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HABITAT UKRAINE - A MODULAR, MASS TIMBER HOUSING APPROACH TO
HELP REBUILD UKRAINE

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HABITAT UKRAINE – A MODULAR, MASS TIMBER HOUSING APPROACH TO HELP
REBUILD UKRAINE

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ABSTRACT

Fear. Destruction. Suffering. These are the words that come to mind upon the mention of the current conflict that the nation and people of Ukraine are submerged in. Millions of them have been forced to leave behind their livelihoods for safety, greatly damaging their financial and general well-being. Though the fighting still rages on, one day it will come to an end. This begs the question: how will these individuals and families be able to return to their native places from which they have been suddenly torn?

Habitat Ukraine explores and proposes a permanent, semi-modular housing design approach focused on facilitating the rehousing of Ukrainian migrants through affordable and quality means. This is made possible due to the modular construction process which reduces fabrication and construction times therefore lowering overall costs. With sustainability, community interaction, and the use of mass timber at the forefront of the design, Habitat Ukraine seeks to help modernize the nation's housing infrastructure and assist in the healing and reconnection to the built environment for the victims which have been so tragically affected by this conflict.

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Thank you also to Jörg Rügemer who donated his time to offer advice to help improve this project drastically. His deep knowledge and passion for quality architectural design is apparent as he has contributed greatly to the outcome of this thesis. Without his feedback, this project would be nothing like it has turned out to be.

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1. INTRODUCTION

Ukraine is embroiled in a national struggle for independence. A conflict that has uprooted millions and will change the country for generations. Hundreds of thousands of men and women have been mobilized to protect the country. Millions have been forced to leave due to indiscriminate attacks on civilian infrastructure and services. Homes and entire cities have been reduced to rubble. Though it is a long and deadly war, it will eventually conclude, and many who have had to fight or relocate will desire to return to their homeland, to their former ways of life. With the large scale of devastation of the built environment, a housing shortage will be inevitable in the regions that have been in proximity to the most combat. Though temporary housing solutions may stifle the potential crisis for a time, permanent ones will need to be implemented at a fast rate across these affected areas to effectively re-situate potentially millions of Ukrainians and rebuild the physical fabric of Ukraine promptly. Traditional housing solutions can help address this problem, but most likely not at a fast enough rate. This is where a prefabricated, modular housing approach steps in. This type of residential design and construction method has the great potential of speeding up this process while also providing energy-efficient, sustainably designed, and comfortable houses to help tackle this glooming challenge. This will provide a foundation to increase the standard of living for Ukrainians and to tie the nation closer to the West helping to develop and expand democratic values and facilitate development and advancement in the realm of urban planning and design. How, though, can a prefabricated modular housing approach be a realistic solution to address the impending housing crisis? How can it provide quality standards of living for Ukrainian migrants who seek to return to their places of origin after the conclusion of the war? How can it fit among the cultural and built environments of Ukraine to incentivize the embracing of it as a viable solution? How can it

potentially be a vehicle to implement sustainable design strategies to advance the cause of environmentally friendly architecture and assist in the fight against climate change? How can this approach serve to help define the future of sustainable humanitarian housing design and development to help rehouse those who are victims of negative political and climatic circumstances outside of their control?

1. Conflict in Ukraine

On February 24, 2022, the nation of Russia invaded Ukraine and began what would become a long, drawn-out war. They entered the country via the Russo-Ukrainian border, Belarus, and Crimea with the goal of capturing the capital, Kyiv, and taking military control of the entire nation. This initial plan failed and transformed the war from one of shock and swift mobility to one of grinding attritional battles that would see the heavy use of artillery and other destructive munitions. This strategic change drastically increased the lethality of the conflict leading to a much higher casualty rate on both sides. Along with this harrowing reality, it brings to life the consequence of leaving many villages and cities both near and far from the frontline damaged, abandoned, or even partially or almost completely destroyed.

1.1. Urban Destruction

Mass destruction is felt across the entire country as villages and cities experience the grave consequences of war. Some cities near the frontline are bombarded indiscriminately, completely ravaging the built environment. Some that are situated farther from it are targeted deliberately with long-range drones and munitions. Some, such as Bakhmut in the east of Ukraine, have almost been completely devastated due to vicious fighting putting on full display the horrors of contemporary war. Both military and civilian infrastructure are targeted with the goal of disrupting the Ukrainian war effort in any way possible. This leaves many without places

of work and living and in some places creates completely desolate environments of debris and rubble. These consequences leave many no choice but to flee to other locations of refuge out of the country.



Figure 1. An aerial drone image of Bakhmut, Ukraine. Credit: Tyler Hicks / New York Times

Losses of Ukraine's economy

from damage of physical infrastructure since the beginning of hostilities (in case of complete destruction)

AS OF 10.05.2022

The analysis of the project
"Russia will pay" – damaged.in.ua

TOTAL

\$94,3

billion

\$564-600 billion*

Infrastructure facilities	Number of items	Total damages, \$ mln
 Residential buildings, mln sq. meters	35.2	30 951
 Roads, thousand km	23.8	29 761
 Industrial enterprises, factories, units	208	10 437
 Civilian airports, units	12	6 817
 Railway stations and rolling stock	n/a	3 572
 Healthcare institutions**	580	1 908
 Bridges and bridge crossings	295	1 646
 Cars, thousand units	89.5	1 358
 Institutions of secondary and higher education	992	1 320
 Land fund, thousand hectares	4.2	1 108
 Ports and port infrastructure	2	622
 Military airfields	12	468
 Administration buildings**	83	454
 Kindergartens	562	445
 Religious buildings	102	349
 Cultural facilities	152	329
 Shopping malls**	24	315
 An-225 Mriya aircraft	1	300
 Storage infrastructure	156	255
 Oil depots	27	227
 Other	–	1 683

* As estimated by the Ministry of Economy and KSE, the overall Ukraine's economic losses due to the war, taking into account both direct losses calculated in this project and indirect losses (GDP decline, investment cessation, outflow of labor, additional defense and social support costs, etc), ranges from \$543bn to \$600bn

** Revaluation is caused by using a more precise estimate of an average unit cost. We are going to further update methodology for this group in the next release.

These estimates are not comprehensive, as the information on numerous damages and destructions may be missing due to the lack of possibility of citizens, local and state authorities to promptly record the damage in each city, town, villages, etc.



Figure 2. Total damages to Ukraine's physical infrastructure and economic losses less than three months after the onset of the invasion. Credit: Kyiv School of Economics

1.2. Mass Emigration

Emigration is an unfortunate reality of war, and it is no different in the case of the conflict in Ukraine.

The United Nations High Commissioner for Refugees (UNHCR) states that,

As a result of heavy shelling and fighting, an estimated 5.1 million people have been driven from their homes and are internally displaced and more than 6.2 million people have crossed into neighboring countries in the region including Poland, Hungary, and Moldova or other countries globally (Ukraine Refugee Crisis, n.d.).



Figure 3. A Polish border guard assisting Ukrainian refugees on February 26, 2022. Credit: Czarek Sokolowski / AP

This number only accounts for refugees who have officially registered as refugees seeking temporary protection across a multitude of nations in Europe, the real number is much higher.

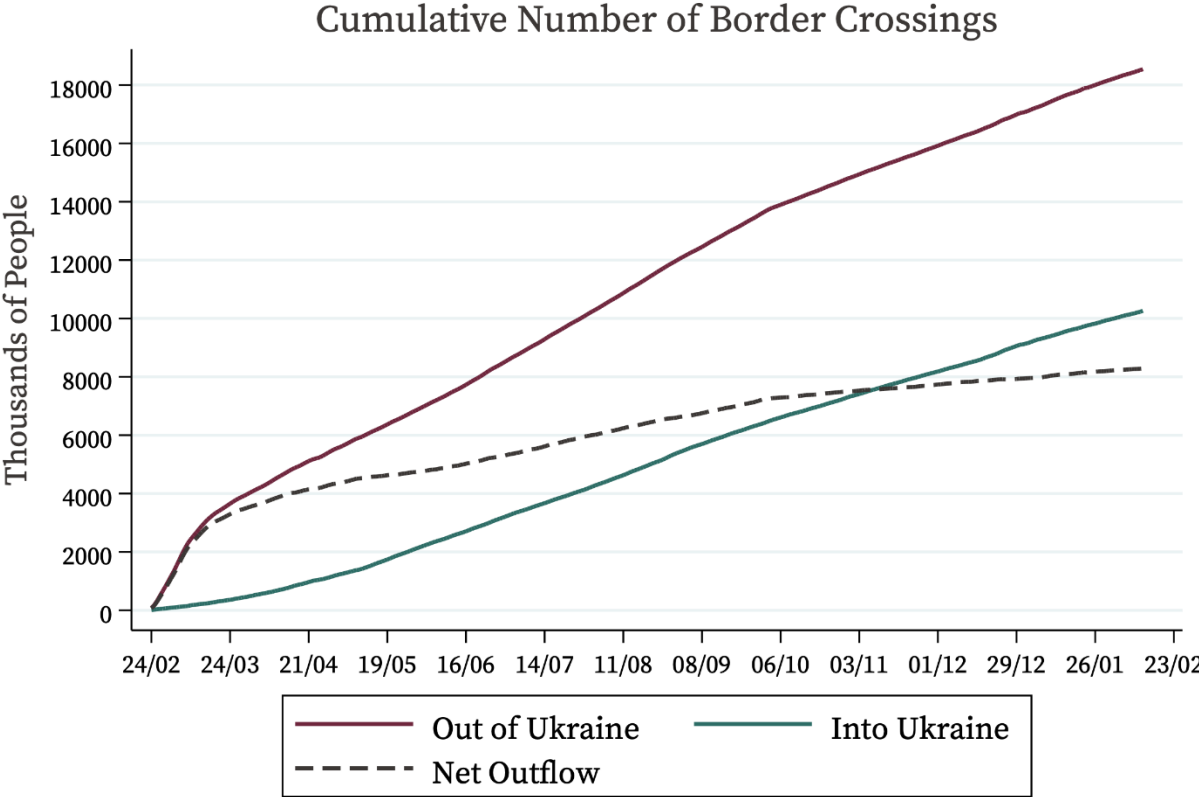
According to Statistica with information obtained from the UNHCR, *As of December 27, 2022, around 16.9 million border crossings from Ukraine into neighboring countries had taken place due to the ongoing war.*

These migrants, mainly women and children, have fled to various surrounding countries such as Poland, Hungary, Romania, Slovakia, Moldova, and even Russia. This truly harrowing number clearly illustrates the grueling effects of war in the twenty-first century and the



Figure 4. Map illustrating the number of refugees who have fled to each respective country or region outside of Ukraine. Credit: statista / UNHCR

impending need to provide housing solutions for these migrants postwar for those who decide to return to their nation of origin.



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Figure 5. Graph showing the number of individuals that have crossed the Ukrainian border as migrants. Credit: Centre for Research & Analysis of Migration

1.3. Opportunity to Rebuild

Through these harrowing events that completely change the lives of millions arises an opportunity. An opportunity to rebuild the nation of Ukraine and redefine its built environment helping to improve the quality of life. In some places, this entails the rebuilding of a small percentage of buildings and urban elements. In other places closer to the frontline, this entails the complete reconstruction of entire urban environments. Eastern and southern Ukraine have been affected the most by the violent destruction that the current conflict brings which has left many

cities almost entirely gutted. When the war eventually concludes, these locations will become blank canvases, serving as opportunities to push Ukraine into the future of design and urban planning. Sustainable strategies can be quickly and easily implemented due to this reality with the aid of foreign capital in order to advance the cause of environmentally friendly design and living. This includes the possibility of the construction of net-zero/positive buildings to combat global warming, the widespread implementation of natural elements to cool urban environments and improve the mental health of citizens, the layout of zero-emission public transportation networks to efficiently move people around these urban environments, the development of renewable energy sources to provide a clean and secure method of energy usage, and the implementation of urban gardens and farms to provide food security; to name a few strategies. These should be implemented at both the urban and neighborhood scales to ensure equal access to sustainable amenities and services for all Ukrainians. Unlike most developed nations, this opportunity can be exploited rapidly due to the aforementioned almost complete destruction of some cities. Other nations that seek to achieve these same goals must do so slowly and methodically with large investments of financial and economic resources to maintain the quality of life for their citizens so as to not disrupt their current ways of living. Ukraine does not need to adhere to these principles to that extent in various cities which allows them to become a catalyst for rapid change and advancement and an example for the entire world of what the future of urbanity can look like. This complicated process will require a large amount of international aid and investment. Ukraine's struggling wartime economy will not be able to facilitate and achieve these objectives in a feasible amount of time to meet the impending housing and commercial demand of its citizens. Nations, mainly developed-western nations, will be presented with an opportunity to invest in the reconstruction and redevelopment of Ukraine's urban and cultural

fabric with the likely potential of reaping future economic and financial rewards. This precedent will not only help Ukraine and its citizens recover their former ways of living but will raise the quality and standards of living and help fight corruption and develop a more transparent government benefiting the lives of millions in many ways.

1.3.1. Advancing the Cause for A More Transparent Government

The nation and government of Ukraine have, since its independence in 1991, struggled to become a transparent and modestly uncorrupt democratic nation.

Jessica Pisano from the “Journal of Democracy” states,

Ukrainian politicians with authoritarian ambitions periodically used economic pressure to compel people to vote for them, leading many Ukrainians to feel that they were being treated like background players on a stage, not agents of their own political destinies, (Pisano, 2022).

This statement indicates the highly volatile and fragile political fabric of Ukrainian democracy since its national founding. She paints a clear picture of the past poor political realities by adding that,

These manipulations affected not only electoral outcomes, but also the meaning of democratic institutions for Ukrainians who were subject to such pressure, (Pisano, 2022).

Prone to exploitation from corrupt officials on both local and national levels, Ukrainians have historically been generally ill-represented as they have been coerced and sometimes even threatened to vote for certain political candidates,

In some rural areas and company towns, party officials threatened people’s livelihoods if they did not turn out to vote for the right candidate or party, (Pisano, 2022).

These circumstances provide a clear justification for the goal of expanding democracy in Ukraine. This is one objective of this thesis, to provide a catalyst for the advancement of the cause to create a more transparent government at both the individual and national level for the benefit of all Ukrainians. This can be incentivized by Western, democratic nations by providing foreign economic aid and investment into the rebuilding of the nation if and only if corruption is effectively fought if citizens are provided the ability to vote for political candidates freely without outside interference, and if officials are held accountable for their actions and promises made to citizens. Though this is not a simple fix that can be done in a short amount of time, this opportunity can further push and reinforce this effort by helping to create a more transparent, resilient, and effective democratic political system and society with the benefit of the Ukrainian people in mind, not only that of powerful officials.

1.4. Objective

The scope and objectives of this research include not only the advancement of the cause to create a more transparent and accountable government in Ukraine but also the conceptualization and facilitation of quality and affordable places of living for Ukrainian migrants and soldiers who have been affected by the conflict. This is to be done by utilizing a prefabricated, modular residential system that can be constructed quickly with a focus on energy efficiency, sustainable design strategies, future expansion/contraction potential to match hyper-local housing demand, and the complete implementation of Ukrainian culture. This will serve to accelerate the development of the nation and push it further into the future of urban design and sustainable living, aiding in the global fight against climate change. The potential implications of this project could create ripples worldwide, helping to provide a jumping-off point for further

research and the procurement of additional, unique solutions for other nations that are prone to disasters or conflict.

LITERATURE REVIEW

2. Background

Formulating a detailed and feasible prefabricated, modular housing solution that is tailored to the nation of Ukraine and its cultural and urban fabric is the goal of this thesis. The implementation of sustainable design strategies such as rainwater collection and reuse, natural daylighting and heating methods, on-site energy generation, and the employment of local, recyclable resources (material and labor), will be imperative to the success of this thesis. This focus aims to be a mechanism to both reduce long-term costs associated with living and expand the fight against climate change providing realistic and affordable means to do so. Of very similar importance, the integration of elements of Ukrainian culture into the modular housing system's design will also be at the forefront of this thesis. Ensuring the reflection of culture will allow this system to fit in place among the existing built environment of the nation and not feel as if it does not belong. This will allow the general population of Ukraine to be much more willing to embrace this approach to rehouse displaced nationals quickly while also being a strategy whose permanence could serve to propel the country into the future of sustainable and environmentally friendly design. These two initiatives bring the very plausible possibility of creating new ways to become further integrated with the West (the United States, the United Kingdom, the European Union, Canada, Australia, and New Zealand), due to its current large effort to both celebrate cultural differences amongst each respective country and to also invest in sustainable ways to reduce the present patterns and consequences of global warming in the built environment. This design approach to housing could very likely open new means of foreign investment from Western nations into important economic industries that could aid in increasing the standard of living for many Ukrainians.

2.1. Previous Research

Extensive research has been conducted on the subject of modular housing. Its benefits and its current weaknesses have been identified in various works of literature. The modularity of these housing solutions allows for the easy design and erection of these structures which normally have the potential to save months of construction time. This is directly responsive to the current goal of this thesis: to provide fast, feasible residential solutions to help rehouse the displaced Ukrainian population at the quickest rate possible. Time will be of the essence. The faster that destroyed villages and cities can be rebuilt, the faster that Ukraine can be able to get back on its feet economically and be able to provide for the needs of its citizens. With that goal in mind, one must look back in time to explore and understand past attempts at achieving similar objectives with similar means.

The “*Packaged House*,” formulated by architects Walter Gropius and Konrad Wachsmann, was, according to Ezgi İşbilen,

...a prefabricated housing system devised to meet the housing shortage in the US during and soon after the Second World War (İşbilen, 2022).

This was the first of its kind. Gropius wrote on the subject of his theory for this system by stating,

The idea of industrialising house construction can be realised by the repetition in each building of the same standardized component parts. ... The possibility of the varied assembly of these interchangeable parts would enable the Company to satisfy the public desire for a home with an individual appearance, (İşbilen, 2022).

