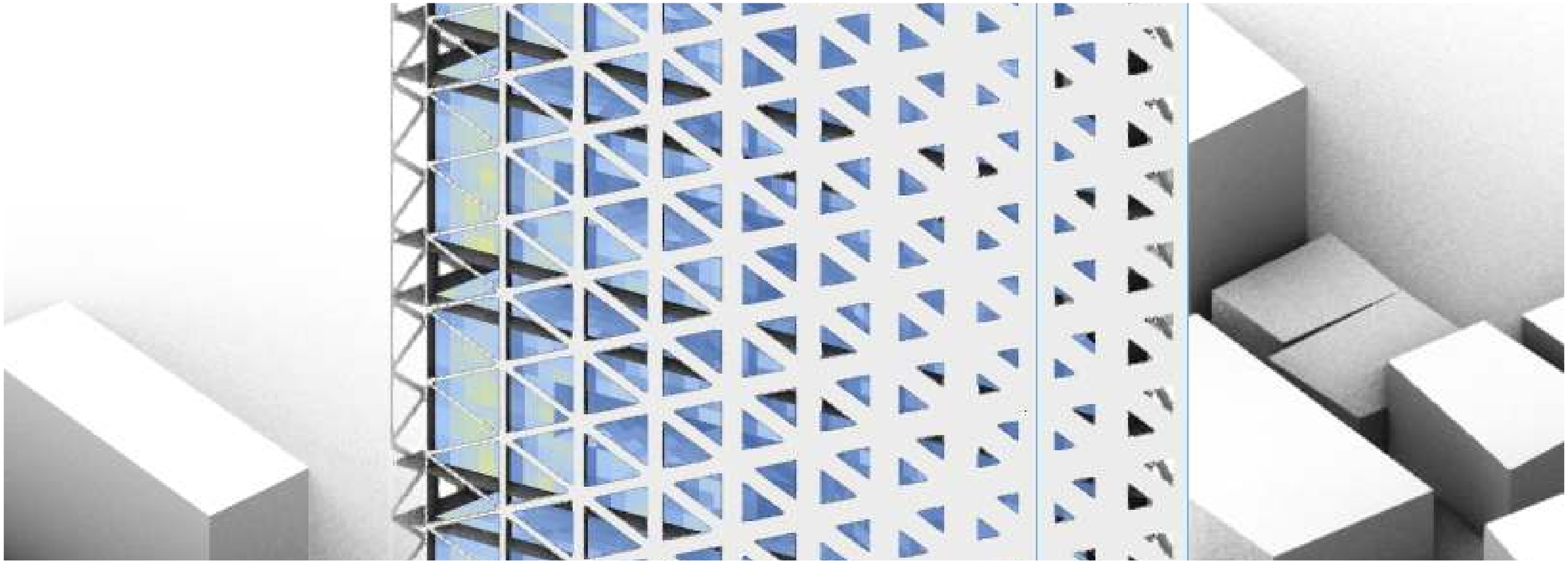
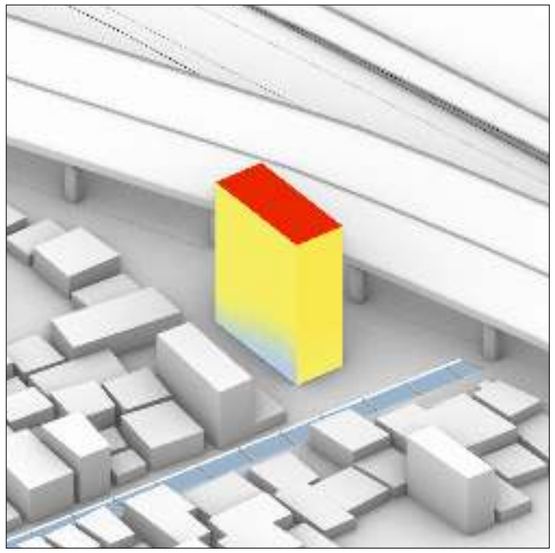


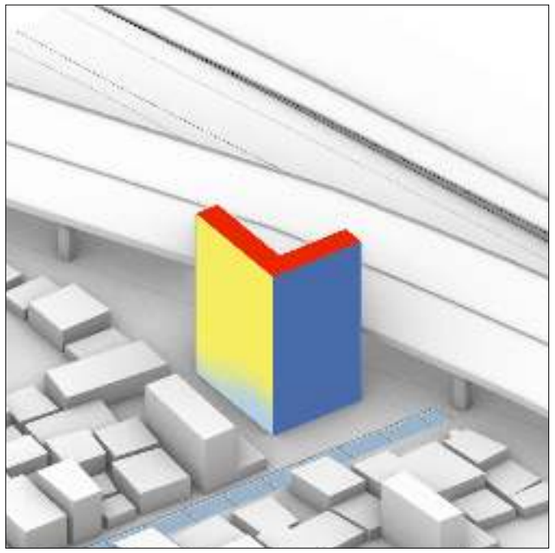
SOLAR STUDY

Submission Date	8/10/2024
Student Name (Nick Name) /Student Number/ Email Address	Nichapa Eamcharoen (Jinnie) / 6538052825 / nichapa.e@cuinda.com

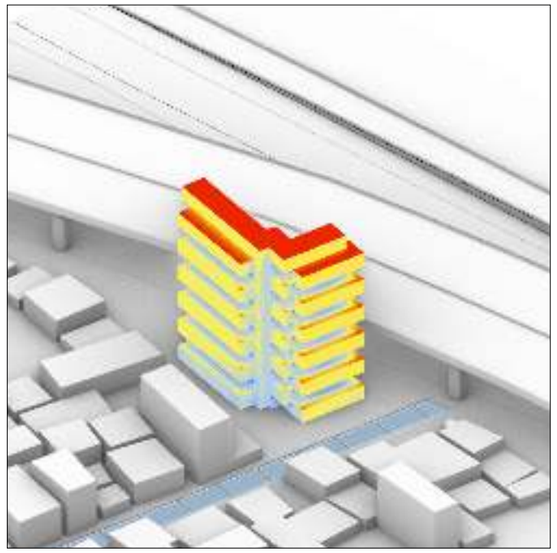
PROTOTYPE STUDY



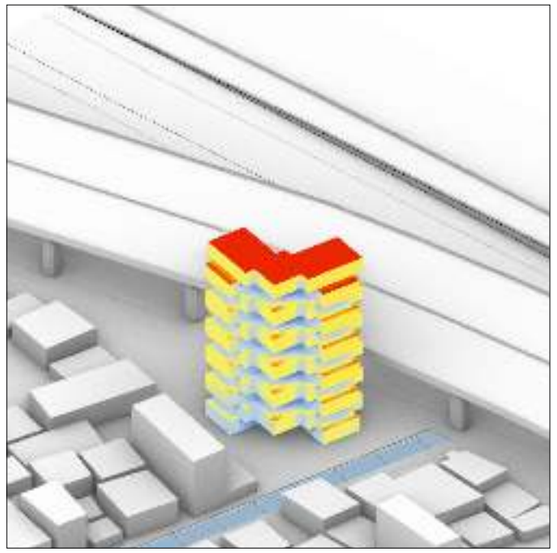
BASELINE



DESIGN 1



DESIGN 2



DESIGN 3

Prototype		
Baseline		
Total Building Surface Area	2,280	m2
Annual Solar Radiation	1,739,400	kWh/year
Averaged Total Solar Radiation	763	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Fail	

Design 1		
Total Building Surface Area	3,440	m2
Annual Solar Radiation	946,616	kWh/year
Averaged Total Solar Radiation	275	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Succesful	

Design 2		
Total Building Surface Area	6,162	m2
Annual Solar Radiation	2,587,700	kWh/year
Averaged Total Solar Radiation	420	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Succesful	

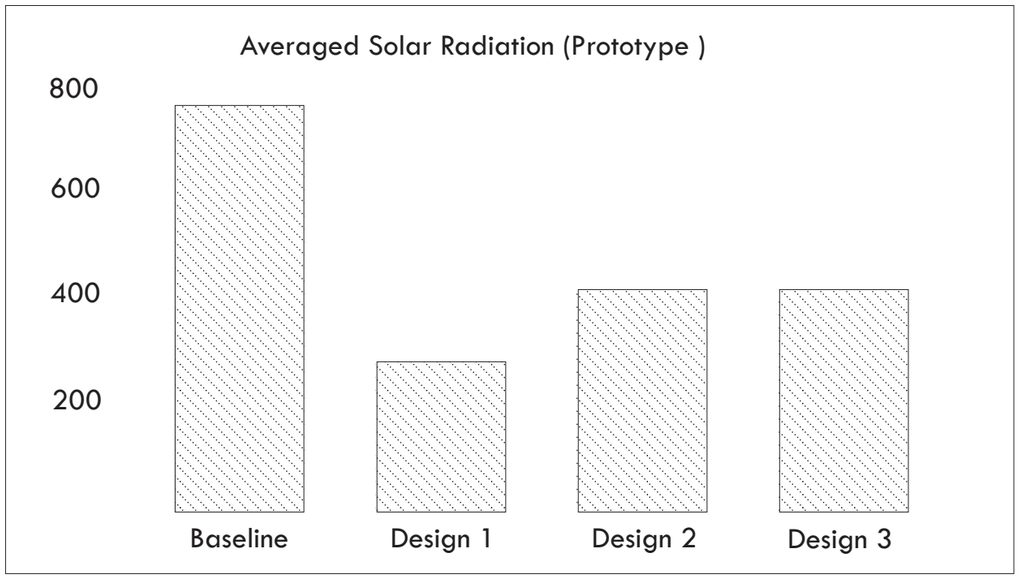
Design 3		
Total Building Surface Area	4,916	m2
Annual Solar Radiation	2,062,600	kWh/year
Averaged Total Solar Radiation	420	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Succesful	

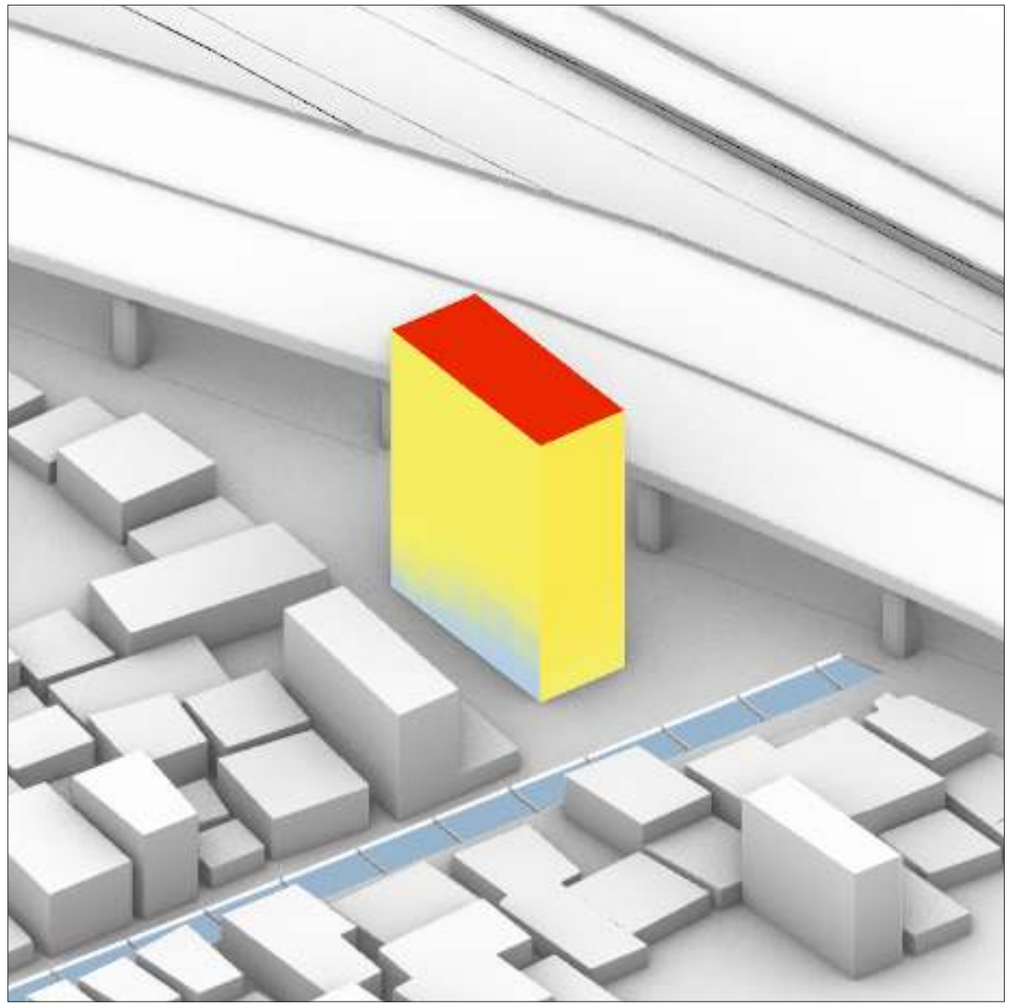
The prototype design consists of approximately 20-30 residential units, each floor area of 120 square meters and a height of 3 meters. The baseline design, initially conceived as a rectangular mass along the site, aligns with the site's layout. However, in response to contextual challenges, particularly the obstructed view caused by the adjacent highway, the design adopts an L-shaped configuration.

This L-shape serves a dual purpose: it not only redirects the views of residents away from the highway but also frames their sightlines towards the local urban fabric, enhancing their connection to the surrounding community.

