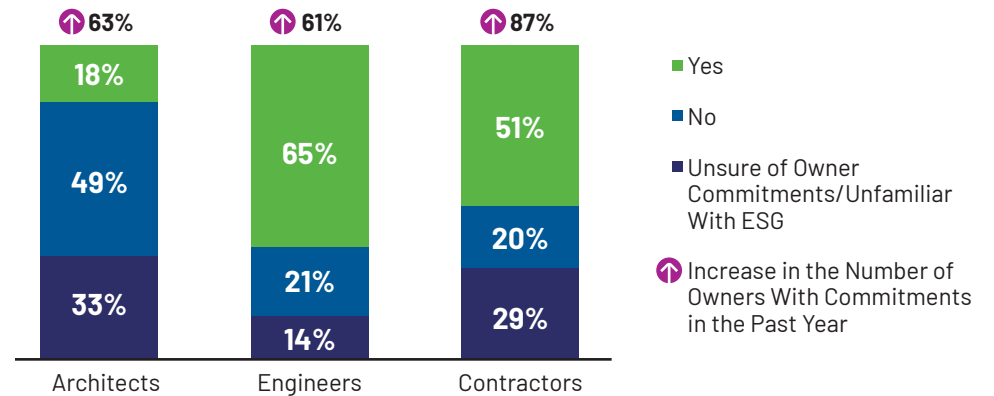
in green projects reported, they frequently have dedicated green staff and formal commitments to reduce carbon emissions.

- **Contractors:** GCs and concrete contractors are more likely to have local or regional projects than engineers, but their green commitments and activities mirror those of the engineers.

One key factor that the study reveals is the recent growth in project owners with ESG commitments. Over half of contractors and nearly two thirds of engineers report that the owners on their projects have these commitments. And most who report this, even the small share of architects, have seen those commitments increase in the last year, which suggest that owners may be key to driving the commitments to carbon reductions seen in this study.

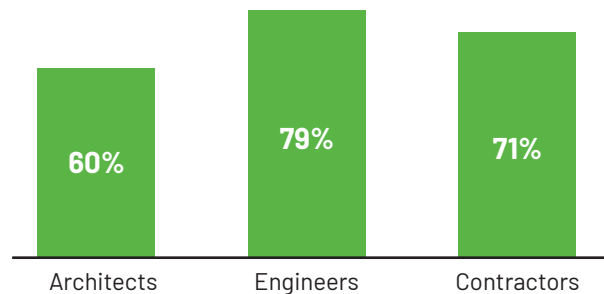
## Involved in Projects With Owners/Investors With Specific ESG Commitments

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## Has a Formal Commitment to Reduce Carbon Emissions

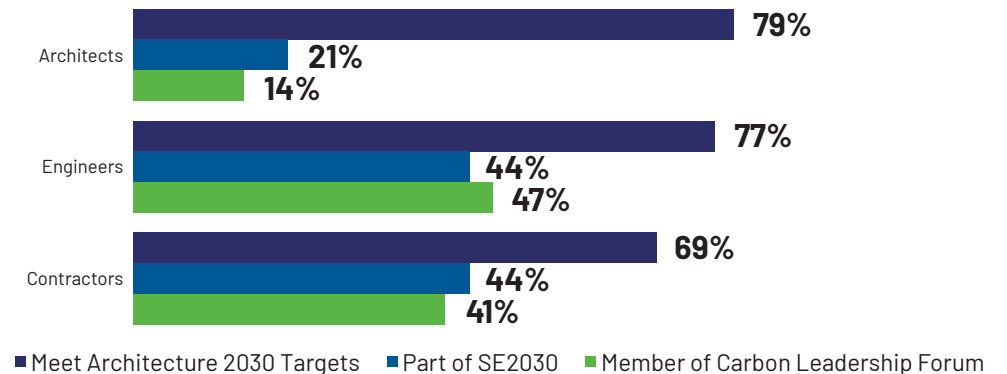
Dodge Data & Analytics, 2022



## Types of Formal Commitments to Reduce Carbon Emissions

(According to Those With Formal Commitments)

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# Addressing Embodied Carbon

## APPROACH TO ADDRESSING EMBODIED CARBON

Embodied carbon involves the entire carbon footprint of a building or construction project, which includes not only the emissions created in building and operating it, but the emissions generated by the production and transportation of the materials used to construct it. Measuring embodied carbon requires transparency across the supply chain, and is challenging, so reducing it will likely require new, innovative approaches to building materials.

Fortunately, there is broad familiarity in the industry with this concept: only 5% of the architects, engineers and contractors in this study were not familiar with it.

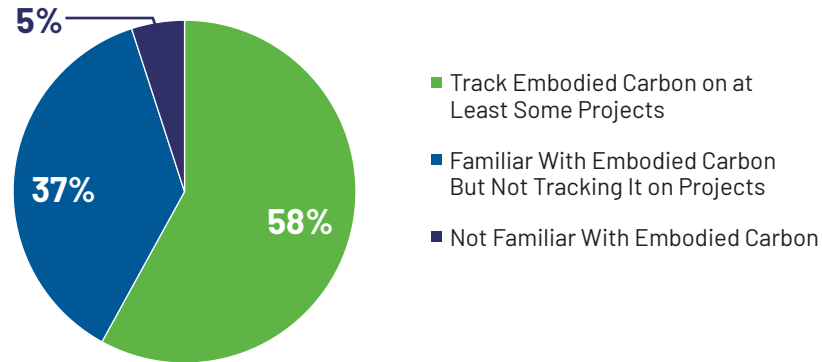
In fact, over half (58%) report that they are currently tracking embodied carbon on their projects. However, the findings differ dramatically by type of company, with 81% of engineers, 69% of contractors and only 24% of architects reporting that they track embodied carbon.

The degree to which they are using the information they gather on embodied carbon to actively seek to reduce it also varies in interesting ways.

- **Architects:** Even though so few track embodied carbon, nearly all of those who do are attempting to reduce it on at least some of their projects. However, their efforts are still in the early stages, with the majority reporting that both tracking and reduction are limited to a few projects rather than a widespread activity at their company.
- **Engineers:** While nearly all the engineers surveyed are at least tracking embodied carbon, nearly one third currently are

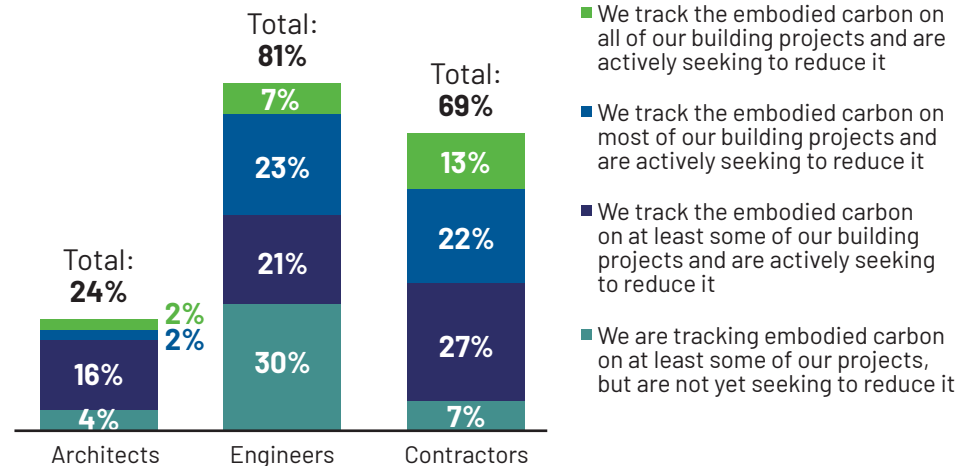
## Familiarity With the Concept of Embodied Carbon

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## Current Approach to Tracking and Reducing Embodied Carbon

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# Addressing Embodied Carbon (CONTINUED)

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

not attempting to reduce embodied carbon on their projects yet, a far higher share than the architects or contractors. However, another 30% are tracking and attempting to reduce embodied carbon on most or all of their projects. This clearly reveals varying degrees of commitments across engineering companies to addressing embodied carbon.

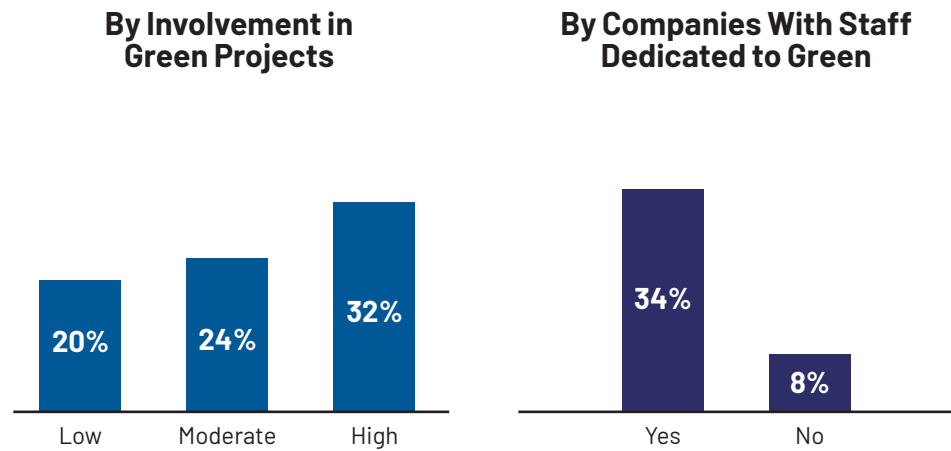
- **Contractors:** A high share of contractors also are tracking embodied carbon, and nearly all of them attempt to address it, with 35% reporting that they track and actively seek to reduce it on most or all of their projects.

The charts at right focus solely on the 23% of all respondents who report that they track and actively seek to reduce embodied carbon on most or all of their projects. They demonstrate that this high level of commitment is more common among those involved in green projects, with staff dedicated to green and by companies with formal commitments to carbon reductions.

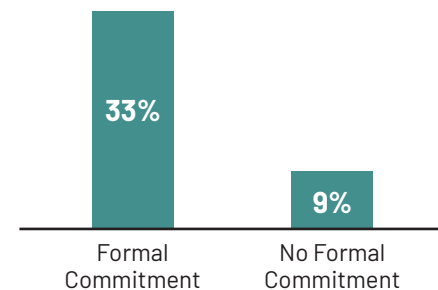
However, it is also notable that even among those with these green commitments, only about one third are currently addressing embodied carbon on the majority of their projects. This finding suggests that the industry is still in the early stages of effectively engaging with embodied carbon.

