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Review Article

Green by Design or by Display? Contrasting Modes of Architectural Sustainability

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Abstract
Sustainability has become a dominant yet often contested concept in architecture. While some firms incorporate it through material strategies and lifecycle design, others approach it more symbolically, using green features as aesthetic statements. This paper examines the contrasting approaches of two contemporary studios: Thomas Heatherwick Studio, known for visually driven, foliage-heavy projects like *Thousand Trees* and *Eden*; and KieranTimberlake, whose work emphasizes quantifiable performance, as seen in *Cellophane House* and the U.S. Embassy in London. By comparing these two methodologies, the paper investigates the difference between superficial greening and deeply embedded ecological thinking, raising broader questions about how sustainability in architecture should be measured and represented.
Keywords: Green Architecture, Sustainable Design, Architectural Sustainability, Environmental Integrity, Material Responsibility, Vertical Gardens.

Definition of Key Concepts: Sustainability, Greenwashing, and Environmental Integrity

In architectural discourse, sustainability refers to reducing environmental harm across a building's full lifespan-through energy performance, resource efficiency, low-carbon materials, and adaptability [1]. A sustainable building is one that not only minimizes harm but ideally contributes positively to its environment, socially and ecologically.

However, not all green architecture is equally rigorous. The term *greenwashing* describes projects that present themselves as sustainable without addressing deeper ecological impacts. This might include adding rooftop gardens, solar panels, or other recognizably "green" features without reducing the building's overall energy use, embodied carbon, or long-term footprint.

Tim De Chant has written critically about this tendency, especially in high-rise and large-scale projects. He points out that many buildings marketed as sustainable rely on materials and construction methods that are highly resource-intensive, thus offsetting the ecological benefits they claim [2]. In such cases, sustainability becomes more of a branding device than a measurable reality.

In contrast, what might be considered *authentic* sustainable design focuses on the performance of materials, energy systems, and lifespan planning [3]. This includes the use of prefabricated components, lifecycle carbon analysis, and passive systems. Architects like KieranTimberlake have championed a process-oriented approach, where sustainability is integrated at every phase-from concept and procurement to assembly and disassembly [4].

Methodology and Analytical Framework

This paper adopts a comparative case study framework, analyzing two architectural practices with sharply divergent approaches to sustainability. Heatherwick Studio is examined through its projects *Thousand Trees* in Shanghai and *Eden* in Singapore, both of which emphasize greening as a visual and spatial experience. KieranTimberlake is examined through *Cellophane House*, a temporary structure developed for MoMA's *Home Delivery* exhibition, and the U.S. Embassy in London, a permanent civic building designed for durability, security, and environmental efficiency.

The comparative method explores three overlapping categories:

1) Material and Construction Strategy
- How low-carbon or reusable materials are incorporated
- The presence of prefabrication, dry assembly, or modularity
- Construction efficiency and waste reduction

2) Lifecycle and Environmental Performance
- Embodied versus operational carbon
- Integration of passive systems or renewables
- Long-term durability and adaptability to future needs

3) Narrative and Aesthetic Positioning
- How sustainability is represented or symbolized
- The role of greenery, spectacle, and storytelling
- Public perception versus actual performance

Sources include firm websites, project documentation, critical reviews, interviews, lifecycle data (where available), and scholarly or journalistic analysis. Where full carbon audits are unavailable-as is the case with Heatherwick Studio-material choices, construction strategies, and expert reviews are used to draw inferences. While architectural performance can be quantified, sustainability in the public realm also involves symbolic, cultural, and political factors. This dual character of sustainability-as both technical and rhetorical-is a key focus of the study.

Thomas Heatherwick: Design Philosophy and Sustainability Approach

Thomas Heatherwick is widely recognized for his sculptural, emotionally charged architecture, often blending storytelling with urban spectacle. Since founding Heatherwick Studio in 1994, he has created a series of iconic projects that merge architecture, art, and landscape, with a design ethos grounded in sensory experience and what he has described as "emotional longevity." His approach to sustainability is similarly framed-not primarily as a set of technical criteria, but as a way to make buildings more beloved and therefore more likely to endure. In his words, "there is an epidemic of boringness… the big issue is not beautiful versus ugly, but boring versus not boring"-a provocation that reframes sustainability as a cultural and perceptual challenge rather than a purely environmental one [5].

