Office to residential conversion

Key engineering concepts to make your project successful

By Scott Campagna

Freddie Mac estimates the U.S. has a housing deficit of 3.8 million units across all housing types, while post-pandemic office vacancies exceed 16%, with some major cities reaching 30% vacancy rates.

> Converting vacant or underutilized office space into residential units is heralded as a way to revitalize communities, help struggling building owners, and address local housing needs.

The market is already seeing this trend. According to RentCafe's annual Adaptive Reuse Report, currently there are over 45,000 apartment units being created as a result of these office conversations.

Some cities, including Boston, New York, and San Francisco, are encouraging these conversions by supporting financial incentives, changing zoning policies, and finding ways to expedite plan reviews.

Each building is unique, and some are better suited to conversion than others. A thorough review of basic infrastructure, systems, and technology needs early on can help ensure a successful project. This executive guide discusses issues of engineering and related services that could add significant costs to a project if they are overlooked in the early stages.

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Structural engineering

An initial structural investigation is a key first step. Every building is unique, and older buildings may not have original structural drawings available or may have had substantial alterations. It's important for a structural engineer to see the structural elements during a pre-acquisition consultation, or at the onset of the project, to help identify issues early in the development. Getting to the structure is not always easy and may mean removing existing ceilings and wall finishes long before the general demolition begins. But skipping this key step can cause significant challenges—and added expense—during construction.

Coordinate with the structural engineering team as you plan unit layouts, plumbing, and HVAC. The architectural layout of a residential unit is unlikely to align with the office framing concept. If the units aren't aligned with the structure the job will be more complex.

Adding natural light

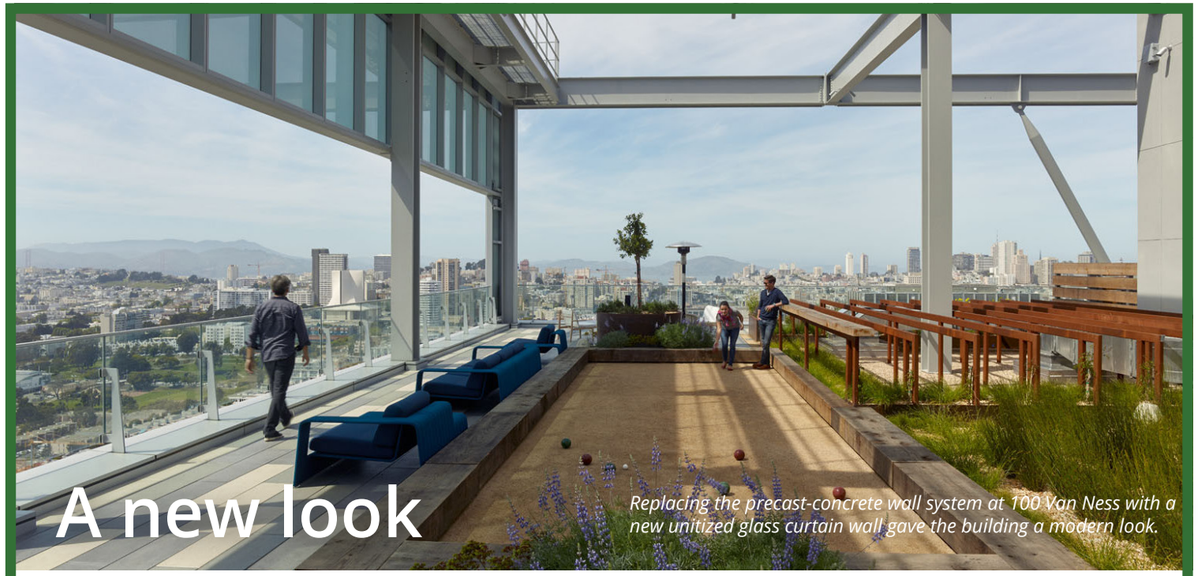
Housing facilities require exterior views in living units and it's important to consider how this can be accomplished in an office conversion. In a recent post-tension slab project, IMEG proposed two solutions to bring in natural light—a central atrium or exterior balcony cut-outs. The atrium was more straightforward structurally because it could avoid post-tension bands, but the owner preferred the exterior balconies.

