

Envisioning Ecological Cities

*Carlton Smith
Thesis Project*

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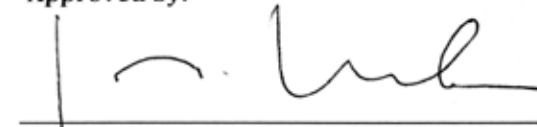
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Envisioning Ecological Cities

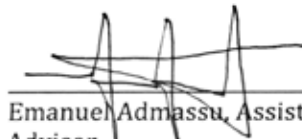
A thesis presented in partial fulfillment of the requirements for the degree Master of Architecture in the Department of Architecture of the Rhode Island School of Design, Providence, Rhode Island.

Carlton Smith
2017

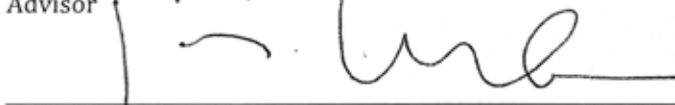
Approved by:



Jonathan Knowles, Professor, Department of Architecture, Primary Advisor



Emanuel Admassu, Assistant Professor, Department of Architecture, Secondary Advisor



Jonathan Knowles, Department of Architecture, Thesis Coordinator

Thin Cities

If you choose to believe me, good. Now I will tell how Octavia, the spider-web city, is made. There is a precipice between two crests with ropes and chains and catwalks. You walk on the little wooden ties, careful not to set your foot in the open spaces, or you cling to the hempen strands. Below this is nothing for hundreds and hundreds of feet: a few clouds glide past; futher down you can glimspe the chasm's bed.

This is the foundation of the city: a net which serves as passage and as support. All the rest, instead of rising up, is hung below; rope ladders, hammocks, house made like sacks, clothes hangers, terraces like gondolas, skins of water gas jets, spits, baskets on strings, dumb-waiters, showers, trapezes and rings for children's games, cable cars, chandelier, pots with trailing plants.

Suspended over the abyss, the life of Octavia's inhabitants is less uncertain than in other cities. They know the net will last only so long.

*Invisible Cities p.75
Italo Calvino*

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Abstract

Our cities are recognized as centers for jobs, entertainment and production; as icons of human innovation. However, they are also recognized as for their consumption. Being that our cities are mechanisms of consumption, they rely on imported resources such as food, water, energy and labor in order to continue to thrive. Though this relationship has fostered technological and mechanical growth, it has also been degrading the natural ecological processes that we rely on to survive. As our understanding of our relationship to the environment deepens, there is a growing push for architecture that embodies an attention to its connections to the environment.

Programs like LEED certification- the national standard for the evaluation of sustainable buildings- engage with how a building operates, its method of construction and its material properties. Though important, these concerns are limited in aspects that do not consider an architecture as a solidary object. In his essay, "The Three Ecologies," Felix Guattari explains that in order to properly address environmental concerns, we have to dissect both the tangible and non-tangible conditions in which they have developed. He states, "The only true response to the ecological crisis is on a global scale, provided that it brings about an authentic political, social and cultural revolution, reshaping the objectives of the production of material and immaterial assets. Therefore this revolution must not be exclusively concerned with visible relations of force on a grand scale, but will also take into account molecular domains of sensibility, intelligence and desire."(pg.28) Architecture has the capacity to embody critical issues of geographical context, social implications, historical contingencies and political agendas. Rather than considering an architecture simply as a vessel, a re-evaluation of systematic parts in which take engages with can broaden our understanding an architecture as component contributing to the systems intertwined

Thesis Statement

Our current methods of generating resources that sustain our cities are outdated and inefficient. Resources like electricity, water and food are constantly being harvested and transported over countless miles to meet the demands of our growing cities. Though these methods have been successful at meeting those demands, a growing concern for the environment have brought these methods under question. Environmental issues of pollution, waste, carbon emissions can be traced back to the ways in which we generate resources for densely populated areas. Programs like LEED certification have responded to this concern by addressing energy efficiency, material use and deconstruction. However, this program operates at a scale that considers an architecture as an object rather than the systems in which this object “plugs” into. For my thesis, I am rethinking the methods in which we generate and distribute resources to our cities. I aim to create a series of architectural structures that capitalize on phenomenon that are unique to the urban environment and extends past the notion of considering an architecture as a solitary object.



Discovery

My thesis began with several questions:

What is the difference between the natural environment and the urban environment?

What does it mean for an architecture to be sustainable?

How does architecture bridge the gap between these contrasting environments?

Answering these questions began with creating a series of manifestos. A manifesto is an artistic or political statement in which you make your intentions easy for people to understand. By understanding the nature of this type of project, I could develop a strong foundation for which my thesis can develop. Through this exploration, I created three manifestos that frame topics in poetics, environment and tectonics.



Poetic

Establishing limits fosters creativity. In my case, those limits were provided by the dichotomy between the natural and urban environments. How can architecture exist within both realms without disrupting the synchronicities within the two environments?

"I shall go even further: my freedom will be so much greater and more meaningful the more narrowly I limit my field of action and the more I surround myself with obstacles. Whatever diminishes constraint, diminishes strength. The more constraints one imposes, the more one frees one's self of the chains that shackle the spirit."

"Poetics of Music"
Igor Stravinsky, Pg. 65



Environment

The development of our cities often reference various facets that contributes to the overall foundation in which a city rest on. Too often, the density of this foundation blocks out a consideration for the original foundation, the natural environment.

“Our society adopts many such superficial palliatives. Because yesterday’s negatives are moved out of sight from their familiar locations many reasons are willing to pretend to themselves that the problems have been solved. I feel that one of the reasons why we are struggling inadequately today is that we reckon our costs on too shortsighted a basis and are later overwhelmed with the unexpected costs brought about by our shortsightedness. ”

“Operating Manual for Spaceship Earth”
Richard Buckminster Fuller, pg. 3,



Tectonics

To break the boundaries between the two environments there must be a recognition of the environment in which our cities exist within and collect resources from. Urban architecture often references the built environment for making design and structural based decisions. If we want our relationship with the natural environment to improve, we must rethink the way in which we design and create architecture in relations to its physical relations to nature.

“...there are only two important attitudes to the context. The tools of the first are mimesis, organic imitation and the display of complexity. The tools of the second are the assessment of physical relations, formal definition and interiorization of complexity. ”

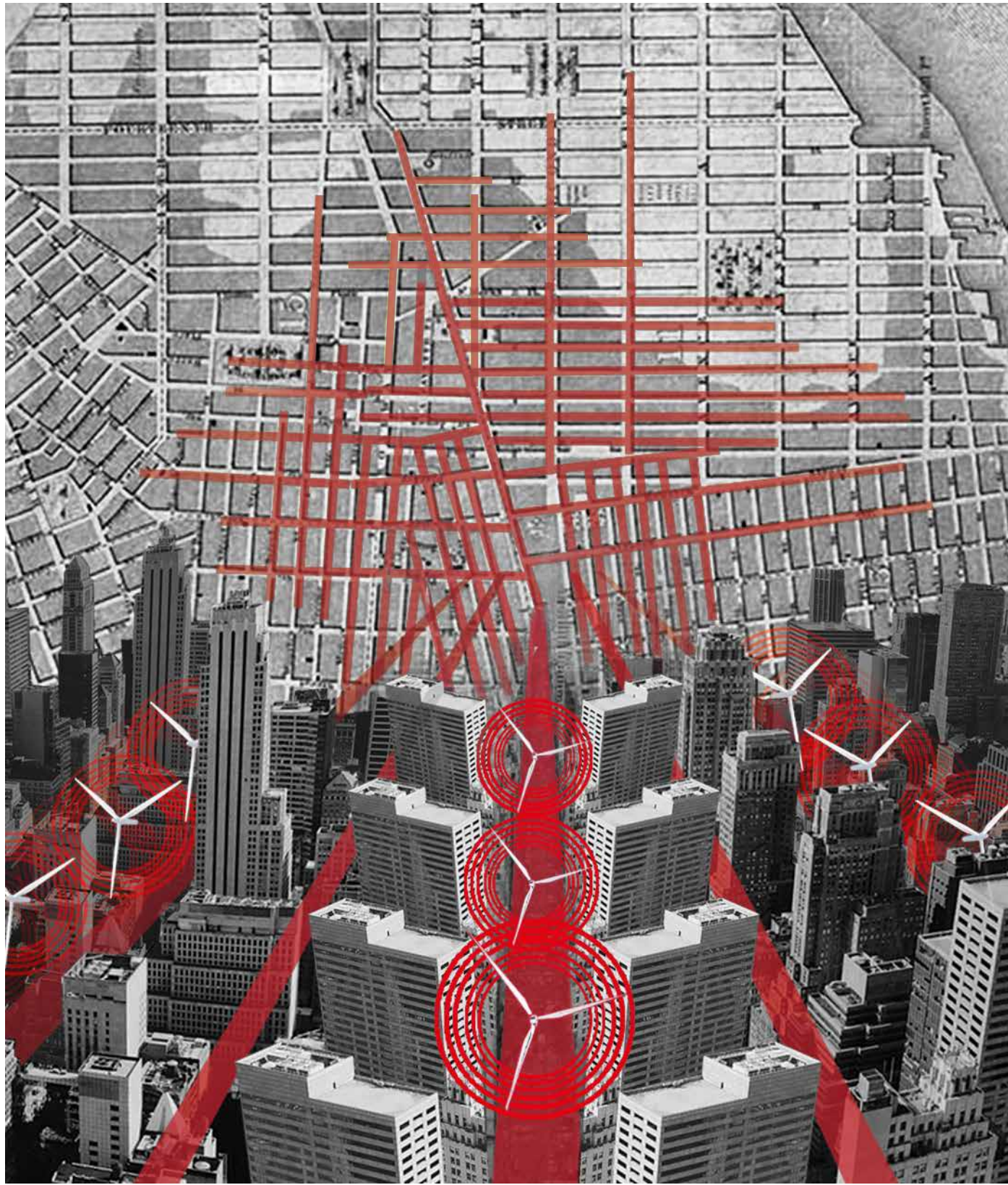
*“Studies of Tectonic Culture”
Kenneth Frampton, Pg 8*



Inspiration

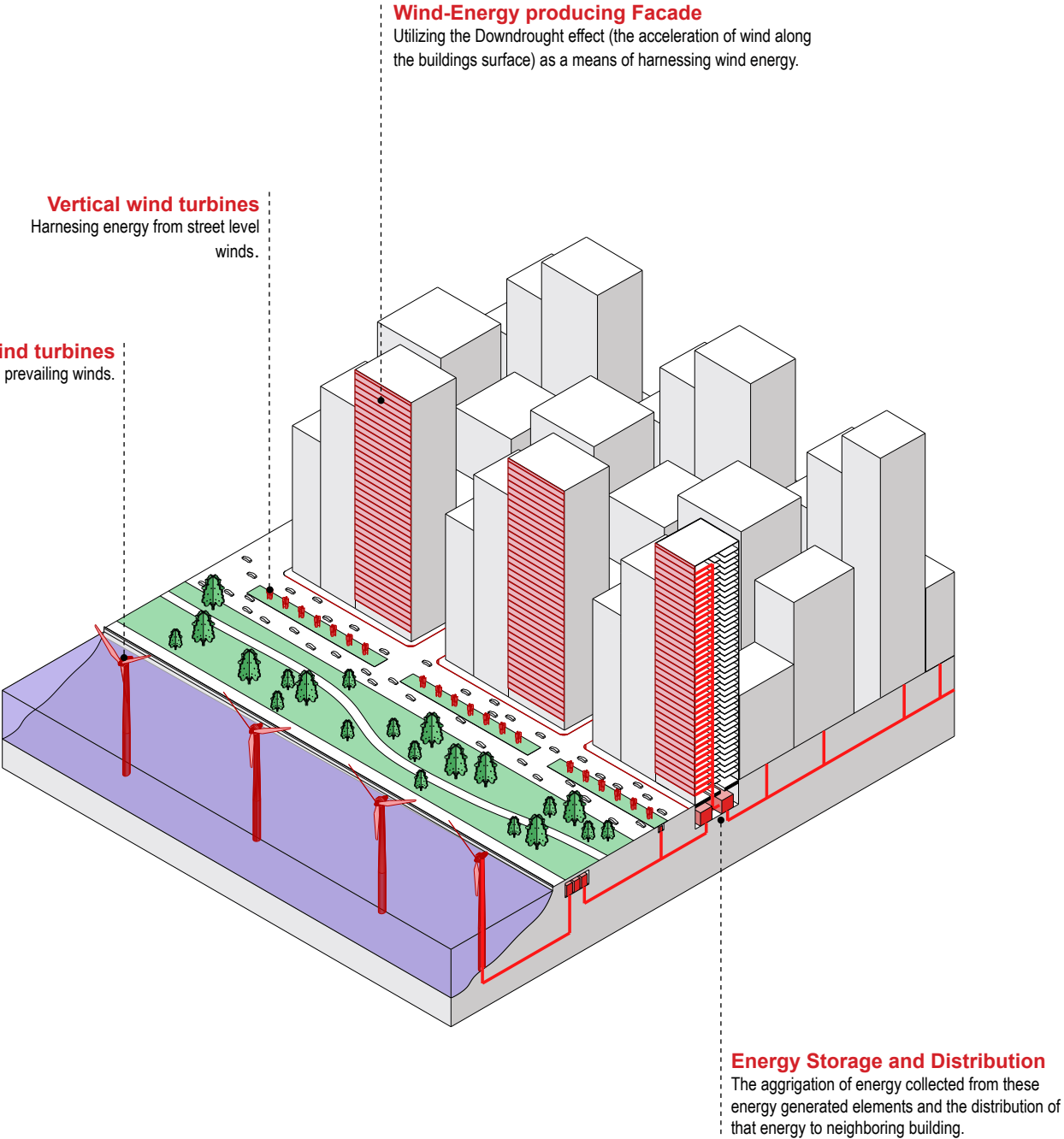
Diving deeper in my exploration of the natural and urban environments, I created a series of collages and diagrams to develop an understanding of the two conditions. Both types of illustrations utilize phenomenon unique to the urban environment as opportunities of introducing elements derived from the natural. The collages sought to illustrate the density of the urban environment by using repetition and layered perspectives. The red lines present throughout each piece highlight the otherwise concealed network that these interventions rely on. In juxtaposition to that, the diagrams lead into a practical approach to how these interventions can exist and provides more details into how they are deployed.