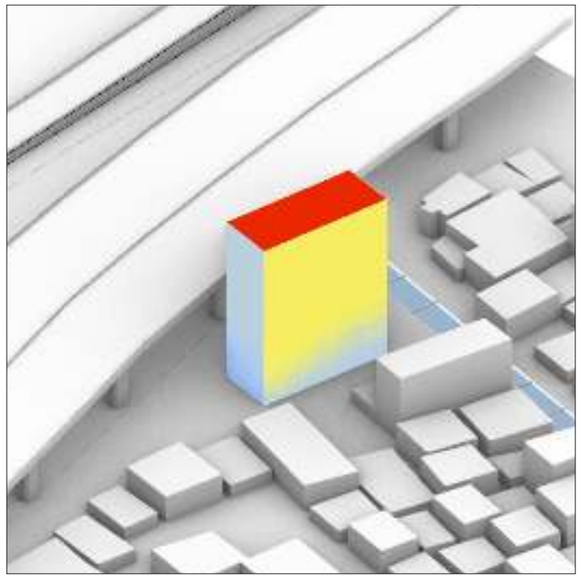
The design evolves from a straightforward, minimalistic shape into increasingly complex forms, which integrate passive shading strategies. Each iteration of the design further enhances the building's ability to manage solar exposure, with the more intricate forms functioning as shading devices themselves.

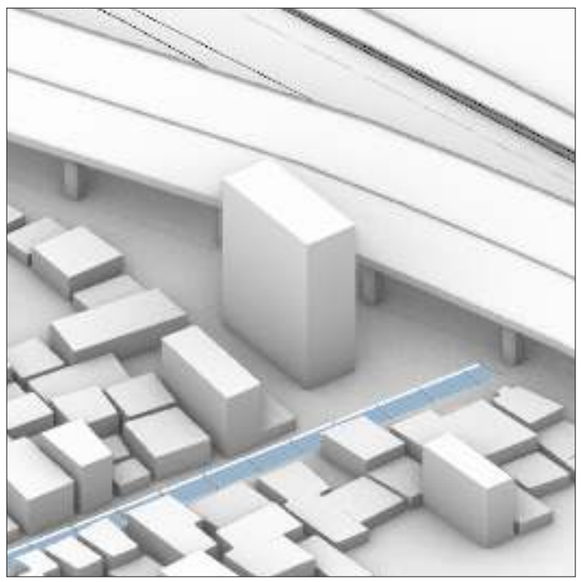
Among the variations, the first design iteration proves to be the most effective in terms of solar performance, achieving the lowest solar radiation value of 275. This reduction is primarily due to the orientation of the building's surface area, with most of it facing the south side, which naturally mitigates the impact of solar heat gain. At the same time, the design incorporates a range of complex architectural strategies, which further reduce solar radiation compared to the baseline rectangular design. These strategies not only enhance the visual aesthetics of the building, creating a harmonious balance between form and function.





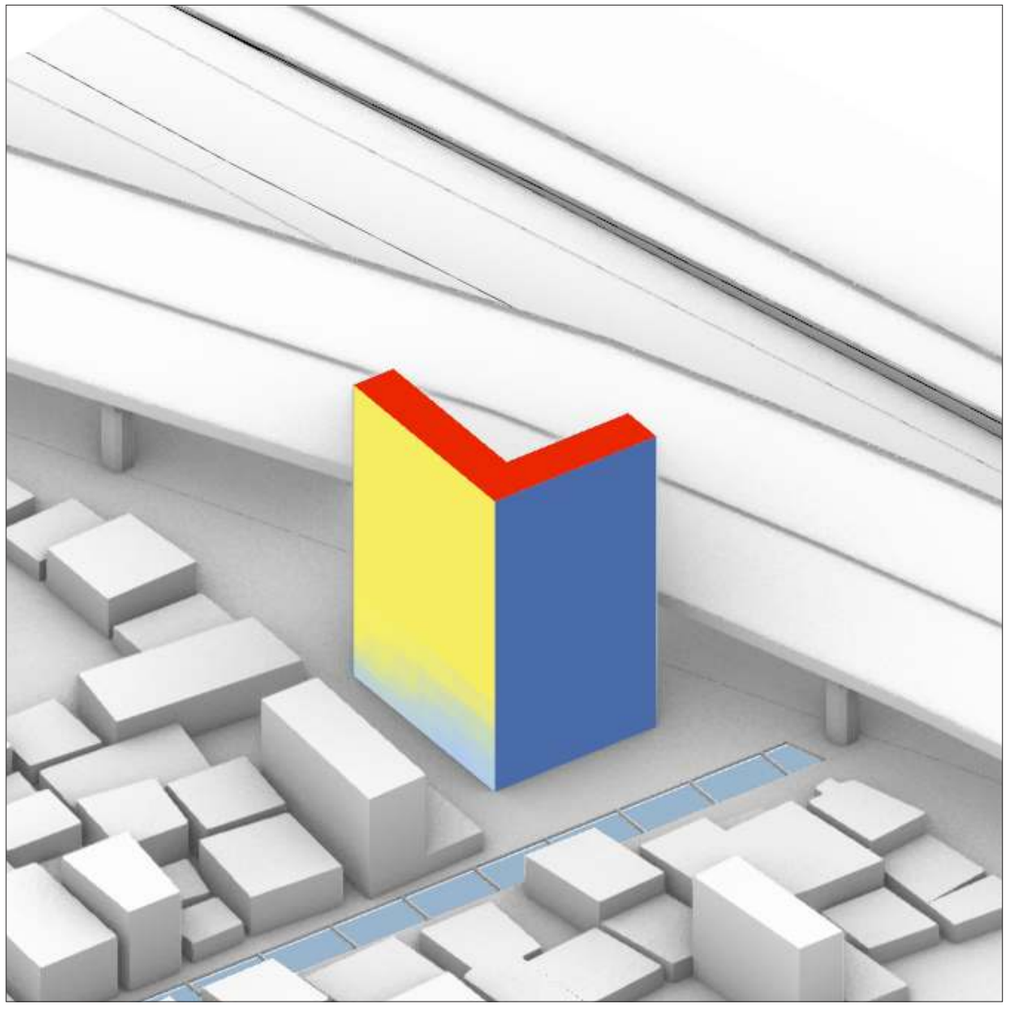
BASELINE



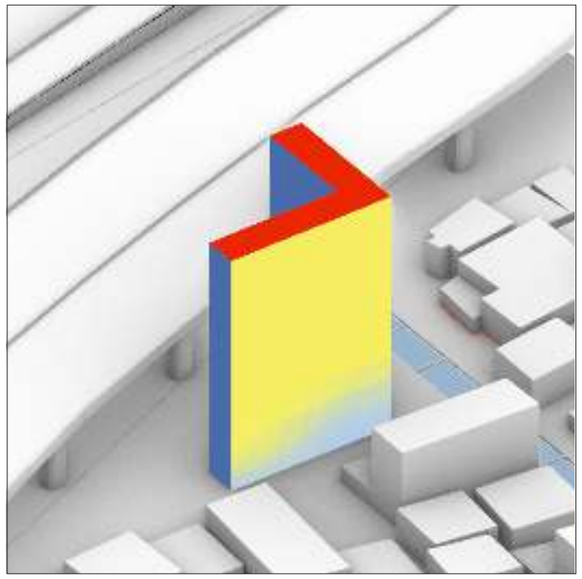


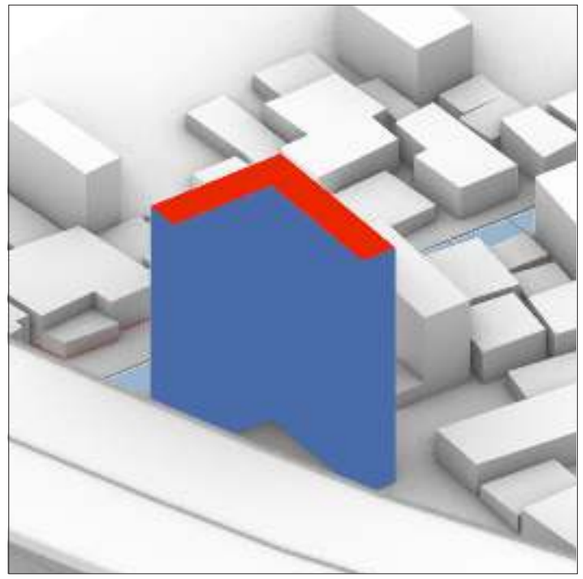
The baseline design is created using a simple rectangular shape as the starting point, intended to serve as a basic form for experimenting with solar radiation. Without any advanced design interventions or layering strategies, this initial configuration results in the highest levels of solar radiation exposure. The solid, unbroken shape and the large surface area leave the building vulnerable to direct sunlight, significantly increasing heat gain. This highlights the importance of developing more intricate designs and shading strategies to effectively manage solar radiation in the subsequent iterations.

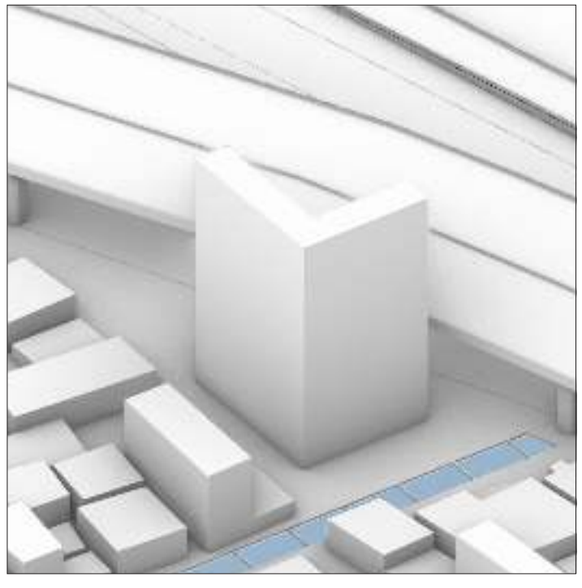
Baseline		
Total Building Surface Area	2,280	m2
Annual Solar Radiation	1,739,400	kWh/year
Averaged Total Solar Radiation	763	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Fail	



DESIGN 1

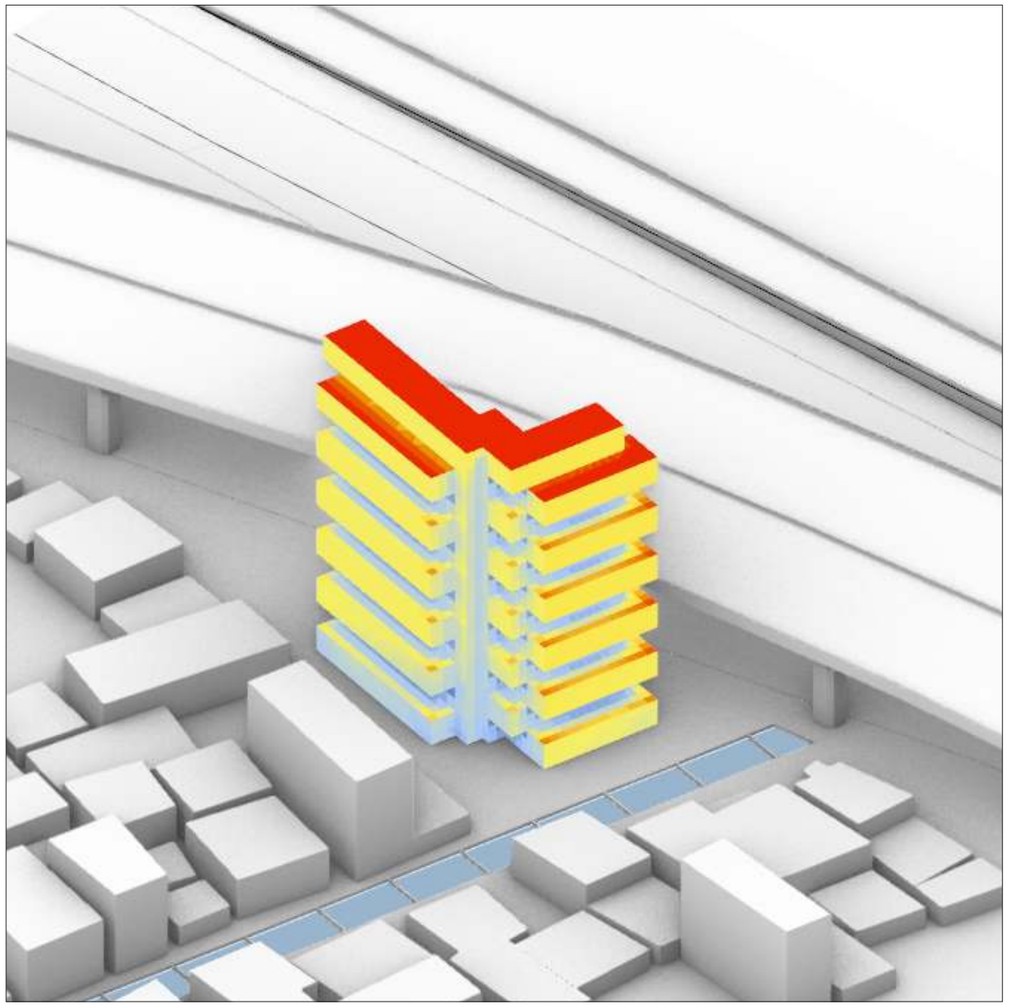




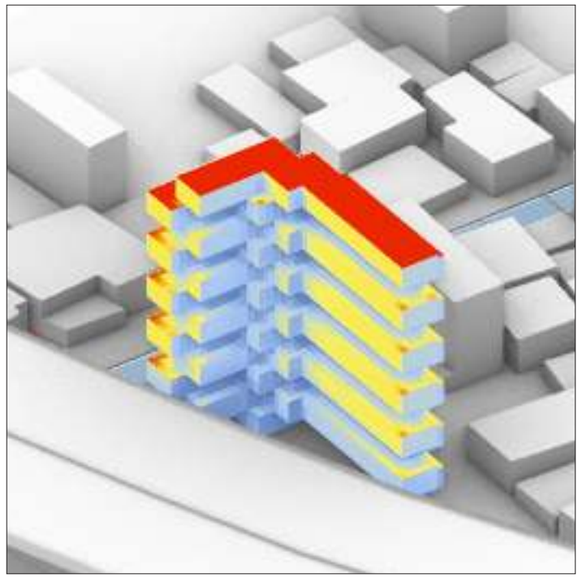


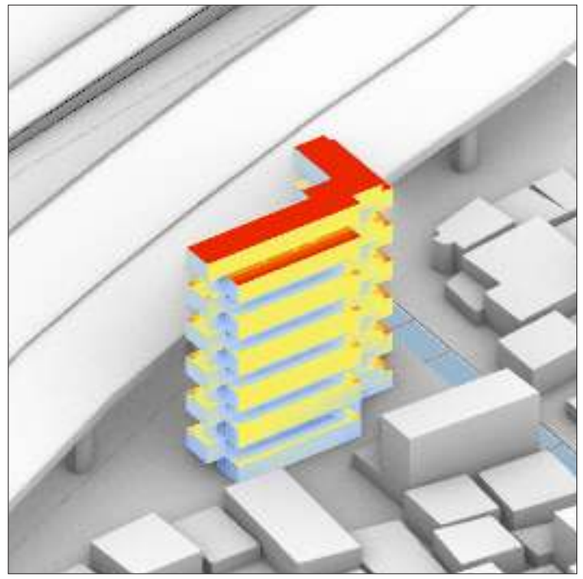
Design 1		
Total Building Surface Area	3,440	m2
Annual Solar Radiation	946,616	kWh/year
Averaged Total Solar Radiation	275	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Succesful	