To create the balconies, the post-tension bands on each slab edge would need to be eliminated, which is no small task. To add strength, IMEG offered two solutions: add beams below, or strategically locate new posts to reduce the slab spans. The owner preferred the second approach since the new posts could be integrated into the corners of the new windows. Fiber-reinforced polymer composites can also be used to provide external strengthening where additional strength is needed.

Coordination with MEP

A conversion will greatly impact existing and new MEP systems, so the structural team will need to account for new floor and wall openings for conduit, piping, and HVAC. A new ground floor restaurant or retail space can further complicate a conversion, as new shafts and penetrations will need to be run through the building. In older buildings this can be a challenge as the original shafts are likely smaller than current codes require, and the locations may be difficult to re-use.

The 29-story 100 Van Ness is the largest office-to-residential conversion in San Francisco to date.



Replacing the precast-concrete wall system at 100 Van Ness with a new unitized glass curtain wall gave the building a modern look.

A new look

To make the building attractive to the marketplace, it's important to update the exterior. Removing outdated and heavy exterior systems can improve aesthetics and energy efficiency. When IMEG worked on the conversion of 100 Van Ness, a 1970s-era office building in San Francisco, the original precast-concrete wall system was replaced with a new unitized glass curtain wall.

To make that switch, crews spent six months removing 1,600 precast-concrete panels, each weighing 7,000 to 14,000 pounds. Not only was the finished product a more modern glass building that appeals to tenants, but it also helped prevent a seismic retrofit because the curtain wall had much lighter loads than the original precast panels.

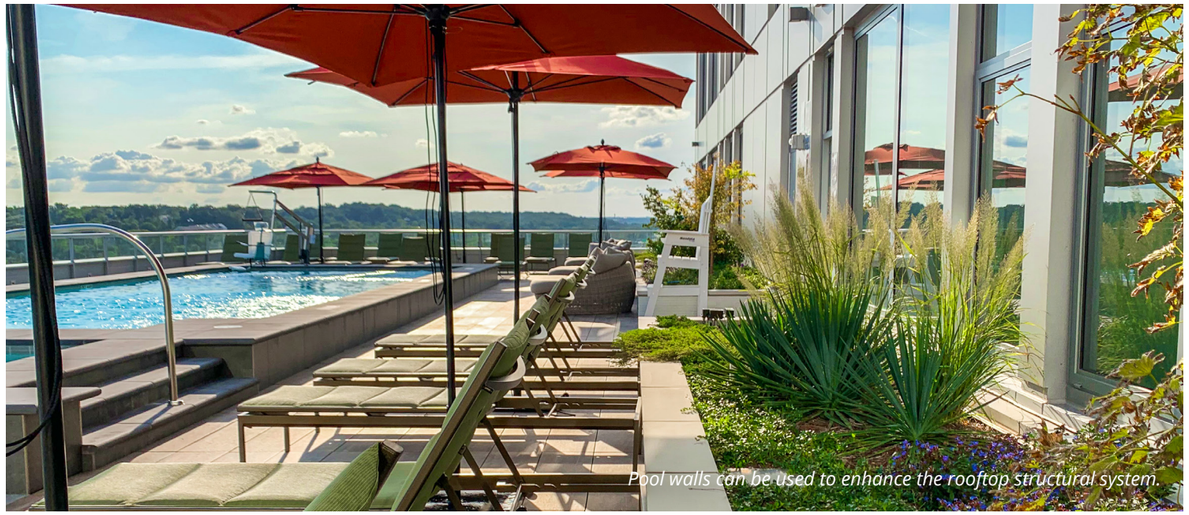
Determining whether the floor plate is made of concrete, steel, or wood also has a significant impact in the feasibility of a project. Steel or wood is generally easier to adapt in a conversion. If it's concrete, in particular post-tensioned concrete, you'll need to scan the slab to locate rebar and the tendons to avoid hitting them with new cores and openings for MEP systems.

Conversions involving steel, heavy timber, and clay tile in historic structures pose additional challenges.

A structural engineer can help account for those materials upfront to avoid surprises and extra costs later.

Rooftop amenities

There's good news on the roof. An office building's HVAC equipment is likely heavier (and perhaps outdated), and more than a new residential building would need. So, you should be able to reduce the amount of mechanical, electrical, and plumbing



Pool walls can be used to enhance the rooftop structural system.

equipment on the roof. That leaves room (and reserve structural capacity) for desirable rooftop amenities, like a bar or pool, and the structural impact is not likely as much as you'd think. A structural engineer can help evaluate the structure and creatively supplement the structural system where it is most needed. For example, pool walls can be used as structure and upturned beams can be hidden by a built-up raised decking system.