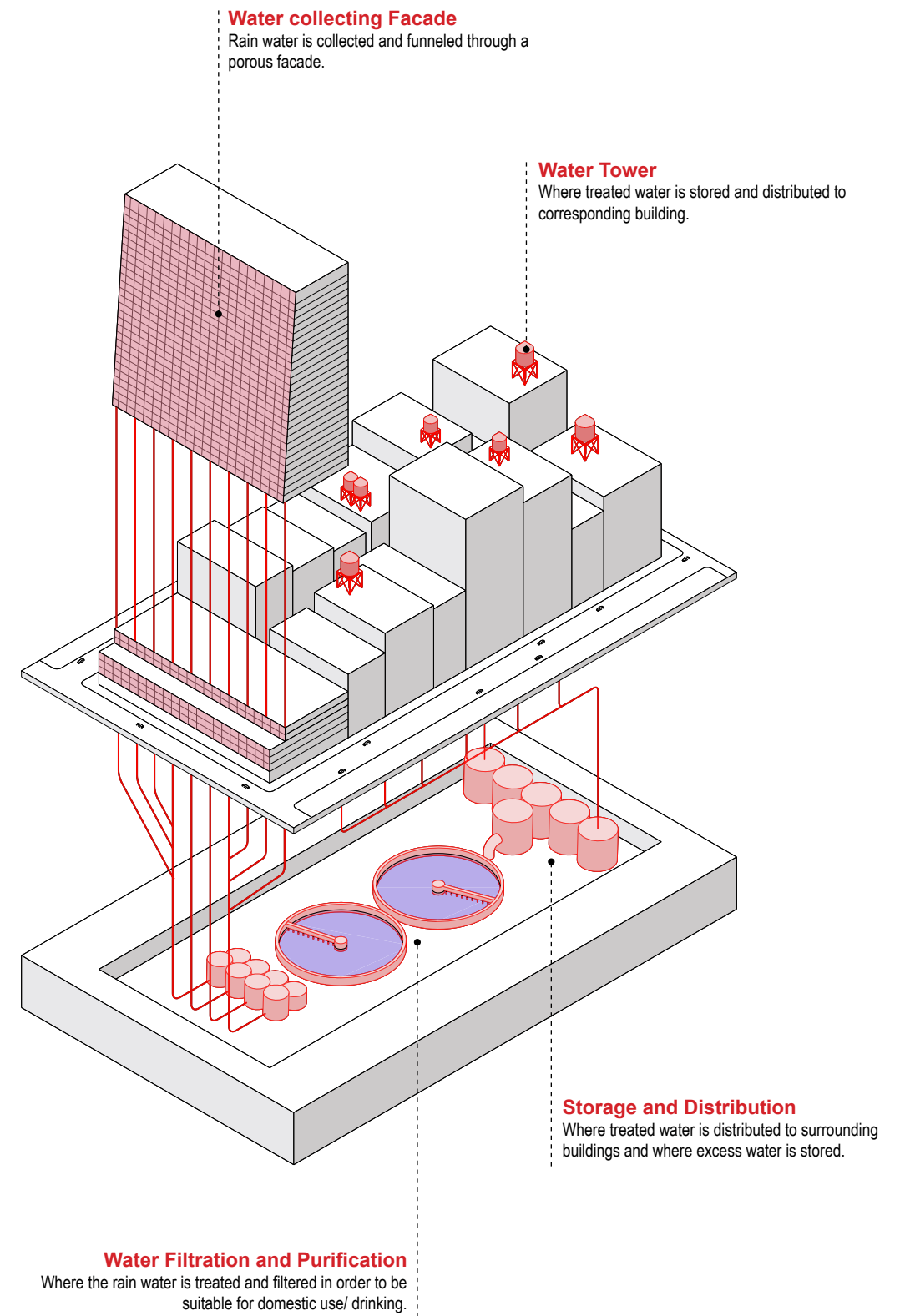
By simultaneously creating these series of images, I examined the nuances between the two methods of drawings to identify elements that exist within urban phenomenon for which to capitalize on. This series provides spaces that embody resolutions of generating energy, harvesting water, transportation and providing nourishment.



Vertical wind turbines
 Harnessing energy from street level winds.

Wind turbines
 Energy generated from prevailing winds.





Water collecting Facade

Rain water is collected and funneled through a porous facade.

Water Tower

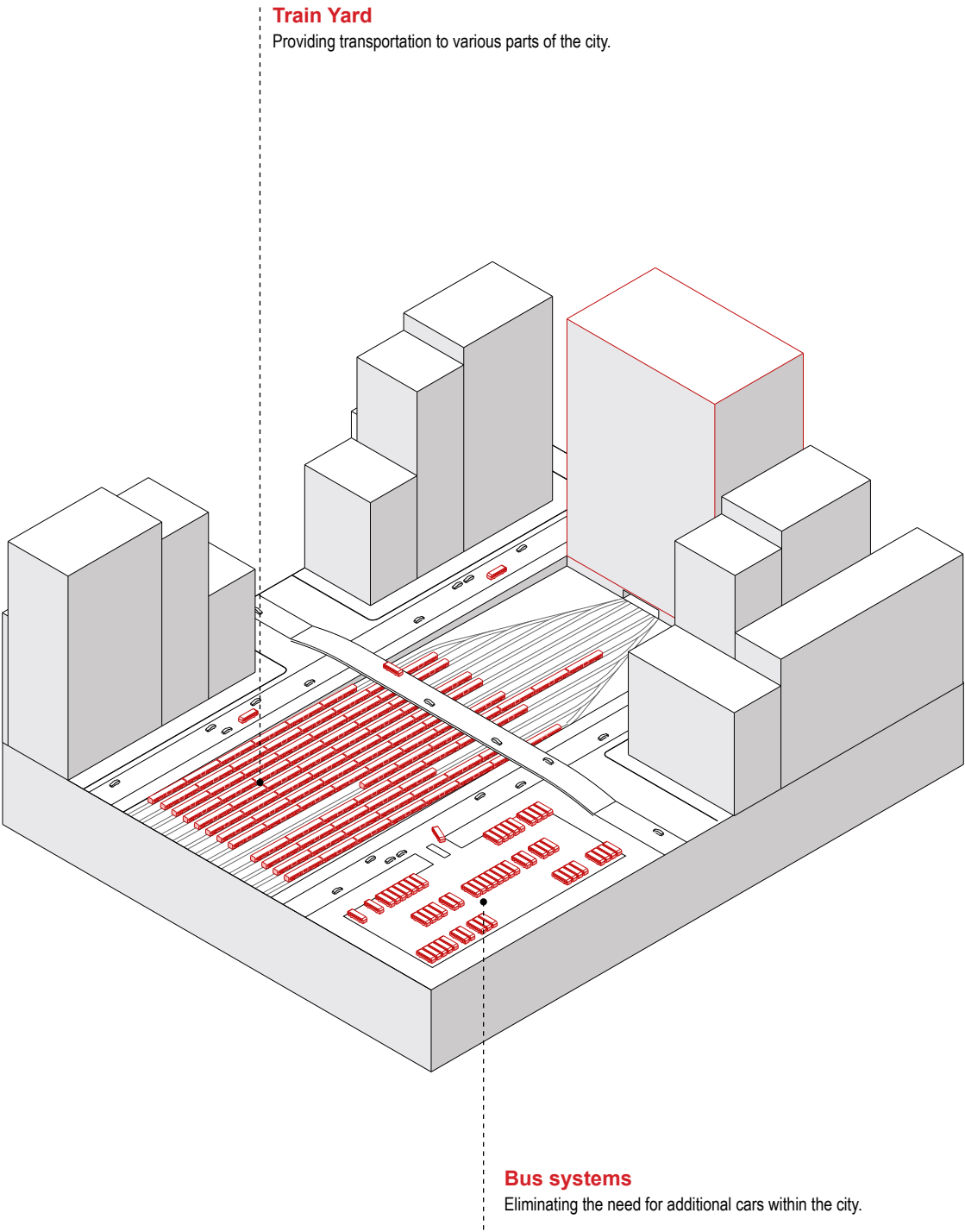
Where treated water is stored and distributed to corresponding building.

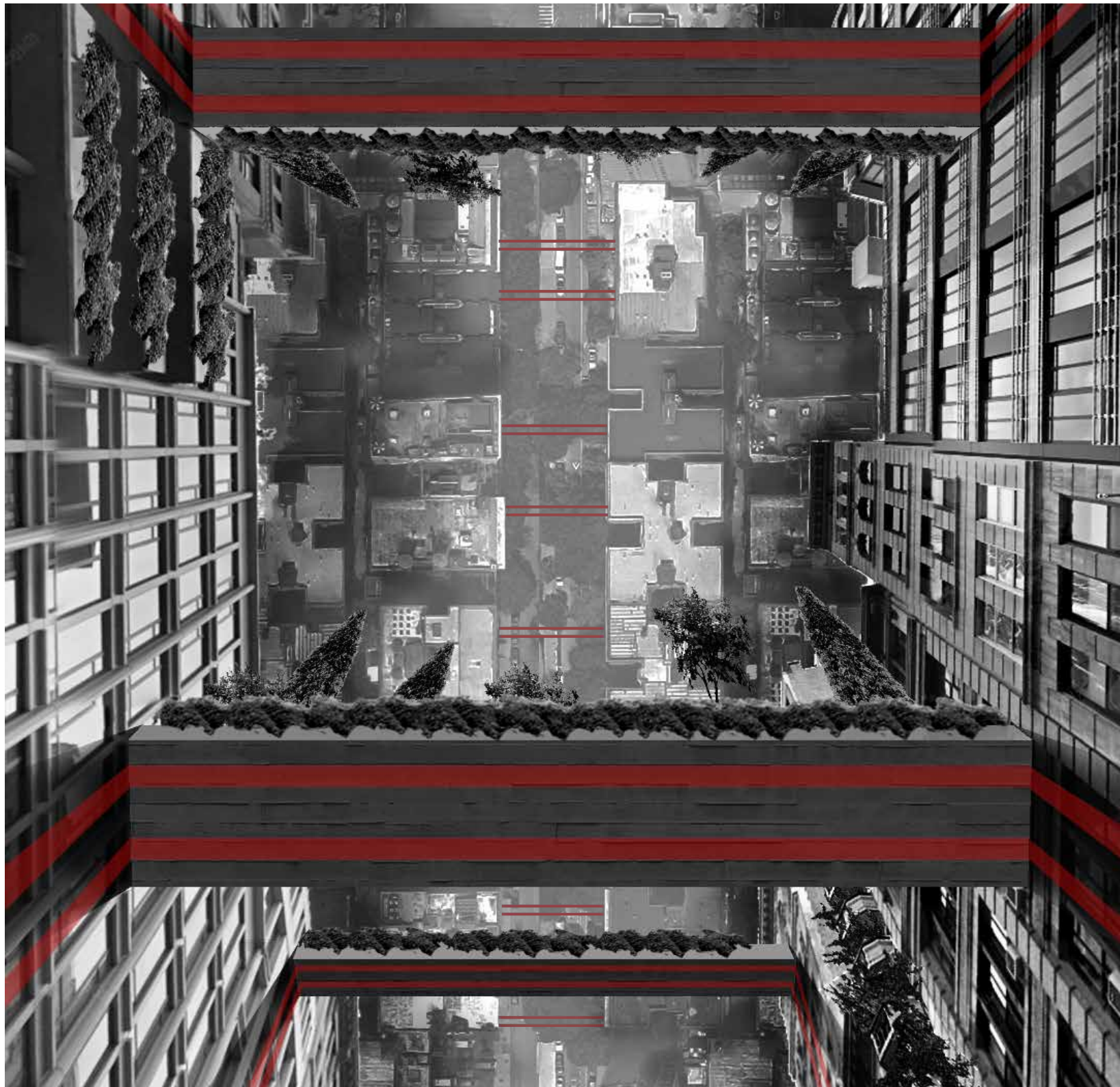
Water Filtration and Purification

Where the rain water is treated and filtered in order to be suitable for domestic use/ drinking.

Storage and Distribution

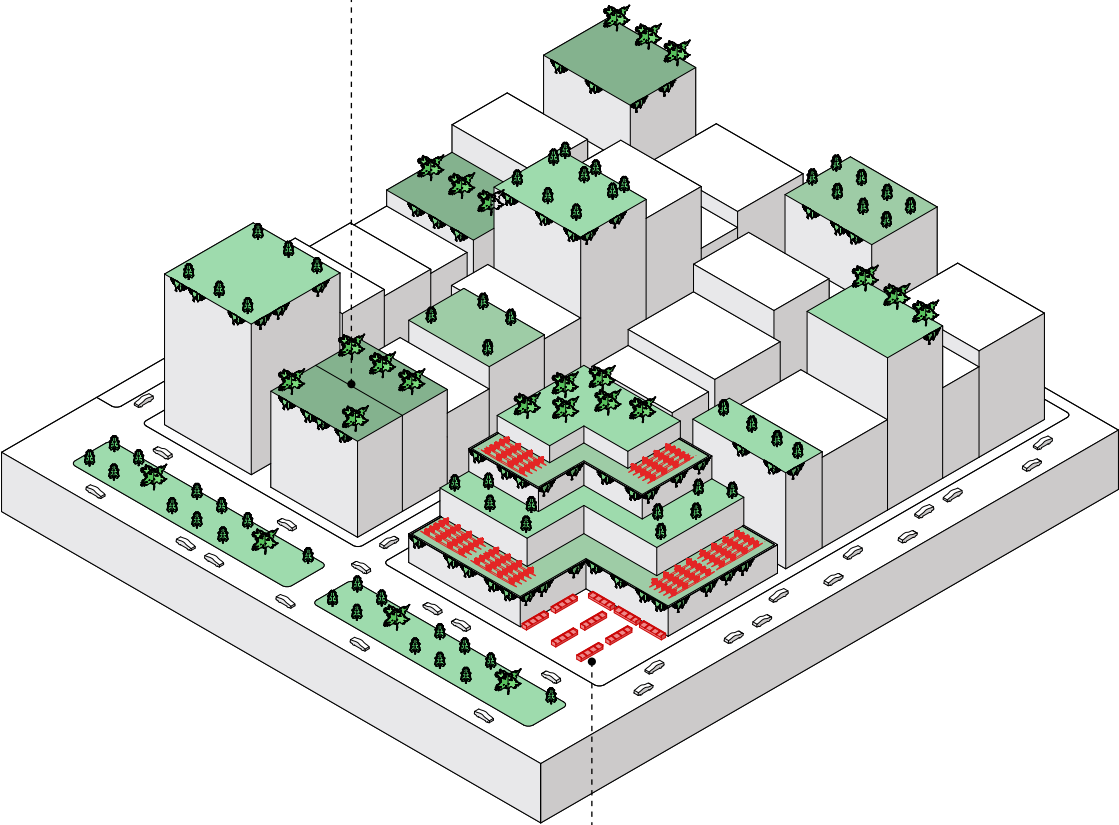
Where treated water is distributed to surrounding buildings and where excess water is stored.





