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### Case Study

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### The significant electricity supply currently required to operate a vertiport may be an issue, and early engagement with electricity providers would be prudent to assess viability and cost.”

Humphreys, page 58
Americas

An investment from the Canadian federal government will support an affordable housing component with CA$130 million (US$99 million) in downtown London, Ontario. Consisting of two residential buildings at 495 Talbot Street and 110 Fullarton Street, the development is slated to designate a quarter of its 420 units toward affordable housing.

In Toronto’s Liberty Village, a 16-year-long redevelopment project draws to a close with the launch of the 28-story, mixed-use Liberty Market Tower. The building will complete the Liberty Market Complex, which includes the Liberty Market Building and Liberty Market Lofts.

Further down the lakefront from Toronto, Mississauga is set to be the site of a massive, 37-tower megaproject, called The Square One District, which just received phase-one approval and will unfold over multiple decades. The development is planned to host 18,000 residential units, as well as office, retail, and entertainment space over its 1.6 million square meters of programming.

In the always-busy New York City, the cantilevered, glass-clad H Hotel W39 is progressing, with an estimated delivery date of 2021. The 65-room hotel is rising from a narrow plot below Bryant Park, and will eventually top out at 132 meters. Uptown, a proposed hospital tower redevelopment, the Lenox Hill Hospital Complex, has gone through a change to its design, which may include amending or eliminating the 41-story residential tower that was to accompany the hospital campus.

A permit has been filed for a high-rise tower to replace a parking garage on Boston’s waterfront. The Pinnacle at Central Wharf would be a 42-story, 182-meter tower, with a mix of retail and dining, offices, and residential programs, according to plans.

Along Chicago’s popular lakefront, a creative plan was unveiled to bring 500 units to a corner site just west of the city’s Lake Shore Drive. The proposed project, 640 West Irving Park Road, would convert the multi-building campus of a former high school into 275 residential units. A 23-story tower, which would replace the existing parking lot, would add 220 senior living, assisted living, and memory care units. In Detroit, the David Stott Building, an Art Deco skyscraper, has been fully renovated. Purchased in 2015 for US$14.9 million, it had been undergoing renovations for the past several years, which included replacing windows, terra cotta and approximately 60,000 bricks on its exterior. Despite two delays, Lakeview Tower, a 15-story residential building, is slated for Duluth’s downtown, delivering 204 apartments and commercial space on the ground floor. Construction is expected to start in the winter of 2020.

Over on the United States’ West Coast, the Planning Commission in San Francisco has approved a new 61-story, 246-meter mixed-use tower at Transbay Center. Located at 542–550 Howard Street, the high-rise is anticipated to potentially be the last significant tower in the Transbay district.

Further south in Los Angeles, Park Fifth, a 24-story high-rise building, along with a seven-story mid-rise building called Trademark, have reached completion in the city’s downtown. Park Fifth offers 347 apartments, as well as a 360-degree-view rooftop deck, an infinity pool, and other amenities. It is located near the Pershing...
Square Metro Station, in order to increase commuter convenience.

In Atlanta, a 46-story mixed-use tower is set to rise, potentially up to 168 meters, at 1138 Peachtree Street. If completed, the tower would feature 317 luxury apartments, as well as 3,000 square meters of retail space, and a nine-story parking deck.

In Charlotte, North Carolina, 700–722 North Smith Street is a 37-story residential tower coming to the fast-growing city. The project has been permitted to have up to 603 square meters of commercial space and 350 condo or apartment units on the site.

A site in the Symphony Park District of Las Vegas could host a 20-story residential tower by 2024. The City Council granted approval to the project’s developer to proceed with building 400 units in the downtown area at 600–798 West Symphony Park Avenue.

In another metro region with a growing high-rise living market, Frisco, Texas, part of the Dallas–Fort Worth metroplex, the new 19-hectare Gate development will contain Gate Tower with a 231-room luxury hotel and a 90-residence apartment component, slated for a 2024 opening.

Two residential complexes are making headway in Guatemala City. Parque Mateo, a planned three-tower complex, is part of a revitalization of the city’s Zone 7, and will deliver a total of 450 apartments in two-bedroom and three-bedroom configurations. The four towers that comprise Céntrico, a complex in the city’s Zone 5, will each reach 14 stories, and contain 497 apartments total between them. Construction will consist of four phases, with each one focusing on the completion of a tower. The project’s aesthetic was inspired by Europe’s urban landscape. In Zone 4, Granat, a mixed-use, 16-story building is topped out, and set for a completion in 2020. The tower, which features greenery on its exterior, has two commercial levels, four levels of offices, one boutique hotel story, and nine stories of apartments.

