
COVER STORY

FUTURE FACADES: DESIGNS, TECHNOLOGIES & MATERIALS



The collector Office, Pune by Sunil Patil & Associates

Buildings, as the largest users of energy, are also our greatest opportunity for energy conservation and protection of the environment. The rapidly growing energy needs have raised global concerns over continued depletion of energy resources and their negative impact on the environment. The façade is one of the most significant contributors to the energy conservation and comfort parameters of any building. Strategies and technologies that allow us to maintain our satisfaction with the interior environment while consuming fewer of the resources have always been the major objectives for contemporary façade design.

A well designed façade can effectively control the physical environmental factors such as heat, light and sound, thus improve the occupant comfort within a building. The location and climate are crucial factors in selecting appropriate façade materials and deciding on the design strategies for sustainable facades.

The cover story of this edition focuses on the various approaches for designing sustainable facades for the future, which are high performing, comfortable, safe, at the same time aesthetic. It also discusses emerging façade technologies, and advanced, smart materials for facades, describing their properties and applications.

Architecture is a great responsibility to strike the right balance between human aspirations and our ecosystem, says **Ar. Sunil Patil, Founder, Sunil Patil & Associates**. Today, the growing aspirations

of the mankind and the random use of the natural resources of the earth has posed a great threat not only to the environment but also to the planet itself. Hence any development on the earth has to be



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Kirtisagar Bollar,
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Rishi Raj Khare,
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carried out cautiously. Environmental sustainability is of paramount importance. Eco-friendly and sustainable architecture is not a fashionable design concept anymore, but it is the only way to deal with architecture today.

The architectural façade, an inevitable part of any building, has long been a compelling focus of interest for building physicists and designers combining attributes of both appearance and performance in a holistic manner. Façades, as building envelope, form the outer skins of buildings as a projected image and creative intent. Increasingly, they are also understood as important environmental moderators. A thoughtfully designed skin can make a new building work more effectively for its owners, occupants and environment. It can also transform the performance of an existing building.

Façade today has evolved from a skin around the building to an element which needs to have a soul, a purpose and a reason to be there, observes **Kirtisagar Bollar, Associate Architect, Architect Hafeez Contractor**. Today projects demand a significantly larger chunk of design and planning around façades.

It is a common knowledge in the industry, observes **Ninad Tipnis, Founder & Principal Architect, JTCPL Designs**, that the facade of any structure is often considered the most important aspect from a design POV, as it lays the groundwork for the rest of the building. As far as the engineering front goes, the facade is also of great importance due to its environmental impact.

Rishi Raj Khare, Principal Architect, Inspire Design, notes that novel facade technologies, showcasing



Adani 'INSPIRE BKC' by Architect Hafeez Contractor



Hiten Sethi,
Founder and Principal
Designer of Hiten Sethi
Associates



Ashish K Jain,
Partner- AEON Integrated
Building Design Consultant



Hans Brouwer,
Founder, HB Design



Amit Bhat,
Principal Architect, AB
Architects

new patterns and designs which are more visual, are evolving constantly in order to create greener healthier eco-friendly places for users. He adds that the builder's expectations are sky rocketing and designers is a very challenging job. According to him, the target of the designer has always been to deliver more scalable designs with commercial appeal, at the same they should be cost effective and perceived as an investment.

Ar. Hiten Sethi, Founder and Principal Designer of Hiten Sethi Associates (HSA) adds that the whole building performance approach should be used towards achieving the efficiency in order to find the most cost effective solution. The envelope of a building is a very critical component for evaluating the efficiency and lifecycle of the building. Façade has an impact on the interior spaces as well as on external neighbourhood.

