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## **Case Study: European Central Bank, Frankfurt**

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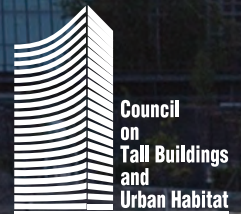
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# Case Study: ECB – European Central Bank, Frankfurt

## Two Towers, One Market



Wolf D. Prix

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### Wolf D. Prix

Wolf D. Prix, is co-founder, Design Principal and CEO of COOP HIMMELB(L)AU. He is counted among the originators of the Deconstructivist architecture movement. COOP HIMMELB(L)AU had its international breakthrough with the invitation to the exhibition *Deconstructivist Architecture* at MoMA New York in 1988. Over the years Prix and COOP HIMMELB(L)AU have received numerous international architecture awards, including the Great Austrian State Award and the Austrian Decoration of Honor for Science and Art. He is a permanent member of the Austrian Art Senate and the European Academy of Sciences and Arts, as well as chairman of the Curia for Art since autumn 2014. Two universities have conferred him the Doctorate Honoris Causa: the Universidad de Palermo, Buenos Aires, (2001) and the "Ion Mincu" University of Architecture and Urbanism, Romania (2014).

The design of the new European Central Bank (ECB) in Frankfurt combines a twisted double tower, which rises to 185 meters, integrated with the horizontal structure of the landmarked 1928 Grossmarkthalle, formerly the city's main wholesale market. United by an entrance building, these two elements form an ensemble of special architectural significance. Featuring bridges, pathways and platforms, the glass atrium between the two high-rises creates a vertical city that represents the ambitions of a united Europe.

### Design Concept: The Hyperboloid Cut

From the beginning, it was an explicit part of the brief from ECB to create a unique, iconic building as a symbol for the European Union. The designers felt such a goal could only be achieved by way of a completely different kind of geometry. The architectural concept of the ECB, therefore, is to vertically divide a monolithic block through a hyperboloid cut, wedge it apart, twist it, and fill the newly created intermediary space with several glass atriums (see Figure 1). The result is a very complex geometry, and a multifaceted building offering a completely different appearance from each angle: massive and powerful from the southeast (see Figure 2), slender and dynamic from the west (see Figure 3).

### The Office Towers

The two towers house the vast majority of nearly 2,900 workstations at the new premises, as well as internal meeting rooms. The large council meeting room and the offices of members of the ECB's decision-making bodies are located on the upper office floors. All floors offer a high level of flexibility, to allow for a variety of office configurations, from single offices to larger offices that can accommodate 10 to 12 people. The offices are located along the outer façades of the towers, and on every floor there is a kitchenette and communal area.

### The Principle of the "Vertical City"

The concept behind the glazed atrium between the two office towers is one of a "vertical city," with interchange platforms and bridges creating the impression of urban streets and squares. The exceptional atrium and

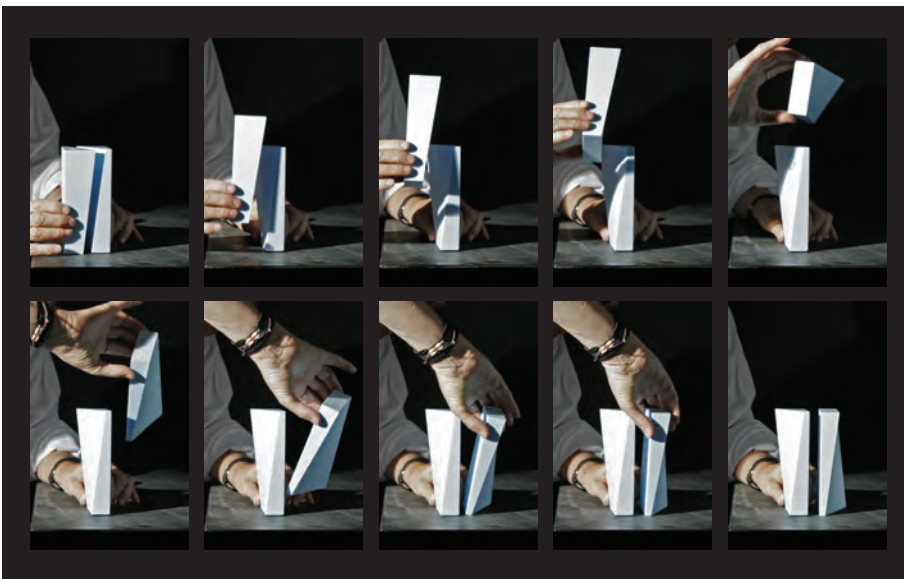


Figure 1. ECB design concept study.



