URBAN GREEN | U.S. GREEN BUILDING COUNCIL CHAPTER | JULY 2014

HIGH CHOLESTEROL BUILDINGS

Urban Green Council
Urban Green Council, the U.S. Green Building Council of New York, is a nonprofit dedicated to advancing the sustainability of urban buildings through education, advocacy, and research. Our educational programs range from technical workshops for architects and engineers, to outreach to thousands of building owners on major new New York City laws, to GPRO, a national training and certificate program for building trades, contractors, and operators. With our in-house technical staff and network of expert members and pro bono consultants, Urban Green Council is a center for urban green building policy development, leading the NYC Building Resiliency Task Force and the NYC Green Codes Task Force.

Urban Green Council
20 Broad Street, Suite 709
New York, NY 10005

Copyright

Disclaimer
None of the parties involved in the funding or creation of this study—including Urban Green Council, its members, and its contractors—assume any liability or responsibility to the user or any third parties for the accuracy, completeness, or use of or reliance on any information contained in the report, or for any injuries, losses or damages (including, without limitation, equitable relief) arising from such use or reliance. Although the information contained in the report is believed to be reliable and accurate, all materials are provided without warranties of any kind, either express or implied, including but not limited to warranties of the accuracy or completeness of information contained, merchantability, or the fitness of the information for any particular purpose.

As a condition of use, the user pledges not to sue and agrees to waive and release Urban Green Council, its members, and its contractors from any and all claims, demands, and causes of action for any injuries, losses, or damages (including without limitation, equitable relief) that the user may now or hereafter have a right to assert against such parties as a result of the use of, or reliance on, the report.

INTRODUCTION

Every day, millions of people make choices to prevent serious health problems down the road. We watch what we eat, exercise regularly, keep an eye on our cholesterol, and make other common-sense lifestyle decisions now for better health in the future. But sometimes we take shortcuts, like fad diets that shed pounds in the short term while spiking our cholesterol and damaging our health in the long run.

Buildings are no different; by making relatively modest improvements in our construction choices today, we can ensure healthy buildings in the future. Yet time and again we choose not to do this. Instead we seek out shortcuts: "fad diets" that make it seem at first glance that we're building green, when in fact we are setting ourselves up to pollute more in the future.

These "high cholesterol" choices are reflected in the buildings that are designed and constructed every day throughout the U.S. A glaring example is the subpar walls, windows and roofs (the "envelope") we put in our new buildings. Unlike mechanical systems like air conditioners and ventilation fans, a building's envelope is one of its longest-lasting components. The average curtain wall, for example, can last longer than 50 years—the design lifespan of the Tappan Zee Bridge.

The problem lies in good part with a key regulatory loophole. Builders and developers are allowed to construct walls of any material of their choosing—such as glass, a notoriously poor insulator—so long as the completed building achieves the net energy performance required by the building code. This means that, on paper, glass and other subpar envelopes look good enough. But like a fad diet, they'll only lead to long-term health problems for our cities in the future.

The following report outlines the current problems with today's building envelopes, issues with how they are regulated, and the solutions we can pursue now.

THEY BUILT BETTER WALLS IN THE MIDDLE AGES

Our forebears of 3,000 years ago thought about carbon emissions as much as they thought about cholesterol. Despite our enormous technological advantages now, their buildings sometimes had more efficient walls than those of today.

The envelope (walls, windows, and roof) of today's average building doesn't insulate very well, and some are outright terrible, creating a devastating tax on our energy resources. Centuries ago, when people had to gather their own wood and maintain a fire to keep warm, the relationship of quality walls and roofs to better protection from the elements was obvious. Today, a button on the thermostat or air conditioner takes care of that problem with no work whatsoever. Unfortunately we often forget that the cost of comfort in our subpar buildings can cause high energy bills, degraded air quality, and increased carbon pollution.