Roof Top Green Spaces

Green spaces provided by suitable buildings that could then be used as real estate for agriculture, social spaces and carbon sequestration.



Urban Farmer's Market

An urban space where a market can be established.



Envision

An element of validity was needed to explore these ideas thoroughly. The consideration for a specific site and the development of form were essential for providing limitations for the projects to build upon. These limitations manifested themselves as architectural considerations for the site's conditions, restrictions in scale, and an analysis of structural feasibility.

Site locations were chosen based on the type of assumptions made in constructing conditions portrayed within the previous illustrations. These images provided questions that framed phenomenon for these architectural proposals to capitalize on. This series of proposals explore physical models and data driven analysis to address a finer detail of architectural components like the façade, structure or program of the building.

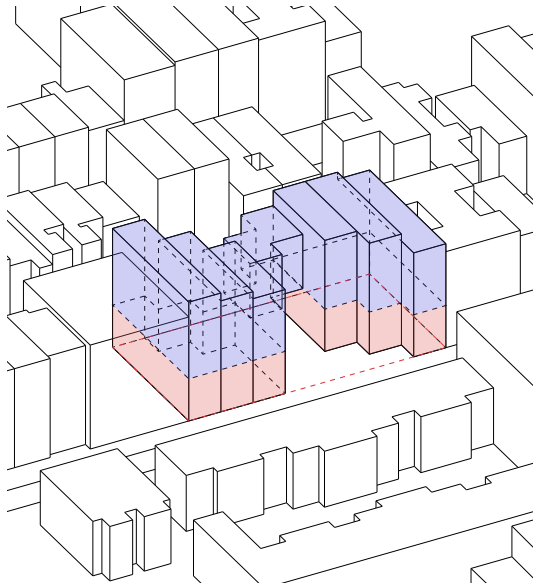
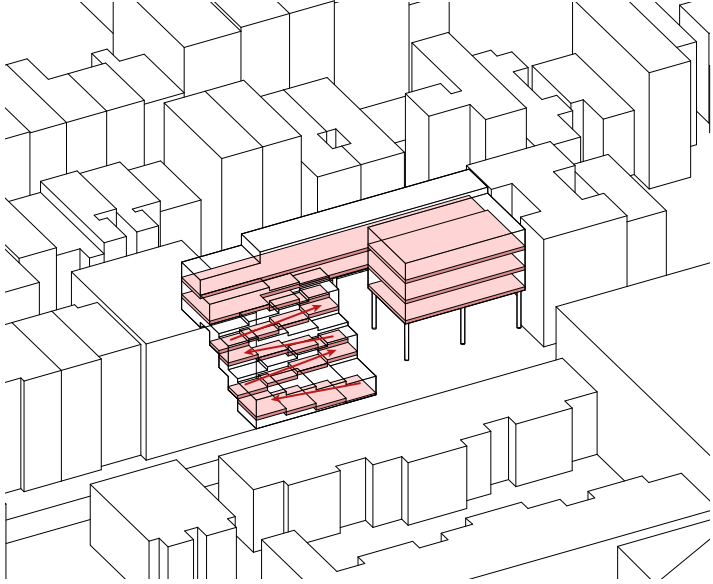
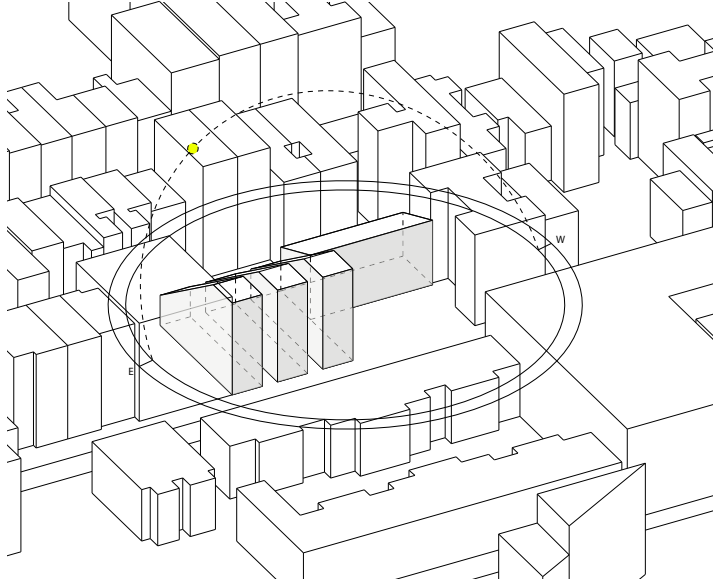


Green Typology

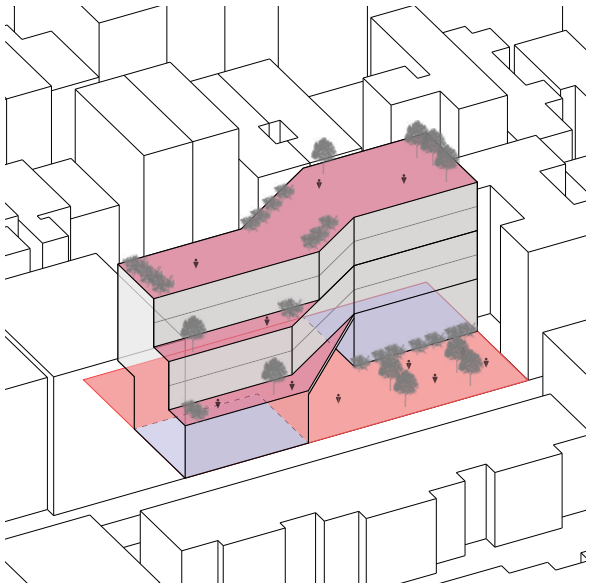
The first intervention site is located within the East Village area of Manhattan, at an existing green space called “The Green Oasis Garden.” Like most green spaces within New York City, the Green Oasis Garden embodies an idea of a green space as a refuge. An escape from the monotony of living within the city. Located in a residential district, this garden is filled with vegetation that obscures the view to the street and the buildings to give the residents of the surrounding buildings a place of rest.

Currently, the garden does not get utilized due to only being accessible by the residents of the area. An intervention within this space required an awareness to the project’s accessibility to the public and private audiences while also giving an incentive for both private residents and public pedestrians to want to interact with the space. The incentives provided for the residents included spaces for urban gardens, storage and a community center in which goods can be distributed and sold. Pedestrians would have access to the community center so that they can purchase produce while also enjoying the green spaces framed by the building.

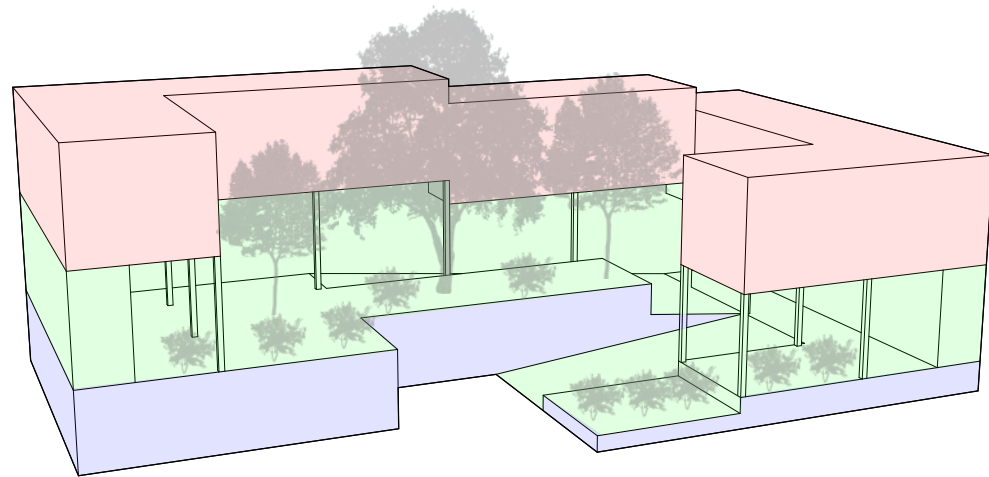




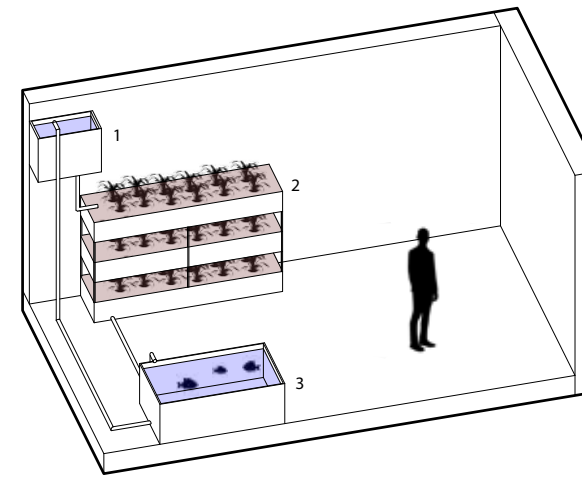
- Interior Gardens
- Storage
- Composting rooms
- Water Collection and Storage
- Classrooms
- Market/Retail Space
- Public Space



- Public
- Private

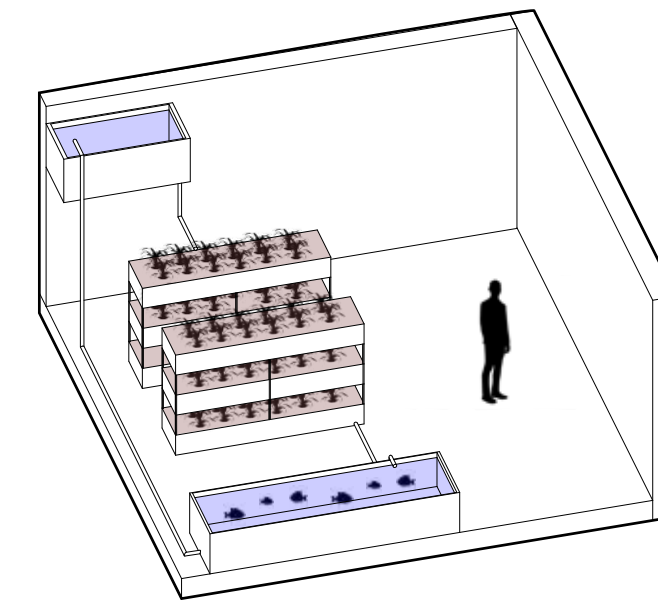


- Light weight structural frame
- Contains aquaponics units
- Public green space
- Vertical circulation
- Structural beams and columns
- Heavy structural elements
- Atrium space
- Containing high- volume aquaponic units



Aquaponics

- 1- Flood tank empties nutrient-rich water into the growing beds
- 2- The water gets filtered and provided food for the plants
- 3- The aerated and filtered water returns to the fish



Sizing the growing beds and fish tanks

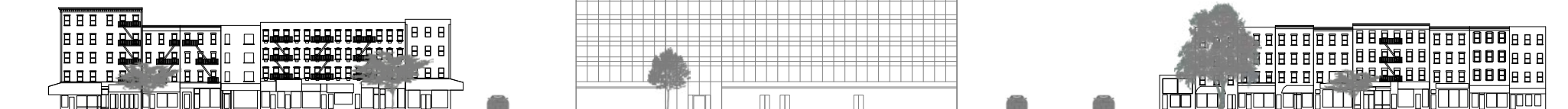
- 1lb of fish : 1 sq ft of growing bed surface area
- 1lb of fish : 5-10 gallons of fish tank water

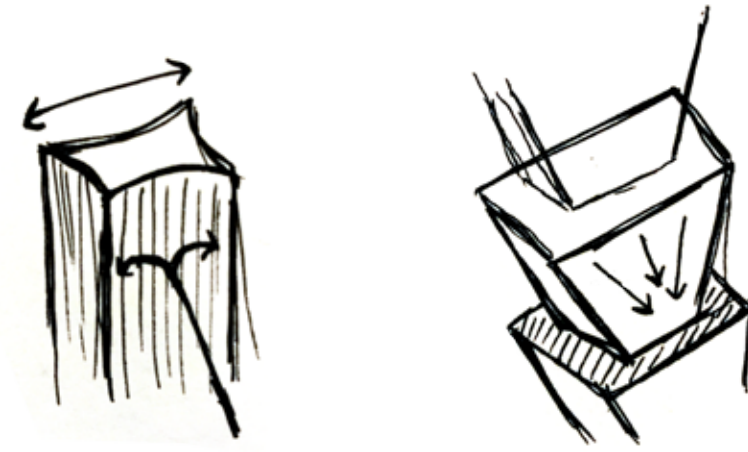


Water Typology

The second intervention site began with questioning the zoning laws regarding 252 East 57th Street in the Midtown East section of Manhattan. Being a commercial district, the height restrictions of a structure is not placed under the same restrictions as the Residential districts. In the elevation, the current building existing on the site is about 15x larger than that of the surrounding buildings. Since there are no buildings of similar height within the immediate area, we should take advantage of the natural elements that this building is exposed to.