Occupancy

Changing occupancy from office to residential triggers requirements for upgrading non-structural components of the building to comply with current code requirements. However, for the structural systems, where the existing building code is used, the trigger is based on a change in risk category instead of occupancy. Office and residential occupancies are in the same risk category, which would not trigger a wholesale upgrade of the structural system based on occupancy alone.

Several local jurisdictions have adopted their own triggers which do require structural system upgrades, so it is best to verify with the local jurisdiction's amendments. There also have been changes to how risk category is defined, so buildings with over 5,000 occupants or significant public assembly areas can now trigger a change in category. Substantial alterations to the structure or additions also would trigger upgrades. Historical buildings may also have their own code and unique requirements.

Seismic

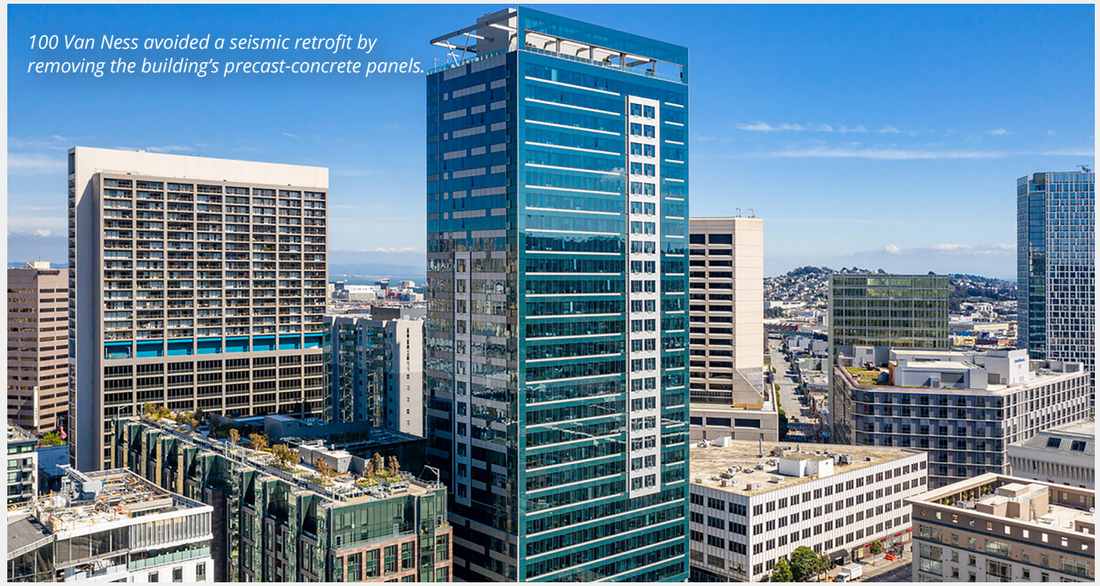
Jurisdictions have significant variabilities in seismic requirements that can trigger upgrades for specific building changes in occupancy and use for office-to-residential conversions and the associated alterations and additions. In most cases, newer construction buildings are "benchmarked" and do not require a retrofit.

Every jurisdiction is different and conversions from office to residential may trigger a seismic rehabilitation, which will need to be determined on a building-by-building basis. Owners often ask for voluntary seismic strengthening with the goal of creating a safer structure or reducing the probable maximum loss (PML).

For more information, contact Joe Gulden, Project Executive, Structural.

Local amendments can affect mandatory seismic upgrade triggers

- San Francisco: Known as the "2/3 rule," SFBC 503.11.1 requires a seismic upgrade when two-thirds or more of the building floors are categorized as a substantial alteration—defined per floor as two-thirds or more of the floor area of a floor undertaking significant non-structural alterations. This is cumulative of any alterations within a two-year period. Retrofit is done to approximately 75% of new code levels.
- Portland, OR: Substantial increase in the seismic hazard in the region in the 1980s prompted the city code, Title 24.85 Seismic Design Requirements for Existing Buildings, which triggers a seismic upgrade on a change of occupancy or use to more than one-third of the floor area and where the occupant load is more than 149. Retrofit is done to approximately 75% of new code levels, depending on the change in relative hazard classification.
- Seattle: Retrofits are triggered when a significant investment extends the useful life of the building. Similar in intent to the San Francisco 2/3 rule, this would likely trigger a retrofit on significant conversion project. Retrofit is done to approximately 75% of new code levels.
- Los Angeles: Municipal Code 91.2.506.5.3 requires buildings be upgraded to 75% of new code level for change of occupancy from commercial to residential. Codes 91.8203 and 91.8204 require buildings to meet the current code.