Technology has gradually emerged in recent decade, driven largely by the pursuit of transparency in the building façade among international building designers, says **Ashish K Jain, Partner, AEON Integrated Building Design Consultant LLP.** The façade is also the focal point of energy efficiency in a building design because it works as the first frontier to face the intense heat and a major source of heat ingress into the buildings. As an enclosing building component, it connects or separates the interior and the exterior. All components of the building façade, therefore, need to work together to regulate the indoor environment, responding to heating, cooling, ventilation, and natural lighting needs. It must balance requirements for ventilation and daylight while providing thermal protection appropriate to the local climatic conditions. The optimally designed building façade is an important

factor not only for achieving the energy efficiency, but also the human comfort for which the buildings are actually designed. Agreeing to this, Ar. Bollar adds that the design community today has moved ahead from creating fancy looking non-functional facades to more climate and context responsive ones which are much more sensitive than it has even been.

The main challenge with building performance in the tropical and subtropical environments is how to minimise heat gain, observes **Hans Brouwer, Founder, HB Design.** According to **Amit Bhat (Principal Architect, AB Architects),** "Efficient, Adaptive & Scalable" these are the terms which



VVIP Circuit House by Sunil Patil, Sunil Patil Associates



Design for ONGC by Architect Hafeez Contractor

will define the future of facade systems in India. For gaining maximum benefits of natural resources with maintaining comfort of user inside a building, facade and fenestration will always play an important role.

The façade design is transiting from staid static to responsive dynamic, remarks **Indrajit Kembhavi, Principal Architect, Kembhavi Architects**. Cutting edge technological advancement is leading to the generation of façade design that is responsive to environment changing dynamically with weather and seasons, aligning with nature, nurturing a green ambient environment and is constantly evolving. In addition to being sustainable, these emerging technologies are instruments of visual drama that is again non constant, but presenting it differently creating a play in the skyline, he adds.

Like Kembhavi, **Gautam Bhasin, Regional Manager – Inhabit Group, India** says that technology for the last few generations of building facades has been



Indrajit Kembhavi,
Managing Partner,
Kembhavi Architects



Gautam Bhasin,
Regional Manager – Inhabit
Group, India

focused on conserving energy, improving aesthetics while enhancing comfort.

A building façade can have both positive and negative effects on work performance, adds Ashish K Jain. Negative effects are associated with discomforts, distractions or health risks that interfere with peoples’ ability to do their work, whereas positive impacts are associated with enhancing work performance, psychosocial well-being, and health to enhance the overall performance.

Let’s have a look at the parameters for responsible and effective facades:

DESIGN AND ENGINEERING

Most of the times facades we see are output by placing some components externally, after designing the whole building. According to Amit Bhat, whatever type of building we may design, envelope of these should be a product of consideration of climate, function, surroundings and most importantly planning aspects of that building.

“Climate Responsive Architecture” is the key to achieve sustainable architecture, points out Ar. Patil. It has been proven for decades in our traditional



A project for KBS Creations by JTCPL Designs

“NEXT DECADE WILL SEE DYNAMIC FACADES & DYNAMICALLY CHANGING GLASS”

What are your thoughts on future facade and fenestration- designs, technologies and materials?

If we study the history carefully, it is evident that the structural frame and the building envelope had a design, technological and material synchronisation. The façade methodology has always been remained complimentary to the structural systems along with other factors like climate and aesthetical preferences. With the inception of framed structures precast and prefabricated facades came into the picture. The same factors are going to define the future facades. Earth's climate, health and safety, lifestyle and rapid urbanisation will result into super tall and smart buildings. The buildings will have complex but efficient structural systems like diagrids, exo-skeleton, space trusses, etc. and façades would follow the process. The material choice and the combination would derive creative character of the facades. Steel, aluminium, zinc, tile, stone, extruded resin, ETFE and so on, the list is endless.

What are the expected evolutions in façade technologies and materials?

In the last century, all the major experiments in building envelopes were focused on aesthetics and environmental protection. The further evolution should not just make the facades protect and project, but they should think, behave and perform. Façades need not just envelope the buildings, but they should simultaneously participate in the structural systems as well. The selection of material and technology should make the building environmentally responsive.