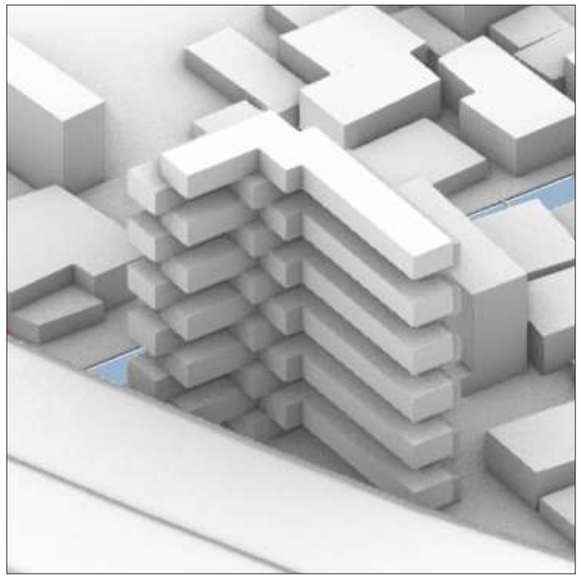
The design process begins with the adoption of an L-shape as the central concept for the building, driven by the site's context and the visual obstruction created by the nearby highway. This shape effectively redirects residents' views away from the highway, allowing for more appealing sightlines toward the local environment. Additionally, the L-shape is highly efficient in minimizing solar radiation, achieving the lowest levels among the design options. By reducing direct sun exposure, it enhances thermal comfort within the living spaces and promotes a healthier indoor environment. Overall, the L-shape is an ideal choice for this particular site.



DESIGN 2



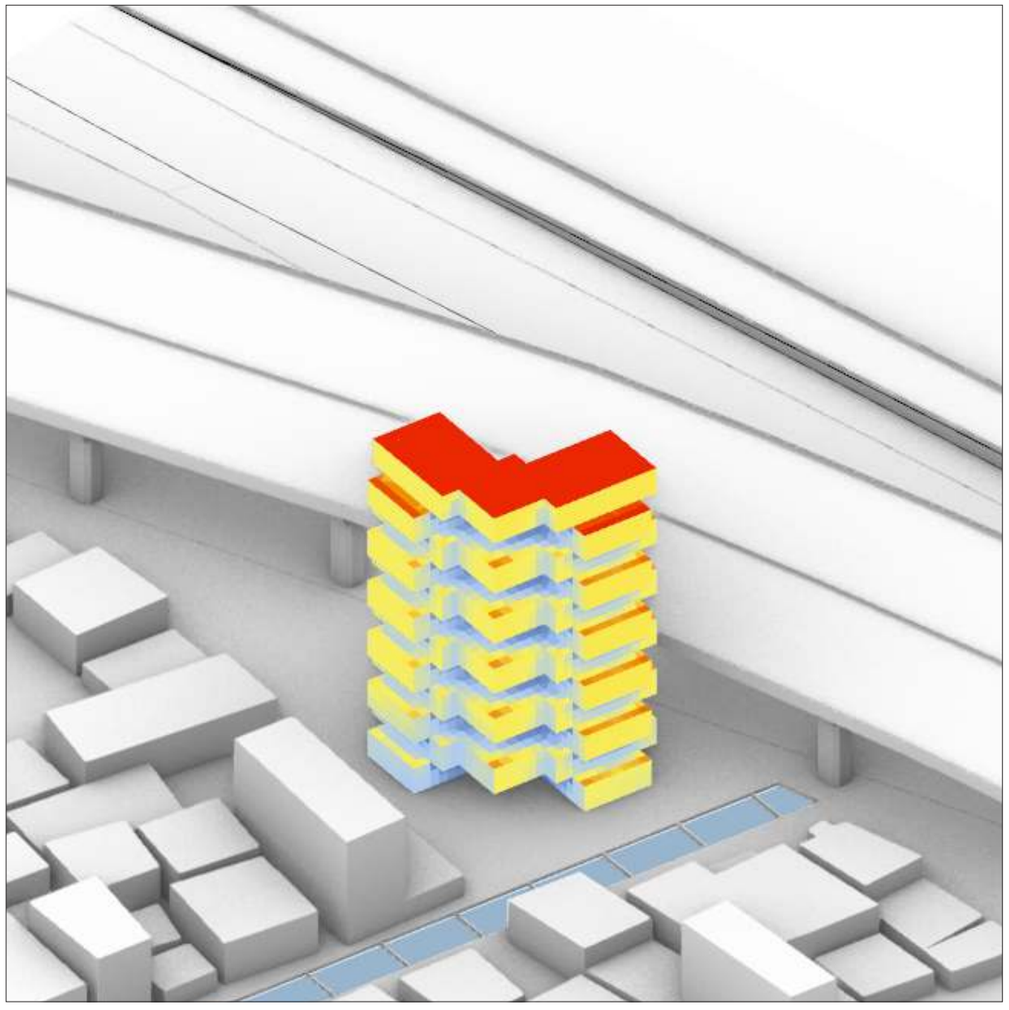




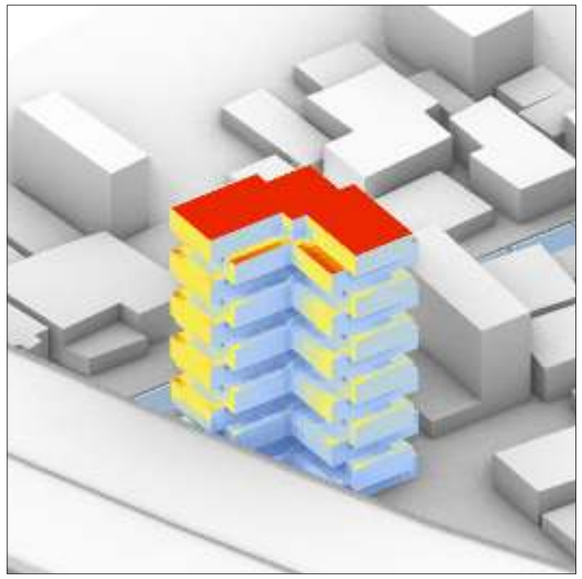
This second design expands upon the original L-shaped concept, incorporating two sizes of residential units tailored to the site area. The building is arranged in a zigzag formation, creating a dynamic and complex shape that offers unobstructed views of the surrounding urban landscape.

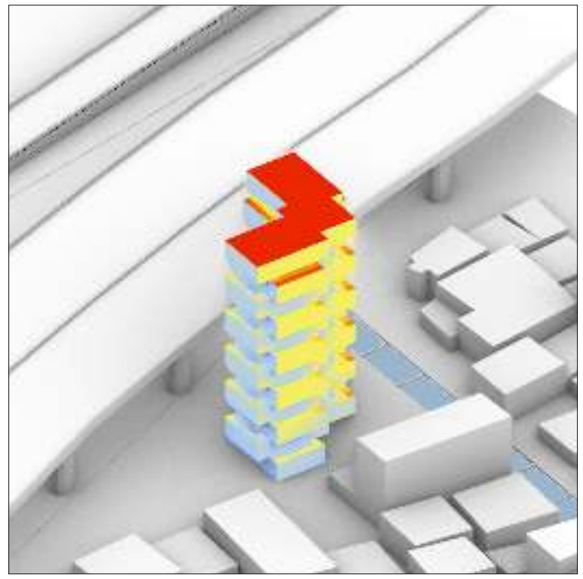
By framing the residents' perspectives toward the local urban side, the design intentionally shifts focus away from the busy highway. This arrangement enhances natural light and cross-ventilation, ensuring a comfortable living experience while maximizing the unique characteristics of the site.

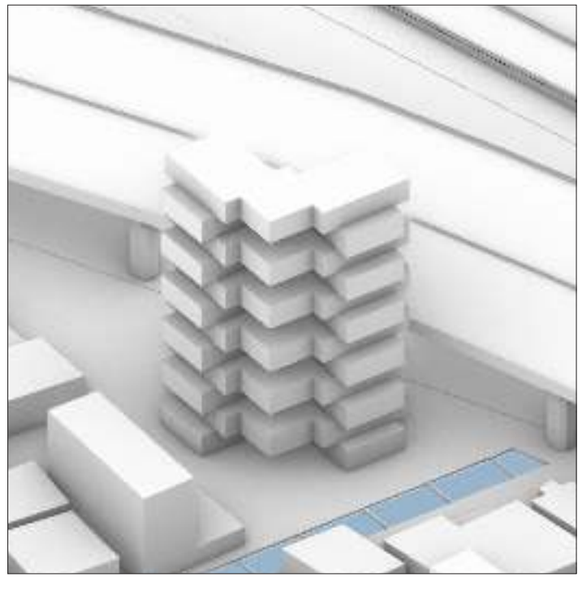
Design 2		
Total Building Surface Area	6,162	m2
Annual Solar Radiation	2,587,700	kWh/year
Averaged Total Solar Radiation	420	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Succesful	



DESIGN 3



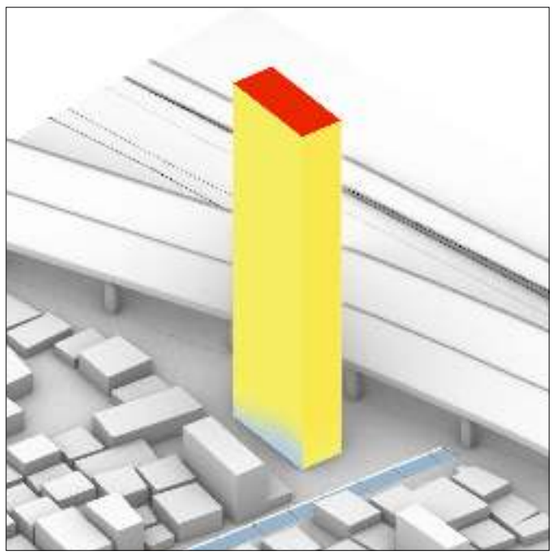




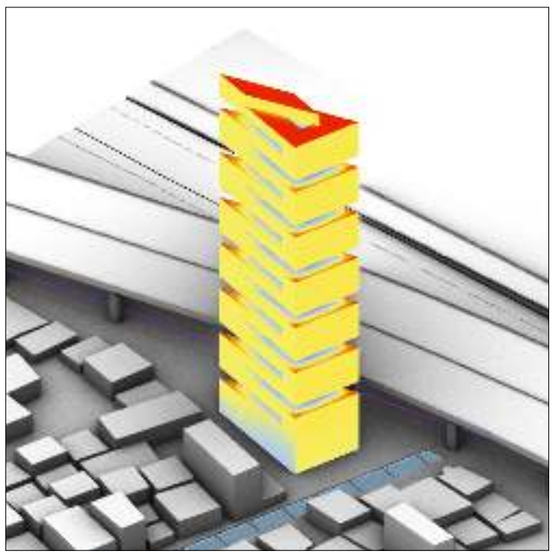
Design 3		
Total Building Surface Area	4,916	m2
Annual Solar Radiation	2,062,600	kWh/year
Averaged Total Solar Radiation	420	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Succesful	

The building design evolves from the concept of an L-shaped structure, with each floor featuring only two units. This layout aims to create private residential spaces, ensuring that each unit enjoys a full, unobstructed view without interference from the highway. By strategically positioning the units, the design fosters a sense of intimacy and comfort for residents.The zigzag arrangement of the rooms not only enhances visual interest but also acts as a natural shading device, minimizing direct sunlight while maximizing visual connections to the surrounding environment. This design allowing residents to fully enjoy their living spaces while embracing the urban context.