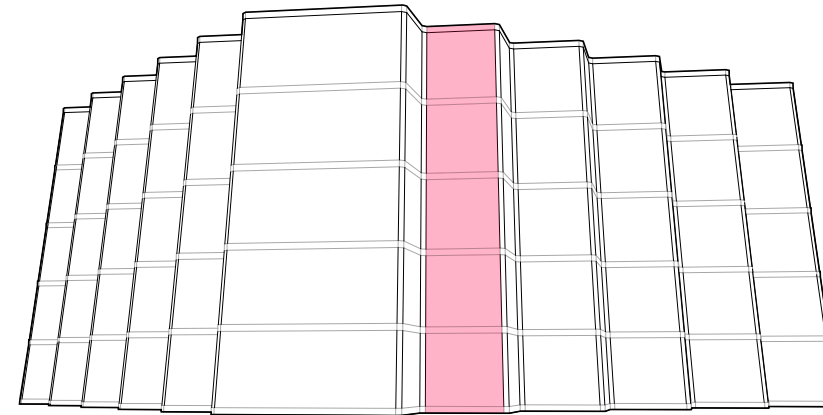
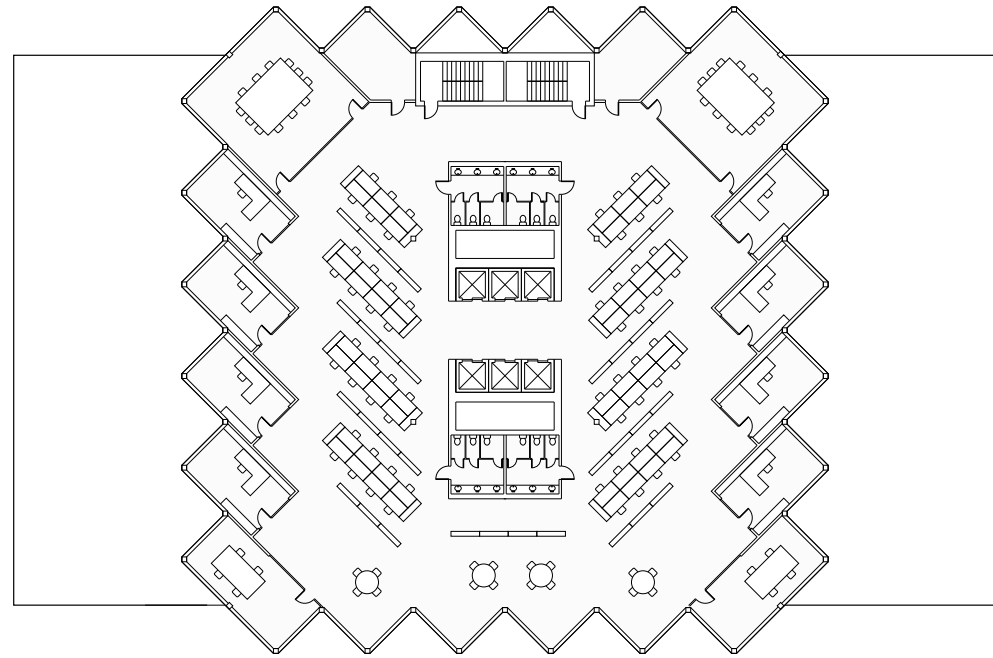
The proposed intervention is ones that exists within the façade of the building. The design of this building is assuming that if rain falls at an angle, the façade of the building can be utilized in order to collect, store, filter and redistribute to the within its area.



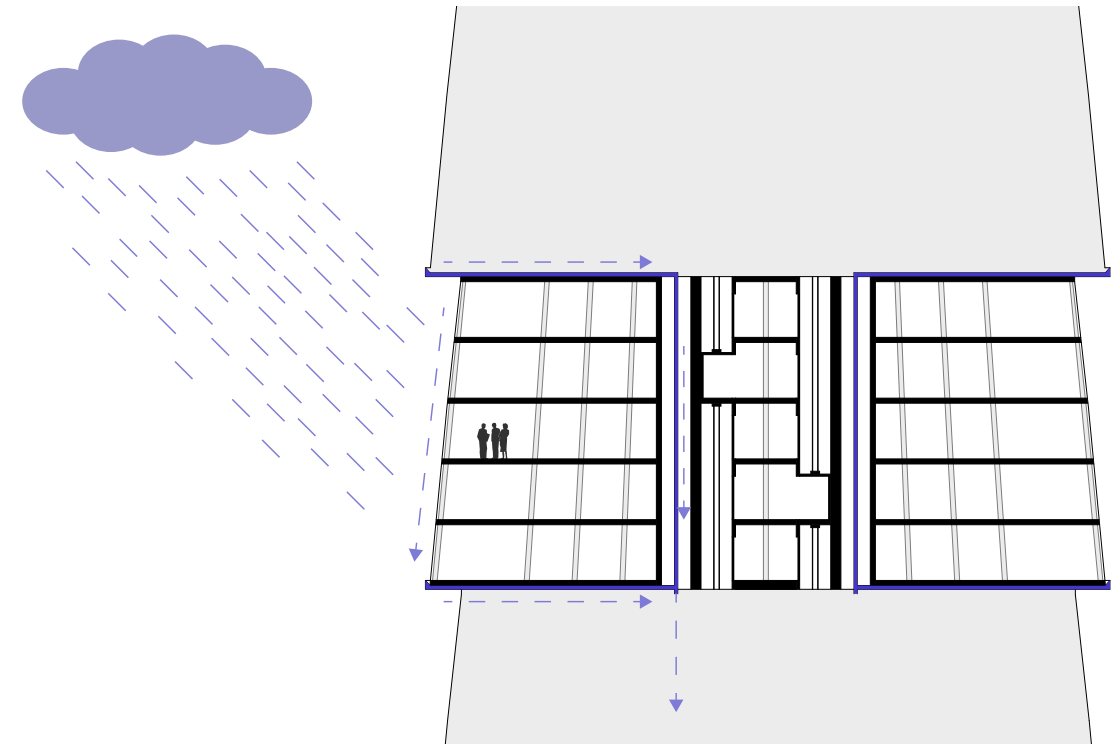


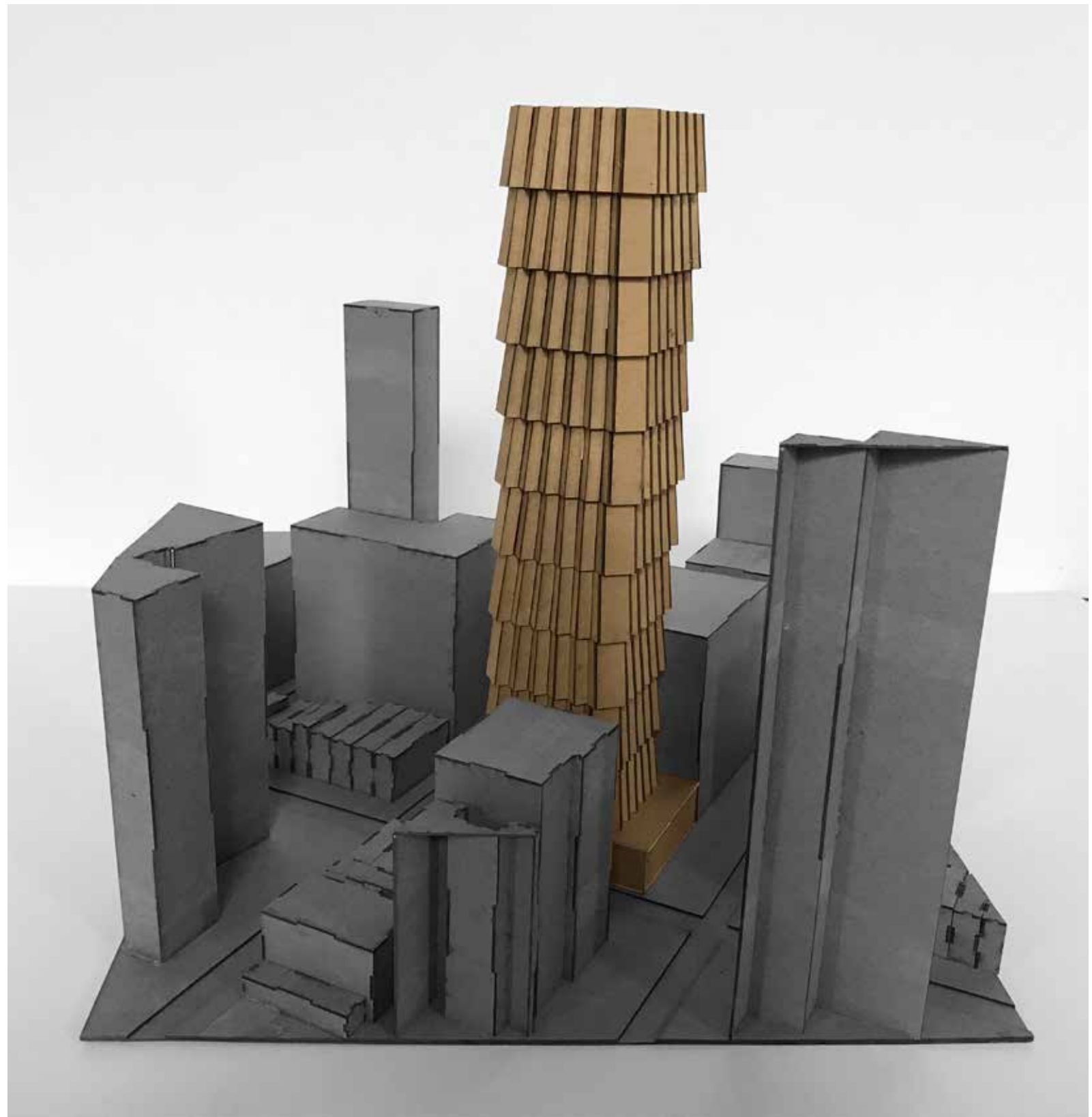
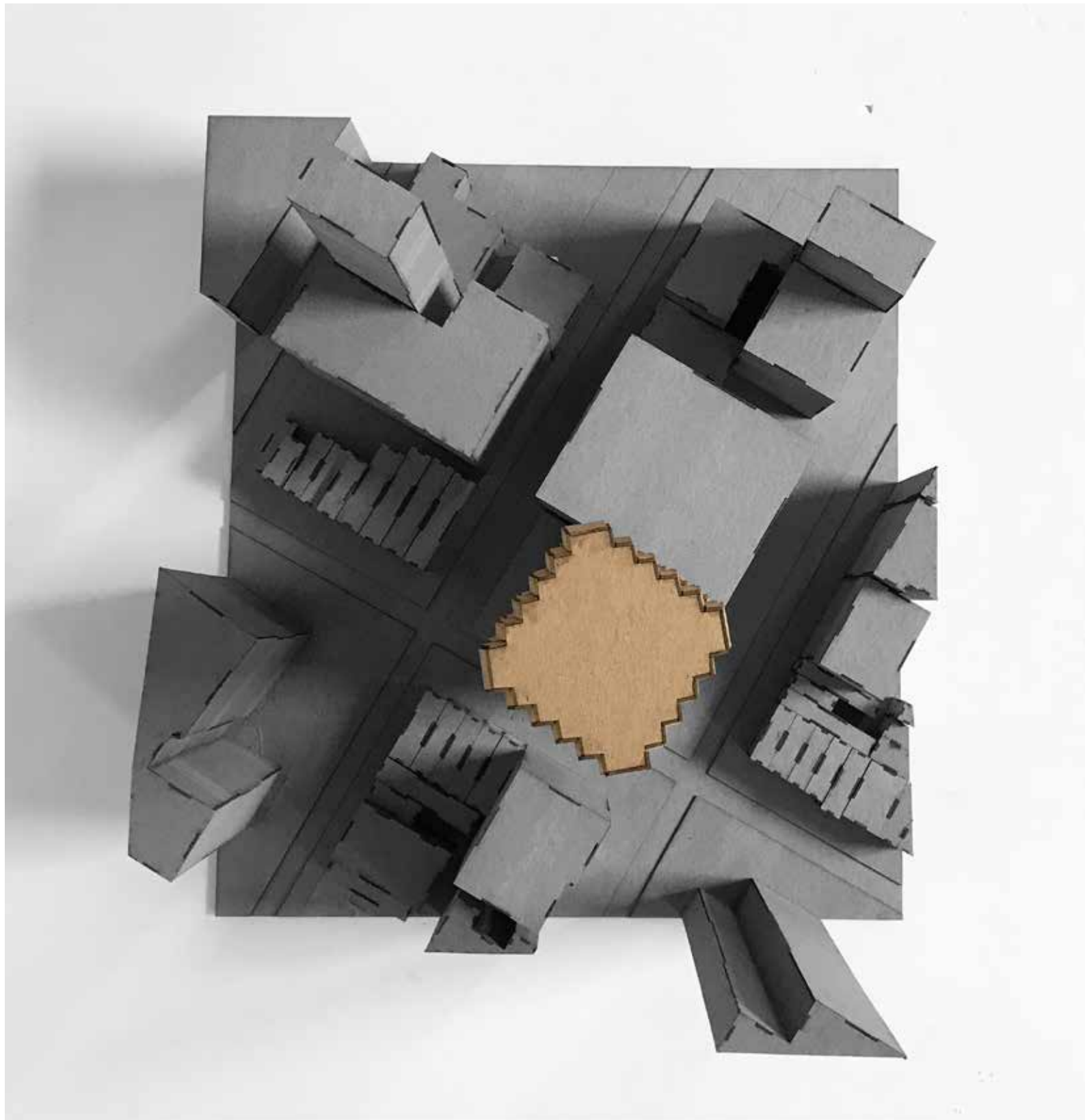
Form and Function