Gropius envisioned a solution to the housing shortage that permitted both the rapid constructability of residences, while also providing for the innate desire among consumers for a large degree of customization and individuality between each structure. Though multiple prototypes were constructed to show the feasibility of this system, it never garnered any traction

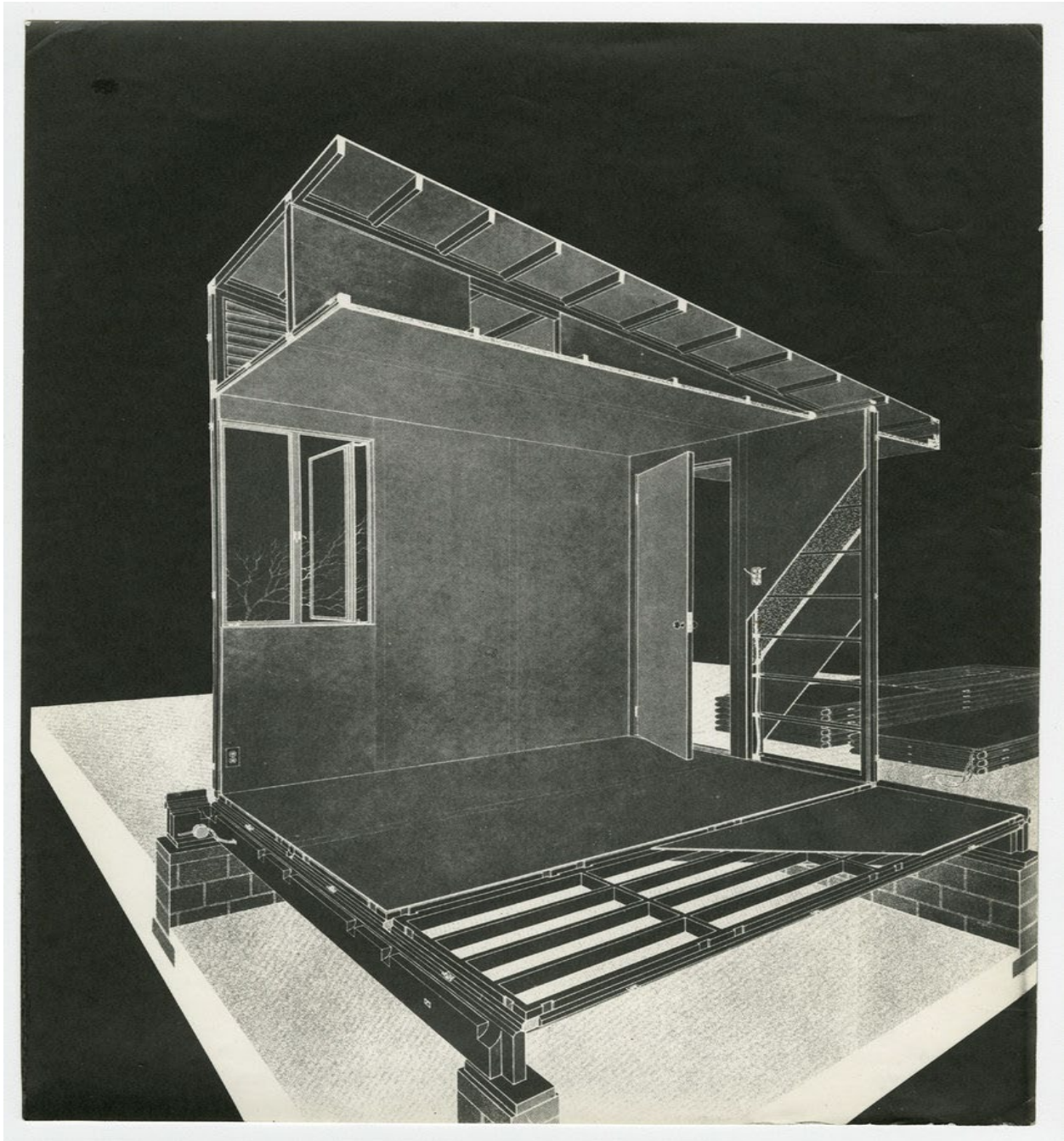


Figure 6. Section perspective view of the "Packaged House." Credit: Ricardo Meri de la Maza

and was never actualized. This is due to multiple reasons, but the largest was the hesitation of the banking system in the United States to fund it.

The openness of the project made it an ‘unorthodox case’ for credit. The financing of construction projects or purchase of buildings, also known as the mortgage system, depends on the financed entity’s continued presence” (İşbilen, 2022).

Because it was such a new and unknown housing system, financial institutions had little faith in its practicality and therefore refused to provide credit for their construction. This denial of funds made it extremely difficult to implement this system in the built environment. Along with other setbacks the system faced, the United States government lost patience with this slow process and incentivized traditional methods of residential construction to combat the housing shortage due to the return of millions of American soldiers who were overseas during the Second World War and the subsequent population boom that followed. Though the Packaged House system was never implemented on a large scale, the work of Gropius and Wachsmann still provided a foundation for modular residential design to develop and find precedence in the housing industry.

Though the Packaged House showed the potential of a prefabricated housing system to be realized, there are still many shortcomings of the prefabricated industry itself that inhibit its implementation into the built environment of today. The largest, most inherent obstacle is the lack of degree of customization between each unit. The primary purpose of modular housing is to standardize the process of design, fabrication, and construction to provide housing solutions more quickly and efficiently for people. The trade-off of this focus is a lesser degree of customization of form, layout, and materiality when compared to traditional methods of residential design and construction.

Mathew Aitchison, author of “*A House Is Not a Car (Yet)*” makes this evidently clear by identifying the following disadvantages.

This level of customization is seen as leading in the car industry—but is problematic in housing. Fit to site (item 3), issues around parts and compartmentalization (item 2), combined with user/functional diversity (item 4) would make for an extremely complex platform-range relationship, and an exponential number of product permutations.

Historically, the outcome of ‘user choice’ and customization in housing has tended to be a more stringently standardized housing product with superficial modifications, such as kitchen countertop material, color selections, and carpet swatches, (Aitchison, 2017).

Houses are large, complex structures that need to adhere to a range of conditions and criteria in order to be feasibly realized and constructed. This has only allowed consumers, during the customization phase of the typical prefabricated residence, to have a say on small, minute details. Along with this point, houses hold tremendous economic and cultural value to owners. They usually require a significant number of resources to obtain and maintain.

For most people (taking Australia as an example), a house is the most significant investment they will make in their lifetime. Often a one-off investment, it has a privileged place among people's economic and social value systems, (Aitchison, 2017).

The vast significance, importance, and value of a house to owners drives them to desire unique dwellings that express themselves and their ways of living.

Most housing users are different, even if the traditional market does not reflect this in their offerings. There are obviously different types of houses, occupied by very different group sizes: for example, families, retirees, singles, couples, home/office, multifamily, share houses, or any combination of the above. When these different uses are combined

both with the number of users and with the vagaries of individual tastes, expectations, needs, and traditions (not to mention the wide range of housing typologies), the resulting permutations are very large in number, (Aitchison, 2017).

The general desire among the house-buyer and owner population to dwell among environments that are tailored to their needs and reflective of their character, beliefs, values, culture, etc., pushes them to be more prone to consider and select traditionally designed and constructed homes in lieu of standardized ones due to their heightened ability to have profound design flexibility. The current lack of viable customization of prefabricated, modular houses is one of the largest factors that contributes to the hesitation of the implementation of it as an alternative residential solution in the housing market and environment.

2.2. Gap Identification

The degree of customization is the primary feature that present modular housing systems lack. This reality creates a large barrier and is a great hindrance to its implementation in the residential construction industry around the world. Though research has been conducted on the subject previously, feasible real-world applications are not so prevalent. The difficulty of balancing standardization with adaptability and design individuality between structures paired with the general lack of ability for the construction industry to adopt new techniques of design and construction inhibits these systems from being embraced completely. This is where this thesis's principal purpose arises. The most important objective is to research, develop, and propose a system that will be able to be relatively easy and cost-effective to produce while also

allowing consumers to have the ability to customize the final product to a somewhat substantial degree. Balancing these two notions is imperative to the success of this approach.



Figure 7. Image of identical houses in a row. Credit: patjo / Shutterstock

This thesis's approach to modular housing design looks to produce a system that is also able to be easily and efficiently expanded or contracted based on hyper-local demand for housing without producing significant carbon emissions and without contributing to global warming. This is an idea that has not received much attention, exploration, or research in the real world. The methods of expanding a building in the present day require a large amount of time and resources to complete. Designing the new expansion, the use of heavy construction equipment and machinery, and the large amounts of materials and resources needed, all equate to a normally long, drawn-out process of expanding a current building's footprint to suit its rising needs. The demolition methods used today see the widespread use of heavy construction equipment and machinery as well as the misutilization and waste of materials. This contributes to the disastrous

FIGURE 1: LIFECYCLE STAGES
Data source: BS EN 15978:2011

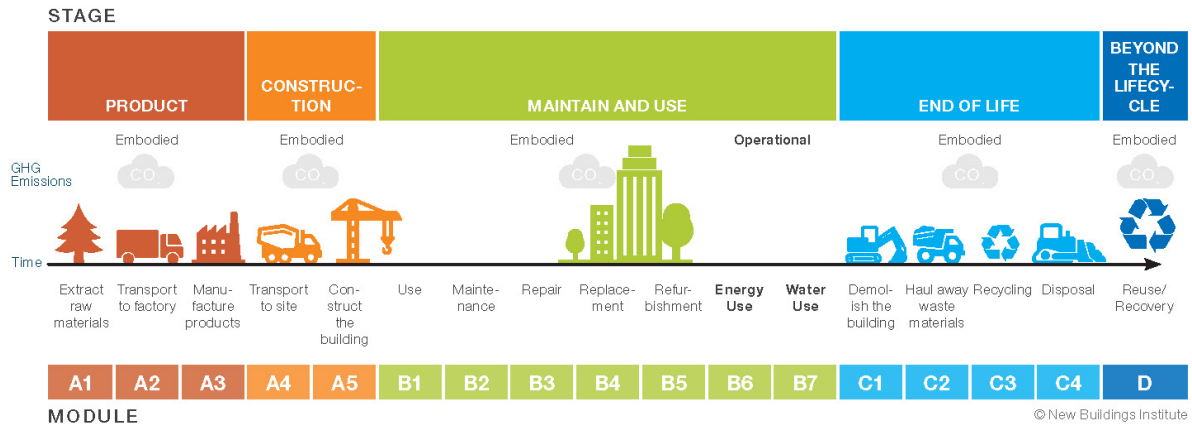


Figure 8. Illustration showing the typical lifecycle of a building. Credit: New Buildings Institute

effects of climate change due to the fact that these materials are not often recycled and reused causing them to go to a landfill or waste management facility and be disposed of. When a new building needs to be built, the extraction of new raw and manufactured materials from natural and industrial environments sees embodied carbon emitted into the atmosphere and natural ecosystems and environments disturbed or destroyed causing a wave of consequences to follow. Embodied carbon, which Figure 9 defines as, “the emissions from manufacturing,

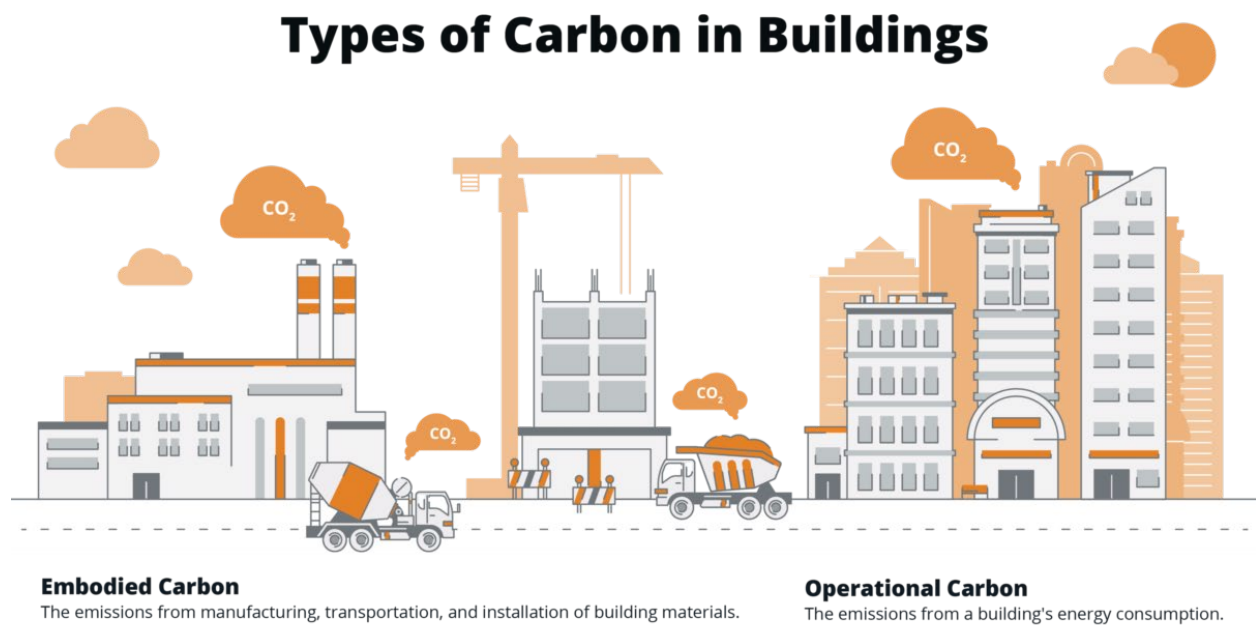
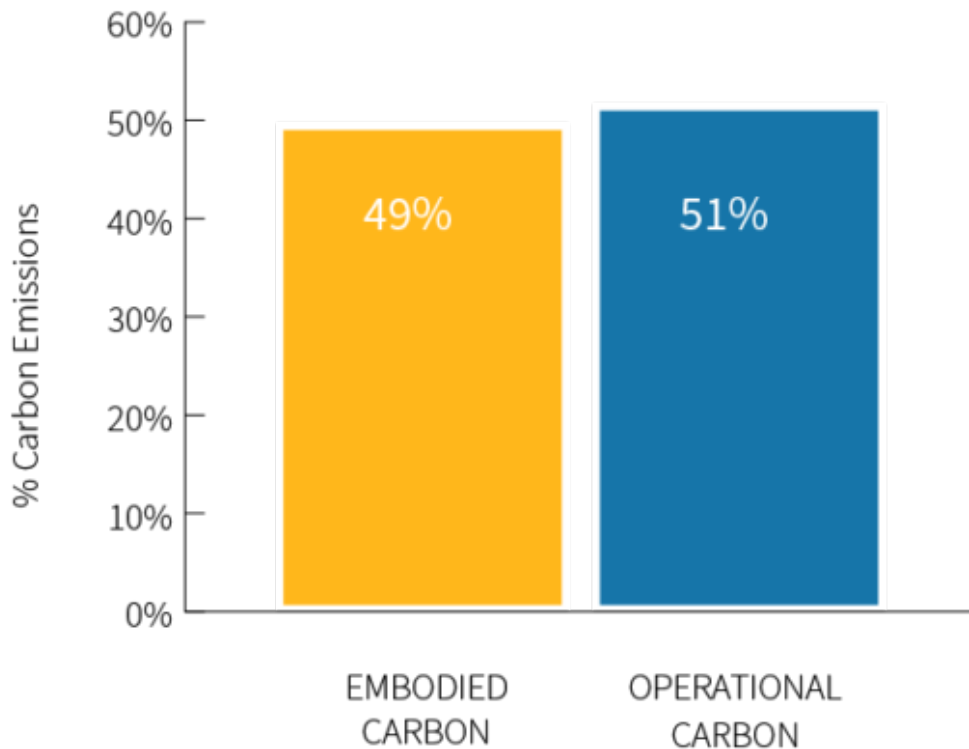


Figure 9. Graphic defining the two types of carbon emissions in the building industry. Credit: Carbon Cure

transportation, and installation of building material,” is responsible for 49% of global building constructions as shown in Figure 10. Lowering this number as much as possible with construction methods for the development of both new and existing buildings is instrumental in the fight against climate change as the building sector contributes a significant amount to global carbon emissions. A system that allows for housing complexes to be easily expanded or

Total Carbon Emissions of Global New Construction from 2020-2050

Business as Usual Projection



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Figure 10. Graph showing the percentage that each type of carbon emission in the building sector accounts for on a global scale. Credit: Carbon Cure

dismantled without the use of large, carbon-emitting equipment or machinery and without the widespread waste of materials would help to combat global warming and could be a future way to design and construct residential buildings of all sizes and typologies. In order to realize this goal, a number of criteria would have to be met. These include a structural system that can expand or be dismantled relatively easily without compromising the integrity of the building as a whole, a structural system that allows for the use of interchangeable, standardized pieces of

material, the utilization of material that is able to be recycled across the majority of the system, and the employment of a simple structural layout, such as a grid, that does not require extra or unnecessary structural support to ensure integrity. If a system can successfully meet these requirements, it could hold a very real possibility of being able to support the building's ability to be further developed or dismantled rapidly without causing noticeable environmental damage and without contributing to climate change. The benefits of this would be large in scope and could serve to be a basis for further development on sustainable and environmentally friendly design and construction.

2.3. Project Type

This thesis's objectives are to solve the previously listed "gaps" in research and modular housing design. Among these goals lies additional ones such as being able to rapidly design and construct these structures and also having them fit among the Ukrainian built and cultural environments. Achieving these objectives is instrumental to the success of this thesis and its proposed approach to housing. Creating a prefabricated, modular housing system that can easily be constructed and developed over time, employ sustainable design strategies, be environmentally friendly, and implement Ukrainian culture in the design and function is the vision of this thesis. It is hoped that this system will be able to respond effectively to the impending housing crisis that is likely to arise in Ukraine after the current war and to the current pattern of intensification of global warming, creating a model to serve as a basis for future design.

2.4. Project Issue

This thesis's purpose comes to fruition due to the devastating consequences of the current conflict in Ukraine which sees millions fleeing the country for safety. Housing potentially millions of these migrants who may seek to return to their country of origin postwar by providing them with quality places of living is incredibly important to this thesis. This migratory issue gives rise to new opportunities for explorative architectural design.

“Balbek Bureau,” an architecture firm based in Kyiv, Ukraine, has proposed multiple conceptual temporary housing ideas to combat this impending issue. One such concept is aptly titled, *RE:Ukraine Housing Pilot Project.*”

According to the project description on Balbek Bureau's website, this project seeks to experiment with a different approach to temporary housing and,

...test different construction technologies and find the best option in terms of time, labor costs, and energy efficiency (RE, n.d.).

This approach sees the implementation of a structural system that can easily,

...adapt to different types of terrain, site shapes, budget, and settlement density (RE, n.d.), and be constructed in a relatively short timeframe of 2-3 months while providing basic, comfortable amenities to residents.

The housing system is designed to be arranged in “blocks” to ensure relatively easy and rapid construction and the easy designation of space typology to balance the ratio of public and private space in the complex. This feature is instrumental to being able to respond to the housing crisis quickly by providing displaced refugees with quality temporary housing until homes can be eventually rebuilt. Though this is a viable solution to the impending problem, this project is



Figure 11. “RE:Ukraine Housing Pilot Project” conceptual render. Credit: Balbek Bureau

just that, temporary. This will only act as a mitigatory response to delay an all-out crisis. Ukraine needs a permanent solution that can be realized and constructed quickly, which gives purpose to this thesis.

This thesis, in the end, seeks to answer questions specific to this type of project. How can a prefabricated, modular housing system be made economically viable to implement and construct within the built environment of Ukraine? How can sustainable design strategies be incorporated into the design of the housing system to limit energy consumption, limit reliance on external sources of energy, and have the ability to be reused/recycled at the end of the lifespan of the structure? Is it possible to create a system that can expand/contract relatively easily based on local demand for housing without a large exhaustion of additional time, effort, and resources? How can Ukrainian culture be integrated into the design of the system and its components?

METHODOLOGY

3. Approach

To answer these questions, additional research must be conducted on current modular housing systems and the methods that are used to allow for the rapid design and construction, current sustainable design strategies used in residential architecture, structural systems that will enable a process of building expansion to be feasible and its pertinence and potential implementation into the field of modular design, and on Ukrainian residential design elements that define the culture as one of individuality. This will be achieved by reviewing and referencing case studies, thesis proposals, and other professional work done on the subject matter. Illustrations, diagrams, charts, and other graphic representations of data will be imperative in supporting the goals and narrative of this thesis and the exploration of the feasibility of this proposal.

3.1. Data Collection

Research will be conducted from scholarly articles and journal entries that will provide a proper background on the subject of modular housing and the many components of design that compose it. From the initial historical design concepts to present-day fabrication methods, topics such as these will be explored in order to gain an increased understanding of the potential benefits of this housing design and construction methods in lieu of traditional construction techniques. Along with this, the supposed relevance of this subject in relation to the country of Ukraine and its culture will also be explored through these sources.