## Track and Seek to Reduce Embodied Carbon on Most/All Projects

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## By Companies With a Formal Commitment to Carbon Reduction





# Addressing Embodied Carbon (CONTINUED)

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

## CLIENT DEMAND FOR REDUCING EMBODIED CARBON

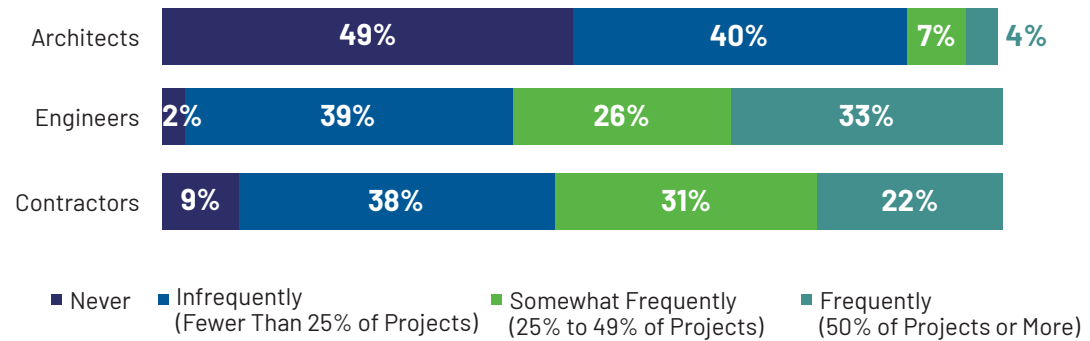
Architects, engineers and contractors were asked how frequently their clients request that they reduce the embodied carbon on their projects. Their responses, shown in the chart at upper right, reveal that engineers and contractors are experiencing owner demand for this issue to be addressed, with over 50% of each reporting client requests on 25% or more of their projects.

While this may not occur on the majority of their projects, it happens frequently enough for engineers and contractors to consider it good business sense to be able to respond to this requirement.

Those who report that their clients ask them to reduce embodied carbon were asked whether their clients have formal commitments in this area, and nearly two thirds (64%) affirm that this is the case. In addition, as was revealed in the Introduction (see page 5), engineers and contractors also frequently find that their owners have specific ESG (environmental, social and governance) requirements that influence their financial ratings.

## Frequency of Client Requests for Reducing Embodied Carbon

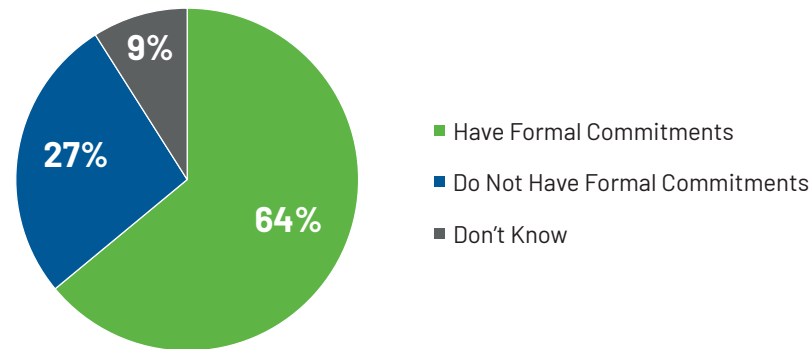
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## Share With Clients That Have Formal Commitments to Reduce Embodied Carbon

(According to Those Who Have Clients That Request Reductions in Embodied Carbon)

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# Addressing Embodied Carbon (CONTINUED)

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

## REASONS COMPANIES CURRENTLY CONSIDER EMBODIED CARBON AT PROJECT START

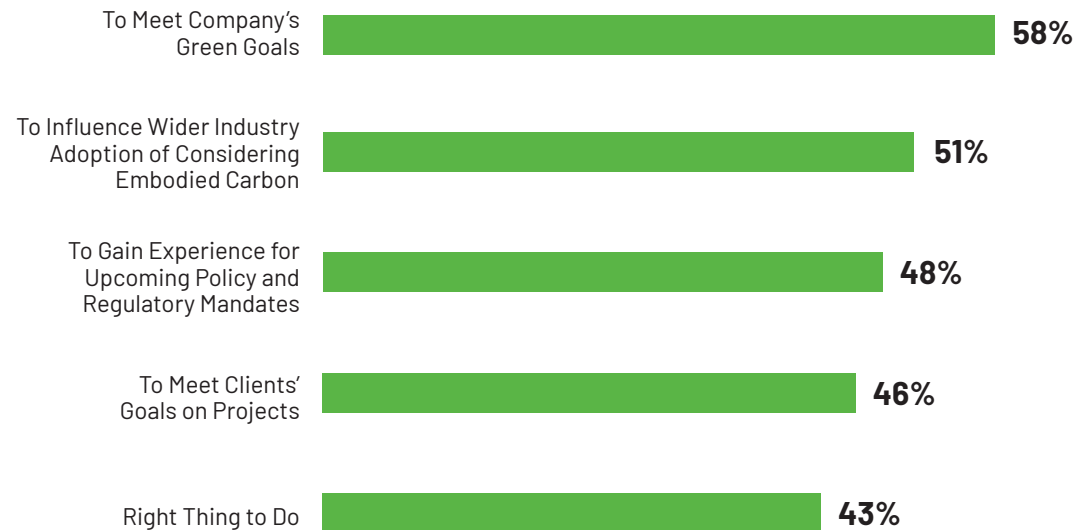
All architects, engineers and contractors who report that they track embodied carbon on at least some of their projects were asked why they take embodied carbon into consideration at the project start. Their responses are shown in the chart at right.

- The top reason they consider embodied carbon is to meet their own company's green goals. This is even more widely reported by those with formal commitments to reduce carbon emissions (66%) and with staff dedicated to green activity (64%). These internal drivers represent important commitments that are less likely to fluctuate from project to project.
- Over half are also seeking to influence wider industry consideration of embodied carbon. Notably, this is much higher than those who report they do it because it is the right thing to do, although that is the top factor for architects.
- External drivers are also critical, though, as 48% report that they want to be ready for upcoming policy and regulatory mandates and to meet clients' goals on projects.

These findings make clear that internal green goals and external, competitive drivers are helping to encourage the industry to track embodied carbon.

## Reasons That Embodied Carbon Is Taken Into Consideration at Project Start

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# Addressing Embodied Carbon (CONTINUED)

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

## REASONS EMBODIED CARBON IS NOT CONSIDERED

All architects, engineers and contractors who do not track embodied carbon on all of their projects were asked why they do not do so. There are notable differences in the findings by type of company and by having a formal commitment to reducing carbon.

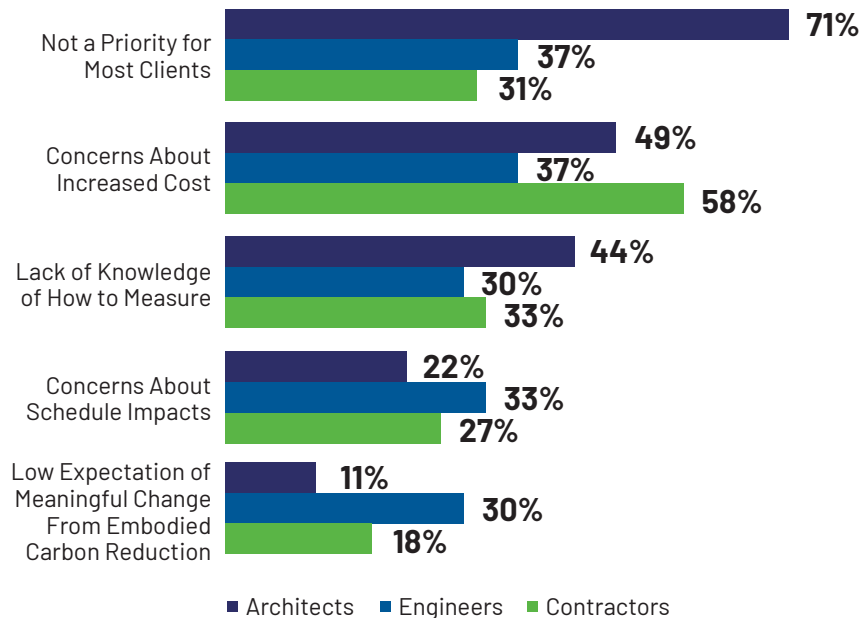
Architects are most often deterred from considering embodied carbon because it is not a priority for their clients, while contractors find

increased cost the biggest obstacle. There is no dominant reason that prevents engineers from considering carbon, with between 30% and 37% picking all of them.

The top reason that those whose companies do not have formal carbon reduction commitments cite is that it is not a priority for clients, while those with those commitments are more influenced by concerns about increased costs.