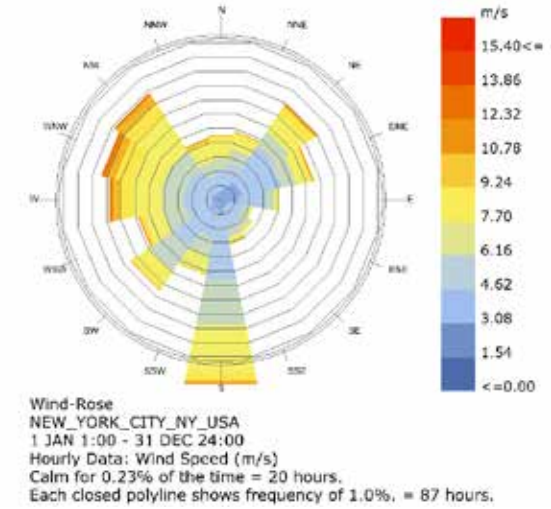
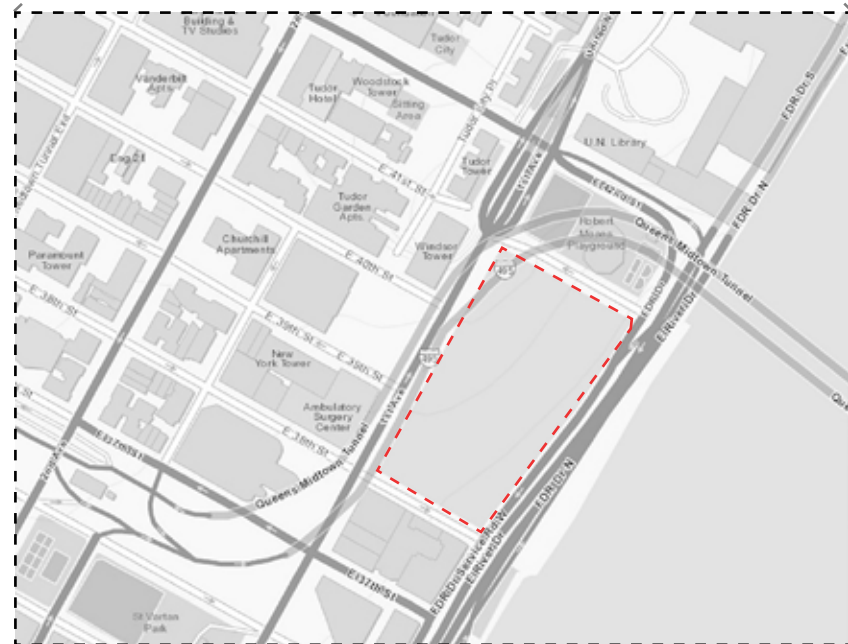
Developing the formwork of the building took account for how the shape of the building should be designed to maximize the amount of water that is collected through the façade. Each design takes into consideration the amount of surface area that the rain hits, how to reduce the surface wind so the rain particles do not blow off, and where to collect the water once gathered.



The façade of the building has been changed so that it takes on an accordion like appearance. This form doubles the amount of surface area that the rain can come in contact with and allows the collection of water from multiple directions. For every inch of rain, .62 Gal per sqft of it can be collected. Using the surface area of one panel, each one has the capability of collecting 21,297 gal of water each year in New York city. This water can be used as grey water throughout the building and to the surrounding buildings.





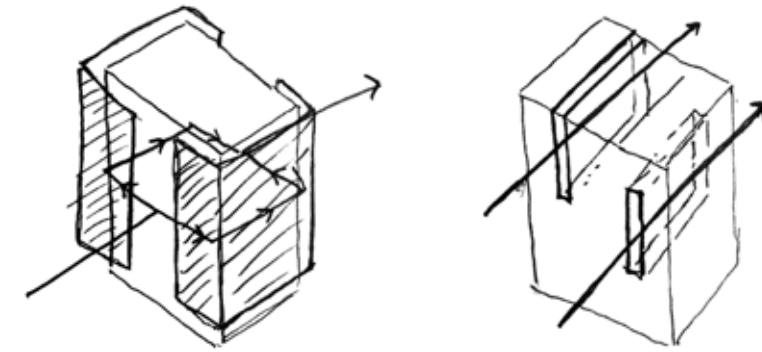


Wind Typology

The last intervention site is located along the east harbor near the Queens Midtown Tunnel. It is the largest site out of the three with a total of 400,000 sqft belonging to the property. Similar to the Water Typology proposal, there are no buildings adjacent to this structure so the structure is entirely exposed to the elements. In this case, the element under consideration is wind. This is due to the site's proximity to the east harbor, and the lack of buildings interfering with the prevailing winds.

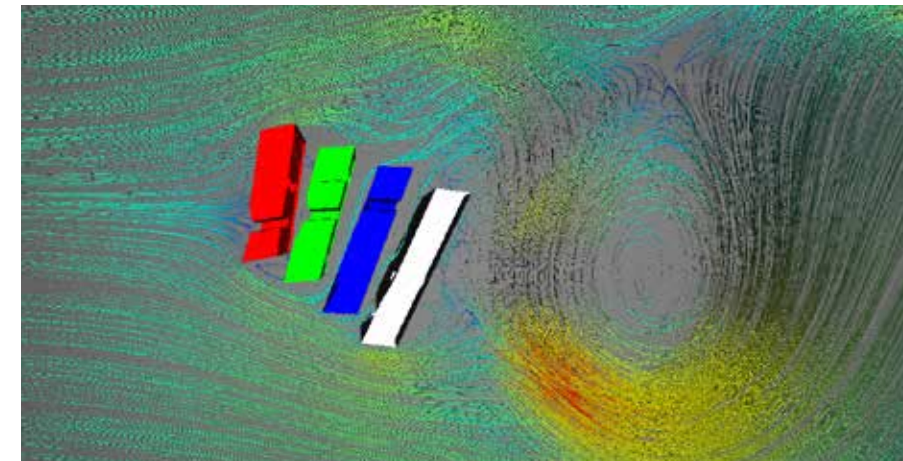
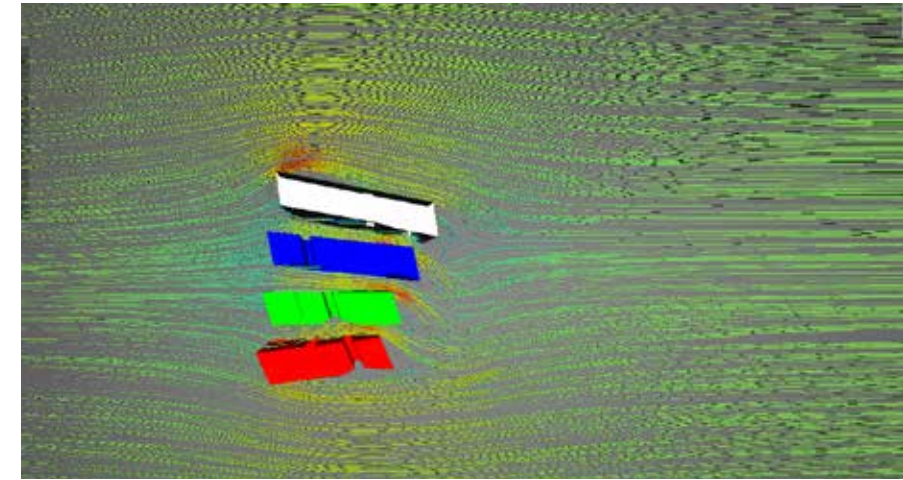
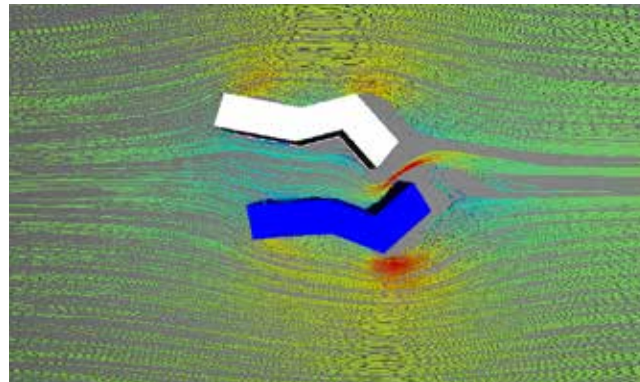
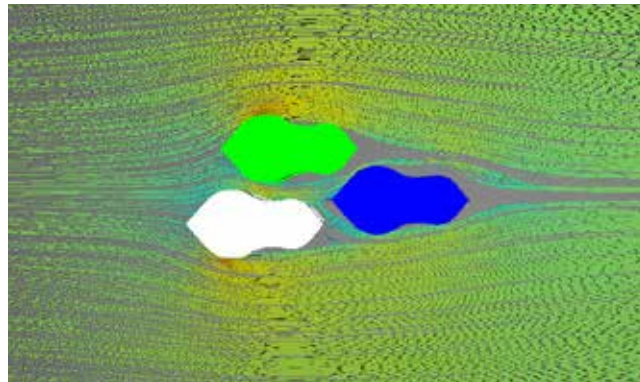
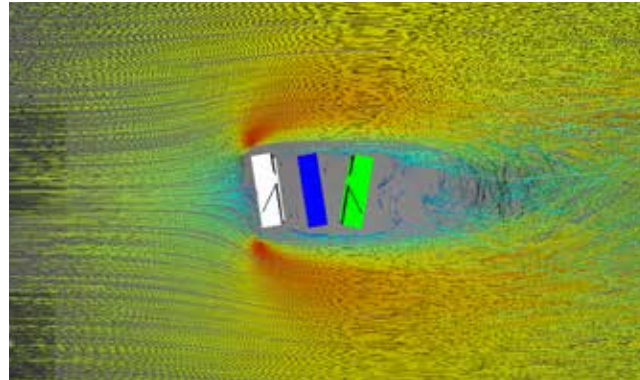
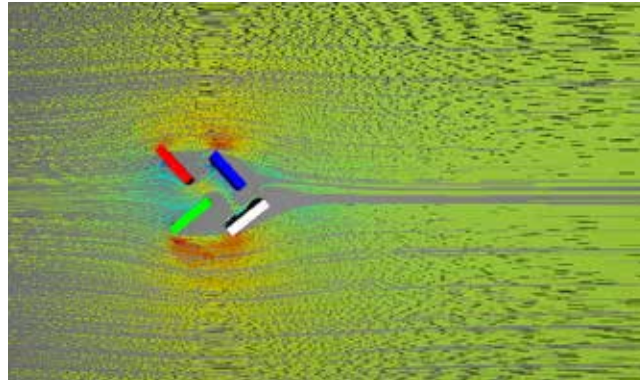
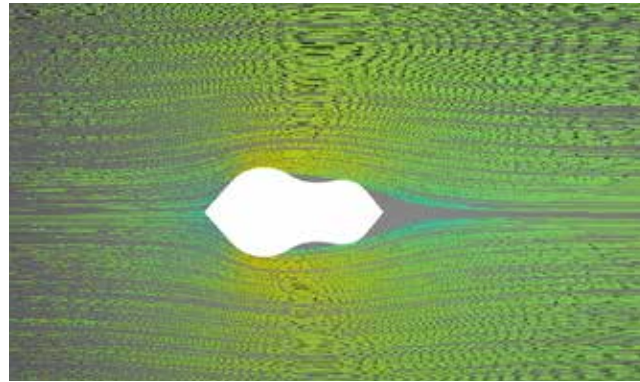
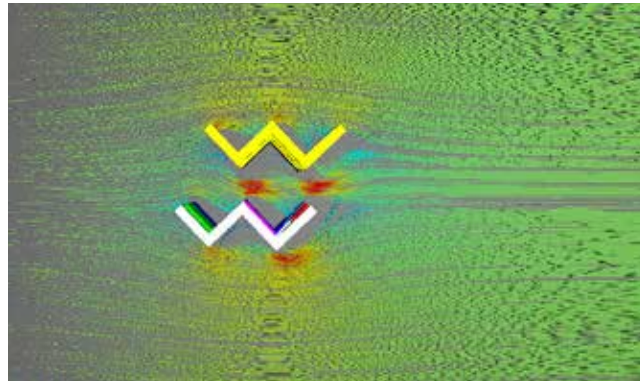
The proposed intervention for this site is one that has been molded in relation to the wind conditions existing in the site. In New York City, the prevailing winds prominently come from the South and the West. Using this information, the form of the building took on qualities that would channel the wind so that it can be utilized in generating wind powered energy.





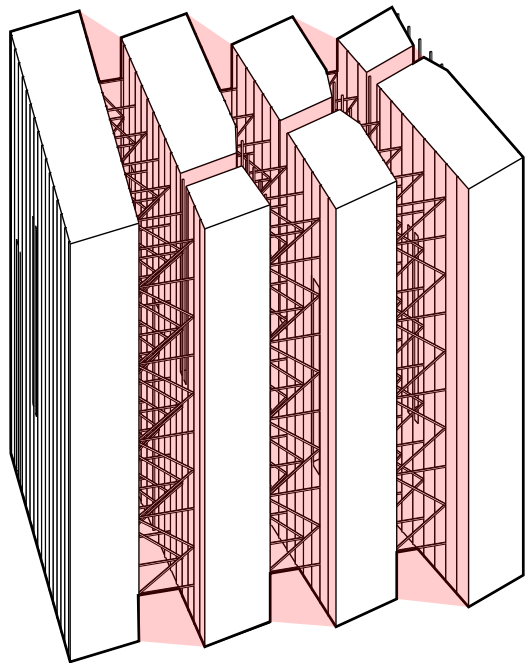
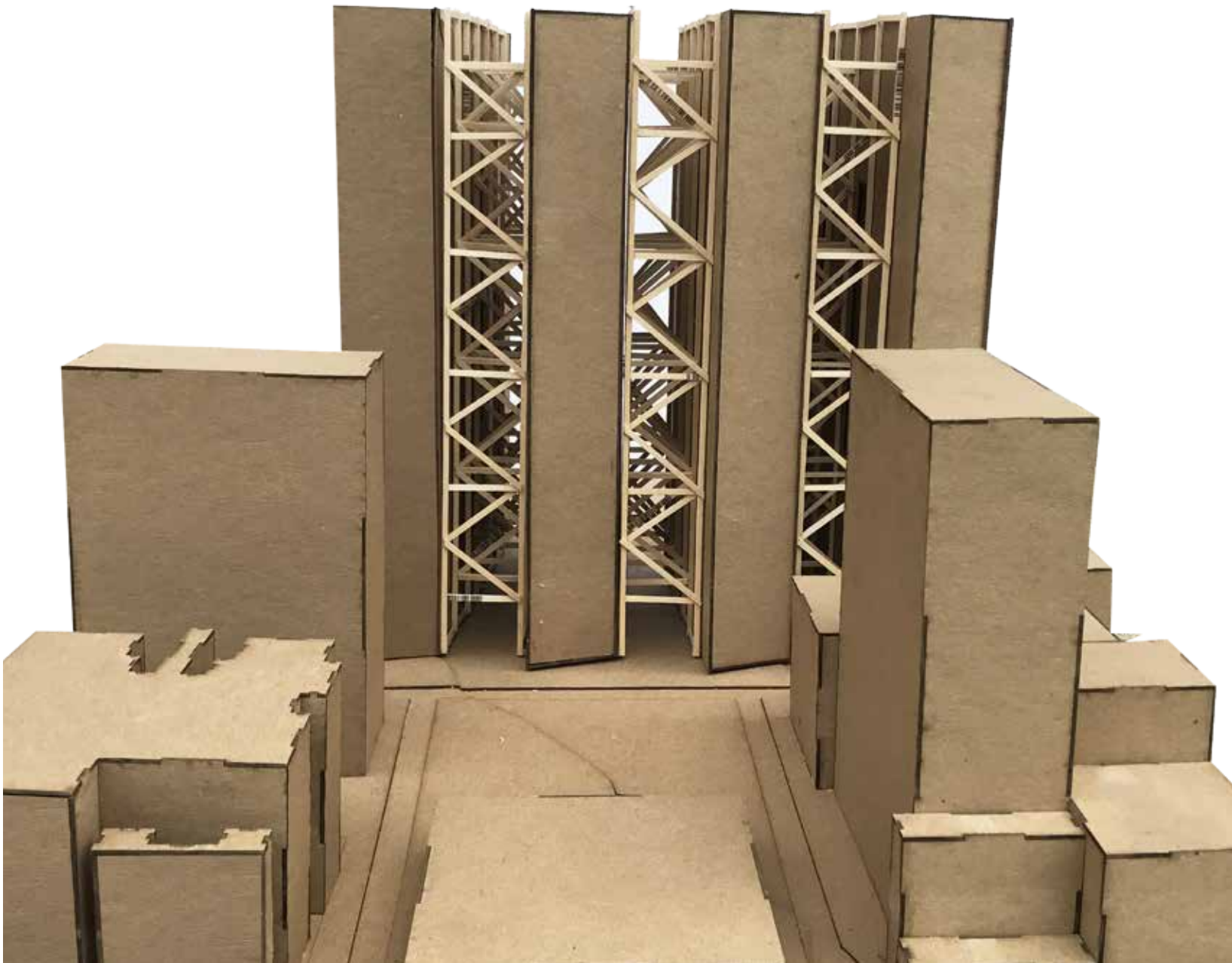
Form and Function