Figure 2. View from the southeast. © Paul Raftery



visible steel support structure place the ECB building within an entirely new typology of skyscrapers. The interchange platforms enable people to change from the express elevators to the local elevators. They can be reached via sets of stairs leading from the respective floors above and below, making it easy for staff to move between the two towers and communicate with each other informally.

The connecting and transitioning levels divide the atrium horizontally into three sections with heights from 45 to 60 meters (see Figures 4 and 5). This is where all vertical entry points are joined – and just like public squares, they invite visitors to communicate. The planned “hanging gardens” will ensure a pleasant room climate, while elevators and stairs connect these places with the offices and communication areas of the Grossmarkthalle.

#### The Grossmarkthalle as “Urban Foyer”

The semi-public and communicative functions are located in the former Grossmarkthalle. In addition to fulfilling numerous functional and technical requirements, the architects were required to retain the fundamental appearance of the Grossmarkthalle, a listed building, and incorporate it into their designs for the new ECB premises. The existing landmark Grossmarkthalle, a former wholesale market from the 1920s, is used as an “urban foyer.” The conference and visitor’s center, library, and employee cafeteria are placed diagonally in the spacious interior of the hall as independent building structures (executing a “house within a house” concept) (see Figure 6).

#### The Entrance Building

A floating entrance building penetrates the hall structure from the outside, creating an aesthetic and functional link between the office tower and the Grossmarkthalle. With its asymmetrical contours, slanted façades, and generous windows, it marks the representative access to the ECB from the north of the site. The lobby, two-story press conference room, and a lecture room are located here. The press center is accessible via its own lobby, above



Figure 3. European Central Bank – overall view. © Paul Raftery

“The concept behind the glazed atrium between the two office towers is one of a “vertical city,” with interchange platforms and bridges creating the impression of urban streets and squares.”



Figure 4. View looking up central atrium.

which there are temporary workstations for journalists. There is also a second auditorium next to the large press conference room. The so-called “loop” – a glass walkway between the high-rise and the market hall – completes the ensemble.

The location of the entrance building in the Grossmarkthalle was determined on the basis of the original substance of the roof shells that defined the marketplace’s architecture. During the 1950s, five of the 15 roof shells were rebuilt using the traditional rib construction method. As their structural framework thus differed from that of the original roof shells, the historic preservation authorities agreed to the removal of these shells and structural frameworks to make way for the entrance building.

### The Sustainable Energy Concept

Energy efficiency and sustainability issues were important considerations during the architectural design competition, and at all stages of the evaluation procedure, as well as during the planning phases.

The energy design of the ECB optimizes the energy performance to 30% below the German energy-saving directive. To achieve this aim, various possibilities were analyzed, particularly with regard to the façades and technical systems. The energy concept includes the following measures: utilization of rain water, heat recovery, efficient insulation, solar protection, and daylighting, as well as natural ventilation for the offices (see Figures 7 and 8). Some areas, such as the atrium and open zones of the Grossmarkthalle, are not equipped with an air-conditioning system; instead they serve as buffer zones between the interior and exterior climates. The “shield hybrid façade” of the office towers consists of three layers and offers a direct and natural ventilation of the offices via vertical, room-high ventilation elements.

The outstanding energy-conserving features are:

- **Efficient insulation** – the insulation of the surface areas of the Grossmarkthalle, e.g., the roof and windows, has been improved. Furthermore, the new facilities, such as the staff restaurant and conference area, have been built into the market

