Transforming "Dumb" Buildings into "Smart" Buildings with Energy-Generating Façades

By Maryruth Belsey Priebe

"Dumb" buildings may provide shelter and comfort, but they consume more energy than they should, and yet they dominate the conventional building market. A smart building, on the other hand, is one that can produce some, if not all, of the energy that it requires for day to day operations. It's smart because it exists independent of outside energy sources.

Given that buildings are some of the biggest consumers of energy – requiring approximately 40% of all energy consumed in the European Union and generating 36% of all greenhouse gas emissions[1] - that's a tall order to fill. But intelligent building façades are offering solutions to this challenge, potentially making energy-hungry buildings a thing of the past.

Direct Energy Production with Building Integrated Photovoltaics

CIS Tower in London, UK with BIPV built into the smart façade via Flickr Gene Hunt

Governments around the world are pushing for buildings to reach aggressive net-zero energy goals, and for that buildings need to create as much or more energy than they consume. Perhaps one of the most well-known forms of smart façades are building integrated photovoltaics or BIPV. This straightforward concept involves using small-form photovoltaic (PV) modules that are integrated directly on to the exterior of a building. Often you'll find PV materials incorporated seamlessly into a building's roof, windows, or skylights, integrating energy production with the exterior design. In most cases, they are hardly noticeable, which is one of the benefits of this type of renewable energy system.

A great example of this BIPV concept is the CIS Tower in London, England. Originally built in 1962 and covered in tiny individual tiles, this building was retrofitted with a smart façade consisting of 7,244 Sharp PV modules that were used to clad the exterior of the building. The system is estimated to provide approximately 80 Watts of electricity that is fed into the national energy grid, saving the building 103,944 kg of carbon dioxide every year.[2]

Advances in BIPV technologies are offering even more flexibility and customization for building designers. Several companies have recently developed semi-transparent photovoltaics in a variety of forms that can be used for building glazing. Some involve laminating semi-transparent solar panels onto existing windows and doors. These lightweight, flexible thin-film solar panels still allow daylight to filter through existing windows while collecting energy as they do so. Though the efficiency of these types of PV panels needs to increase in order to achieve higher returns on investment, they are a lower-cost, relatively easy to install option for adding renewable energy to existing buildings.

New innovations are being developed in transparent photovoltaics that expand the applications of this type of BIPV. Some companies now offer photovoltaic transparent glass which can be used for skylights, windows, and doors. They are customizable based on how much UV radiation and infrared radiation you require. You can further customize the thickness, color, size, and transparency depending on your requirements and design goals.

All of these options offer the ability to generate renewable energy, making smart façades a breakthrough idea being used by architects and builders to lower the carbon footprint of the built environment without compromising on design and style.

Creating Smart Façades by Combining Aerodynamics, Biology, and Optics with Architecture

BIPV is certainly a step-up from traditional glazing options, but what if you want to have the option of generating even more energy through your building façade? Enter the intelligent building design concept which makes triple paned windows look like child's play.

Take scientists at the Syracuse Center of Excellence in Environmental & Energy Systems (SyracuseCoE), for instance, who are testing a new dynamic building concept – Integrated Concentrating Solar Façade (ICSF). This multi-functional renewable energy system incorporates a variety of technologies to squeeze as much out of solar energy as possible, including PV cells, solar heated water tubes, and magnifying lenses, all combined into linked modules.

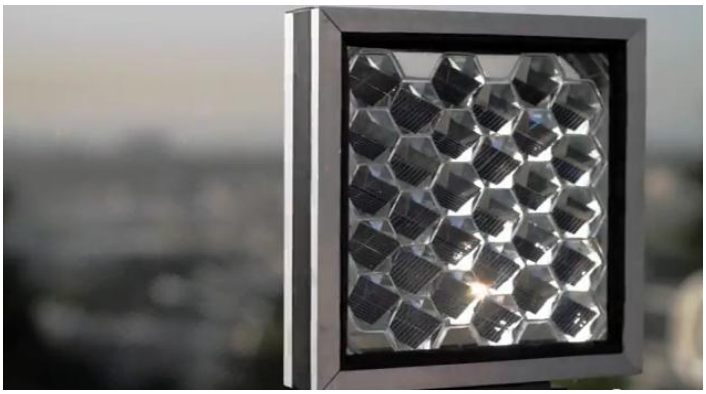
HeliOptix Integrated Concentrating Solar Façade System at SyracuseCoE

Built into the side of a building in place of conventional windows, these ICSF systems are inspired by heliotropic plants that follow the movement of the sun. The system is encased between two weather-sealed panes of glass. Pyramid lenses track the sun throughout the day like magnifying lenses, concentrating sunlight 500 times onto small high-efficiency PV cells. In addition, any solar energy that is converted into heat is captured and used for hot water heating and radiant heating inside the building.

In all, the system provides electrical power, beautiful enhanced daylighting, and also reduces

solar heat gain through absorption and reflection. It's a full-service renewable energy system in a stunning package.

A similar concept is being applied to building integrated solar façades with SolarOr, a company who has developed what they call the BeeHive PV. Unlike the ICSF used at SyracuseCoE, these honeycomb-shaped panels are installed more like windows or glass blocks than entire walls of glass. That said, like the SyracuseCoE design, these frames have tiny prisms used for focusing the solar energy on to little solar photovoltaic panels. The PV cells and prisms are housed between double glazing and can produce energy two and a half times more efficiently than traditional solar PV.



