BuildingGreen

SPOTLIGHT REPORT

Saying Goodbye to the Office—and Hello to Housing

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Carlyle Crossing

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About BuildingGreen

BuildingGreen, Inc. is an independent consultancy committed to providing accurate, unbiased, and timely guidance to help building industry professionals and policy makers improve the environmental performance of buildings and reduce their adverse impacts.

We offer consulting, training, facilitation, and online resources to help our customers design and build from a whole-systems perspective. Our integrated design approach minimizes ecological impact and maximizes economic performance.

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Saying Goodbye to the Office—and Hello to Housing

The way we use (and don't use) our offices is irrevocably changing. But what are we going to do with all these vacant buildings?

By Paula Melton

Office work is changing. During the heat of the COVID-19 pandemic in 2020, the average commercial office vacancy rate across the U.S. leapt from about 12% to 15%, according to CBRE. Some big companies, including Facebook, Salesforce, and Microsoft, have announced that they will be allowing remote work indefinitely. Experts disagree about how much the office market will recover nationwide: some predict work-from-home real estate doom while others forecast a gradual return to normal. But with urbanites flocking to suburban and rural areas, there's no reason to think that the post-pandemic recovery is going to improve matters in metropolitan office districts.

There's also the issue of office space "classes." The newest and most expensive (Class A) spaces will likely be in high demand after the pandemic due to amenities like modern HVAC systems and touchless design, according to Paimaan Lodhi, senior vice president of policy and planning at the Real Estate Board of New York (REBNY). That could leave lots of older Class B and Class C buildings—which were already underperforming pre-pandemic—vacant.

Meanwhile, nearly every major city in the U.S. is struggling with a years-long affordable housing crisis that is forcing people to share close quarters or move farther and farther away from their jobs. It's leaving many without shelter altogether. Why not convert those empty office buildings into housing?

It sounds obvious. And yet there are both design problems and economic roadblocks. This report analyzes the sustainability opportunities and challenges of urban office-to-multifamily conversions.

Photo: BKV Group

Octave 1320, formerly a drab office building in Silver Spring, Maryland, was transformed by BKV Group into market-rate multifamily housing near transit and retail services.

The Case for Adaptive Reuse

"The greenest building is the one that is already built," the old saw says. In certain cases, that already built structure

can also be more economical. Adaptive reuse can also revitalize neighborhoods.

Embodied impacts

Newly made building materials come with environmental burdens, particularly greenhouse gas emissions from manufacturing steel and producing the cement for concrete. The CO2 emissions associated with building materials are known as their *embodied carbon*.

"Reuse is a big strategy to save embodied carbon," said Travis Albrecht, regional design resilience leader at Gensler's Austin, Texas office. "Some of our studies have shown, for an office building especially, upwards of 80% of the embodied carbon of the building is associated with the primary structure and floor areas," he told BuildingGreen. And that's "a lot of what you would preserve even in a residential conversion. You save a ton of embodied carbon off the bat."

And it's not just carbon: there are other embodied impacts too, like the potential for smog creation, and pollution of water and soil. Because there are so many variables having to do with building typology and project-specific renovation needs, though, few studies have taken on the challenge of comparing the embodied impacts of renovations with new construction. But this one from 2019 sets up a methodology for doing so, and an associated case study found reductions ranging from 53% to 75% in six impact categories.

Old buildings, new codes

With few exceptions, a major renovation like converting a commercial building to multifamily is going to require bulking up the envelope as well as upgrading mechanical, electrical, and plumbing (MEP) systems. "When you convert these buildings, you have to comply with the latest building and energy codes, which are much more stringent than they were decades ago," Lodhi pointed out. "There will be higher performance standards than you saw previously."

That's a huge sustainability opportunity, and there are even some inherent benefits when it comes to this specific type of adaptive reuse, according to Albrecht.

"The MEP systems are a little different between building types, but I think there are some advantages, depending on how the office buildings were set up. Having a more centralized [HVAC] system is better than a more distributed one for efficiency and maintenance." Instead of hundreds of HVAC units that you have to keep track of and service, "office buildings usually have one air handler per floor. That can be augmented and used as a central system," noted Albrecht.

