Building-Integrated Vegetation **Redefining the Landscape or Chasing a Mirage?**

Text by Aditya Ranade

The rapid urbanisation around the globe during the last five decades has come at a heavy price to the environment, with rising air pollution, the worsening heat-island effect, and losses of biodiversity and green spaces. With increasing awareness about these issues, government bodies are looking at building-integrated vegetation (BIV)—green roofs and green walls—as a tool to mitigate the environmental degradation and improve liveability.

This article shares some of the research by Lux Research Inc., which examines the drivers as well as barriers for growth in this emerging market and projects the global market size for green roofs and walls from 2012 to 2017.

Scenarios Used for Market Forecasting

The major value proposition for green roofs and walls is that they help reduce urban infrastructure environmental problems, such as stormwater volume, urban heat island effect, and air pollution. However, these technologies are also very expensive and their payback periods often exceed five years. Given those two facts, it is not surprising that the cities in the developed world such as Dusseldorf, London, New York, Chicago, Singapore, Tokyo, and Toronto have driven the growth of this market. However, as the emerging economies get richer and face infrastructure environmental issues brought about by blistering economic growth, cities such as Shanghai and Bogota are too participating in this market. With this in mind, we have constructed three scenarios for market forecasting.

Likely scenario

The impact of the Euro zone crisis is limited. New construction in the United States and Canada recovers. Beijing, Shanghai, Copenhagen, Basel, Toronto, and Tokyo meet their targets for green roof and green wall installations.

Low scenario

Euro zone crisis has a negative impact on the adoption. Austerity programmes in the UK and falling credit rating for France hurt growth prospects. China does a "hard landing" in 2012, resulting in a considerably slower rate of new construction.

High scenario

This describes a macroeconomic situation identical to the likely scenario, but with many more cities joining in the adoption of green walls. In China, adoption moves beyond Beijing and Shanghai to Dalian and Chengdu. In Switzerland, adoption moves beyond Basel to Geneva and Zurich. Many new nations come on board, with cities like Mumbai, Kuala Lumpur, and Rio de Janeiro adopting green roofs to address the stormwater volume.

Methodology for Market Sizing and Forecasting

We conducted a comprehensive analysis of all the known green roof and wall projects in the world via interviews with technology developers, city officials, and secondary research on databases available from trade associations such as Green Roofs for Healthy Cities, *greenroofs.com*, and Living Roofs. We triangulated the market size estimation for 2011 using at least two different sources. We only took countries with green roof installations greater than 1,000 square metres in 2011 and green wall installations greater than 100 square metres in 2011 into account.

The Bass logistical curve was used for market forecasting. Also known as the "S" curve, this forecasting method estimates the market size at a future date based on current market size, market size at saturation, and the coefficients of external and internal influence. The Bass logistical formula calculates the future market size (N_t) using the following formula:

$N_t = N_{t-1} + p\,(m - N_{t-1}) + q\,N_{t-1}(m - N_{t-1})/m$
p = coefficient of external influence
q = coefficient of internal influence
m = market size at maturity

The price for green roofs and green walls varies somewhat from region to region. As the market for BIV grows, these prices are also reducing, significantly more so for green walls than green roofs. To estimate the market size in monetary terms, we assumed an average price of USD 500 per square metre in 2011 for green roofs installed in Germany, USD 450 per square metre in the Americas, and USD 300 per square metre in Asia-Pacific region, all decreasing at an annual rate of two percent. For green walls, we assumed an average price of USD 1,100 per square metre in 2011 for Europe, USD 900 per square metre for the Americas, and USD 700 per square metre in Asia-Pacific, all decreasing at an annual rate of five percent.

Coefficient of external influence (p)

This coefficient takes into account policy incentives and regulatory requirements. It represents the likelihood that a building owner, who is not considering a green roof or wall installation, will do an installation at a future date due to the policy attractiveness.

Coefficient of internal influence (q)

This coefficient represents the likelihood that a building owner who is not considering a green roof or wall installation will do so at a future date because of a word-of-mouth recommendation from a current user. In essence, this metric captures the momentum of the market. Geographical regions with a core group of successful early adopters get a higher score.