Case studies will be utilized heavily and analyzed carefully. These will help identify and define current strategies and methods of constructing modular housing solutions in different regions and countries. The diverse set of examples of modular residential design will help inform

the project on how others design and adapt to their unique climatic and cultural environments. They will also help bring awareness to various types of sustainable design strategies that have been employed worldwide. Sustainability is a clear focus of this thesis to serve as a foundation for future environmentally friendly design approaches which many Western governments and businesses are currently investing in and incentivizing the development of. The differing degrees of scale of these housing approaches will also help to inform the research and final design of this project in terms of helping to determine the most efficient and feasible size of a housing complex for this specific location and project scope. Paying attention to the local demands of certain potential sites in Ukraine will help to effectively address the needs of those who will live in and around the proposed complex to provide adequate housing opportunities for those disadvantaged by the conflict. However, the scope of these case studies can be expanded to cover those outside of the nature of modular housing. Having knowledge and awareness of other housing approaches outside of the aforementioned topic will also help in informing the approach and design of this project. There may exist other types of building elements and components that could be integrated into a prefabricated modular housing typology. If these supposed solutions can be implemented to fit within Ukrainian cultural design parameters and the built environment of the country itself while paying attention to the needs of Ukrainian people, they could serve as instrumental pieces to the project, helping to increase the likelihood of effectively responding to the needs of residents in Ukraine and potentially advancing the development of this untapped housing potential.

Another type of useful data that will serve to assist this research process is illustrations and graphics such as charts, diagrams, conceptual renderings, and other visual representations of information and projects. These can range from displaying information on population and

demographic trends, schedules, design concepts, case study diagrams, and project renders. These graphics will be gathered, like the case studies, from scholarly articles and online sources. This will allow for a high degree of confidence in the credibility of information to exist in order to define a clear picture of the current conditions and criteria, such as site, human, and cultural demands, and also a clear path on how to address these problems effectively. Climatic conditions, demographics, occupational information, design codes and standards, government parameters and incentives for design, site conditions, residential building layouts, and more information will be imperative in achieving this undertaking. Displaying this information graphically will help give this thesis the ability to communicate its ideas, proposals, and the current demands of designing and developing in the country of Ukraine in an easy-to-understand manner.

3.2. Analysis

This paper is constructed and developed using data collected from scholarly articles and other online sources. Every source was read thoroughly and analyzed to identify its relevance to this thesis's topic at hand. The subjects presented and explored in these sources range from the history and current limitations of modular housing, the methods of construction that bring about the many benefits of modular housing, and the potential future development of a structural system that allows for the expansion or contraction of the number of apartment units based on local housing demand. Case studies, being the primary focus of the analysis process, will be researched and compared in direct relation to this thesis. The information that will be obtained will be discerned and analyzed by creating a scoring system (principally for the case studies) that evaluates each piece of related information upon a myriad of criteria that apply to this thesis project's desired outcome. This will help to define which case studies are most likely to fit

within this typology and which methods of design and construction should be considered to be potentially utilized in this thesis' housing approach. Building upon knowledge about modular design and construction that has already been applied in the real world will speed up the design process and help divert sufficient attention to additional subjects, such as sustainable design strategies and the implementation of Ukrainian culture in the final design of the system.

3.3. Conclusion

The research points to the need to address a wide range of topics in order to increase the ability of the proposed prefabricated modular housing approach to respond to the needs of potential Ukrainian migrant residents. These include the rapid construction, affordability for Ukrainian migrants, utilization of sustainable design strategies, ability to quickly and efficiently expand or contract, the implementation of Ukrainian culture in the design, and the fostering and strengthening of community in this proposed prefabricated modular housing model. These key aspects of design require the utmost attention during the design process. These all serve to provide enhanced value to this proposal which seeks to rehouse refugees in a fast manner and provide quality living standards for them. If the duration of construction can be shortened, the likelihood of being able to provide a more affordable means of living for migrants increases. Along with this benefit, more consideration for other amenities for residents, especially sustainable design strategies, can be given with the time saved. Playgrounds and sports facilities for children, communal activities for all residents and, biophilic design incorporation are only a few examples of design aspects that can be explored to discover which will most effectively complement and enhance the quality of life given by this housing approach. This thesis project has the potential to push residential architectural design into a future that sees the fight against global warming and the cause of equal access to quality housing clearly defined and prioritized.

3.4. Project Location (City Scale)

This project will be located in the capital city of Ukraine, Kyiv, which sits upon the Dnipro River, a major waterway for the nation. It is one of the most developed and populated areas in the country.

According to the United Nations in, “*World Population Review*,”

“Kiev’s 2023 population is now estimated at 3,016,789. In 1950, the population of Kiev was 815,410. Kiev has grown by 6,580 in the last year, which represents a 0.2% annual change” (Kiev Population 2023, n.d).

The city is a large urban center and because of this fact, the government, on both the local and national levels, prioritizes development to meet the everyday needs of the many citizens who

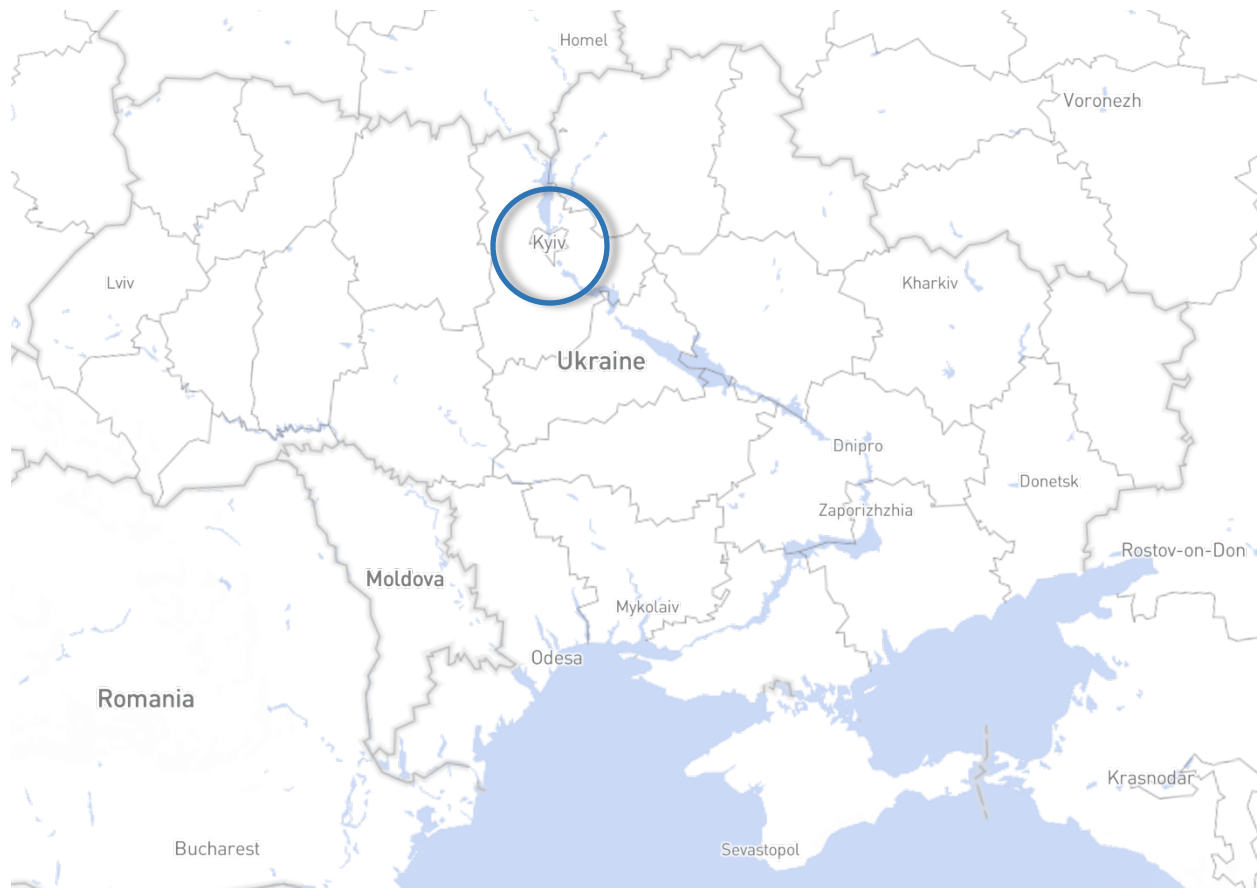


Figure 12. Map of Ukraine highlighting the location of the capital city of Kyiv. Map created using “Mapbox”

live there. It is a large economic and cultural hub of the country of Ukraine, which is expected to draw many migrants who have fled the country from the war to move there to seek out financial and living opportunities. This will allow this project to most effectively be tested in the country and address the impending housing crisis with the potential result of being implemented nationwide to the other places that have been affected by the war.

The climate in Kyiv is rather moderate, with warm temperatures during the summer and colder temperatures during the winter. According to Figure 13, temperatures do not seem to trend

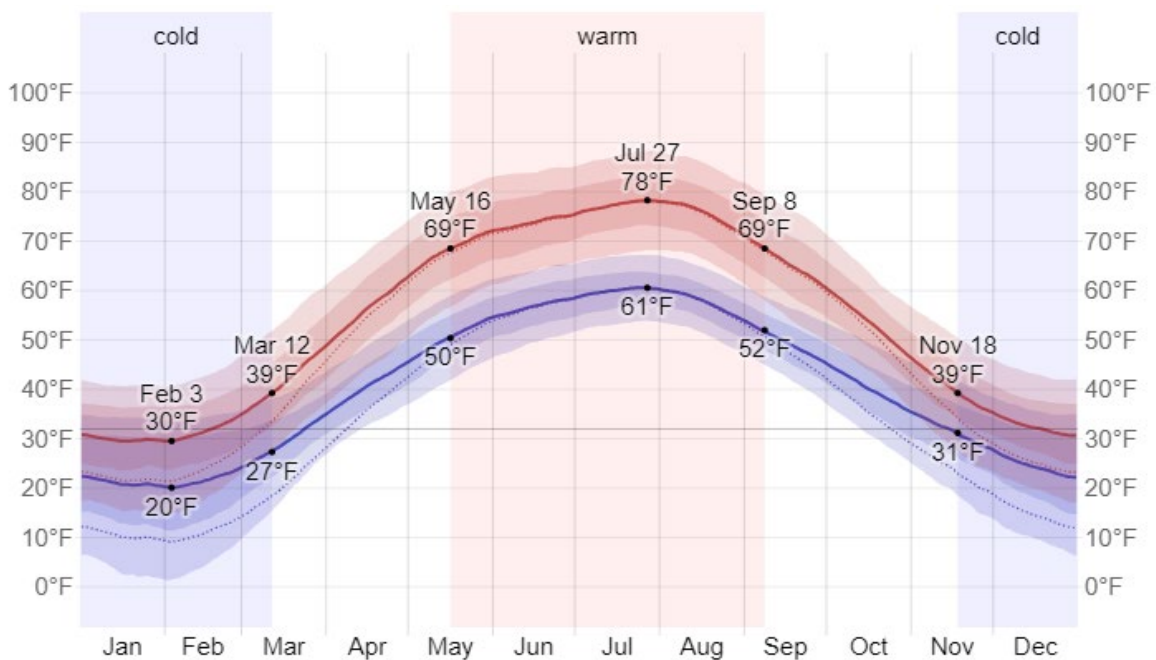


Figure 13. Graph displaying the average high and low temperatures of each season in Kyiv, Ukraine in the year 2023. Credit: Weather Spark

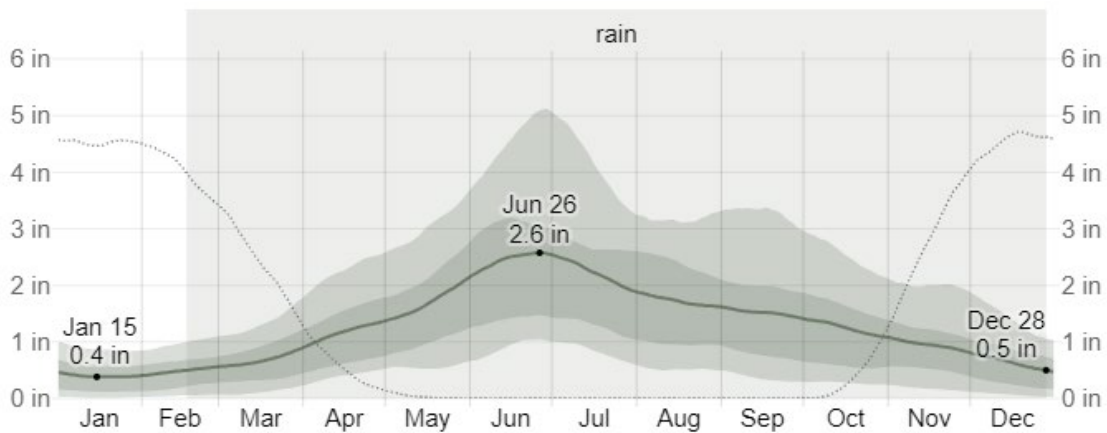


Figure 14. Graph displaying the average amount of rain Kyiv receives each month. The dotted line displays the average amount of snowfall. Credit: Weather Spark

toward extreme, uncomfortable conditions, making living in this region rather pleasant. Kyiv receives moderate rainfall primarily during late spring and early summer. It also receives a mild amount during winters as well. This reality, along with the moderate amounts of snow that can be received during an average winter according to Figure 15, see ideal conditions realized for year-round water collection. This water can be used for consumption or other grey-water purposes such as waste removal and cleaning. This potential can help to increase water security for many Ukrainians easing stress on local, central water networks. Kyiv also receives a

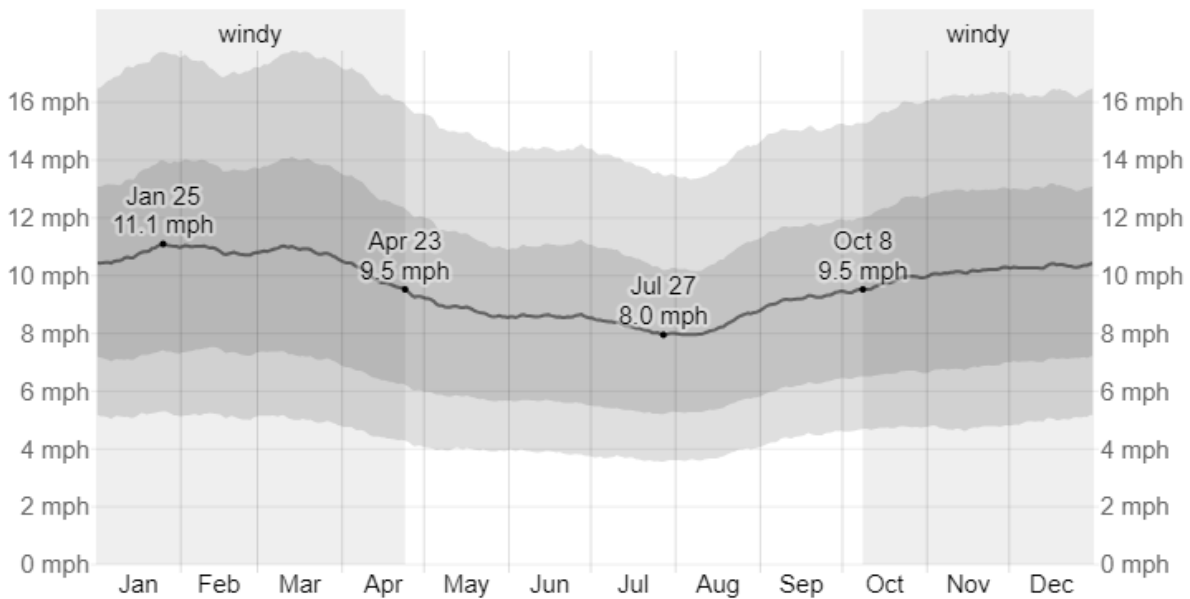


Figure 16. Graph displaying the average wind speed in Kyiv throughout the year. Credit: Weather Spark

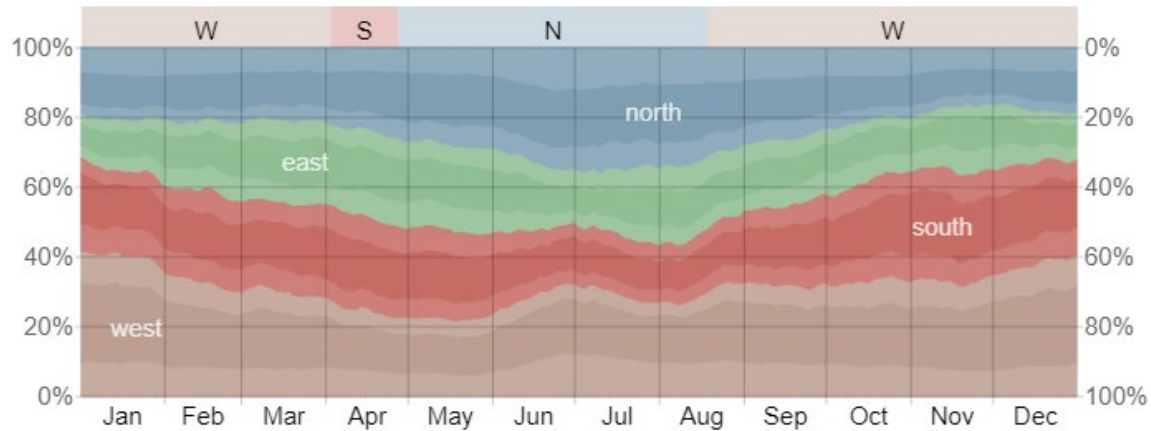


Figure 17. Graph displaying the average percentage of hours where the mean wind direction is from a certain cardinal direction in Kyiv throughout the year. Credit: Weather Spark

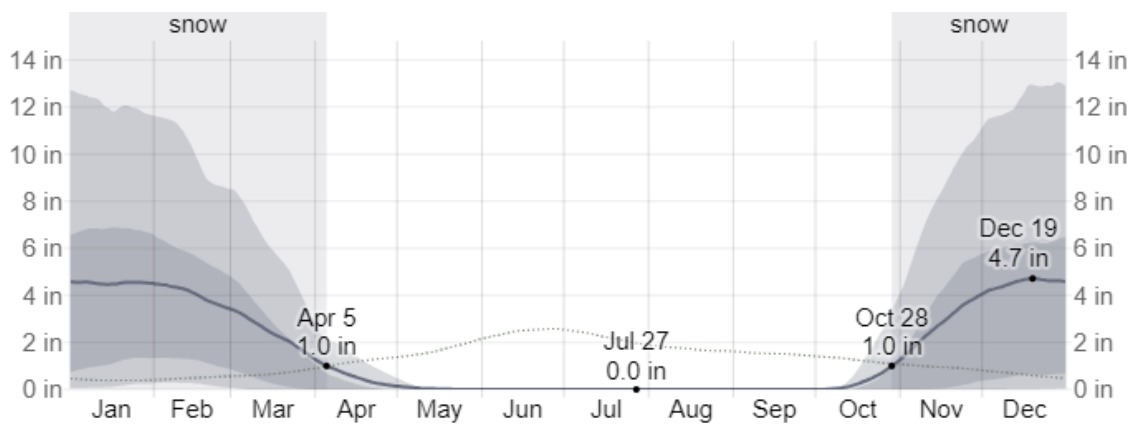


Figure 15. Graph displaying the average amount of snow Kyiv receives each year. The dotted line displays the average amount of rainfall. Credit: Weather Spark

moderate amount of wind. This reality provides an excellent opportunity to take advantage of natural cooling methods to alleviate the need for the employment of mechanical systems to create comfortable interior living conditions. Figure 17 illustrates which direction wind generally comes from during each month of a typical year. This information can be utilized to directionally orient this thesis project to take full advantage of natural cooling methods to limit the carbon footprint of the building and to push the cause of sustainable living forward in the country of Ukraine.