Good indoor air quality may also be easier to achieve with an office HVAC system in place. Many commercial buildings have a dedicated outdoor air system (DOAS) that "pulls in all the fresh air you need to get good air changes throughout the office and keep the air nice and mixed," Albrecht said. "On the residential side, you usually have to do that through the façade. So you can tap into an office [system] and can do it more efficiently."

Also, commercial office buildings often start out with better envelopes than residential buildings do, Albrecht continued. "If you can maintain as much of that existing skin or envelope [as possible], it can also help with efficiency on the back end. Less air leakage and heat exchange through the wall is beneficial for the residential building."

Finally, with systems needing to be upgraded anyway, there's an opportunity to electrify, says REBNY vice president of policy Zachary Steinberg. "Sometimes it makes sense to convert over to electric," he told BuildingGreen. Although it must be determined case by case, "the code

INSIGHT

What about the 'Burbs?

Although this report focuses on cities, the question of underutilized suburban office parks, coupled with an ongoing uptick in suburban migration, presents some fortunate synergies as well.

"We are actually seeing opportunities to convert empty office buildings and shopping malls into not just housing but mixed use," notes SERA's Timothy Smith. There can be housing, offices, community spaces, and retail all in one former office park or mall. "You are taking something that was really a relic of the 1950s lifestyle—something that has incentivized single-occupancy vehicle travel and thus carbon nastiness—and turning it into something where you could live, work, and play all in one place."

There is a hiccup, though, Smith said. Although these new mini-villages encourage walking and cycling, they are "located in places as far from transit as possible. It is not necessarily creating a transit-oriented village unless there is a way to extend transit to a place that was formerly an automobile heaven." He added, "If municipalities are quite strategic about this, they could think about doing that."

There's also the issue that a lot of suburban buildings were designed for a 50-year lifespan, and many have exceeded that. "Can you take an already compromised building and try to do something with it?" Smith asked. "Or is it better to take it down, recycle the materials or reuse them if possible, and start again in a much better way?"

Image: Cooper Carry

This new construction project by Cooper Carry is located directly across the street from The Foundry, which is an example of office-to-residential reuse designed by the same firm. Between the two projects, the concept is to stimulate development of a high-density, transit-oriented district in a former fringe area that used to host a lot of parking

should help with that. Over time, the pressure is going to be on those buildings to electrify as they do this kind of stuff."

Construction time

Adaptive reuse can be economically beneficial because it can reduce construction time, allowing buildings to go on the market more quickly and start recouping the investment.

Because it was a converted office building, the Foundry in Alexandria, Virginia, started leasing earlier than a new building would have, according to Steve Smith, AIA, principal at Cooper Carry. "You may be paying … six-figure interest dollars every month on the loan you've taken out to build," Smith said. "Getting to market quicker is really important. … We shaved two-and-a-half months off the project and got it weathered in faster." (You can read a case study of the Foundry below.)

Transportation

When commercial buildings get converted to housing, the rest of the office district doesn't go away. This type of construction creates what Lodhi calls a "walk-to-work neighborhood." In cities with good transit, that can ease the strain on the system; in places where driving is common, it results in less transportation carbon.

Neighborhood vitality

Probably one of the best outcomes of newly mixing uses in a commercial business district is that it can bring a 9-to-5 neighborhood to life by supporting more retail activity and nightlife. This also increases safety.

In downtown Baltimore, when there were no apartments in the business district, there was nothing to do at night or on the weekends, explained Michael Muldowney, a multifamily broker at CBRE. This made the district ripe for

"drug abuse, prostitution, and burglary," he said. Now that several buildings have been converted, it's a different story. "It turn[ed] into a 24/7 neighborhood, with everything from fast casual to fine dining, entertainment venues to corner pubs. There are many positive aspects about conversion, especially when you have a stock of older office buildings."

"It can have a catalytic effect," agreed Albrecht. "What people are coming to realize and learn is that [single-use zoning] can be detrimental to feeling like a place or a community. It's an urban design opportunity to mix uses and bring life to some of these districts in cities that may be declining because the new shiny office product has moved elsewhere, and so areas need a boost of life. Residential could be that boost."