Market saturation potential (m)

For cities with publicly announced targets, we used those figures as guidelines for market saturation potential. For example, the Beijing city government has announced that by 2030 it will install green roofs on 30 percent of all flat roofs, which will stand at an area of three million square metres. In the absence of explicit targets from city governments, we used an estimate of the total flat roof area for all key cities in each country, and assumed 15 percent as the saturation potential for mature markets like Switzerland and Germany and 1 percent of early-stage markets such as the United States. The key findings by Lux Research Inc. are summarised below.

BIV is Driven by City-Level Incentives and Mandates

Unlike other "green" sectors such as solar photovoltaic or biofuels, BIV adoption is not driven by national-level policy measures, but entirely by city-level hyperlocal priorities. Specifically, the two major types of policy drivers for BIV are as follows:

Building code requirements and mandates

Building code requirements on stormwater discharge, such as those in London, mandates for green roofs, such as those in Copenhagen, and mandates for green walls in Shanghai will drive adoption.

Financial incentives

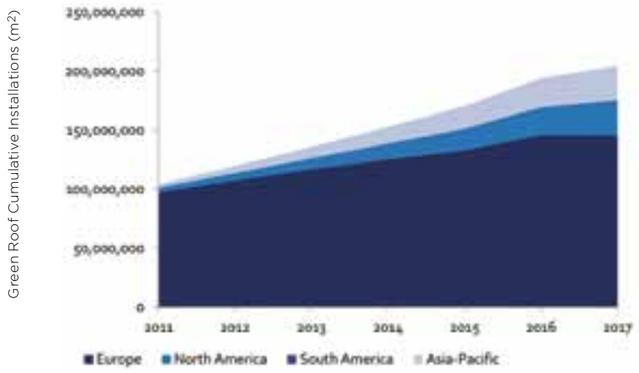
Financial incentives, such as cash rebates for installing green roofs in Portland and exemptions in stormwater surcharge in London, will shorten the payback period and the upfront capital expenditure.

Value Proposition against Competing Technologies is a Major Barrier to Adoption

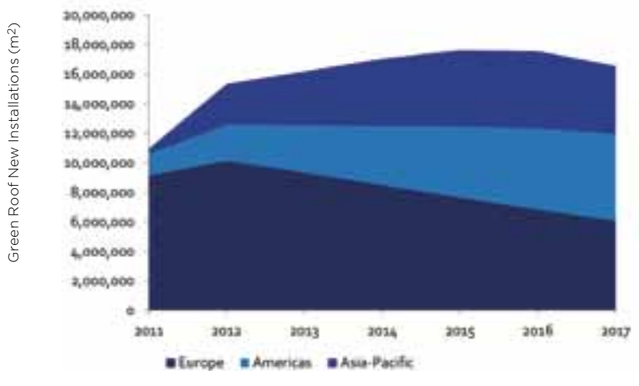
Green roofs and walls offer a multitude of benefits, such as reducing solar heat gain during summer, removing pollutants from ambient air, reducing stormwater volume, and increasing acoustic insulation. However, for every such benefit, a competing technology exists with an arguably better cost-to-performance tradeoff. Installed costs of USD 300 per square metre to USD 500 per square metre for green roofs and USD 900 per square metre to USD 1,100 per square metre for green walls are of an order of magnitude higher than alternative technologies, such as cool roof coatings that offer the thermal insulation benefits, photocatalytic coatings that remove pollutants from ambient air, and rainwater harvesting tanks that reduce the stormwater volume. Therefore, cities or building owners evaluating technologies to address a single environmental issue will likely not adopt green roofs or walls. Only cities that are looking at all the possible environmental benefits of green roofs and walls will design supportive policy instruments.

BIV Will be a USD 7.7 Billion Market by 2017

In the likely scenario, green roofs will be a USD 7 billion market by 2017, with a USD 2 billion opportunity for suppliers of polymeric materials, such as geosynthetic fabrics and waterproof membranes, and the rest going towards vegetation, installation, and operating businesses. In the likely scenario, green walls will be a USD 680 million market by 2017, with a USD 200 million opportunity for suppliers of materials, such as self-supporting polyurethane foam growth media.



1. Cumulative Green Roof Installations Double over the Next Five Years



2. Green Roof Market Size Split by Region 2011–2017: Most Likely Scenario

Commercial buildings in North America and Asia-Pacific will be the growth segment

Maturing Swiss and German markets will slow down their growth, but early-stage markets in the Americas and Asia-Pacific will provide significant growth opportunities. Commercial buildings in particular will be a key growth segment, due to the tolerance for high capital expenditure.

