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White Paper

Indoor-outdoor living: Architects design biophilic homes perfect for the post-pandemic era

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Abstract

The science shows that people benefit from daylight, views, and natural ventilation. Buildings designed to create an indoor-outdoor context—and ease perception and movement between those environments—foster better physical, mental, and social health. This connection is a central component of biophilic design, which responds to positive benefits of incorporating elements from nature into buildings. Today's glazing technologies allow architects to balance the appeal of sunlight with today's important thermal performance requirements. Windows are no longer "punches" in walls, but portals that illuminate interiors. A set of case studies showcases how architects rise to the challenge of designing indoor-outdoor residences that meet the demands of contemporary life. Though these homes were designed pre–COVID-19, they are even more relevant as the pandemic recedes.

Introduction

The lockdown conditions that people endured during the early stages of the COVID-19 pandemic in 2020 reinforced a few ideas that architects and laypersons alike have long recognized as common sense: Humans are hard-wired to appreciate nature. An environment with variety and greenery stimulates us to be at our best, while confinement in unchanging spaces among manmade materials makes us prone to cabin fever.

In residences of all styles and in all locations, window and door designs bring much-needed light and ventilation to homes while addressing thermal challenges previously associated with large openings. These elements help make domestic environments—now a domain of remote work—pleasant, healthy, and beautiful.

Built on Science and Research

Many scientific studies demonstrate the physical and mental benefits of outdoor exposures. According to one data visualization based on Google Community Mobility Reports, residents of most nations have spent considerably more time at home since the spring of 2020. The study confirms what most of us have experienced subjectively: We spend too much time inside. It wasn't much better to start with, as the pre-pandemic baseline for that condition was already high: The Environmental Protection Agency (EPA) has estimated since 1989 that "Americans, on average, spend approximately 90 percent of their time indoors."

The consequences of this statistic for people's mental health have been serious. Borrowing a concept that Richard Louv, author of *Last Child in the Woods*, identified as "nature deficit disorder," one might speculate that this condition of environmental deprivation, already widely perceived to affect children throughout the developed world, has made alarming recent inroads into the adult population as well.

Research on the pandemic's psychological effects links contact between home and

O-asis House by The Ranch Mine

nature ("blue-green spaces," with water or vegetation) with fewer symptoms of depression and anxiety. This finding adds to a body of work indicating that natural light promotes multiple elements of health: visual acuity, entrainment of circadian systems, vitamin D production, and others. Daylight also protects people against myopia, improves sleep quality, correlates with better alertness and cognitive-test performance, lowers growth of pathogenic bacteria and fungi, and reduces absenteeism from work (along with "presenteeism," or performance impairment by illness without workplace absence). As people's homes increasingly become their workplaces, the more knowledge about work environments applies to residential environments.

Remote work (telecommuting, or "telework") has become more prevalent during the pandemic, according to a U.S. Bureau of Labor Statistics analysis based on the bureau's 2021 Business Response Survey, and Pew Research Center data suggest that for nearly six in ten workers who can do their jobs from home, telework is their choice rather than a necessity. For many workers, replacing time-draining commutes and other adverse features of office life with the comforts, independence, and familiarity of working from home is no longer a temporary adaptation to an urgent pandemic but perhaps a lasting change in the structures of their personal time and space. The design and adaptability of that space influence the quality of that time.

If these trends continue, residential environments that optimize mental, physical, and social health will become—and are already becoming—increasingly desirable. Spaces that offer ample daylight, fresh air, stimulating interior and exterior aesthetics, and opportunities for movement are drastic improvements over spaces that resemble solitary confinement. Some of the healthiest designs on any scale, professional and educational as well as residential, use operable glazing elements to minimize the distinctions between inside and outside.

Plus House by Timbre Architecture and CB Design

Daylight matters. It outperforms electric light in nearly every respect, providing continuous distribution along the spectrum of visible wavelengths, variety during the day, stability without flicker, and other qualities, all available without cost (other than its shaping through architecture). Artificial light is more controllable, particularly for thermal comfort, but incurs ongoing costs of energy use and only loosely approximates the physical qualities of daylight.

Windows, doors, and other building features establish extended contact with—and views to—the outdoors. They help construct an emotional relationship to our surroundings and set the scene for sustained interactions between people and their habitats.