How do you envision the facades of 2025?

I believe that, by 2025 we will witness multiple options and experiments in automated or electronically controlled dynamic facades and its properties changing glass for improved energy efficiency, indoor comfort and overall environmental quality. The facades will generate and even store renewable energy. Advanced embedded photovoltaic cells, micro wind mills and heat filter membranes in facades will take care of more than 50 per cent of the energy needs of the buildings. The light dam panels on facades would be used with two-way fibre optic cables to illuminate the dark interior of the buildings in the day time and illuminating the façade in the night with reverse flow of light thus resulting in lot of saving.



Ar. Vivek Bhole,
Chairman & Managing
Director, Vivek Bhole
Architects Pvt. Ltd.



Commercial Building Mumbai by Vivek Bhole Architects Pvt. Ltd.

buildings as well. The building envelope has to be designed to suit the climate to achieve the thermal and visual comfort of the space. India, being a tropical country, has 'hot dry' and 'hot humid' climate in most of the regions. Hence the real challenge is to deal with harsh radiation from the south and west at the same time allowing natural ventilation. Every facade needs to be treated differently as per the climatic conditions.

Taken to its ultimate development, an interactive facade should respond intelligently and reliably to the changing outdoor conditions and internal performance needs. It should exploit available natural energies for lighting, heating and ventilation, should be able to provide large energy savings compared to conventional technologies.

According to Bhasin, the next evolution of facades



Design for a residential project by Inspire Design



Residence for Gaurav Agarwal by Inspire Design

will be expected to be more responsible towards the energy it consumes - both while manufacturing and across its installed design life. Facades could even feed energy back to the grid to reduce the burden of peak loads on the sources of power generation.

BUILDING MATERIALS

Building materials make or break any project. Continuous innovations in building materials towards performance and efficiency help to reduce carbon footprint; e.g.

- a. High-strength hollow block masonry units using natural mineral-based geopolymers help in reducing the load on the building at the same time give a better thermal performance.
- b. Light, responsive façade that 'breathes'. This façade is made up of series of faceted fiberglass rosettes, which open and close in response to the temperature of the façade thereby avoiding excess of heat to come inside the building.
- c. Double screen façade made from special tiles that can clean the air around it. UV light activated free radicals from the tiles destroy any existing pollutants from the air leaving it cleaner for the people inside the building.

Ar. Patil reiterates the need for reinventing the vernacular ethos of traditional buildings. "We have been using stone jalis in our traditional building facades which can be derived in the form of metal louvers or fins in a contemporary style today's facades. This can be pursued further by creating dynamic facades using modern technology, which will transform itself in response to the changing sun positions, lighting conditions and the functional requirements," he adds.

GLAZED FACADES: WHY & HOW

Man needs natural light to survive and the glass makes it possible to allow light into the interior. Towards the end of the 20th century, glazing became the ideal design solution. Early 21st century saw the growing interest in highly glazed building facades, driven by a variety of architectural, aesthetic, business and environmental rationales. Today, the highly glazed facade has become an indispensable component of a 'green building', and building designers and owners have dependably been intrigued by the broad utilisation of glass in building envelopes. But many of these buildings are with profoundly reflective glazings or utilise exceedingly transmissive glass and come across serious internal comfort issues that could only be overcome with extensive HVAC systems, resulting in significant energy, cost and environmental penalties.

Glass, in its present form is not very safe (unless it is processed and tempered or laminated), says **Rajeev Trehan, Senior Associate, Architect Hafeez Contractor**. It has to ultimately evolve into a safer building material. Major issue with glass is safety and excessive heat gain. At present, the research on production of more efficient and safe glass is at a very basic stage. As we move on, we hope that the research would result in high performance, energy generating glass which is inherently very safe as a construction material, adds Trehan.

