A Primer for Building Sustainability and Resilience

Everyone has a role in the journey toward sustainability.

By Jose B Rodriguez

SUSTAINABLE BUILDING PRACTICES HAVE EVOLVED from ancient traditions that used local materials and passive design to modern innovations addressing current environmental challenges. Today's sustainable buildings emphasize energy efficiency, resource conservation, and occupant health using advanced materials and technologies such as energy modeling and lifecycle assessments to minimize their carbon footprint. Certification systems like Leadership in Energy and Environmental Design (LEED) set rigorous standards, requiring buildings to meet criteria for energy use, materials, and indoor environmental quality. The movement now addresses decarbonization, resilience to climate hazards, and ethical considerations, while also facing challenges like greenwashing and market adoption. Looking forward, the focus is shifting toward restorative

Digital Object Identifier 10.1109/ESM.2025.3583840
Date of current version: 26 September 2025

©SHUTTERSTOCK.COM/KB_3

During the energy crisis of the 1970s, greater efficiency in buildings grabbed the public's attention, and the first standard for energy use was developed.

design as some question whether current practices truly achieve long-term sustainability.

The following article, although not exhaustive, aims to provide the reader with context and a primer on how sustainability is addressed in the buildings' industry. The goal is to illustrate innovative and sustainable solutions that promote resilience and environmental stewardship in building design and operations while ensuring their "sustainability" claims are legitimate.

What Is in a Word?

In the architecture, engineering, and construction (AEC) industry, *sustainability* has for some time been a catchall word, an umbrella term that accommodates, perhaps simplifies, a wide range of topics and strategies related to the environmental performance and physical health of assets.

Renewable and geothermal energy? That's sustainability. Carbon emissions, health and wellness, air and water quality? That's also sustainability. Daylighting, providing bicycle facilities and EV charging stations, healthy building material selection, window and glass performance? Yes, all of these are within the building sustainability realm.

Origins

Environmentalism

Marine biologist and conservationist Rachel Carson's 1962 breakthrough book, *Silent Spring*, explained the regrettable consequences of human actions on the environment, noting knock-on effects to the ecosystem. Through her scientific research, she was able to link the increased and prolific use of the pesticide chemical DDT (dichloro-diphenyl-trichloroethane) to a decline in bird births. Her early work in educating the public on the side effects of unmitigated use of chemicals credits her as one of the earliest champions of the modern environmental movement, which insists on a comprehensive understanding of decisions to avoid future regrettable outcomes.

Carson was a pioneer of her generation, but she was not alone. She was not the first to loudly voice the impact that human actions have had on the environment or to have the idea of designing with the environment in mind. The "tree hugging" concept dates to the Bishnoi religious sect in northern India in the 18th century. The solar architecture movement during the middle of the 20th century as part of the American modernist styles experimented with insulation and passive solar heat storage way before solar photovoltaics were feasible. At the time, they were considered an alternative or fringe movement without deep market penetration. Today, designing with the sun in mind, and with climate-responsive strategies, have become essential in the architecture industry.

A Crisis Creates a New Industry

Environmental and passive design concepts continue to evolve today as they have for the past 50 years. During the energy crisis of the 1970s, greater efficiency in buildings grabbed the public's attention, and the first standard for energy use was developed. Since 1975, the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) has been publishing the industry standard, known today as *ASHRAE 90.1 Energy Standard for Buildings*. The document has had 11 updates over the last 50 years, most recently in 2022. This became not only a building energy performance standard for states and municipalities, but the baseline for future building sustainability performance.

Globalization of Sustainability

The United Nations (UN) created the World Commission on Environment and Development (WCED) in 1983. The WCED published the report "Our Common Future," also known as *The Brundtland Report*, in 1987. The report introduced the broader concept of sustainable development, which it defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs," and included the notion of sustainability in buildings. The report stated that critical environmental problems were primarily the result of

LEED is a third-party certification program for a building's sustainable design and construction achievements.

the enormous poverty of the Global South and the nonsustainable patterns of consumption and production in the Global North.