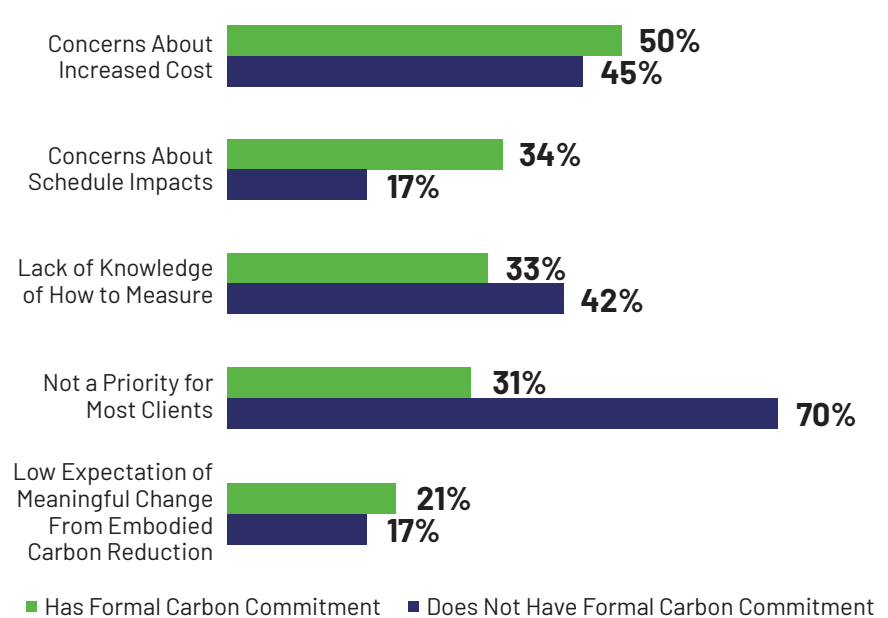
## Reasons That Embodied Carbon Is Not Considered When Starting Projects (By Company Type)

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## Reasons That Embodied Carbon Is Not Considered When Starting Projects (By Those With/Without Formal Carbon Commitments)

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# Addressing Embodied Carbon (CONTINUED)

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

## FUTURE IMPORTANCE OF REDUCING EMBODIED CARBON

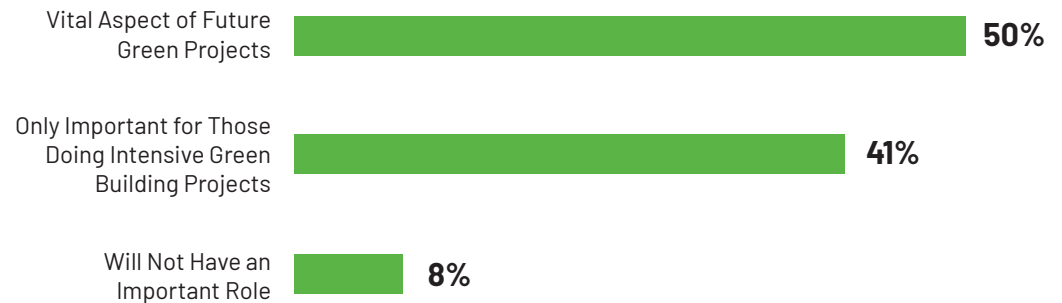
One key measure of whether an emerging trend will grow in the industry is the degree to which it is perceived as a vital part of that industry's future. Therefore, to better understand how likely it is that architects, engineers and contractors will expand the degree to which they track and reduce embodied carbon on projects, they were asked to select the option from the chart at right that best describes their expectations for the integration of the reduction of embodied carbon into green building projects in the next five years.

Nearly all agree (92%) that embodied carbon will play a role in green projects in the future. This clearly suggests that there is likely to be more investment in the ability to reduce embodied carbon in the future.

However, those who think it will be integrated into green building projects are nearly evenly split between those who expect it to be a vital aspect of all future green projects and those who think it will be important only on intensive green building projects. Given the concerns expressed about costs among both those with and without formal carbon commitments (see page 10), it may require more client consideration of the need to reduce embodied carbon to truly drive more engagement with it in the future.

## Expected Integration of the Reduction of Embodied Carbon Into Green Building Projects in Next Five Years

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# Addressing Embodied Carbon (CONTINUED)

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

## VARIATION BY TYPE OF COMPANY

Currently engineers are more likely than architects or contractors to believe that reducing embodied carbon will be considered a vital aspect of green building within five years. The findings of this study certainly suggest that engineers are strong proponents of reducing embodied carbon currently (see pages 5 and 6), and this finding suggests they will continue to lead in this area in the future.

## VARIATION BY SCALE OF COMPANY

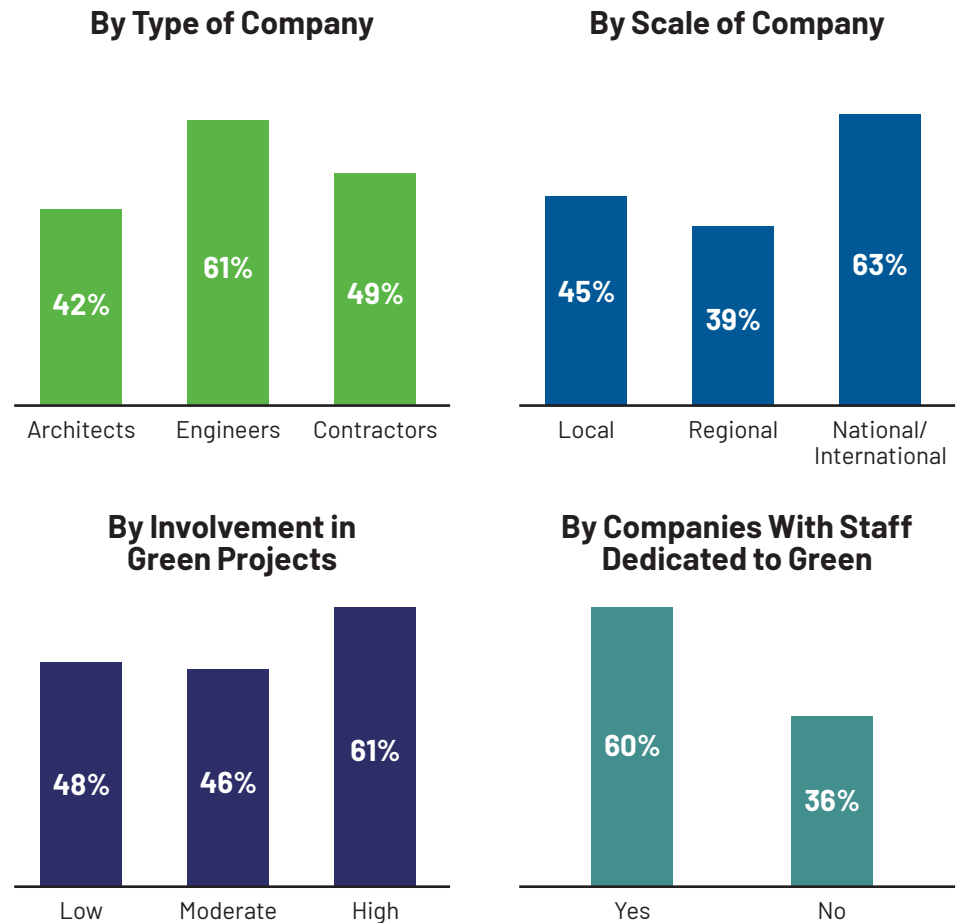
More respondents from companies that operate nationally/internationally expect embodied carbon to be vital for green building in the future.

## VARIATION BY ENGAGEMENT WITH GREEN

Notably, roughly 60% of respondents with a high level of engagement with green building agree that reducing embodied carbon will be a vital part of green building in the next five years. This includes the two groups represented on the charts at right, as well as those with a formal commitment to reducing carbon emissions and those who currently track embodied carbon on their projects.

## Believe Reducing Embodied Carbon Will Be Vital for Green Projects

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# Addressing Embodied Carbon (CONTINUED)

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

## IMPORTANCE OF REDUCING THE EMBODIED CARBON OF CONCRETE

Architects, engineers and contractors were asked about the impact of reducing the embodied carbon of concrete in particular on any of their projects that include concrete. Surprisingly, there is notable variation in their responses, as the chart at right reveals.

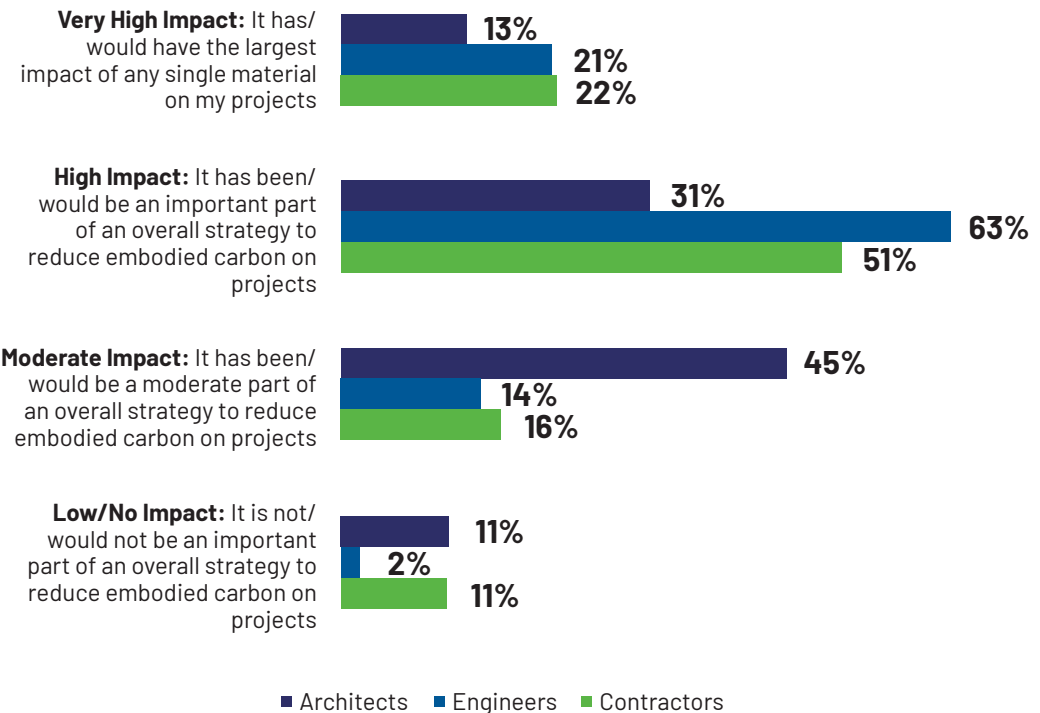
- About one in five engineers and contractors think it would have the single biggest impact of any material in the building, but fewer architects agree.
- Most engineers (63%) believe it is an important part of the strategy to reduce embodied carbon on projects, and over half of contractors agree.
- Conversely, the largest share of architects expect reducing the embodied carbon of concrete to have only a moderate impact on reducing carbon in their projects.

Notably 80% of those who track embodied concrete on their projects believe it has either the largest or an important impact.

These findings suggest that the engineers and contractors who prioritize reducing embodied carbon should seriously consider options that impact concrete in particular. See pages 27 to 30 for some advancements in the composition of concrete that can help reduce embodied carbon and the degree to which these are known in the design and construction industry.

## Impact of Reducing Embodied Carbon in Concrete on the Overall Reduction of Embodied Carbon (for Projects Involving Concrete)

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# Means for Measuring Embodied Carbon

## INTRODUCTION

In order to be able to tackle embodied carbon, practitioners must first be able to measure it. The chart at right shows how many architects, engineers and contractors who actively measure embodied carbon are using three different means to do so: environmental product declarations, project lifecycle analysis and digital tools designed specifically for the purpose of determining embodied carbon.