But it might not just happen on its own, warned Timothy Smith, AIA, principal at SERA Architects. "If cities played their cards right, they could really curate this activity and not just let it happen through market happenstance," he said. "That ground-level [retail] space has been historically what activates cities. Cities will become disemboweled from [losing] that ground-floor vibrancy. We really need to figure this out." Working to diversify neighborhoods for mixed use is one way that municipalities can take charge of this revitalization.

"You see boarded-up retail even in Manhattan now," lamented Yogesh Saoji, AIA, planning and urban designer with DLR Group. "It's a little scary." To solve for that, he said, we will need to merge residential and commercial districts.

Saving history

"Historic buildings are wonderful, but finding new uses for them is a struggle," said Jack Boarman, AIA, CEO at BKV Group, which has designed many

Image: BKV Group and Douglas Development

The Cotton Annex is a housing project currently being developed by Douglas Development and designed by BKV Group. Seen in the foreground is a U.S. Department of Agriculture office building that was abandoned more than ten years ago. Located in Washington, D.C. blocks for the National Mall, the project will add multifamily buildings to the downtown core.

office- and industrial-to-residential conversions. Although not all converted offices are historic buildings, they are an important piece of the puzzle. Often, it's these buildings that have become obsolete because of floor plate sizes that aren't a good match for contemporary office needs. That makes them better candidates than newer buildings are for residential conversions.

By repurposing historic office buildings as housing, you also get a product that can be especially attractive to prospective tenants because of the unique character of each project, says BKV senior partner Mike Krych. "There is such a variety," he said, so you can provide "unique housing within these very unique structures. … A lot of projects sat in disrepair, but then became a catalyst to really anchor and spur continued development."

According to Boarman, historic conversions often include some new construction as well, "creating a scale that makes them both viable." The Cotton Annex in Washington, D.C., abandoned more than ten years ago by the U.S. General Services Administration, is an example of such a project. The original 100,000-square-foot building will become part of a 600,000-square-foot residential development. "Sometimes the historic, repurposed building becomes the aggregate around which a whole new development is created, and the historic building becomes that little jewel that you wrap the new construction around. It enhances both, so there's a dynamic there of mutual purpose."

Challenges and Some Solutions

Adaptive reuse of office space is not a panacea, and it's also not an easy path. From equity issues to cost barriers, there are many reasons it hasn't yet become a bigger trend.

Zoning

Commercial buildings tend to be in commercial business districts, which exist in clusters because of zoning laws. To move forward with an office-to-residential conversion may require a zoning variance (which may or may not be granted), adding months to the project

Challenges of Office-to-Residential Conversions—and Some Policy Solutions

	Challenge	Policy Solution
Zoning	Commercial buildings tend to be in districts zoned for commercial business. Variances take time (=money in the real estate world).	Zoning laws can change. History has shown that allowing mixed use in former commercial districts can turn desolate neighborhoods into lively 24/7 communities.
Displacement	Revitalization can have a downside if municipalities are not intentional about it. Land values can rise, gradually pricing existing residents—often those of slim means—out of their own communities.	One strategy is simply to require that a certain percentage of new housing be affordable. This is not a new idea, but it should be top of mind when encouraging mixed use with new zoning laws and other incentives.
Floor plates	One of the biggest barriers to conversion is the size of modern office floor plates. Converting these requires so much effort that new construction might be a more responsible path.	Choosing older buildings for conversion helps as they tend to have narrower floor plates. Cities can create incentives that encourage this specific kind of reuse.
Cost	Adaptive reuse can often be comparable in cost to new construction. And it's not just the cost of building that's a problem but also the amount of time owners or developers will not be collecting any rent.	Affordable housing tax credits can kill two birds with one stone here. And property tax abatement can ease the transition time between construction and fully leased space.
Reluctance to repurpose	Perception of obsolete office buildings is generally negative. Why try to salvage something ugly and old if you can build new at a similar cost?	Carbon incentives would certainly encourage building reuse. But in the meantime, preservation tax credits can make "old" buildings more attractive for development.