An environmental impact study was submitted to the Panama Ministry of Environment for a planned development in the San Francisco district of Panama City. The two-tower, mixed-use complex, called Le Parc Residences, will have commercial space and 288 apartments. In San José, Costa Rica, the second tower in the Azenza Towers residential complex has commenced construction. It will be the same height as the existing tower in the complex: 23 stories and 78 meters.

Asia & Oceania

In Tokyo, projects continue apace, as Toranomon Hills Business Tower wraps up construction. The 36-story tower is part of the mixed-use Global Business Hub at Toranomon Hills Complex, which is planned to deliver five towers, some exceeding 50 stories. Over in Asakusa, a 1970s Tokyo icon, the 26-story Kokusai Akasaka Building is to

THEY SAID

“Miracles and dreams can become real.”

Helmut Jahn, Principal, JAHN. Letter to Illinois Governor J.B. Pritzker to save the Thompson Center, Chicago, from demolition.
Introduction

In 2019, Paris La Défense ranked fourth among the most attractive business districts worldwide, after the City of London, Midtown New York, and Marunouchi in Tokyo (Lhermitte et al. 2017). Built on an artificial slab 60 years ago on the western edge of Paris, La Défense, which had once benefited from cheap land, must today reinvent its model. Originally designed to vertically separate pedestrian from vehicular flows, so as to create a more functional city, inspired by Le Corbusier’s Plan Voisin, La Défense has overcome and reconstituted the morphological constraint of its raised plinth, which once made it difficult for users to understand and navigate (see Figure 1).

It has been a goal of the developer to make La Défense more urbane and more human-scaled. Over the last 10 years, several projects have been launched to sew the circular boulevard around the La Défense slab more tightly together, creating a real urban continuity that extends beyond La Grande Arche, reinventing the office park, and especially, infusing the district with new uses.

Figure 1. Site plan showing the location of Trinity Tower and its immediate neighbors.
At the base of the new, ultra-modern office towers are restaurants, bars, shops and public spaces that have the potential to transform La Défense into a 24-hour-a-day district, a destination for white-collar workers and all Parisians, on weekdays but also on weekends.

If it is to become more urban and claim its rightful place as a desirable destination in "Le Grand Paris," La Défense must not lose sight of its goal to become the top European business center. Its particularly low office vacancy rate reflects the dynamism of the French business center.

Trinity was designed as a comprehensive and contextual urban project for La Défense (see Figure 2). In order to successfully integrate into an atypical site, it combines three major axes in a single construction program: the erection of a building, the creation of major urban link, and a large-scale intervention to enclose highways. In other words, Trinity is at once a work of architecture and urbanism, with public benefits.

**An Urban Project**

Trinity was designed for a narrow site and a need to span a highway, but also for its immediate surroundings, which include several architectural icons: the CNIT and Tour Areva, smaller buildings such as Notre-Dame de la Pentecôte Church, and residential buildings. The tower was sculpted to slip into this dense urban context, keeping a 27-meter minimum distance from Tour Areva, while conserving views and perspectives for its neighbors, notably between Tour Total Coupole and the CNIT. Continuous exchange with the neighborhood via public consultation meetings throughout development enabled the project to mature and meet residents' expectations.

The concrete slab built over the highway provides real solutions for creating urban connections and enhancing the quality of...
Improving the Energy Efficiency of a Mediterranean High-Rise Envelope

**Abstract**

This study focuses on the building envelope as the mediator between interior and exterior climatic conditions, examining its influence on energy loads. The parameters are: climatic conditions of the building’s location (Mediterranean climate), the thermal properties of the building envelope, and the effect of building height, on a high-rise office building with increased internal heat gains. The proposed envelope under study is a glazed curtain wall design, reflecting current high-rise architectural tendencies. Simulation results are in favour of a double-skin envelope design, with double low-e glazing as the exterior layer, and single-layer clear glazing on the interior, with two exterior windows that open and close in relation to building height, exterior environmental conditions and interior thermal comfort. The outcome is a dynamic building envelope that adapts and performs in relation to the above parameters.