As the chart shows, environmental product declarations are the most common means, followed by conducting project lifecycle analysis. Clearly, both of these are essential tools for this task.

Among those doing green projects, EPDs and lifecycle analyses are more widely used than the digital tools designed specifically to determine embodied carbon. This section explores the full use of these methods among all the architects, engineers and contractors who responded to the survey.

Their prevalence and the increasing engagement with them by designers and contractors provide insight into the degree to which the design and construction industry is poised to more widely tackle the issue of embodied carbon in building projects.

## Means Currently Used to Determine Embodied Carbon on Projects

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# Means for Measuring Embodied Carbon: Environmental Product Declarations

## USE OF ENVIRONMENTAL PRODUCT DECLARATIONS

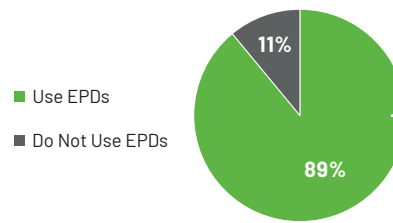
Architects, engineers and contractors were asked about the frequency with which they use environmental product declarations (EPDs) on their projects when specifying or purchasing materials. This use was not specifically tied to the issue of reducing embodied carbon, and as the pie chart at upper right reveals, the majority of the respondents have used EPDs on at least some of their projects.

- About half of those using EPDs do so as a regular practice on all their projects. This is a promising finding, revealing that it is becoming common at a high share of companies to have greater transparency about the impacts and makeup of the building products they work with.
- Over one third, though, only use EPDs on projects with specific sustainability goals. This is still a substantial share, which suggests that the use of EPDs, while nearly universal among companies, is not yet as universal across projects.

The chart at lower right shows that EPDs are requested for a wide range of building materials, most commonly for those inside of walls. Even though they rank third, EPDs for structural materials, including concrete, are still sought by 70%, revealing demand in the industry for a better understanding of these.

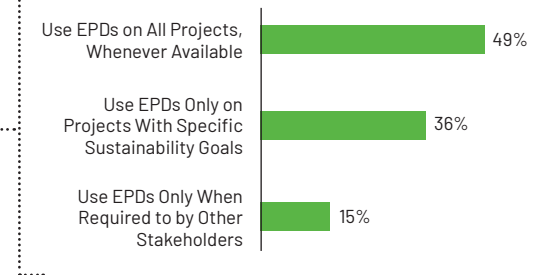
## Use Environmental Product Declarations (All Respondents)

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## Frequency of Use of EPDs (According to Those Using Them)

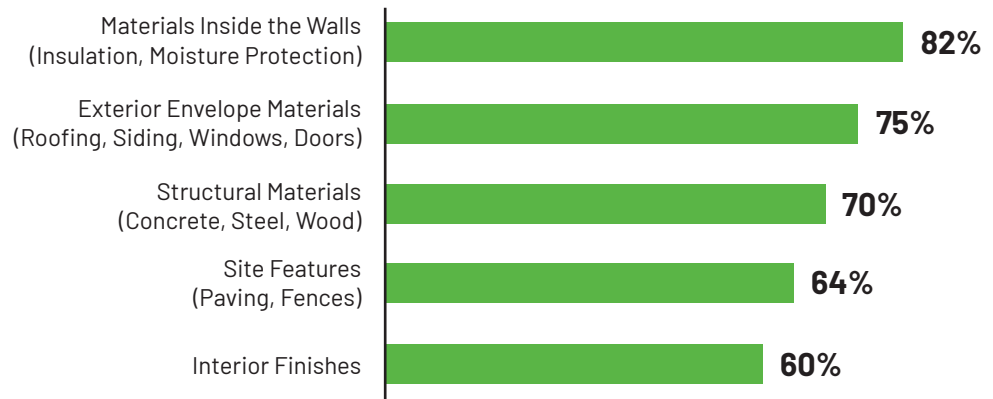
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## Materials for Which EPDs Are Requested

(According to Those Who Use Them)

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# Means for Measuring Embodied Carbon: Environmental Product Declarations

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

The charts at right provide more information about the companies that use EPDs on all of their projects, whenever available.

## VARIATION BY ENGAGEMENT WITH GREEN

Respondents with a high involvement with green projects, who actively track embodied carbon and whose organizations have formal carbon reduction commitments are all much more likely to use EPDs than those with lower levels of green engagement. This suggests that, once you have a high level of green engagement, the practices you use on green projects become more commonplace on all of your projects.

## VARIATION BY TYPE OF COMPANY

Engineers and contractors use EPDs on all their projects when available far more frequently than architects do. This may seem surprising, given that architects report a higher share of green projects (see page 4). However, architects far less frequently track embodied carbon (see page 6) or have formal carbon commitments (see page 5) than do contractors and engineers, and this may reduce the frequency with which they utilize EPDs.

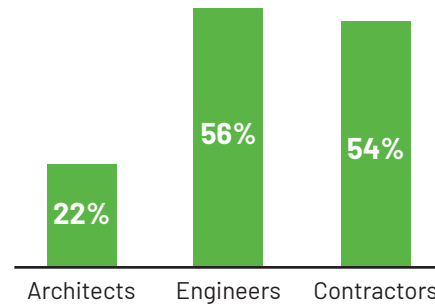
## VARIATION BY SCALE OF COMPANY

Far more respondents who work at national/international companies utilize EPDs whenever they are available than do those at local or regional companies.

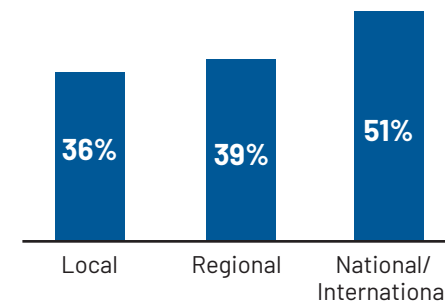
## Use EPDs on All Projects, Whenever Available

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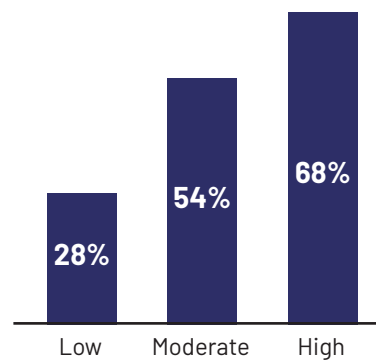
### By Type of Company



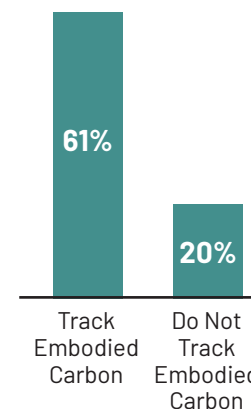
### By Scale of Company



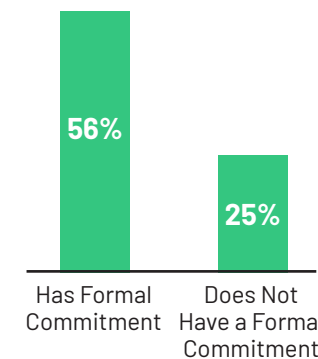
### By Involvement in Green Projects



### By Those Who Track Embodied Carbon



### By Those With Formal Carbon Commitments



# Means for Measuring Embodied Carbon: Environmental Product Declarations

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

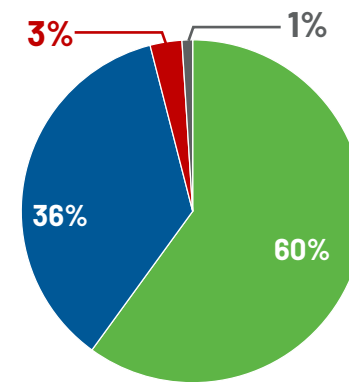
## INCREASED USE OF ENVIRONMENTAL PRODUCT DECLARATIONS

60% of respondents report that their use of EPDs increased in the last year. This finding suggests a true sea change in the industry, with EPD use becoming much more widespread.

However, this recent increase in use is not universal across design and construction. The majority of engineers and contractors experienced it, but only one third of architects did. In addition, the vast majority of those who track embodied carbon or who have dedicated green staff report this more frequently than the average, but the degree of involvement with green projects has no significant impact. This may suggest that for many companies, the focus on carbon reduction outweighs the importance of engaging in all green building practices.

## Change in the Use of EPDs in the Last Year

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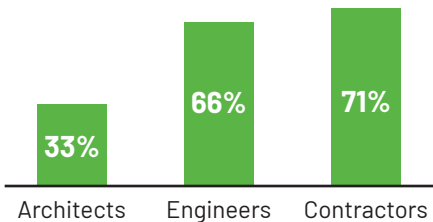


■ Increased ■ Remained About the Same ■ Decreased ■ Not Sure

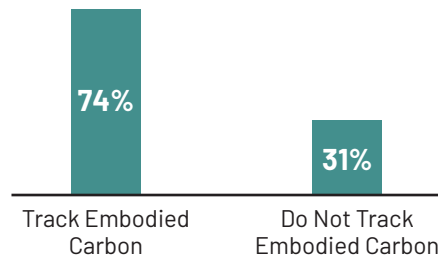
## Use of EPDs Increased in the Last Year

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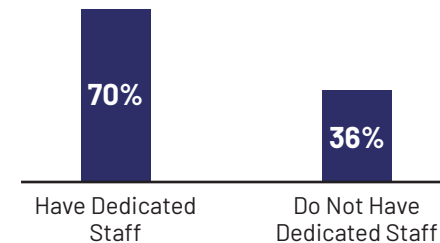
### By Type of Company



### By Engagement in Tracking Embodied Carbon



### By Companies With Dedicated Green Staff



# Means for Measuring Embodied Carbon: Environmental Product Declarations

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

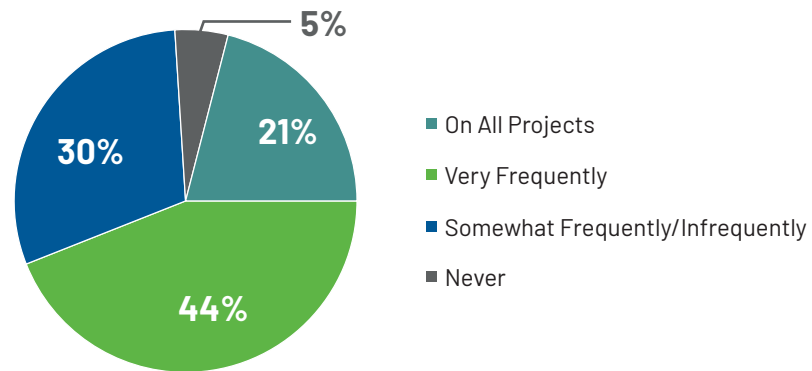
## FREQUENCY WITH WHICH EPDs ARE REQUESTED BY ARCHITECTS, ENGINEERS AND CONTRACTORS

Nearly two thirds (65%) of those using EPDs report requesting them either very frequently or on all projects in the last three years. This makes it clear that manufacturers need to be able to provide EPDs to engage with a large share of the design and construction industry.