New energy codes will ratchet up standards so that minimum requirements include decent insulation and better windows, and for the first time the model energy codes (on which our local code is based) will require testing residential buildings for air leakage.[1] But even with these changes, our insulation and window standards lag far behind those in Europe; U.S. buildings will be allowed to leak two to three times as much air as some EU countries.[2]

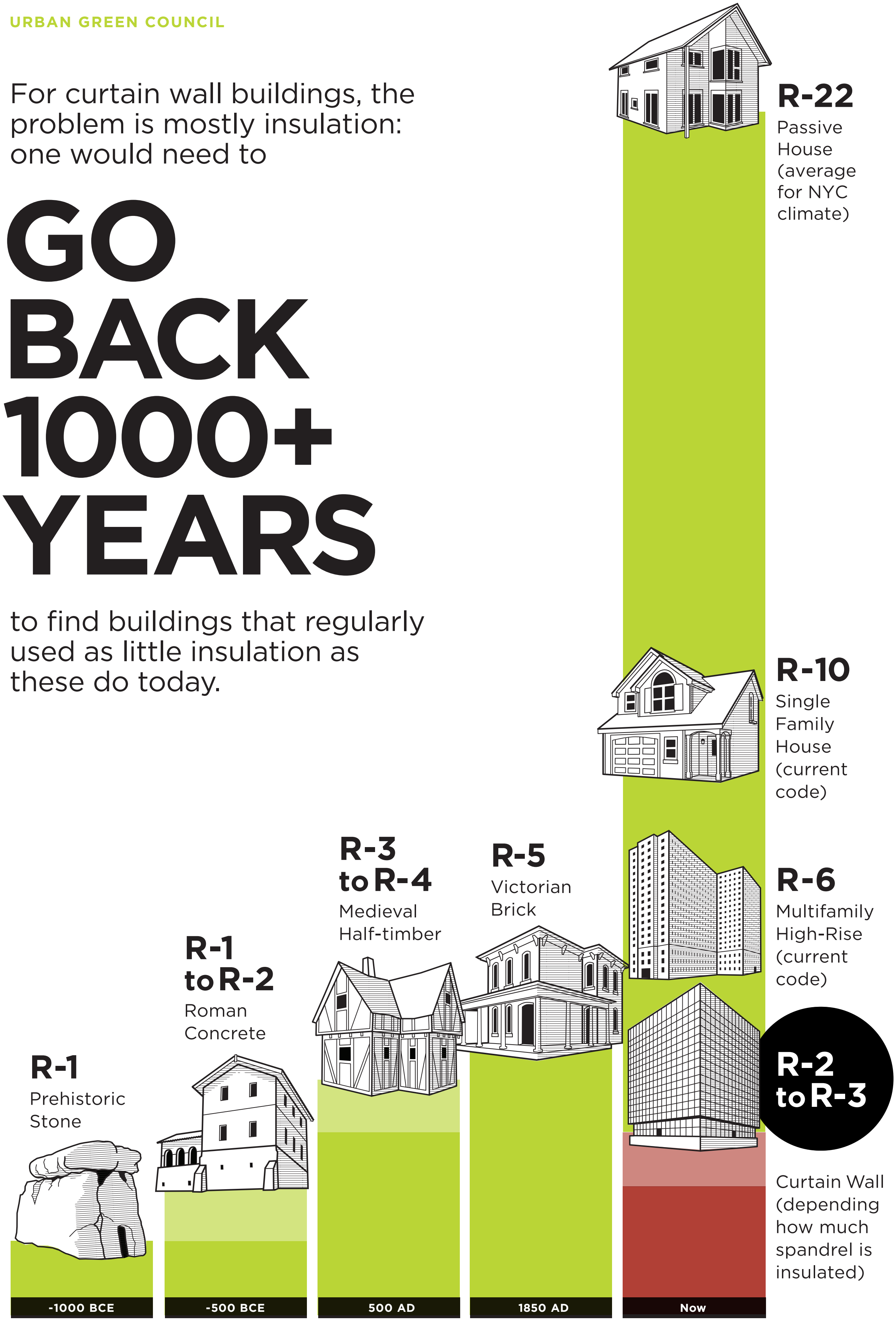
In masonry (brick) buildings and homes, the biggest problem is draftiness. But because contractors often have a limited understanding of air leakage, the issue is not addressed. Some may understand insulation but still neglect thermal breaks, where heat-transferring materials (like wood and metal) placed incorrectly can undermine insulation's effectiveness.[3]

For curtain wall buildings, the problem is mostly insulation: one would need to go back 1000+ years to find buildings that regularly used as little insulation as these do today.[4]

For curtain wall buildings, the problem is mostly insulation: one would need to

GO BACK 1000+ YEARS

to find buildings that regularly used as little insulation as these do today.



