



Evolution of All-Glass Architecture: Harmonizing Aesthetic Purity and Superior Performance with Multifunctional Façade Systems

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Presented by Stekar

1. Introduction

All-glass architecture has become a hallmark of modern urban design, valued for its sleek aesthetic, openness, and ability to maximize natural light. Cities like Boston and New York showcase countless glazed structures.

However, fully glazed façades present significant challenges. Traditional curtain walls struggle to meet evolving energy codes, particularly in climates with extreme seasonal variations like New England. Issues such as heat loss in winter, excessive solar heat gain in summer, and poor soundproofing in dense urban areas create major concerns for architects, contractors, and building owners.

As energy regulations tighten and curtain walls alone become less viable, architects are increasingly adopting hybrid solutions. By integrating both glass and opaque elements, these designs maintain the sleek, contemporary aesthetic while significantly enhancing performance in energy efficiency, durability, and acoustic control.



A showcase of transparency and precision, full glass façades that define contemporary architectural beauty.

2. The Historical Architectural Appeal of All-Glass Buildings

Fully glazed façades have captivated architects and developers for decades, symbolizing progress, modernity, and openness. Their sleek, reflective surfaces integrate seamlessly into urban landscapes, making them a defining feature of contemporary architecture. Cities like Boston, New York, and Toronto showcase numerous glass-clad structures, where cutting-edge design coexists with historical context.

Glass has become a preferred material across commercial, institutional, and residential projects due to its ability to reflect the surrounding skyline and enhance a building's visual impact. However, its popularity is not solely aesthetic. Glass also serves functional roles that contribute to its widespread adoption.



Full glass architecture depicting the elegance and sleek modern look of glass façades.

Why Fully Glazed Façades Are So Popular

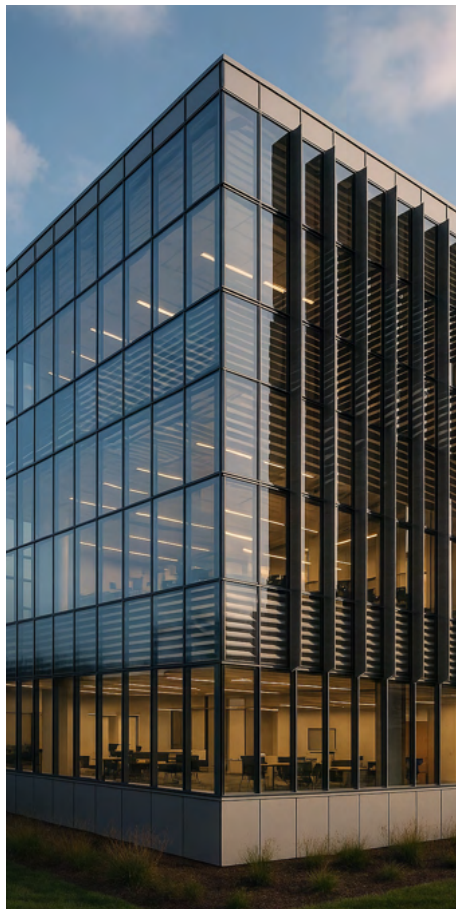
1. **Maximizing Natural Light** – One of the most significant advantages of all-glass buildings is their ability to flood interiors with daylight. Natural light enhances occupant well-being, reduces reliance on artificial lighting, and creates an inviting atmosphere.
2. **Minimalist and Sleek Aesthetic** – Glass aligns with modern minimalism, favoring clean lines and simplicity over heavily ornamented designs. This architectural principle is particularly evident in corporate offices, high-end residential towers, and cultural institutions.
3. **Transparency and Connection to the Environment** – Glass blurs the boundaries between indoor and outdoor spaces, fostering a sense of openness and engagement with the city and landscape. In dense urban areas, this transparency enhances the relationship between architecture and its surroundings.
4. **Ease of Maintenance** – The chemical composition of glass makes it very easy to clean and maintain. Its smooth and non-porous surface helps with stain resistance. Thus, fully glazed façades require minimal maintenance to retain their aesthetic quality for the first 20–25 years. While this is less of a concern for low-rise buildings, it becomes a significant consideration for high-rise structures.