The United Nations Conference on Environment and Development (UNCED), also known as the *Earth Summit*, held in Rio de Janeiro in 1992, further solidified sustainability as a global priority. The UN adopted Agenda 21, a comprehensive action plan that included chapters on promoting sustainable human settlements, which influenced sustainable building practices worldwide.

People, Profit, Planet

John Elkington, an economist and self-labeled "ambassador from the future," in 1994 used the concept of People-Profit-Planet to describe a framework, the pillars, to measure a company's social, environmental, and economic impact. This triple bottom-line approach encourages businesses to consider all three areas equally, rather than solely focusing on financial profits. The concept transcended from the financial and corporate realm into the building industry and fundamentally shaped how buildings should be evaluated.

Environmental Pillars in Buildings

After focusing on building science for more than a half century, the Building Research Establishment in the United Kingdom created BREEAM (Building Research Establishment Environmental Assessment Method), which launched in 1990. BREEAM adopted a holistic approach to assess various aspects of a building's environmental impact, including energy, water, materials, waste, ecology, and management processes. BREEAM then became a model for the certification framework known as *Green Globes*, which launched in 2000 in Canada.

The establishment in 1993 of the first Green Building Council, which later became the U.S. Green Building Council, and the development of the Leadership in Energy and Environmental Design (LEED) sustainable building certification system in 1998 further formalized the concept of sustainability in buildings in North America. This period also saw the introduction of standards and certification systems to promote sustainable building practices around the world. Today, there are LEED-certified buildings in more than 140 countries, and there is a chapter of the World Green Building Council in more than 100 countries.

Delivering Building Sustainability

Many of today's projects include a comprehensive array of sustainability and resilience frameworks that support the advancement of environmental and human health objectives in the built environment. Some of these frameworks assess buildings, sites, master plans, or products, and collaboration with project design teams is expanding to include a wider array of disciplines to explore and implement green building, energy, and health goals. It is common for teams to hold integrative workshops to set sustainability objectives, engage stakeholders, and develop a unified vision for environmental performance. In such workshops, the traditional role of architects and mechanical engineers in setting performance targets has expanded to include other disciplines due to the increased importance of energy management, supply, generation, and storage.

How does sustainability consulting work in the AEC industry? Most of the time it is as straightforward as the definition of the project itself. Someone needs a new library, a fire station, a warehouse, or a workspace fit out. They have a program, budget, and schedule. The design, construction, and owner teams are aligned and have a performance goal and establish key performance indicators as part of the basis of design for the project. The team anticipates a percentage of energy savings, aims to achieve water savings, and makes thoughtful selections of construction materials to reduce the embodied carbon (EC) and maintain good indoor environmental quality. So, they hire a consultant or consultants to 1) manage a third-party assessment process, 2) create a water-use model, 3) create a lifecycle analysis model for EC and other global warming

metrics, 4) conduct a specifications review, and 5) create an energy model. All these models feed information back to the holistic sustainability assessment. The most widely used assessment today is LEED.

LEED

LEED is a third-party certification program for a building's sustainable design and construction achievements. The program was created in 1998 and is administered by the U.S. Green Building Council, and third-party verification of compliance is performed by Green Business Certification Inc. The goals of LEED are to reduce resource consumption of energy, water, and materials and to design healthy indoor environments to promote productivity and work output.