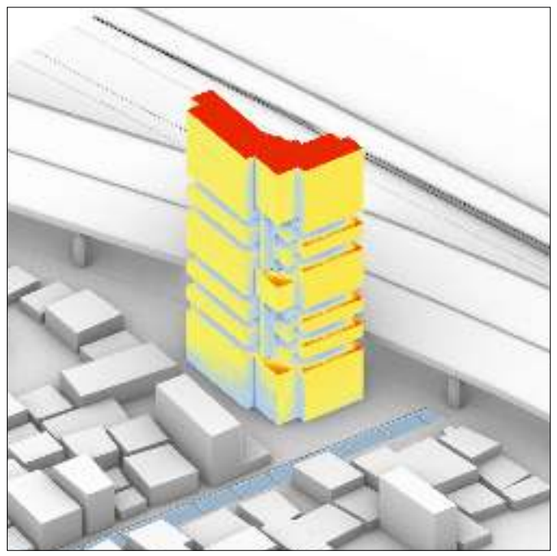
BUILDING MASS



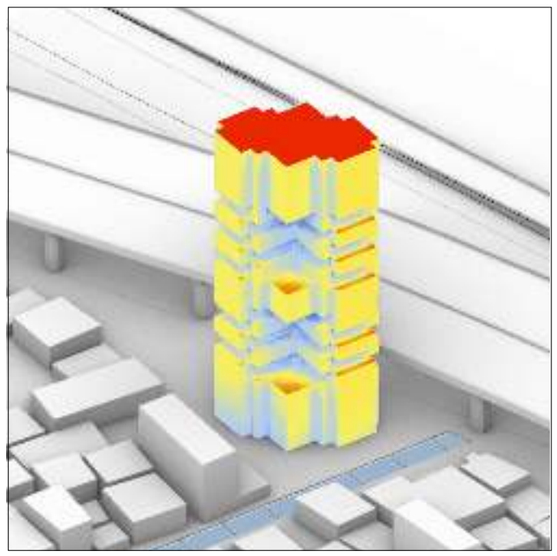
BASELINE



DESIGN 1



DESIGN 2



DESIGN 3

Prototype		
Baseline		
Total Building Surface Area	5,952	m2
Annual Solar Radiation	4,319,200	kWh/year
Averaged Total Solar Radiation	726	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Fail	

Design 1		
Total Building Surface Area	10,875	m2
Annual Solar Radiation	4,981,600	kWh/year
Averaged Total Solar Radiation	458	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Succesful	

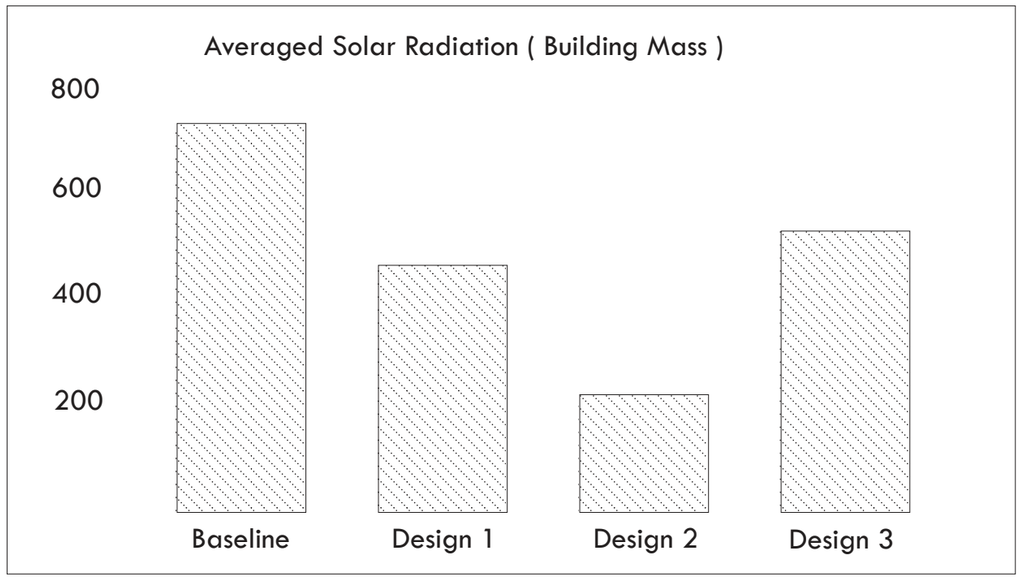
Design 2		
Total Building Surface Area	20,721	m2
Annual Solar Radiation	4,392,400	kWh/year
Averaged Total Solar Radiation	212	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Succesful	

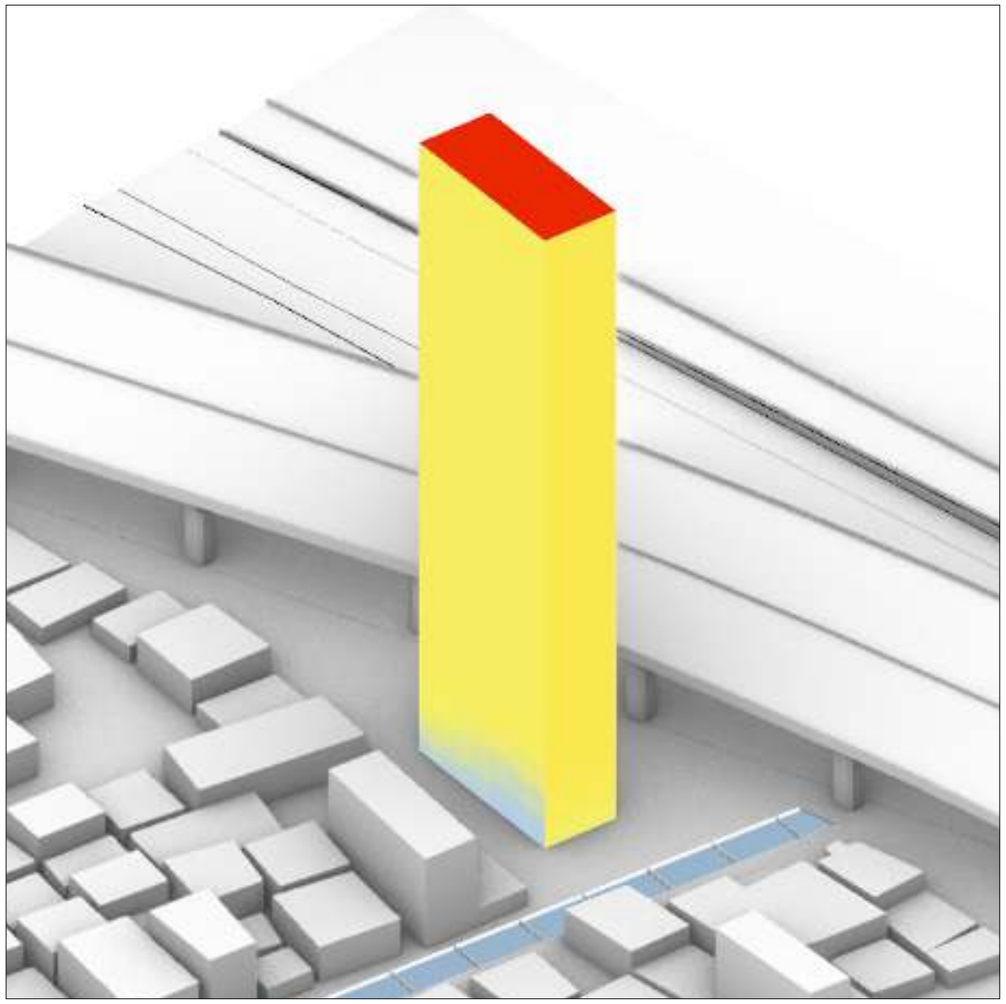
Design 3		
Total Building Surface Area	6,556	m2
Annual Solar Radiation	3,410,600	kWh/year
Averaged Total Solar Radiation	520	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Succesful	

The next phase in the building design introduces common spaces, with a total area of 2,000 square meters and a ceiling height of 6 meters. These shared areas are strategically integrated into the building to not only enhance the sense of community but also provide a seamless link between the individual residential units. The placement of these spaces is carefully considered to ensure easy access for all residents, encouraging interaction and fostering a communal atmosphere.

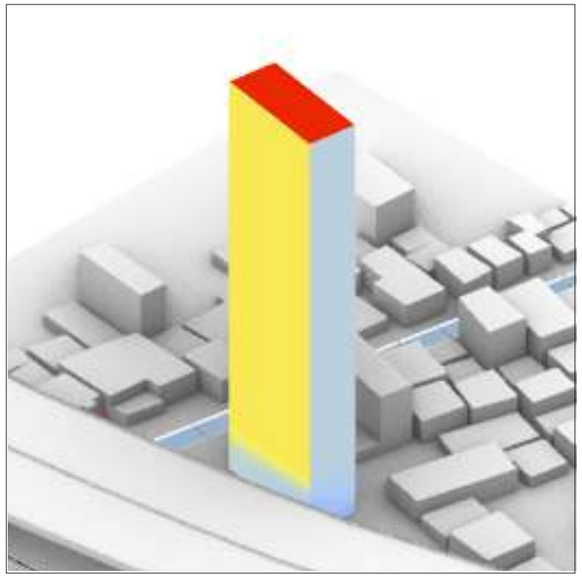
The largest common areas are situated on the first floor, where they serve as the primary point of connection between the various units, and on the rooftop, offering residents access to open-air spaces for relaxation and social activities. Each design iteration experiments with different placements of the common areas, balancing the need for functional access with the desire to preserve the architectural integrity and shape of the overall building form.

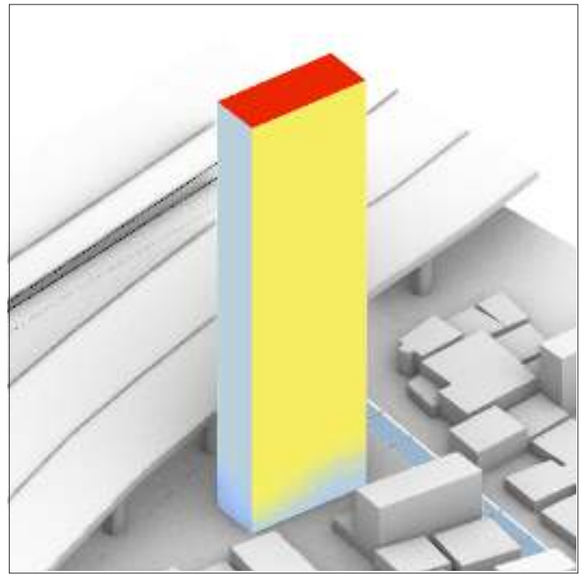
In terms of solar performance, design two , achieving an even lower solar radiation value of 212. This reduction is achieved while maintaining a form nearly identical to the prototype design. By carefully placing the common spaces in optimal locations, the design succeeds in maintaining its low solar radiation level. The interplay of residential and common spaces in the design not only enhances the living experience but also adds complexity and depth to the architectural form, contributing to both aesthetic appeal and environmental performance.