There has long been concern that the thermal insulation of curtain walls and other common glazed structures counteracts energy savings on artificial light, outperformed on the increasingly important energy and carbon-emission metrics by masonry with punched windows and more thermal mass. Contemporary glass technology responds to this challenge through multiple strategies: low-emissivity coatings, double and triple glazing, frit patterns, thermal breaks, electrochromic and other dynamic forms of glass, argon and krypton gas insulation, and vacuum insulation.

Using this information, today's architects have unprecedented options for providing for clients the hybrid environments so many are seeking, balancing the psychological and aesthetic advantages that ample fenestration offers with the performance that an energy-conscious future requires.

Westlake Terrace House by A Parallel Architecture

Case Studies

To build on the research and knowledge above, it's useful to see how architects have translated the utility of glazing into notable design projects. Architects synthesize many concerns when working on homes: There are issues related to site, climate, budget, style, and, of course, client. In five projects sited across the U.S., products from Western Window Systems help control the transmission of light and heat, give residents an immediate connection to the natural environment, and create indoor/outdoor spaces that foster an exceptional quality of life.

This lasting result is a key goal of biophilic design, a practice that, as explored by Dr. Stephen R. Kellert and Elizabeth F. Calabrese, works from direct principles:

1. Biophilic design requires repeated and sustained engagement with nature.
2. Biophilic design focuses on human adaptations to the natural world that over evolutionary time have advanced people's health, fitness and wellbeing.
3. Biophilic design encourages an emotional attachment to particular settings and places
4. Biophilic design promotes positive interactions between people and nature that encourage an expanded sense of relationship and responsibility for the human and natural communities.
5. Biophilic design encourages mutual reinforcing, interconnected, and integrated architectural solutions.

Each project also implicitly establishes a context for which occupants can sustain relationships with natural surroundings.

Case Study #1: Sanctuary House, Palo Alto

In the temperate climate of Northern California, Tai Ikegami of San Francisco's Feldman Architecture sought to give clients a close connection to the outdoors and to protect the local flora, including four large trees that organize the site (oaks to the front and side, a redwood in back, and a persimmon, he said, "that almost kisses the building" near the master suite). A modern design with floor-to-ceiling glazing, Ikegami reasoned, would be appropriate; the house includes massive picture-frame windows, upper clerestory windows, and a retractable wall of glass doors in a central 40 foot by 20 foot great room, so that the full envelope is approximately 50 percent glass.

The remaining material palette is a simple combination of board-formed concrete and Alaskan yellow cedar.

The occupants named the residence Sanctuary House. "The design," Ikegama said, addressed the question "'How can the architecture start to dissolve?' So that while you're sheltered, you're still strongly connected both visually and physically to those outdoor spaces." Seamless transitions to courtyards and gardens give each area of the house its own connection to nature. The clerestory component contributes cross-ventilation as well as daylight to the central volume of the house: "The amount of natural

daylight and cross-ventilation we were able to achieve through those openings is a huge part of the success of the design," he added.

In plan, Sanctuary House is organized around a long lateral axis that merges the entry hallway with the great room (a combination kitchen, dining room, and living room), with the master-bedroom suite and two other bedrooms at opposite ends, plus a separate rental apartment on the second story. By supporting the structure (even the concrete driveway) on piers, Ikegami and colleagues were able to preserve the trees' roots and integrate the entire building gently into its landscape. Shaded by the large oak in the front yard—with vegetation visible throughout the house, thanks to a Western Window Systems Series 600 Window Wall in the master suite, a Series 980 Pivot Door opening onto the persimmon, and multi-slide doors in the main living area—this house expresses respect for its surroundings in every detail.

Case Study #2: O-asis House, Phoenix

The Arizona desert posed challenges on multiple levels for principal architect Cavin Costello of The Ranch Mine, a local husband-and-wife firm that primarily serves "people with the pioneer spirit." For a couple seeking an alternative to city life on a 1.7-acre horse property in the Phoenix Mountain Preserve with an emphasis on sustainability and a minimalist aesthetic, Costello designed an O-shaped, solar-powered house with a central courtyard that measures 18 feet by 58 feet. With an outside height of just 12.5 feet, the white stucco structure's horizontality allows it to vanish visually into the desert landscape, while creating a peaceful space for the residents, their dogs, and their grand piano.