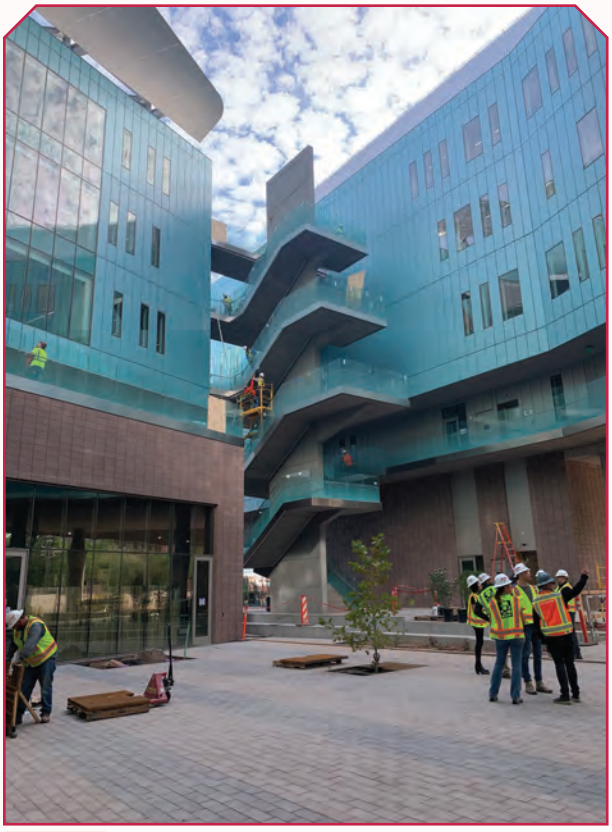

figure 1. The Rob and Melani Walton Center for Planetary Health at Arizona State University in Tempe is a LEED certified building at the Platinum level. The Walton Center maximizes sustainable best practices to reduce operational energy, water demand and embodied carbon. The floor slabs incorporate a bubble system to create voids and reduce the amount of concrete as part of the strategy implemented to mitigate greenhouse gas emissions from the cement's embodied carbon. The glass fiber reinforced concrete (GFRC) facade offers self-shading properties that were inspired by the Saguaro cactus to balance daylight and solar heat gain. (Courtesy of Thornton Tomasetti.)

LEED certification is a point-based system and the designation is earned by achieving all prerequisites and additional points toward a desired certification level (see Figure 1).

In some instances, buildings are required to achieve a specific level, such as LEED Silver or LEED Gold, to comply with local laws. Other times, LEED is pursued as a market differentiator and means of improving asset value. Many property owners pursue LEED certification to achieve environmental goals and are using LEED as an industry-accepted benchmark for high performance, with a maximum certification level of Platinum.

LEED Building Requirements

LEED is a performance-based benchmark with seven credit categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation in Design Process, and Regional Priority. There are 110 points available in the current LEED system (v4), and to achieve certification, a project must receive a minimum of 40 points, 50 for Silver, 60 for Gold, or 80 for Platinum. Some of the sustainability strategies that LEED encourages are:

- Provide clean indoor air to occupants. Prohibit smoking inside and in proximity to the building.
- Encourage early interaction among team members. Discuss opportunities for energy and water-use reduction through simple energy modeling and whole-building water modeling during the schematic design phase.
- Avoid development on environmentally sensitive lands. Select a project site on previously developed land, outside a flood zone, away from water bodies and wetlands, and not within an endangered species habitat or on prime farmland soil.
- Encourage the use of low-carbon and mass transportation options and reduce greenhouse gases emissions from vehicle travel.
- Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.
- Restore soil health.
- Reduce stormwater runoff from paved surfaces and encourage use of greenspace as a water sink.

Energy modeling can forecast a new or an existing building's performance against standards or carbon emissions goals.

- Reduce consumption of potable water for landscape irrigation.
- Reduce energy requirements and consequent greenhouse gas emissions from building operations.
- Reduce building greenhouse gas emissions through electrification.
- Use building materials with critically assessed and publicly documented human health impact statements.
- Reduce consumption of raw materials.
- Limit use of building materials with known human health impacts from volatile organic compounds.
- Incentivize projects to achieve credits that are most significant to their geographic area.

Modeling a Proposed Building's Energy Use

Energy modeling is the process of generating software models to forecast a building's total annual energy consumption. Building energy modeling software has evolved significantly in the last 30 years, and with today's advanced technologies, a modeler can create a virtual representation of a building's geometry, thermal envelope, and electrical and mechanical systems to simulate interactions with its environment, weather, and occupants. This is an extremely useful tool that enables design teams to optimize a building's energy performance by evaluating different design scenarios. It is also used as the standard means of demonstrating compliance with state and municipal energy codes as well as green building certification programs.