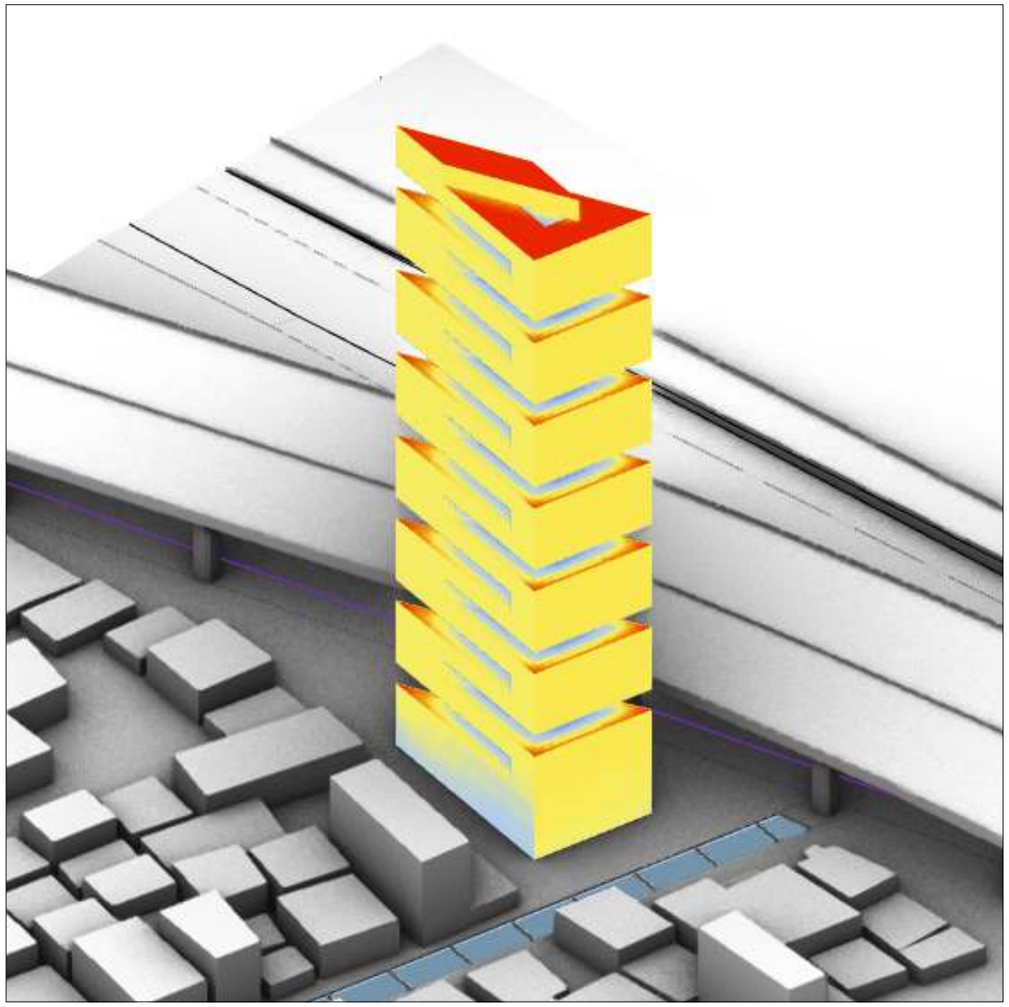
BASELINE



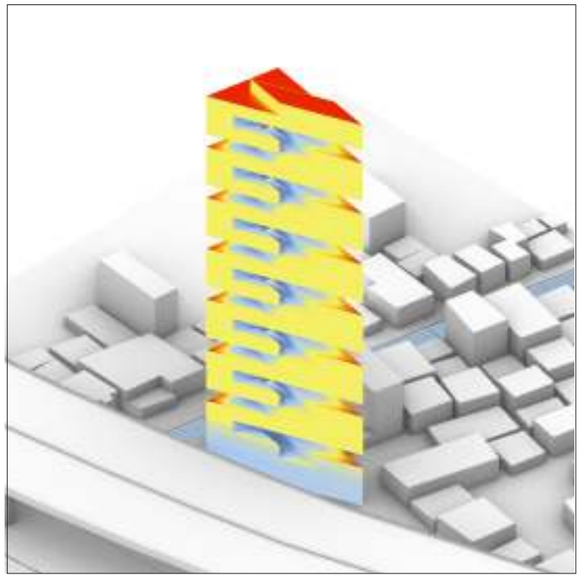


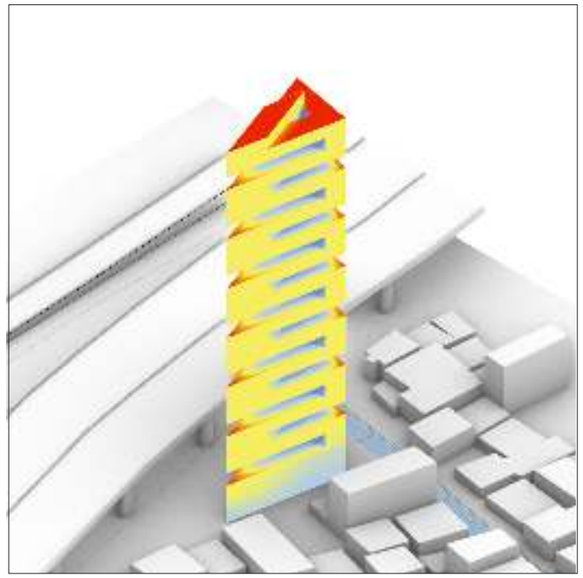
The baseline design for the common area incorporates shared spaces between the buildings to ensure convenient access for all residents. Emphasizing both the first floor and the rooftop, these areas foster social interaction and community engagement. The first-floor spaces allow easy accessibility, while the rooftop provides a relaxing setting for recreation, enhancing the overall living experience by promoting connectivity and community.

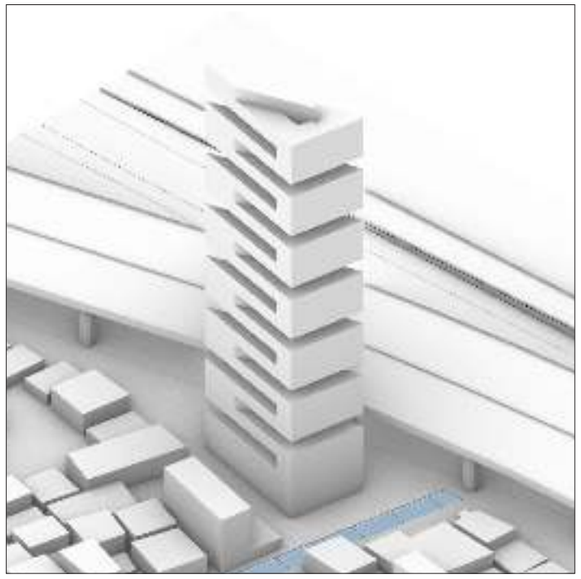
Baseline		
Total Building Surface Area	5,952	m2
Annual Solar Radiation	4,319,200	kWh/year
Averaged Total Solar Radiation	726	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Fail	



DESIGN 1

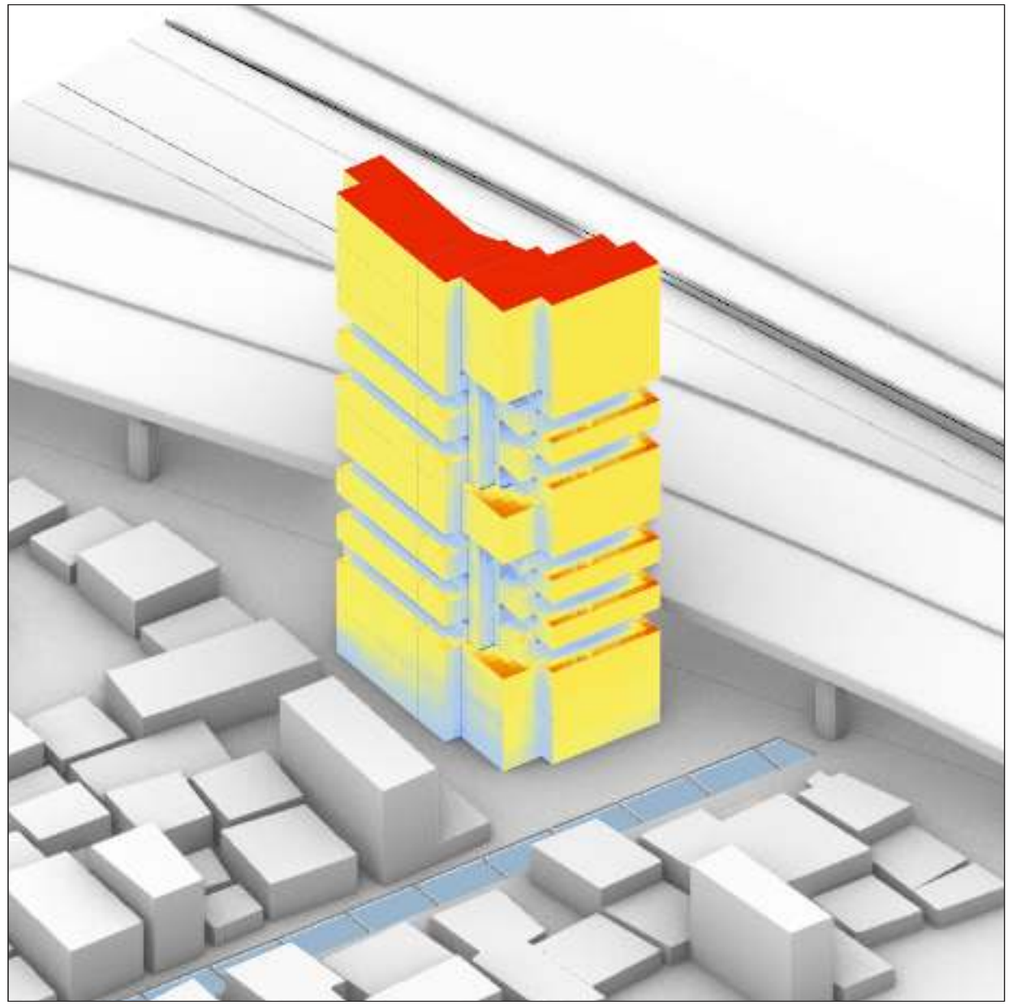




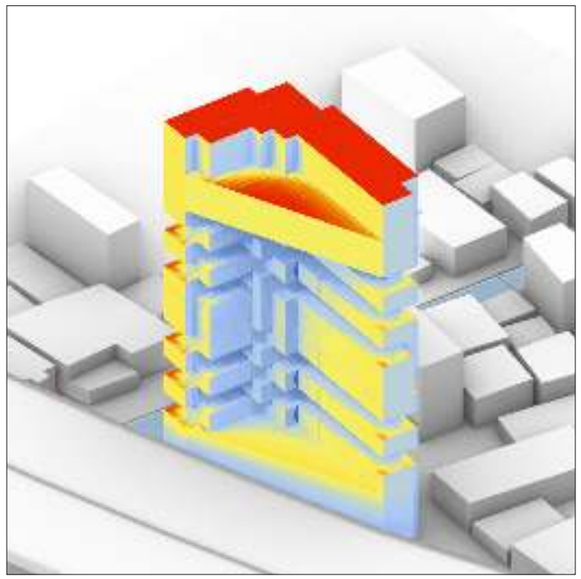


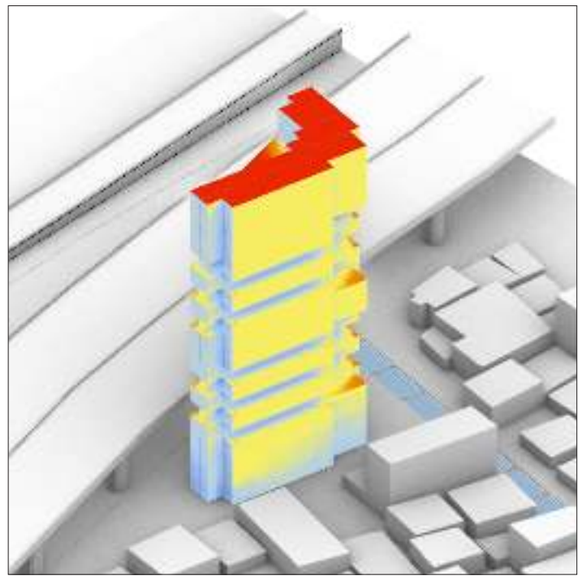
The design evolves from the initial L-shape by connecting both sides, creating a cohesive structure centered around a triangular geometric element. Each floor unit is strategically placed to follow the concept of frame viewing, optimizing sightlines for residents. Common areas are intentionally oriented toward the highway, allowing for active social spaces while ensuring that residential units face the local environment. This arrangement enhances residents' connections to the community, providing them with unobstructed views of the neighborhood and minimizing the visual impact of the highway.

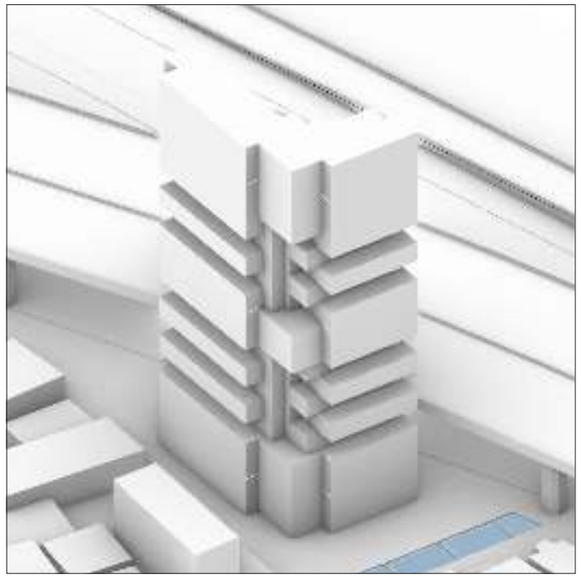
Design 1		
Total Building Surface Area	10,875	m2
Annual Solar Radiation	4,981,600	kWh/year
Averaged Total Solar Radiation	458	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Succesful	