3. Balancing Aesthetics with Performance

Although fully glazed buildings offer undeniable visual appeal, architects face increasing pressure to balance form with function. **The challenge lies in ensuring energy efficiency, occupant comfort, and long-term sustainability while maintaining the striking aesthetics of glass façades.** In regions like New England, where stringent codes rule, all-glass designs require careful thermal management. Without proper strategies, these structures become energy-intensive, leading to excessive heating and cooling costs.

Thermal Inefficiencies and Energy Consumption

Traditional curtain walls rely on aluminum framing, a highly conductive material that **contributes to heat loss in winter and excessive heat gain in summer.** Without proper thermal breaks, these systems drive up energy consumption and operational costs. The issue is further compounded by the high ratio of vision glass to opaque elements, which limits the integration of high-performance insulation.



Aluminum-framed curtain walls: sleek but thermally vulnerable. High conductivity leads to energy inefficiency year-round.

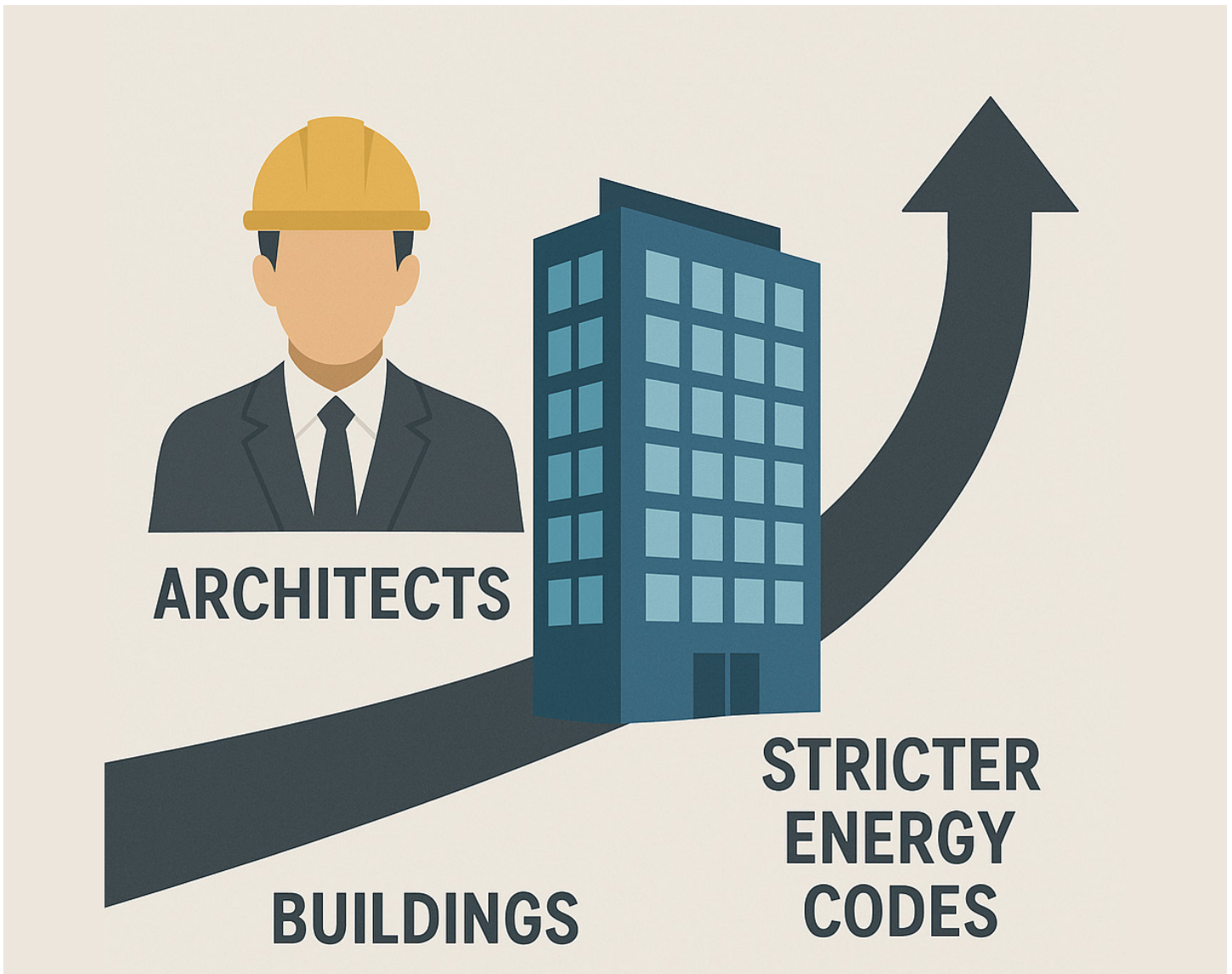
To mitigate these inefficiencies, architects and engineers have adopted advanced solutions:

- Triple-glazed units with Low-E coatings minimize thermal transfer of vision areas.
- Warm (non-conductive) spacers are proposed to reduce heat transfer of IGUs and fenestration products.
- Thermally broken aluminum assemblies or composite framing disrupts conductive heat flow.
- Dynamic shading systems and automated blinds regulate solar heat gain throughout the day.

While the fenestration components of curtain walls can meet very high-performance standards, **it is primarily the opaque sections, or spandrel areas,** that often fail to comply with updated energy codes. Typical curtain wall spandrels achieve R-values between 3 and 8 ft²·°F·h/BTU, depending on insulation depth, panel sizes, and overall design. This is, on average, four times lower than most energy codes—and that's without considering the most restrictive ones.

For instance, in America, the ASHRAE Standard 90.1 defines stringent requirements for building envelopes. In climate zone 4A, spandrel panels within curtain wall systems are required to meet U-values as low as 0.064 BTU/h·ft²·°F, corresponding to an R-value of minimally 15.6.

Regulations like the **Connecticut High Performance Building Standards (HPBS)** reflect the shift towards more stringent sustainability criteria. Under these guidelines, state-funded construction projects must meet or exceed **LEED Silver certification**, ensuring that high-performance materials and systems are integral to the building envelope.



As building codes evolve and become stricter, architecture and real estate professionals are rethinking materials and methods to meet modern performance demands.

Acoustic Considerations

In high-density urban environments, where noise pollution is unavoidable, large glass surfaces present acoustic challenges. Continuous aluminum mullions and lightweight curtain wall assemblies allow for sound transmission between floors and rooms, reducing overall occupant comfort.

To enhance noise insulation from the start and avoid retroactive soundproofing, architects are progressively incorporating:

- Laminated glass with specialized interlayers (pvb) that absorb sound vibrations and improve Sound Transmission Class (STC) ratings, thus more effectively reducing the airborne sound transmission.
- Polymer membrane covering on sound-bridging elements.
- Discontinuous façade systems, where breaks in framing reduce noise transfer between floors and units as well.

For instance, a standard double-glazed curtain wall typically has an STC rating between 28 and 33. By incorporating laminated glass, this can be increased to around 40, which is particularly beneficial in high-traffic areas. For comparison, in a typical hotel with a wall rated STC 30 between two rooms, normal conversations from the adjacent room can be clearly understood. **However, when the STC is increased to 40, only loud speech can be heard, but not understood.**



Dominated by reflective curtain walls, New York's skyline highlights both the allure and thermal challenges of modern architecture.

Structural and Cost Constraints

Curtain walls also introduce significant structural and financial challenges, especially in high-rise applications where wind loads and building movement must be carefully managed. The reliance on aluminum framing often necessitates additional reinforcement, increasing both material costs and installation complexity.

The additional weight of glass, combined with structural support requirements, leads to:

- Higher deadloads, demanding more robust support structures.
- Complex anchoring systems, extending construction timelines and increasing labor costs.

Given these limitations, the industry is shifting towards hybrid façade solutions that integrate high-performance materials and rainscreen technology. **These systems offer greater design flexibility while improving energy efficiency, acoustic comfort, and structural integrity.**

Although fully glazed façades have become a signature of contemporary architecture, their widespread adoption has often been driven by aesthetic and market-driven considerations rather than performance. Today, architects must navigate the evolving landscape of energy regulations, sustainability requirements, and urban constraints to ensure that glass remains a viable and responsible design choice.

By embracing hybrid systems and innovative materials, the industry can maintain the visual elegance of glass architecture while significantly enhancing its efficiency and functionality. This aims to bolster the evolution of all-glass buildings in a way that balances beauty with practicality.