Finding the right system integrator partners will be the key to success for material suppliers

Since payback periods for BIV run in decades, owners of such buildings are rightly concerned about water leaks, maintaining the vegetation, and ensuring that the roof or wall underneath the vegetation is able to withstand the additional weight. This dynamic creates a preferential market opportunity for reputable systems integrators with expertise across these diverse domains. Materials suppliers should seek such partners as a channel to market their services.

In the Most Likely Scenario, Cumulative Green Roof Installations Grow to 200 Million m² by 2017

Figure 1 shows our five-year forecast of cumulative green roof installations, doubling from 120 million square metres in 2012 to 204 million square metres in 2017 at a compound annual growth rate of 11.33 percent. Specifically, the forecasts are:

Green roof installations will slow in Europe due to maturing markets in Germany and Switzerland

Europe has led the growth of the green roofs market in the last two decades. Germany alone commands a staggering 86 million square metres of installed green roofs, out of a cumulative 104 million square metres in 2011. However, markets in Germany and Switzerland are maturing and close to their saturation points. In Germany, 10 percent of all flat roofs are green roofs already. In Switzerland, the most prominent city with green roof mandates, Basel is already at 70 percent of its stated target for green roof installations. Therefore, as seen in Figure 2, Europe's share of new capacity is expected to decrease from 83 percent in 2011 to 36 percent in 2017. Still, cities like Copenhagen and London will be able to provide growth opportunities even in this shrinking geographical segment.

> In the likely scenario, green walls will be a USD 680 million market by 2017, with a USD 200 million opportunity for suppliers of materials, such as self-supporting polyurethane foam growth media.

Coastal cities drive growth in North America to an annual 5.8 million m² in 2017

The North American market is at an inflection point. A number of cities in the United States and Canada have announced mandates or incentives for green roofs. In addition, this market segment is far from maturity, with green roofs occupying less than a fraction of one percent of flat roofs. As a result, North America's share of new installations is expected to increase from 13 to 35 percent. Expect to see cities like Portland, Toronto, and New York lead the way and cities with maturing green roof markets such as Chicago drop in new installations.

Colombia and Peru sow the seeds for a burgeoning market in South America

The use of recycled materials and frugal design principles have brought down the costs of green roofs in Colombia and Peru. In addition, both governments have announced supporting incentives in building code requirements and financing. As a result, there is already a budding market and credible local suppliers, such as Biotectonica. However, given the size of these countries, the market at maturity is likely to be small. Therefore, it is projected that new green roof installations in Colombia and Peru will grow modestly from 28,000 square metres in 2011 to 39,000 square metres in 2017. There are larger countries in South America, such as Brazil and Chile, that could potentially adopt green roofs. However, given the current level of negligible activity in those countries and the long purchasing cycle for green roofs, the likely scenario does not include any contribution from them.

Shanghai, Tokyo, and Sydney propel Asia-Pacific to an annual 4.6 million m² by 2017

Faced with urgency in addressing urban environmental issues, such as air pollution and stormwater management, cities such as Beijing, Shanghai, Tokyo, and Sydney have announced ambitious targets for green roof installations. Starting at a small base, the Asia-Pacific market will not reach maturity until 2016, or even 2020, if additional cities such as Osaka decide to participate. Asia's share of new green roof installations is projected to rise dramatically from 3 percent in 2011 to 28 percent in 2017.

Optimistic scenario projects cumulative installations to an annual 28 million m² by 2017, owing to a host of new cities adopting green roofs

The participation of new cities, such as Stockholm, Osaka, Kuala Lampur, and Mumbai, will propel green roof installations to an annual 28 million square metres by 2017 in the optimistic scenario. A lack of onboarding new cities and stagnant new construction on existing cities is also expected to hold back growth across the board to an annual 12.5 million square metres in 2017 (see Fig. 3 – 5).