The charts below focus on respondents whose companies request EPDs on all of their projects. Contractors lead by far in this category, suggesting that EPDs are likely to influence purchasing decisions. Involvement in green projects is the most influential factor, with 45% of those doing 60% or more of their projects green stating that they request EPDs on all projects.

## Frequency of Requests for EPDs in the Last Three Years

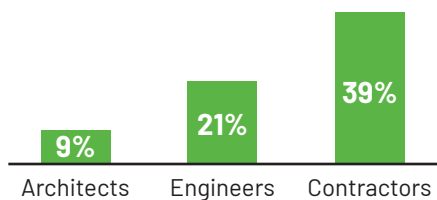
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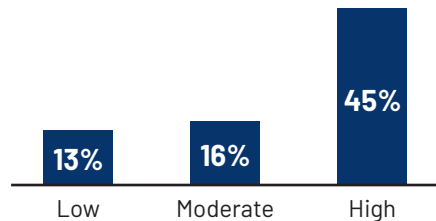
## Request EPDs on All Projects

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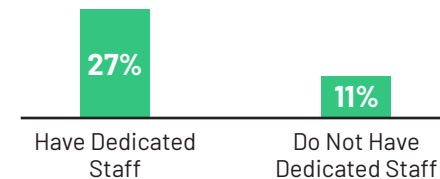
### By Type of Company



### By Involvement in Green Projects



### By Companies With Dedicated Green Staff



# Means for Measuring Embodied Carbon: Environmental Product Declarations

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

## AVAILABILITY OF EPDs BY PRODUCT CATEGORY

EPDs are a critical tool in calculating embodied carbon on projects, so one of the hurdles to increasing that activity is their availability for the products that architects and engineers want to specify and contractors want to purchase.

The chart at right contrasts their availability by building product categories according to the architects, engineers and contractors who report requesting these EPDs.

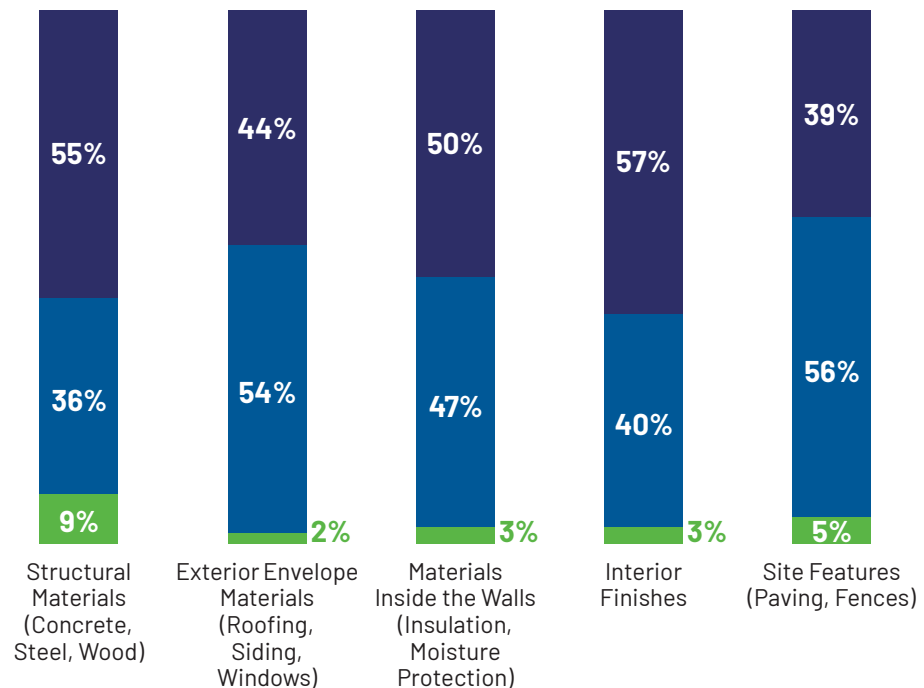
Only a small percentage report that they are rarely available. Instead, most of the respondents are nearly evenly split between those who find them widely available and those who find that they are only available for some products/from some manufacturers. The fact that around half report that EPDs are widely available in most of these product categories and around half find their availability limited may suggest that practitioners need a better way to determine the products for which EPDs are available. The only exception may be site features, where far more respondents find EPDs limited to some products or some manufacturers.

In some cases, regionality may be influential.

- Over half of those in the Northeast and South report that EPDs for exterior envelope materials are widely available, while fewer than 30% in the Midwest and West report this.
- 61% of respondents from the South also find that EPDs are widely available for materials inside the walls.

## Availability of EPDs by Product Category

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■ Widely Available ■ Only Available for Some Products/From Some Manufacturers ■ Rarely Available

# Means for Measuring Embodied Carbon: Environmental Product Declarations

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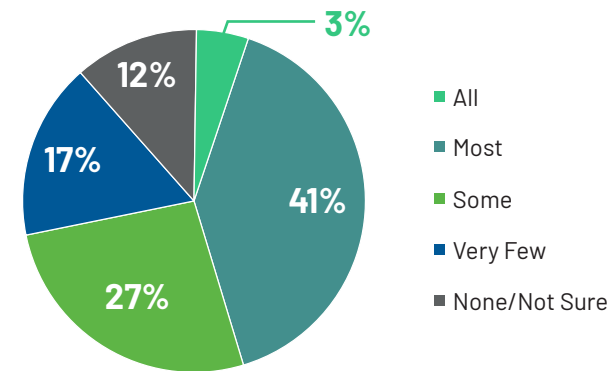
## CLIENT DEMAND FOR EPDs

Nearly half (44%) of architects, engineers and contractors report that all or most of their clients request EPDs on their projects. However, even more promising is the fact that nearly two thirds of engineers (63%) and contractors (64%) report that this is true. Client desire for EPDs likely aligns with their increased ESG commitments (see page 5).

In addition, many of those who report that they track embodied carbon and with formal carbon commitments report that their clients are interested in EPDs. More surprisingly, the same is not true of those doing a majority of their projects green, with only 32% reporting these client requests, even less than those with fewer green projects in their portfolios (51%). This may indicate that client interest in EPDs is particularly motivated by concerns about the carbon footprint of their projects, rather than an attempt to address all green priorities.

## Frequency of Clients Asking for EPDs

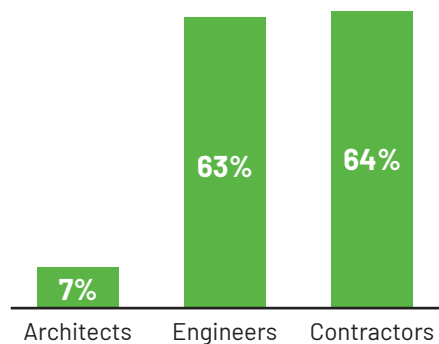
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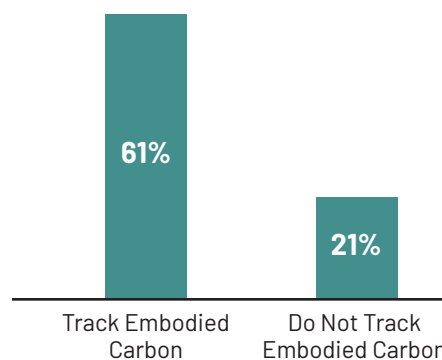
## Most/All Clients Ask for EPDs

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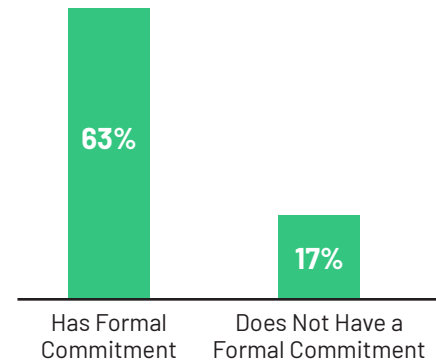
### By Type of Company



### By Those Who Track Embodied Carbon



### By Those With Formal Carbon Commitments



# Means for Measuring Embodied Carbon: Lifecycle Analysis

## USE OF LIFECYCLE ANALYSIS

Lifecycle analysis is another critical tool for measuring embodied carbon on projects, and like EPDs, is used for other reasons as well. This page and the next explore the degree to which it is in use and the obstacles preventing wider use.

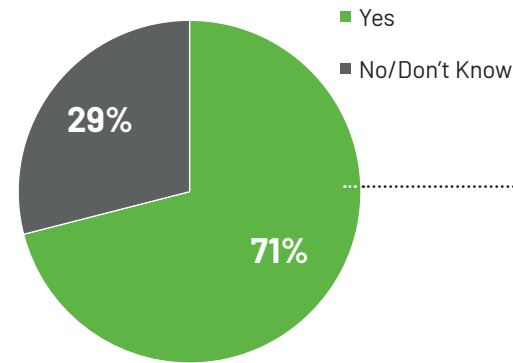
Fortunately, industry familiarity with lifecycle analysis is high, with 71% of architects, engineers and contractors using it on their projects. Users also use it frequently, on average on 41% of their projects, and the survey responses suggest it is used on about 29% of total projects. Thus while not yet commonplace, it is a well-established tool among practitioners.

As with the EPDs, engineers and contractors are using it more frequently than architects, since it is deployed on about one third of their projects, compared with 20% of the architects' projects.