Most jurisdictions require that a proposed building estimates its annual energy use against a baseline. In many areas, new construction projects are required to demonstrate a percentage improvement over a code-minimum building.

This workflow of an energy modeling process includes the assessment of energy convervation measures (ECMs). Based on viable design and system selection alternatives, a measure is compared against both the baseline code-compliant building as well as the proposed design to demonstrate its energy and cost savings. Some ECMs are intended to limit solar heat gain exposure, analyzing different mechanical systems such as all-electric heating and cooling, gas-fueled systems, air distribution, exterior shading configurations to minimize cooling, and building management systems and controls to adjust things like ventilation rates to assess their impact on overall energy use.

Use of Building Energy Models

Not only can the energy model predict annual usage, but the data can also be translated into operational greenhouse gas emissions using local grid emissions factors.

Some municipalities, such as New York City, have mandated greenhouse gas emission limits for buildings. Energy modeling can forecast a new or an existing building's performance against standards or carbon emissions goals. This information helps architects, operators, and developers make lifecycle cost decisions that not only align with the construction budget but with the operational budget, capital expenditures, and company commitments as well. It also enables compliance with local laws.

Several third-party sustainability certification programs for new construction require whole-building energy modeling and associated high performance as a part of the certification. Some projects strive to go above and beyond code-minimum and base sustainability certification requirements to pursue net-zero energy or carbon, where the energy or the carbon emissions of a project are offset 100% by renewable energy generation on an annualized formula.

Energy models can be used as part of a lifecycle cost analysis to evaluate the total cost of ownership of a project over its lifespan for different design options. Owners can then select designs that balance first costs and operational costs throughout the useful life of the asset, not simply the day-one construction costs.

Buildings' Lifecycle Environmental Footprint

EC is the greenhouse gas emissions from the extraction, manufacture, transportation, and installation

of construction materials. In simple terms, a building's carbon footprint consists of operational carbon plus EC. Until the mid-2010s, the building industry's focus has been on reducing its operational impact, which includes the financial costs of the energy used to operate a building and the carbon emissions associated with that energy.

Thanks to advances in understanding how to manage building energy demand through better design and more stringent energy codes, that operational footprint is shrinking, leaving the EC piece as the next evident challenge to tackle. On average, more than half of a building's carbon footprint is in its structure, and at least 23% of global CO_2 emissions stem from the production of concrete, steel, and aluminum.

EC is assessed by modeling and quantifying the quantities and types of materials used on a project. Materials suppliers are asked to provide a disclosure on the environmental impact of their products via a third-party approved declaration (environmental product declaration or EPD). All materials' and products' impacts (largely foundations, superstructure, and façade) are aggregated and compared against a baseline. The baseline varies by project and specific sustainability rating system requirements, but it could include national or regional averages, peer projects, and industry standards.

The lifecycle assessment (LCA) of carbon is expanding from a focus on analyzing building structures and façades to identifying options to reduce EC and other greenhouse gas indicators. This occurs during the whole life of a building, where the core and shell is assessed as well as the comparative impact of operations and future maintenance. LCAs are starting to factor in the lifecycle carbon impact of energy storage, carbon sequestration, and onsite renewables. Traditional linear modeling to optimize design via conservation strategies is no longer sufficient.

Next are some common building materials and approaches for reducing EC.

Cement and Concrete

Cement makes up for approximately 95% of the carbon footprint of concrete. Global cement production accounts for roughly 8% of carbon emissions every year. Some strategies that project engineers use to mitigate the EC footprint of concrete include design optimization, volume reduction, alternate concrete capacity, and cement alternatives (limestone cement and by-products of steel manufacturing, like fly ash or slag).