THE ENERGY MODELING LOOPHOLE

Even though energy codes are getting better every year, computer energy modeling allows builders to continue their fad diets. But how can a tool designed to keep energy use low be so harmful?

How energy modeling works and why it makes sense.

New buildings are required to meet minimum energy efficiency requirements, and standard building codes provide two options to get there. The design can meet detailed construction standards (the "prescriptive path"). Or, owners can use any materials and equipment of their choosing, so long as energy modeling indicates the building will achieve the same overall energy performance as it would with the prescriptive path (the "performance path").

This dual-track system makes sense. Simpler projects can follow a straightforward prescriptive path, while more complex projects can opt for the performance path, using energy modeling to make sophisticated decisions based on design, cost effectiveness, and market needs. This way, government achieves its policy goals while getting out of the way of innovation.

Large buildings trade off poor envelopes for better mechanical systems.

Today, almost all large, complex buildings make the same type of trade-off: they add more glass (leading to an energy penalty), and make up for it with superior mechanical systems. Why is this so common? According to leading real estate owners, floor-to-ceiling windows have more impact on rent than just about any other building feature. The commercial reality is "the more windows, the better." (Although a recent Urban Green Council study[5] suggests this demand may be more complicated: 59% of the window area in the glass buildings we studied were covered by blinds.)

But because glass is such a poor insulator, glass buildings need to offset the hit to their overall energy performance by investing in more efficient mechanical systems. This way they are able to achieve the energy modeling goal set by the prescriptive path.

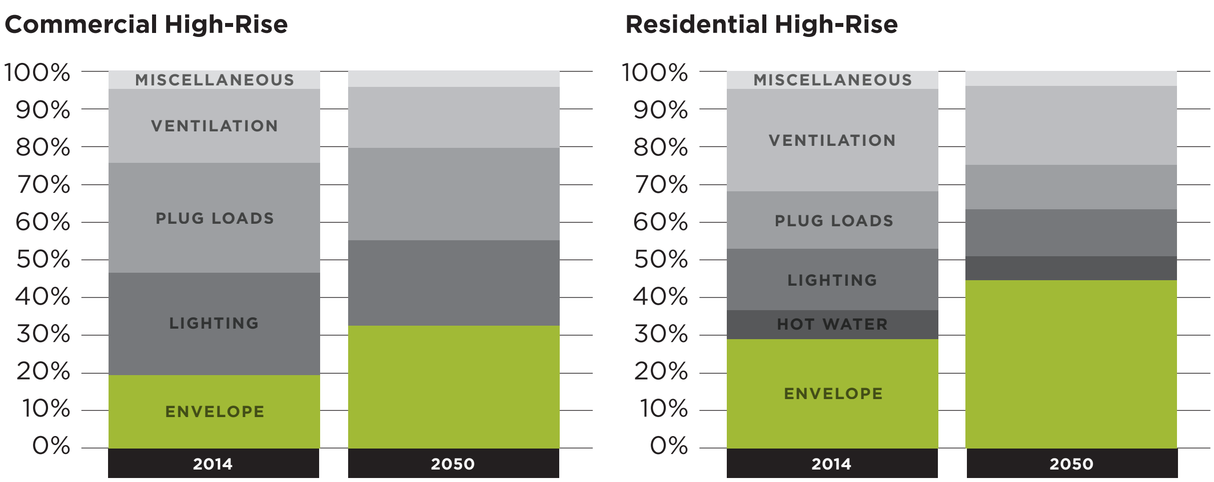
The sensible theory behind our dual-track energy code—that what matters is achieving the energy performance goal, not how one gets there—would say that the envelope-mechanical system tradeoff doesn't matter. But there are unintended consequences.

The Problem Will Get Much Worse Over Time.