Rather than reducing emissions through strict metrics or performance modeling, Heatherwick's sustainability often appears as a formal or atmospheric gesture. Greenery is frequently used not only to soften the built environment, but to serve as a primary architectural language. This visual greening strategy has made his work emblematic of a broader movement within global architecture: one where eco-credentials are communicated visually, and sustainability becomes an aesthetic mode. However, this approach raises questions. How much does the presence of greenery actually reduce environmental harm? Is sustainability being used as narrative enhancement rather than systemic reform? The answers become more complex when studying specific projects like Thousand Trees and Eden.

Thousand Trees, Case Study (2021)

Designed by Heatherwick Studio and completed in 2021, *Thousand Trees* is a mixed-use development located along Suzhou Creek in Shanghai. Rising from a former industrial site adjacent to the M50 arts district, the project comprises two mountain-like volumes constructed from a grid of concrete columns which extend above the roofline and support full-sized trees and dense vegetation [6]. These planter-columns, each containing one or more trees, generate the building's defining visual identity: a stepped green topography resembling a hanging garden.

The planting strategy is deliberately ambitious. Over 25,000 plants across 46 species are distributed among the structure, chosen to match different microclimates identified along the building's terraces [7]. Heatherwick Studio has claimed that this biodiversity not only evokes a seasonal landscape but also contributes to air purification, evaporative cooling, and carbon absorption. According to the developer, the building's trees sequester approximately 21 tonnes of CO_2 per year [8].

The rhetoric surrounding *Thousand Trees* suggests a novel synthesis of architecture and ecology. However, critics have argued that this synthesis is more symbolic than systemic. In *The Architectural Review*, the

project is positioned as a prime example of the "false promises of floating gardens"-highly visible green gestures that disguise, rather than resolve, the environmental impacts of construction [9]. The building's massive use of concrete and steel, required to support the structural grid of planters, results in an enormous amount of embodied carbon-far greater than what the vegetation can realistically offset within its functional lifespan.

Landscape ecologist Philip Oldfield underscores this imbalance: "The carbon footprint of a single concrete planter column is so large, it would take over a century of tree growth to balance it out" [10]. The vegetation, while extensive, is mostly confined to isolated planter units with limited soil volume, root depth, and no subterranean connectivity. This challenges the ecological effectiveness of the design. Also he notes that, "it would take 150 years of photosynthesis to offset the embodied carbon of a single planter-column" [11]. The result is a paradox: an ecologically themed project whose carbon-intensive structure undermines its stated intent.

The critique extends beyond carbon accounting. The project may appear to bring nature into the city, but it relies on a heavy structural framework and decorative green imagery. As a result, it fails to address deeper sustainability issues like stormwater management, soil health, or biodiversity support [8]. The trees, in this case, serve more as architectural ornamentation than participants in a functional ecosystem. Since each tree is isolated within a discrete planter, the system lacks the interconnectivity typical of a true ecosystem-limiting biodiversity, soil health, and habitat value. Landscape architect Qicheng Zhong observed that while the building is lush, "it's not an ecosystem-it's just little trees on columns" [12].

The deeper issue may lie in the conflation of ecological imagery with ecological benefit. As the vertical placement of trees in buildings is less efficient, more resource-intensive, and often serves a symbolic function over an environmental one, for instance reforestation on the ground [13]. In this light, *Thousand Trees* becomes a metaphorical green mountain-an image of ecological commitment rather than a structurally or ecologically optimized model.

Ultimately, while *Thousand Trees* offers a striking vision of how architecture might incorporate landscape, its legacy may depend less on how many trees it holds and more on how clearly it reveals the limits of visual sustainability. It demonstrates how architectural spectacle can hijack ecological language, and how difficult it is to measure environmental value when green aesthetics obscure material realities.

Eden, Case Study (2020)

Completed in 2019, Eden is Heatherwick Studio's first residential building in Asia. Rising 20 stories above Singapore's Orchard Road district, the project was developed as a luxury tower that fuses modernist minimalism with tropical abundance. Each of the 20 full-floor apartments opens on three sides and is framed by expansive balconies filled with tropical planting. Instead of typical glass facade, the building features deep concrete planters that allow vegetation to spill over the facade.