Source: BuildingGreen, Inc.

timeline. And every month of delay is a month of not receiving rent.

But zoning laws can change. Over the course of about 20 years, Lower Manhattan's residential population grew dramatically, according to Lodhi. It went from a nine-to-five office district to a 24/7 live-work-play district and weathered tough times, including 9/11, the financial crisis, and Hurricane Sandy. How did that happen? It started with changes to zoning laws allowing residential development in other types of districts. "Could you replicate that more broadly?" he asked. Doing so would "provide flexibility for old office buildings, giving them the opportunity to convert to residential."

Already it's possible in NYC commercial districts to convert pre-1961 office buildings to residential use, Lodhi said, but REBNY would like to see that change to 1980. And right now, the state of New York is working on changes to zoning laws that limit that kind of flexibility in other types of districts where "zoning is antiquated." (For example, the Garment District in NYC is zoned for manufacturing, which hasn't actually taken place there for decades.)

Displacement

Adaptive reuse is not always the best thing for a community. "Of course it brings new life to a neighborhood where maybe there was an abandoned building," said Timothy Smith. "Those things are not only eyesores but sometimes dangerous because people get into them and start living there." But revitalization can have a downside if we're not intentional about it, he added. "It begins a trend of increasing land values, which can contribute to displacement if there are not measures in place to alleviate that." There are numerous examples of communities of people with slim means living in "revived" neighborhoods that gradually kick the original residents out. "A decade later … the community has been supplanted."

This is a risk with any urban development in a neighborhood that is in need of greater vitality—and it's less of a problem in what have traditionally been commercial zones, but it could have impacts in edge areas, where zoning boundaries meet.

Affordable housing doesn't happen on its own; inducements are typically needed to ensure that new housing accommodates people with low and moderate incomes. One strategy is simply to require that a certain percentage of new housing be affordable. That's how New York's proposed law that specifically encourages office-to-residential conversions is written. (Such rules are not new to NYC or other cities.) "Everyone recognizes that you wouldn't be able to do something like this without addressing the affordable housing piece," Lodhi said.

Another approach, according to Timothy Smith, is the community housing trust model. A nonprofit organization holds the assets permanently in order to ensure long-term affordability.

There are also existing affordable housing tax credits available to incentivize that type of development.

Floor plates

One of the biggest barriers to conversion is the size of modern office floor plates. Converting these requires so much effort that new construction might be a more responsible path.

"Older buildings can be more appropriate," according to Albrecht. "They usually have a smaller footprint. Instead of 30,000-square-foot plate that you might find in a suburban area, historic ones can be smaller—in the 8,000- to 12,000-square-foot range. That's typically what you would see in a residential

development." Pre-1960 buildings, he added, "might also have more articulated facades instead of large expanses of glass or ribbon windows that may not feel residential."

One BKV project in Minneapolis "had such a big floor plate that we cut atriums in it and used that to bring natural light into the inner part of the building," said Boarman. He added that in Arlington, Virginia, there are currently a lot of studies going on to try to convert a cluster of 1970s office buildings. "There are such large plates and no ability to have operable windows. Office owners are getting despondent over repurposing them because the costs are just equal to a new building."

Cost

Adaptive reuse can often be comparable in cost to new construction. But it's not just the investment in construction that's problematic. With any leased project, every month spent offline is a serious concern. And since struggling commercial offices are seldom completely vacant, owners often must give up revenue just to get started.

"When you're thinking about converting your buildings, there's an opportunity cost," noted Lodhi. "You have to basically vacate the building, let all the leases expire. You spend time and money renovating, then spend time leasing it up. That whole process could take five years." He added that it would probably take 20 years to totally recoup the initial investment through rent collections.

Sure, you "don't have to build all the structure," said Albrecht. "You get some things just because of the building" that's already there. But by the time you start taking into account things like plumbing and drywall, that can drive up costs quickly.