DESIGN 2

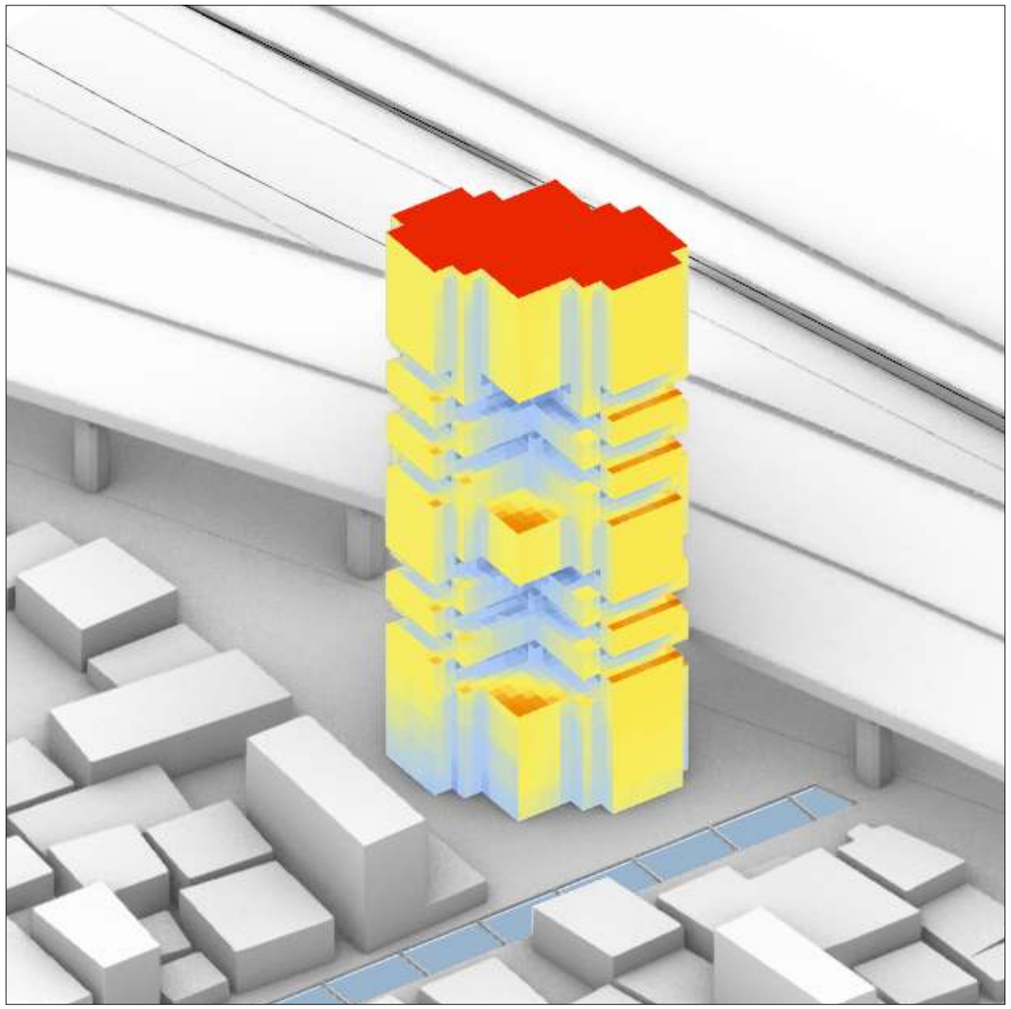




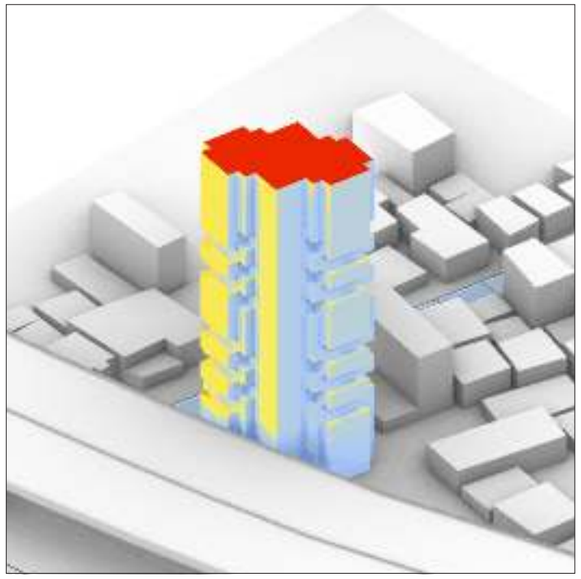


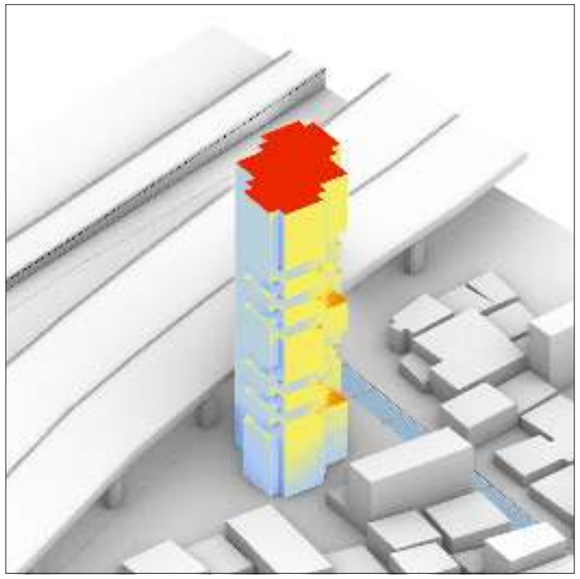
This design integrates common spaces by linking the two sides of the L-shape, creating shared areas for residents between the buildings. While slightly altering the building's initial form, these spaces effectively reduce solar radiation. This thoughtful addition enhances functionality and fosters community by serving as gathering points for social interactions. By providing accessible areas for relaxation and collaboration, the design improves the overall living experience and cultivates a vibrant environment.

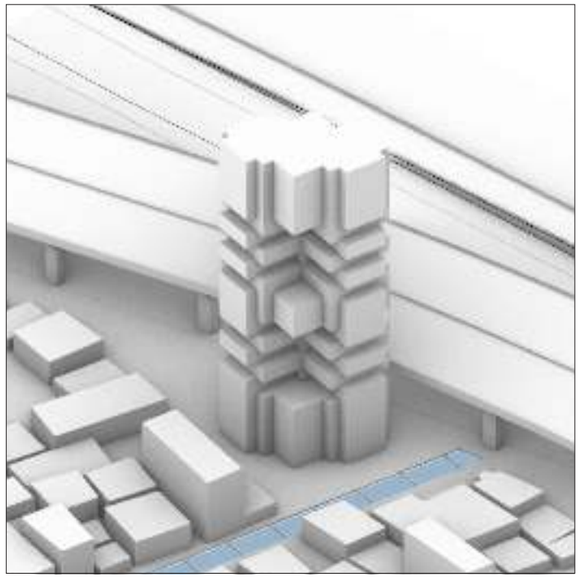
Design 2		
Total Building Surface Area	20,721	m2
Annual Solar Radiation	4,392,400	kWh/year
Averaged Total Solar Radiation	212	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Succesful	



DESIGN 3



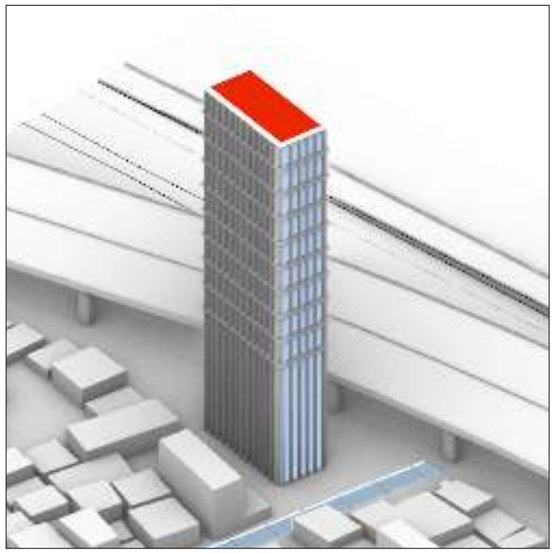




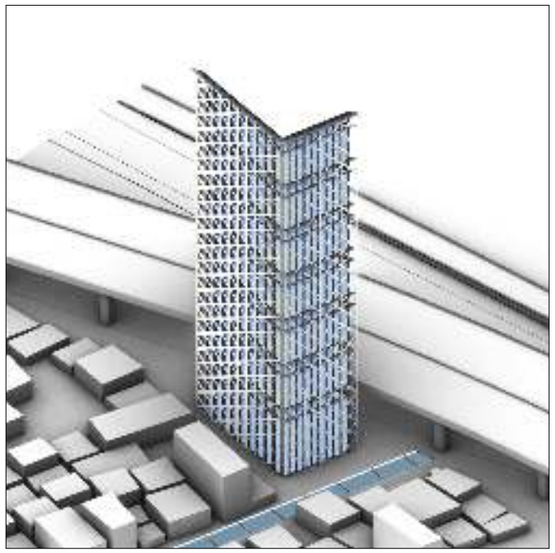
The design retains the initial shape of design three while incorporating common areas strategically placed between the buildings. This enhancement facilitates easier access for residents and creates inviting pathways that encourage movement and interaction among the spaces. By adding these common areas, the design promotes community engagement, allowing residents to gather and connect in a welcoming environment. Despite these changes, the overall architectural form remains cohesive, reflecting the original concept. This balance between maintaining the established shape and enhancing functionality contributes to a vibrant and accessible living experience.

Design 3		
Total Building Surface Area	6,556	m2
Annual Solar Radiation	3,410,600	kWh/year
Averaged Total Solar Radiation	520	kWh/m2/year
Target Solar Radiation	600	kWh/m2/year
Result	Succesful	

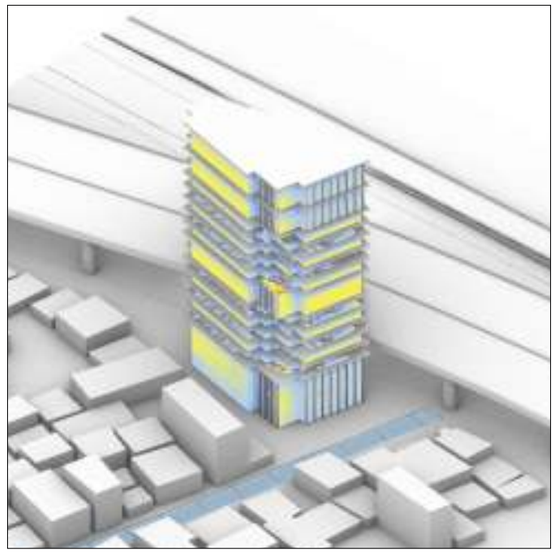
FACADE AND SHADING



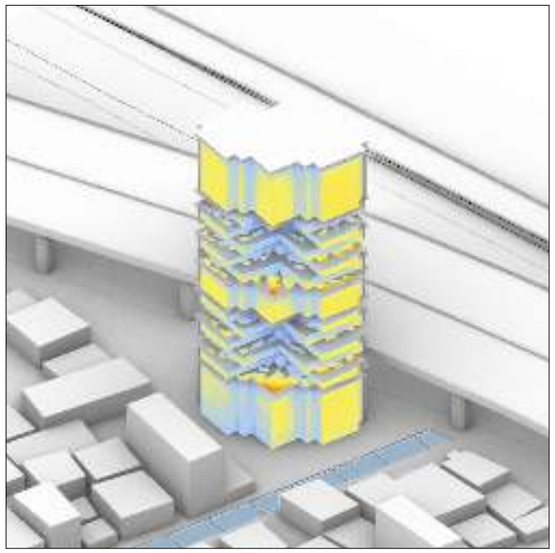
BASELINE



DESIGN 1



DESIGN 2



DESIGN 3

Prototype		
Baseline		
Total Building Surface Area	5,952	m2
Annual Solar Radiation	2,206,200	kWh/year
Averaged Total Solar Radiation	371	kWh/m2/year
Target Solar Radiation	500	kWh/m2/year
Result	Succesful	

Design 1		
Total Building Surface Area	10,875	m2
Annual Solar Radiation	2,490,200	kWh/year
Averaged Total Solar Radiation	229	kWh/m2/year
Target Solar Radiation	500	kWh/m2/year
Result	Succesful	

Design 2		
Total Building Surface Area	20,721	m2
Annual Solar Radiation	2,072,000	kWh/year
Averaged Total Solar Radiation	100	kWh/m2/year
Target Solar Radiation	500	kWh/m2/year
Result	Succesful	

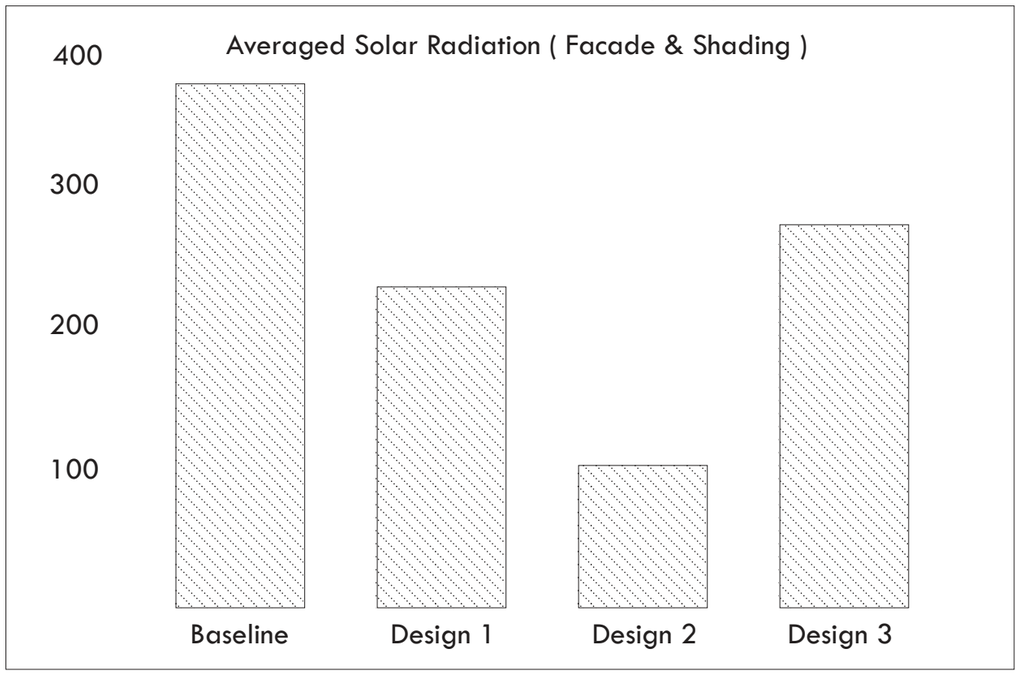
Design 3		
Total Building Surface Area	6,556	m2
Annual Solar Radiation	1,787,900	kWh/year
Averaged Total Solar Radiation	273	kWh/m2/year
Target Solar Radiation	500	kWh/m2/year
Result	Succesful	