4. Technical Innovations Shaping All-Glass Façades

The evolution of all-glass façades is driven by cutting-edge materials and engineering advancements that enhance both aesthetics and performance.

Key Innovations in Façade Design

- **Hybrid Façade Systems** – Integrating rainscreen assemblies with high-performance insulation behind glass elements significantly improves energy retention while maintaining transparency. For example, Multifaçades™ features an independent rainscreen installed in front of a traditional insulated wall, enhancing thermal efficiency. The thermal resistance of the opaque section is given by the wall assembly itself, which can be composed of practically any insulation depth.
- **Advanced Thermal Breaks** – Innovations in polyamide-based thermal break systems and clip attachments reduce conductivity, allowing for superior insulation while preserving sleek, modern profiles. These innovations mainly result in increasing the effective thermal efficiency of assemblies, obtained by considering all the thermal bridging embedded in them.
- **Acoustic Control Strategies** – Continuous aluminum mullions contribute to noise transmission. Discontinuous framing solutions, laminated glass, and composite materials help mitigate sound transfer between floors and spaces, improving acoustic comfort.
- **Structural Integration of Opaque and Transparent Elements** – By optimizing the ratio of opaque and vision glass sections, architects can meet energy codes, daylighting needs, and performance standards while maintaining a seamless glass aesthetic.



New materials and advanced cladding systems are redefining the capabilities of fully glazed buildings. Vacuum-insulated glass and photovoltaic-integrated façades present architects with new opportunities to push design boundaries while ensuring compliance with modern sustainability standards.

Sleek like a curtain wall but engineered for superior thermal performance, The Marriott Courtyard Quebec showcases the potential of multifunctional façades.

5. The Evolution of Multifunctional Façade Systems

Multifunctional façade systems have gained rapid adoption among architects, engineers, and construction professionals in North America. These advanced systems seamlessly integrate opaque and transparent elements while optimizing thermal performance, structural efficiency, and durability.

Key Advantages of Multifunctional Façade Systems

1. Enhanced Building Performance

- a. Incorporates engineered rainscreen technology, creating a pressure-equalized cavity that effectively manages moisture and prevents water infiltration by limiting air movement in front and behind the cladding.
- b. Reduces condensation risks, extending the façade's lifespan.
- c. Utilizes high-performance insulation behind glass or opaque materials in an optimized configuration, minimizing thermal conductivity without compromising aesthetics.
- d. Prevents the use of galvanized steel back pan unlike conventional curtain wall, leading to a way better overall thermal performance for the opaque sections.
- e. Advanced thermally broken attachment systems (e.g., polyamide clips, composite sub framing) eliminate thermal bridging, reducing operational energy demand.

2. Superior Acoustic Insulation

- a. Eliminates continuous aluminum framing, practically nullifying sound transmission between floors.
- b. Integrates, if needed, laminated glass with high-STC interlayers, minimizing external noise infiltration.
- c. Opaque sections serve as natural sound barriers, absorbing and diffusing sound in the same way they insulate the building from exterior weather variations.
- d. Ideal for high-rise residential and mixed-use developments, where noise reduction is critical.

3. Optimized Structural Performance

- a. Hybrid designs distribute structural loads more efficiently, improving overall building stability.
- b. Eliminates continuous aluminum mullions, reducing wind-driven movement in tall buildings and allowing for smaller mullions to be installed for vision openings.
- c. Modular subframe systems and engineered connection points enhance long-term durability while minimizing maintenance costs.
- d. Uses moisture-resistant materials to prevent environmental degradation, lowering repair and replacement expenses.
- e. Offers complete independence of panels and windows, facilitating window replacements as well as general building inspections throughout time.



Aligning with Evolving Building Standards

From a sustainability perspective, multifunctional façades are setting new benchmarks for energy-efficient design. These systems align with stringent environmental certifications such as:

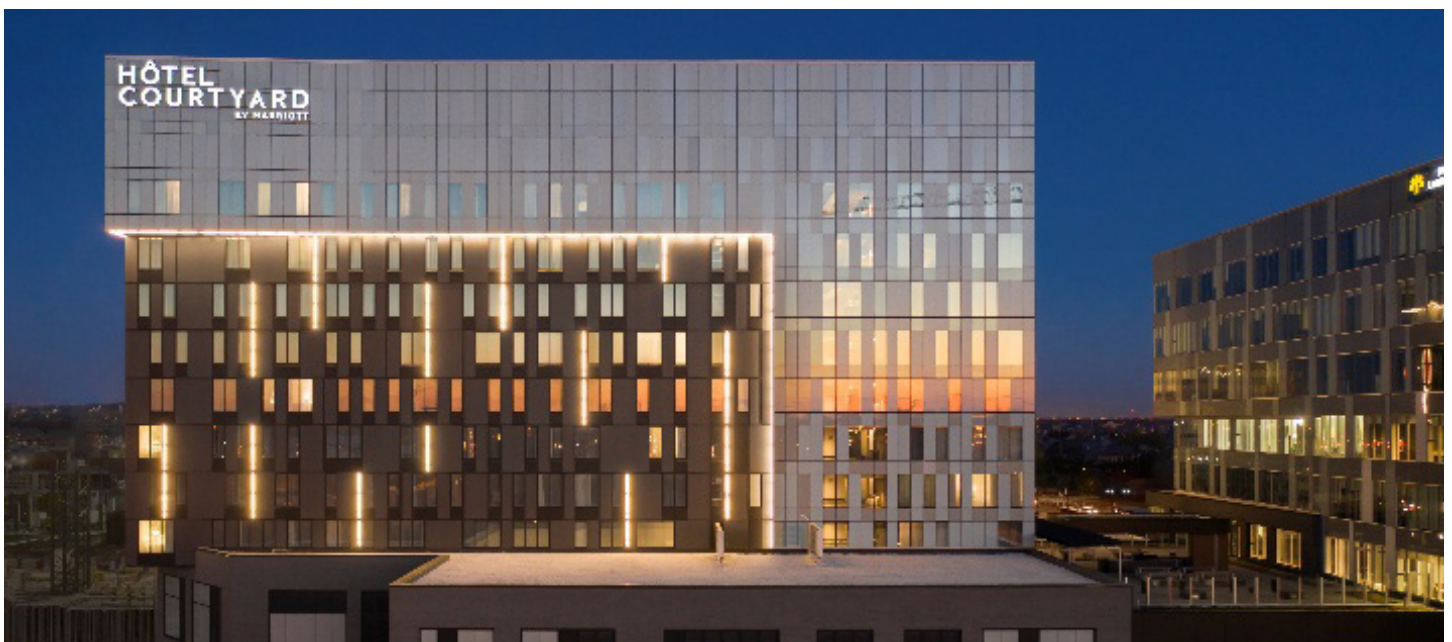
- LEED (Leadership in Energy and Environmental Design)
- Passive House
- Net-Zero Energy

Multifaçades at scale, MaryRobert combines the look of curtain wall with high-performance cladding across two iconic Montreal towers.

Innovations like photovoltaic-integrated opaque sections enable façades to generate renewable energy, directly contributing to a building's sustainability goals. Additionally, automated shading and dynamic glazing regulate solar heat gain throughout the day, reducing cooling loads and peak energy demand.

6. Achieving Architectural Flexibility Without Compromising Performance

Performance must never be compromised, especially in urban developments where buildings must meet a variety of demanding technical and regulatory requirements. Nonetheless, it remains a non-negotiable factor. Multifunctional façade systems provide architects with unparalleled design flexibility while ensuring high-performance standards.



Courtyard Marriott in Brossard features a multifunctional façade system that achieves the sleek appearance of a curtain wall harmonized with opaque cladding.

Design Freedom with Hybrid Façade Systems

Multifunctional façades allow architects to integrate a range of materials without disrupting the sleek, modern aesthetic of the building.

- **Material Diversity:** Incorporate glass, metal panels, ceramic elements, or composites while preserving a cohesive exterior appearance.
- **Customizable Fenestration:** Integrate windows of varying shapes and sizes to optimize daylighting while minimizing heat loss. These windows are also adapted to any type of glazing unit, whether it's a double or triple pan.
- **Seamless Integration of Vision and Opaque Elements:** Combine high-performance glass with well-insulated opaque sections for improved energy efficiency while maintaining a contemporary look.