Steel

EC in steel is driven primarily by the energy demand used to melt and combine raw materials in a steel furnace. There are two predominant types of industrial furnaces: a basic oxygen furnace (BOF), which accounts for 75% of global steel production, and an electric arc furnace (EAF), which accounts for the other 25% (with a larger percentage in North America).

A BOF is reliant on direct on-site fossil fuel combustion. Meanwhile, a EAF uses primarily electricity, with the potential to be powered by renewable energy sources. The carbon footprint of a BOF can be as large as 3× that of an EAF.

Project teams will consider strategies such as design optimization, selection and specification of steel shapes and members supplied by EAF.

Timber

Timber construction can lower the EC of a typical building by as much as 60% over steel and concrete. Unlike steel and concrete, which rely on change and innovation to reduce EC, timber construction technologies are available to us now and at scale. Codes are continuing to expand and promote the use of wood construction for all building typologies.

There are several timber certification schemes, such as the Forest Stewardship Council, the Program for the Endorsement of Forest

figure 2. Timber construction is gaining traction as a sustainable building material due to its low EC and ability to store carbon. Mass timber products can be used for everything from single-family homes to high-rise buildings. (Courtesy of Thornton Tomasetti.)

Certification, and the Sustainable Forestry Initiative, which take a conservation-based approach to managing forests.

But timber alone is not a silver bullet. Structures that include large spans using timber can demonstrate a higher carbon footprint than more traditional construction methods. Engineered timber still has a significant carbon footprint and, as the volume of timber for a project increases, it can become inefficient in terms of EC, particularly when topping concrete is added for finishes, acoustics, and/or deflection mitigation (see Figure 2).

Timber sequesters carbon during a tree's growing life, a process known as *biogenic carbon*. Although age and tree species determine exactly how much carbon is stored by a particular specimen, research indicates that a single timber product stores, on average, 1 ton of CO_2 per 1.3 yd^3 of wood.

Healthy Buildings, Sick Buildings

As the sustainability and environmental movement tackles the "planet" pillar of the triple bottom line of the built environment, other criteria have been developed to address the "people" pillar. The health and wellness of building occupants has been studied for a long time, and the indoor environmental quality has a direct impact on the well-being of its occupants. Sick building syndrome occurs when buildings cause chronic disease or infection to their occupants. This can occur when insufficient fresh air is provided within the building, or if toxic or hazardous materials are present within the building or its components due to inadequate cleaning or the application of pesticides. Common symptoms occur among many people who regularly visit or work within the building, and can include headache, sinus irritation, fatigue, nausea, skin irritation, and asthma.

Some of the health and wellness strategies provide adequate fresh air to occupied spaces, adequate artificial lighting, comfortable temperature set points and the possibility of individual controls, interior acoustic performance, occupant access to nature and natural systems, monitoring and testing of air and drinking water quality, and ergonomic furniture.

The WELL Building Standard was launched by Delos in 2014, and it is currently managed and administered by the International WELL Building Institute (see Figure 3). WELL addresses a wide range of health issues within buildings and communities. WELL can be achieved regardless of the building type and is often pursued in commercial office spaces.

Decarbonization

Decarbonization of the built environment requires a holistic look at the impact of buildings and other structures—a whole-life carbon approach. Whole-life carbon refers to the combination of operational and EC during a project's entire lifespan. It also targets high-performance envelopes, fully electric buildings, carbon sequestration and future proofing relative to retrofits, future energy supply, and operations under a more diversified electric grid condition (see Figure 4).

Building electrification is helping to drive decarbonization in the built environment. New strategies and requirements involve replacing fossil fuel-powered appliances and energy systems in buildings with electric alternatives, like electric heat pumps for heating and cooling. This process aims to reduce reliance on fossil fuels, lower carbon emissions, and improve air quality both indoors and outdoors. Local and state governments are implementing policies and regulations to promote, incentivize, or mandate utilities and building electrification, often through incentives and requirements for new construction and retrofits.