Photo courtesy Cooper Carry

Small windows and a large floorplate made The Foundry, which this "before" building would soon become, a challenge to turn into housing. Architect Cooper Carry took advantage of the extra space at the core to provide leasable storage space to tenants

Muldowney concurred: the concrete is poured, the steel is set, the elevators are already there. "It's got to be less to reuse," people think, but "when you really dig into it and you get an architect on the case and bring MEP contractors in and all, it's really not that much of a difference" in cost compared with new construction. And most of the time, he said, even if you have to lower the rent to attract tenants, you can still get more money out of an office building than you can out of a multifamily project.

But in some markets, it's a different story. Muldowney offered the example of Baltimore, where there is a central business district full of "gorgeous office buildings with beautiful, ornate architecture." But they lack modern HVAC and IT systems, and appropriate floor plates. Such buildings often go through a series of purchases and are ultimately lost to the lenders. "It diminishes and diminishes and diminishes [in value] to the point where the [rent potential per] square footage matches up with the costs of converting it."

Downtown Baltimore, with the help of government organizations, has a special program that encourages conversion of obsolete office buildings to apartments, according to Muldowney. This has resulted in the creation of 10,000 residential units over the last 15 years in older office buildings. The main driver is property tax abatement. Owners start out paying nothing and gradually move up to paying full property tax right around the time they are starting to recoup their investment in the conversion.

Reluctance to take on a dinosaur

Perception of obsolete office buildings is generally negative. Why would an owner or developer want to repurpose an unwanted property—especially if it's going to be expensive and come with potential zoning-related delays—instead of building something shiny and new? Here's where policy can step up.

Carbon incentives

"When is it best to take down a building and start from scratch?" asks Timothy Smith. "If there were carbon incentives, now we need to think twice about taking down this building. Maybe it doesn't lend itself to a wonderful social design" on first analysis, he suggested, but that just means "we have to get more creative about how to make it that way or reuse the building or piece of the building." And even if the building really does need to come down, "Let's get more rigorous about what we do with the materials."

Tax incentives for preservation

Because older buildings tend to be better candidates for office-to-residential conversion, some projects can benefit from federal historic preservation tax credits put in place in the 1980s. By selling these credits, developers can pay for 20% to 25% of the cost of construction, according to Boarman. "It has created a legacy of historic buildings over the last 40 years," he said. There are similar programs offered by many states, which can help pay for another large chunk.

But don't take these incentives for granted, Boarman warned. "In many states, they're rescinding those programs and reducing those programs" due to funding pressures, he told BuildingGreen. "From 1930 to 1960, urban renewal in downtown cities cleared out huge numbers of historic buildings." The tax credit programs "ended that devastation of historic buildings and created the opportunity economically to do this repurposing and preservation for the future. There's something to be lost if these rules are rescinded." And one of those things could be the opportunity to convert older office buildings to housing.

Case Study: The Foundry

Size: 740,000 ft^2, 520 residential units

Location: Alexandria, Virginia (in "Old Town")

Architect: Cooper Carry

MEP engineer: Integrated Design Consultants

Structural engineer: SK&A

General contractor: Balfour Beatty Construction

The Foundry, a 13-story multifamily building located half a block from a Metro transit station in the Washington, D.C. metro area, began life 38 years ago as an office building populated by U.S. Department of Defense workers. "It's Main Street, U.S.A.," according to Cooper Carry's Steve Smith, referring to the historic downtown feel of Old Town Alexandria. The U.S. General Services Administration was abandoning the structure, and there was no prospect of future office tenants. "It had small windows and an antique mechanical system," explained Smith. "Its life as an office was over. It was going to be a big behemoth sitting there empty."

Cooper Carry is also working on a new construction project, Carlyle Crossing, directly across the street. This new development will have three residential towers with condominiums, apartments, and senior living, totaling more than 700 units. A Wegmans supermarket will inhabit the ground floor. Between the two projects, the concept is to stimulate development of a high-density, transit-oriented district in a former fringe area that used to host a lot of parking.