**Keywords:** Climatic Response, Envelope, High-Rise, Mediterranean Climate, Thermal Performance

**Introduction**

Although the potential of tall buildings to improve the overall sustainability of urban life is strong, further research and experimentation is needed, in order for this typology to comply with current and near-future regulations on embodied carbon and carbon emissions (EU 2010; Voss, Musall & Lichtme 2011; NYC 2015). Additionally, there is a significant gap between the practice of high-rise development worldwide, and the expertise gained on how to make these buildings more sustainable and energy-efficient (Donnolo, Galatro & Janes 2014; Simmonds 2015).

Tel Aviv, Israel, the focus of this study, has experienced vibrant high-rise activity. In 2011, the city’s Planning and Construction Committee issued the 2025 City Master Plan, setting new guidelines allowing further skyscraper development (Fox 2011) (see Figure 1). This study considers high-rise buildings as an urban phenomenon closely related to city living, and studies design strategies for advancing their energy efficiency.

An important consideration of high-rise buildings is their vast scale, which is also translated into increased energy loads, in comparison with low-rise construction (Cook, Browning & Garvin 2013; Leung & Ray 2013). As a result, their impact on the urban scale is much more energy-intensive than all other construction. According to the United Nations Environmental Program - Sustainable Buildings and Climate Initiative (UNEP-SBCI), the emissions produced from the operational energy (OE) of buildings, mainly used for heating, cooling and lighting, form the largest source of building-related greenhouse gas (GHG) emissions (approximately 80–90 percent), in relation to the emissions produced by the embodied energy (EE), used in the process of raw material extraction and processing (La Roche 2012). In addition, the building sector today is the most energy-intensive sector, accounting for almost 50 percent of GHG emissions. So, in order to reduce these, it becomes crucial to enhance the energy efficiency of buildings by reducing the OE.

This study looks at improving the energy efficiency of high-rise buildings, by focusing on the initial concept design stages, and more specifically on the design of the building envelope, considered as a passive design strategy that has the potential of

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**Keywords:** Climatic Response, Envelope, High-Rise, Mediterranean Climate, Thermal Performance
reducing energy loads, by acting as a mediator between indoor and outdoor conditions (Cheung, Fuller & Luther 2005; Saroglou et al. 2017). A vital consideration in this relationship is the climatic conditions of the building’s location. So, by designing a climatically responsive building envelope that interacts appropriately with the ambient climatic conditions, it is possible to take advantage of passive heating and cooling techniques, and reduce the operational energy, i.e., heating and cooling (Yik 2005; Choi, Cho & Kim 2012).

However, current architectural tendencies, initiated from the mid-20th century onwards, especially prominent in high-rise buildings, portray an increased transparency of the envelope, and lightness of the structure, resulting in high cooling and heating energy loads (Allard & Santamouris 1998). On the other hand, during the last few years, double-skin façades (DSFs) have gained popularity over single-skin curtain walls, as a more advanced envelope scenario that leads to improvements of the building’s energy performance (Wood & Salib 2013). But, despite the number of built DSF built projects, and the numbers of DSF studies conducted, design guidelines on DSF energy performance are lacking, especially in relation to local climate (Joe et al. 2014; Ahmed et al. 2015; Ghaffarianhoseini et al. 2016).

This paper studies the performance of a building envelope for a high-rise reference model at different heights, in the hot and humid climate of Tel Aviv. The Tel Aviv climate (in terms of dry-bulb temperature, relative humidity, wind speed, and wind direction) is shown in Figure 2. Heating and cooling load comparisons are made by gradually upgrading the thermal properties of the building envelope for improving energy efficiency. Studies in hot climates are of special importance, due to the increased solar gains entering a glass façade, intensifying the cooling requirements. In addition, most research on double-skin envelopes, the focus of this study, has predominantly been undertaken in cold and temperate climates, with limited research taking place in hot ones (Hamza 2008; Pomponi et al. 2016; Halawa et al. 2018).

Design Considerations for High-Rise Energy Efficiency

The Effect of Height on High-Rise Energy Loads

A building interacts with the outdoors through the envelope (walls, roof, windows) generally, and specifically with the thermal properties of the materials that make up the building envelope. When estimating the energy loads of a high-rise building, it becomes important to take into consideration the changing microclimate with height, and how this affects the materials of the building envelope, through heat exchange with the ambient air by
Abstract

This research paper, an abridged version of a white paper produced by the Chicago Chapter of the Council on Tall Buildings and Urban Habitat (CTBUH), reviews the potential impact of changes to the city's building code as it is adapted to the International Building Code standard. Its main objective is to uncover the effect of IBC loading standards on the structural designs of a range of taller buildings in Chicago that may utilize prescriptive code design methodology, to assess the cost implications of a change in loading standards, and to assess the effect of IBC's seismic loading requirements on representative local building projects.