The chart at lower right shows the degree of use by various green measures, from having a high share of green projects to having staff dedicated to green activity. The largest share of respondents with a formal commitment to reduce carbon emissions and staff dedicated to green activity report using it on at least some of their projects. However, the only group using it on a significantly larger share of their projects than the average are those who are highly involved in green building. This suggests that its deployment is closely linked to green projects, and it is used less frequently just to address the issue of carbon on projects that do not prioritize other green attributes (such as water use reduction, healthier indoor air environments, etc.).

## Use Lifecycle Analysis

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## Average Share of Projects on Which Lifecycle Analysis Is Used

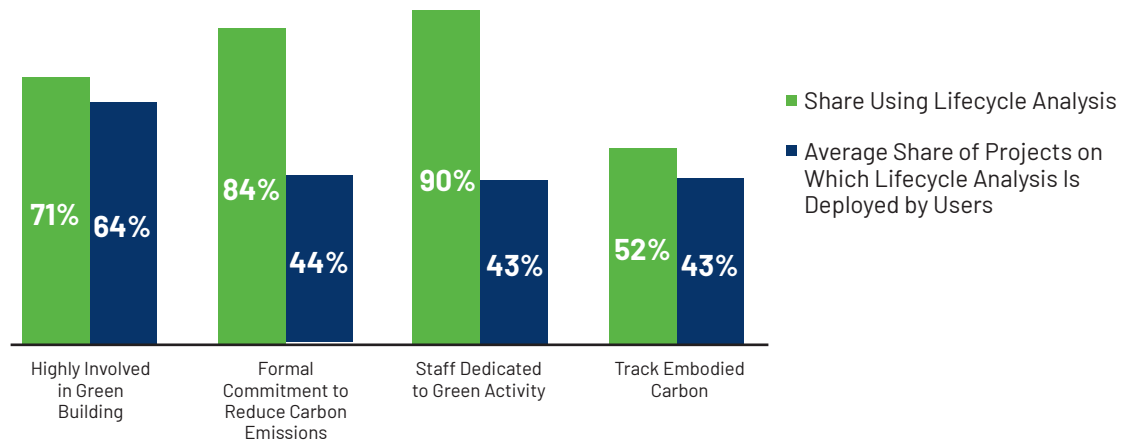
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## Use of Lifecycle Analysis

(By Green Engagement)

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# Means for Measuring Embodied Carbon: Lifecycle Analysis

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

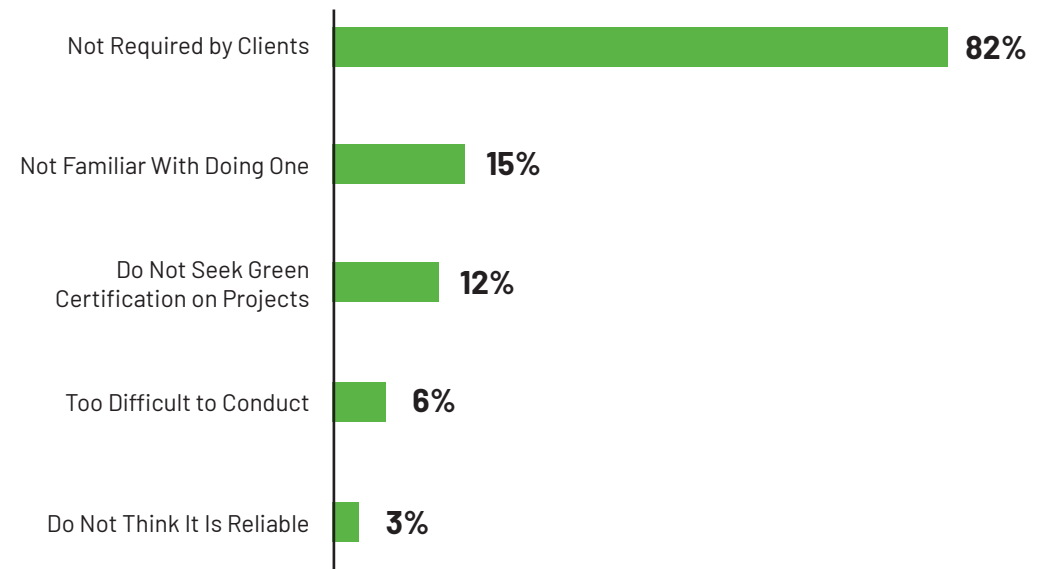
## REASONS FOR NOT CONDUCTING A LIFECYCLE ANALYSIS ON A PROJECT

Architects, engineers and contractors who implement a lifecycle analysis on fewer than 5% of their projects were asked to select up to two options from the list of five in the chart at right that best explain why they elect not to conduct them.

The results make it clear that client demand is the major reason for doing lifecycle analysis, since the absence of it is the overwhelmingly dominant reason given for not doing so. This suggests growth in using this method must come from client demand. Promisingly, with so many respondents reporting that their owners have ESG (environmental, social, governance) requirements, and that the number of owners with these requirements is growing (see page 5), it is very likely that even more companies will perform lifecycle analyses on a larger share of projects.

## Reasons for Not Conducting a Lifecycle Analysis on a Project

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# Performance-Based Specifications for Concrete

## INTRODUCTION

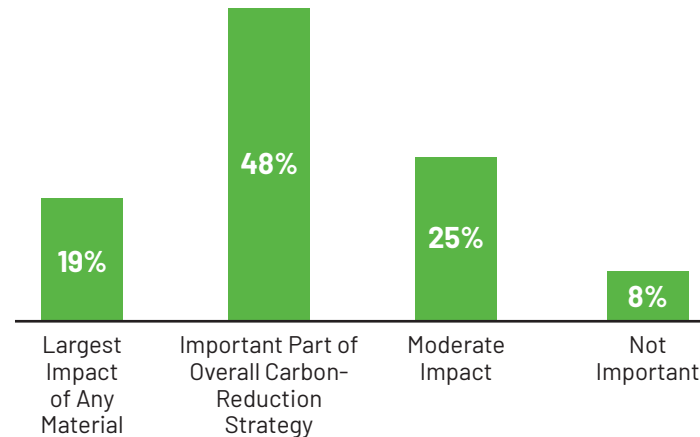
The traditional concrete products used in construction are highly carbon-intensive. In order to improve the overall embodied carbon of a project involving concrete, it should be an important part of that strategy. As previously discussed in greater detail on page 13 and summarized in the chart at right, about two thirds (67%) of the architects, engineers and contractors in the survey, all of whom have experience with buildings involving concrete, agree on the importance of addressing concrete as part of the carbon-reduction strategy.

Performance-based specifications for concrete can be effective to reduce the carbon of the product installed. The definition of a performance-based specification included in the survey is that it delineates the specific performance requirements desired, and that it provides contractual requirements to ensure that performance targets are met over a period of time after the asset is placed in operation.

This section of the report examines the use of performance-based specifications versus prescriptive specifications specifically for concrete in order to better understand current industry practice and the degree to which it is expected to change.

## Importance of Reducing Embodied Carbon of Concrete to Overall Embodied Carbon Reduction

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# Performance-Based Specifications for Concrete (CONTINUED)

## USE OF PERFORMANCE-BASED SPECIFICATIONS FOR CONCRETE

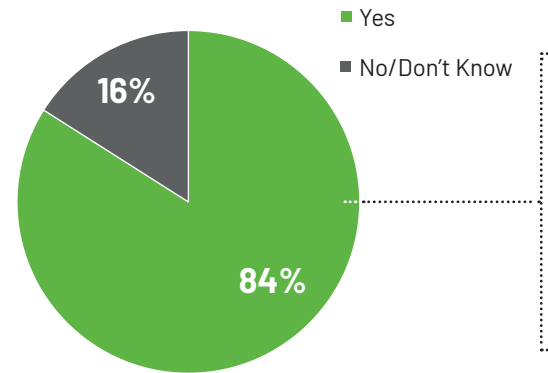
Architects, engineers and contractors were asked about the share of their concrete projects on which performance-based specifications are used for concrete. As the chart at upper right reveals:

- 84% report the use of these specifications on at least some of their projects, so industry familiarity with them is high.
- However, they are not universally adopted: 40% of concrete projects, on average, utilize performance-based specifications for concrete. While this does indicate that the practice is well-established, it is still not occurring on the majority of projects.
- One revealing finding is that while most contractors (87%) see performance-based specifications for concrete on some of their projects, only 15% report that they are used on 50% of their projects or more, compared with over 40% of architects and engineers who use them that frequently.

The chart at lower right reveals that nearly all (over 90%) of those with a high level of green involvement, including commitments to reduce carbon, employing staff dedicated to green activity or actively tracking the embodied carbon, are using performance-based specifications. However, it is also worth noting that over two thirds of those who do not report these high levels of green involvement also are using these specifications. Thus it is clear that while green engagement drives their use, other factors contribute to the decision to use performance-based specifications as well.

## Use Performance-Based Specifications for Concrete

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## Average Share of Projects on Which Performance-Based Specifications Are Used

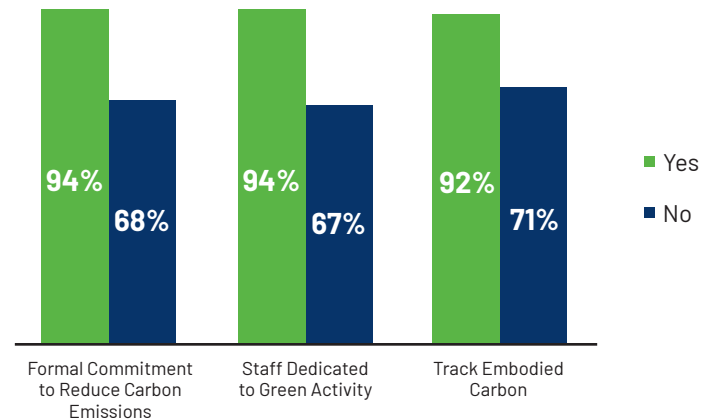
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## Use of Performance-Based Specifications

(By Green Engagement)

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# Performance-Based Specifications for Concrete (CONTINUED)

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

## EXPECTED CHANGE IN USE OF PERFORMANCE-BASED SPECIFICATIONS FOR CONCRETE IN THE NEXT THREE YEARS EXPECTED USE

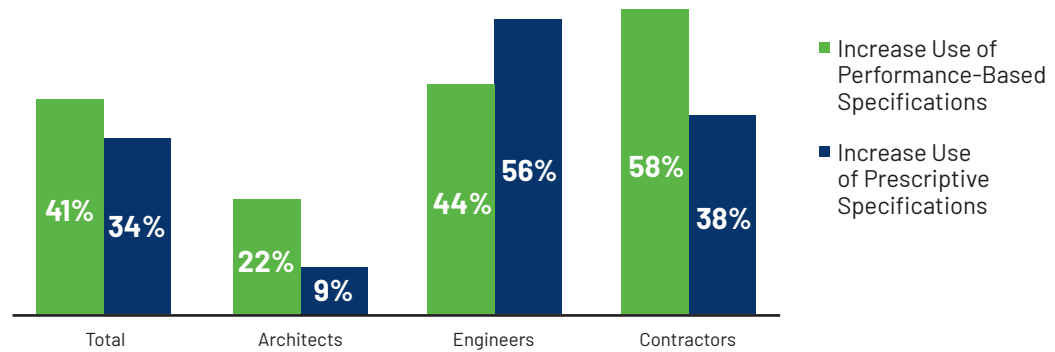
Architects, engineers and contractors were asked how they expect their use of both performance-based and prescriptive specifications for concrete to change in the next three years.