High rise buildings of this magnitude have a large impact on the weather conditions within its immediate area. Their broad surfaces and sharp corners can either slow down or accelerate the wind that enters its area of influence. Taking advantage of this, the formwork for this building utilizes methods of funneling the air through designated areas that alter the speed and direction of the wind's flow. Channeling wind into specific areas of the building opens an discussion on the types of methods used in generating energy under these conditions.



Behavior

Using a program called FlowDesign, I placed each shape into a virtual wind tunnel to gain a deeper understanding of how wind would interact with the building. The data I collected help me determine what type wind turbines I should utilize in these types of wind conditions.



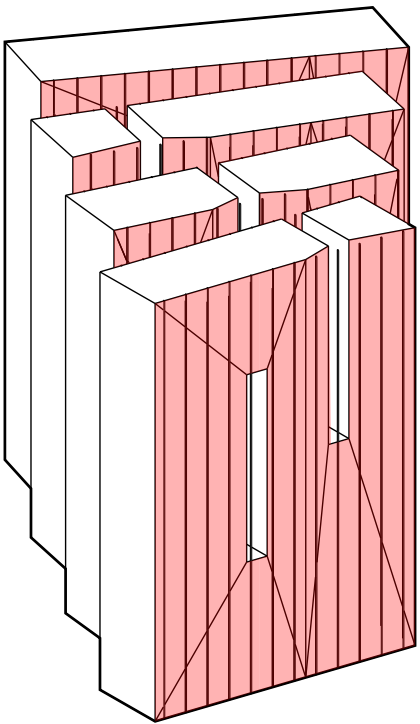
North- West Isometric

External Structural Elements

Directs wind between buildings

Location of Windspires

Primary location for Vertical Circulation

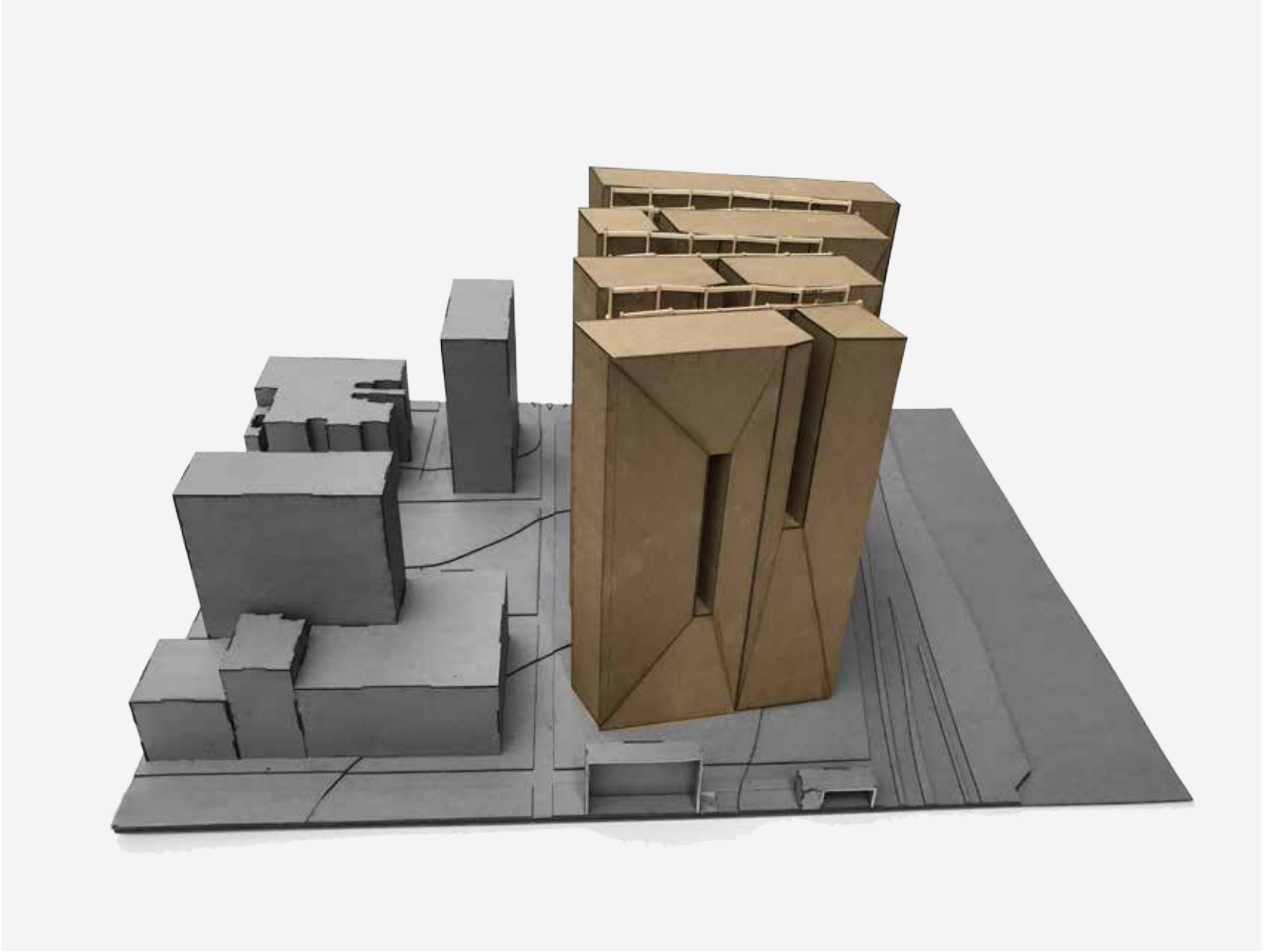
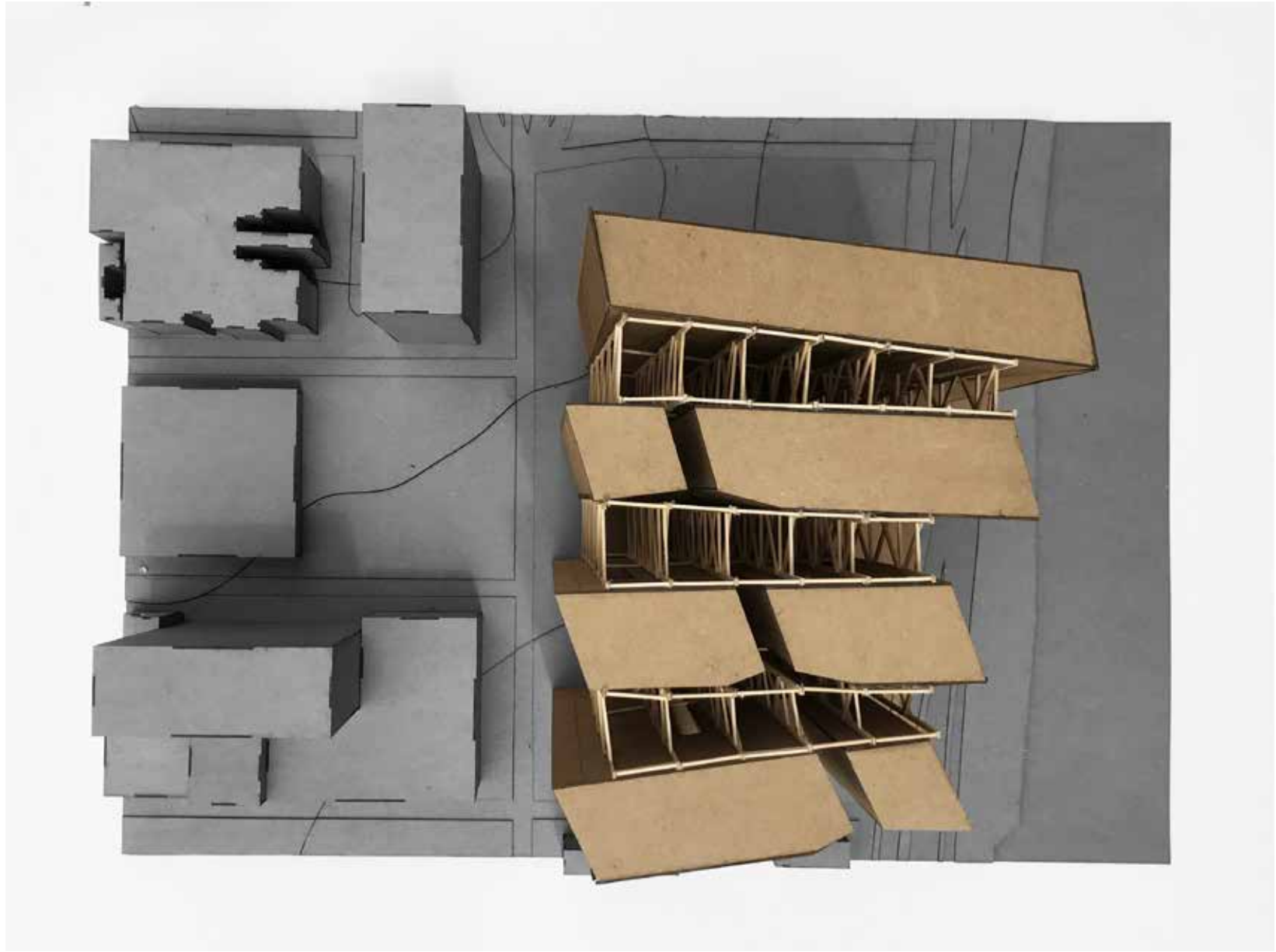