3.5. Project Location (Neighborhood Scale)

The chosen site is located in southeastern Kyiv on the east side of the Dnipro River in the Darnytsia district. It lies just off Staroboryspilska Street near Boryspilske Road, which is a

central transportation artery. The area around to the north, west, and south of the site is populated with residential, commercial, and industrial development, while the west of it is an undeveloped forested area. The residential neighborhood to the north of the site features numerous educational institutions, commercial establishments, and a mixture of single-family and multi-family residential buildings. A multitude of medical facilities are also within proximity to the site. This area in the city grants locals ample access to these services, greatly improving living conditions. The industrial district to the southwest of the site consists of a sewage and water treatment plant,



Figure 18. Map of the city of Kyiv showing the chosen site location. Map created using “Mapbox” among other manufacturing buildings. This area is inferred to be largely unsuitable for community use. The land flanking this sector seems to be mostly undeveloped forests. To the west of the selected site lies Vyrlytsya Lake. This appears to be a modestly sized lake whose proximity to the aforementioned industrial district could be the origin of a supposed degree of potential pollution. Due to this, this lake may not be safe to swim in, fish from, or even be around. Regardless of this possibility, high-density residential apartments are located to the west



Figure 19. Satellite image detailing the selected site location of this thesis' project and the surrounding context. Image obtained from Google Maps.

of this lake, pointing to the possibility that this lake may not be polluted after all and may be suitable for human recreational use. To the south of the site lies an expansive suburban neighborhood principally consisting of single-family dwellings. Rather dense forested land sits directly between the site and this neighborhood as well as to the east of the chosen site. This land is predicted to be the target of future development as the city of Kyiv grows in population.

Lying on Staroboryspilska Street near the large roundabout is the Boryspilska Metro Station. Kyiv features very extensive public transportation infrastructure which includes well laid-out networks of busses and underground metros. This stop provides the ability for citizens living near here the ability to navigate the city fairly easily without having to own an automobile. This greatly improves this site's value in pertinence to this thesis' project as it is catered to migrants who possess few financial resources to obtain an automobile or other form of personal transportation. This metro network consists of three main lines that run in different directions serving many who live outside of the dense downtown area. Figure 20 shows a map of these three lines and the areas which they serve. It is apparent that many areas of the city have access

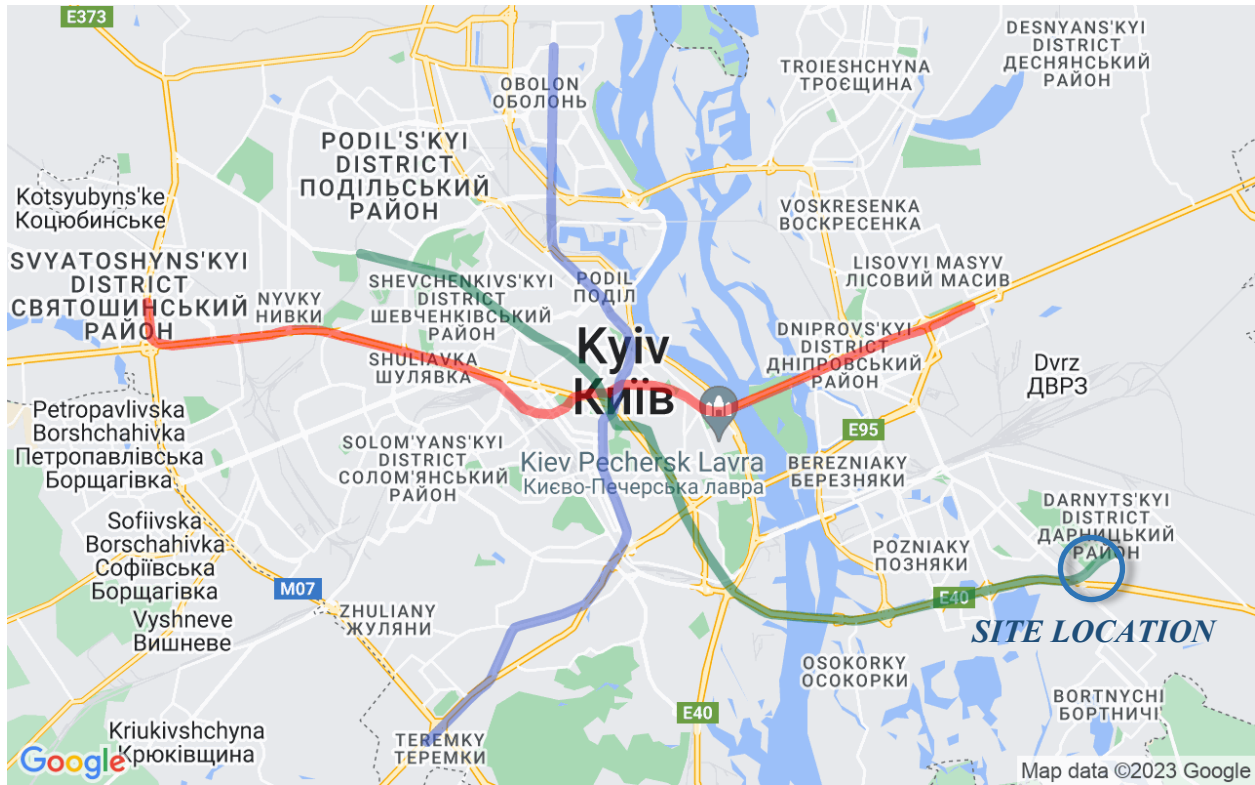


Figure 20. A map of the Kyiv metro network lines overlaid on Google Maps. Credit: "Visit Kiev Ukraine"

to the metro, but it is also obvious that some do not. Kyiv features urban rail and express tram transportation services serving these areas of the city that are not within accessible range to any metro stops. This dense public transportation network provides individuals across this large urban environment with the means to travel to many areas fairly easily and affordably. This greatly reduces the requirement for automobiles which in turn helps to limit carbon emissions and improve living conditions in the city.

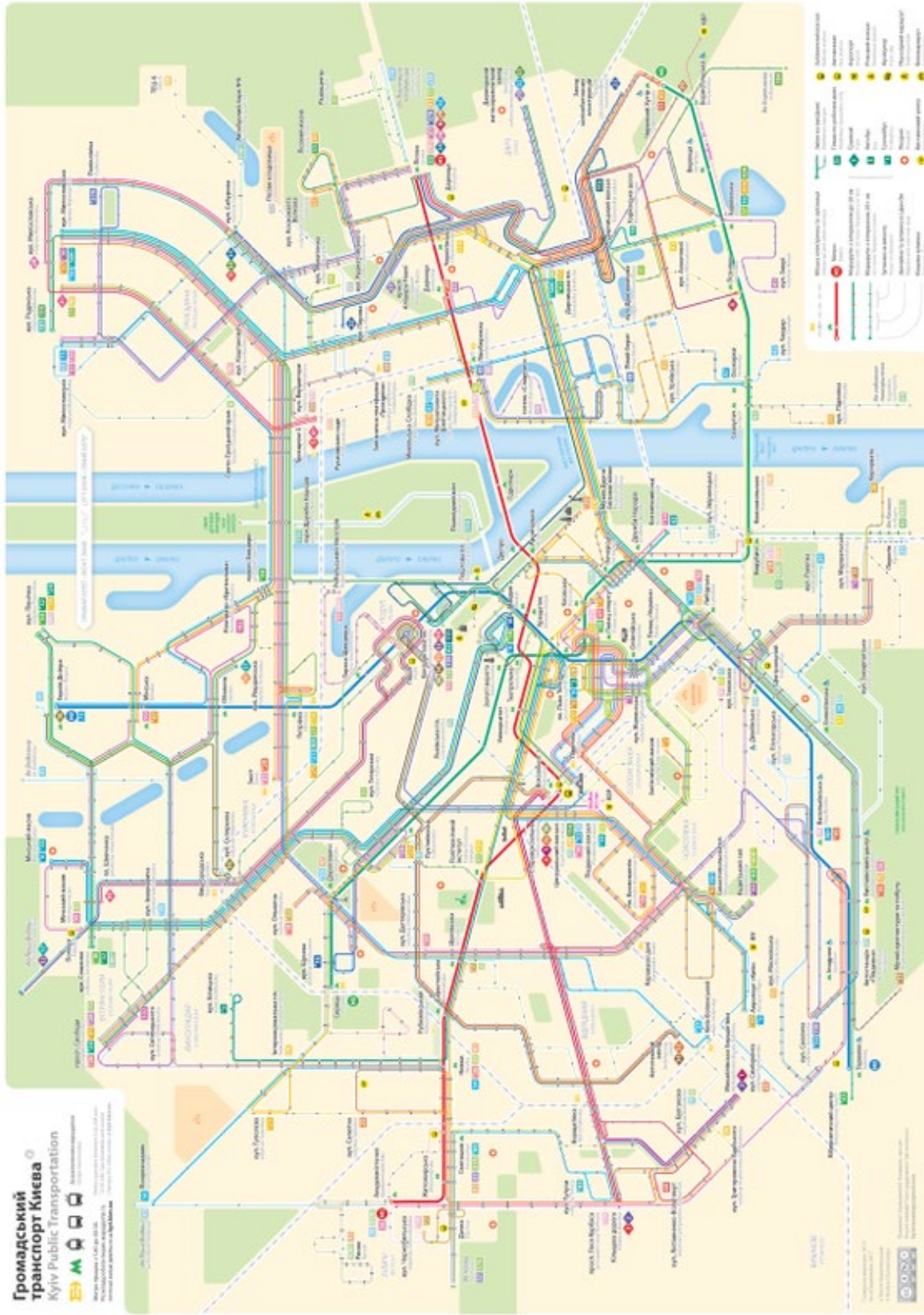


Figure 21. Unofficial transit map of Kyiv featuring urban rail, metro, tram, bus, and trolley bus routes. Credit: Kostya Cherepovskiy / Wikipedia, 2017



Figure 22. A map on the “Kyiv Tourism and Cultural Hub” website showing a more generic layout of the metro system with stops included. Credit: “Kyiv City State Administration” and “Kyiv City Council”

3.6. Specific Site

The selected site itself lies in a heavily forested area largely undeveloped. It features a few hiking trails that wind through the wooded landscape. It is located near the confluence of two larger roadways which define the shape of the surrounding forest. The proposed site will be accessed via Staroboryspilska Street which is flanked on the south side by Boryspilske Road.



Figure 23. Satellite image showing the perspectives of each of the contextual site images in relation to the selected site location. CSI = contextual site image. Image obtained using Google Maps.



Figure 24. Contextual site image I. Image obtained using Google Earth.

The site will not have direct vehicular access to Boryspilske Road so as to not unnecessarily deforest parts of the surrounding landscape. With the metro stop being located on Staroboryspilska Street near the large roundabout, residents of this thesis' housing project will be able to commute on foot with ease in order to travel into the city to conduct daily activities such as working, grocery shopping, or meeting up with colleagues. This reduces the need to designate

land for vehicular parking on-site, allowing this project to be more efficient with its site design and to provide additional outdoor amenities to enhance local living conditions for residents and other potential users. It also strengthens this thesis' objective of producing a housing approach that employs sustainable design elements to lower the building's carbon footprint and create a healthier environment for residents to live in. Encouraging residents to travel by walking or by bicycling through design will help to push this narrative and achieve this goal. Residents will be able to utilize both surrounding roadways and will have access to them through trails and sidewalks. Minimal vehicular access to the site will be provided via Staroboryspilska Street. This



Figure 25. Contextual site image II. Image obtained using Google Earth.



Figure 26. Contextual site image III. Image obtained using Google Earth.

main roadway, along with Boryspilske Road feature small sidewalks allowing pedestrians the ability to safely traverse alongside them. This is an unexpected feature of these due to their



Figure 27. Contextual site image IV. Image obtained using Google Earth.



Figure 28. Contextual site image V. Image obtained using Google Earth.

location on the outskirts of Kyiv. This region of the city is less densely populated by city-dwellers, and it would be assumed that it is easier to access this area of the city via automobile. It is inferred that these roads feature sidewalks solely due to the existence of the metro line that runs under them and the metro station near the roundabout. This is a beneficial feature in this locality as it lowers the amount of money and additional resources required to facilitate



Figure 29. Sun diagram detailing the path the sun takes in Kyiv throughout the year. The yellow circle indicates the path of the sun during the June solstice and the blue circle the December solstice. Information obtained from “Gaisma.”

pedestrian traffic to and from the site. Heavily wooded areas flank both roadways which lead outside of Kyiv towards the east. As this area is modestly developed, this site would enjoy the benefits of the tree covering which at certain times in the day would provide shade to the site. Figure 29 indicates the path that the sun takes in Kyiv, the times that it rises and sets during both solstices, and the degree of variation of these throughout the year. During the summer the site is predicted to receive ample sunlight as the sun will have a higher azimuth and be able to shine over the tree covering. This highlights the importance of having proper shading devices and design elements to keep residents cool during this season, especially during the middle of the day. As the sun lowers in azimuth as winter approaches, the site will not receive nearly as much sunlight due to the tree coverage. This may give the need to increase the height of the residential building itself in order to capture enough light and heat from the sun to provide natural heating opportunities for the building itself and to limit its reliance on mechanical systems to create comfortable interior conditions.

The area surrounding the selected site features elevation changes of up to about 30 feet, from 107 meters to 116 meters, though the site itself only varies by at most 10 feet, from 107 meters to 110 meters. This allows development of this site to be facilitated rather easily. This



Figure 30. Topographical map of the selected site illustrating the rate of elevation change. Map obtained from "topographic-map.com"

gradual elevation change assists the site to drain in wet conditions somewhat properly such as when it rains or snows. To the east of the site lies a hill that is responsible for the increased variation in the topography which renders development there more difficult. With the prevalence of the few hiking trails that run up and around it, residents will be more apt to utilize them to exercise and be among nature due to the proximity of them to the site. This is encouraged to promote healthy lifestyles for residents to improve their general well-being.

The level of noise this site receives on a typical day is predicted to be very moderate. The only major sources of noise are the vehicular traffic from the surrounding roadways and the mechanical systems of buildings adjacent to the site. Apart from those, minor sources of noise from nature such as animals, trees rustling, wind, and insects would be able to be heard at times at the site. The surrounding tree coverage will play a crucial role in diluting and reducing noise from sources within proximity to the site, helping to create a more pleasant and comfortable

environment to live in. The tree coverage also will partially block air and wind movement from reaching the site. During the winter this will be a great benefit, helping to keep residents warm when outside, but a burden in the summer when temperatures rise to warm and even hot, potentially uncomfortable levels.

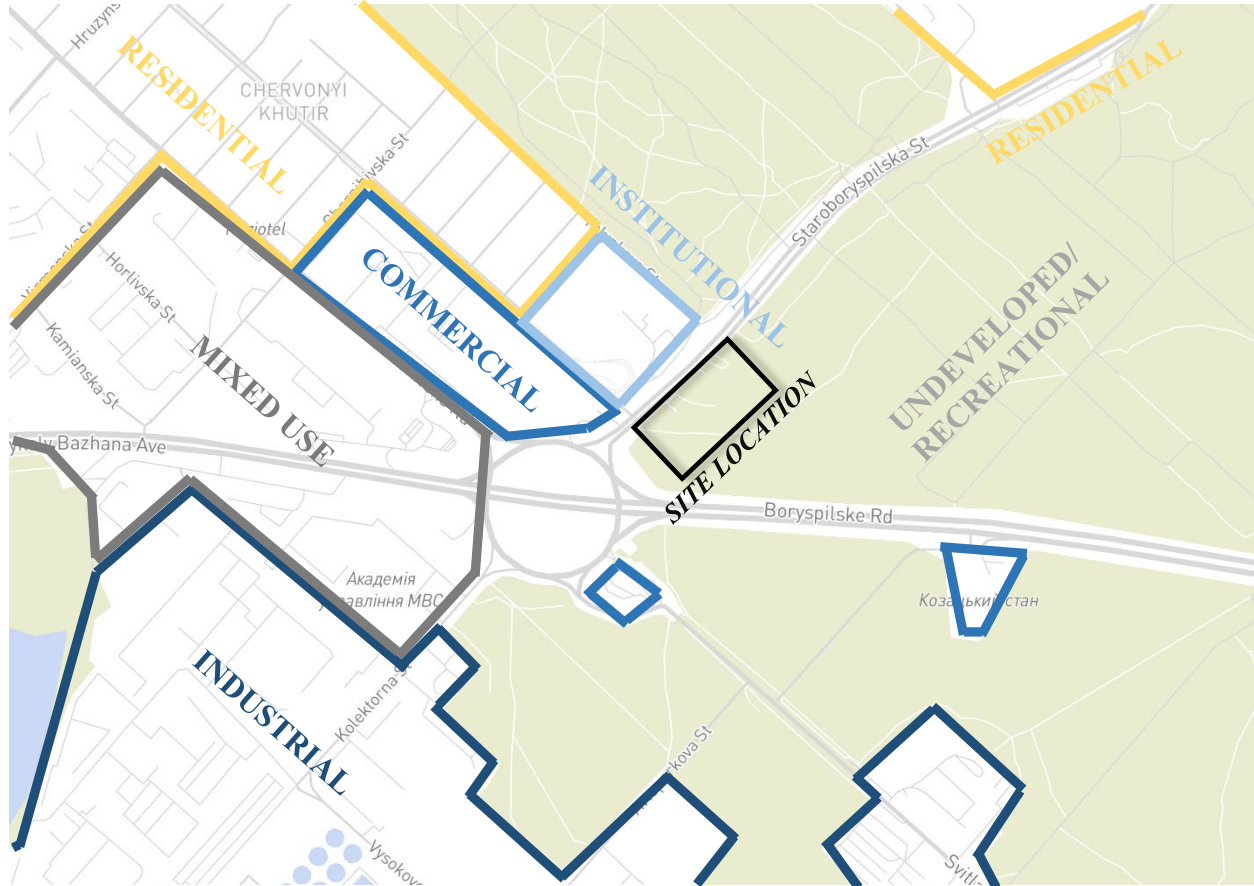


Figure 31. Map of current land use in proximity to the chosen site location. Map created using “Mapbox.” Information obtained via Google Maps. Credit: Andrew Tovsen

This site is ideal for this project due to its proximity to the metro and nature, the small amount of elevation change, the tree coverage which will limit noise and light pollution from external sources, close access to commercial amenities, and its large amount of developable land. Having this site mostly undeveloped eliminates the need to demolish existing buildings or other structures in order to realize it. Though the tree coverage will limit the ability for this housing system to take advantage of natural cooling and heating techniques, the rather moderate climate of Kyiv already lowers the reliance on these sources of comfortability. Trees and other natural

elements will have to be removed from the site to facilitate construction, but it is predicted that these materials can be used by this housing system. The proximity of the industrial district slightly lowers the apparent value of the site, but it is inferred that enough distance between the two exists where it is not a noticeable inconvenience for potential users of the site. This site all in all is ideally situated and composed for this housing approach providing it with ample means to realize its ambitions.