The chart at upper right shows the findings about increased usage.

- Overall, 41% expect to see an increase in the use of performance-based specifications, compared with 34% for prescriptive specifications. This could help spur a greater emphasis on reducing carbon if that becomes a common performance requirement included in the specification.
- Contractors are most likely to expect an increase, which is also telling, since they are closer to final procurement decisions that control what materials are actually installed.
- Engineers predict the greatest overall increase in the use of specifications for concrete. Although most (56%) will grow their use of prescriptive specifications, a strong 44% expect to do more performance-based specifications, potentially contributing to further carbon reduction.

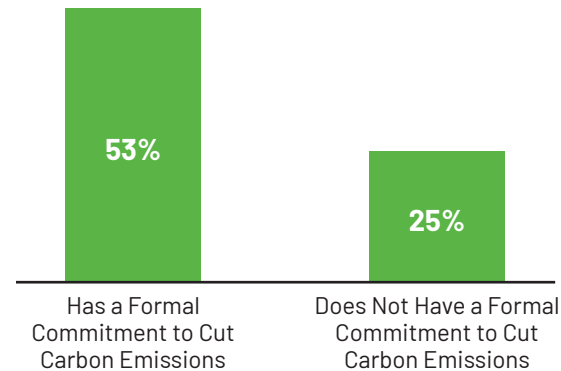
## Expected Change in Specification Practices for Concrete in the Next Three Years

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## Expects Increased Use of Performance-Based Specifications in the Next Three Years

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# Performance-Based Specifications for Concrete (CONTINUED)

- In contrast, few architects expect much change to specification practice at all.

Not surprisingly, the lower chart show that those with formal commitments to cutting carbon are far more likely to expect a shift to performance-based specifications than those that do not have those commitments.

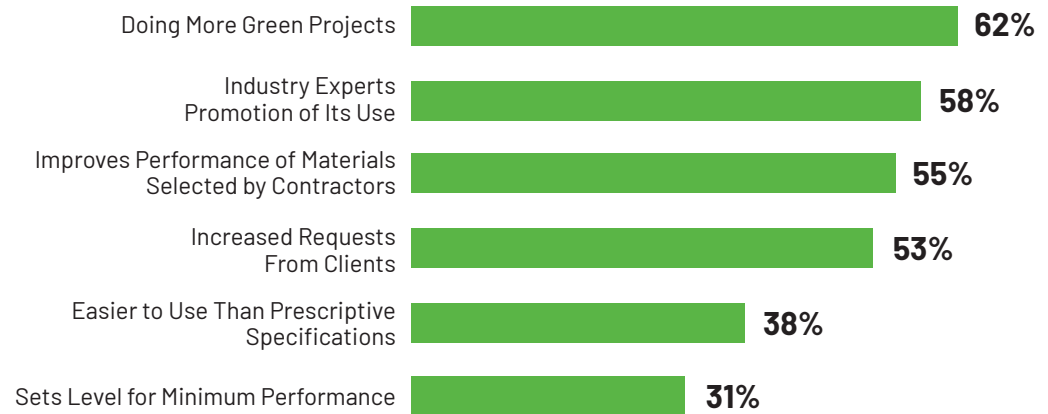
## REASONS

The respondents were asked to explain why they thought the use of performance-based specifications would/would not increase. Their responses are shown in the charts at right.

- Once again, client demands (or lack thereof) are a big factor.
- Green projects are also an important driver for increased use.
- Those expecting an increase tie it to more promotion by industry experts and improved performance of materials.
- About one quarter of respondents cite each of four reasons other than client demand for not expecting an increase. These include doubts about performance, concerns about control over product selection and difficulty to use.

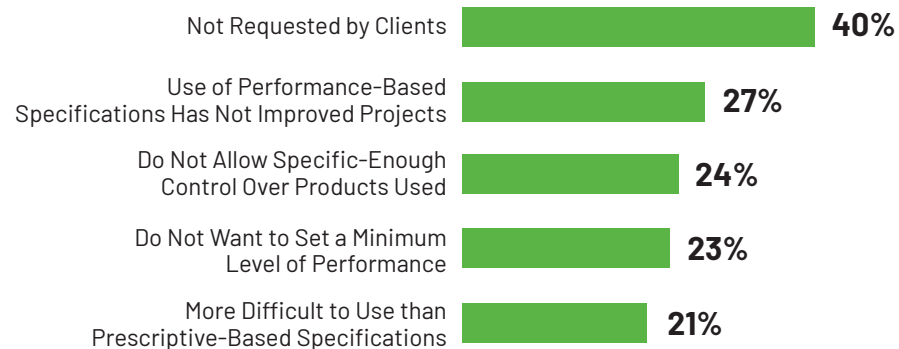
## Reasons for Increasing Use of Performance-Based Specifications

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## Reasons for Not Increasing Use of Performance-Based Specifications

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# Advancements in Green Concrete

## AWARENESS OF CONCRETE PRODUCTS WITH LOWER EMBODIED CARBON LEVELS

The findings in this report demonstrate a high level of interest in reducing the embodied carbon content of concrete projects, and some recognition of the critical importance of addressing the carbon footprint of concrete to do so. This is especially true of the engineers and contractors who responded to the survey.

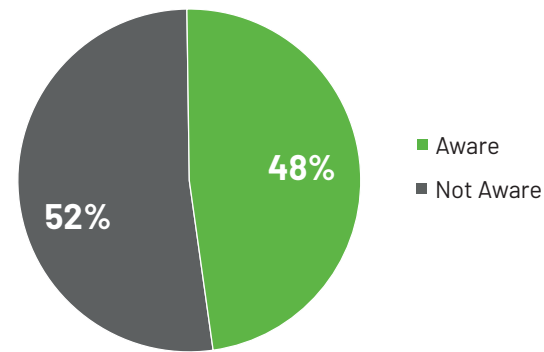
However, the commitment to do so and use of the tools to track the embodied carbon are not enough. Practitioners also need to be aware that there are products currently available that can help them achieve their goals. Currently, as the pie chart at upper right shows, the respondents are nearly evenly split between those who are aware of products they can use to address this issue and those who are not.

- Engineers have the greatest awareness of these products, which bodes well for specification in structural systems or in site work.
- However, with only half of contractors being aware, the purchasing decisions in some cases may not fully reflect the overall carbon reduction goals of the projects.
- Awareness is much greater among those with a high level of green activities and commitment. However, it is notable that about 40%, even among those who track embodied carbon and/or have a formal commitment to reduce carbon emissions, are not aware that these products exist.

These findings bode well for a growing market for green concrete, as more companies that prioritize carbon reduction learn of their options for materials to support that goal.

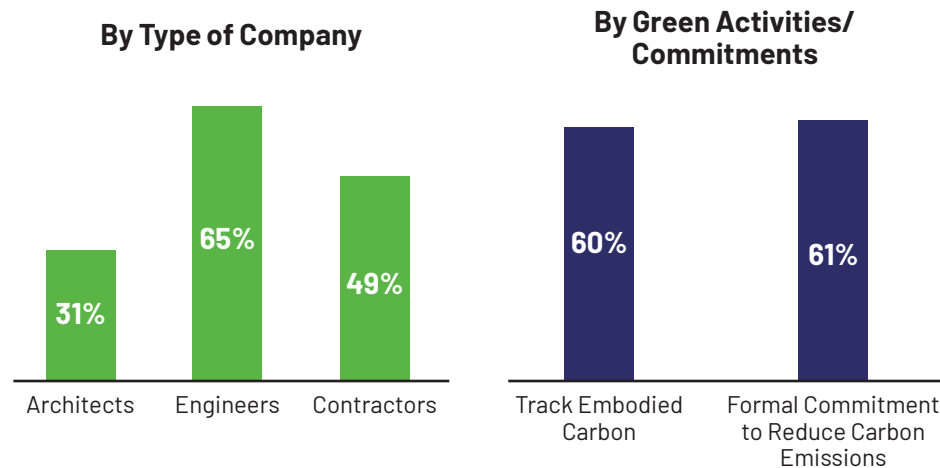
## Aware of Concrete Products or Companies That Can Reduce the Level of Embodied Carbon in Concrete

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## Share Who Are Aware of Concrete Products or Companies That Can Reduce the Level of Embodied Carbon in Concrete

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# Advancements in Green Concrete (CONTINUED)

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

## REDUCING CEMENTITIOUS CONTENT TO LOWER CONCRETE'S EMBODIED CARBON

All the architects, engineers and contractors who participated in the study are involved in either the specification or purchase of concrete for their projects. They were asked to rate the degree to which green approaches to reduce cementitious content in concrete would influence their specification or purchase decisions.