Demand for more efficient, responsive facades lead to the replacement of conventional glazing by a new generation of high performance, intelligent facade systems that meet the comfort and performance



Rajeev Trehan,
Senior Associate,
Architect Hafeez Contractor



Nishant Gupta,
Associate Architect,
Architect Hafeez Contractor

needs of occupants while satisfying owner economic needs and broader societal environmental concerns. Products such as heat absorbing glass, reflective glass and double glazing glass emerged.

Experts tried to optimise the use of these products and to come-up with an ideal, static design solution to make the facade more responsive. Thus more sophisticated design approaches and technologies have emerged using new high-performance glazing, improved shading and solar control systems, greater use of automated controls, and integration with other building systems. Another relatively new architectural development is the facade that can provide improved acoustics, better solar control and enhanced ventilation.

WINDOW WALL RATIO

One of the basic design motives for the building envelope is to protect the indoors from external elements along with providing optimum daylight and to optimise the solar heat gains in the building. This can be achieved through simple passive low cost measures based on the principal of demand reduction through building envelope design by controlling the Window to Wall Ratio (WWR), SHGC, U value (based on choice of building material), says Ar. Hiten Sethi. The daylight analysis of the design at regularly occupied spaces should be carried out at the designing stage

itself to ensure that they are adequately lit as per the required task based lux levels. These levels can be achieved through appropriate design of the spaces along with right shading devices and glazing specification. The WWR can vary from design to design. Having the right ration ensures the efficiency. Appropriate shading with respect to orientation with a combination of high performance glazing ensures compliance with SHGC requirements as per ECBC. For moderate climate, the prescribed SHGC for a design with WWR < 40 percent is 0.4.

Indoor daylighting is achieved by providing glazing having specific VLT values and efficient space planning. Another important design motives of a façade is to maximise the external views while causing minimum glare.

It can thus be seen that the use of higher performing glass increases the initial cost of construction, but it helps in reducing the cost of operations of the building by reducing the load on the HVAC system in the long run.

SOLAR CONTROL

The sun is a very potent source of energy and is the primary contributor to cooling loads in our buildings. There are two main ways to deal with this issue, informs Ar. Hans Brouwer. The first is to deal with this on the surface of the building - with the cladding (whether this is with a curtain wall system or a window wall system). Keeping fenestration percentages to below 35 percent is a good guideline for energy efficient buildings. Where fenestration is required, high performance glazing specifications should be deployed - ideally double-glazed units (DGU) with a low emissivity coating (low-E).

The other approach is to prevent direct insolation (sun rays hitting the glazed surfaces). This is done by introducing an additional screening layer outside the building. In our Marvel Edge building this is a fine mesh screen that cuts out 60 percent of the sun's

Performance and cost implication for SHGC compliance in a typical project:

	Option 1	Option 2	Option 3
Glass Specification	Saint-Gobain 5 mm clear glass	High performance glazing under single glass unit. (SGU)	High performance glazing under double glass unit.
SHGC	SHGC = 0.85	SHGC ≤ 0.35	SHGC ≤ 0.25
VLT	VLT = 89%	VLT = < 26%	VLT = > 26%
Cost implication	@Rs. 700/- per sq. m.	@Rs. 1500/- per sq. m.	@Rs. 3300/- per sq. m.