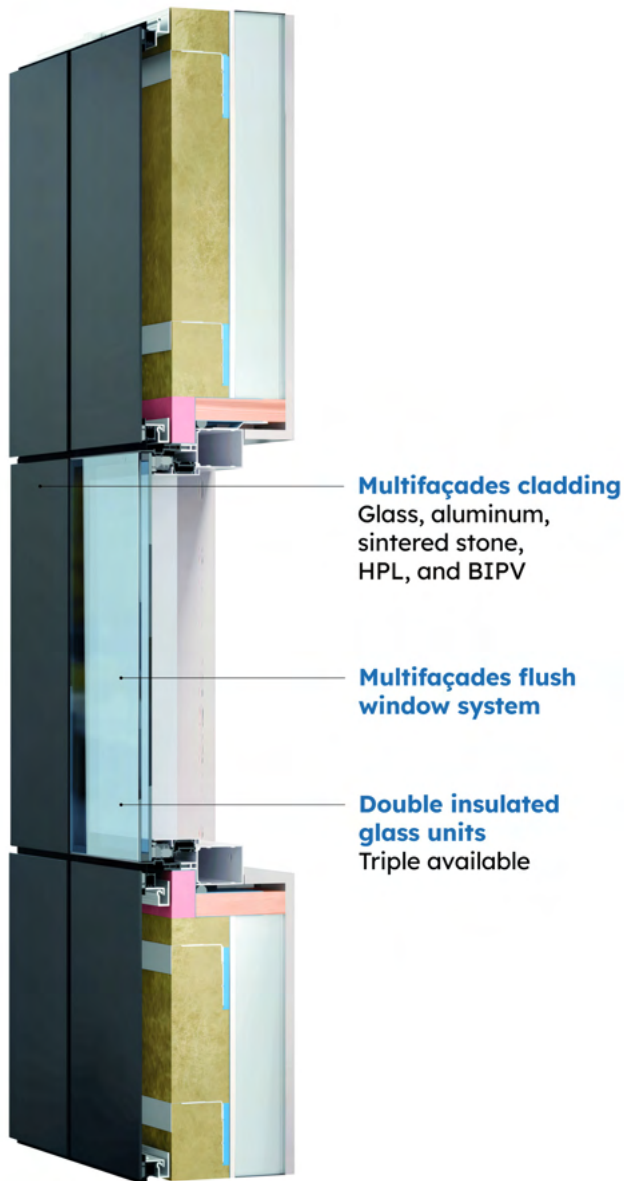
Enhancing Energy Performance Without Visual Disruption

Advanced façade components are key to achieving optimal energy performance. They represent strategic components in the entire envelope design.

- **Thermal Break Technologies:** Essential for preventing unwanted heat transfer, these technologies maintain interior comfort and reduce HVAC dependency. With a strategic geometric configuration, the integration of those thermal breaks can be done without affecting the exterior and interior look of the building.
- **Dynamic Solutions & Smart Glass:** Technologies like electrochromic glazing enable façades to adapt to changing sunlight conditions, minimizing solar heat gain while optimizing natural light. Moreover, vacuum insulated glass products are gaining popularity and confidence in the market as their look is improving. The pillars, which maintain a constant distance between the glass layers, thus preventing them from collapsing under the atmospheric pressure, are now almost invisible. Same goes for the building integrated photovoltaic panels (BIPV) as the electric cells and junction boxes are engineered in a way that the panels look almost the same as standard glass. To push it even further, IGUs are now being developed with photovoltaic cells.
- **Strategic Placement of Transparent and Opaque Sections:** Well-placed transparent and opaque sections reduce energy loss and enhance thermal efficiency. **For instance, prioritizing opaque elements on façades looking North is a judicious choice for achieving stringent code that requires 60/40 vision to opaque ratio of the envelope.**

Multifaçades™ System

This cut shows a pressure-equalized glass cladding system. **Functionally like a basic aluminum panel, it stands out with a sleek, all-glass appearance.** An integrated dry gasket around each panel improves water management and pressure equalization, preventing water from reaching the insulation or AVB barrier. The system is compatible with all window types—from residential to high-end architectural—and its frame and railing are designed for a perfectly flush integration. On the left, the flush window demonstrates an impressive feature: **despite being misaligned with the insulation, it still performs on par with the best curtain walls in terms of energy efficiency.**



A noteworthy example is the *Technopôle Angus* project, where a high-performance façade system achieved the appearance of an all-glass structure. This design, featuring an advanced rainscreen system, balances insulation, controlled ventilation, and aesthetic appeal. It also meets strict energy efficiency standards (even stricter than the most restrictive code adopted in the area at the time of construction) and earned LEED Platinum certification, exemplifying how transparent and opaque elements can be harmoniously integrated to optimize energy consumption while preserving architectural integrity.