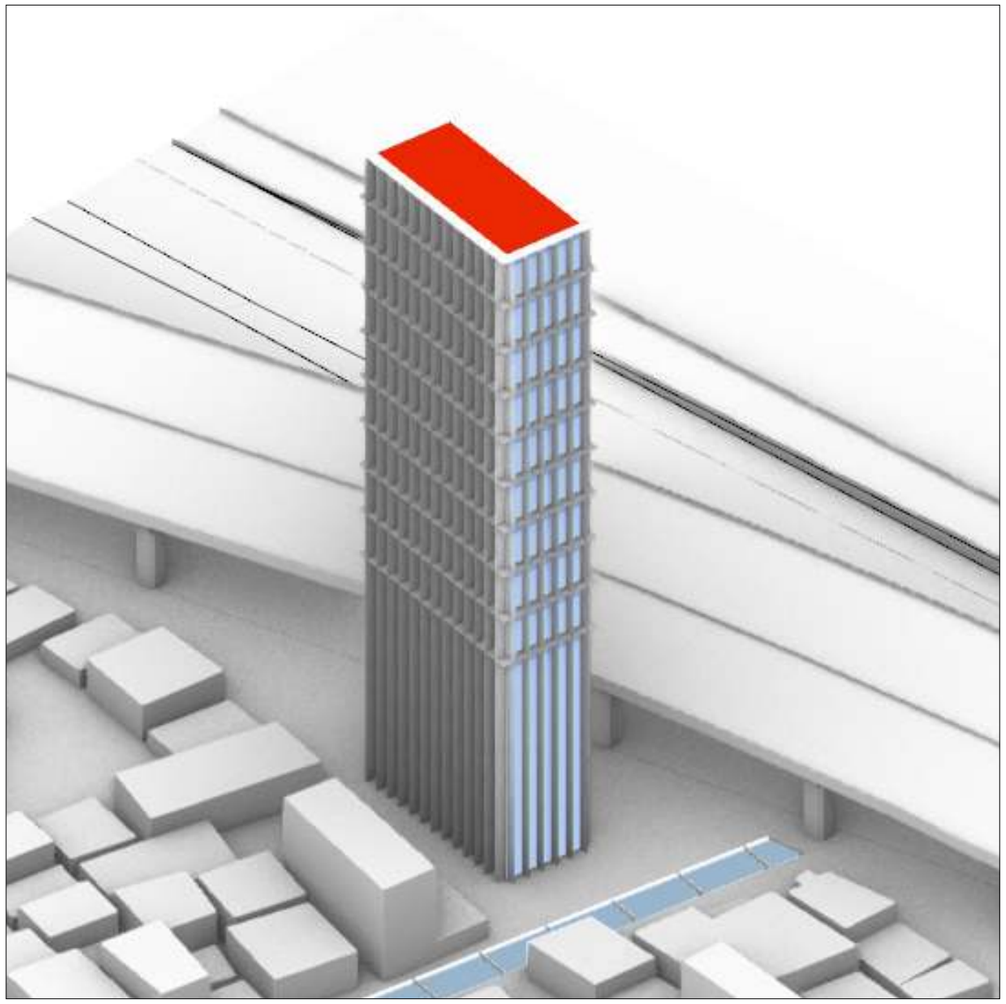
The final phase of the building design focuses on incorporating shading elements and façades, with the primary strategy being the careful placement of dense façades on the highway-facing side of the building. This approach follows the overarching design principle of frame viewing, which aims to shield the residents from the undesirable views of the highway while enhancing the framed perspectives toward the local urban landscape.

Each design iteration features its own unique façade, developed in alignment with the building's initial form and concept. These façades are not merely aesthetic features but serve critical functions in regulating solar exposure and contributing to the overall shading strategy of the building.

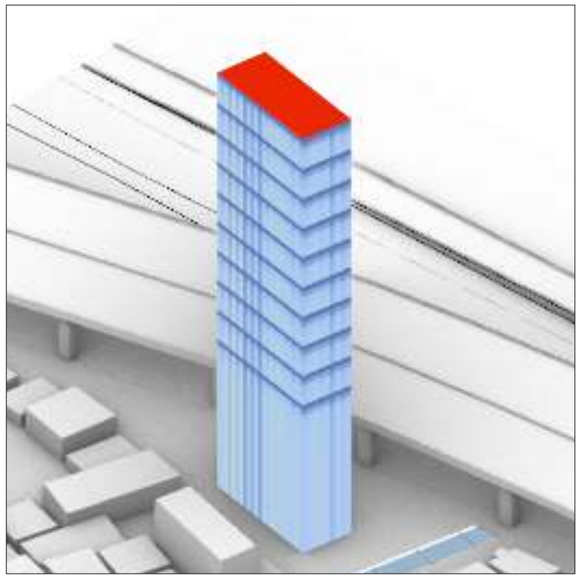
Among the designs, design two stands out for achieving the lowest solar radiation value of 100. Despite its simplicity, this façade proves to be highly effective in minimizing solar heat gain, utilizing clean lines and a straightforward layout.

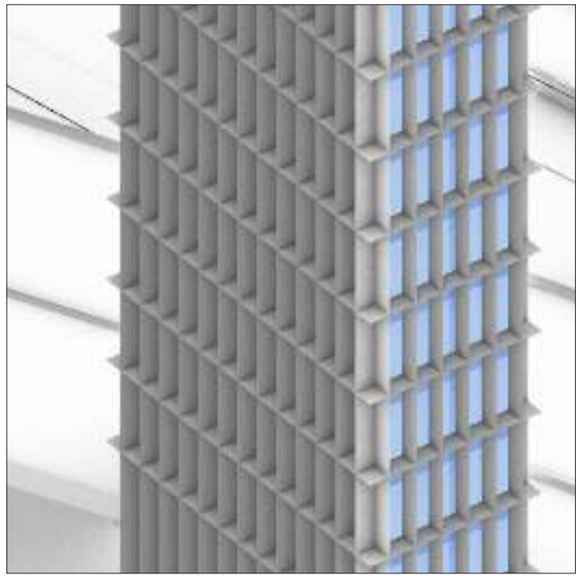
However, the most innovative approach is found in design one, where Grasshopper is employed to generate a dynamically varying façade density. This parametric design allows for precise control over shading, adjusting the density of the façade in response to solar angles and exposure levels. As a result, design one achieves a solar radiation value of 229, striking a balance between functional shading and architectural complexity.





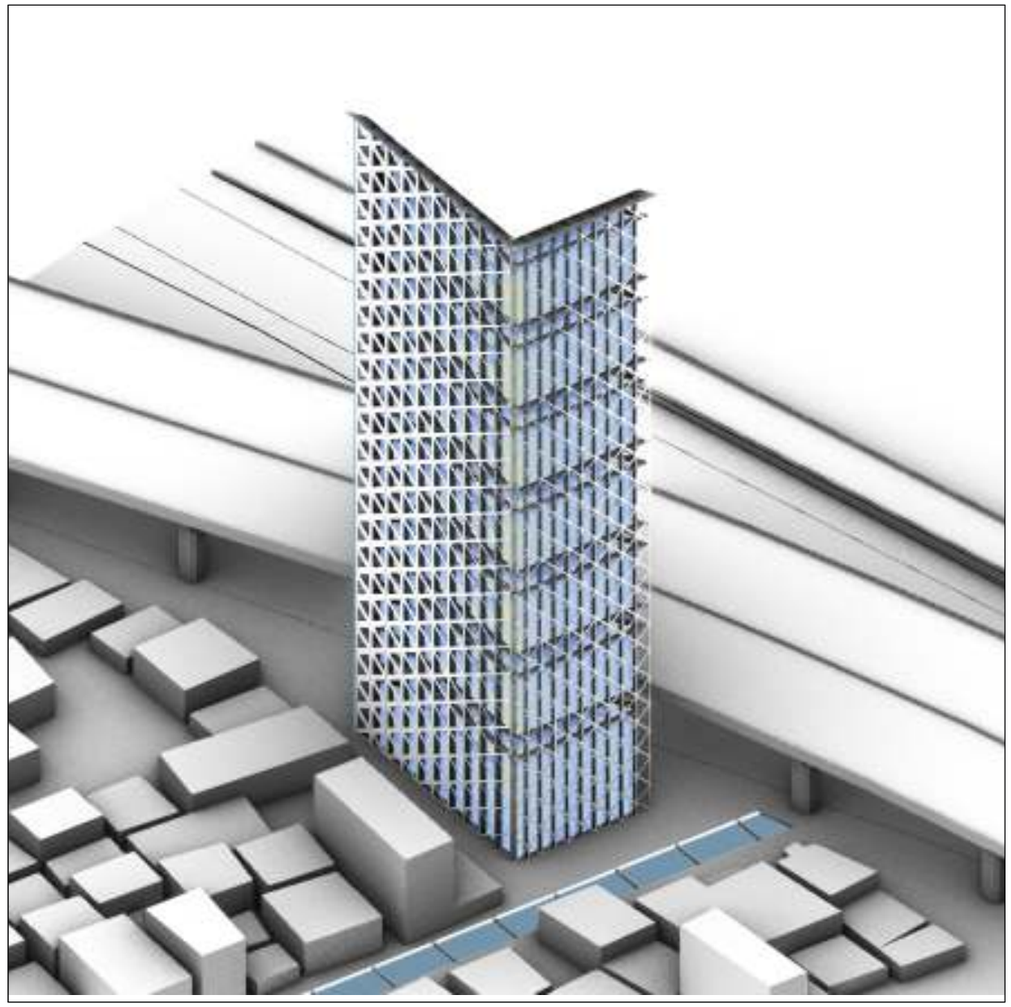
BASELINE



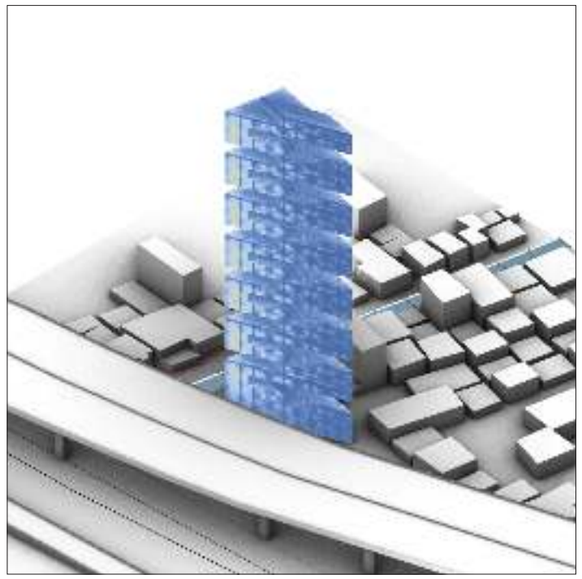


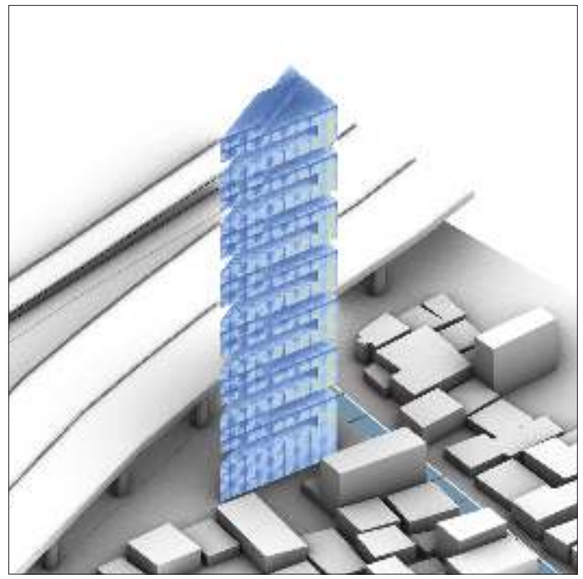
Baseline		
Total Building Surface Area	5,952	m2
Annual Solar Radiation	2,206,200	kWh/year
Averaged Total Solar Radiation	371	kWh/m2/year
Target Solar Radiation	500	kWh/m2/year
Result	Succesful	

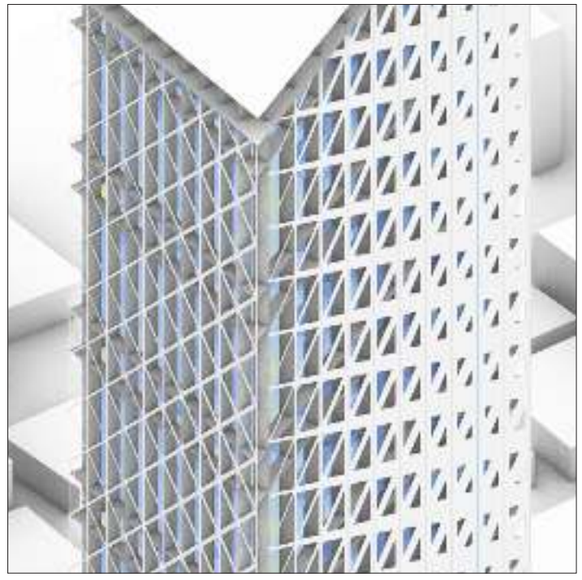
The baseline facade design employs the simplest geometric shape, featuring a straight facade that significantly reduces solar radiation and heat gain. While this approach enhances energy efficiency, it also blocks residents' views, limiting their connection to the surrounding environment. This restriction raises concerns about livability and aesthetics. Although effective in addressing solar radiation, the design highlights the need for a balanced approach that considers both energy efficiency and quality views. Future iterations must find ways to optimize efficiency while maintaining visual connections for residents.



