Residential Adaptive Reuse

Global Benchmarking and Good Examples

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Residential Adaptive Reuse:

Global Benchmarking and Good Examples

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Working Paper 2024:2

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Last but by no means least, I am grateful to Jonas Clarin and Ardian Miftari who contributed to the data collection for several of the case examples. Furthermore, they studied this topic from the real estate owner’s perspective and produced an excellent Master’s thesis, which I had the pleasure to supervise at the Divison of Real Estate Science, LTH.

As the Swedish love to create new words for everything, our project quickly got the nickname *'Bostadisering'*. Bostadisering best translates to '*turning into apartments'* in English. My hope is that this report, with 20 intriguing examples from around the world, would inspire owners, developers, and contractors to take on the sometimes challenging but always circular act of turning vacant and obsolete facilities into high quality, high-in-demand apartments.

Lund, 10 July 2024

Introduction

Many megatrends, including globalization, digitalization, and urbanization have led to a lack of housing but a surplus of other types of facilities in many places globally. The global covid pandemic and associated rise in remote working further aggravated the situation when it comes to office buildings. At the same time, the pressing environmental crisis is forcing us to look for ways to better utilize what we already have, instead of demolishing and building new. Adaptive reuse refers to a change of use and is typically connected with major renovation works. Repurposing or conversion are also sometimes used to describe the process. Residential adaptative reuse specifically refers to adapting a building for housing purposes.

Adaptive reuse is a circular strategy, which optimizes the use of a building by prolonging its life, saving embodied energy and emissions. Yet, almost without exception, adaptive reuse projects must be deemed economically viable to be kicked off. The heightened risk when working with existing structures, whether real or perceived, are hampering economic viability. Apart from the risks, the scale of the project may also hinder adaptive reuse. For a profitable project, as a rule of thumb, a minimum of 10 housing units should be developed. Adaptive reuse projects are typically in prime locations within existing urban fabric, in central business districts of waterfront locations to ensure profitability.

Cultural heritage is another key deciding factor in adaptive reuse. Heritage buildings may not only be protected from demolition but often valued due to their aesthetics qualities. Conserving buildings from different eras also contributes to the diversity and overall aesthetics of urban areas. Finding a new use to an existing building could potentially also vitalize the surrounding area.

The motivation for this global benchmarking is to pinpoint good examples and reveal key lessons learned from real-life residential adaptive reuse cases. The global benchmarking includes 20 examples of residential adaptive reuse from around the world. Cases have mostly been found through newspaper articles, LinkedIn, and recommendations from the project Advisory Board.

The cases represent a wide variety of adaptations, but all have some type of housing as the new use. Several are examples of adaptations to students housing, short-term living, or hospitality.

Although most cases are from Sweden, with Gothenburg standing out as a city, examples from elsewhere in the Nordics (Finland, Denmark), Germany, and rest of the world (US, Australia) are also included. Figure 1 depicts the geographical spread of the cases.

Figure 1 The geographical spread of the case examples. Map by Unknown is licensed under CC BY 2.0.

The following presents and categorizes the cases based on their previous use. First, pre-war buildings which have mostly been in office use before are presented, followed by post-war buildings which have been in office use. After that, we report presents cases of former industrial facilities and parking structures. Finally, buildings in other types of previous use are presented. After introducing the individual case examples, this report presents some joint conclusion made based on the examples.

A. Pre-War

The first category focuses on older, pre-war buildings, which have previously been in office or other commercial use. Building from this era are known to be better suited for housing than more modern office buildings. This is mainly due to the depth and other dimensions of the building and façade which allow for sufficient daylight. Buildings from this era are may also be more prone to be adapted because they cannot be demolished due to their heritage value. On the other hand, an official heritage listing may also incur challenges and additional costs during the adaptation process. The cases are presented from the oldest building to the newest.

A1. Inom Vallgraven 3:2, Gothenburg, Sweden

First developed: 1854
Previous use: office, retail, housing, manufacturing
Adaptative reuse: 2022
New use: 16 rental housing units
Owner/Developer: Hufvudstaden
Main contractor: NCC
Designer adaptation: Josef Eder/General Architecture
Area: 2 200 m^2 (1 300 m^2)

Figure A1 The building after adaption. Picture by Jonas Clarin (2023).

The case is a 1850s former commercial facility adapted to rental housing. The adaptive reuse project is part of a larger development project in Gothenburg center with ten buildings and ca 50,000 sqm. The larger project will include new construction, adaptation, and extensions for commercial use, while the case building is the only part intended for residential use. The adaptive reuse project emerged through an agreement with the city of Gothenburg, to replace some of the housing that is being adapted to commercial use in the larger project. The Owner/Developer has only commercial property in their portfolio before, but are planning to keep this property, nonetheless. The plan is to use the residents for short-term housing of e.g., the company's visitors.

Working within dense existing city structure creates challenges for the demolitions and construction works. Maintaining cultural heritage is important for this project, and the building is heritage listed. Working within dense existing city structure created challenges for the required demolition and construction works. The heritage listing entails challenges for the construction works. For example, the old doors could not be replaced, which meant coming up with the innovative solution of adding another door that complies with the existing building code and fire safety regulations. Windows and the façade were likewise to be left as they are, which meant that no balconies were allowed to be built.

The Owner/Developer saw that this made the housing units more suitable for short-term than permanent housing. The façade was, already suitable for residential use as is which is a major cost saving factor. In fact, the façade was a deciding factor in selecting the building to be adapted. The project also struggled to meet requirements with accessibility, such as, the installation of elevators. Daylight and acoustics have been another concern. The challenges were solved with creativity and negotiations with the public officials. Many interior details from the heritage building have been kept in place or to maintain the aesthetics and atmosphere of the place.

Map A1 Location of the site within Gothenburg, Google Maps (2024).

A2. Holtermanska, Gothenburg, Sweden

First developed: 1893
Previous use: hospital, offices
Designer: Adrian Crispin Peterson
Adaptive reuse: 2023
New use: 66 rooms for student housing/hospitality
Owner/Developer: Chalmers Studentbostäder (CSB)
Main contractor: Kålltorps bygg AB
Sub-contractors: Tegelfogen (façade)

Figure A2 The building before adaption. Photo by Unknown licensed under CC BY.

The case is a late 1800s building on university campus, which was first developed as a hospital but has seen various previous uses. Most recently the building hosted offices and an innovation hub. The new use comprises a student hotel and the new headquarters for the foundation. The owner/developer is the university of Chalmers student housing foundation, who acquired the building in 2017. Zoning from 1996 did not allow housing, however, hospitality was allowed. The location of the site was attractive on a university campus with good connectivity to the city center. A new zoning process is underway, which would allow for new development of 300-500 student housing units onsite. The zoning has received complaints and is still in court in spring 2024.