These tradeoffs ensure that in the first year a typical glass building is occupied, it won't consume more energy than allowed by code. But as the rest of the building's systems are upgraded over time, today's glass envelopes will be responsible for a greater and greater share of energy consumption in the future. And we'll be stuck with them.

Why? Aside from the building structure, envelopes are the longest-living building system. In Class A buildings (which cater to prestigious tenants and command the highest rents), office equipment is typically replaced every five years, lighting every 10 years, and the HVAC systems every 20 years or so. But glass walls can last 50 years. This means all the major building systems will likely be replaced multiple times before the envelope is changed. Meanwhile, those systems will have become vastly more efficient while the envelope remains frozen in time.

The chart below[6] shows how the energy impact of typical high-rise residential and commercial buildings will change between today and 2050, assuming a 50% reduction in consumption from increasingly efficient plug load, lighting, and HVAC systems. As you can see, by 2050 the envelope becomes an energy and carbon pollution drag, holding back what could otherwise be an exceptionally efficient building.



Envelope: Energy used by heating and cooling systems to offset heat gains and losses through the building's walls, windows, and roof.
Lighting: Energy used by lights, as well as the extra cooling needed to remove the extra heat the lights put off.
Plug Loads: Energy used by computers, appliances, and other plug-in equipment, as well as extra cooling needed to remove waste heat produced by this equipment.
Ventilation: Energy used to deliver fresh air indoors, as well as the energy needed to heat and cool the air to appropriate indoor temperatures.
Hot Water: Energy used for heating water for sinks, showers, and laundry.
Miscellaneous: Energy used by elevators, plumbing equipment, exhaust fans, and other items not covered elsewhere.

WHAT TO DO

All this adds up to the fact that today's glass building envelopes will contribute to carbon emissions long into the future unless we curb our appetite for them. Because energy modeling discounts the importance of envelopes, our cities are stuck with the products of short-sighted decisions we're making today. Instead, we could have "healthy" envelopes through a combination of modern technology and techniques that have been around for millennia.

Yet we have a major challenge when it comes to addressing this issue. More glass translates into higher revenue today, but that same glass saddles buildings with poorer envelopes tomorrow. To advocate for policies that reduce glass could put the green building movement at odds with major owners and developers who are some of the strongest supporters of green codes and efficient buildings. Here's what we can do:

1. Better glass.

The industry can come up with envelope innovations that waste less energy, while keeping the aesthetics and great views that glass provides. Better performing glass, such as the triple-pane windows increasingly common in Europe, are a first step. Windows that allow in visible light while blocking heat can save energy in summer. Improvements to mullion design and material (such as those that limit the amount of heat lost, and use of fiberglass instead of highly conductive aluminum) can also play a role.

There is no question that glass can and will become a better insulator. But windows will never insulate as well as walls. The R-value of the typical New York City curtain wall assembly is R-2.5 to R-3.0; walls are R-30 or better. Even if we imagine windows improving two- or three-fold, there will still be an enormous gap between how well windows and walls insulate the building. More glass means a less efficient wall. It's that simple. Ultimately, whole buildings of floor-to-ceiling glass need to go the way of high cholesterol.

2. Better design.

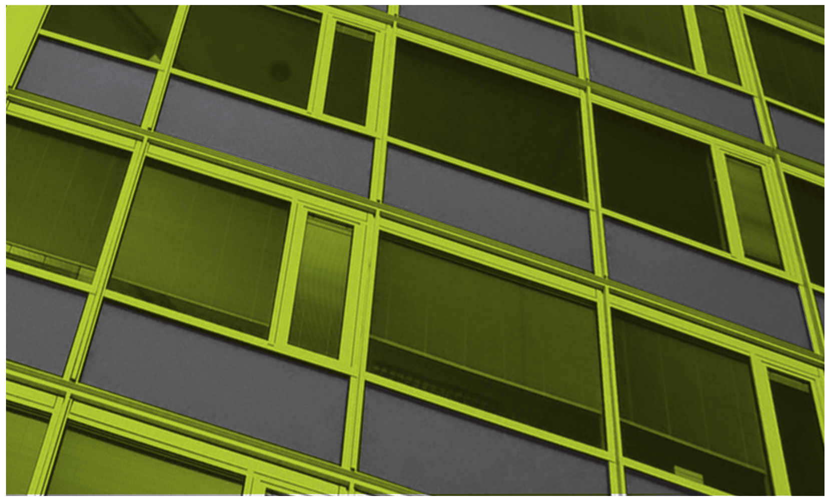
More glass does not necessarily mean better views. Glass near the floor is often blocked by furniture, and may only reveal a foreground of unattractive rooftop mechanical equipment. Selective use of glass can be used to enhance attractive vistas, creating "designed" views that conceal what's not so pretty. In addition, spaces like bedrooms, where more privacy is required, don't need so much glass.