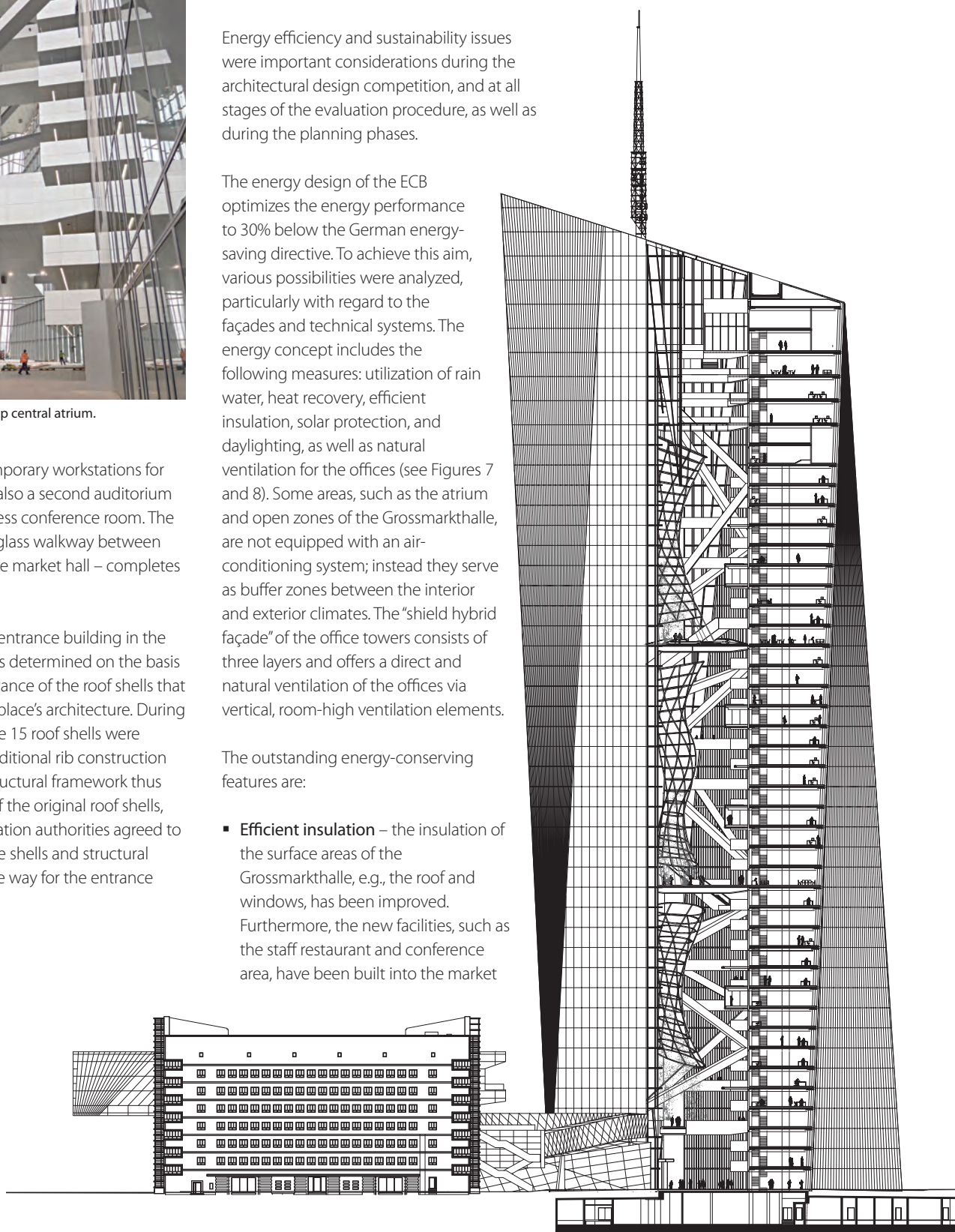


Figure 5. Section drawing showing the atrium between the office towers, which reinforces the “vertical city” concept.



hall as separate “house-in-house” elements, with their own internal façades. Consequently, they have their own microclimates.

- **Energy-efficient triple-glazed façade** – the high-rise façade combines commonly available but high-quality façade elements in order to ensure an outstanding energy-conserving skin for the buildings, which can also be reliably replaced.
- **Natural ventilation of offices** – in addition to the central ventilation systems, motorized ventilation elements have been incorporated into the building façades, which allow the direct natural ventilation of offices, thereby satisfying users’ desires for fresh air without the use of mechanical ventilation. As a result, people also have a better idea of the weather outside.
- **High-efficiency sun shading** – in order to prevent the buildings from absorbing too much heat from the sun, highly efficient sun screens/glare shields have been integrated into the façades.
- **Recycled heat** – the waste heat generated by the complex’s computer center is fed back into a ceiling heating system in order to heat the offices. The new ECB premises are connected to the highly energy-efficient combined heat and power system of the City of Frankfurt.
- **Geothermal energy for heating and cooling** – in order to further reduce energy costs, geothermal loops were incorporated into the pile foundations of the high-rise, which descend about 30 meters until they hit Frankfurt’s bedrock. These loops can be connected to a water circuit and heating pumps in the heating center, in order to extract heat from the ground in the winter and cool air in the summer.