Keywords: Chicago Building Code, International Building Code, Structural Engineering, Tall Buildings

Background

For many years, local design and construction industries understood there was a need to better align Chicago’s Building Code (CBC) with more modern codes and standards used throughout the US. Through collaboration with many departments within the City of Chicago, the Mayor's Office, and more than 150 volunteer technical experts and industry leaders, the Chicago Building Code was comprehensively revised in 2019. The revised structural requirements are based upon the International Building Code (IBC)—the modern national standard, while maintaining and introducing special Chicago-specific provisions.

As part of the new code adoption process, projects filed between 1 December 2019 and 1 August 2020 will have the option of using a design methodology based on the original (pre-2019) CBC or the new 2019 CBC, which references the 2018 IBC. After 1 August 2020, all new designs submitted for approval will need to conform to the new 2019 CBC.

Study Objective and Scope

Structural engineers familiar with the CBC and IBC recognize that design lateral forces developed by the two codes can vary significantly. Low-rise buildings may realize a reduction in wind loads with the IBC, but as a building gets taller and the exposure category increases (as specified by ASCE 7 Exposure Category B to D), wind loads can significantly increase. Additionally, the IBC requires that designs consider seismic loading, so heavier low-rise buildings may also see an increase in demand from new code loading.

The study presented in this paper attempts to answer the following questions:

• How does the IBC loading affect the structural designs of a range of taller buildings in Chicago that may utilize prescriptive code design methodology?
• How significant is the impact to structural cost?
• How does seismic loading impact these sample building designs?

In order to gain insight into these questions, three prototype buildings were analyzed and designed according to both CBC and IBC. The prototype buildings considered do not represent the full range of Chicago’s building stock, but are representative of the building types that are less than 400 feet (122 meters) tall, and as a result can utilize prescriptive code provisions for design (i.e., no wind tunnel testing). Additionally, a low-rise reinforced concrete office building is also considered for study, since short and heavier buildings are more susceptible to seismic loading.
The three prototype buildings examined as part of this research paper are shown in figures 1 and 2 and a detailed description of each is provided below.

Prototype Building 1

Prototype Building 1 is a residential tower with a 15-foot, 8-inch (4.8-meter) ground floor lobby and 36 floors at a 10-foot, 8-inch (3.3-meter) floor-to-floor height. The building roof has an elevation of 399 feet, 8 inches (121.8 meters) (see Figure 1), just below the 400-foot (121.9-meter) threshold requirement for wind tunnel testing per IBC. The floor plate is 100 feet (30.5 meters) square, with columns around the perimeter spaced at 30 feet (9.1 meters) on center (see Figure 2). Elevated floors are 8-inch (203-millimeter)-thick post-tensioned concrete slabs. The lateral system consists of a concrete bearing shear wall core with dimensions of 44 feet, 9 inches (13.6 meters) and 30 feet (9.1 meters). The core has web walls at the elevator and stairs that are 10 inches (254 millimeters) thick and are included in the analysis model. Concrete link beams at the core wall door openings are 29 inches (737 millimeters) deep and match the thickness of the shear walls. This corresponds to a door opening height of 8 feet, 3 inches (2,514 millimeters). Widths used for the door rough openings are 4 feet (1,219 millimeters) for single doors, and 8 feet (2,438 millimeters) for double doors.

Prototype Building 2

Prototype Building 2 is an office building with a 20-foot (6.1-meter)-high ground floor lobby and 19 floors at a 14-foot (4.3-meter) floor-to-floor height. The building roof has an elevation of 286 feet (87.2 meters) (see Figure 1). An exterior windscreen extends an additional 14 feet (4.3 meters) forming a mechanical penthouse for a total building height of 300 feet (91.4 meters) above grade.