100 Van Ness avoided a seismic retrofit by removing the building's precast-concrete panels.

The former AAA headquarters in Philadelphia is now 2040 Market, 282 units of apartments with ground-floor retail.

Mechanical, electrical, plumbing

A multifamily residential building has different mechanical, electrical, plumbing, and fire protection needs than an office. Issues of demand, metering, and power distribution will need to be solved for a successful conversion.

Utilities

Multifamily housing will make greater demands on the plumbing utility than an office.

- The sanitary and domestic water services, including the water meter, will need to be upgraded or replaced, and you must ensure the site sewer has adequate capacity to handle the increased demand.
- The fire protection and electrical utility sizes are typically adequate to support a living facility.

Metering

Who pays for power and water usage? That's a big decision for a developer, and one that's often based on market analysis. In a conversion:

- Water usage can typically be easily sub-metered, so the resident pays the utility company directly.
- If you use the existing electrical and HVAC systems, individually metering the power usage may be difficult. Office owners may have structured leases to pass utility costs on to the tenant. If not, individually metering each living unit may be difficult unless you change the power distribution system.
- If you intend to meter each unit separately, you will have significantly more meters than in an office tenant environment. You will need to find space for this equipment.
- If it is not feasible to individually meter power, water and/or HVAC usage, the costs will be built into the rent. If you are in a market where tenants pay for their own power, your asking price with power included will likely be above the market rate. Be sure to communicate the benefit of these higher rents to potential tenants.
- Many states and utility providers will not allow you to sub-meter power and charge back the tenant. If they do, you may need to prove your system is more efficient and offers a benefit to the end user before you can sub-meter and "sell" power.

HVAC

Each residential unit needs its own thermostat for HVAC control. This is typically accomplished with localized HVAC equipment. But in office buildings, HVAC systems are usually centralized, with large rooftop units and shared air handlers.

- The existing HVAC system may need to be updated or replaced to provide localized HVAC controls to the tenant.
- HVAC systems for office buildings are sized to handle large loads for a set amount of time, e.g., from 8 a.m. to 5 p.m. Apartment HVAC systems are sized for average usage over a season or year. The load on

an existing HVAC office system may not translate well to residential.

- Office HVAC systems tend to be more efficient. If it can be reused, that offers opportunities to improve energy efficiency in the building.

- If you can provide localized tenant control from a central HVAC system, you will need to decide if you will sub-meter those costs or include them in the rent. Keep in mind, however, that if a central-based HVAC system on a floor goes out, every tenant on that floor will lose HVAC.

- Outside air ventilation differs for commercial and residential—each residential unit will need outside air ventilation, either natural or mechanical. You may need new infrastructure to support the switch.

- Evaluate the available roof and ground area. Is there enough room to accommodate a new HVAC system? A single-split system heat pump condensing unit needs a 3-feet by 3-feet of space per unit.

Rooftop HVAC systems may need to be updated or replaced to provide localized controls to tenants.

Electrical

Office environments have plenty of electrical power, but it's distributed differently than a residential property.

- Plan to remove power back to the main distribution rooms for a living unit.

- If the office building has 460 volts, all residential units will need to be converted to 208 volts, which may require additional transformers (and finding space for this equipment).

- Electrical panels need to be in each unit.

- Office lighting will be removed. Can lights, ceiling fan light kits, and decorative kitchen sconces will be added to each unit.

- Multifamily residential will require more electric vehicle (EV) chargers than an office building. How that power is routed within the building could have implications on the site or parking garage.

Fire Alarm

Residential buildings need far more fire alarm devices. The office's existing fire alarm system and panel may need to be upgraded or expanded to accommodate these new devices.

- A typical 1 bed/1 bath unit will have six to eight fire alarm devices.

- Dwelling units require carbon monoxide detection when gas-fired heating, cooking, or ambiance equipment is applicable.

Plumbing

An office has significantly fewer plumbing demands than a multifamily residential building. Most of the internal sanitary system, particularly under slab, will need to be replaced to accommodate the higher demand.