Ethical Decarbonization

Ethical decarbonization is an emerging topic aimed at identifying risk and ultimately eliminating forced labor and human trafficking from the building materials supply chain. Millions of people globally live in modern slavery, with numbers on the rise. At its core, modern slavery reflects extreme inequality. This is part of the "people" pillar in the sustainability triple bottom line.

Although laws around the world exist to combat this issue, including those pertinent to U.S. and European imports of construction materials, they are not fully implemented, and violators are not always held accountable.

Many people are unaware of the rights they have to dignity and freedom, allowing for a power imbalance that fosters an environment conducive to forced labor and human trafficking. Even where people are aware of their rights, they may live in communities where police ignore their concerns, or worse, retaliate against them and their families. Some of the building products with the highest risk of labor issues include brick, concrete, copper, glass, iron, mica, polysilicon, polyvinyl chloride, flooring, rubber, steel, stone, timber, and zinc.

figure 3. Terminal Warehouse, a landmarked structure in New York's West Chelsea Historic District, is undergoing a transformation. Built in 1892, the 1.2-million-square-foot warehouse complex is being converted into an office, retail, and hospitality space. Thornton Tomasetti led the development of a comprehensive, site-specific climate risk assessment that involved analyzing vulnerabilities and evaluating cost-effective resilience strategies. The project is pursuing LEED Platinum and WELL Gold certifications and focuses on biophilic and active design elements. (Courtesy of Bess Adler/Thornton Tomasetti.)

figure 4. When completed in 2021, Harvard University's Science and Engineering Complex in Cambridge, MA, was the largest building and first with wet labs to achieve the Living Building Challenge Material Petals certification. The project team analyzed more than 6,000 materials to identify, source, and purchase nontoxic products that reduce the university's supply chain impact and prioritize occupant health. (Courtesy of Bess Adler/Thornton Tomasetti.)

Resilience to Climate and Environmental Hazards

As the AEC industry becomes more proficient at minimizing its impact on the environment, we are challenged by the impact the environment is having on buildings, cities, and communities due to climate change. Assets often face chronic stresses and shocks from extreme events, such as floods, hurricanes, and earthquakes, and their ability to prepare, adapt, respond, and rebound affects their current and future performance.

An integrated resilience strategy includes a multidisciplinary approach to climate risks and identifies solutions for increasing resilience to these climate-related hazards, most importantly considering the current and future trends that building codes tend to neglect.

A climate hazard risk assessment evaluates the susceptibility of buildings, infrastructure, and communities to shocks and extreme events. Those hazards may include sea-level rise and coastal flooding, storm surges, extreme precipitation, freeze-thaw, heavy snow and hail, rising groundwater levels, wildfire and smoke, extreme heat, droughts, seismic events, landslides, land subsidence, coastal erosion, hurricanes, severe thunderstorms, and tornadoes.

The analysis of a building's ability to withstand or adapt to climate hazard risks will consider the historical, current, and projected future climate conditions

that have or may impact the site. This process identifies potential threats from climate shocks and stresses and uses a site-specific risk analysis to inform the development of strategies for enhancing resilience. The goal is to ensure the safety of structures, systems, and occupants while minimizing operational disruptions during climate hazard events throughout their useful lifetime.

Organizations that aim to future-proof their buildings and infrastructure against evolving climate risks find these studies particularly valuable. As the sustainability frameworks become more comprehensive, climate hazard risk assessments for all new construction, core and shell, and existing buildings will become a requirement to sustainability certification (see Figure 5).