The floor plate is 180 feet by 130 feet (54.9 meters by 39.6 meters). Columns are spaced on a 30-foot (9.1-meter) grid in the longitudinal direction with 45-foot (13.7-meter) lease spans on each side of an interior 40-foot (12.2-meter) bay (see Figure 2). The floor system consists of 3-1/4-inch (83-millimeter) lightweight concrete on a 3-inch (76.20-millimeter) metal deck supported by structural steel infill framing at 15 feet (4.6 meters) on center. The lateral system consists of a concrete bearing shear-wall two-bay core, centered in the building with overall dimensions of 60 by 40 feet (18.3 by 12.2 meters). Concrete link beams at the core wall door openings are 36 inches (914 millimeters) deep and match the thickness of the shear walls. This corresponds to a door rough opening height of 11 feet (3,353 millimeters). Widths used for the door rough openings are 8 feet (2,438 millimeters).

Prototype Building 3

Prototype Building 3 is an office building with a 20-foot- (6.1-meter)-high ground floor lobby and 9 floors at a 14-foot (4.3-meter) floor-to-floor height. The building roof has an elevation of 146 feet (44.5 meters) (see Figure 1). The Chicago Wind Climate model suggests that wind loading from the easterly winds is expected to be significantly lower than prevailing strong winds from south and west.

The Chicago Wind Climate model suggests that wind loading from the easterly winds is expected to be significantly lower than prevailing strong winds from south and west.
In this paper, innovations in the constituent disciplines that bring tall buildings to life, and even extend their lives—architecture, construction, renovation, the engineering of façades, fire & risk, geotechnical engineering, interior space, MEP, and structural engineering—are all explored. By diving into such details, a comprehensive portrait of the tall building world emerges, and a number of trends, some summarized below, come into focus. Here, we gather together the projects that are most representative of the dominant trends in, as well as the highest aspirations achieved by the tall building industry in 2020.

Urban Allure

New design-forward residential projects are cropping up on dense urban corners all over the world, some of them in neighborhoods in major cities not typically known for their domestic offerings. But as demand for uncompromising homes in downtown cores continues to gather momentum, giving the “suburban ideal” a run for its money, these projects boast lavish amenities, impeccably designed interiors, and sculptural, evocative morphology.

In Miami’s downtown, long known for its arts, shopping and dining, One Thousand Museum (Best Tall Building, 200–299 meters) dubbed the “Scorpion Tower” due to its exterior bracing that resembles an arthropod, makes a splash on the residential market with its futuristic façade.

The striking silhouette of OMNITURM (Best Tall Building, 100–199 meters) brings new life to a cluster of corporate headquarters in downtown Frankfurt. The slender and rationally stacked tower is interrupted by sculptural shift in its mid section, where its program changes to residential. The floor
plates slide out in a spiralling movement, creating terraces and overhangs for enhanced city living.

A layered building skin with solar refracting properties adds visual intrigue to ARO (Best Tall Building, 200–299 meters), a slender, residential tower in New York City’s theater district. The building’s unconventional shaping distributes unit size, mix, and program from top to bottom, as well as providing a generous suite of amenities.

Making Way

As urban environments continue to densify, finding spacious, undeveloped sites on which to build new vertical projects becomes increasingly challenging without costly demolitions that produce disruption and debris. Then there is the matter of pre-existing infrastructure or heritage projects that are an indelible part of the neighborhood, both of which may require innovative workarounds, resulting in the slotting of complex projects into compact sites.

This is exemplified in dense Asian cities like Tokyo, where projects such as DaiyaGate Ikebukuro (Structural Engineering), creatively use unconventional spaces. By hovering over the tracks of the Seibu line, it provides a connection between two sections of the busy Ikebukuro Station, helping to consolidate busy commuter flows for a more streamlined experience, and stitching together two sides of a divided neighborhood. Space is also particularly tight in China’s capital city, where the soaring, full-height atrium of Leeza SOHO (Best Tall Building, 200–299 meters) unites the tower’s two volumes, split diagonally by a new underground rail line.

In one of Melbourne’s historic precincts, 271 Spring Street (Best Tall Building, under 100 meters) deftly navigates around a bevy of site-specific challenges on its already limited plot—underground rail loop tunnels through the center of the site, an electricity sub-station, two high-voltage easements, two preserved buildings, and an archeological overlay—to build a new, cantilevered office tower with façade screen elements that reinterpret the heritage roof geometry below.

In another example of turning spatial quandaries into remarkable designs, Shanghai’s InterContinental Shanghai Wonderland Hotel (Fire & Risk Engineering) didn’t have to contend with existing rail or utility lines; in fact it had a quite particular problem: building into the side of quarry on the outskirts of the city gave it a completely blank slate, except for the pockmarked canyon it had to transform into a resort. But transform it did, using the quirks of the quarry to give the hotel a distinctive setting. Further, it confronted a huge and nearly unprecedented obstacle to evacuation, literally turning “upside down” most of the conventions of tall building egress.