DESIGN 1

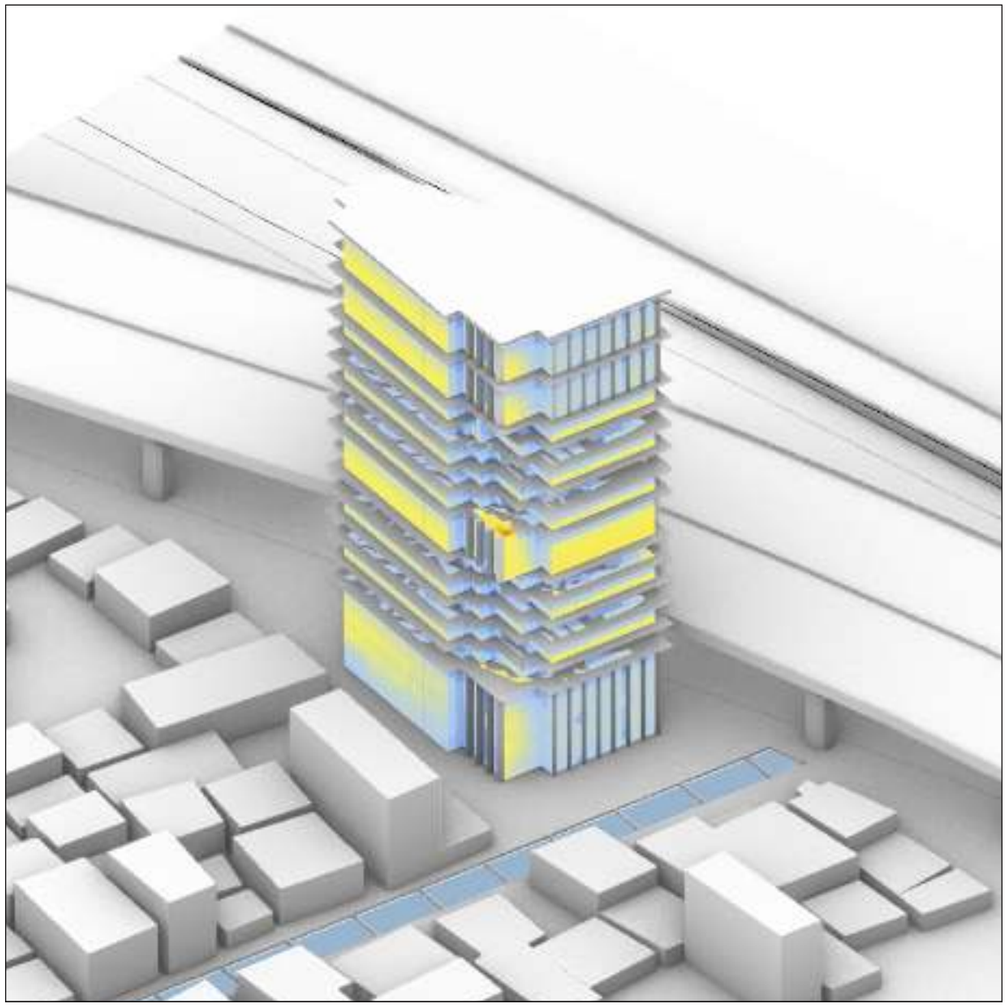




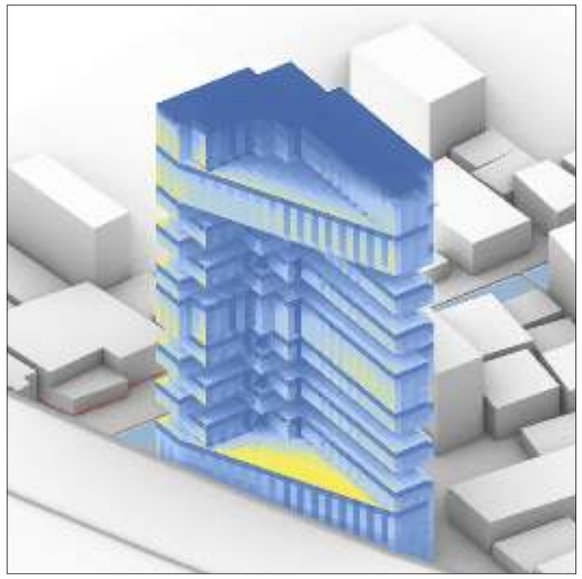


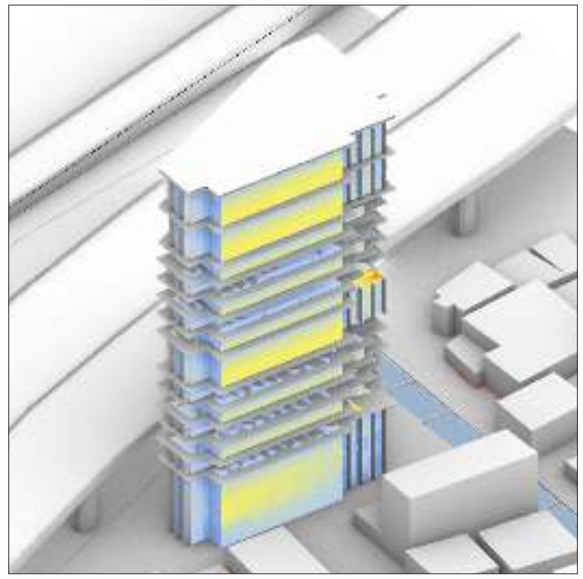
The façade design is intricately inspired by the building's triangular form, employing Grasshopper to generate a dynamic gradient that frames the residential units. This approach not only enhances the visual appeal but also integrates the concept of frame viewing into the architectural expression.On the side of the building that faces the highway, the façade is intentionally designed to be dense, incorporating smaller triangular sections that create a planar surface wall. This design choice serves a dual purpose: it effectively provides shading and improves aesthetics by minimizing the visual impact of the highway. The façade significantly reduces solar radiation, decreasing it from 458 to 229, demonstrating its success in achieving effective shading. Additionally, the interplay of light and shadow, creating beautiful shadow patterns.

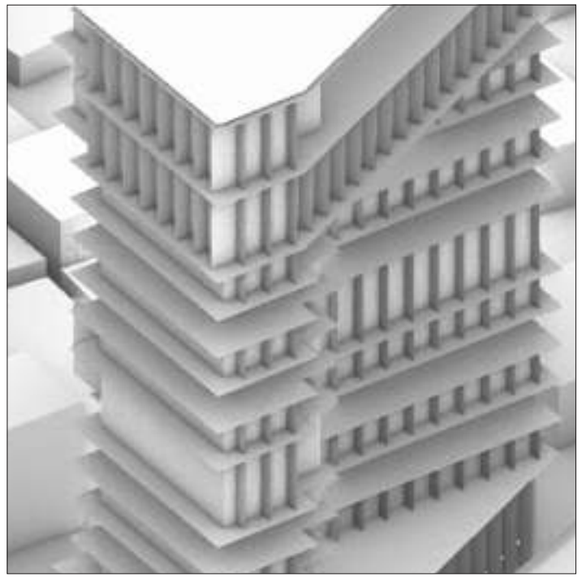
Design 1		
Total Building Surface Area	10,875	m2
Annual Solar Radiation	2,490,200	kWh/year
Averaged Total Solar Radiation	229	kWh/m2/year
Target Solar Radiation	500	kWh/m2/year
Result	Succesful	



DESIGN 2

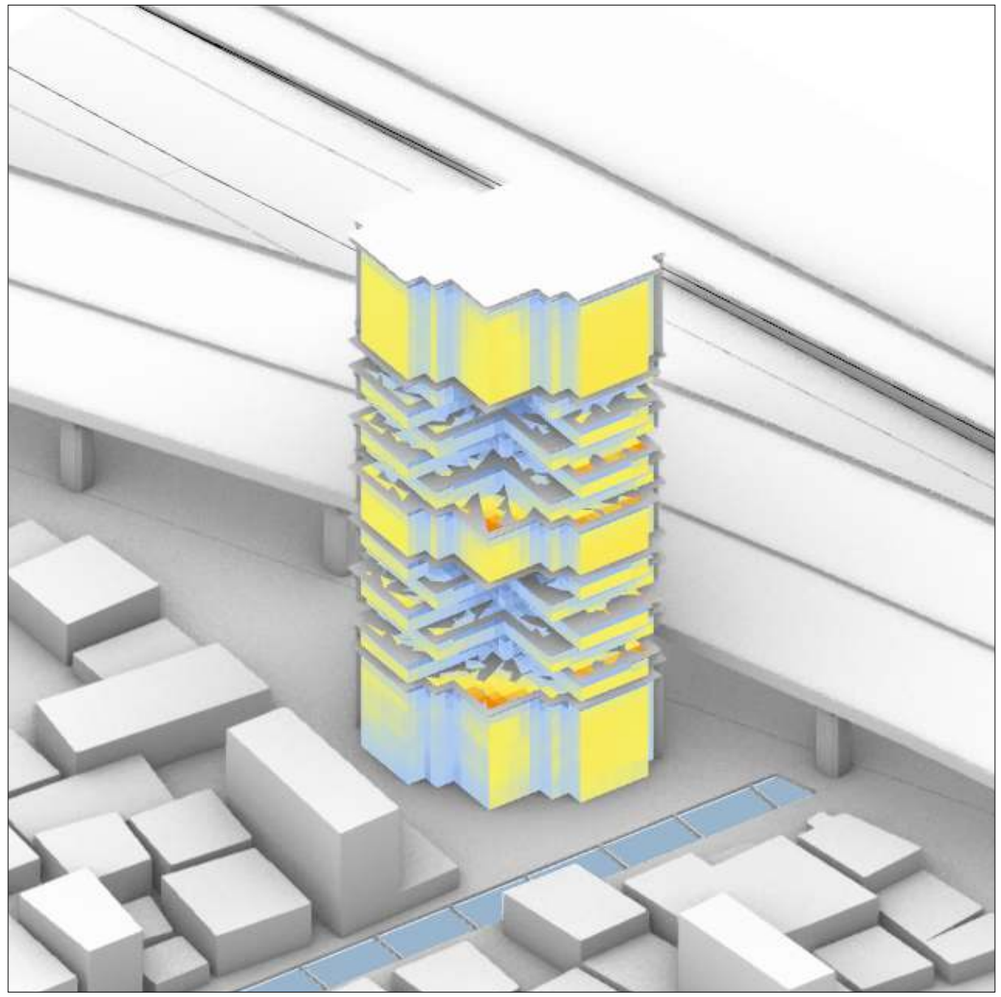




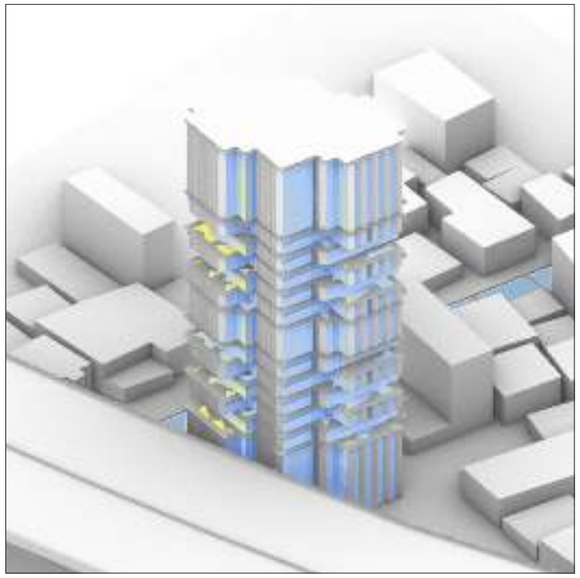


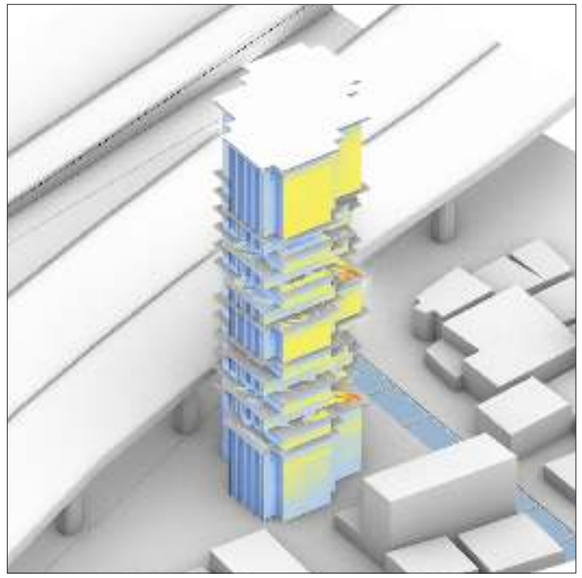
This façade design features a simple, straight profile that follows the baseline shape of the building. By adhering to this straightforward design, the façade achieves an impressive solar radiation measurement of 100, effectively minimizing heat gain. The alignment of the façade with the building's shape is intentional, while the side facing the local context remains open, enhancing the visual connection with the surrounding environment. This design fostering a harmonious relationship with the local architectural context, promoting a sense of unity within the neighborhood and contributing to the overall aesthetic appeal of the structure.

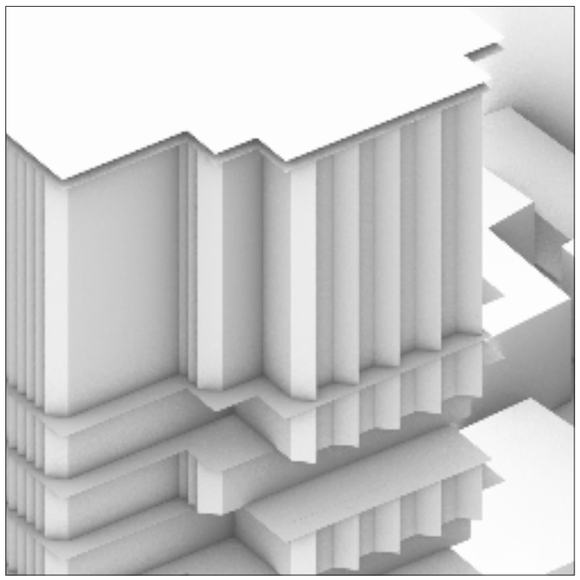
Design 2		
Total Building Surface Area	20,721	m2
Annual Solar Radiation	2,072,000	kWh/year
Averaged Total Solar Radiation	100	kWh/m2/year
Target Solar Radiation	500	kWh/m2/year
Result	Succesful	



DESIGN 3







Design 3		
Total Building Surface Area	6,556	m2
Annual Solar Radiation	1,787,900	kWh/year
Averaged Total Solar Radiation	273	kWh/m2/year
Target Solar Radiation	500	kWh/m2/year
Result	Succesful	

In Design 3, the façade showcases a tilted design specifically engineered to reduce solar radiation effectively. This innovative tilted façade is strategically positioned on the side facing the highway, where sunlight exposure is most intense. In contrast, the side overlooking the local houses features a standard façade design, allowing for an unobstructed view that enhances the building's complex geometric shape. This thoughtful approach not only minimizes heat gain but also contributes to the overall aesthetic of the structure. The façade design achieves a remarkable reduction in solar radiation, decreasing it from 520 to 273, demonstrating a significant improvement.