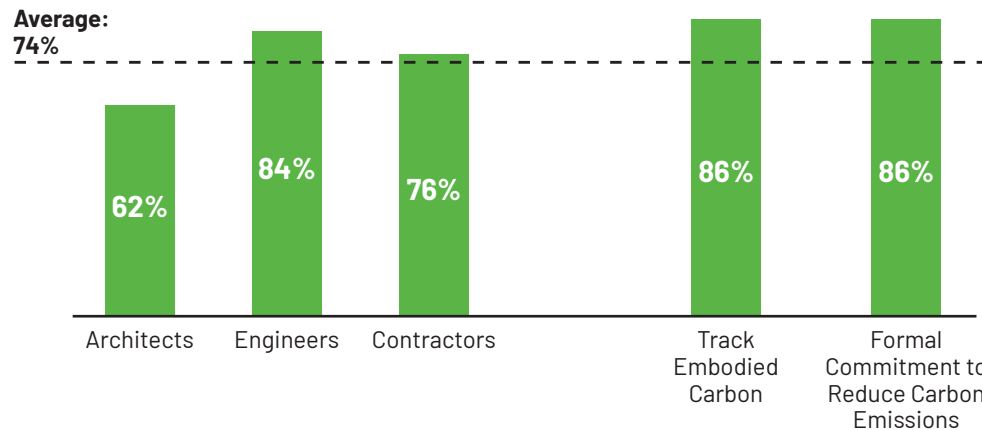
As the chart at right shows, the idea is generally popular, with nearly three quarters on average (74%) who agree this would be either positively or highly positively influential in their decisions. While levels are high for all respondents, they are particularly high for engineers, those who track embodied carbon and those with a formal commitment to reducing carbon emissions.

Those who regarded these features as influential were then asked to rate the influence of the performance of the concrete in three areas. Again, all are considered influential by over 70%. The findings demonstrate that respondents would highly value adding compressive strength, finishability and decreased water permeability as considerations in their decisions.

- The only significant difference in the share who regard increased compressive strength as influential is between those who track embodied carbon (86%) and those who do not (70%).
- About 78% of those who track embodied carbon, have formal commitments to reduce carbon emissions or have staff dedicated to green activity view decreased water permeability as influenced, compared with about 61% of those without this level of green engagement.

## Agree That Green Approaches Reducing Cementitious Content Would Be Positively Influential on Specification/Purchase of Concrete

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## Share Who Find Specific Concrete Features Influential/Highly Influential in Their Decision to Specify/Purchase Concrete With Green Approaches

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# Advancements in Green Concrete (CONTINUED)

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

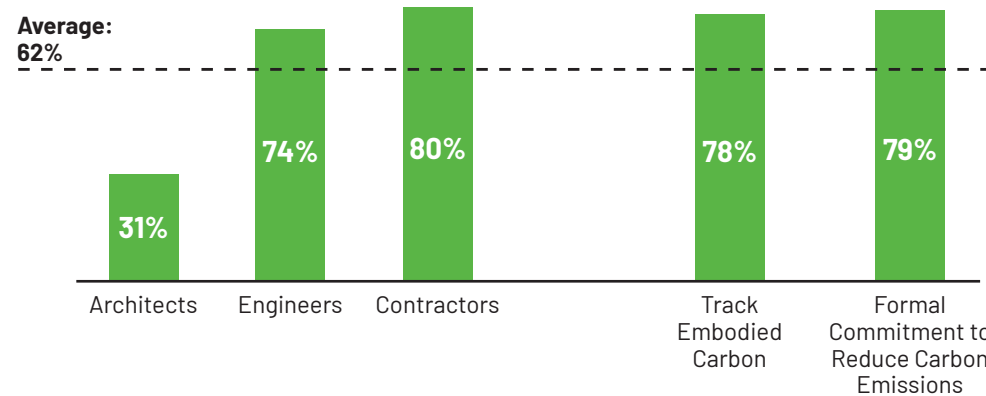
- However, there are no significant differences by company type or level of green activity in those who would be influenced by finishability.

In addition to the performance aspects of the concrete, the respondents were also asked about whether increased recognition of their company as a leader in green would encourage them to specify or purchase this type of concrete.

- Nearly two thirds (62%) would find this influential, with wide agreement among engineers and contractors on its influence, but only about one third of architects who would be swayed by this recognition.
- Again, most of those who track embodied carbon (78%) or whose company has a formal commitment to reduce it (79%) find green leadership to be influential. This is not surprising, since they are clearly investing in their company's green reputation in many ways.

## Importance of Increased Recognition of Company as a Leader in Sustainability in the Decision to Specify/Purchase Concrete With Green Approaches

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# Advancements in Green Concrete (CONTINUED)

THE DRIVE TO REDUCE EMBODIED CARBON IN CONCRETE CONSTRUCTION

## GREEN CONCRETE ADVANCEMENTS

To learn what share of practitioners are aware of certain concrete advances and how many are actually deploying them, all respondents were asked about the four specific approaches to improving the sustainability of concrete shown in the chart at right.

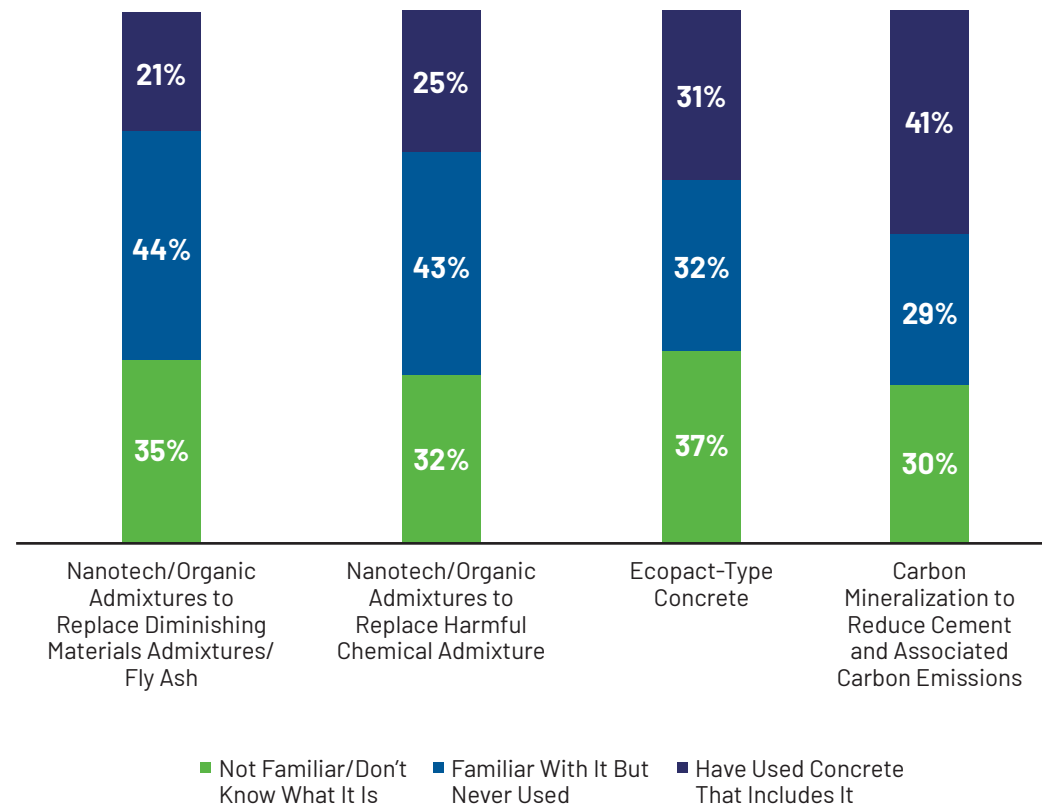
About two thirds are aware of each of these approaches, and many of those are using them.

- Carbon mineralization to reduce cement and associated carbon emissions leads in deployment (41%), especially with engineers(51%), contractors (49%) and those with green commitments/activities (55% on average).
- Nearly as many are familiar with the admixtures, but only one quarter or less are using concrete made with each of them.

These findings also highlight that many practitioners still need to learn about the specific methods being used to make these products greener.

## Familiarity With/Use of Advanced Concrete

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# Methodology

The purpose of this study is to examine the awareness and usage of methods to reduce embodied carbon in construction projects in general and, in particular, for projects involving concrete.

To examine this, an online survey was conducted from April 26 to May 16, 2022, among 133 architects, concrete contractors and structural engineers. Respondents were recruited using the Dodge Architect Panel and a third-party fieldwork vendor.

## PROFILE OF RESPONDENTS

To participate in the study, respondents had to be located in the US, have single-family residential projects comprising less than 25% of their portfolio, and had to be involved with or have influence over the specification or purchase of concrete for projects.

Response rates were as follows:

- 45 architects
- 43 structural engineers
- 45 contractors

Most respondents were in roles of firm/project leadership:

### ARCHITECTS

- Managing Principal: 18%
- Design Principal: 24%
- Project Manager: 22%
- Design Architect: 24%
- Staff Architect: 9%
- Specifications Writer: 2%

### ENGINEERS

- CEO/COO/President: 12%
- Project Manager/Assistant Project Manager/Construction Manager: 70%
- Structural Engineer: 19%

### CONTRACTORS

- Owner/CEO/COO/President: 25%
- Project Manager/Assistant Project Manager/Construction Manager: 73%
- Other: 2%

The largest share of responses came from companies located in the South (36%), with the rest divided as follows: West (24%), Northeast (23%), Midwest (17%).

### PROJECT TYPES

Nearly all respondents work in the commercial construction sector, but several other project types are also widely represented.

- Commercial (e.g., office, retail, hospitality): 80%
- Multifamily Residential: 47%
- Industrial (e.g., factory, warehouse): 38%
- Institutional (e.g., healthcare, education, public): 37%
- Single Family Residential: 25%
- Transportation: 11%
- Civil Construction (e.g., infrastructure, utilities): 11%
- Recreational: 9%
- Other: 1%

### DEFINITION OF EMBODIED CARBON

The following definition of embodied carbon was provided to the survey respondents:

Embodied carbon is the carbon dioxide (CO<sub>2</sub>) emissions associated with materials and construction processes throughout the whole lifecycle of a building or infrastructure asset.



# Contacts & Resources

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Research Director  
Industry Insights

## ADDITIONAL RESOURCES



CarbonCure manufactures a suite of technologies that enable concrete producers to add captured carbon dioxide into the production process, resulting in the same reliable concrete but with a reduced carbon footprint. CarbonCure's carbon dioxide removal technologies are used in hundreds of concrete plants around the world every day, helping to reduce the carbon footprint of our built environment—one truck at a time.

<https://www.carboncure.com/>



Bio Graphene Solutions (BGS) is a manufacturer of consistent, high-quality graphene from 100% organic source materials. Our revolutionary, clean-tech production process enables BGS to produce biographene that, as a performance additive, can significantly increase strength, elasticity, conductivity, and longevity in different materials and applications within the concrete and asphalt industries

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■ Design and Construction Intelligence

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