### Structural frameworks

The overall structural framework of the office tower consists of reinforced concrete in the two towers and a vertical steel frame in the

“The tower façades consist of flat glass panels, 90% of which are identical. Each one runs the entire height of each story, so that only the vertical fittings are visible. The result is a homogeneous curved glass surface made up of flat panels.”



Figure 6. The Grossmarkthalle. © Paul Raftery

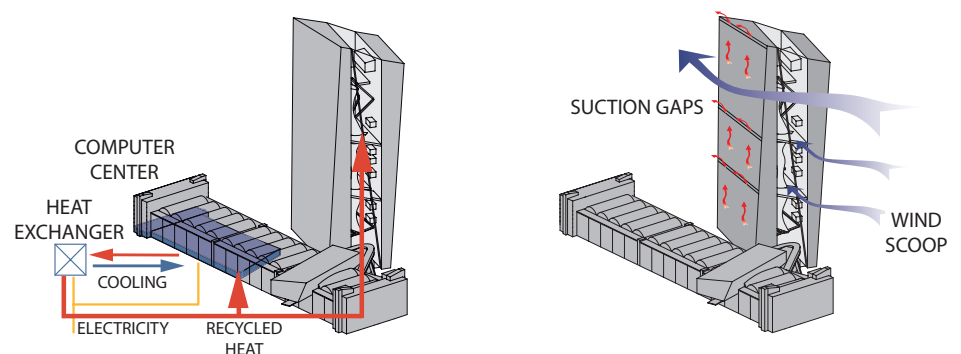


Figure 7. Energy and environmental concepts.

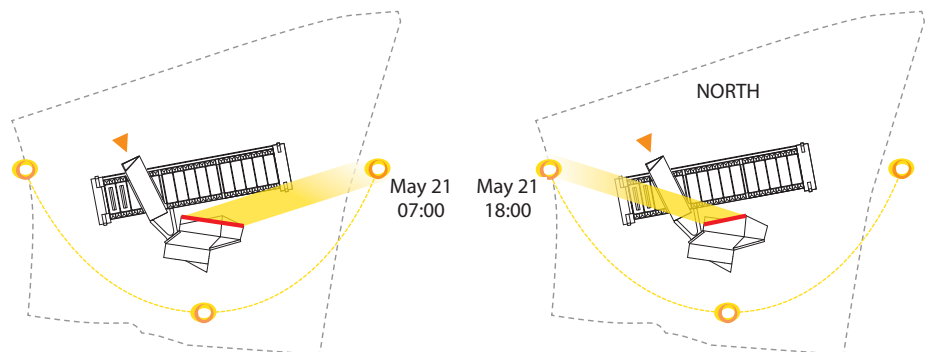


Figure 8. Solar exposure and illumination study.



Figure 9. The atrium forms a dramatic unified space between the two towers. © European Central Bank/Robert Metsch



Figure 11. The office towers use a "shield hybrid façade" for energy efficiency and occupant comfort. © European Central Bank/Robert Metsch

atrium between them. Aside from the twisting of the high-rise and the torsion of its façades, the appearance of this steel frame is a defining element of the office tower's structure. The entrance building and the "house-in-house" building elements in the Grossmarkthalle are steel-framed structures.

The structural framework of the atrium is a feature of its overall design. It consists of clearly visible, angled steel trusses that stabilize the two towers and accentuate the open spaces of the atrium, which are up to 60

meters high in some places. The atrium also has four interchange platforms, which, in addition to serving as communal areas and informal meeting points, serve as structural support for the two towers. The combination of diagonal steel trusses and interchange platforms creates a vertical framework (see Figure 9).

The elevator cores immediately adjacent to the atrium function as bracing elements. This enables the floor space on the office floors to be used efficiently. All of the elevators face the

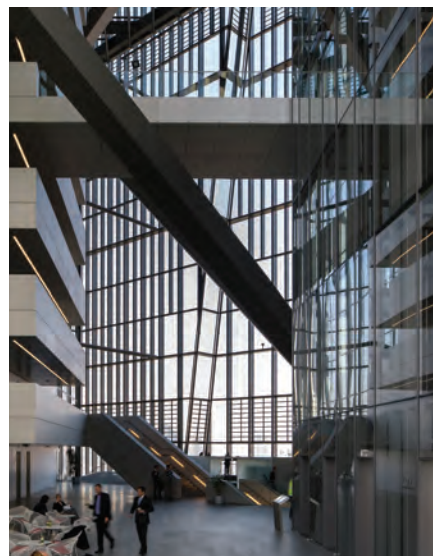


Figure 10. The ECB's elevators face the atrium, energizing the large void, orienting passengers and saving office floor space.

atrium, the open space and views to the outside, making it easy for people to work out where they are and where they have to go when they exit (see Figure 10).