The project comprises 4 buildings with 3-4 storys. Maintaining the cultural heritage was crucial as the building is listed with ‘q’. The heritage thinking directed the design of e.g. the façade and windows. The existing brick façade was damaged and needed replacement bricks and reassembly of parts of the façade. Some moisture damage was also found during construction works. The current building code imposed some challenges regarding accessibility. The issues were solved by consulting experts and negotiations which allowed some deviations from the accessibility requirement. Generous ceiling height and daylight from large windows were enablers for the project. The rooms include single, double, or larger family rooms.

During the summertime the hostel is available for everyone, while during the study semesters the 66 rooms are used for longer (max. 4 month) term housing by students and visiting scholars. The rooms have shared bathrooms and kitchens. A long-term plan is to provide permanent student housing, the future adaptation had to be considered already in this project.

Map A2 Location of the site within Gothenburg, Google Maps (2023).

A3. Flatiron Building, New York City, US

First developed: 1902
Previous use: retail, office, press
Designers: Daniel H. Burnham
Adaptative reuse: planning phase
New use: approximately 40 luxury housing units (details not known)
Owner/Developer: GFP Real Estate, Brodsky Organization

Figure A3 Flatiron building. Photo by by o palsson is licensed under CC BY 2.0.

This New York landmark building was first developed in 1902 by the construction company and developer Fuller, and first called the Fuller building. However, the unique shape gave the building a nickname that is used to this day. When first developer there were concerns of the structural integrity, however, the building has a steel frame which has held fast. Prior to the current plans of adaptive reuse, an energy retrofitting project was planned by the co-owners. However, disagreements between the owner about e.g. cost led to a judge declaring auction, and finally one company, GFP Real Estate gained sole ownership at 161 million USD.

The adaptive reuse project is in the planning phase and the construction works are estimated to take 3 years to complete. The intent is to keep the ground floor in retail use, lower floors for offices, and adapt the upper floors to luxury apartments. The building is a National Historical Landmark, New York City Landmark, and included in the National Register of Historic Places. The heritage status will not allow altering the façade without consent from the authority. The building differs from other office towers considered for residential adaptive reuse as the available square meter area is much lower.

Map A3
Location of the site within New York City, Google Maps (2024).

A4. Tribune Tower, Chicago, US

First developed: 1925
Previous use: newspaper office
Designers: Raymond Hood and John Mead Howells
Adaptative reuse: 2018
New use: 162 housing units
Owner/Developer: CIM Group, Golub & Company
Main contractor: Walsh Group
Designer adaptation: Solomon Cordwell Buenz, Interior design: Gettys Group
Area: 88 300 m^2

Figure A4 Tribune Tower. Photo by Unknown licensed under CC BY-ND.

The Tribune Tower is an iconic office building, first developed in 1925. The original design is by US architects Raymond Hood and John Mead Howells who won a competition against European star architects of the time. The 34-storey building was originally developed for newspaper Chicago Tribune and has been extended in 1930 and 1950. The newspaper sold the building to the CIM group in 2016 and relocated offsite in 2018. The case is an example of the recent development of adapting office towers in North American cities to housing. The building now comprises 162 luxury apartments, along with 5,110 m2 of other facilities including retail, parking, a pool area, a fitness center, a communal outdoor terrace and garden, and bookable event space.

The project included the vertical extension of the lower parts by four new floors, as well as demolishing part of an adjacent building to create an inner yard. This solution allowed for more green area, more daylight, and balconies for the residential units. The design focused on maintaining the characteristics of the existing building. The city has had a strong involvement due to the heritage status of the building; the building is a Chicago-designated landmark.

Minimal intervention was a guiding principle in the new design, and a stated goal was that the post-project would like as if nothing happened onsite. Although the minimal intervention principle was based in aesthetic and heritage considerations, it also entailed less costs, which was the main reason for the developer choosing the design. Preserving interior details, such as elevator doors, was also important to maintain the characteristic of the building. Bridging old with new is visible in e.g., window design, which hints to neo-Gothic architecture style. Meanwhile, significant upgrades were done to the interior. Building services and electrical systems were also updated. Smaller rooms are due to building dimensions but said to create an intimate feel.

Map A4
Location of the site within Chicago, Google Maps (2023).

A5. Gamla Polishuset, Malmö, Sweden

First developed: 1934
Designer: Frans Ewers
Previous use: police station
Adaptative reuse: 2021
New use: 60 rental housing units
Owner/Developer: Riksbyggen
Main contractor: BAB Bygg AB
Sub-contractors: WSP (building services), Bricon (fire safety)
Designer: Rits Arkitekter, Jaenecke Arkitekter
Area: 9 726 m^2 (total area for project)

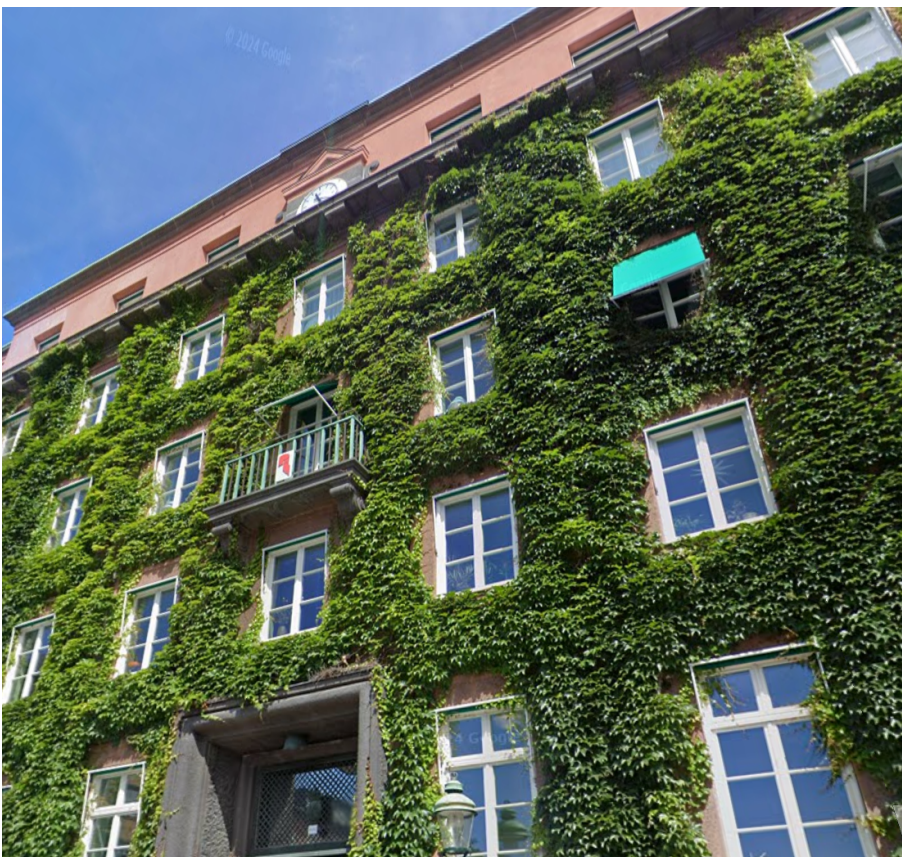


Figure A5 Streetview of the building after adaption. Google Maps (2022).