South- East Isometric

Pitched Building Facades

Directs wind through apertures

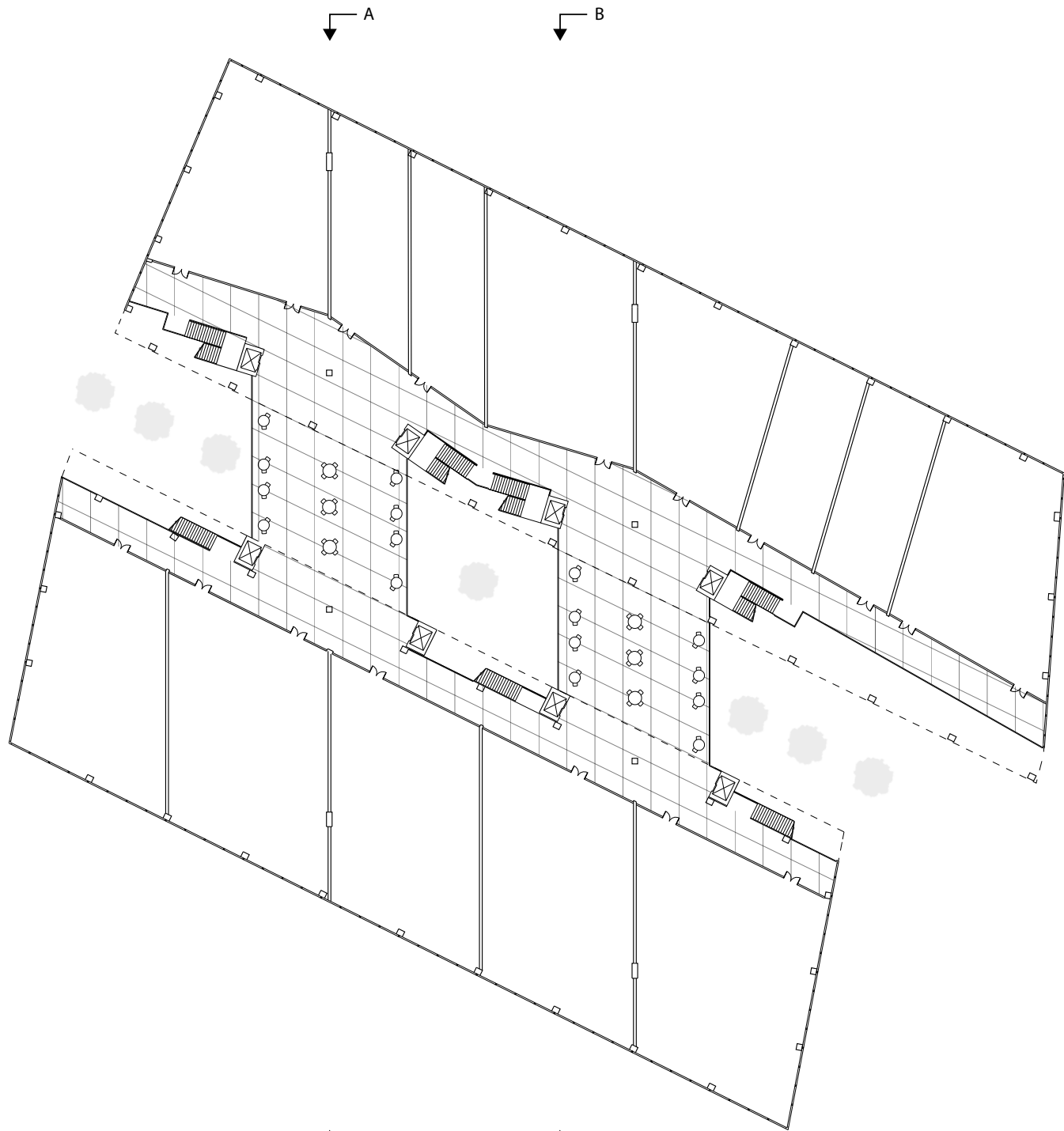
Location of Windspires



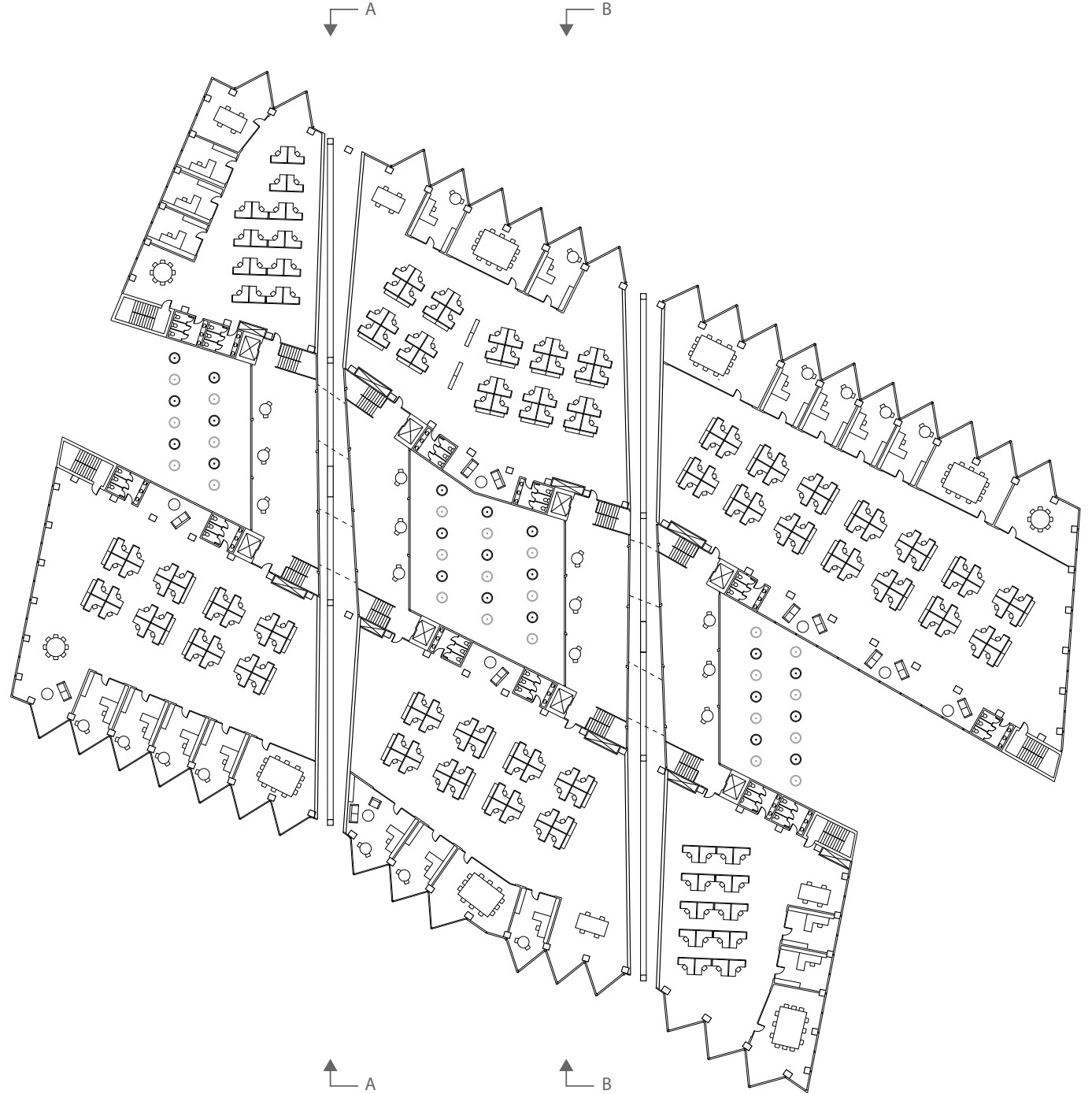


This final section focuses on the execution of conceptual ideas into a cohesive architectural proposal. The proposal merges the ideas in the Water and Wind typology analysis so that their concepts work in tandem with one another. Combining the two typologies provided the proposal with an understanding of types of façade system and an insight to the form that the building would adopt. In this proposal, there is a deeper consideration on the types of technology and the locations in which these tools are employed within the building.

Its located in the same site as the Wind typology proposal due to the site's lack of interference from the surrounding buildings. Since both typological studies capitalize on wind, the building would perform at a more operable level under these types of conditions. The proposal is a 40 storey, high-rise building. The bottom portion of the building provides retail spaces while the rest of the floors are composed of office spaces.