Structural challenges

The very first challenge the team encountered was the building's "humongous footprint," as Smith put it. The building is 124 feet deep and 274 feet long. A multifamily building is typically closer to 65 or 70 feet deep, according to Smith. In the end, the design solution was simple. In addition to the normal core services like elevators, the core of the building has an amenity that's nearly unheard of in the multifamily world: large storage spaces (where the bathrooms used to be) that tenants can rent. "That has sold like gangbusters," Smith said.

There were also inconveniently placed columns. The team managed to design in such a way that there was a demising wall around each one.

Keeping all the columns, all the slabs "kept all that stuff out of a landfill somewhere," said Smith. "All that goes into not just good practice from a sustainability and health standpoint, but goes into making the deal work from a financial standpoint."

Smith knows that because when he first got the call, he did three studies for the owner: keep the building and work with it, take down half the building and replace it with parking, or "scrape it all out" and start from scratch. It was keeping the building that penciled out.

Parking

A transit-oriented district is great, but you still need parking for residents, pointed out Smith. The problem? The parking for the office building used to be where Carlyle Crossing is now going up.

Because it had been a Department of Defense building, said Smith, the entire ground floor had no windows. Some of that eventually got opened up and became retail space, but some also incorporates a parking garage. "We had to cut slabs and ramps to turn three levels of the office building into parking," he explained.

The project also included bike parking and special parking for energy-efficient vehicles. Between that and the nearby

Photo: Judy Davis, Architectural Photographer

The Foundry, a Cooper Carry-designed office-to-residential conversion project in Alexandria, Virginia, repurposed a commercial building left behind by the U.S. General Services Administration. It is part of a new mixed-use development that includes a large supermarket and three residential housing towers across the street.

Metro station, the project was allowed reduced parking ratios.

New floors and roof

Because they were losing so much leasable space by using three floors for parking, the team checked out the structural capacity of the foundation and then convinced the City to allow the addition of three more stories to the building. But instead of a rectangular shape, the new levels have a Z shape with double-loaded residential corridors.

"From a sustainability standpoint, we were looking at opportunities for the roof," said Smith. "We were able to introduce roof gardens up there, which handled stormwater." He said that the building manages 100% of rainwater on-site now. "It acted as if the building was never there" in that regard.

In the unplanted portions of the roof, white TPO was used to reduce the heat-island effect.

Envelope

"It was amazingly under-insulated," said Smith. To correct that, the team got the roof to R-30 and the walls to R-25.

The office building also had tiny windows—non-thermally-broken single-pane glass, said Smith. These were replaced with larger high-performance windows that "allow more light to come through while also reflecting [heat] back out."

Mechanical system

Even if they had wanted to reuse the antiquated mechanical system, the original one wouldn't have offered the unit-by-unit controllability that tenants expect, explained Smith. They replaced the original through-wall mechanical system, with a central boiler on the roof, with packaged terminal air conditioners (PTAC units). Between that and the new windows, "IAQ was much better, and access to daylight," said Smith. "All those kind of things were really important for health."

Zoning

"Favorable zoning really helped this job go faster," said Smith. Alexandria had recently changed its commercial business district zoning to include multifamily development. "A lot of jurisdictions out there are looking to provide those incentives."

But is it a trend?

Smith thinks conversions like these may be on the horizon as a real trend.

"A handful of years ago, more than 80% of office space in the metro Washington area was greater than 25 years old," said Smith. "It's heading toward needing a refresh." Since working on the Foundry, Cooper Carry has gotten calls from brokers around the country, from Michigan to Kentucky to California, with ideas for similar projects.

"We're all questioning: Are we going back to the office? And how much?" said Smith. Even though we may need more square feet per person for social distancing, "it's not going to be 100% of the people 100% of the time. Americans are entrepreneurial. If there's a problem, we all look for ways to solve it."

With the need for office space reducing, he surmised, a lot more older buildings will go on the market. "The diminished value of buildings—that's what leads to adaptive reuse that allows it to pay off at the end of the day."

If You Don't Have to Build It ...

"I would say [office-to-residential conversion] is not a massive trend," said Timothy Smith. "People are doing it because they see the writing on the wall." His own firm is looking for new office space currently and is considering cutting back to 80% or 90% of what it has now because leadership is expecting a lot more remote work after the worst of the COVID-19 pandemic is over. "People are now realizing that people can be just as productive at home as they can be at the office. Maybe we will see an acceleration of this trickle of a trend."