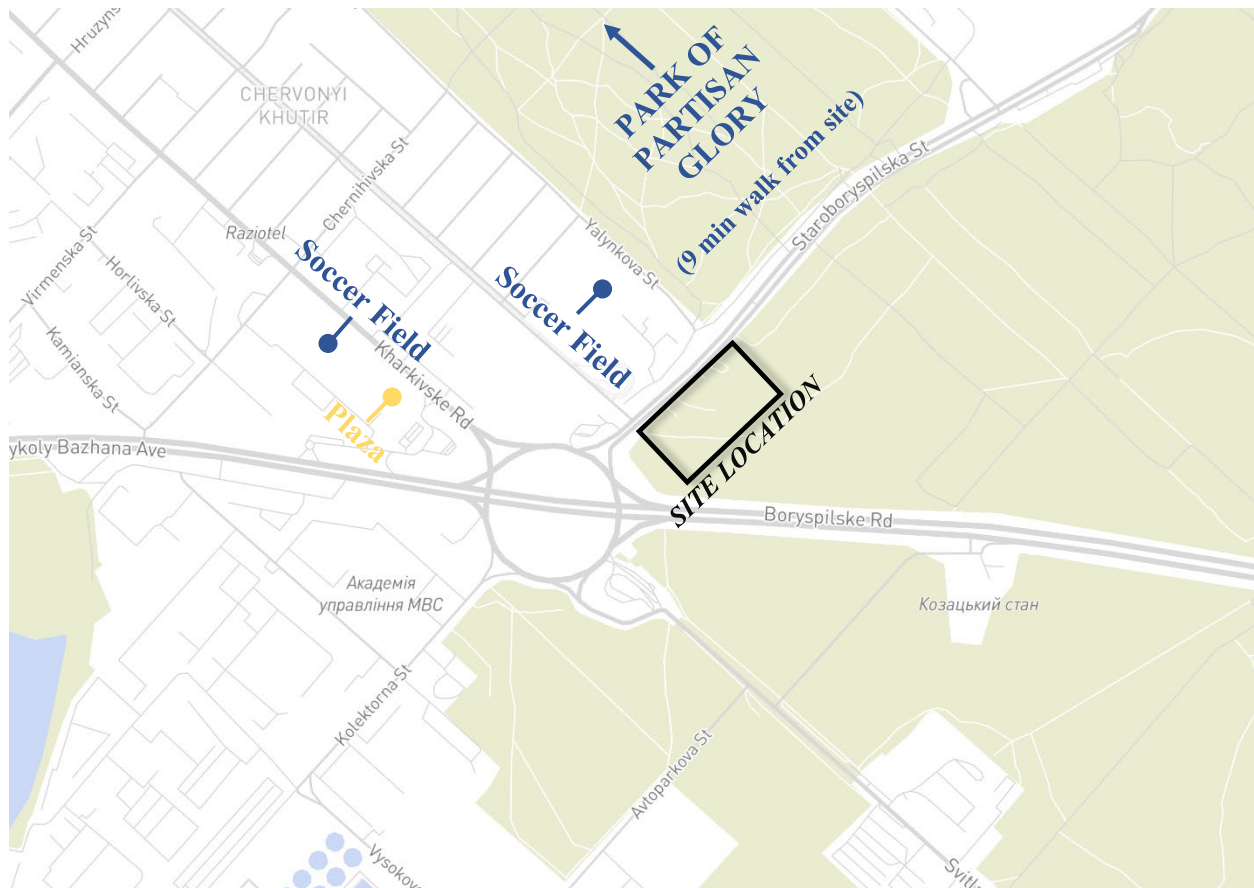


Figure 32. Map identifying the locations of parks, recreational spaces, and other public spaces in proximity to the chosen site location. Map created using “Mapbox.” Information obtained via Google Maps. Credit: Andrew Tovsen

There are a small number of recreational areas and public spaces near the chosen site location shown in Figure 32. To the northwest of the site there are two soccer fields nearby. The one directly northwest is located behind a “specialized school” and therefore could be limited in its ability to be used by the general public at certain times in the day. The other soccer field

further west is also located next to an educational facility but appears to be easily accessible to the public due to its proximity to Kharkivske Road, which seems to be a larger roadway in comparison to the surrounding ones. Close by is a plaza that appears to feature both hardscapes and greenspace. The hardscape plaza could be utilized for educational purposes such as events or other activities for the school (Odes'ka Yurydychna Academia), which is directly near, but it also seems to be easily accessible and usable by the general public. The adjacent greenspace to the southeast features a small central pond and waterfall, multiple walking paths, various vegetation such as trees, plants, and flowers, and benches to sit upon. This space, which is connected to the hardscape plaza, seems to be accessible to the public as well due to its shared proximity to Kharkivske Road. To the north of the site lies the Park of Partisan Glory. This is an extremely large public park that features a plethora of hiking trails that weave through moderately wooded land, multiple ponds, sporting facilities such as soccer fields and tennis courts, and open space for other outdoor activities. It can be inferred with great confidence that this park is a central node that is used by many who live in the residential districts that surround it.

Though residents of this thesis' project may not have access to a multitude of quality public spaces, the Park of Partisan Glory serves to be an important amenity that will be imperative to utilize for their physical health. Careful attention will be given to link the chosen site location to the park through the construction and expansion of the existing walking trail and path network. This will no doubt be an excellent opportunity for residents to exercise and enjoy the outdoors, improving their quality of life in this suburban area of Kyiv.

The surrounding area near the chosen site location features a multitude of restaurants and some bars, but very little additional options. The choices for entertainment in this locale of the city are limited, but residents will still have access to them rather easily as most of them are

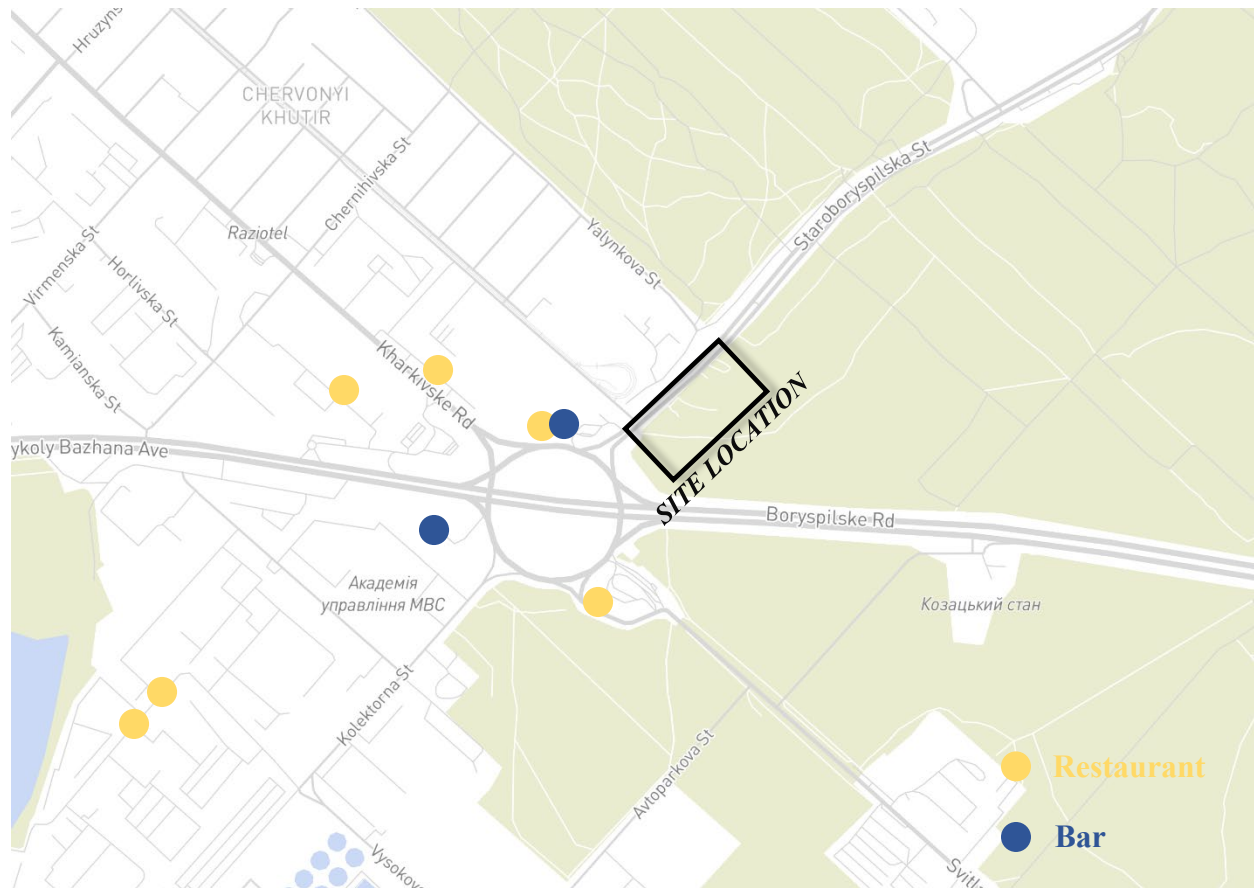


Figure 33. Map identifying places of entertainment in proximity to the chosen site location. Map created using “mapbox.” Information obtained via Google Maps. Credit: Andrew Tovsen

within reasonable walking distance. This circumstance, though unfortunate, is offset by the ability that residents have to access the metro system with ease which can transport them around the city for entertainment purposes. This reality creates a streamlined process for residents to be able to enjoy the culture of the city and amuse themselves without requiring an automobile or other expensive means of transportation.

There are very little places to park in this area of the city besides in small parking lots designated for commercial establishments and on the sides of residential streets. This lack in places to park cars discourages the purchase and use of them and reinforces the notion of encouragement for residents to utilize other means of transportation, such as the metro and bus

system and bicycling, which lowers the carbon footprint of this part of the city, and even the entirety of it.

There seems to be very few bicycle lanes near the chosen site location. Bicyclists seem to share wide sidewalks with pedestrians, or roads with vehicular traffic. Figure 34 shows a map of bicycle lanes that are used predominantly in the downtown and more densely populated areas of



Figure 34. Map showing bicycle lanes and how often they are used by bicyclists. Credit: "kievmap360.com"

Kyiv. The site location is located outside of the eastern border of the map and therefore it cannot be determined with absolute certainty the extent of bicycle infrastructure there. This will need to be accounted for in the design phase of the housing complex as there will most likely be a need to expand bicycle infrastructure to this locale to encourage the use of non-carbon emitting means of transportation for residents who desire to access the surrounding regions of the city. Bicycle lanes will have the most efficient effect in supporting this objective by being located on Staroboryspilska Street. This will allow residents to bicycle to the Park of Partisan Glory and access the metro and other services and places of entertainment to the west of the site. This would, along with helping to lower carbon emissions, help improve the physical health of residents who choose to bicycle as they would typically receive a sufficient amount of exercise in a day.

3.7. Precedents/Case Studies

3.7.1. Dortheavej Residence

The Dortheavej Residence, a prefabricated, modular, low-income housing complex located in northwestern Copenhagen, Denmark, is a remarkable example of the financial benefits paired with the exceptional design qualities of modular construction. Designed by Bjarke Ingels Group (BIG), this complex was completed in 2018 with a size of 6800 m² (73,195 ft²). It comprises of five floors featuring a total of 66 residential units with 3.5 m (11.48 ft) high ceilings, terraces, and floor-to-ceiling windows. This project, designed for,

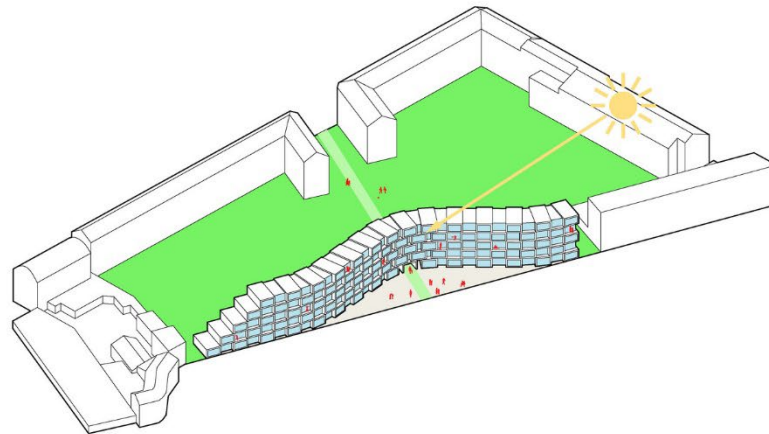
...non-profit affordable housing association Lejerbo, (Homes for All - Dortheavej Residence | BIG - Bjarke Ingels Group, n.d.), was,



Figure 35. Image showing the front exterior façade of the Dortheavej Residence Credit: Rasmus Hjortshøj / Bjarke Ingels Group

...realized on a strict budget, (*Homes for All - Dortheavej Residence* | *BIG - Bjarke Ingels Group*, n.d.), in order to provide quality home for less fortunate citizens.

The narrow form of the housing complex allows it to be as unintrusive to the site and the



SOCIAL REALM
THE SYSTEM COMBINES A VALUABLE PUBLIC SPACE WITH SOCIAL HOUSING UNITS OPTIMALLY ORIENTED.

Figure 36. Graphic showing the form and context of the Dortheavej Residence complex and how it encourages public usage. Credit: Bjarke Ingels Group

surrounding buildings as possible. As evident in Figure 36, the smooth curved shape of it also helps to define the creation of two public spaces, one in the front and one in the back (the courtyard). Though the inner courtyard is flanked and almost completely surrounded by buildings, the usage of it by the general public is encouraged with a number of entrances. One of the most prominent is that within the Dortheavej Residence. Figure 37 shows just how the design of the building does this. Three passageways on grade allow for fluid access to both spaces inviting not just those who live among the surrounding buildings to use it, but everyone. This gives way to the development of an intimate and diverse community to develop by discouraging



Figure 37. Image of the three passageways on grade of the Dortheavej Residence complex which allows the general public access to the two outdoor public spaces defined by the building's footprint. Credit: Rasmus Hjortshøj / Byarke Ingels Group

social isolation and exclusion, which can often be the case with affordable housing projects that are realized on low budgets.

Upon analyzing the exterior façades, one notices right away the patterned design of the building. The modularity of the building, though not directly apparent, can be noticed upon closer inspection. The checkered pattern created by these modules, along with the pushing and pulling of the front façade, creates a dynamic and functional design by creating space for outdoor balconies for residents and allowing them ample access to natural daylighting helping to create a more welcoming and comfortable environment. The specific material palette consisting of light wood and unfinished concrete also aids in creating an open and inviting exterior and interior environment.

The monotone and unintrusive color tones of these materials allow residential units to feel open as light from the sun is allowed to reflect off them via the large floor-to-ceiling



Figure 38. Image showing a typical living room in a residential unit featuring the floor-to-ceiling window. Credit: Rasmus Hjortshøj / Bjarke Ingels Group

windows. Paired also with the white color of the interior walls, these design features connect the resident to the outdoor environment further by discouraging a complete degree of segregation from the exterior. This notion is pushed even further with the outdoor balcony that is featured just outside the dining room. The balcony, that is created from the changes in depth of the south-facing (front) exterior façade, helps to increase the standard of living for those who are financially less fortunate. Designing a layered system between the public and private environments helps to increase comfortability of residents. They can choose to enjoy the public spaces just outside of the complex to access elements of nature and interaction, utilize the

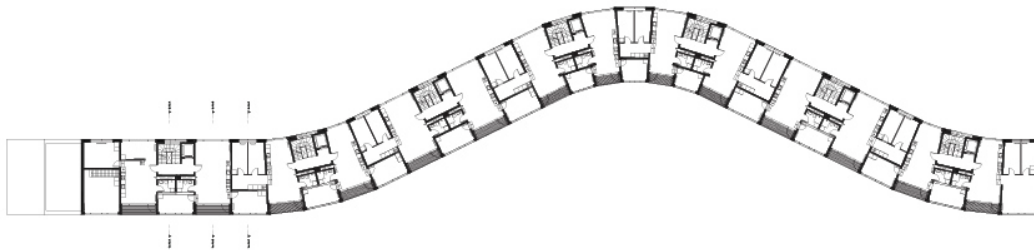


Figure 39. Floor plan detailing how the modules come into place to complete the curved shape of the footprint of the complex. Credit: Bjarke Ingels Groups

balcony which is a sort of “grey zone” lying just in between those two sentiments, or they can retreat into solitude and tranquility in their residences to relax and rest. Having the ability to access both notions whenever wanted is a design feature that is often paid little attention to, especially in low-income housing, but does wonders by improving living conditions and promoting healthy living.

The Dortheavej Residence responds to the needs of the financially less fortunate who live in the city of Copenhagen. This is done by designing the complex to create public spaces for both residents and city-dwellers alike, who are all encouraged to utilize them, by providing ample amenities and exceptional living standards in comfortable interior environments for residents, and by using cost-effective design methods, such as modularity, to create an affordable living option that is also comfortable. Bjarke Ingles Group clearly designed this project with intention and purpose as it has garnered much attention among the international community.

Drawing upon this project’s success will be important for the design approach of this thesis. The modular approach which sees separate, individual modules come together to create

the form of the structure makes evident the many design opportunities that exist to ensure cost-effectiveness. This notion will be instrumental in this thesis' design approach to help reduce the cost of renting a unit and therefore increase access to quality housing for the many Ukrainian refugees who do not possess substantial economic resources. Providing quality standards of



Figure 40. Exterior image showcasing the simple yet intentional design of the Dortheavej Residence complex. Credit: Rasmus Hjortshøj / Bjarke Ingels Group

living for these disadvantaged people is a focal point of this thesis, and the Dorteavej Residence shows that this can feasibly be realized.

3.7.2. The Stack - Modular Housing in Manhattan

The Stack NYC in Manhattan, New York is a residential complex that looks to combat the issue of high rental rates associated with living in this expensive city. Designed by the architectural firm: GLUCK+, this complex is 37,710 ft² and was completed in 2014. It applied a



Figure 41. Exterior photograph of The Stack in Manhattan, New York. Credit: Amy Barkow / GLUCK+

modular approach that, according to Maria Francisca Gonzalez from ArchDaily, took,

...advantage of offsite construction methods. Offsite construction offers an accelerated schedule and shorter financing period, turning sites that might otherwise be considered risky and turning them into opportunities, (*The Stack Modular Housing in Manhattan / Gluck+, 2020*).

This permitted the budget for the building to stay lower than if it were built using traditional methods of design and construction, which was instrumental in having the ability to offer affordable means of living in this dense urban setting.

The Stack NYC is located in West Manhattan in close proximity to the Hudson River with New Jersey being just on the other shore. Lying straight to the north of the site is Inwood



Figure 42. Site plan showing *The Stack's* footprint among the other buildings in proximity to it. Credit: *GLUCK+*

Hill Park which provides residents of *The Stack* to have access to nature, human interaction, and the outdoors in general in this bustling urban environment. The complex itself was built directly adjacent to the existing building to its east resting right up next to it. These two structures share a courtyard in between them allowing residents of both buildings to share a small space that grants



Figure 43. Photograph illustrating the scale of the courtyard and the natural elements such as trees, plants, and shrubs within it. Credit: Amy Barkow / GLUCK+

them a greater ability to access the outdoors within a shorter vicinity from their places of living. This positively contributes to the overall quality of living there and makes for a more comfortable setting to live in.