The project was awarded Singapore's Green Mark Platinum certification, the highest national rating for environmental performance, due to its use of passive ventilation, deep shading, and locally appropriate plantings [14]. Each unit features cross-ventilation that minimizes reliance on air conditioning, and the planters are embedded in the structure itself, enabling the support of sizable vegetation with deeper root volumes than conventional green walls or balconies.

As with Thousand Trees, the structure relies heavily on reinforced concrete-one of the most carbon-intensive building materials. Unlike timber or hybrid systems, concrete is neither renewable nor easily recyclable. The structural overhangs and deep balconies add surface area and mass-more than is strictly needed for enclosure or stability [15]. The embodied carbon required to construct such a system likely dwarfs the carbon sequestered by the vegetation planted within it, though no public life cycle assessment has been published to verify this tradeoff.

The building's exclusivity further complicates its sustainability claims. All 20 apartments-each roughly 3,000 square feet-were sold en bloc to a single ultra-wealthy family shortly after completion. This mode of occupancy sharply limits the social reach of its environmental features. Passive cooling, fresh air, and biodiversity may be achieved, but only for a select few. Critics have questioned whether sustainability that is not scalable-or accessible-should count as sustainability at all. In this light, Eden could be seen as an example

of "green luxury," where ecological strategies are instrumentalized as branding for high-end lifestyle rather than leveraged for broader urban or systemic impact [16].

Moreover, while Eden presents a more integrated use of greenery than Thousand Trees, it still reinforces a now-familiar visual trope: vegetation as virtue. In Singapore, a city known for its "City in a Garden" policies, such imagery is common-often aligned with state-backed ecological urbanism. But even in this context, the tension between symbolic greening and measurable performance remains unresolved. The project does not include public green space, communal ecological infrastructure, or broader landscape remediation. Instead, it consolidates environmental capital within private domestic space, aestheticizing it as an amenity.

Overall Critique of Heatherwick's Approach

Across projects like *Thousand Trees* and *Eden*, greenery functions as a design motif-an architectural finish that cloaks buildings in environmental language. But this language often masks deeper contradictions. In both projects concrete-heavy construction undercuts any carbon benefit the planting scheme might provide. Vegetation becomes a visual signal of ecological concern, but its actual function-as a carbon sink, habitat, or climatic device-remains limited or unquantified.

This tendency has led many to accuse Heatherwick's work of greenwashing: the strategic use of environmental aesthetics to satisfy public and investor demand without altering the environmental logics of the architecture itself. As noted by *The Architectural Review*, projects like *Thousand Trees* exemplify "the false promises of floating gardens," where environmental imagery is leveraged to greenlight carbon-intensive forms [9]. Similarly, landscape ecologists have warned that isolated planters and rooftop trees do little to support real ecosystems, likening such strategies to "aestheticized containers of nature" that fail to engage with soil health, biodiversity, or hydrological cycles.

The result is an architecture that excels in spectacle but falters in performance. It is built for photography, for investor brochures, and for public fascination-but often at the cost of measurable ecological benefit. That Heatherwick's buildings are widely discussed, photographed, and admired is undeniable. Whether they meaningfully advance sustainable practice remains deeply contested.

KieranTimberlake: A Systems-Based Approach to Sustainability

In contrast to the expressive and visual sustainability of Heatherwick Studio, KieranTimberlake adopts a performance-based, systems-oriented approach. Founded in 1984 by Stephen Kieran and James Timberlake, the firm is known for integrating environmental science, material research, and design technology into architecture. Their buildings rarely advertise their green credentials through appearance. Instead, sustainability is embedded in how they are designed, assembled, and maintained over time.

This strategy is grounded in their influential book *Refabricating Architecture* (2004), which argues that modern construction is inefficient, wasteful, and environmentally unsustainable. The authors call for architects to take responsibility not only for form, but also for the entire lifecycle of a building-from material sourcing to disassembly [4]. This philosophy underpins KieranTimberlake's work and is particularly visible in two major projects: *Cellophane House* and the U.S. Embassy in London.

Case Study: Cellophane House, MoMA (2008)

Cellophane House was a five-story temporary structure built for the Museum of Modern Art's Home Delivery exhibition. The project explored how buildings could be constructed, used, and disassembled with minimal waste. Unlike conventional buildings, which are often demolished through destructive means, Cellophane House was designed to come apart cleanly. Its aluminum frame and polycarbonate panels were connected using dry joints-meaning no adhesives, screws, or welding were required. As a result, the entire structure could be assembled in just 16 days and deconstructed in two [17].