The former offices of the Swedish Policy Authority in Malmö, Sweden have gotten a new life in residential use. The building dates from the 1930s and was occupied by the polices until 2015. The building housed both offices and a jail and has previously even housed police horses. Not all parts of the old building were easily adaptable, and therefore the jail with thick floors and tiny windows was demolished. The case is an example of urban densification through infill development. Three new 6-story buildings and 62 residential units were developed in connection to the adaptive reuse. The site further hosts joint areas, such as bookable event space, for inhabitants to share.

Construction works within a dense urban structure were causing some nuisance to the neighbors. The construction phase for the entire project was 35 months. The developers saw major risks with the old architectural drawings not being accurate. Previous experiences with adaptive reuse projects were seen crucial in tackling surprises and finding creative solutions.

The project has gained the Swedish green building certification 'Miljöbyggnad' level Silver, which is the second highest level and in 2021 the project was awarded with green building of the year, 'Årets miljöbyggnad 2021'. The lower carbon impact than new construction is noted in the justifications for the award. Materials and fittings, such as, lighting fixtures have been reused onsite. The adaptation included an update to an improved energy class, and there is small scale energy production onsite. Auxiliary buildings in the inner yard have a green roof, and the site includes a garage with bike and car sharing options. The building is a listed cultural heritage building. The intent was to maintain the 'soul' of the site despite the new construction. The history of the jail is restored in the archives of the city museum. Different actors had a good collaboration throughout the project, working towards the common goals. Minor deviations from fire regulations were made using creative solutions, like fire safe paint.

Map A5 Location of the site within Malmö, Google Maps (2023).

B. Post-War

The next category presents newer, post-war buildings that have previously been in office use. This category of building receives perhaps the most attention currently when discussion potential for adaptation. The typical challenges of adaptive reuse are often said to be highlighted in these more modern buildings, with issues such as, low ceiling height and wider dimensions. Two of the examples are from the 1960-70s, and two from 1980-90s. Two of the cases are from the US, one from Sweden and one from Finland. The cases are presented from the oldest building to the newest.

B1. 25 Water Street, New York City, US

First developed: 1969
Previous use: office
Designer: Carson, Lundin & Shaw
Adaptative reuse: 2023 (estimated)
New use: 1,300 housing units
Owner/Developer: GFP Real Estate, Metro Loft Management, Rockwood Cap
Designer: CetraRuddy
Area: 102 193 m^2

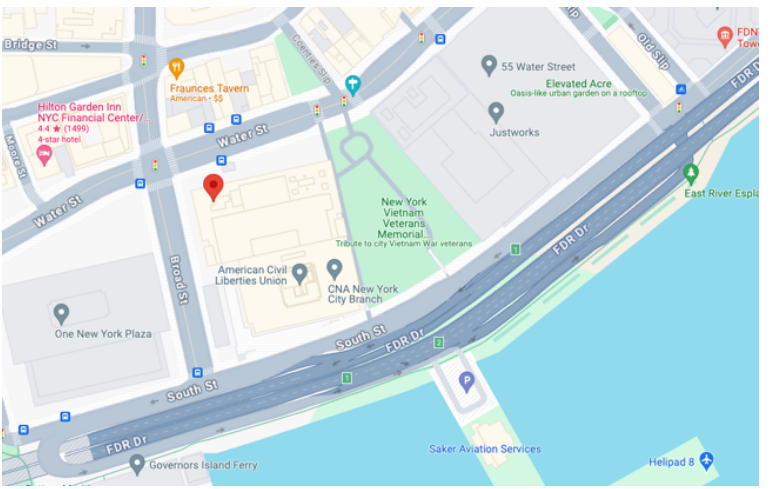
Figure B1 The building before adaptation. Picture by SnowFire licensed under CC BY 4.0.

The case project is a 1960's office tower in New York city. The building began construction in 1967 and was developed in 1969. The construction process was considered quick at the time. The brutalist style building housed several tenants. In the 1990s, the building was in the ownership of JP Morgan, after acquiring the Chemical Bank who was the main tenant at the time. JP Morgan became the main tenant thereafter. Sale-and-leaseback took place in the aftermath of the 2007-2008 financial crisis. In addition to JP Morgan, the main tenant was the New York Daily News. Due to the covid pandemic, the main tenants were either cutting of downsizing their office space in 2020-21. A joint venture between three real estate market actors, GFP Real Estate, Metro Loft Management, and Rockwood Capita bought the building in 2022 with the intent to adapt to residential use.

The brutalist style building has relatively few, narrow windows due to air-conditioning reasons as it was intended for use as a data center. The façade is of red brick, which was intended to fit with the surroundings. Paradoxically, many of the surrounding buildings have since been demolished. The building will host as many as 1,300 apartments, intended for the rental market in the megacity. Ten new storys, in addition to the existing 22 will be built. The facade will be transformed from the original red brick.

The example highlights the recent trend of adapting office towers in New York city to housing. Changes have been made by the initiative of the mayor to the building code and zoning regulations to allow for more flexible adaptation to housing.

It should be noted that in the spring of 2024, the project has still not been completed.



Map B1 Location of the site within New York City, Google Maps (2024).

B2. Postipuiston tähti, Helsinki, Finland

First developed: late 1970s
Previous use: logistics office
Designer: Toivo Korhonen
Adaptative reuse: 2021
New use: 97 housing units
Owner/Developer: U-H Rakennus
Main contractor: U-H Rakennus
Sub-contractors: Sähkö Sinisalo, U-H Talotekniikka
Designer: Marja-Riitta Norri, Reeta Laine, Sanelma Hihnala
Area: 6 223 m^2

Figure B2 Streetview of the building after adaption. Google Maps (2023).

The building is the former office of the Finnish Post. After the Post, the building was used for temporary housing, namely, as a reception center for asylum seekers in 2015. The project is part of a new neighborhood in Helsinki, intended for approximately 5,000 new inhabitants. The building was one of the first ones ready for move-in. The adapted building hosts 97 apartments, joint facilities, and one commercial facility. The adaptation includes a vertical extension by one floor to a total of 9 storys, and a horizontal extension with the one commercial facility. Joint facilities on the bottom floor include a gym and a sauna.