Shifting focus to the exterior of the building itself, one notices two apparent things right away: the flat, windowless west façade, and the “blockish” character of the front, south façade. It can be inferred that eventually in the future, a building will be designed and constructed right next to The Stack covering this almost empty wall. This shows that the designers at GLUCK+

paid careful attention to development patterns in this locality and are mindful of potential future developments as well. The front elevation has a distinct design character that makes visible the



Figure 44. Photograph detailing the “push and pull” notion of the front exterior façade giving light to the modular anatomy of the complex. Credit: Amy Barkow / GLUCK+

modularity of the building itself by playing with the notion of “push and pull,” which aesthetically defines the boundaries of each pre-constructed module. This allows The Stack NYC to stand out architecturally and make a name for itself as a rather attractive piece of the built environment that is also functional by providing residents affordable means of housing.

Figure 45 shows a sample floor plan that illustrates how residential units are laid out within the unorthodox footprint of The Stack. It also shows how the footprint interacts and exists rather independently from the other building to the immediate east. None of the edges of the exterior façade line up with it, (which is evident by the odd and irregular shape of the courtyard created between both buildings) with exception to the front south-facing one. This, along with

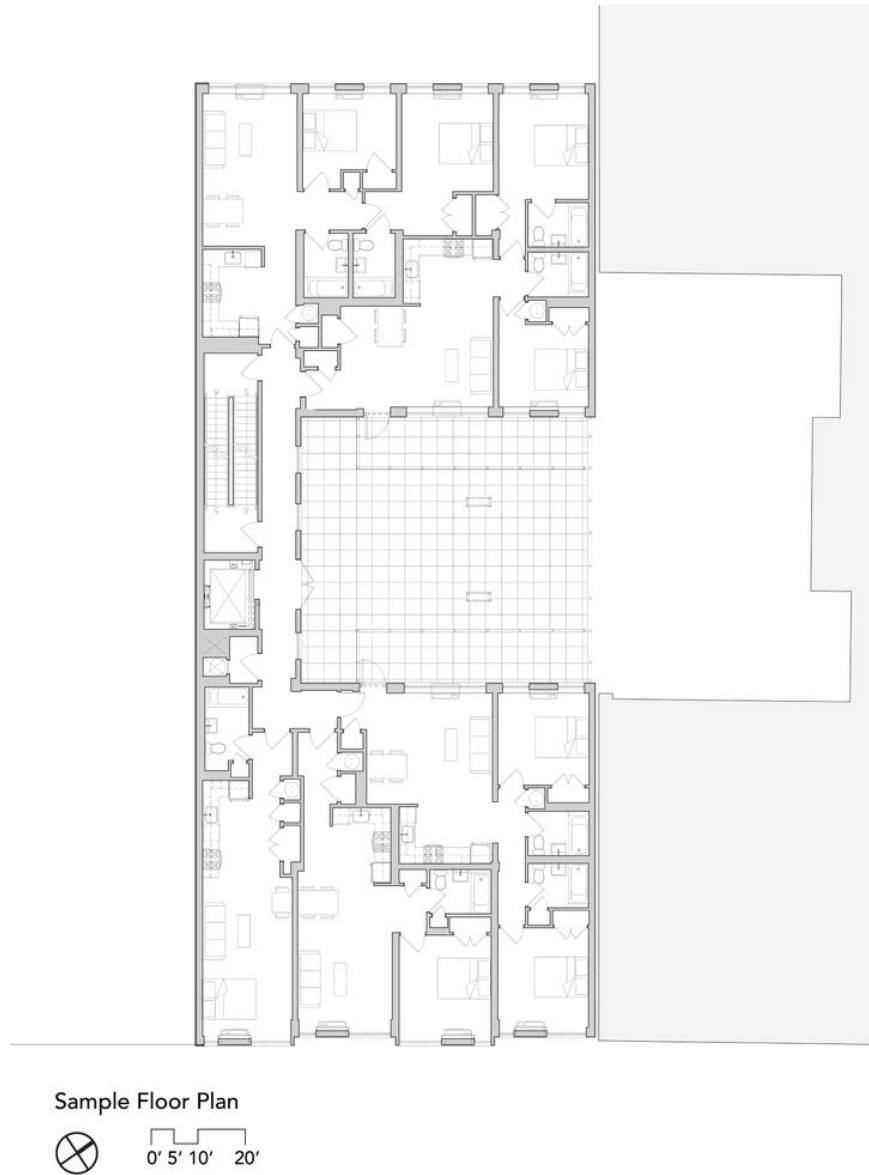


Figure 45. Sample floor plan showing how a typical story is laid out and used among residents. Credit: GLUCK+

the tight site and footprint parameters displays how people can be housed in dense urban environments by making efficient use of smaller spaces. A typical level in The Stack NYC features five units of various sizes and configurations. These range from studios to two-bedroom apartments and make efficient use of the little space that they take up. Connecting the two wings that flank the courtyard is the egress section of the floor plan which features a stairwell, elevator, and a small utilitarian space. The lack of more utilitarian space, at least on this sample floor plan,



Figure 46. Picture taken of a living room of an apartment unit. Credit: Amy Barkow / Gluck+

makes apparent the constrained site limits that this project had to face as GLUCK+ designed only for what was necessary for the complex. This shows that efficient use of limited space is possible in today's world of excess which helps to push the cause of sustainable design and living.

The successful implementation of a modular design approach is what defines The Stack NYC. The work done by GLUCK+ and the many consultants of the project shows the careful planning, coordination, and implementation of this less popular method of design with this high-density living typology. This made possible the ability to reduce the amount of time required to complete the project, saving both resources and money. Along with these benefits exists the increased efficiency of the units and the building itself. Being fabricated in a controlled environment, (a factory) drastically reduced the imperfections of the constructed product helping to save further resources and money over time as the demand for energy and other present-day

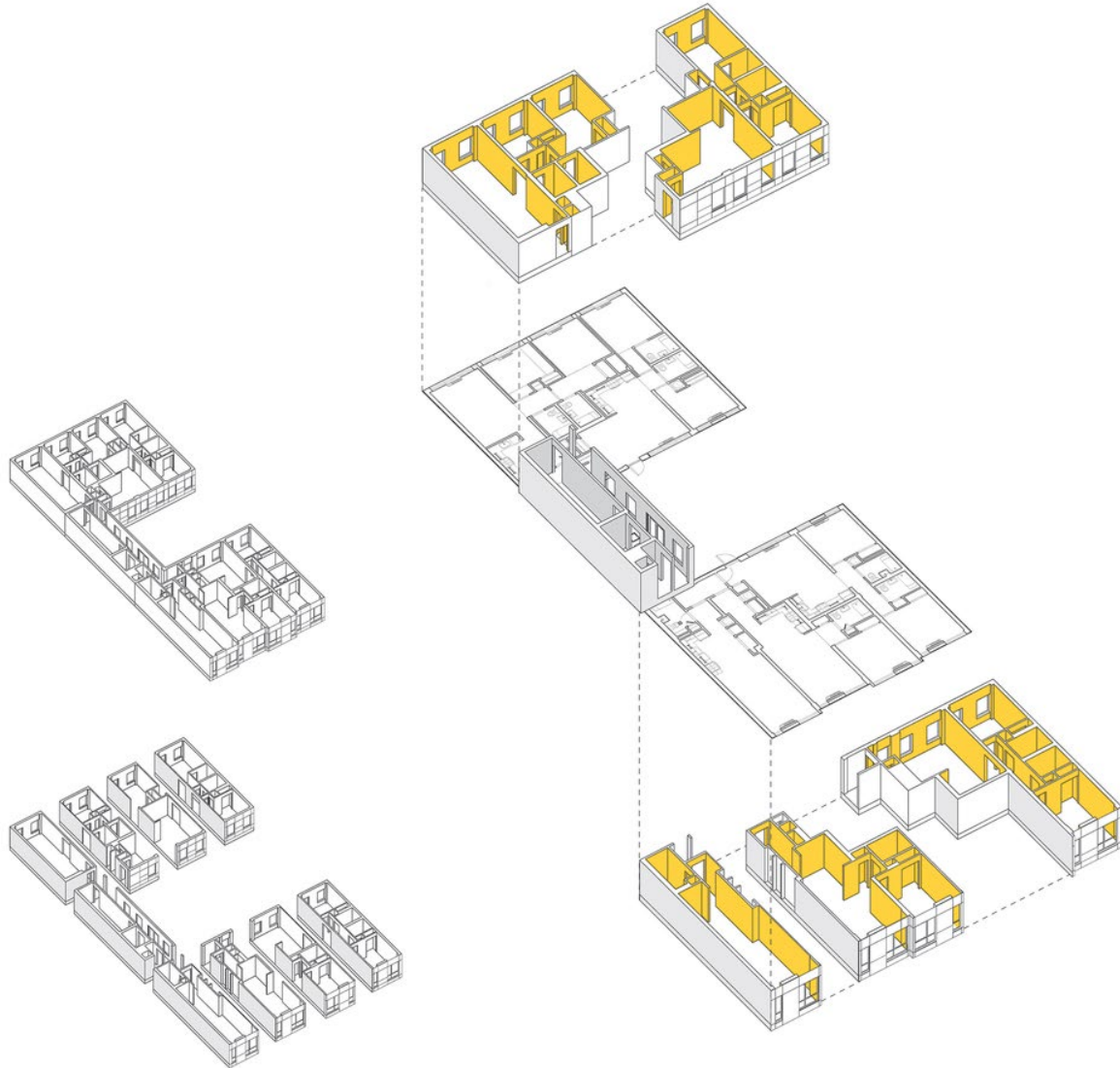


Figure 47. Diagram that demonstrates the modularity of The Stack NYC and how modules come together to form a complete floor plan. Credit: GLUCK+

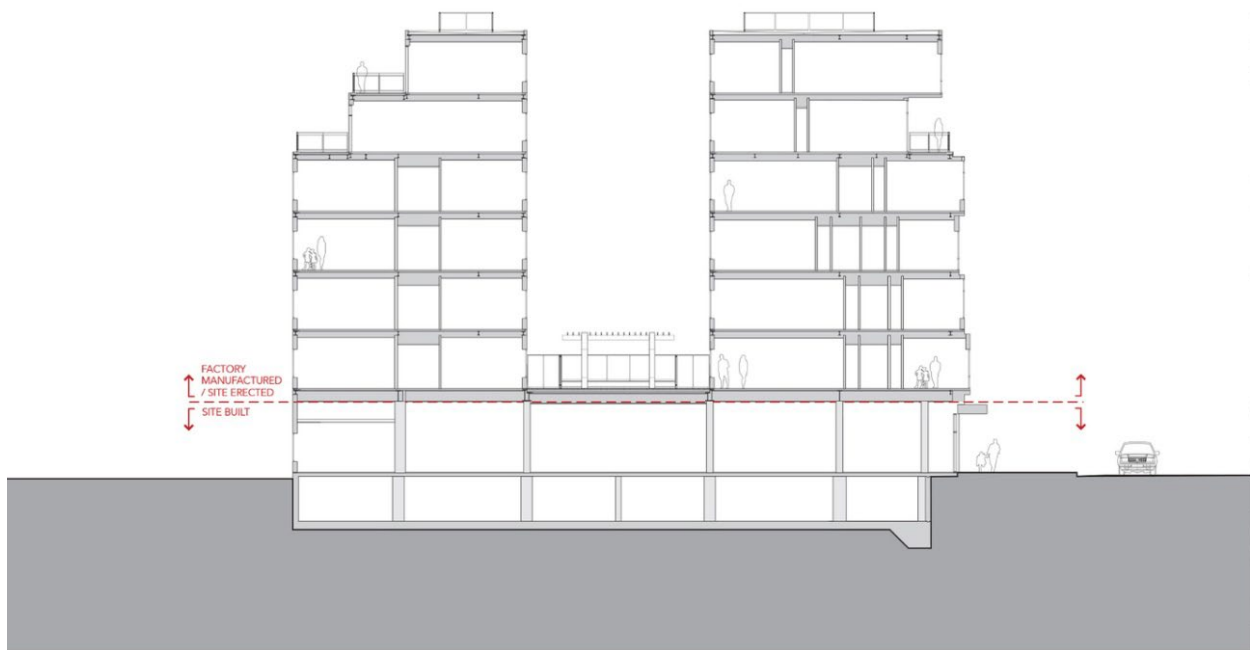
living needs will be able to be lower than a traditionally constructed building this size. This reality creates a more comfortable and affordable means of living for those who find themselves among the residents of this unique apartment complex.

The Stack NYC shows the possibilities and benefits of modular construction in urban environments. Existing among demanding and limited site conditions, it was able to successfully



Figure 48. Image of the controlled industrial environment in which the individual modules of The Stack NYC were fabricated. Credit: GLUCK+

adapt to them providing more affordable living options in Manhattan. This is an extremely useful example which will apply directly to this thesis and its objectives. Kyiv, Ukraine is also a dense urban environment with generally higher land value. This makes living more expensive, which limits the number of living options for many. Modular design and construction can help to alleviate this burden. Reducing initial and future costs associated with equipment usage, material implementation, energy demands, and other aspects of construction is a central goal of this thesis due to limited financial resources available to many Ukrainian refugees. The efficient use of limited space also is something to take away from this case study. Limiting sprawl in urban environments will help to reduce the Urban Heat Island effect, which plagues so many cities around the world making living more uncomfortable and unhealthier for people and will help to make amenities and services more easily accessible for as many people as possible. This will also help to push the cause of sustainability in design and aid in the fight against global warming which, on top of the goal of housing less financially fortunate Ukrainian migrants, will help give




Building Section
 0' 5' 10' 20'

Figure 49. Section diagram showing the site-made structural foundation along with the factory-built modules that comprise the upper floors. Credit: GLUCK+

this thesis a greater ability to be responsive to the problems currently at hand both at local and potentially global scales.



Figure 50. Picture of a module being lifted into place to be secured to The Stack. Credit: GLUCK+



Figure 51. Image that illustrates the construction process of The Stack NYC with the assemblage of the individual modules into one building. Credit: GLUCK+

3.7.3. Argyle Gardens

Argyle Gardens is a multifamily housing model in Portland, Oregon consisting of four residential buildings with a total of 42 units. The largest building holds thirty-five 220 ft² studio apartment units while the other three smaller ones hold two six-bedroom units. Completed by Holst Architecture in April of 2020, this low-income housing approach of 24,000 ft² is focused on providing affordable living options for homeless individuals and families, members of the workforce, or students. This is possible due to the modularity of these structures which altogether reduced construction time, kept the budget modest, and helped provide means to improve resource and energy efficiency of each residential building over time.



Figure 52. Image of the Argyle Gardens multifamily housing site. Credit: Holst Architecture

Though relatively small in grandeur, this project was no “walk in the park.” According to Holst, there were some obstacles during the design process that had to be overcome, “

The site’s steep topography and existing vegetation provide privacy but challenged the design team to locate the buildings in a way that balances ADA access requirements, environmental consideration, and the maintenance of the large staging area required for modular construction... (Parliament, 2018).

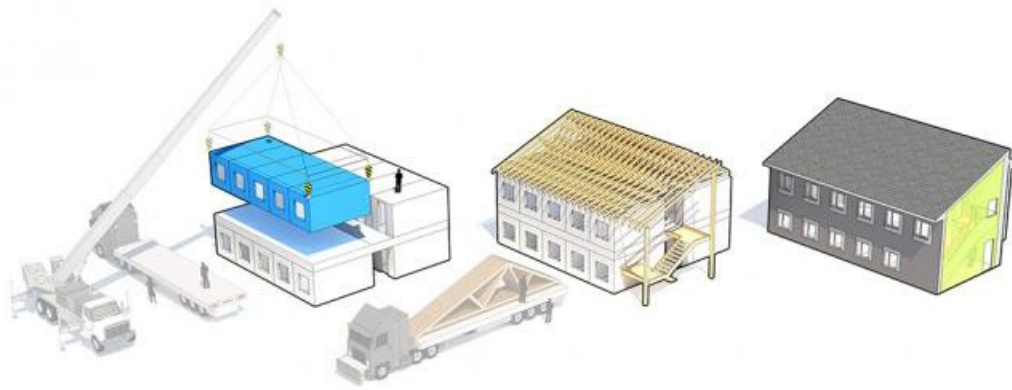


Figure 53. Diagram briefly illustrating the construction process of the modular residences. Credit: Holst Architecture

Though there were existing site conditions that were unfavorable, this model was still able to adapt and be successfully constructed which highlights the ability for the widespread implementation of this design approach among many different and unique settings.



Figure 54. Image of the shared kitchen space in one residence. Credit: Holst Architecture

Argyle Gardens is designed to have residents, “*share community space and support*” (Parliament, 2018). This is done by limiting the number of amenities provided in each individual residential unit, instead providing communal spaces such as kitchens, bathrooms, community rooms and laundry facilities. This reduces the resource demands of each building promoting

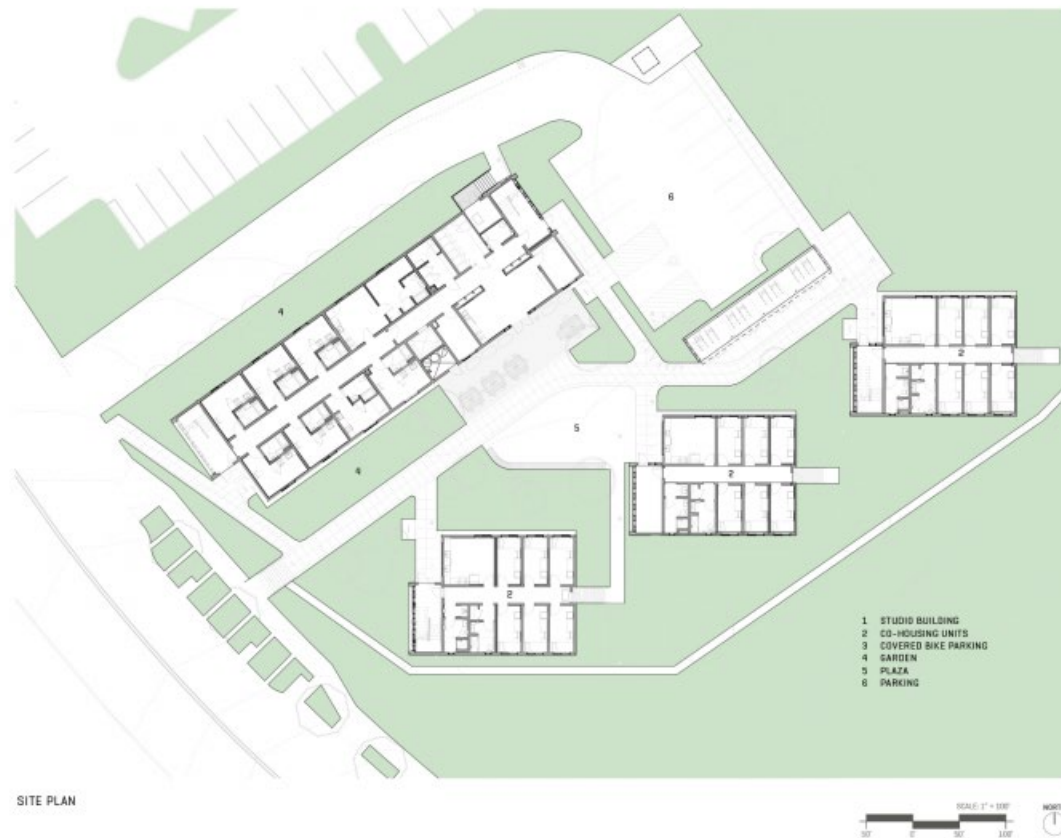


Figure 55. A site plan including floor plans of each residence in the Argyle Gardens complex. Credit: Holst Architecture

efficiency and sustainability. Further promoting the cause of sustainability are the photovoltaic panels on each roof and a communal garden where produce can be grown and consumed. This limits the carbon footprint of this multifamily housing complex by decreasing its reliance on a central power grid and increases its food resiliency and independence helping to further promote more sustainable and environmentally friendly construction methods and architecture.