The design prioritized passive environmental strategies. Its skin, called Smartwrap, utilized a technology that is "mass customizable, energy-generating, lightweight, and sustainable envelope that integrates the segregated functions of a conventional wall into a multi-layer skin of just a few millimeters in thickness, which can be wrapped around the structural frame of a building" [18]. The envelope filtered daylight while blocking excessive heat, and its operable windows enabled cross-ventilation. These features reduced the need for mechanical systems like air conditioning. Rather than compensating for inefficiency with technology, the house minimized energy use from the beginning.

The project's name is also symbolic. "Cellophane" suggests fragility and disposability, but the house challenged those ideas by showing how temporary structures could be environmentally thoughtful. In doing so, it redefined sustainability not as permanence, but as flexibility and material responsibility.

Perhaps most significantly, Cellophane House challenged the assumption that sustainable architecture must look green. There were no trees, no rooftop gardens, and no elaborate environmental symbolism. Its sustainability came from intelligent design decisions-not from decorative gestures. It offered a quiet but radical statement: architecture can be environmentally responsible without drawing attention to itself.

Case Study: U.S. Embassy, London (2017)

Where Cellophane House functioned as a small-scale prototype, the U.S. Embassy in London brought KieranTimberlake's principles to a much larger and more complex building. Completed in 2017, the new U.S. Embassy in London is located on the South Bank of the Thames in the Nine Elms district. The 12-story cubic building houses one of the most secure and symbolically important diplomatic functions in the world. The project was the result of an international design competition to replace the outdated embassy in Grosvenor Square, a site that no longer met modern security, environmental, or accessibility standards.

The Embassy builds on many of the principles first introduced in KieranTimberlake's book *Refabricating Architecture*. However, rather than repeating the exact methods used in *Cellophane House*-like modular construction and fast disassembly-the Embassy adapts those ideas to suit a far more complex context. This includes strict security needs, long-term durability, and high environmental standards.

The Embassy serves as both an operational headquarters for U.S. diplomatic activity in the United Kingdom and as a cultural symbol of America's presence abroad. As such, it had to balance competing priorities: stringent security demands, long-term adaptability, environmental performance, and civic engagement. KieranTimberlake's design aimed not only to meet these requirements, but to reimagine how a 21st-century embassy could express openness and sustainability in architectural terms [19].

The guiding concept of the Embassy was to move beyond the fortress-like embassies-defined by heavy walls, restricted access, and symbolic detachment-and instead project a new image of transparency, security, and ecological responsibility [20]. To achieve this, the architects developed a layered approach to security and openness. Rather than erecting visible perimeter walls or fences, the building is set within a gently sloping landscape that incorporates water features, low walls, and vegetation as soft barriers. These features satisfy blast-resistance and setback requirements, but also allow for a continuous pedestrian experience around the site.

Sustainability at the U.S. Embassy in London is not presented as a visual statement, but as a deep structural condition embedded throughout the building. Rather than using superficial green features like rooftop gardens or symbolic vegetation, the design integrates environmental performance into the building's materials, envelope, systems, and long-term adaptability.

The building's most prominent environmental feature is its ETFE façade, which functions as both an architectural and ecological element. ETFE (ethylene tetrafluoroethylene) is a lightweight polymer that transmits daylight while blocking solar radiation, creating a thermal buffer that significantly reduces heat gain. Unlike glass, ETFE is far lighter and more flexible, requiring less structural support and generating lower embodied carbon in production [21]. This outer skin wraps the entire building in a translucent veil, filtering light and softening shadows while cutting down on energy demand for lighting and cooling. The result is an envelope that simultaneously communicates openness and ensures high-performance thermal control.

Internally, the building is organized to maximize natural light and air circulation. Workspaces are placed around a central atrium that draws in daylight across multiple floors. Operable windows and smart sensors regulate airflow, reducing reliance on mechanical systems. HVAC systems are optimized for efficiency, responding dynamically to occupancy and environmental conditions. By prioritizing passive strategies-such as solar orientation, cross-ventilation, and daylight harvesting-the design minimizes energy consumption without compromising functionality or comfort.

Construction materials were selected based on both durability and lifecycle carbon impact. Structural systems were modeled digitally to reduce excess material use and simplify construction logistics. Where

possible, locally sourced materials were prioritized to reduce transportation emissions. Interior finishes were chosen for low toxicity and ease of future replacement. Together, these choices contribute to a vision of architecture not as static object, but as a dynamic system-responsive to environmental conditions and adaptable over time.