In some cases, making way might mean finding a method for removing defunct infrastructure that is inhibiting useful
CTBUH Research Report

The Tallest 20 in 2020: Then and Now

Abstract
This research paper undertakes a review of the 2012 report by the Council on Tall Buildings and Urban Habitat, “Tallest 20 in 2020: Entering the Era of the Megatall,” assessing the accuracy of the predictions made at that time against the reality of the present day. It reviews the development trajectory of CTBUH’s 2012 predicted and unanticipated 20 tallest buildings in the world in the year 2020, and places the results in regional, industry and historical context.

Keywords: Development, Economics, World’s Tallest Building

In 2012, the CTBUH Journal published a research paper titled “Tallest 20 in 2020: Era of the Megatall—The Projected World’s Tallest 20 Skyscrapers in the Year 2020.” Though it was only eight years ago, the pace of change in the tall building world at the time was such that 2020 seemed like a distant lodestar in the future. The future, of course, has the inconvenient habit of appearing in the present far too early for the comfort of most. Today, the CTBUH Research and Editorial teams review the projections we made in 2012, the assumptions that guided them, and the roller-coaster reality of what has come hence.

Prediction 1
“By 2020, we can expect that at least eight megatall buildings (of 600 meters’ or greater height) will exist worldwide.”

Reality
In the second quarter of 2020, there are three megatall buildings in existence. These are the Burj Khalifa, Dubai (828 meters); Shanghai Tower, Shanghai (632 meters); and Makkah Royal Clock Tower Hotel (601 meters), Mecca (CTBUH Skyscraper Center 2020).

What Happened?
Five of the eight megatall buildings projected in 2012 to complete by 2020 did not achieve that goal. Here are their stories:

Wuhan Greenland Center, Wuhan
• Predicted 2020 rank in 2012: 7 (606 m)
• Actual rank in 2020: n/a (476 m)*

The Wuhan Greenland Center had been intended to be a “megatall” at 606 meters (left) but was cut down by aviation authorities, to 476 meters (right). © AS+GG (left); Baycrest (cc by-sa) (right)

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* Workers from the site until the dispute could be settled (Sun 2019).

Jeddah Tower, Jeddah
• Predicted 2020 rank in 2012: 1 (828 m)
• Actual rank in 2020: n/a

Jeddah Tower, which began construction in 2013 and was then called Kingdom Tower, has experienced numerous delays and remains under construction in 2020. News reports peg a “topping out” by the end of 2020, but it is unclear when completion may finally happen (Gibbon 2020). If it were completed now, and for some time in the foreseeable future, it would become the World’s Tallest Building at more than...
1,000 meters (the exact height figure remains undisclosed).

**Seoul Light DMC Tower, Seoul**
- Predicted 2020 rank in 2012: 4 (640 m)
- Actual rank in 2020: n/a

The predicted world's fourth-tallest building in 2020 was expected to reach 640 meters. In 2012, the contractor that had intended to construct the building failed to pay for the land plot, and the project was scrapped (Bae 2015). Discussions have been ongoing since 2015 to restart the project, potentially with a shorter tower (Kim 2018).

**Signature Tower, Jakarta**
- Predicted 2020 rank in 2012: 4 (638 m)
- Actual rank in 2020: n/a*

The Signature Tower in Jakarta, proposed in 2009, at 638 meters, was anticipated in 2012 to become the world's fifth-tallest building by 2020. However, multiple design changes and failed geotechnical/hydrological tests caused the first round of delays (Alexander 2014). The project eventually received design approval from local authorities in 2015, and approval for construction in 2017 (Alexander 2015a, 2015b; Freycinetia & Puspa 2017). However, it was still short some US$1.7 billion in funding, and remains stalled (Dwijayanto 2018).

This is not to imply that the road had been smooth for the three megatalls that did complete, however—or for that matter, for practically any of the buildings on the 2020 World's Tallest List, then or now.

**Burj Khalifa, Dubai**
- Predicted 2020 rank in 2012: 2 (828 m)
- Actual rank in 2020: 1 (828 m)

The Burj Khalifa, completed in 2010, became the World’s Tallest Building at that time and retains the title today. Its iconic status has driven much development around its periphery, delivering value above and beyond the building itself. Its grand opening was in January 2010, which coincided with a name change from "Burj Dubai" after Sheik Khalifa bin Zayed al-Nahyan provided financial assistance to finish the project (Thomas 2010). It was declared the World’s Tallest Building by the Council in March 2010 (CTBUH 2010).