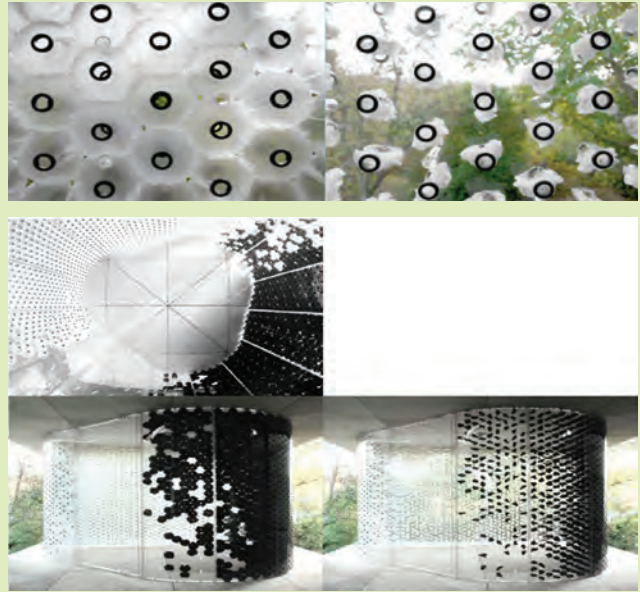
BIOMIMICRY IN FACADES

The 'Breathing Skins Project' by Tobias Becker

Over the years, climate change has been another contributing factor to the rising need for amalgamating futuristic designs & energy efficiency concepts. Facades with adaptive features help reduce the energy needs of buildings and accommodate climatic requirement better. For instance, the 'breathing skin project' developed by Tobias Becker is based on the concept of biomimicry.

The technology is inspired by organic skins that adjust their pores to control the necessary flow of light, matter and temperature between the inside and the outside. Technologies like this one can revolutionise the way we approach façade and fenestration for years to come. More than anything, the moral conscience and vision of architects play a huge role in the way facades and fenestration can revolutionise contemporary architecture globally.

(As told by Ninad Tipnis, Founder & Principal Architect, JTCPL Designs)



rays, leaving sufficient daylight for good internal lighting without the challenge of too much glare. In this case, the glazing specification doesn't need to be as high, as the heat build-up has been dealt with before the actual building envelope. It also provides for a façade that has a lot more interest and depth, in contrast with the ubiquity of glazed, curtain wall buildings that adorn our modern cities, adds Brouwer.

Ar. Hiten Sethi also agrees that the solar insolation study helps to analyse critical façade and designing them based on the heat gain requirements based on the climatic conditions of the location of the building. Design elements like light shelves, double screen façades, sun breakers, etc., also contribute in achieving the requisite indoor thermal and visual comfort.

FUTURE FACADES

According to **Nishant Gupta, Associate Architect, Architect Hafeez Contractor**, future facades would be more advanced in terms of material and technology. They will be more interactive, and more environment responsive, and much more innovative in design. They could draw moisture from outside and collect water. They could capture solar energy and make the building self sustainable. Facades

could filter the polluted air and provide fresh air for the inmates. The façade could warm or cool the building depending on the climatic condition and requirement. We might see facades which could



Orbit Haven, Mumbai by Architect Hafeez Contractor

I-FACADES

"I-facades" will be the future thing. Capable of thinking on their own the computing powers integrated with these skins will convert any material into thinking surfaces. They will be able to connect to the building systems as well as the building occupant's mobile phones or systems giving real time data and capable of converting these data to maintain the buildings internal as well as external experience.

These "I-facades" will not only be linked to its users, but will be "talking" to the surroundings as well. It will be capable of generating electricity and charging things wirelessly in and around it. Cities will no longer depend on grid supply for electricity. The future buildings with its smart façade and systems will itself be the source of energy. Electric cars will be able to charge themselves wirelessly around these buildings. At a macro level, integration of similar skins of buildings with a central control system will help the local authorities in regulating large swathes of urban patches with efficient energy distribution and management. When we talk about such future, it seems far, but as time has proven, these technologies will be out in the market in no time.

(As told by Kirtisagar Bollar, Associate Architect, Architect Hafeez Contractor)

expand and contract as per the space requirement. We can also look forward for facades which could be taken off from one building and installed on another.

Like Nishant Gupta, architect Amit Bhat also is optimistic that in future we would develop a facade/fenestration system which provides us a way to generate green energy from natural resources. Now a days we are hearing about the use of photo voltaic cells on facades so that the buildings can generate energy and could become self sustainable in power requirement. But, at present, the system seems to be phenomenally expensive. As photovoltaic costs decrease in the future, these on-site power systems will be integrated within the glass skin and these facades will become local, non-polluting energy suppliers to generate enough energy. Wind farms near coastal areas will help to generate more energy. These innovative concepts create habitable clean energy harvesting system.