The construction phase of the project lasted 16 months. The building has a brick facade and a brick and concrete structure. The adaptation required partial demolition of the building. However, the bearing structure, staircase and elevator shaft were able to be kept. The previously narrow windows were extended, floor to ceiling. New modular and prefabricated bay windows both shape the façade and bring more daylight to the apartments. The building permit allowed some exemptions from the zoning. For example, the zoning would have required a brick façade and hung balconies. Yet, a puts façade with supported balconies was chosen as the existing structure would not withhold brick or hung balconies. Parts of the building have a green roof. The entrance has a special characteristic as it is surrounded by bedrock.

Map B2
Location of the site within Helsinki. Google Maps (2023)

B3. Santander Tower, Dallas, US

First developed: 1982
Previous use: office
Designer: HKS Architects
Adaptive reuse: 2023 (estimated)
New use: 228 housing units
Owner/Developer: Woods Capital/Mintwood Real Estate
Main Contractor: Adolfson & Peterson Construction (AP)
Designer: WDG Architecture
Area: 130 000 m^2 (total for building)

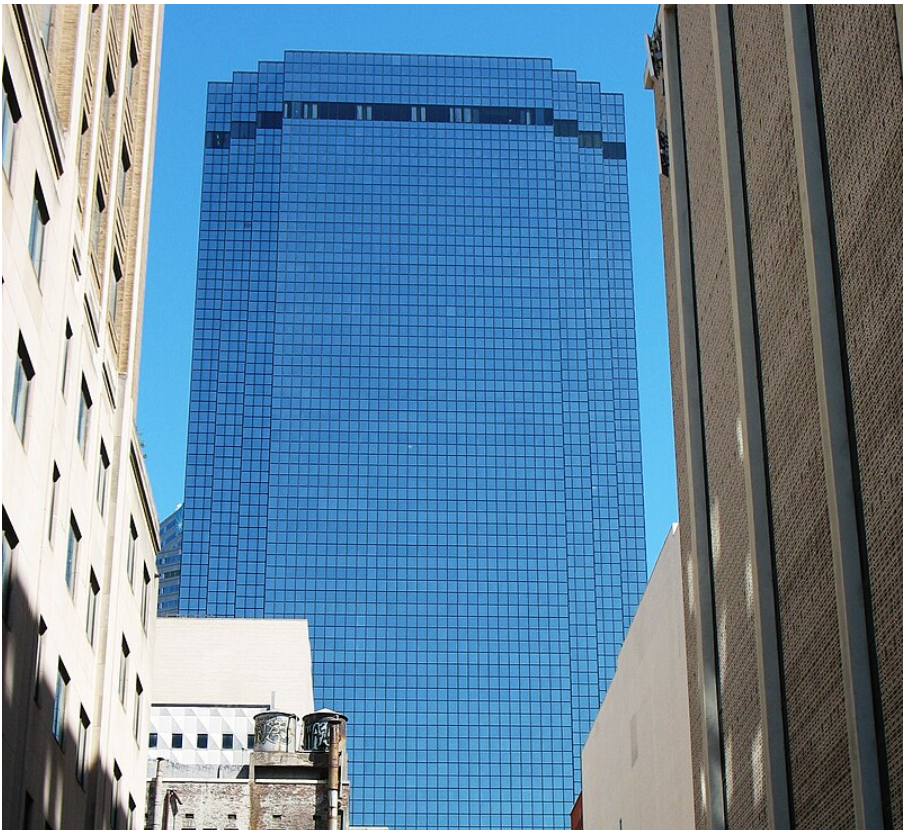
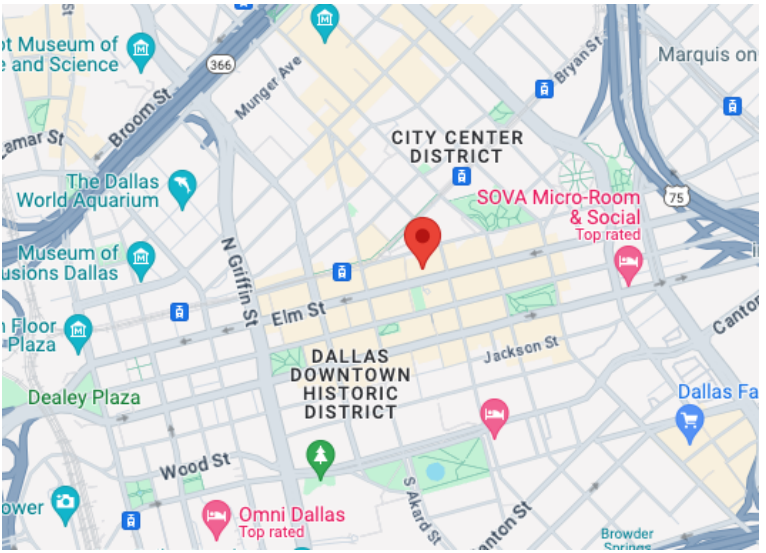


Figure B3 The Santander Tower. Photo by Unknown licensed under CC BY-ND.

The case is an office tower located in the historic center of Dallas, Texas. The 50-storey building is currently the 8th tallest building in the city. The tower is named after a main tenant, Santander Bank. The previous name was Thanks-Giving Tower. The current owner Woods Capital acquired the building in 2013 and has engaged in revitalizing not only the building but also the surrounding area through e.g. upgraded lobbies and common areas. In connection, also building systems were upgraded along with maintenance improvements. The intent was to contribute to the liveliness of the mixed-use downtown area.

The adaptive reuse project is the result of the pandemic and resulting hybrid working mode, which has left several floors of the building vacant. The project is a joint effort between the owner Woods Capital, and the developer, Minwood Real Estate. In 2022, Adolfson & Peterson Construction won the bid for the project. The floors adapted to housing include 18-25 and 37-39. The ground floor will also be renovated. The luxury apartments are 1-2 bedrooms, and the services comprise a swimming pool, dog park, fitness room, as well as joint areas including a kitchen. The mixed-use building continues to host offices, hospitality, and restaurant services.

It should be noted that in the spring of 2024, the project still has not been completed.



Map B3
Location of the site within Dallas. Google Maps (2023).

B4. Vintertullstorget 1, Stockholm, Sweden

First developed: 1990s
Previous use: Office
Adaptative reuse: 2021
New use: 77 housing units, retail
Owner/Developer: Brf Vintertullstorget 1
Main contractor: Savana Entreprenad
Designer: Urban Couture Arkitekter
Area: 7 600 m^2

Figure B4 Streetview of the building after adaptation. Google Maps (2023).