It Looks Like a Curtain Wall, But It's Not

You've probably noticed by now, after looking at the photos, that some of these buildings really look like curtain walls.

And that's no coincidence.

As an engineer and product specialist, I can tell you: this system gives architects the option to mimic that clean, continuous glass look that's still so dominant in North American cities.

But here's the difference: it's not a curtain wall. It just looks like one.

As mentioned, what's really driving the shift towards this type of system isn't just design preference, it's the increasingly strict energy codes and performance demands being placed on buildings today. Because curtain walls are still widely used, the innovation must come from the system itself, from behind the scenes of the façade. In the case where the curtain wall look is a fundamental part of the architects' vision, the Multifaçades™ system quietly solves a lot of the problems that come with traditional curtain wall design.

The Multifaçades system is an advanced rainscreen cladding solution that integrates multiple window types into a single, seamless design.



An internationally acclaimed marketing firm, LG2 selected the multifunctional façade system to shape a headquarters that marries visual character with building performance.

7. The Future of High-Performance Façades

The construction and façade industry are increasingly focused on integrating cutting-edge materials and technologies to enhance both energy efficiency and occupant comfort, ensuring that façades contribute to a building's long-term performance.

Next-Generation Materials Driving Innovation

High-performance materials are revolutionizing façade systems. Some key advancements include:

As mentioned earlier, here are the top 3 advancements in the glass industry that are driving new façades technologies.

- Vacuum-Insulated Glass (VIG)
- Electrochromic and Thermo-chromic Glass
- Building-Integrated Photovoltaics (BIPV)

When it comes to thermal break materials, **aerogel** is what's truly shaking up the industry since the introduction of **polyamide** (Nylon 66 reinforced with glass fiber). Aerogel is more than ten times less conductive ($0.024 \text{ W/m}\cdot\text{K}$ at 20°C) than polyamide, making it one of the most insulating substances on Earth. However, its integration into curtain wall assemblies is still under exploration. That said, aerogel is already a component in **thermally broken clips for cladding systems**, which are gaining traction in the North American market.

From another angle, **phase change materials (PCMs)** are also rising in popularity due to their ability to **store and release energy**. During the day, they absorb heat by changing from a solid to a liquid state. At night, when temperatures drop, they return to a solid form, releasing the stored heat to improve occupant comfort and reduce energy use. Currently, PCMs are mainly used in the **opaque components** of floors, walls, and roofs—such as **plasterboards and drywall systems**—to help regulate solar heat gain.

Adaptive and Responsive Façades

Emerging trends include:

- Kinetic Façades
- AI-Driven Climate-Responsive Design
- Biophilic and Living Façades

Regulatory Trends and the Impact on Façade Design

Key future considerations include:

- Net-Zero and Carbon-Neutral Buildings
- Stronger Air and Moisture Control Requirements
- Circular Economy and Material Reuse

The Role of Architects in the Future of Façades

The next era of architecture will see façades evolve from static elements to dynamic, responsive components integral to the built environment. The ability to balance aesthetics, efficiency, and functionality will define the future of architectural design.



A timeless industrial form meets the elegance of snow. Jefo's factory uses a multifunctional façade system to blend beauty, purpose, and precision.

8. Conclusion

The evolution of façade systems marks a pivotal shift in architectural design, where aesthetics, performance, and sustainability must be seamlessly integrated. The limitations of traditional curtain walls have paved the way for multifunctional façade systems that offer architects innovative solutions to balance beauty with efficiency.

By becoming an all-in-one solution that incorporates advanced materials, thermal advancements, and acoustic solutions, modern façade systems offer a path forward that meets both regulatory demands and environmental goals. As urban environments evolve and energy codes become more stringent, **architects and developers will continue to embrace technologies that push the boundaries of façade engineering.**

The buildings of the future will be evaluated not only for their visual impact but for their ability to optimize energy use, enhance comfort, and **contribute to a more sustainable built environment.**



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