Argyle Gardens introduces a community-based living approach which sees residents sharing resources and living space in order to provide affordable housing for financially less fortunate individuals and families. This model consequently saves resources and promotes healthy and sustainable living. This unique and responsive project greatly applies to this thesis as it was designed, constructed, and is operating at affordable rates. As with the other case studies explained previously, affordability is at the forefront of this thesis. As stated, Ukrainian migrants do not have abundant financial resources at their disposal while displaced. Returning to an environment that has been drastically devastated from the conflict will make it more difficult for them to get back on their feet. Alleviating the burdens associated with searching and paying for a home can go a long way in helping to improve the quality of life for Ukrainians in Ukraine much faster. This is where this model, or a related version, can step in. The modularity of the residences and the use of the site of Argyle Gardens helps to create a community with quality amenities and living conditions for those with few financial resources. It also encourages resiliency by being efficient with the use of resources such as food, energy, and water, by deeply



Figure 56. Image capturing the immediate exterior, the stairwell, and the interior characteristics of a residence in Argyle Gardens. Credit: Holst Architecture

encouraging and incentivizing the sharing of them through design and layout. The semi-dispersed nature of the living accommodations balances the notions of publicity and privacy. The shared spaces such as the kitchens and community rooms encourage interaction among residents and foster a deeper sense of community and unity while the ability to retreat to a separate bedroom provides them with a sense of privacy whenever desired which helps to maintain and



Figure 57. Image showing the layout of the site of Argyle Gardens. Credit: Holst Architecture

improve mental health. This balance, engrained within the design of Argyle Gardens, is what helps to make it a comfortable and quality place to live. This approach, or components of it, could be utilized to formulate a system specifically tailored for Ukraine and its culture and built environment. Deviating from the traditional style of high-density residential building (one large building with multiple stories) may be a logical and effective manner in which to provide affordable housing options for migrants, encourage sustainable and environmentally friendly ways of living (such as local power generation and community gardens/urban farms), balance the notions of publicity and privacy, and facilitate the development of a profound sense of

community among residents. This system has the potential of not only responding to the impending housing crisis in Ukraine but providing a vehicle to build upon for future generations.

3.7.4. Conclusions

These case studies all apply to the specific scope of this thesis detailing diverse ways in which to provide affordable housing and positive living environments through the employment of modular design and construction methods. With that being said, specific criteria must be developed in order to effectively analyze this information and draw meaningful conclusions that apply to this thesis. These criteria include several themes that this thesis strives to address and design for. These include but are not limited to: number of housing units, total square footage, overall design quality, degree of modularity, affordability for residents, provided amenities, responsiveness to site needs, and ability of fostering a sense of community. Each of these categories will, for each case study, be given a numerical value from 1 to 10 based on the degree of perceived fulfillment and satisfaction. 1 being highly unresponsive and unsatisfactory and 10 highly responsive and incredibly achieved. Explanations will then be given to illustrate why each category was given the said number for each case study.

Overall design quality entails the physical elements of the building that altogether create the form and identity of it. How is the building utilizing design to enhance the environments in and around them? The design and degree of “attractiveness” that this project will have is important in helping to create a more desirable place to live. Architectural quality should not be ignored throughout this project as it helps to enhance environments through experience and perception.

Degree of modularity indicates how modular design and construction techniques were integrated throughout the process of development and procurement of the building. This is meant

to help define and illustrate methods used, the composition of modules and components, and how they were pieced together to form the finished product. This will help to inform this thesis about differing techniques of modular design and construction to help identify the most relevant and responsive approach for this specific project.

Affordability for residents will be defined by standard rental rates of certain room types between all case studies. These will be compared to paint a clear picture of how each building's design and construction processes and techniques used, paired with other external factors, influenced prices for residents. Rental rates will differ due to external factors which will be accounted for in the evaluation. This information will be gathered and analyzed to better define an approach to this thesis' design to help lower rental rates as much as possible for migrants.

Provided amenities between each case study's building will be analyzed to better understand the basic living standards of residents among each locality in which they exist. This information will also be used to aid in understanding how amenities affect rental prices and overall quality of life. This information will be dissected to inform this thesis project's potential amenities to offer in order to create a realistic image of what a housing complex would need to provide to residents in Ukraine.

Responsiveness to site needs seeks to discern how the building itself fits among its surrounding context and environment. It also aims to illustrate different ways in which these projects utilized their individual sites to provide extra amenities or activities for residents. These can include gardens, playgrounds, public space, etc. This will inform this thesis on ways in which to create more socially conducive and enjoyable environments to increase the general level of comfort for residents.

Lastly, the ability to foster a sense of community will attempt to identify how design, layout, and other factors influence those who utilize the building and site of each project. This criterion will be evaluated by analyzing design methods such as the inclusion of public space and the interior spatial layout of each project to obtain a better understanding of the conduciveness of these case studies to positive social interaction. This notion is highly important to this thesis' design as a deep sense of community created and enhanced through design greatly helps to improve living conditions and the general well-being of residents. The success of this thesis is heavily based upon the feelings and opinions of each resident and how they feel that the building and site respond to their needs and desires.

CASE STUDY EVALUATION	Dortheavej Residence	The Stack NYC	Argyle Gardens
Number of housing units	66	28	42
Total square footage	73,195	37,710	24,000
Overall design quality	9	8	7
Degree of modularity	9	10	8
Affordability	7*	9	10
Provided amenities	8	7	7
Responsiveness to site needs	8	5	8
Ability to foster sense of community	7	5	9
Total	48	44	49

Table 1. Case study evaluation illustrating perceived fulfillment of each category by each project in relation to this thesis' project typology and scope. Credit: Andrew Tovsen

Table 1 seeks to provide a form of rating for each case study with the goal of better understanding their relevance to this thesis' specific project. This data has been generated based upon personal opinion of how each case study satisfied each category with the information available. The numeric values from each of the six categories were then added together to produce a final score defining the degree of supposed "success" that each case study possessed and its relevance to this thesis. This information will be used to better understand and highlight the methods of design and construction that are most relevant to this thesis' project itself. This is to help ensure that the project is as responsive to the needs of Ukrainian migrants as possible in order to create more healthy and enjoyable environments for all residents.

3.7.5. Dortheavej Residence

The Dortheavej Residence scored a total of 48 points in this study. This is a rather exceptional score and shows that this apartment complex takes into account a myriad of factors to provide excellent living conditions. The overall design quality of it is simple yet elegant. The soft tones of the wood exterior cladding compliment the large windows of each residential unit. The checkered pattern of the south façade along with the gentle curved shape of the building footprint enhance the design quality giving it a unique personal identity. The complex utilized a very modular construction approach. Individual modules were designed and fabricated off-site and were then assembled at the site. This allowed the duration of construction to be lower when compared to traditional construction methods which ultimately permitted the budget to be lower therefore increasing affordability. It is not known what actual rates are for housing units in the Dortheavej Residence. This could be due to it being a public housing building which would require potential renters to apply online to be approved by the government and its respective departments before being given a price. It is assumed, though, that this is a mostly affordable housing option compared to others in the city of Copenhagen. It has received praise from various press sources for its affordability and ability to combat rising rental rates in the city. This is why in this category this case study received a 7.

The Dortheavej Residence provides adequate amenities to residents helping to enhance the quality of life among each one. A typical residential unit features a basic kitchen and dining room space, a bathroom, two small bedrooms, tall ceilings, and a balcony. These all come together to create an environment whose standards of living are exceptional for this typology. The focus on the user experience of each resident is truly something to be applauded and learned from. This type of living can be achieved while also lowering costs. This is done through careful

consideration, purposeful design, and by being as efficient as possible with the use of space. This helps to create a pleasant living environment for residents and allows the project to also respond to site needs and the context surrounding it. This building fits very well among the other buildings that surround it. It has a very similar height to them in order to assimilate with the local area and not stand out as something that does not belong there. It also creates two separate public spaces due to its clever curved design. This along with the ability for the entire public to access these spaces invites people to interact and create a stronger sense of community. These sentiments all culminate into a building that not only satisfies site needs but creates its own unique environment that is conducive to the strengthening of community ties for all users.

Though the site achieves great success in this category, the building itself does little to do the same. The interior is composed to only serve as living space, not community space. There appears to be a distinct lack of social spaces or places where residents can interact. The narrow depth of the building's footprint makes hallways very difficult to design on each floor which requires vertical circulation space to be ample across the entire length of the building footprint. As each residential unit extends from the south façade to the north, there requires seven separate stairway and elevator spaces to exist across each floor. This design decision gives users very little opportunity to encounter and converse with others. Residents seem to only utilize this building for living purposes and very little else. This, though, is acceptable due to the public housing typology of this project. In order to make these residences affordable in the first place, efficient use of the given space must be prioritized. However, the surrounding site offsets this disadvantage somewhat, helping to provide some ability for this project to foster a sense of community.

The Dortheavej Residence is clearly a success when it comes to providing affordable, quality housing. The skillful use of material, the unique footprint of the complex, the access to balcony space for each unit, and the way it fits among the surrounding context are all subjects that will be taken into deep consideration for the design of this thesis' project. This case study makes evident the feasibility of providing excellent standards of living for residents while keeping rental rates rather moderate. Despite the lack of interior community space, this project responded to the needs of less fortunate individuals and families by not only providing quality housing, but the ability for a community to grow, increasing the wellbeing of so many who live in and use this building and its site.

3.7.6. The Stack NYC

The Stack scored a total of 44 points in this evaluation which is the lowest among the three case studies. This is mainly the result of the parameters of the site which sees very little space able to be utilized by the building itself. As the city of New York is a highly dense urban metropolis, efficient use of limited space must be prioritized for almost any project situated here. This is no different for The Stack which naturally prohibits the existence of meaningful community space apart from a small courtyard that is shared with the adjacent building. Though it falls short on that important subject, it is itself an example of the benefits of modular construction which sees this building provide quality housing options which are at rental rates that are lower than the average for New York City.

The Stack possesses a simplistic overall design quality that is pleasant and attractive. The most obvious element of this is the front exterior façade design. Almost every module of this side of the building has a different depth than the others adjacent to it, which creates a unique, lively character for the complex. This enhances the building's street appeal and renders the

existence of a unique identity for the building to develop. The abundance of white paired with the darker grey color on the exterior gives it a character that stands out from other aged buildings around it, which are mostly comprised of red brick. The metal panel cladding breaks up the flat form of the west façade. It also illustrates the modularity of the complex as the lines formed between each panel follow the form of each module. These modules were stacked on top of a site-made foundational structure which supports them. This building is an excellent example of one strength of modular construction which is the ability to quickly erect a building on small sites like this one. This is in contrast to traditionally built structures that require large construction equipment in order to construct and therefore more space. This is greatly useful in highly urban environments where space is typically limited.

This modular approach, similar to the Dortheavej Residence, permitted lower rental rates to be possible for residential units. According to information obtained on “*StreetEasy*”, an online source that provides real-estate information for the city of New York, rental rates are clearly lower than the average of the city. A studio can be as little as \$1,700 a month, a 1 bed \$2,095, and a 2 bed \$2,675. The average rent according to “*renthop.com*” for a studio apartment is, as of December 2023, \$3,250, a 1 bed \$3,838, and a 2 bed \$4,595. The Stack NYC clearly provides much more affordable housing options in a city that is so expensive to live in. It is for this reason that this case study scored so highly on the category of affordability.

The Stack provides quality amenities that create a comfortable environment to live within. The typical unit features a kitchen and dining space, a living room, bedroom, and a bathroom. These address the needs of residents but do not go much farther than that. With the compact size of the building, not much room is available to utilize for the implementation of additional amenities. Efficiency appears to be the main focus of this project which seeks to make

good use of every square foot. This notion is reinforced by the previously mentioned small site that the building sits on. This largely inhibits this complex from being responsive to site needs due to the apparent lack of any usable community space around it. The only element that gets anywhere close to this is the courtyard which provides private outdoor space for residents.

The courtyard is the main feature of The Stack that makes possible the fostering of community to develop. Though not too large in size, it grants residents the ability to enjoy the outdoors and converse with others. This is very important in any multi-family living complex as it greatly contributes to positive social environments which aid in improving the physical and mental wellbeing of residents. It is unknown if any interior community space exists to further strengthen this notion, but it is apparent based upon the floorplans that a typical story does not feature any community space, only residential units, vertical circulation space, and small utilitarian spaces. The lack of usable community space creates an environment where it is more difficult to interact with other residents to form a strong sense of community.

The Stack NYC is a project that is indicative of the advantages of utilizing modular construction techniques. Being able to be constructed in a shorter time span than traditionally built buildings of equivalent size allows money and other resources to be saved in the process. It helps to lower rental rates for residents, helping to increase access to quality housing options. The efficient use of limited space and the successful modular construction process employed are the two biggest subjects that stand out for this case study and will be considered in this thesis' project. The Stack is limited with its potential by the strict site parameters, but the complex puts on full display the ability to adapt to these conditions and produce a successful solution. Thoughtful design, intuitive modular construction techniques, and close coordination with others

were all necessary in the development of this project which fully achieved its main objective: to create more affordable housing in a very expensive city.

3.7.7. Argyle Gardens

Argyle Gardens received a total of 49 points illustrating that it is the most relevant case study to this thesis as it is supposedly the most “successful” one. This case study satisfied all of the categories as it is very affordable, community oriented, and sustainable. The overall design quality is satisfactory. The colored metal panels on small portions of each residential building add a unique characteristic to this otherwise standard housing design. The gabled roofs and vinyl siding on each structure are typical of American suburban houses and therefore do little to express design creativity. The quality of these homes does seem to be high due to the modular construction methods used. Each module was constructed off-site in a controlled environment. This environmental consistency, that is the controlled interior environment of a factory, creates ideal conditions for fabrication that enhance the climatic efficiency of each module. Insulation can be better installed to help improve interior temperature control and comfortability, windows can be better sealed to prevent thermal breakage, and design elements can be better implemented within and on the modules to improve quality of design. Along with this benefit, the decreased duration of construction of this project, along with the other case studies, aided in saving time and other resources. This in turn allows rental rates to lower increasing access to quality housing to homeless and other disadvantaged individuals or families as was stated as the primary goal of Argyle Gardens.

According to “*Quantum Residential*,” a single room occupancy residential unit furnished with a bed, chair, wardrobe, and desk, starts at \$321 per month to rent. A studio room with its own bathroom starts at \$648 per month. This is far below what many pay for units of a similar

size as “*Apartments.com*” states that for a studio unit in Portland, Oregon renters pay an average of \$1,224 per month. Argyle Gardens charges almost half of what many other apartments do in the city. This is possible because of the efficient employment of modular construction techniques and the limited number of amenities provided. Because this affordable housing project is tailored for those with few financial resources, there is not an abundance of amenities to increase the standard of living at Argyle Gardens. The necessities of comfortable living are provided to residents, but that is mainly the extent. This is to maintain affordable rental rates to increase access among the less financially fortunate population of the city.

Sustainable design initiatives have been taken throughout the conceptualization and construction phases as each residence is fitted with photovoltaic panels on one side of each roof and the site features a community garden. Along with that, the site provides access to green space for children to play and for others to exercise and enjoy the day. The efficient use of the limited space by implementing these elements shows that designers at Holst Architecture put careful thought into the responsiveness of both the user’s and the site’s needs. These elements altogether increase resiliency of the multifamily housing complex by lowering its reliance on the external energy grid, further lowering rental rates, improving access to healthy food options, and help to foster a sense of community within it.

Fostering a strong sense of community is at the forefront of Argyle Gardens. Residents share amenities such as kitchens, bathrooms, and in some cases living units. This increases the chances that residents will be able to encounter and interact with others, which helps to build trust and improve the wellbeing of many. The community garden and outdoor space also aid in increasing the likelihood of residents building ties among themselves through work and play.

This is what defines Argyle Gardens and helps it to stand out as a community-oriented housing solution.

Argyle Gardens' unique multifamily living approach places great emphasis on community and affordability. These are the strongest elements of this project which apply greatly to this thesis' project. The balance between the notions of providing both public and private space for residents creates a more comfortable environment for all and helps to create a more positive environment. The sharing of resources and amenities, such as the kitchen utilities or bathrooms (which are both shared spaces among residents), helps to lower rental rates and increase interaction. This housing approach scored the highest on the case study evaluation and clearly applies to this thesis as it satisfies all categories. These strong suits of this case study will be further examined and considered throughout the development of this thesis' project as affordability and community are two of the most important subjects with it.