In the Most Likely Scenario, Cumulative Green Wall Installations Will Rise from 244,000 m² in 2011 to 4.2 Million m² by 2017

The green wall segment shows a dramatic increase in the forthcoming five-year period, specifically, for these reasons:

Green walls are a nascent market

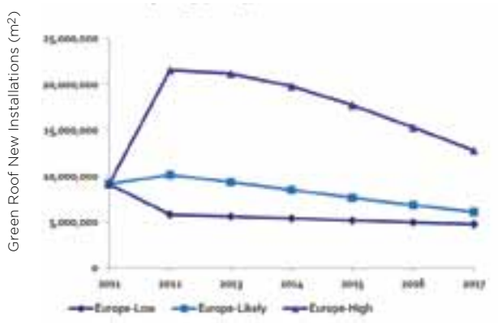
Unlike the established green roofs market, the green wall market is in its infancy. In the likely scenario, vegetated walls are projected to be adopted at a fast clip, from 28,000 square metres in 2011 to 1.02 million square metres in 2017. The cumulative green wall installations will rise from a small base of 244,000 square metres in 2011 to 4.2 million square metres in 2017 (Fig. 6). Building materials companies that are looking for an early-stage growth segment should identify system integration partners for joint development.

Asia-Pacific leads the pack

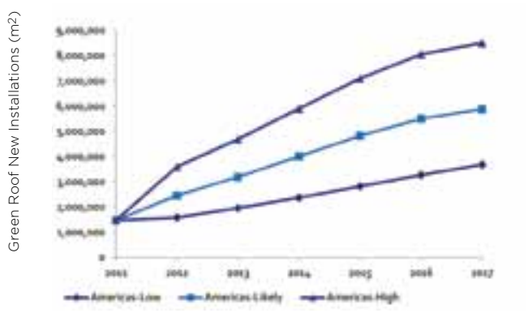
The most prominent supporting policy measures for green walls exist in Asia, particularly China and Singapore. Hence, it is not surprising that the Asia-Pacific market share of green wall installations is projected to stand at 40 percent in 2017. Europe and North America follow closely at 35 and 25 percent respectively, owing to green wall adoptions in showcase corporate and institutional buildings (Fig. 7). Colombia remains an early adopter of BIV technologies in South America, with projects such as the eight-storey green wall in Hotel Virrey, Bogota.

In all scenarios, all the regions are at an inflection point of growth for green walls

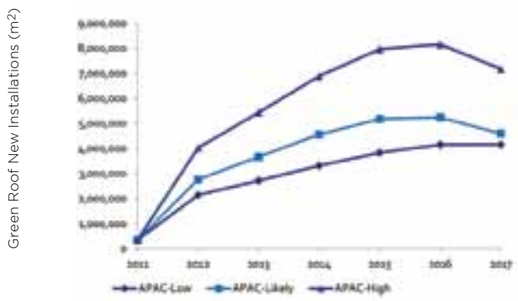
As seen in Figure 8, even in the most conservative scenario, the cumulative installations are expected to rise to 3.1 million square metres by 2017. In the most optimistic scenario, the cumulative installations will rise to 6.1 million square metres by 2017. In the most likely scenario, the global market for green walls will increase from USD 25 million in 2011 to USD 680 million in 2017.



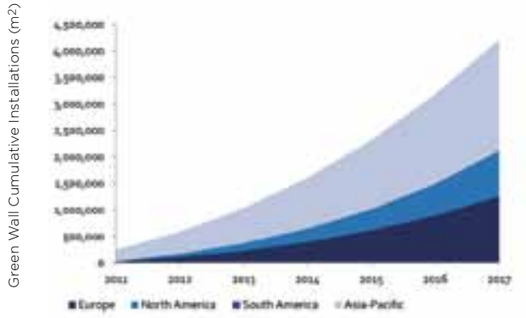
3. Green Roof Installations in Europe: High, Likely, and Low Scenarios



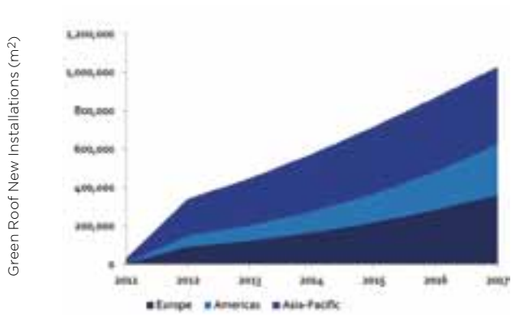
4. Green Roof Installations in the Americas: High, Likely, and Low Scenarios