"One of the first things we did was to look at ways to live in the desert that have been happening for thousands of years and even just a few hundred years here in the desert Southwest, and that was to create a courtyard-style home," he said. "By creating a courtyard, you create a mini micro-climate inside the house." The external climate requires one: Summer temperatures there frequently exceed 100° F. Site conditions also include assorted predators; the house is surrounded by a steel rattlesnake fence, and the dogs spend their outdoor time safely inside the courtyard, evading any coyotes, bears, or mountain lions who may happen by.

Western Window Systems Series 600 Multi-Slide Doors allow courtyard access, and floor-to-ceiling Series 600 Window Walls frame the space. “When the doors and windows of the main living space are open, it essentially transforms the indoor living space into an outdoor living space,” Costello described, noting that these features are in constant use in “a very seamless open-and-close situation.” Solar heat gain in this area is substantial, and these glazing products perform well in such conditions, he adds, with low U values and thermal breaks to prevent heat transfer through the frames.

A large glass opening shows off desert flora surrounding a 500-year-old ironwood tree in the courtyard, visible from the front door. The 4,090-square-foot building includes an 860-square-foot guest suite used by in-laws. With an outdoor pool whose calm surface echoes the glazing, a built-in fire-pit bench, and mountain views to the south, O-asis House allows its residents an existence spent near and within the desert, yet protected from its harsher aspects, striking a balance between civility and ruggedness.

Case Study #3: Plus House, Oakland

Transforming existing buildings to meet today's standards is a recognized sustainable strategy, since "the greenest building is the one that already exists," as former AIA president Carl Elefante famously said. To renovate a two-story, 1,980-square-foot post-and-beam box home in Oakland's hilly Montclair neighborhood, architects Bridgett Shank and Megan Carter (principals of Timbre Architecture and CB Design, respectively) joined forces to create an indoor-outdoor masterpiece with unobstructed 180-degree views of San Francisco, Oakland, and the East Bay. Merging the upper and lower levels with a central staircase, gutting the upper level, and adding 38 linear feet of glass to each floor, the architects improved the 1956-vintage building's layout, circulation, and daylighting.

The west façade of the building is now almost entirely glazed. Two of the three first-floor bedrooms feature 7-by-14-foot-wide Western Window Systems Series 600 Multi-Slide Doors topped by clerestory windows; the rooms are separated by a glassed-in stair bay that rises to bisect the second floor as well, where the living room and kitchen/dining areas now enjoy sunlight from multiple directions. Above the stair bay is a cupola-like "light monitor," as the architects call it, adding height, light, and views without disrupting the tighter ceiling height of the

original second-floor spaces. The remodeling project preserved the second floor's Douglas fir ceiling, one of several wooden details throughout the house along with a maple-veneer plywood first-floor ceiling and teak veneering in the kitchen, bedrooms, and new fireplace. The combination of wood and glass marks the building as both modern and contextually Californian, and the usage of woods on both the floor and ceiling reinforce the tenets of biophilic design.

The second floor owes its impressive view to two massive Series 600 Sliding Glass Doors, one for the living room and one for the kitchen/dining room, opening onto a full-width outdoor terrace and joined at the center by a giant fixed window above the stair bay. The building's structural grid remains intact from its earlier condition; it is now named the "Plus House" for its cruciform intersection of horizontal glazing and vertical stairs. With its jaw-dropping bay view and its openness to western breezes when the doors are open, the house's generous combination of external and internal glazing is a definite plus. The ability to have air circulating helps connect residents to their surroundings through thermal comfort in a region where air conditioning is not a requirement for livable interiors.

Case Study #4: Hudson River House, Croton-on-Hudson, NY

Another hillside house addresses the climatic demands of the New York City suburbs with high-performance glazing, marrying the majestic vistas that inspired 19th-century Hudson River School landscape painters with today's energy concerns. Rob Luntz, founder of New York's Resolution: 4 Architecture, used thin 9-foot-high steel columns to support this elegantly futuristic building precipitously on one of Croton's highest overlooks, giving the residents (a pair of urban refugees ready for Hudson Valley panoramas after decades in Manhattan) the sensation of being suspended in the sky among the trees. Clad with metal siding and slatted Brazilian walnut, the 2,400-square-foot house brings a touch of industrial grittiness to the Westchester woods.