The conference area has been integrated into the Grossmarkthalle using an external steel skeleton framework on the basis of the "house-in-house" concept. The angled supports and joists of the framework surround the meeting rooms in the conference area. Based on the design, this large structural framework also displays kinks and distortions that make the existing building system a design feature of the new building elements. In keeping with the conference area in the Grossmarkthalle, the entrance building is a reinforced concrete/steel-frame composite structure, which projects outwards and upwards from the Grossmarkthalle and houses the press center. It consists of a lattice of steel trusses more than one meter in height each, thus defining the visual appearance of the new premises at the main entrance. As in the conference area, the ceilings consist of reinforced concrete. The steel skeleton of the entrance building is covered with aluminum sheets, and therefore hidden from view.

## Façades

The office tower is covered entirely with glass





Figure 12. Atrium façade. © Paul Raftery

panels, creating a dynamic interplay between light and shadow at any time of the day. The kinks and torsion of its glass façades mean that the light of the sun and reflections of cloud patterns are always different. A combination of different geometries makes the office tower look like a large crystal, with oblique western and eastern façades, and hyperbolic paraboloid surfaces on the northern and southern façades. For reasons of cost efficiency, it was important to ensure that the hyperbolic paraboloid surface could be produced through two sets of straight lines. It is this principle that formed the basis for the design of the façade for the high-rise.

The tower façades consist of flat glass panels, 90% of which are identical. Each one runs the entire height of each story, so that only the vertical fittings are visible. The result is a homogeneous curved glass surface made up of flat panels (see Figure 11). These surfaces have been covered with a state-of-the-art, triple-layered “shield hybrid façade,” which is a refined synthesis of classic façade constructions, combining the functions of box windows, double-glazed windows, and double façades. Aluminum blinds have been fitted between the two panes of glass to enhance the level of solar protection.

There is air conditioning in the offices, but there is also the possibility of natural ventilation through the use of a novel



Figure 13. Entrance building. © European Central Bank/Robert Metsch

opening mechanism, whereby the slats move out horizontally from their frames. This mechanism is “hidden” behind the outer façade and supplies the offices with fresh air through the gaps that it creates. If the ventilation slats are open, the air conditioning in the offices automatically shuts down in order to conserve energy. The opening mechanisms are motor-driven and allow users to control the width of the ventilation gaps.

The glass panels of the façade of the atrium are attached to a customized steel grid that is strong enough to bear the weight of the glass panels along the full height of the atrium, and is therefore clearly visible through them. In line with the design concept, the glazing of the atrium is neutral in color and transparent. This enables people to see straight through the atrium and view the high-rise as two separate towers. The roof of the atrium is also made of glass in order to further enhance the impression of a translucent atrium. Owing to the carefully thought-out placing of the coating on the glass and the various layers of solar protection, it absorbs less than 10% of the energy from the sun, though the sky can still be seen through it (see Figure 12).

The entrance building is covered predominantly with aluminum sheets that create an intricate lattice of narrow seams and distinguish it clearly from the Grossmarkthalle. The façade of the end of the entrance

building that projects out of the Grossmarkthalle towards Sonnemannstrasse is curved in two directions, which, in contrast to the façade of the office tower, was not produced using flat glass panels, but rather using panels with a shell-shaped curvature. The press conference room is located behind this large panoramic window. The façade of the entrance area underneath the press conference room is largely composed of glass panels, as is the walkway to the high-rise (see Figure 13).

### Urban Construction and Architecture

The ECB’s architecture was carefully attuned to its location in Frankfurt’s Ostend district. With its clear orientation toward the urban perspectives, the ensemble enters a dialogue with Frankfurt’s most important reference points: the Alte Oper, the Museum Embankment, and the skyline of the financial district. The distinctive double tower can be seen from all of the important places in Frankfurt’s city center and from the Main River, creating a strong point of reference for a second center on the east side of Frankfurt (see Figure 14). This corresponds to the principle of a polycentric city, which is much more dynamic than a monocentric city. Tension areas begin to emerge between the centers, in which new developments have been initiated.



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#### Conclusion

The design of the ECB headquarters is reflective of the tensions inherent in its location in time and place, and of its role in the governance of European economic policy. Though the concept of a united Europe remains strong, any astute observer will note that the history and present of Europe is not free from dynamic tensions between people and nations, economic priorities and the environment, press and government. Thus the building design is of a suitable complexity to reflect its constituency. This makes its unifying elements all the more profound, and its presence on the skyline that much more representative and optimistic.