In Stockholm a 1990s office has been converted into 77 apartments, with retail space on the ground floor. The adaptation includes a vertical extension, as three more storys added to the existing structure. This meant extensive demolition works within dense urban structure in the mixed-use neighborhood of Södermalm. A major challenge was taking out the existing glass roof and structure. The project was done with fixed price contacting with a total budget of approximately 400 million SEK. Renting out a retail space has been good financially for the housing association.

The project has focused on retaining the concrete structure, adding a new façade. The unique shape and depth of the block created a challenging framework for both the design of the volume and the layout of the floor plan. The large variety of apartment types is a pre-condition for a mixed group of users.

Regardless of the nuisance, the neighbors have had a very positive attitude towards the project. Even the city officials have been positive, and the project has been in close collaboration with the city, ensuring that the new architecture relates closely to the surroundings. As an example, the façade color has been decided in collaboration with the city. Furthermore, despite the vertical extension, the building respects the scale of the surrounding buildings. To increase daylight, the building terraces towards the courtyard. A common green roof terrace supports stormwater management.

The project includes many site-specific and tailor-made solutions, which together with the designer's and contractor's experience and high-quality craftsmanship gives a luxury feel. Future residents have also been able to influence their apartments material choices. To allow for reuse within the project, a material bank with marble and other tiles, glass, railings, and lighting fixtures was set up. The main entrance uses both existing and recycled marble in combination with new details and restored lighting fixtures.

Map B4
Location of the site within Stockholm. Google Maps (2023).

C. Industrial

This category includes former industrial facilities adapted to housing. Adaptive reuse from industrial to housing has been popular over the past decades, specifically in the post-industrial cities of Global North. The large pane windows and generous ceiling height make for splashy apartments. The examples in this report include two former grain storages in waterfront locations, a former textile factory in a national industrial heritage site, and a distillery in new mixed-use neighborhood, which is still under development.

C1. Juvelkvarnen, Gothenburg, Sweden

First developed: 1914
Previous use: mill
Designer: Per Lennart Håkanson
Adaptative reuse: 2004-2005
New use: 59 housing units
Owner/Developer: JM AB
Main contractor: SERNEKE
Designer: Semrén & Månsson

Figure C1 The building after adaptation. Picture by Ankara is licensed under CC BY-SA 3.0.

The site is an industrial heritage site in Gothenburg Sweden. An old mill had been active at the waterfront since the 1910s. The site was in use as a grain mill until 2001. The adaptive reuse project was done as part of a larger real estate development project comprising infill development, demolition, and new construction with an additional 90 units. A landmark silo was demolished and replaced with an 80-meter-high new construction. However, the old mill with cultural heritage was saved from demolition and adapted to 59 housing units. The budget was 1,8 billion SEK, with the demolition costs at 10-15 Mio SEK.

Map C1
Location of the site within Gothenburg. Google Maps (2023).

C2. Silo, Copenhagen, Denmark

First developed: 1960s
Previous use: silo (grain storage)
Adaptative reuse: 2017
New use: 39 housing units, restaurant, and public spaces
Owner/Developer: Klaus Kastbjerg and NRE Denmark
Designer: COBE Architecture
Main contractor: NRE Denmark
Sub-contractors: Balslev and Wessberg Engineering (structural engineering)
Area: 10 000 m^2

Figure C2 The Silo after adaptation. Picture by Leif Jørgensen licensed under CC BY-SA 4.0.

The case is a former silo used as a grain storage, dating from the 1960s. The concrete structure is in an attractive waterfront location in the Danish capital Copenhagen. Which has been developed as a new residential neighborhood, Nordhavn. The adaptation project was commissioned in 2013 and completed in 2017. The industrial buildings structures of Nordhavn have played a key role in defining the identity of the harbor. The project was deliberately leaving traces so the inhabitants and the immediate environment will understand the former identity and heritage. Retaining the identity and repurposing the existing concrete structure creates continuity between new and old.

The Silo has good spatial variation floor by floor, which creates space for 38 unique apartments. The original structure varied 22 cm from front to back and side to side, so all new exterior units needed to be uniquely produced. Generous ceiling heights of up to 7 meters and panoramic, floor-to-ceiling windows and balconies offer great views of the city. Including both private housing and public functions ensure that the building remains active all day. The public functions are located on bottom and top floors and include a restaurant and a viewing deck.

The new façade is constructed of high-precision prefabricated 3D modules, which allow for more daylight. A layer of insulation was added to the exterior to serve as the new building envelope. On the outside of the layer of insulation is a secondary layer of protective skin made of galvanized steel plates. The angular faceted geometry of the façade allows the building to catch both daylight and reflections from the nearby water. From the environmental perspective, 2,740 m³ of concrete were reused, the equivalent of more than 500 tons of embodied CO_2e. Furthermore, leftover concrete from windows, decks and doors has been reused to make seating and podiums in the landscape surrounding the building.

Map C2
Location of the site within Copenhagen. Google Maps (2022).

C3. Yllefabriken, Norrköping, Sweden

First developed: 1905
Previous use: wool factory
Adaptative reuse: 2016-2019
New use: 100 housing units, office, retail, other
Owner/Developer: Gamlebro AB
Main contractor: SEFAB
Designer: Helen & Hard, White Arkitekter
Area: 20 000 m^2 (total for project)

Figure C3 Street view of the industrial site of Yllefabriken. Google Maps (2023)

The case is a former wool factory, and part of a nationally important industrial heritage site. In additiona to the adapted building, the site has also seen a lot of new construction, with a 17-story residential building with 35 new housing units, completed in 2022. The re- and new development of the area is said to be a benchmark for sustainable urban development. It is noted that preserving and reusing an existing building is inherently sustainable. The adaptive reuse project was done with SEFAB as the design-build contractor with partnering.

Map C3
Location of the site within Norrköping. Google Maps (2023).

C4. Spritfabriken, Eslöv, Sweden

First developed: 1904
Previous use: distillery
Adaptative reuse: 2022-2025
New use: 55 housing units
Owner/Developer: Eslövs Bostads AB
Main contractor: NCC
Designer: Link Arkitekter
Area: 4 500 m^2

Figure C4 Building before adaptation. Picture by by Väsk is licensed under CC BY 4.0.

The case is a former distillery, and part of a nationally significant industrial heritage site. Parts of the old industrial site will be demolished; however, parts are adapted for new use as rental housing. The project will also include underground parking structure and offices. The contractor is NCC with a design-build contract. The total budget is 320 million SEK. Due to the risk and uncertainty, restoring cultural heritage has higher cost than other new construction. The municipal owner/developer is expecting a deficit the first year of completion

The project includes horizontal extension of the existing building, in total the project comprises seven adapted and new built structures. The rental apartment are mostly 1-4 bedrooms.