Summary Analysis: Built-in Responsibility vs. Visual Expression

While *Cellophane House* focused on how a building could be taken apart quickly and with little waste, the Embassy reinterprets that idea through permanence. Its design focuses on long-term use, low maintenance, and the ability to adapt to changing needs over time. In this way, it carries forward the same logic of resource efficiency and flexibility, but applies it to a building meant to last for decades, not days. The result is a structure that may not be disassembled like *Cellophane House*, but still reflects the same goals: using fewer materials, reducing energy demand, and planning for change rather than resisting it.

KieranTimberlake doesn't rely on visual signs to show sustainability. Instead, they build it into the structure, systems, and long-term use of the building itself. Their architecture does not seek attention for looking green-it seeks impact by being green. This emphasis on lifecycle performance, material logic, and systemic adaptability sets their work apart from more image-driven practices.

In contrast, Thomas Heatherwick's work embraces a more expressive, emotionally resonant model of sustainability. His projects often use greenery as a dramatic and symbolic gesture-building large-scale planted facades and visually striking landscapes into the architectural form. Heatherwick argues that beauty leads to preservation: if people love a building, they will maintain it. From this perspective, sustainability becomes a matter of emotional connection rather than technical performance.

However, the difference between these two methods raises important questions. While Heatherwick's designs are engaging and publicly recognizable, their environmental effectiveness is sometimes difficult to verify. Projects like *Thousand Trees* and *Eden* rely on visual strategies to signal ecological concern, but critics have pointed out the high material costs and maintenance demands of such vertical gardens. By comparison, KieranTimberlake avoids spectacle and instead focuses on reducing energy, minimizing waste, and designing for the long term-even if those features are not immediately visible to the public.

Both approaches seek to respond to the climate crisis, but they define sustainability in very different terms. Heatherwick treats it as a cultural and emotional project-something to be felt and seen. KieranTimberlake treats it as a technical and ethical responsibility-something to be calculated and built into the architectural process from the beginning. In an era when architecture is increasingly expected to do more with less, KieranTimberlake's model suggests that true sustainability lies not in what a building expresses, but in how it performs over time.

Conclusion

Comparing Thomas Heatherwick and KieranTimberlake reveals a deeper question at the core of sustainable architecture today: should we measure sustainability by appearance, or by actual environmental impact?

Heatherwick's work contributes to an important cultural shift in architectural thinking. By using greenery as a central design feature and promoting the idea that emotionally resonant buildings are more likely to be preserved, his projects attempt to reconnect people with the built environment. In doing so, they help make sustainability feel approachable and inspiring to a broad audience. His belief that beauty leads to longevity offers an alternative view of sustainability-one rooted in public attachment rather than engineering.

However, the risks of this approach are also clear. When green design is treated primarily as a visual language, it can easily slide into greenwashing-presenting the appearance of ecological responsibility without addressing the full environmental impact of construction and operation. Projects like *Thousand Trees* and *Eden*, while visually compelling, raise valid concerns about carbon cost, maintenance, and long-term ecological benefit. In these cases, greenery may serve more as an image than a system, delivering symbolic value but limited performance.

By contrast, KieranTimberlake represents a model of sustainability that is less visible but more rigorous. Their buildings are designed to operate efficiently, adapt over time, and reduce both embodied and operational carbon from the start. Through lifecycle assessments, prefabrication strategies, and passive systems, their work defines sustainability as a technical and ethical standard-not a stylistic choice. Even in

high-security, politically sensitive projects like the U.S. Embassy in London, they demonstrate that environmental performance can be embedded without sacrificing function, safety, or architectural dignity.

Both approaches contribute to the evolving landscape of sustainable design. Heatherwick's architecture helps spark public imagination, while KieranTimberlake's ensures that environmental accountability remains grounded in measurable outcomes. Yet as climate pressures intensify, the discipline must be cautious. Architectural sustainability cannot rely on symbols alone. It must be proven through data, embedded in systems, and designed for longevity beyond the first impression.

In the future, sustainable architecture might need both emotional appeal and technical performance-but what's most important is how well the building actually works for the environment. Beauty may draw attention, but only material responsibility can deliver impact.

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