Market Penetration

In his book *Reinventing Green Building*, Jerry Yudelson notes that green building sustainability certifications have seen limited market penetration in both commercial and residential structures in the United States and Canada. By 2015, less than 4% of these buildings were certified, suggesting a significant gap in achieving widespread adoption of sustainability standards. In contrast, commercial real estate services firm CBRE found that 14% of commercial office buildings in the United States have a sustainability certification. This represents more than 42% of the total office space across the top markets in the country. This gap suggests that sustainability in buildings has not yet reached all markets, and opportunities still exist to demonstrate the value and benefits of environmental certification

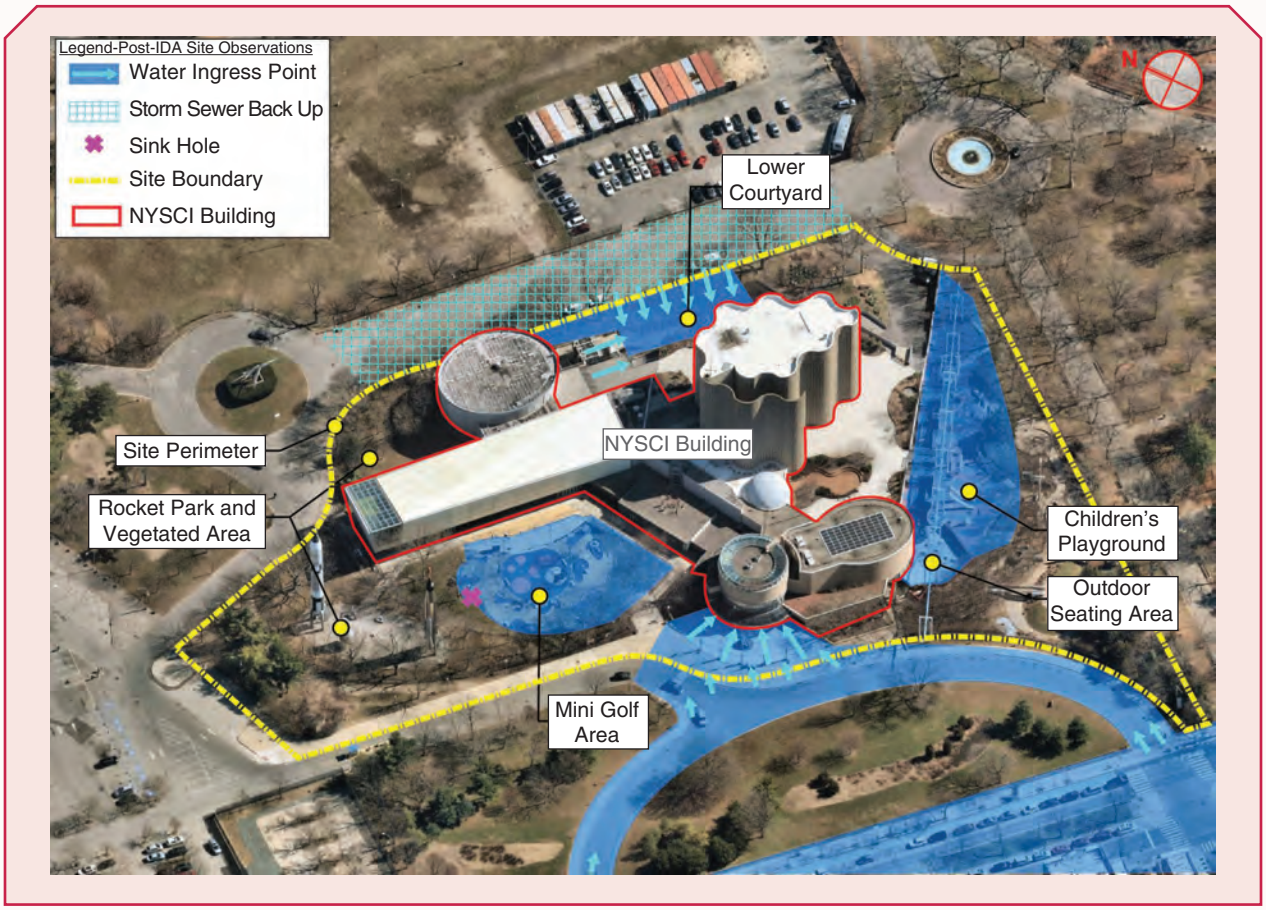

figure 5. When Hurricane Ida struck the New York City area, the New York Hall of Science in Flushing Meadows–Corona Park in Queens, incurred interior and exterior damage. A preliminary comprehensive resilience strategy was developed to minimize the impact of current and future climate hazards on people, property, operations, revenue, and the integrity of the building. A hydrological analysis was performed to assess the extents of the watershed contributing to the sheet flow entering the building and found the facility to be at the low point of the neighborhood. The assessment identified resilience measures that can be implemented in the short, medium, and long term to optimize feasibility and resources. (Courtesy of Thornton Tomasetti.)

and increase acceptance within the building industry.