The adaptation project has engaged in the reuse of building materials such as brick and beams, stairs, cast-iron windows, and pillars. As an example, more than half of the brick are recycled onsite to the new constructions. Preserving the façade has been a challenge in terms of building technology. The interior will be completely renewed.

Daylight and acoustics have needed special attention. While the intent is to maintain the industrial heritage feel. modern building code requirements for e.g. accessibility and energy use must be met also. The modern requirements for e.g. ventilation are not supposed to affect the cultural heritage. The ambition is to reuse as much as possible and deliver savings in CO2e, resources, and waste. Due to the industrial use, the site has been contaminated, however, soil remediation work has been done.

Map C4
Location of the site within Eslöv (Google, 2023).

D. Parking

The category includes three examples of former parking structures adapted to housing. Adapting parking structures is a topic which has gained traction lately as cities are striving to be less car dependent. Still, not examples were found yet in Sweden. Two of the examples are adapted to luxury apartments in prime locations in Melbourne, Australia and New York, the United States. The third example is a project from Berlin that has not been commenced but would turn a parking structure into modern offices and a hotel.

D1. 17 East 12th Street, New York City, US

First developed: 1920s
Previous use: parking structure
Adaptive reuse: 2015
New use: 9 luxury housing units
Owner/Developer: Rigby Asset Management
Designer: Bromley Caldari Architects
Main contractor: David Haller
Area: 4 645 m^2

Figure D1 Street view of the building after adaptation (Google Maps, 2022).

The case is a former parking structure in a prime location in Greenwich Village, NYC. The adaptation includes a vertical extension from an 8-storys to an 11-storys. The adapted building hosts 9 luxury apartments. The three-, four-, or five-bedroom apartments feature expansive rooftop terraces on the upper level, herringbone floors, fireplaces, and folding glass walls. The apartments sold at 24,765 EUR per square meter.

The luxury feel is enforced with imported materials and fittings. As examples, the brick façade from English imported brickle, and marble in the interior from Italy, and kitchen appliances from Germany.The facade was stripped of its original brick, but the frame remains intact. This significantly decreased the overall cost, virgin materials, embodied energy, and carbon compared to demolition and new construction of similar size. The project was more efficient both in fiscal and material terms than new construction.

The initial challenge of ceiling height was solved by design. Integrating the electrical, sprinkler, and HVAC ducts was a particular challenge due to the deep beams that span the width of the structure. The issue was solved by cutting holes in the beams to accommodate pipes and reinforcing the holes and threading the beams to integrate services within the latent load-bearing system.

Map D1
Location of the site within New York City. Google Maps (2023).

D2. QV Eight Apartments, Melbourne, Australia

First developed: 2005
Previous use: Parking
Designer: John Wardle Architects and NH Architecture
Adaptative reuse: 2015
New use: 8 housing units
Owner/Developer: Grocon development
Designer: Breathe Architecture
Main contractor: May Constructions

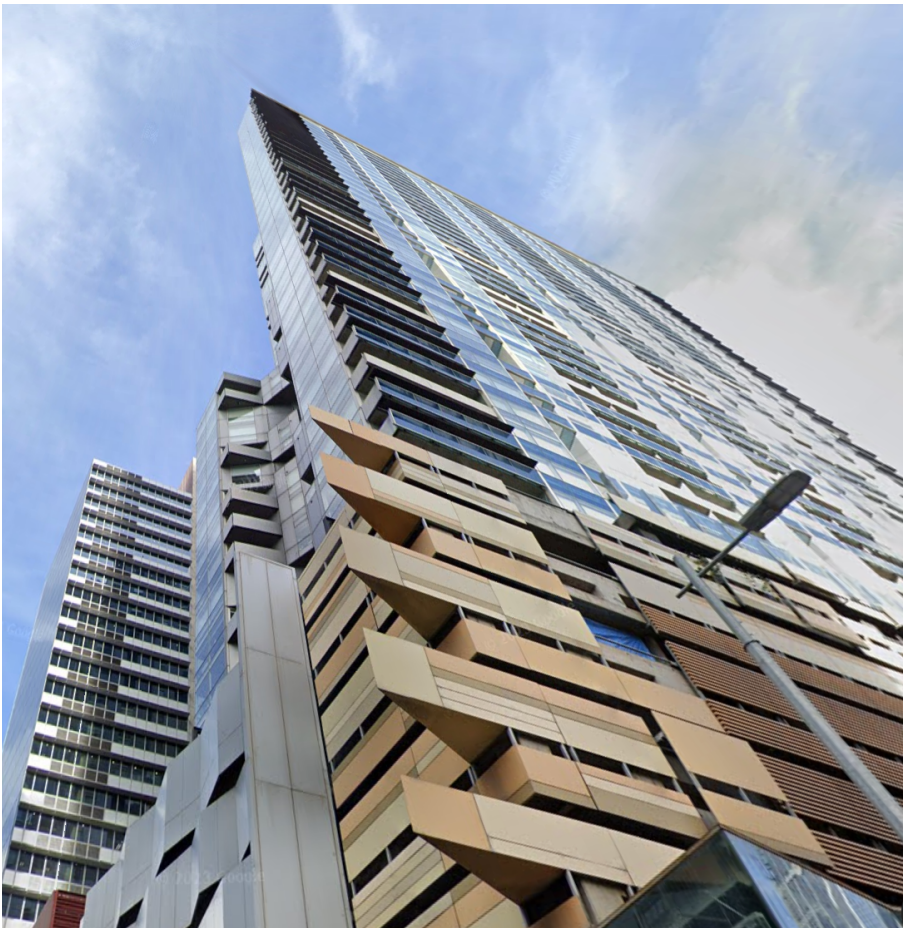


Figure D2 Streetview od the buidling after adaptation. Google Maps (2023).

The case is the first parking to residential adaptation in Australia, and located in Melbourne CBD. The building was first developed as part of a larger development of the historical Queen Victoria Village in the early 2000s. The adaptation concerns the top level of a 44-story residential building, where 20 parking spots were converted into 8 housing units with 2-3 bedrooms.

All apartments are unique because of the floor plan. The adaptive reuse project is cited to be a new type of urban infill development. The project was awarded the 2015 Sustainability Award, due to the re-use and reclaiming space from cars in cities. During construction of the original building, a decision was made at the last minute to build five storys higher. As a result, the building's eighth level required structural reinforcements which made is unsuitable for parking purposes. Housing was chosen as a new function based on the location and potential value.

The apartments eventually sold for between 1 and 2 million AUD, or 640,000 to almost 1.3 million EUR. The architects and designers required six months to resolve the issues associated with the project, naming acoustic insulation, daylight, views, low ceilings, and ventilation. Windowless rooms get natural light from surrounding spaces. Solved by allocating balconies for each unit, providing generous floor area, cross ventilating each unit with both north and south exposure, and using translucent materials in the interior to maximize the filtration of light. Robust concrete structure has the benefit of thermal mass making it energy efficient and providing a constant indoor temperature.