Ar. Rishi Raj Khare too foresees that, in future facades, solar panels will be used and LED systems which help to provide light. Both interior and exterior skins with bioclimatic effective façade will help to moderate wind, noise, light, heat and pollution, he adds. Vertical gardens can reduce the thermal loads; rainwater harvesting systems and recyclable products used for construction would add to the greenness of the building. All these challenges will make the job of a façade engineer one of the most interesting and creative one.

By integrating innovations with proactive façade management strategies we can work towards a greener and more sustainable future, ensuring these combined strategies both play their part in supporting global sustainability targets.

As with design and technology, materials too will play an important part in contributing to the smart and



Club House design by Kembhavi Architects



Commercial building by Kembhavi Architects

FACADES OF THE FUTURE: THE TRENDSETTER

Catering to the demands of an ever expanding industry and innovative designers, the presentation shifts in its last segment to sensitising on the future technologies in Building Facades which will provide better efficiency, aesthetics and commercial value to the developments addressing a wider spectrum of issues covering the following:

- **Facades generating Power – Photovoltaic Glass Unit (PGU)**

Building integrated photovoltaic's capture the solar radiations and turn it into energy. A high level of energy generation (up to 12 percent efficiency) can be generated through Photovoltaic Glass unit. The advantage of this technology is that it is allowing the usage of fenestration part of the building as PGU's provides transparency to the human eye upto 70 per cent.

- **Thermally Dynamic Facades – Phase Change Materials (PCM)**

Çaade, which responds in accordance with the variations in outdoor conditions. Thermally dynamic facades use phase change material wherein a layer of salt crystals captures the heat radiated by the sun and release it back to the environment during non-operational hours. The thickness of conventional materials used in buildings is much more than the equivalent heat capacity of a one-centimetre-thick PCM.

- **Biomimicry in Facades – Living Buildings**

Just like the surface of a leaf, the 'skin' of future buildings may react to external stimuli, opening, closing and breathing throughout the day through a system of 'cellular' openings that allow light, air and water in the apartments contained within.

- **Facades Enhancing Outdoor Environment – Microclimate Impact**

Growing vegetation on the façade can potentially create a positive microclimate around the built form. A microclimate is a local atmospheric zone where the climate differs from the surrounding area. The studies accounts that a reduction of approx. 2°C can be achieved by using green vegetation around buildings compared to the surrounding ambient in composite climates like Delhi.

- **Facades Enhancing Indoor Environment – Growing Fresh Air**

Most developing countries have high pollution levels and as a result the indoor environment can be even more polluted. Drawing ventilation air through a green façade or a greenhouse offers a potential to counter the toxins, VOC's, microbial infections, etc. in an air-conditioned building.

- **Çaade Addressing Fuel Crises – Building Powered by Algae**

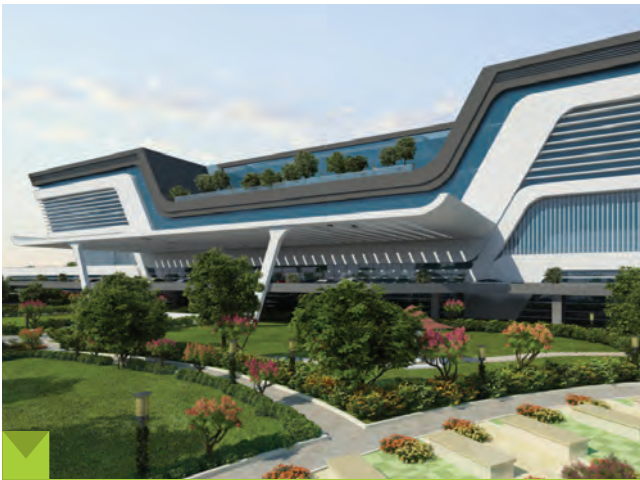
A classic example of this technology is BIQ building algae panels generating power where the algae is grown on façade and burned to provide an alternate energy source.