- Typical offices have core restrooms and then miscellaneous fixtures out in the spaces. Therefore, there are limited plumbing penetrations in the floors.

- For a typical 1 bed/1 bath unit, you will need eight to 10 floor penetrations to accommodate the plumbing fixtures, sanitary stacks, and vent stacks. This could have a negative impact on the structure. A structural evaluation will be required.

- If you have a post tension (PT) floor plate, it becomes even more difficult as all fixtures and new holes in the floor need to be routed around the PT tendons. This can make it difficult to have typical unit types as the fixtures may need to be in different locations from unit to unit based on location of PT tendons.

- The cold-water supply system will need to be replaced. The water demand in a living facility is significantly higher than in an office.

- If there is an existing domestic booster pump, it will need to be replaced to accommodate the higher demand load. Even if you do not need a domestic booster pump initially, consideration should be made to prep for one if it is needed in the future.

Working on a large California conversion? Plan to limit your embodied carbon emissions

By Laura Hagan, Senior Building Performance Consultant

California has adopted new building codes to limit embodied carbon emissions in large buildings, effective July 1, 2024.

The changes to the 2022 California Green Building Standards Code (CALGreen) Title 24 limit the embodied carbon emissions in the construction, renovation, or adaptive reuse of buildings of 100,000-sf or larger.

Embodied carbon is the greenhouse gas emissions from a building's entire life cycle—manufacturing, transportation, installation, maintenance, and eventual disposal or reuse of structural and architectural materials.

The code offers owners and developers three paths to compliance:

- Reuse of at least 45% of the existing structure
- Using materials that meet an emission limit guidance for five high-impact materials
- Whole Building Lifecycle Assessment analysis (WBLCA) with a 10% improvement over baseline

A structural engineer conducts a WBLCA to supply data on the embodied carbon of the building materials used in building construction. The analysis helps clients understand and compare the potential embodied carbon of the structural design options.

IMEG can also conduct a structural-focused Embodied Carbon Study early in a project. This supplies crucial data and insight on the materials and applications being considered before the project reaches initial milestones.

Fire Protection

- You will need to add sprinkler heads and piping to the existing system.
- For an average 1,000-sf living unit, you may need eight to 10 sprinkler heads. The same size space in an open office environment would need four or five sprinkler heads.
- If there is an existing fire pump, it should be adequately sized to handle a living facility.
- If hose pull allowances are exceeded in the new floor plan layout, new hose valves and a supply pipe may be needed on each floor.

Life Safety

- High-rise office buildings will have stairwell, elevator, and corridor pressurization. When the layout is reconfigured for residential, those emergency systems will be impacted and may need to be modified.
- Generators that support emergency systems will need to be evaluated. The upgrades and changes to the emergency systems may require a new generator.
- New fire walls may be needed in the living facility arrangement, particularly across a corridor. This could impact how electrical distribution occurs.

Acoustics and Noise Abatement

The key to acoustics and noise abatement is to understand residential quiet, particularly for a condominium project. An office is not a bedroom and noise control is much different in an office than in a home. People want to sleep and live without hearing others next to them 24/7, so the expectations are different. Owners/developers should include an acoustics expert who knows about noise transfer and how an office building may or not meet standards and codes. It's more than patching the building up or adding a few layers of drywall.

Acoustic standards and local isolation codes between units vary by municipality, but in the planning stages, two issues will drive your budget:

- Are you planning private ownership or condominiums? Tenant ownership will drive an entirely different design, notably for noise and barriers and floor impact. It's more stringent than apartments. Condo owners are less tolerant of footfall noise and will worry about resale value if there is noise intrusion.

- Are you pursuing LEED certification? Codes vary by state unless you're pursuing LEED, which has a fundamental for acoustic comfort readily available. Those metrics will drive the scope, minimum standard of care, and budget, and the design scope can be predicted in advance to understand budget viability.

Next, focus on unit-to-unit separation with a common demising wall. Will you put holes in the walls for electrical boxes, ducts, loudspeakers, subwoofers, or recessed kitchen lighting? They will need to be assessed and benchmarked for percentage openings and noise flanking between the units. This will depend on a site test to understand where the noise is and if the assembly can be worked with.

In office-to-residential conversions, the living spaces are often placed along the outside where there are windows. In downtown areas, second- or third-floor units will be closer to street level, which means noise from the street, transportation, pedestrians, and loading docks. Take a look out the windows to get an idea of the noise that will need to be abated.