A view of New York's stunning skyline... and its rooftop equipment, water towers, and wiring.

With something as straightforward as a windowsill, we are able to capture views we find beautiful while leaving out those we'd rather avoid.

Rendering Provided by Skidmore, Owings & Merrill LLP

This isn't simply a matter of choosing between the clean look of a glass curtain wall or better-insulated masonry construction with windows. Curtain walls can achieve the same performance of a punched window building and maintain their sleek design by increasing the proportion of insulated spandrel glass (the non-transparent part of the curtain wall) to vision glass (the transparent window areas).



3. Better training.

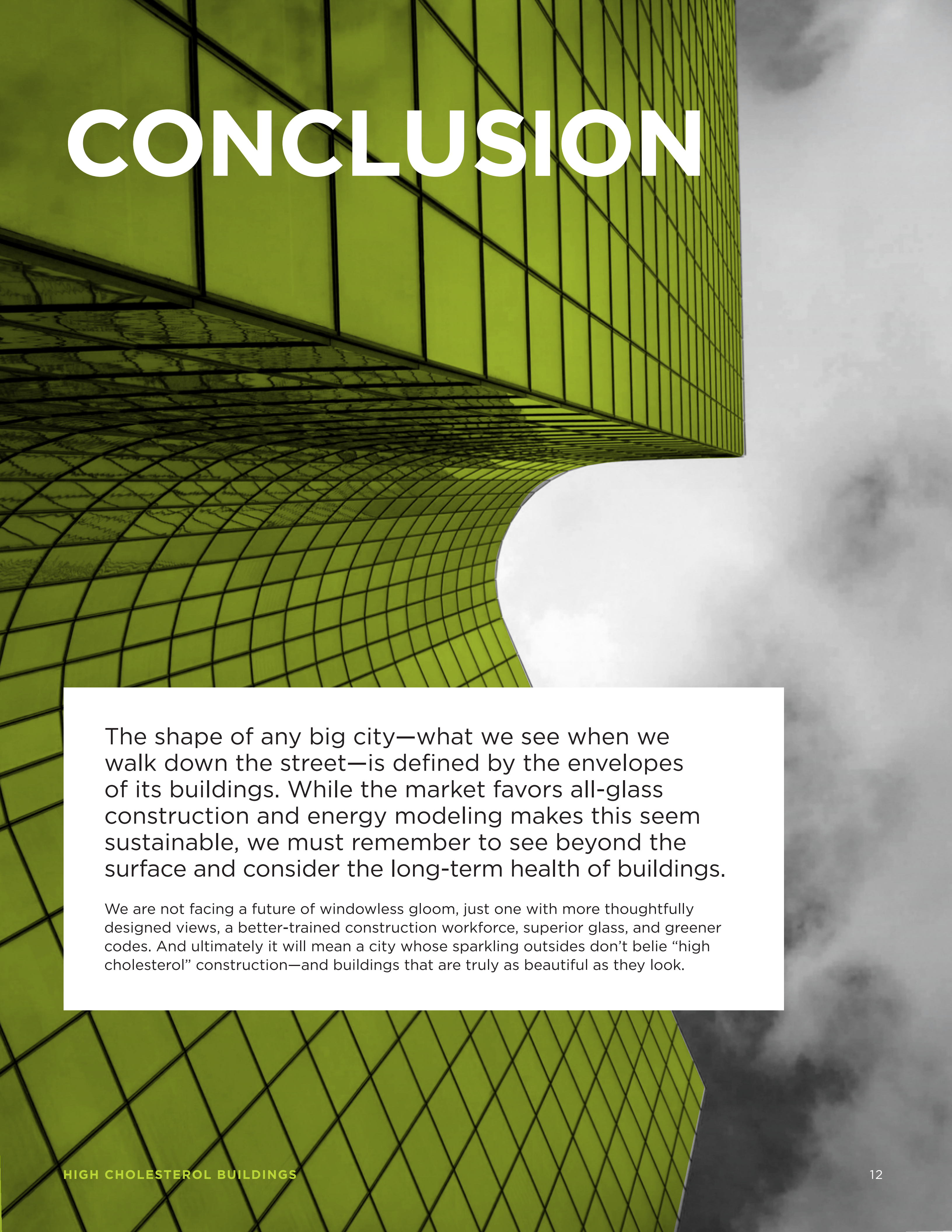
The overall health of the envelope significantly depends on the decisions and techniques of the construction crew. Unfortunately, typical U.S. construction practices do not stress air sealing and elimination of thermal breaks, especially for masonry and window walls, and on smaller projects. Because curtain walls are a fully designed envelope system, thermal breaks are largely a matter of the manufactured product and air leaks are reduced, but the joints between sections must still be carefully prepared.