SolarOr's beehive-shaped transparent building integrated solar pv

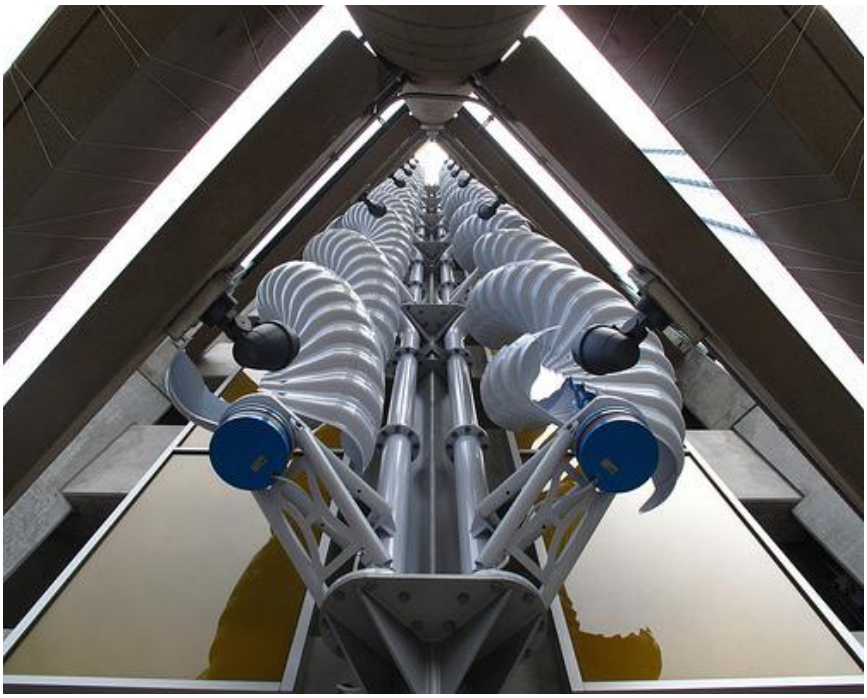
They also have insulating properties to prevent too much solar heat gain or loss, while allowing daylight to enter the interior of the building for natural, low-cost lighting as well.

Fusion of Art and Science for Wind Generating Building Façades

The world of architectural design has always been competitive, with practitioners looking for the next most innovative, awe-inspiring exterior creation to garner accolades and crowds alike. And with recent advances in material technology, energy efficient façades like those that generate electricity through solar are have gained a lot of attention. But what of wind energy generation via the intelligent building façade?

Noise, vibration, and turbulence have presented several big obstacles to the success of smart façades that integrate wind energy into a building's exterior. But beyond just mounting some wind turbines on the roof of sky scrapers, several designers have created building integrated wind energy that fuses magnificent sculpture-like façades to augment wind flows onto turbines and generate more renewable energy than is traditionally possible. Simultaneously, these artistic wind generating façades overcome some of the traditional problems with this type of dynamic façade, like noise and vibration.

Many of these building integrated wind energy systems use the concept of Wind Assisted Rotor Platform (WARP). These consist of smaller wind turbines mounted to the exterior of an aerodynamically shaped building. The saddle ridge shaped modules swirl around the exterior of the building to channel and amplify the flows of wind, while adding visual interest to the structure. Current estimates suggest that this type of smart façade can generate 150% more energy than the next most efficient option.



Wind turbines integrated into a Chicago parking lot via Flickr John Picken

Hope Offered by Smart Building Façades

Given the high cost of keeping buildings lit, conditioned, and connected in a wired world of ever-increasing energy costs, the challenge of making them more efficient has never been greater. With scientists warning of the consequences of climate change and the rising risk inherent in using conventional fossil fuel costs, there has never been a better time to find ways to take the "dumb" out of buildings.

Energy-generating building façades offer huge possibilities for transforming energy-hungry cities into net-zero ones. Thankfully, many of these intelligent building façade ideas can be incorporated into existing buildings. This is especially important given that close to 50% of all building in existence today will still be standing in 2050.[3]

The European Union member countries are looking to adopt new 20-20-20 targets that will require an increase in renewables of 20% of total energy use, 20% cuts in total energy consumption, and a 20% reduction in greenhouse gas emissions.

Some countries are developing their own systems for retrofitting existing buildings ahead of this action. Germany, for instance, just recently passed a budget that includes EUR 1.5 billion annually for upgrading existing buildings for energy efficiency. Part of the Energy Concept for the country, this new program will push for energy efficiency in buildings with new vigour.

This combined with Germany's leadership in the field of smart building technologies makes that country a prime market for new innovations. It's no surprise, then, that smart building façades are making waves in the green building industry as one of the next big solutions for fighting climate change.

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Maryruth has a special interest in cleantech and green buildings. In recent years, Maryruth has worked as the senior editor of The Green Economy magazine, is a regular blogger for several green business ventures, and has contributed to the editorial content of not one, but two eco-living websites: www.ecolife.com and www.GreenYour.com. You can learn more about Maryruth's work by visiting her site, www.jadecreative.com.

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