Map D2
Location of the site within Melbourne. Google Maps (2023).

D3. Karstadt Re-Parked, Berlin, Germany

First developed: 1929
Previous use: Parking structure
Adaptative reuse: 2025 (estimated)
New use: hospitality and offices
Owner/Developer: Signa (NREP)
Designer: Lendager

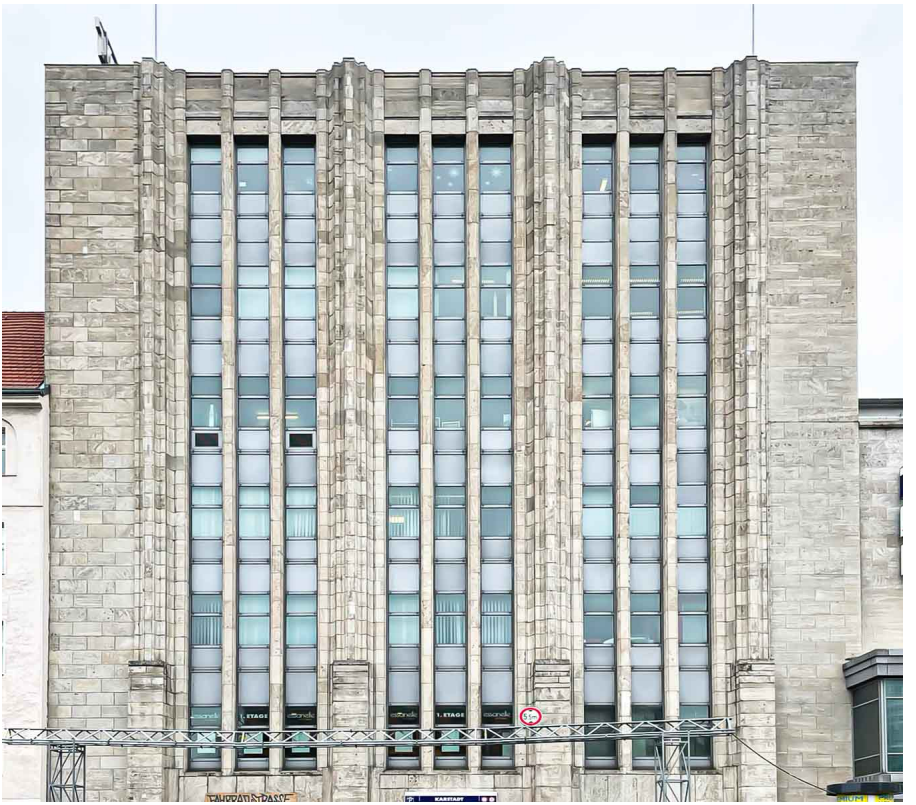


Figure D3 Street view of the building before adaptation. Google Maps (2022).

The project entitled Karstadt Re-Parked is part of a larger project focusing on redeveloping the entire block of the Karstdadt department store. The project has a strong citizen engagement and sustainability focus. Among other things, green mobility (walking, biking) is prioritized. Consequently, the adaptation of a car park to a new use, fits well with the overall profile of the larger redevelopment project. Moreover, currently, the parking garage is said to be only half occupied.

The Danish company Lendager has been commissioned as the designer. The construction works for the Karstadt block were scheduled to start in 2023 and be finished in 2027, with the ReParked sub-project scheduled for 2025.

The building has a concrete frame. Starting point in the design is what is already present on-site in terms of materials and spatial constraints. Still, the façade will be dismantled and rebuilt. Structural floor slabs and the raw concrete core will remain in the existing car park after the demolition. The cut-out materials will be reused as a façade material onsite. Even structural floor slabs will be reused onsite, in combination with a new timber structure.

It should be noted that in the spring of 2024, the developer Signa has filed for bankruptcy and the project is on hold.

Map D3
Location of the site within Berlin. Google Maps (2023).

E. Other

The final category focuses on adaptation from other types of previous uses. The examples comprise a 1930s water tower adapted to student housing, a former horse stable adapted to housing, an 1880s auxiliary building adapted to housing, and a 1960s motel adapted to housing. Notably two of the cases are adapted to student housing, which is often considered a better fit for adaptations. This is e.g. due to smaller room size and looser requirements for accessibility. Furthermore, previous hospitality use has even been considered a "light" version of adaptative reuse due to previous layout, façade and building dimensions.

E1. Guldhedstornet, Gothenburg, Sweden

First developed: 1936
Previous use: water tower
Designer: Ragnar Ossian Swensson
Adaptative reuse: 2008
New use: 74 student housing units
Owner/Developer: SGS Studenbostäder
Main contractor: NCC
Designer: Knut Fredrikson

Figure E1 The building after adaptation. Picture by Mangan 2002 licensed under CC BY 3.0.

The case is a former water tower which was in use until the late 1960s. After the water tower, the building has hosted the radio services of the city as well as the Swedish Police. The first ideas of adapting to residential use emerged already in the 1980s but it took over two decades to realize the project. The city was favorable to the adaptation for student housing. The first design of the adaption dates from 1996. The end results includes both vertical extension and horizontal extension in the form of a half circle. The project was finally finished towards the end of 2008, and the first students were able to move in December 2008. The developer was the student housing company SGS. The main contractor was NCC as a design-build project. The estimated budget for the project was 60-65 million Swedish crowns, which is simialr or even higher than new construction of similar size.

The project includes a vertical extension from129 meters above sea level to 140 meters above sea level. The extension added 5 storys to the seven-story building, resulting in 13 storys. There are seven apartments on each floor, mostly studio or 1-bedroom apartments but also larger two bedrooms. The elevator is located centrally to the building to maximize daylight in the apartments. All apartments are shaped like cake pieces. Joint areas include a viewing deck on the 11 floors as well as shared learning space on the ground floor. The round shape allows for unique spaces but was a challenge during construction.

Demolishing the several thousand cubic meter water container of and its supporting structure was a key challenge as there was a risk that the existing concrete silo would be damaged. Construction works the existing urban structure were also causing some difficulties. building is a landmark building in Gothenburg. The neighbors were originally opposed to the adaptation, mainly due to an associated new parking area.

Map E1 Location of the site within Gothenburg Google Maps (2023).

E2. Ajurien talli, Helsinki, Finland

First developed: 1906
Previous use: horse stables
Adaptive reuse: 2020-2022
New use: 18 housing units
Owner/Developer: Helsingin Top 41
Main contractor: Lakewood
Sub-contractors: Sitowise, Livair, Helimäki, Untamon entisöinti, Paloässät
Designer: Avarrus Architects
Area: 2 000 m^2 , Volume: 6 250 m^3

Figure E2 Interior of the building before adaptation. Picture by Kari Hakli licenced under CC BY.