Widespread trade-specific training, like Urban Green's GPRO and those offered by the Building Performance Institute, is an excellent starting point, and provide a skillset that will be increasingly valuable in the era of climate change.

4. Better codes and standards.

The *Building Resiliency Task Force*, convened by Urban Green at the request of the City of New York, recommended that the city develop a five-year plan to make NYC building envelopes the best in the world. This plan should include a policy recommendation that began with the *NYC Green Codes Task Force*: establish an overall building U-value (a measure of heat flow through a material) that would apply to buildings using energy modeling (the performance path). While not a panacea, it would set a minimum standard for all buildings, and represent a step in the right direction given today's market demand.[7]

It's possible to select a reasonable U-value that would improve building practice without placing limits on glass. Done right, a minimum U-value would become one of the host of factors architects consider at the start of the design process. When incorporated from the beginning, it would have no cost to owners. And it would start us down the path to sound building infrastructure investments that will reap energy and carbon dividends for half a century or more.



CONCLUSION

The shape of any big city—what we see when we walk down the street—is defined by the envelopes of its buildings. While the market favors all-glass construction and energy modeling makes this seem sustainable, we must remember to see beyond the surface and consider the long-term health of buildings.

We are not facing a future of windowless gloom, just one with more thoughtfully designed views, a better-trained construction workforce, superior glass, and greener codes. And ultimately it will mean a city whose sparkling outsides don't belie "high cholesterol" construction—and buildings that are truly as beautiful as they look.

ENDNOTES

[1] The 2012 International Energy Conservation Code (IECC) is currently under review for adoption by New York State.

[2] Public notes of the New York State energy code committee propose relaxing the maximum air leakage from 3 to 5 ACH (air changes per hour); the maximum allowable air leakage in Germany is 1.5 ACH.

[3] Window wall buildings are even worse. While curtain walls hang over the outside of the building structure, enveloping it like a curtain, window wall buildings have exposed slab edges with the windows sitting on the slabs. Those slabs are generally uninsulated, leading to significant heat loss.

[4] R-value estimates of historic buildings provided by Paul Stoller (Atelier Ten) and John Straube (University of Waterloo Civil Engineering and School of Architecture). Estimates for Passive House buildings provided by Ken Levenson (New York Passive House). For buildings from Medieval age onwards, walls, roof, and windows were taken into account. For earlier buildings, R-values only represent insulating properties of wall and roof areas.

[5] Urban Green Council, “Seduced by the View”, December 2013, www.urbangreencouncil.org/seduced-by-the-view.

[6] Estimates of source energy end use in typical contemporary commercial and residential buildings provided by Adrian Tuluca (Vidaris Inc.) and Scott Frank (Jaros, Baum & Bolles).

[7] A U-value requirement would primarily address heat loss in winter, which is the biggest issue in residential buildings. It does not address heat gain from the sun’s heat pouring through windows in the summer, which is often a bigger issue for commercial buildings.