Greenwashing and Other Setbacks

Greenwashing in sustainability refers to the deceptive practice where entities and/or individuals give a false impression or provide misleading information about how environmentally friendly their products, assets, operations, or practices are. This can involve tactics such as vague or nonspecific claims, emphasizing minor eco-friendly attributes while ignoring larger negative impacts, or falsely advertising their assets' sustainability ratings. Greenwashing creates a façade of environmental responsibility, which can mislead consumers, investors, and the public, thereby undermining genuine efforts to address environmental issues and climate change, while also hurting the AEC industry and creating unfair and deceiving advantages.

In 2000, the U.S. federal government began adopting LEED as a standard for its buildings, formally recognizing it in 2008 and recommending it for use in 2013. The following year, the US-GSA (General Services Administration) recommended that new construction and significant renovations achieve at minimum a LEED Silver rating. In early 2025, the federal government seems to be rolling back on these requirements, mostly through semantics. Also, federal programs like Energy Star, a voluntary labeling program by the U.S. Environmental Protection Agency that helps consumers identify energy-efficient including appliances, electronics, and buildings, may face limitations to its reach and delivery.

Industry Commitment to Sustainability

The American Institute of Architects, a leading architecture professional organization with more than 90,000 members, developed and adopted the Framework for Design Excellence in 2019. This approach aims to mitigate and adapt to climate change through building energy efficiency and renewable energy generation, procurement of building materials with transparency about its origins, the protection of water resources, and other strategies to support environmental sustainability by conserving resources and reducing carbon emissions. This framework seeks to inform how the built environment is progressing toward a zero-carbon, resilient, and equitable environment. It is a voluntary framework, although it has a meaningful impact on the selection and recognition of architectural awards.

Restorative Design

The International Living Futures Institute's Living Building Challenge (LBC) was created to evaluate building sustainability based on the principles of restorative design. This holistic approach to creating spaces prioritizes the well-being of people and the environment, aiming to restore balance and enhance the natural world. It goes beyond simply minimizing negative impact and seeks to actively revitalize and improve both human health and the surrounding ecosystem. It seeks to elevate the sustainability standards set forth by other frameworks to include metrics such as reversing damage to the natural environment and design and build for a circular economy, which focuses on keeping materials and resources in use for as long as possible, designing for deconstruction and reuse and minimizing waste generation.

Is a Sustainable Building Sustainable?

A sustainable or green building is one that has been designed, constructed, and operated to minimize negative impacts on the environment, use resources efficiently, and promote the well-being of occupants throughout its entire lifecycle. Sustainable buildings are intended to be sustainable as they are designed and constructed with sustainability as a core goal and pursuing a certification label by a third party, such as LEED, BREEAM, or LBC. However, the label "sustainable" does not automatically guarantee that a building will achieve true sustainability in practice. Several factors affect whether a building lives up to the definition like performance verification; lifecycle performance, from construction to demolition; resilience to future challenges; and addressing all three pillars and not focusing on the environmental aspects alone. The term *sustainability* in the building industry context therefore should be used as a goal and a guideline but not an absolute guarantee unless substantiated by performance and certification. It is meant to encompass all aspects of building performance whether they are evaluated and assessed individually, or comprehensively, from building and systems details to entire buildings, campus, cities, or urban masterplans.

Biography

Jose B Rodriguez (jbrodriguez@thorntontomasetti.com) is with Thornton Tomasetti, New York, NY 10271 USA.