#### Hessian Culture Prize

Wolf D. Prix, Principal of COOP HIMMELB(L)AU, received the prestigious Hessian Culture Prize for the design of the new premises of the European Central Bank in November 2013. Since 1982, this award has been given annually

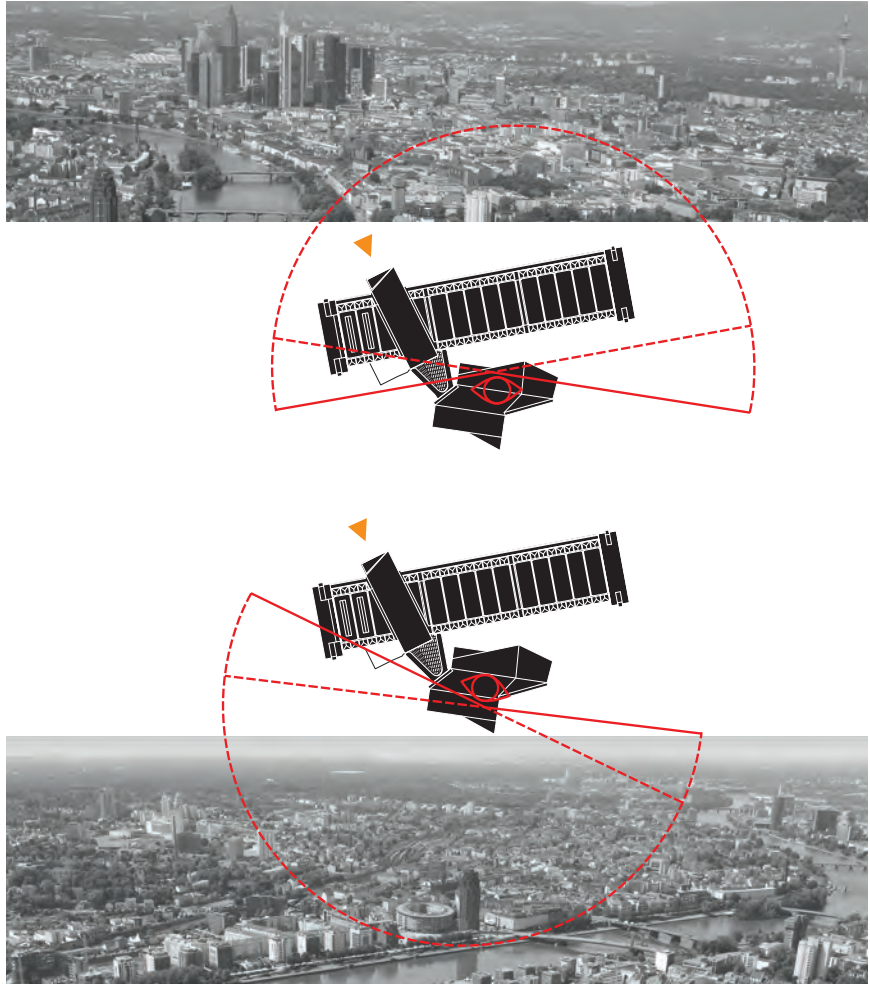


Figure 14. Office towers' view orientations.

for special accomplishments in the areas of art, science, and cultural mediation. “With the new premises of the European Central Bank, COOP HIMMELB(L)AU is creating a new, modern landmark for Frankfurt,” the eleven-member Board of Trustees said in a statement about the award. ■

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#### Project Data

**Completion Date:** November 2014

**Height:** 185 meters

**Stories:** 45

**Total Area:** 106,000 square meters

**Use:** Office

**Owner/Developer:** European Central Bank

**Architect:** COOP HIMMELB(L)AU (design)

**Structural Engineer:** Bollinger + Grohmann (design)

**MEP Engineer:** Arup (design); Ebert-Ingenieure Nürnberg (engineer of record)

**Project Manager:** Drees & Sommer Advanced Building

**Main Contractor:** Linder GmbH; Gartner Group; Seele; Spannverbund; Ed. Züblin AG

**Other Consultants:** ARGE Katzenbach (geotechnical); HHP-Süd Beratende Ingenieure GmbH, Ludwigshafen (fire); Jappsen Ingenieure GmbH, Oberwesel (vertical transportation); unit-design gmbH (way finding); Vogt Landschaft GmbH (landscape)