Albrecht added an environmental reminder. "Adaptive reuse should be considered more and more these days, and a lot of the guidance we're giving our teams in working with our clients is that if you don't have to build it, don't build it."

And yet, although laudable, this particular type of adaptive reuse should not be seen as a panacea. Office-to-residential conversions will need specific types of policy support if they are going to help solve the housing crisis. They need to be done in a systematic way that requires affordable housing, prevents displacement of existing communities, and encourages appropriate retail services.

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Course Level: Intermediate

Description

Office work is changing. During the heat of the COVID-19 pandemic in 2020, the average commercial office vacancy rate across the U.S. leapt from about 12% to 15%, according to CBRE. Meanwhile, nearly every major city in the U.S. is struggling with a years-long affordable housing crisis that is forcing people to share close quarters or move farther and farther away from their jobs. Why not convert those empty office buildings into housing? It sounds obvious. And yet there are both design problems and economic roadblocks. This report analyzes the sustainability opportunities and challenges of urban office-to-multifamily conversions.

Learning Objectives

Upon completion of this course, participants will be able to:

1. Understand the environmental impacts of new construction compared with adaptive reuse.
2. List six reasons to save obsolete urban office buildings and turn them into housing, including why these strategies are environmentally preferable.
3. List five challenges of converting obsolete urban office buildings and the environmentally and socially sustainable policy solutions that can remedy these challenges.
4. Explain how suburban office parks can flourish in the future as new “mini-villages."

QUIZ QUESTIONS

1. **The CO2 emissions associated with building materials are known as their _____.**
   - ☐ a. Total carbon
   - ☐ b. Operational carbon
   - ☐ c. Embodied carbon
   - ☐ d. Energy emissions

2. **What are some possible obstacles to adaptive re-use? (Select all that apply)**
   - ☐ a. Zoning laws
   - ☐ b. Floor plates
   - ☐ c. Dense urban location
   - ☐ d. Cost

3. **According to Travis Albrecht of Gensler, "Some of our studies have shown, for an office building especially, upwards of __ of the embodied carbon of the building is associated with the primary structure and floor areas."**
   - ☐ a. 90%
   - ☐ b. 80%
   - ☐ c. 70%
   - ☐ d. 60%

4. **Adaptive reuse is an environmental win because _____ typically require better performance from the same building.**
   - ☐ a. Building codes
   - ☐ b. Rating systems like LEED
   - ☐ c. Owners
   - ☐ d. None of the above

5. **The dedicated outdoor air system typically found in a commercial office building can do which one of the following when the building is converted to residential use?**
   - ☐ a. Decrease energy use required for ventilation
   - ☐ b. Improve indoor air quality compared with typical residential construction
   - ☐ c. Require residents to open windows
   - ☐ d. Require residents to keep windows closed

6. **Adaptive reuse can be _____ because it can reduce construction time.**
   - ☐ a. More expensive
   - ☐ b. More energy intensive
   - ☐ c. Less expensive
   - ☐ d. Less energy intensive

7. **Changing a commercial business district to mixed use can _____ neighborhood vitality.**
   - ☐ a. Increase
   - ☐ b. Decrease
   - ☐ c. Neither

8. **Why isn't adaptive reuse always the best thing for a community?**
   - ☐ a. Old eyesores should just be demolished
   - ☐ b. Historic buildings should be left alone
   - ☐ c. It can decrease land values
   - ☐ d. It can increase land values and the threat of displacement

9. **What are some ways to encourage office-to-residential conversions? (Choose all that apply)**
   - ☐ a. Changing zoning laws
   - ☐ b. Requiring affordable housing
   - ☐ c. Offering property tax abatement
   - ☐ d. Introducing carbon incentives

10. **A multifamily building is typically _____ feet deep.**
    - ☐ a. 125 to 150
    - ☐ b. 90 to 100
    - ☐ c. 65 to 70
    - ☐ d. 40 to 50

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