- **Facades Addressing Food Crises – Hydroponics**

The idea that fruits and vegetables can grow with water, light and nutrients are the basis of hydroponic: one of the innovative systems of making the building self-sustaining. There have been other numerous advantages of this system as well. A reduction is seen in street level concentrations up to 40 per cent for NO₂ and 60 per cent of particulate matter. They potentially contribute to an increase in biodiversity in urban areas by providing a habitat for birds, etc. The most important aspect is their "rejuvenating effect" on the living creatures around as they contribute in softening of the urban landscape and allowing buildings to seem more 'natural' and pleasing for the people.

Energy efficiency remains a primary challenge in today's commercial construction industry. How important are energy efficiency gains from a building envelope is a topic that is gaining momentum amongst industry-leading architects and design firms. In order to address a few paramount issues in the industry, with ever-increasing pressure for the dual objectives of higher performance and improved payback calculation to stakeholders, innovative trends and forces shaping the future of building skin contain the answer of many unfolded domains.

(As told by Ashish K Jain, Partner - AEON Integrated Building Design Consultant LLP)



National Cancer Institute, Nagpur by Hiten Sethi Associates (HSA)



Marvel Edge is a modern day groundscraper and an unusual mixed-use project at Pune by HB Design

environmentally sensitive design narrative. Building materials will evolve with more recycling friendly alternatives with even upcycling contributions from other industries, adds Ar. Gautam Bhasin.

According to Ar. Indrajit Kembhavi, the material palette of future façades is evolving rapidly ranging from ceramics, multilayer aluminium/metal, to ETFE (ethylene tetrafluoroethylene copolymer) cushion fabric, multilayer ETICS (external thermal insulation cladding system) to green vegetated façade systems. Future technologies would involve façade that is self-cleaning, environmentally dynamic, information sensitive and communicating.

Ar. Rajeev Trehan of AHC is hopeful that the ongoing research on glass will result in introducing completely transparent glasses that are totally safe, insulated and energy generating, and it will become a reality in the near future. The buildings of the future could use this novel material. He believes that gradually it will become mandatory to use such 'hi tech' glass that is transparent (but photo chromatic), lightweight (but strong), safe (without additional processing) and energy generating.

Future façade can be defined as fully responsive parametric façade that are non-static, but kinetic addressing varied issues including sustainability, power generation, vertical farming and are informative and transformational, articulates Kembhavi. The facades, far from being static elements shall start getting responsive and communicative to a situation/environment. However, the biggest challenge shall be to balance the cost to performance ratio.

Forging ahead, Kirtisagar Bollar of AHC visualises the future of facades is going to be much more than the material, looks or performance. It will be a living organ very much like our skin, which will respond in real time to its surrounding presence and will be capable of adapting to it. From facades which will be able to self heat and cool itself a building will no longer depend on its internal building management systems. They will be "intelligent". Yes, intelligent. The big "I".

CONCLUSION

Sustainable design continues to be at the core of the architecture, engineering and construction (AEC) industry, yet very few can agree on how it should be practised, implemented and incorporated into the design process, and take it to the next level, may be to 'net-zero' levels and beyond.

Design teams are changing to become more intensive collaborations. Technologies have advanced to the point where it is difficult for architects to be all-knowing in relation to the effect of various systems on the holistic performance of a building. One shouldn't stop with materials that are already in the palette, but look for much more innovative ones. New materials are flooding the marketplace at an exponential rate. Their introduction requires rapid inclusion in familiar construction systems, considering the qualities like performance, tolerance, compatibility, etc. Building skins in the future will integrate dynamic or kinetic components, creating an architecture that incorporates multiple materials and systems into a singularly performing envelope.