The ample glazing combines floor-to-ceiling operable windows and sliding glass doors across the façade with clerestory windows along the front, which admit light while providing privacy from the driveway. The length and orientation of the house maximize views of the river to the west from every room, along with creating cross-ventilation, cooling the interior naturally with river breezes.
One potential downside of this exposure, however, is thermal inefficiency during winter or summer extremes. The choice of glass—IGUs with low-e coatings and an argon-filled interior—limits solar gain during hot weather and provides insulation in winter.

A ground-level outdoor deck with a lap pool is accessible via a floor-to-ceiling Western Window Systems Series 900 hinged door; on the main level above, a covered balcony deck, enclosed on three sides and accessible through multi-slide doors, is convertible to a seasonal outdoor room with drop-down insect screens and a Baltic concrete fire pit, keeping the deck warm in winter. The main level's open floor plan blends the dining, kitchen, and living areas into a single space. The guest bedroom, connecting to a home office with a built-in desk, includes a Murphy bed, allowing use as additional living space when unoccupied. Views are such a priority that the master suite's built-in bed conceals a television on a mechanism that can hide it when not in use, keeping it from blocking the view through the full-height windows. The kitchen's island and cabinetry are low enough to maintain sight lines as well. Permeability between the interior and exterior defines this house as a well-tuned machine for contemporary living.

Case Study #5: Westlake Terrace House, Austin

A larger house set into a hillside in Austin's Westlake district shows a distinctive synergy between vertical and horizontal elements, as its glass elements with multiple terraced balconies and a negative-edge infinity pool to create strong visual contrasts. This three-story, six-bedroom, 8,174-square-foot building for a family with three young children and a German Shepherd provides 270-degree panoramic views of downtown and Lake Austin, with extensive glazing on the north and east sides and a series of large sliding doors. "The house is first and foremost a view house," said Ryan Burke, principal at A Parallel Architecture, the local firm that designed it; "as such, the fenestration was the top priority."

At the outset of the project, its steeply angled 1.24-acre site was a potential liability. The client discovered an empty lot for sale, undeveloped, absent from the local multiple-listing service, and not even platted and recorded on city maps; despite the apparent lack of interest among buyers, he wondered whether it might be buildable. Burke and his colleague Eric Barth climbed trees and sent up drones to study the space and views, determining that these advantages would justify the difficulties of carving the house into the hillside. With an L-shaped plan centered around the pool and offering decks or lawn access from every level, the architects converted what Burke calls an "otherwise

untraversable lot" into a living composition of three-dimensional spaces. The house puts its verticality to purposeful use through the kitchen's 20-foot ceiling and floor-to-ceiling ambassador brick wall, the top-floor children's bedrooms and playroom, and recurrent interior details of slatted white oak.

Burke credits Western Window Systems for providing "the complicated corner-pocketing multi-slide door [and] butt-glazed corner units," the kind of details that contribute to an uncluttered atmosphere. The glazing, all provided by Western Window Systems, includes a multi-slide door that runs the length of the living room and hallway, opening onto the pool deck, and a window wall in the dining room, offering a treetop view. Railings are extra high for child safety in this high-energy household. Sliding doors receding into the living-room walls allow full openness to the outdoors, with a commanding view across the pool onto downtown Austin. The scale and ambition of this house are far from minimalist, yet its components erase interior-exterior boundaries as subtly as Philip Johnson's Glass House or Mies van der Rohe's Farnsworth House did in very different settings.

The Value of Indoor-Outdoor Living

Residential architecture has come a long way since a heavily glazed 16th-century British mansion attracted mockery as “Hardwick Hall, more glass than wall.” Regardless of differences in size, climate, and topography, residences with extensive fenestration change the relation of indoors and outdoors: A house can now be less a defense against nature than a bridge to it. Through living in a building with well-planned views and a considerate approach to a sensitive relationship with the environment, residents can... residents can derive the multiple biophilic benefits of natural light, variety of sightlines, and proximity to the outdoor world—all the more important now that many Americans now work from home.

The houses profiled here are among thousands that employ the clean lines and dematerialized aesthetic of 20th-century modernism updated to address the 21st century’s needs for thermal performance. This approach is as viable in retrofits as well as in new construction. With the aid of large-scale glass products that can accommodate a wide range of scales and budgets, today’s residential environments are moving in a healthier direction—from the era of nature-deficit disorders to a future defined by greater integration within natural environments.

Plus House by Timbre Architecture and CB Design

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Cover image: Sanctuary House by Feldman Architecture
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