**Ping An Finance Center, Shenzhen**
- Predicted 2020 rank in 2012: 3 (660 m)
- Actual rank in 2020: 4 (599 m)

Like its cousin in Wuhan, Ping An Finance Center received a “haircut” due to aviation restrictions being imposed after the buildings had been designed. The office building was originally intended to reach 660 meters by way of a spire at its top (see Figure 2). During the design process, local aviation authorities, concerned that a building of that height might impede the range of potential flight paths in and out of Shenzhen Bao’an International Airport, restricted its height to 600 meters, maximum. The redesign completed the building’s architectural expression with a pyramidal crown, bringing its final height to 599 meters—and thus removing the classification of “megatall.”

**Shanghai Tower, Shanghai**
- Predicted 2020 rank in 2012: 6 (632 m)
- Actual rank in 2020: 2 (632 m)

While Shanghai Tower didn’t break ground until 29 November 2008, plans for a tower on the Lujiazui financial district site emerged as early as 1993, with a group of three towers; Jin Mao Tower (1999) and Shanghai World Financial Center (SWFC) (2008) comprising the two “sisters” of a “three sisters” tower plan. Shanghai Tower completed in 2015, but had

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* Buildings must be fully clad and ready for occupancy in order to qualify as “complete” by CTBUH criteria, and to be officially entered into height rankings.
In the first edition of the 2012 Journal, CTBUH published a Tall Buildings in Numbers study titled *Tallest 20 in 2020: Era of the Megatall—The Projected World’s Tallest 20 Skyscrapers in the Year 2020*. Now that we have arrived at the second edition of 2020, we look back on the fates of each of the buildings predicted to be the tallest in existence this year—and those that actually did make the list. This report serves as a companion to the research paper beginning on page 44, which provides more background. *For an interactive version, and a link to the original article, visit skyscrapercenter.com/tallest-in-2020.*

### The 20 Tallest Buildings in 2020

In this graphic, the 20 tallest buildings in 2020 are shown in the foreground, while the skyline that was originally predicted in 2012 is shown in gray in the background.

Three of the 20 buildings on the original 2012 list were not completed as planned, due in part to aviation restrictions after the projects had already begun. If each building had been constructed in sequence, the Tallest 20 in 2020 would have taken 126 years to complete.

The *Burj Khalifa* began life as the “Grollo Tower”—a 1990s development concept, originally proposed for Melbourne, Australia.
What Happened to the 2012 Predicted Tallest 20 Skyline?

While the timeline below shows the progress of each building between 2012 and 2020, some buildings completed prior to 2012.

In 2012, South Korea was predicted to have three of the world's tallest buildings by 2020. Instead it has only one—but Lotte World Tower, Seoul, is the world's fifth-tallest building.

The Goldin Finance 117 tower was modeled after a walking stick.

The sum of heights of the actual 20 Tallest Buildings in 2020 is 10,452 meters, compared to 11,953 for the 2012 projection.
How did your firm become interested and involved in architecture around flying taxis and drones?

We started looking at that many years ago. We did a building in Dubai in the early 2000s, and placed some landing structures on it without thinking too much about it. But then, in 2016, we did the first “apartment of the future.” For that project, we not only had flying taxis or electric vertical-takeoff-and-landing vehicles (eVTOLs), but also drone deliveries. We thought, “how would it change tall buildings when drones start delivering packages?” We had already started to see the impact of the huge growth of package deliveries in our projects, which would typically have a small storage space inside the leasing area, that were becoming overwhelmed daily due to volume growth of about 1 percent per month. These were conventional truck deliveries, of course, but then we saw that Amazon and others were developing drone delivery, and realized this was something we needed to look into.

So, in 2016 we started planning for it. In 2018, we did the apartment building Pier 2 in New York as a speculation, and it had the landing pads and everything else more sorted out (see Figure 1). Both manned flying vehicles and drone deliveries were taken into account. We thought, “how would it change tall buildings when drones start delivering packages?” We had already started to see the impact of the huge growth of package deliveries in our projects, which would typically have a small storage space inside the leasing area, that were becoming overwhelmed daily due to volume growth of about 1 percent per month. These were conventional truck deliveries, of course, but then we saw that Amazon and others were developing drone delivery, and realized this was something we needed to look into.