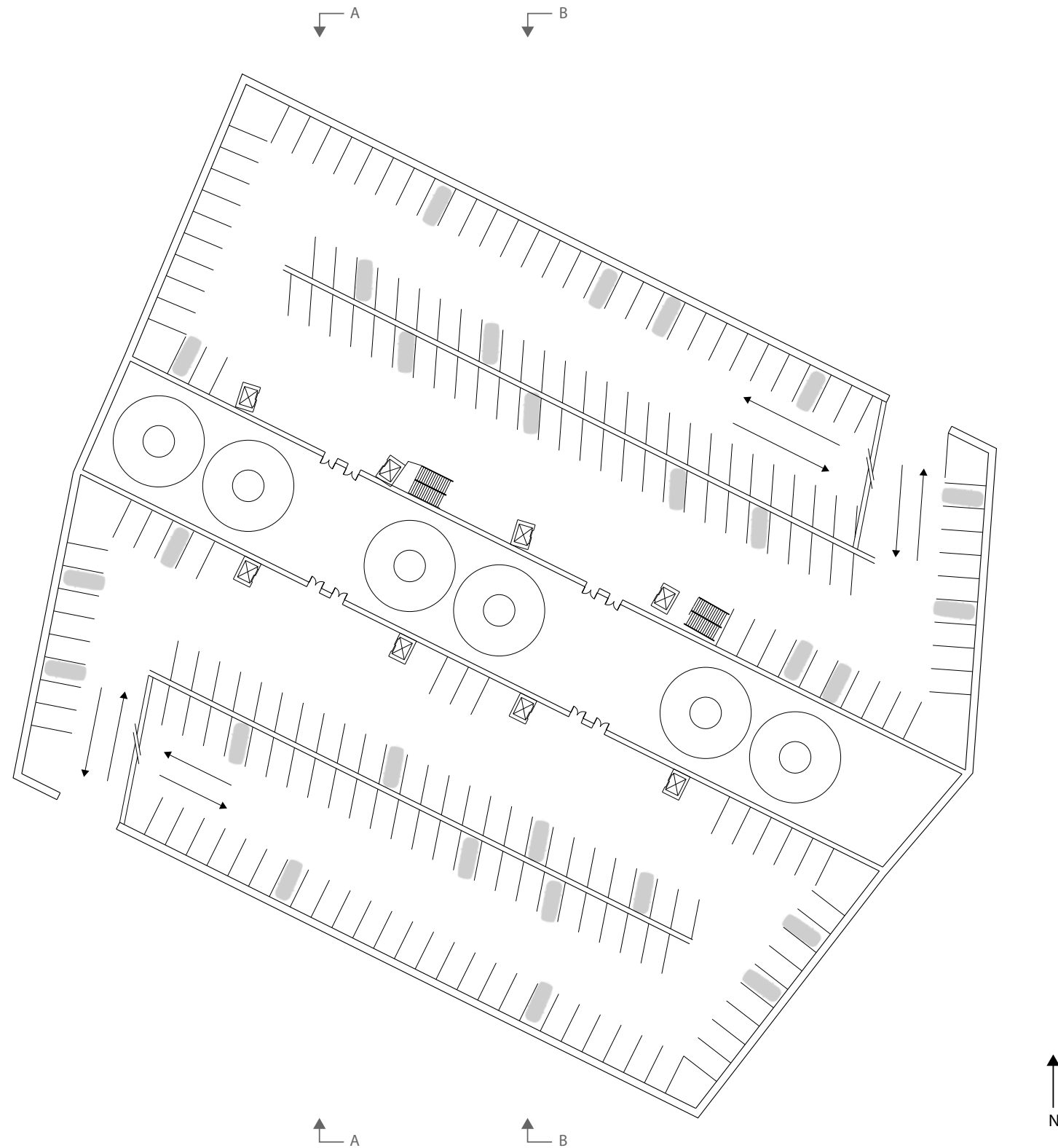


Retail Floor Plan

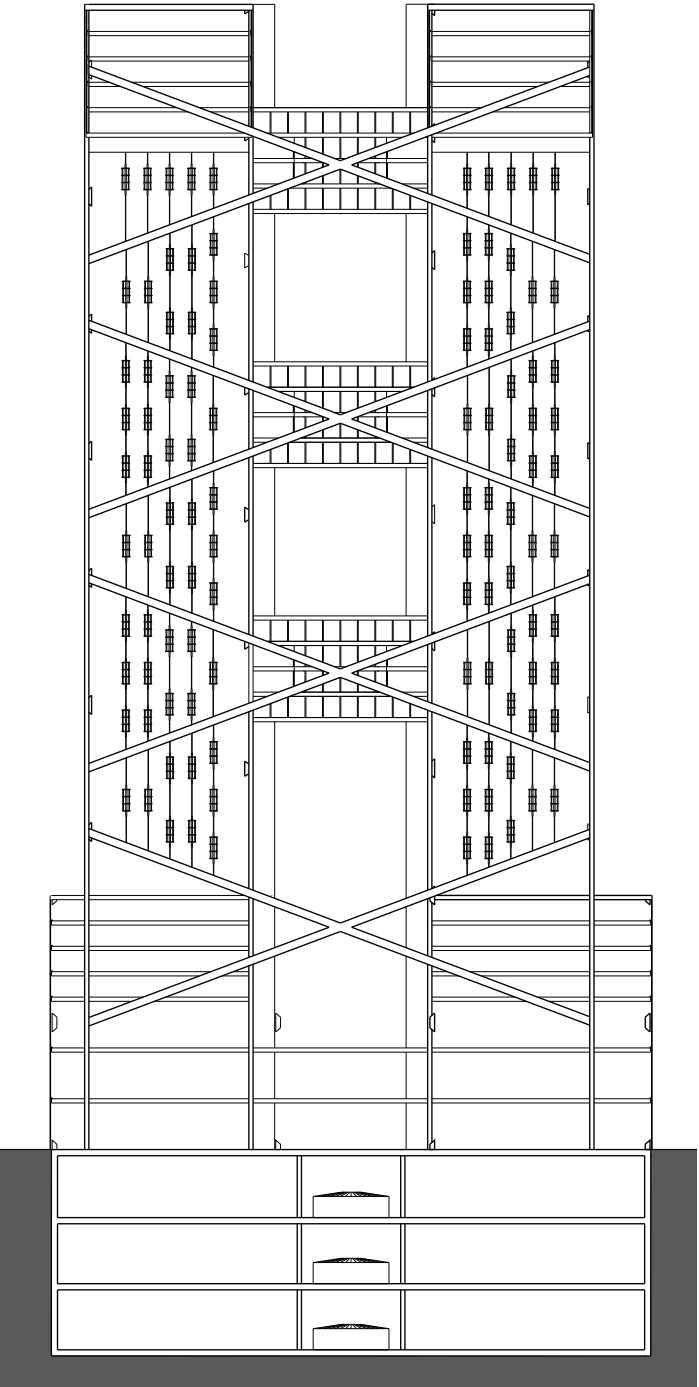


Office Floor Plan





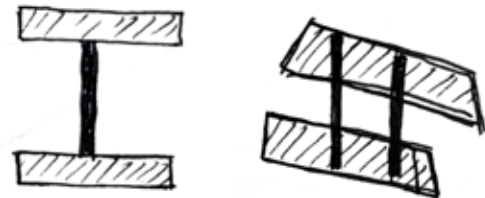
Parking Floor Plan



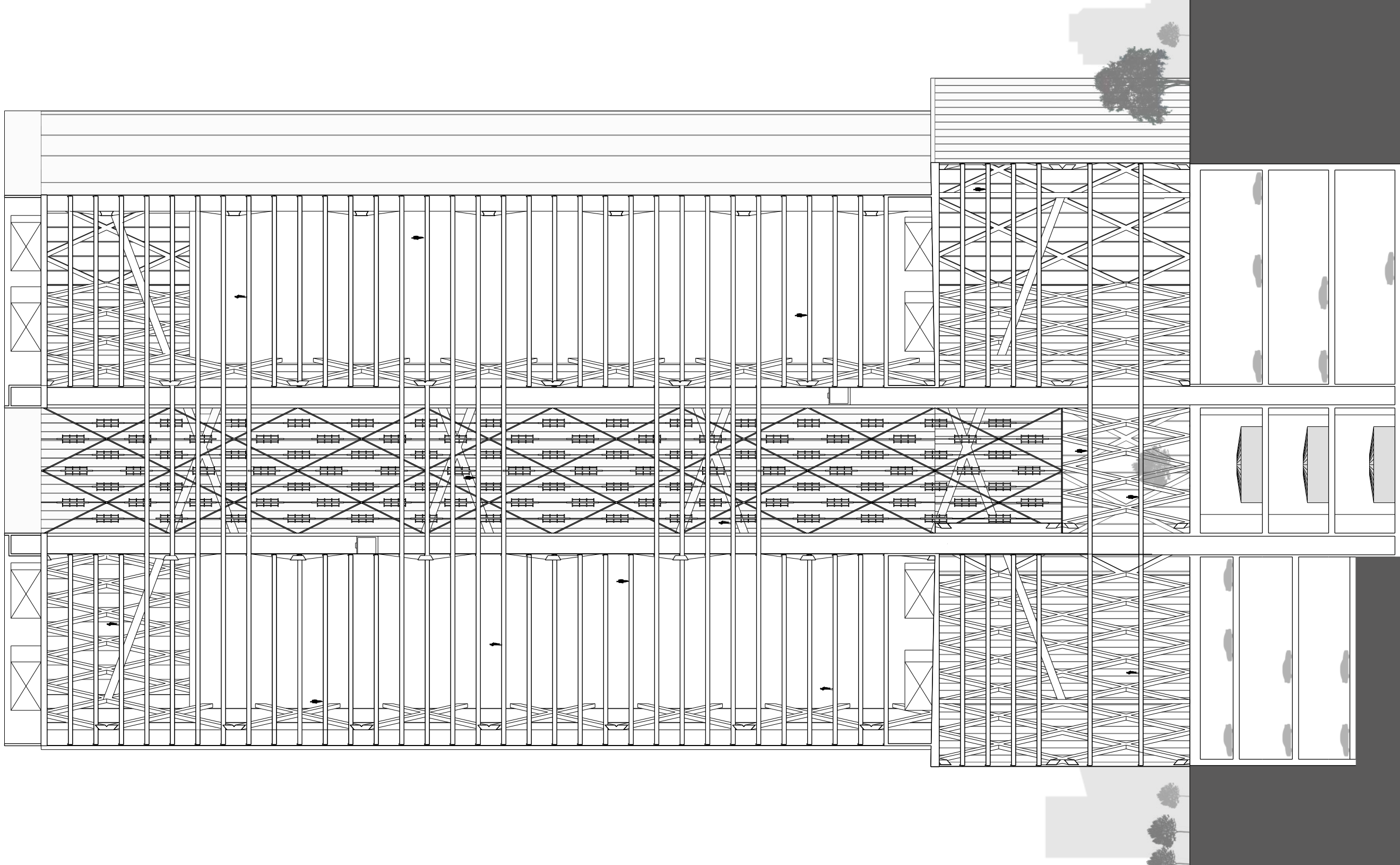
Section Cut B

Structure

The building relies on a Diagrid as its main structural support. Choosing to use this type of structure requires 21% less structural steel than a conventional steel frame system. This system also alleviates the use of columns within the building allowing for large, column-free floor space.

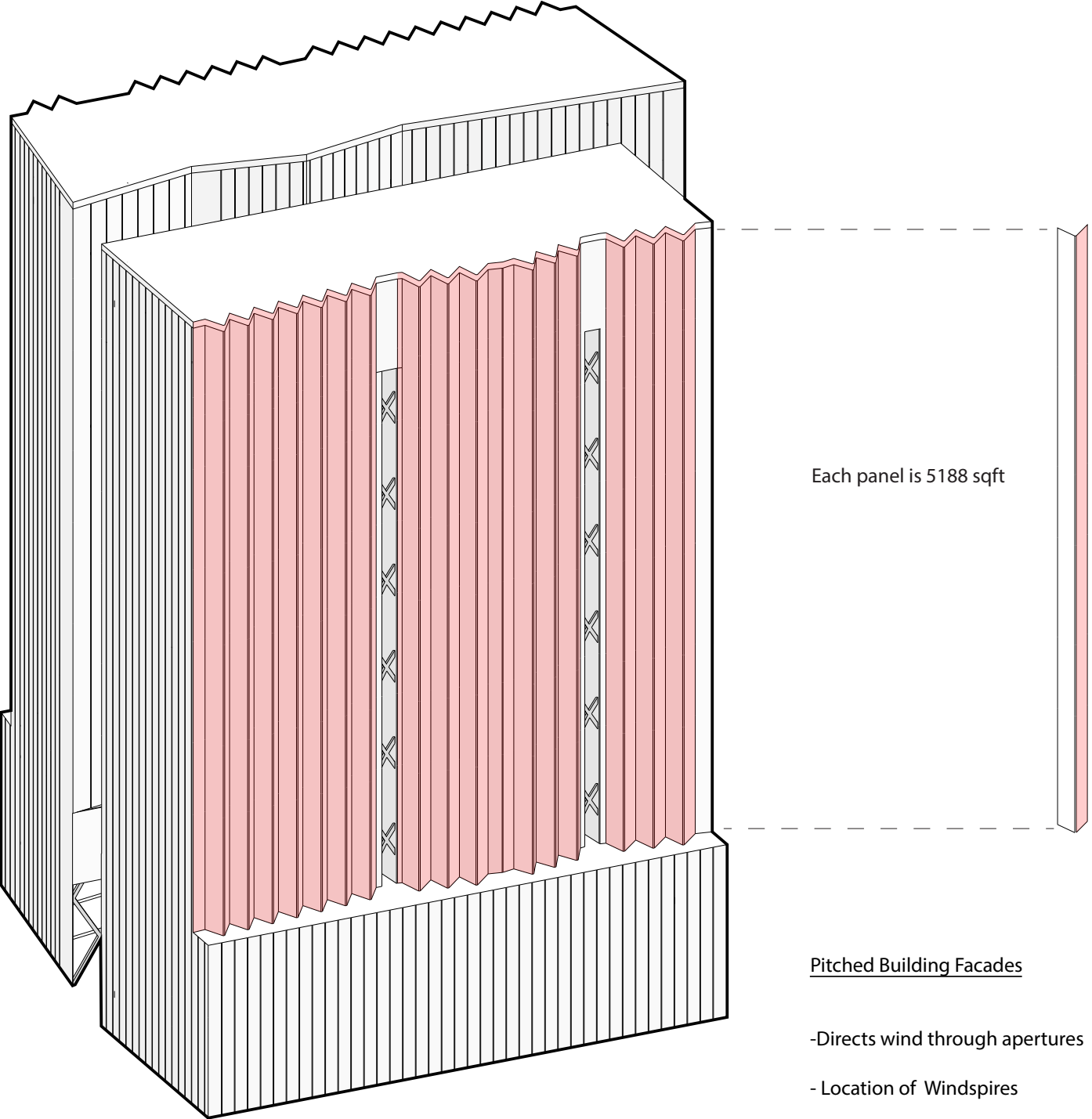


Structurally tying the two towers together was similar to how an I-Beam is connected. In this case, the two towers act as flanges while two cross structures hold the buildings together. These large structural ties are situated so that they align with the building's wind apertures.



Section Cut A

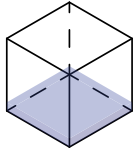
Southern Facade



Each panel is 5188 sqft

Pitched Building Facades

- Directs wind through apertures
- Location of Windspires
- Curtain wall retains and harvests water



.62 Gal per sq.ft can be collected for every inch of rain

New York City gets an 50" of rain per year



National average indoor residential water use per day per person

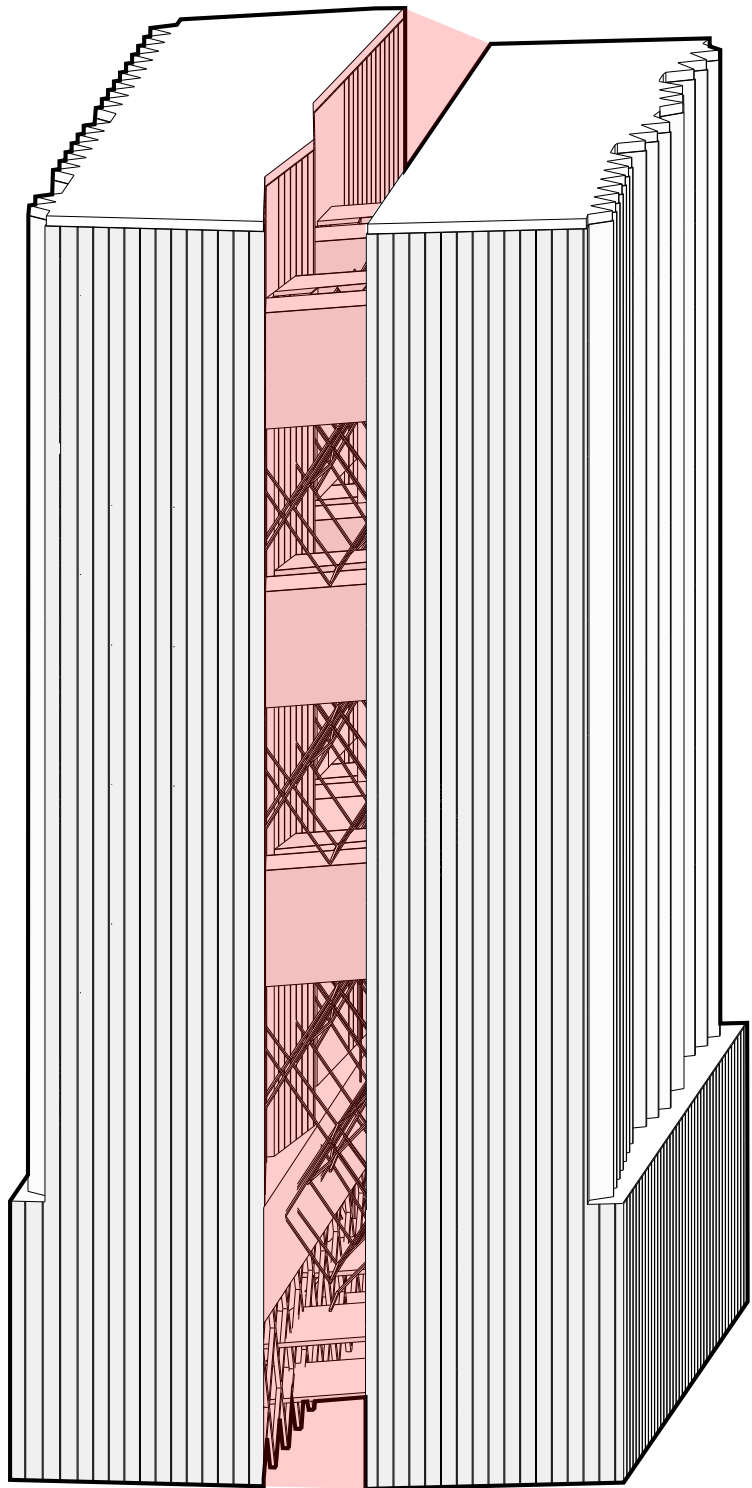
60 - 70 Gallons
per year

21,900 - 25,550 Gallons

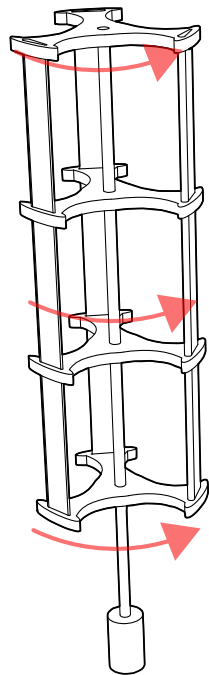
50-70% of all residential water use occurs

In the Bathroom

Similar to the water typology building, this building utilizes an accordion façade. In this case the façade does taper and are only located on two sides of the building. These sides were chosen since they are oriented to the Northeast and the South which allows exposure to the site's windpaths. Each panel of the accordion façade is 5188 sqft. This means that each panel has the potential to collect up to 160,828 gal of water each year. This translates to enough water to provide for about 7 people for the entire year. If the usage is restricted to bathrooms, twice as many people can benefit from this system. The storage units for the water exist within the parking garage of the building.



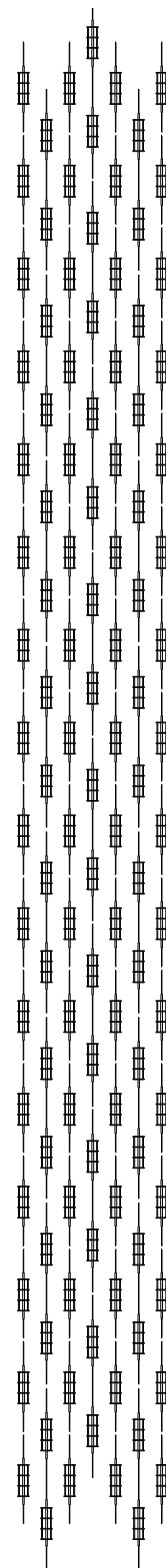
Eastern Facade



Generates 9400 kWh per year

External Structural Elements

- Directs wind between buildings
- Location of Windspires
- Primary location for Vertical Circulation



Windturbine Curtain

Each curtain can generate up to 1,015,200 kWh per year

The building takes advantage of wind from the southern and western directions through cuts made in its form. The first cut separates the building into two towers and is made so that it aligns with the winds coming from the west. This gap holds most the wind turbines in the building and is the location of the sky bridges and vertical circulation components of the two towers. To the south, the building has two large apertures that cut through both towers of the building. In addition to containing wind turbines, the apertures contain the main structure between the two towers and influences the spatial arrangement of the floor plates.

The wind turbines chosen for these areas are based off a model called Windspires. These Windspires were chosen since they have large range of operability (Operating under wind conditions of 10 mph to 32 mph). Each Windspire can generate up to 9400 kWh. When arrange in a curtain like structure, each arrangement can generate 1,015,200 kWh of power each year. Based on Nation Grid's energy assessment of office buildings , each wind turbine curtain can supply power needed for cooling for up to 6 floors. Since the power generated through this system exceeds the power demands of the building, the excess energy could then be supplied to the buildings within the surrounding area.