The case is a former horse stable from 1906, which between 1966-2019 was used as storage space. The adaptive reuse process in total took almost 17 years from changing zoning, permitting, development, design, and construction. The environmental protection agency first issued a temporary ban on any changes to the building in 2000 after a demolition permit was declined. The building was then officially listed as a heritage building. A change in the zoning to allow housing was passed in the City Council in 2016, despite complaints from neighbors. Still, it took several years for the project to become financially feasible, even though located in one of Helsinki's most prestigious housing areas. A small private developer was eventually able to realize the project.

Most of the budget was reserved for the conservation of the façade. Plenty of manual labor onsite was required. One of the key technical challenges was thermal comfort and adapting the previously unheated space to heated space. Due to the heritage status, not many new windows were allowed, only 5% of façade area. Existing windows were mainly skylights, which benefit the upper floor apartments. Neighbors were opposed to new windows facing them. The issue was solved by installing declining walls to block the view. The existing brick frame could be used, despite the poor condition. The existing brick walls were reinforced and isolated. The foundation and some of the walls were also reinforced. The loft floor includes steel beams for support.

The heritage listing directed the design. An inventory and restauration of windows, doors, stairs, and other interior was conducted prior to construction works. The aula and joint areas display the aesthetics and history. Apartments are of a simple, modern design. Each apartment is different. 12 of the 18 apartments are two-story. The project required good collaboration between client, architects, housing company, city permitting officials, city heritage agency, and consultants. The city has allowed for exemptions and interpreted the building code to the project's favor. As an example, the old wooden entrance doors could be left in place as the new fire doors open inwards.

Map E2 Location of the site within Helsinki (Google Maps, 2023).

E3. Lokmästaren, Gothenburg, Sweden

First developed: 1886-88
Previous use: auxiliary building (sv. ‘gårdshus’)
Designer: J A Westerberg
Adaptative reuse: 2017
New use: 9 housing units
Owner/Developer: Herlitz Properties
Main contractor: Herlitz Properties
Designer: Oki Doki Arkitekter, RADAR
Area: 564 m^2

Figure E3 The main building, former staff quarters of SJ. The adapted auxiliary building is located in the inner yard. Picture by Vogler licensed under CC BY-Sa 4.0.

The case building dates back from the late 1800s. The building was first developed as an auxiliary building (‘gårdshus’) to the staff housing quarters of the Swedish Railways. The auxiliary building used to host e.g. laundry facilities.

In 2017, the existing building was adapted into 5 apartments and extended horizontally with two wings comprising an additional 4 apartments. The result is a modern townhouse with 9 apartments. The apartments were priced between 4.2-6.8 million SEK. The Owner/Developer is a smaller local company Herlitz Properties. who were also in charge of the construction works. The 1–2-bedroom apartments are all two-story. The apartments are spacious, and materials are high-end. The heritage style is maintained in the interior. The floors on the ground floor are of concrete, inner walls are of brick and the beams are visible in some apartments. Many details are handcrafted. The outdoor areas have greenery as well as common areas for barbecue. The building has cultural heritage value as well.

It is noteworthy that the project unusually small to be typically considered for residential adaptive reuse.

Map E3
Location of the site within Gothenburg (Google Maps, 2023).

E4. Boathouse, Washington D.C., US

First developed: 1962
Previous use: motel
Adaptative reuse: 2020
New use: 250 housing units, retail
Owner/Developer: Urban Investment Partners (UIP)
Designer: WDG Architecture
Main contractor: UIP General Contracting
Area: 10 900 m^2

Figure E4 Street view of the building after adaptation. Google Maps (2022).

The project is a 1960s hotel building from Washington D.C. The 10-storey building previously hosted the Howard Johnson's Hotel, which is famously linked to the Watergate scandal. The building has also housed student housing. In 2020, it was adapted into high-end multi-family homes. The adaptive reuse kicked off as a student housing project. However, after change in ownership the intended use was to be more towards upscale apartments.

The project comprised major demolition works, eventually only with the structural frame reused, the facade and interior were completely renewed. HVAC systems were upgraded in connection with the adaptation. The project further includes infill development in the former outdoor areas of the hotel. The horizontal extension adds 3,159 m2 to the existing structure. Structural concerns and building contaminants in the 1960s buildings were mending the façade difficult to reuse. Fiberglass and concrete facade elements were in too poor condition to be maintained. As the original structure was kept, more lightweight materials were sought, and the used materials comprise corrugated metal, cementitious panes, and high-pressure laminates.

The dimensions of the grid of the building were also challenging due to the previous hospitality use. The issues were solved through creative re-organizing of the spaces and unusual window sizes. The solutions were also space efficient. The project was awarded with a LEED Silver green building certification and has received other awards related to renovation existing buildings. Amenities include a swimming pool, and a green rooftop with views.

Map E4 Location of the site within Washington D.C. Google Maps (2023).

Conclusions

This report introduces 20 cases of residential adaptive reuse from different types of previous uses. The motivation is to pinpoint good examples and reveal key lessons learned from around the world. The identified challenged are mostly related to meeting the requirements of the current building code. Technical issues, such as, lack of daylight, inadequate ceiling height, or accessibility are typical. While a heritage status often makes buildings prone to adaptive reuse, it is also seen to bring additional costs and challenges. Location within existing urban structure was seen as a challenge for construction site logistics, even though otherwise a central location was an enabler. Some cases showed signs of a slow zoning process hindering the adaptation to new use, causing delays and financial loss. Another key financial obstacle is the higher risk and uncertainty associated with adaptive reuse, as opposed to new construction.

The identified enablers comprise good collaboration with key stakeholders, particularly the municipal authorities. Creative and novel solutions were needed in many cases to overcome the challenges faced during construction works. The possibility to add vertical or horizontal extensions (i.e. infill development) seems to be a driving factor, particularly in the Swedish cases. Acquiring more building rights for new construction was even the main motivation for the adaptive reuse in some cases. The speed of construction compared to demolition and new construction is another positive factor.

All cases were located either in currently attractive locations, or areas subject to revitalization efforts. Mixed use and short-term housing were revealed as characteristic of adaptive reuse projects.

The emergence of circular thinking is clear from the examples. It is reflected both in the understanding that saving the core and shell of the building saves much of the embodied energy and carbon, and the reuse of components, fittings, and materials onsite. Careful consideration of material choices further indicates that adaptive reuse projects embrace a luxury status. The identified need for specialized knowledge and skills, as well las the high level of customizing and crafting create both a challenge and an opportunity for the construction industry in the coming years.

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