Is this entirely speculative, or are you hearing from your client base that they want to have high-rises developed that incorporate provisions for VTOL vehicles and drones?

I think there’s a lot of curiosity and people are asking about it. Most people I talk to seem skeptical about the whole thing, and they don’t realize that it’s something that’s going to happen.
to hit us in the next 10 to 15 years. We have not built any building yet with landing capabilities for drones in the sense that Uber is planning on doing. We have heliports, and similar structures, but there are still a lot of issues to overcome before developers start planning to have them in their buildings. Everybody’s asking about them, but they’re not building them. There’s a lot of “waiting and seeing.”

Does that have more to do with the flying technology or the buildings?
The technology, for the most part, is there already. The biggest issue is regulation, which one of the biggest hurdles to these machines becoming an everyday part of your life. Regulating these vehicles is a very complex issue that falls under the jurisdiction of several agencies—and rightly so; safety is priority number one. The other issue is affordability. The dollars per mile are coming down every year, but they’re still noncompetitive at this point. Drone deliveries are strictly regulated, and we have provided landing pads for them in some cases, but that is not as cost-intensive as building a platform that can handle 150 flights an hour, and not only that—it also needs to move several hundred people an hour through a building and connect to all other urban mobility systems, including traditional modes.

So, there are drones delivering packages to your buildings, but not people?
Correct. While drones delivering people will take a few more years to become a reality, package delivery via either surface or air is already here. There are several companies working on this, including UPS, Wing (an offshoot of Google’s parent company Alphabet), Amazon, and Uber. Some of them have recently received clearance from the Federal Aviation Administration (FAA) in certain parts of the United States.

There is more difficulty around carrying passengers to and from tall buildings. Safety and regulations are prime concerns, but cost is an issue as well. These vehicles that are being developed right now have the capacity for four or five passengers. If you add the cost of a pilot to operate the vehicle, then the cost goes up exponentially, through the roof. At this point, the population isn’t ready yet for flying in an electrically powered, automatically piloted vehicle. Public acceptance is not there yet. It might be a few years before people get into one of those.

Initially, in the first few years we will see eVTOLs that are flown by highly trained pilots, transporting four or five people, which is outrageous in terms of cost. This is compounded by the fact that there is already a pilot shortage in the aviation industry, certifications need to be issued, and coordination with air traffic control needs to be undertaken.

And it is more complicated to design for the newer vehicles than with traditional helicopters and helipads, because the current battery endurance for eVTOLs is not where we would like it to be. They have to be recharged fairly frequently. It’s not like you can charge an eVTOL and take it out in the morning and fly the whole day—they hold a charge for less than an hour on average. Essentially this means you have to charge every time you land. You have to have one platform for charging and another for active takeoffs and landings.

On the autonomous side, you have the issue of cyber security and the threat of someone taking control of these vehicles, of which thousands could be flying through the city’s airspace. The technology for unmanned flying vehicles is ready—it’s just everything else around it that’s not. So, yes, packages are starting to be delivered by drones, but not people, just yet.

What are the accommodations you have made for package deliveries? Are there specialized trays or landing pavilions for drones?
The answer varies depending on building types, but essentially, they all have a few things in common. They all need to handle everything from traditional online packages, to groceries and dry cleaning on a daily basis. We start by providing a drone landing pad, meeting certain regulations regarding clearances, etc. This could be on-grade or high up on the building. In tall buildings,
About the Council

The Council on Tall Buildings and Urban Habitat (CTBUH) is the world’s leading resource for professionals focused on the inception, design, construction, and operation of tall buildings and future cities. Founded in 1969 and headquartered at Chicago’s historic Monroe Building, the CTBUH is a not-for-profit organization with an Asia Headquarters office at Tongji University, Shanghai, a Research Office at Iuav University, Venice, Italy, and an Academic Office at the Illinois Institute of Technology, Chicago. CTBUH facilitates the exchange of the latest knowledge available on tall buildings around the world through publications, research, events, working groups, web resources, and its extensive network of international representatives. The Council’s research department is spearheading the investigation of the next generation of tall buildings by aiding original research on sustainability and key development issues. The Council's free database on tall buildings, The Skyscraper Center, is updated daily with detailed information, images, data, and news. The CTBUH also developed the international standards for measuring tall building height and is recognized as the arbiter for bestowing such designations as “The World’s Tallest Building.”