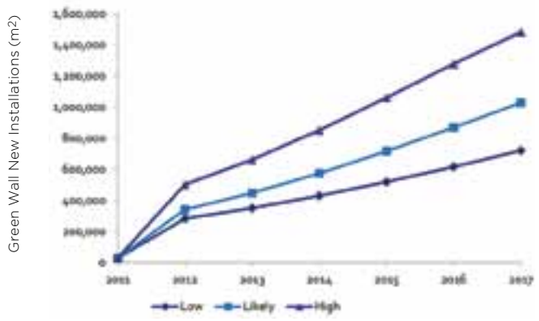
5. Green Roof Installations in Asia-Pacific: High, Likely, and Low Scenarios



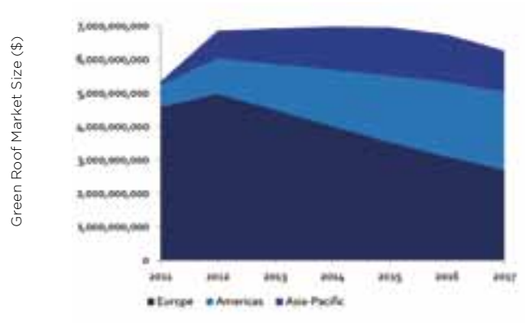
6. Cumulative Green Wall Installations Increase 16 Times over the Next Five Years



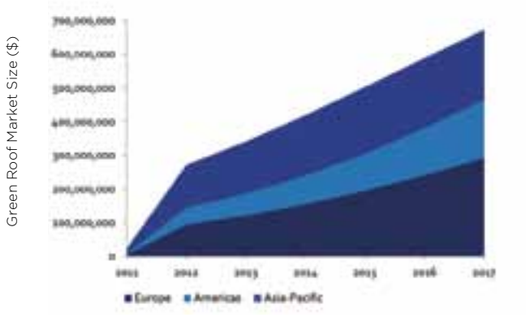
7. Green Wall Market Size Split by Region 2011–2017: Most Likely Scenario



8. Global Green Wall Installations: High, Likely, and Low Scenarios



9. Green Roof Market Size 2011–2017: Likely Scenario



10. Green Wall Market Size 2011–2017: Likely Scenario

Outlook

In trying to address ever-increasing urban environmental problems, cities around the world are likely to adopt BIV technologies during this coming decade. However, significant challenges remain in performance measurements and estimating payback periods, and adopters should expect to see the following trends emerge:

Financial concerns will dictate choices of vegetation

To date, most green roofs and walls have incorporated sedum or other hardy plants that require little external irrigation. However, in the next five years, architects will choose specific vegetation to address food security, mitigate air pollution, or retain stormwater. According to a leading architect and design firm in Southeast Asia, "vegetation selection will be a key performance differentiator as well as a design challenge for green roof and wall installations". The increasing variety in vegetation beyond sedum to suit local conditions will present opportunities for a variety of customised porous materials.

Building material companies will develop special grades of waterproof membranes and geosynthetic fabrics suited for BIV

In the last two decades, building materials companies have marketed the standard roofing membrane, foam, and fabric offerings to the BIV segment. However, as the market becomes more mainstream and performance standards more established, expect to see building materials being engineered for higher compressive strength, water retention, and porosity, in comparison to standard roofing applications.

Payback periods become an important metric

In the last two decades, aesthetics, public relations, and corporate sustainability goals have driven BIV adoption. As a result, most technology developers today cannot give a good estimate of the payback period, which could go as high as 30 years. However, as the market grows beyond this niche, expect to see technology developers become much more sophisticated in their estimates of payback periods to include city tax credits, cash rebates, stormwater tax savings, and energy savings. As BIV technologies compete for market share gains with mainstream energy efficiency technologies the likes of cool roof coatings, technology developers will have to shorten the payback periods considerably.

BIV technologies increasingly integrate with other innovative building materials

Green roofs reduce the operating temperature for photovoltaic panels located next to them and improve their output. Green walls absorb the nitrate solid compounds from photocatalytic coatings, neutralising Nitrogen Oxides (NOx), and reduce the regulatory barriers to adoption. In future, expect to see synergistic combinations of BIV with BIPV (Building-Integrated Photovoltaics), photocatalytic coatings, insulated glazings, and cool roofs. Companies developing these technologies—for example, Sika Sarnafil, 3M, Dow, and AkzoNobel—will look to incorporate them in BIV solutions to capitalise on these synergies.