What will the center space become? Elevators, communal spaces, a home theater? Structural noise is not absorbed by carpeting and other soft goods treatments. That noise will flow very fast in the structure to adjacent units, too, through the hallway doors and openings, via new wall penetrations, and through the new HVAC systems.

Inside the residential units, the structure of the floor will impact noise control and a soft, thin pad under the new flooring will not be enough to dampen it. The sounds of footsteps—footfall impact—can be a 24/7 noise from above. It needs to be remedied at the ceiling and above the floor level. The impact noise or vibration travels though floorboards in walls and through concrete. Sleeping rooms will need more stringent solutions, too. One of the most common leaks around walls is the mullion to the window and the plastic pipe into the bath from below.

Finally, be aware of your neighboring buildings. If you're planning a rooftop bar or amenity space outside or on-grade, with people gathering against the property line, you need a solution for that noise. And they won't like it when the air handling unit is a simple, open slat screen.

For more information, contact Davin Huston and David Wright, Technology Designers of Distinction.

Technology

The unique nature of low-voltage systems, technology, and lighting can also impact the quality of life for the building's occupants. But there's no specific code to follow. Instead, it comes down to budget and the experience you want to provide your residents. As with acoustics, condominium owners will expect a higher level of features.

If the building has an outdated security control system, you'll want to replace it. Residents will prioritize locking hardware, ease of use, and guest access. Typically, the topology of an office access control system isn't going to allow for a smooth conversion to a residential application, and trying to modify it can generate some significant costs.

Technology mobility is constantly evolving, but post-pandemic residents will need the ability to seamlessly work remotely from their portable devices. Future 5G offerings from cellular carriers may offer the expected reliability as a retrofit consideration, but the traditional structured cable solutions of fiber optic and copper infrastructure found in new construction are the benchmark of speed and reliability.

Expanding the legacy cable infrastructure and adding an engineered Wi-Fi solution can achieve the expected mobility and performance for residents and connectivity for most of the building's operational functions. This converged approach can be cost effective and scalable and allows for many of the convenience functions, like smart locks, which attract tenants. Cost savings come from having a well-planned design approach proportional to the resident experience goals, not from over-investing in cable infrastructure and pathways that are not used.

Developers of new construction projects consider technology a marketing opportunity and converged building-wide solutions are commonplace. Find value by implementing these applications, which are no longer designed from a standalone building-wide perspective. Instead, operators choose from a number of hosted solutions that meet amenity and experience objectives. Although the same structured cable connectivity is required, software and control infrastructure are now cloud-based, which can be a cost-savings. It also means the building manager is spared 4 a.m. phone calls when a tenant can't get their smartphone to unlock their door.

For more information, contact Jeff Burton, Client Executive, Technology.

Tenants now expect LED luminaires in amenity spaces.

Lighting

Tenant expectations for lighting and lighting controls have evolved in recent years.

As LED has become the standard, many owners or renters expect LED luminaires both in their units and the amenity spaces. There is a potential to reuse existing downlights or other luminaires, but consider the luminaire condition, the light source, cost to remove, store and relocate, and if they fit within the new space.

In a historic building, where retaining the historic elements and feel is more critical, there may be greater value to reusing existing luminaires. They may need to be rewired and could be provided with an LED source.

Dimming control, at minimum, is expected in front-of-house spaces, and digitally enabled/smart control systems are becoming an expectation in units. If luminaires are reused, consider dimming and the coordination with control stations. Depending on the existing control system components, portions of the system, particularly in the core spaces, may be reused and built upon. The existing dimming protocol is the key to how much can be reused. In many circumstances, a new control system may be desired in the units, but like other technology, the cost on these systems has come down and they are readily available.

For more information, contact Shanna Olson, Architectural Lighting Design Leader.

Putting it all together

By embracing factors covered in this guide and engaging in meticulous planning, developers can unlock the potential of office-to-residential conversions, creating appealing and functional living spaces while simultaneously contributing to urban revitalization and addressing housing needs.

Contact the author

For more information, contact Scott Campagna, Senior Director of Housing.

Doug Sweeney, Senior Engineer, Structural, and Ed Dean, Consultant, also contributed to this executive guide.

The former Brown Brothers Harriman Co. headquarters in Philadelphia was converted into The Beacon, with 98 luxury apartments.

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