3.8. Detailed Space Program

DETAILED SPACE PROGRAM	Number	SF	Percentage
Stories	3	9,350	
Total		28,050	
SHARED SPACE	<i>PER FLOOR</i>	<i>EACH</i>	<i>PER FLOOR</i>
Vestibule	2 <i>(Ground Floor)</i>	65	1% <i>(Of Ground Floor)</i>
Community Space	1	750	8%
Circulation (Hallways)	1	775	8%
Vertical Circulation	2	250	5%
Utility	1	125	1%
Kitchen	1	500	5%
Storage	1	125	1%
Total		2,775	30%
RESIDENTIAL UNITS	<i>PER FLOOR</i>	<i>EACH</i>	<i>PER FLOOR</i>
Studio	2	300	6%
1B	2	550	12%
2B	6	800	51%
Total	10	6,500	70%
OUTDOOR SPACE			
Park	1	900	
Garden	1	500	
Sports/Activities		2000	
Total		3400	

Table 2. Table detailing the space program of the proposed project of this thesis. Information covers interior shared space, residential unit number and typologies, and outdoor space as well. Credit: Andrew Tovsen

Space Program (Per Floor)

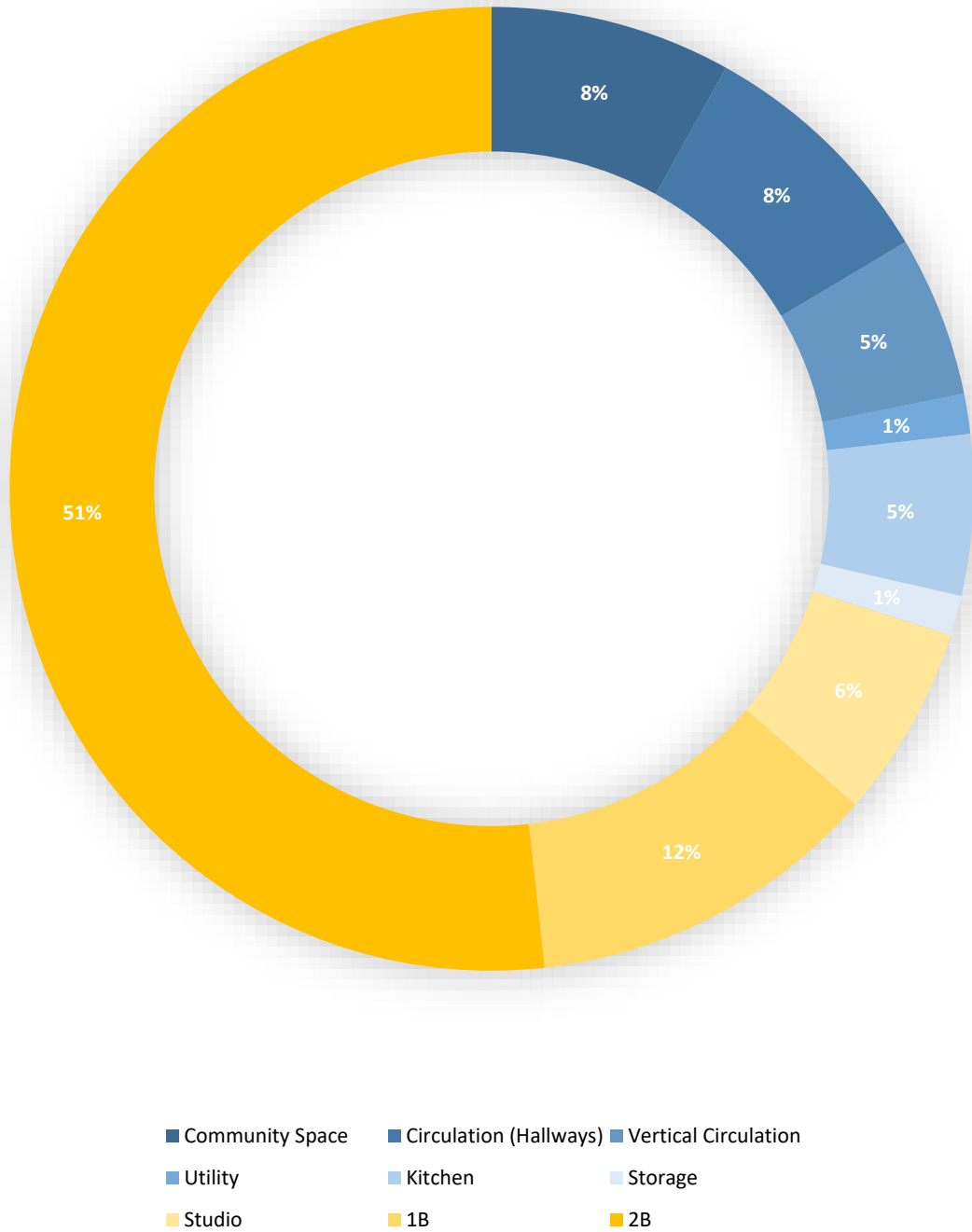


Figure 58. Pie chart illustrating the percentage of floor area each room typology will utilize in the proposed housing approach of this thesis. Credit: Andrew Tovsen

Figure 58, showing the general division of a typical floor in this thesis' proposal, makes evident the moderate balance between private living space and shared communal space. The goal of this thesis is to provide residents the ability to be able to easily access both private and public spaces. This will encourage a deeper sense of community to develop among these residential buildings in order to build trust and increase comfortability.

3.9. Schedule

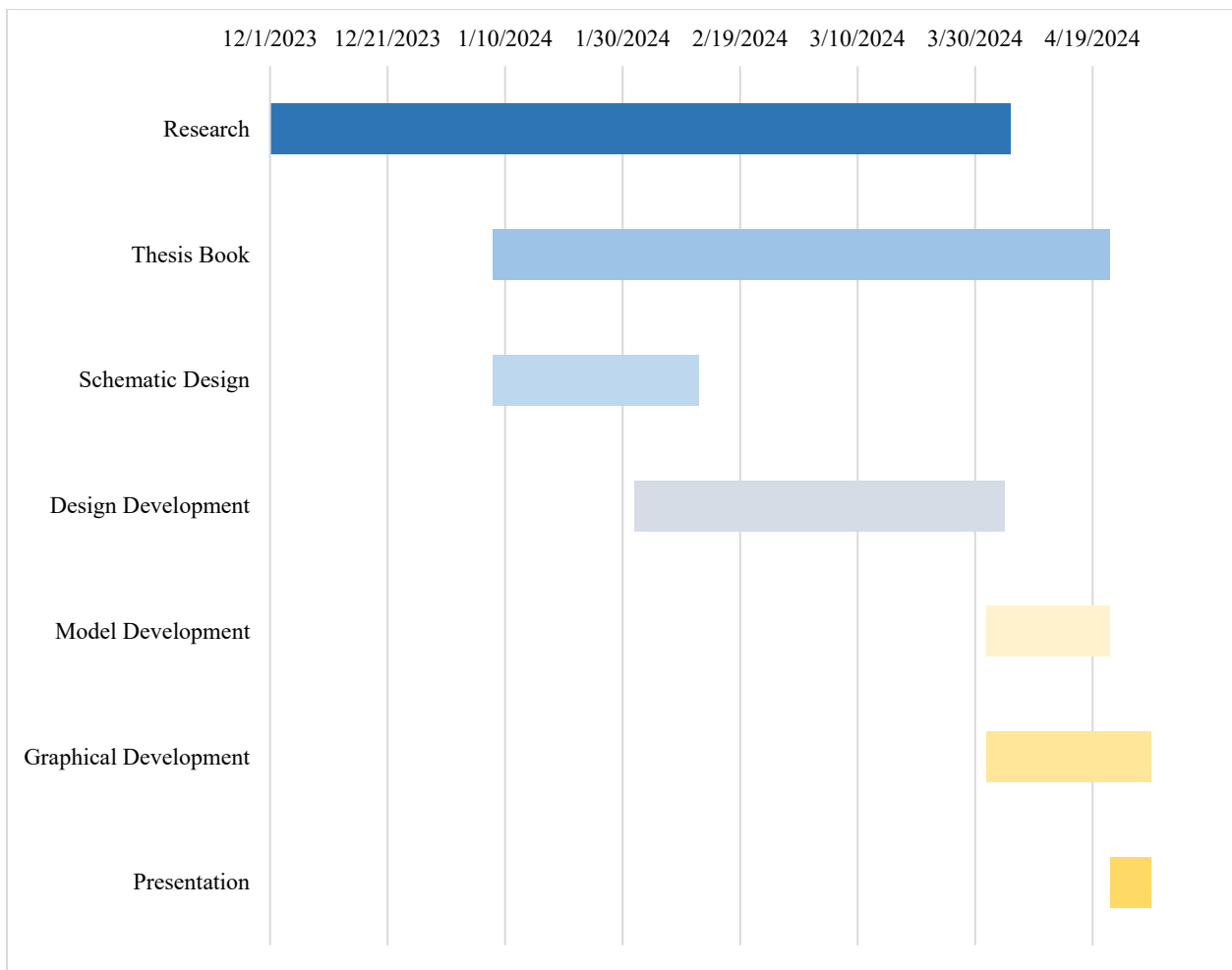


Figure 59. Chart providing a rough outline of what the production phase of this thesis' project will resemble.
Credit: Andrew Tovsen

Figure 59 presented above seeks to represent a general schedule for the production phase of this thesis' project. The research category represents the continued gathering of knowledge on subjects such as modular housing, Ukrainian culture, and sustainable design strategies. This process will last almost all the way until the end of the semester. The thesis book category involves the compilation of information into this document that will need to be further formatted to convey that information in an effective and organized manner. Graphics, images, and other illustrations will be crucial in achieving that goal. The schematic design phase entails the conceptualization of initial design concepts for the housing approach through sketching and other forms of visualization. This will lay the foundation for the next phase. Design development involves utilizing the conceptual designs developed to create a more refined and realistic design for the housing system. This will include the exploration of structural systems, materiality, and sustainable design strategies. Modeling using computer programs will be a key part of this phase. Once a design has been developed that adheres to the narrative of this project, time will need to be allocated to construct a model to further convey the idea of this project. This model, it is hoped, will be able to show the modularity of the project, being able to be expanded and contracted using separate modules that can be pieced together to show the degree of customization and potential of the project. Graphics will need to be created to help illustrate the final design of this project. Renders, diagrams, floor and site plans, and elevations will serve to further enhance this project's feasibility. Details will be shown to define how this system can be realized in the real world. Lastly, a slideshow presentation will need to be developed showing the development of the entire thesis. From the research, to conceptual, to development phases, this storyline will be useful in detailing how and why this thesis was undertaken and the value that it holds to the fields of architecture and humanitarian design.

3.10. Project Brief

This thesis project, as previously stated, seeks to create a modular housing solution to help house Ukrainian migrants by being as affordable as possible while offering high quality living standards for residents. As shown in Figure 58, the spatial programming of a typical floor will consist of both private living and communal amenity space. It is assumed that as many as thirty-five residents can live rather comfortably on each floor, and is recommended that, because of the limited space, this number not be exceeded. Currently, two-bedroom (2B) units take up a majority of the residential living space allocated on each floor. This is to help families, who are more vulnerable to financial troubles having to take care of children, find quality residences that suit their needs. This includes providing a bedroom for adults, a separate bedroom for children, a living/dining area, and bathroom for each family. These amenities may be considered minimal for many western nations (especially with the lack of a private kitchen space) but are predicted to suit the needs of families well in Ukraine. On top of that, the minimal nature of each room will help to lower rental rates, which is a primary objective. One-bedroom (1B) units will be laid out in a similar manner without a bedroom for children. These are to accommodate individuals or couples who are not guardians of any children. These units, paired with the studio units, are designed to be as efficient as possible with the limited space available to promote affordability and sustainable living by not requiring unnecessary amenities or standards of luxury/high-class living.

The shared communal spaces on each floor are to be designed to encourage interaction among residents to build trust and a more comfortable living environment for migrants affected by conflict. The community space will be a central node for residents to gather, socialize, play, and eat. As residential units will be small in size compared to their western counterpart living

standards, residents will be pushed to use the more spacious community rooms, increasing the chances of interaction and dialogue among them. In addition to that, the kitchen will be used by most residents on each floor. As most residential units will not feature a private kitchen (to promote sustainable living and lower consumption), most residents will be highly encouraged to utilize the large communal kitchen. The kitchen is expected to be equipped with three electric stove tops, three ovens, three sinks, a refrigerator, a microwave, a coffeemaker, and ample storage, countertop, and dining space. Kitchens will not feature dishwashers as residents will have to clean their own dinnerware to not utilize an unnecessary amount of water and soap. These kitchens are predicted to be able to accommodate a majority of the residents' cooking and eating needs on each floor at one given time. They, very similar to the community space, will be central nodes for gathering and therefore will also encourage interaction and the sharing of resources such as food, dinnerware, etc. The rest of a typical floor will consist of circulation (a central corridor, a stairwell(s), and an elevator), storage, and other utilitarian spaces that will not be used as often as the residential and community spaces.

Outdoor spaces will be designed to help accommodate the physical needs of residents, mainly children. A playground space, several sporting facilities (basketball/tennis courts for example) and trails linking with the existing ones already on site will be designed for the use of residents. Along with those a community garden plot will be allocated to further strengthen the community bond of the complex by encouraging all residents to participate in the cultivation process of a variety of produce together. This garden will also help increase the local food security of the residents and can be a basis to sell produce to others who do not live at the complex. This can become a secondary income for some, also helping to increase the financial security and resilience of residents.

Several sustainable design strategies are sought to be employed in the design of the housing complex. Photovoltaic panels will be installed on roofs and possibly some south-facing facades. These will be utilized to generate electricity for residents, helping to reduce reliance on the central power grid of the city of Kyiv. Green roofs will be designed to reduce the energy needs of the complex by shielding the actual roof from light and heat, absorb pollutants and carbon dioxide, and increase biodiversity by harboring certain plant life. They will also aid in the water retention and collection process as cisterns will be installed under each structure to be filtered and used for consumption, cleaning, or waste removal. Natural heating and cooling strategies such as the employment of operable windows and thermal masses will be explored but may be hindered in effectiveness by the surrounding tree coverage. Each of these design elements could help further reduce the energy needs of each structure thereby allowing operation costs to be reduced over time, the carbon footprint of each building to be minimal, and the general cause of sustainable living to be proven as a feasible alternative to the environmentally damaging ways of living in many western countries aiding in the improvement of the overall health of the planet itself.

4. HABITAT UKRAINE

Habitat Ukraine is the name given to the final result of this project. It embodies the desire for this project to be a housing approach that easily facilitates the rehousing of these migrants to allow them to return to their native places of origin. Modularity, a focus on community, and the intent for this to be an environment conducive for healing are the main themes that compose the essence of this project. Focusing on the affordability aspect as well as the quality of design of the project is of the utmost importance, helping to limit the required expenditures of each migrant and their family, who most likely have very few financial resources at their disposal, and aiding in the healing process of each resident. It is imperative to keep in mind the very plausible chance that many of these migrants may be victim to both physical and mental health problems due to the sudden violence and uprooting from their places of social and environmental comfort and familiarity. Though these issues may vary greatly from each other and may require professional assistance to combat, architecture can be an effective way to assist with this healing process. This can be realized through intentional design strategies: a combination of the utilization of warm materials, the creation of bright interior environments, the allowance of ample natural daylight, and the thoughtful layout of rooms and spaces can all culminate to provide a place of retreat and comfort for these migrants, allowing them to address their possible hardships at their own will. In the end, creating a habitat, a place of refuge, safety, comfort, community, and healing is the desired end goal of this project. Effectively responding to these goals is what has guided the design and production process of this thesis project. Though most of these have been fundamental points from the conception of it, there have been changes that have developed throughout the process.

4.1. Turning Point

Halfway through the production process of Habitat Ukraine a turning point arrived. The initial design that was developed responded primarily to the affordability aspect of the design, as that was a principal pillar in the overall mission of the project. Though this has, since its inception, been a very important aspect of the project, it gave very little room to focus on the quality of design of the building for residents. This revelation was made and was quickly acted upon. The design of the project shifted from one based solely on the complete modularization of the design and construction process, to one based upon the utilization of mass timber and a panelized modular design/construction system to realize the building. This in turn led to a wider degree of creative freedom and also gave the result of Habitat Ukraine being more responsive to the needs of potential residents in terms of healing through the creation of warm, bright, and inviting interior and exterior spaces. Although the affordability aspect of the design was scaled back, the panelized modular construction technique still provides financial benefits for residents helping to make living more affordable.

4.2. Modular Construction

The panelized modular construction process focuses on the fabrication of exterior wall panels off-site which would then be shipped to the site when ready. Once the mass timber structure is erected, the individual panels would be hoisted up and attached to the structural members in their respective places. This process still provides cost savings throughout the construction process as materials are used more efficiently during fabrication, time is saved due to the ease of attachment, and consequently rental rates are lower for future tenants helping to make this type of housing more affordable and accessible to many. In conjunction with this

advantage, the quality of design is allowed much more of a place within Habitat Ukraine due to the exposed mass timber structural members.

4.3. Mass Timber

Mass timber is the future of design and construction. It is sustainable, abundant, and aids in the creation of bright and inviting spaces. The warm colors and unique textures make it much more of a viable and preferred material option over its cold and often lifeless counterpart, steel. In Habitat Ukraine, mass timber is utilized greatly to help realize the creation of these kinds of spaces. Spaces that welcome and help heal residents simply through their design and what they consist of. Spaces that seek to respond to the needs, whether known or unknown, of each resident, putting quality over financial savings. Mass timber is an incredible option when it comes to materiality and the construction of quality buildings and spaces for users. As time passes, its popularity is predicted to explode due to its ample advantages.

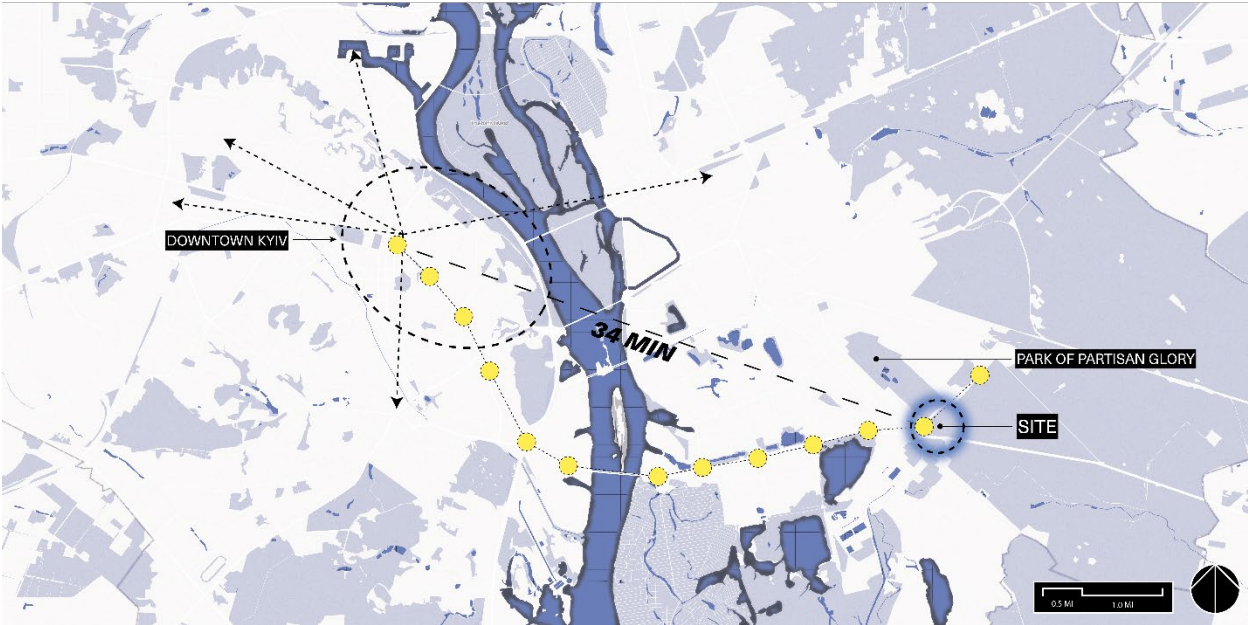


Figure 60. Map of Kyiv diagramming the metro line that would be utilized by residents of Habitat Ukraine to access downtown Kyiv and the average duration of the trip.

4.4. Connecting to City and Site

Habitat Ukraine lies on the chosen site detailed earlier. As stated previously, though the site is located a notable distance away from the center of Kyiv, the extreme proximity of the Boryspilska metro station allows residents easy access to most parts of the city. The average amount of time it takes to travel from the station to downtown Kyiv lasts a little more than a half of an hour. This is extremely reasonable and helps to drastically lower the need for residents to purchase an automobile to travel around the city. Residents can commute to work, school, and access services and amenities in the city without the stress of driving and having to navigate through often crowded roadways with the fear of damaging property or injuring others. Another great benefit of the site is its proximity to the Park of Partisan Glory. From Habitat Ukraine it only takes twenty minutes on foot to reach the expansive urban park. It features a plethora of hiking trails among the forests that lie in it, sporting facilities such as basketball courts and soccer fields, and places to sit, relax and unwind. The short distance between the site and the park will encourage residents to get outdoors, exercise, and be among nature, which serves as a healing factor for many of these residents who have been so greatly affected by the conflict.

Habitat Ukraine lies within the heavily forested site with the goal of intruding as little as possible on the natural surrounding environment and its elements. It integrates seamlessly with the existing hiking trail infrastructure present on and around the site. This further incentivizes

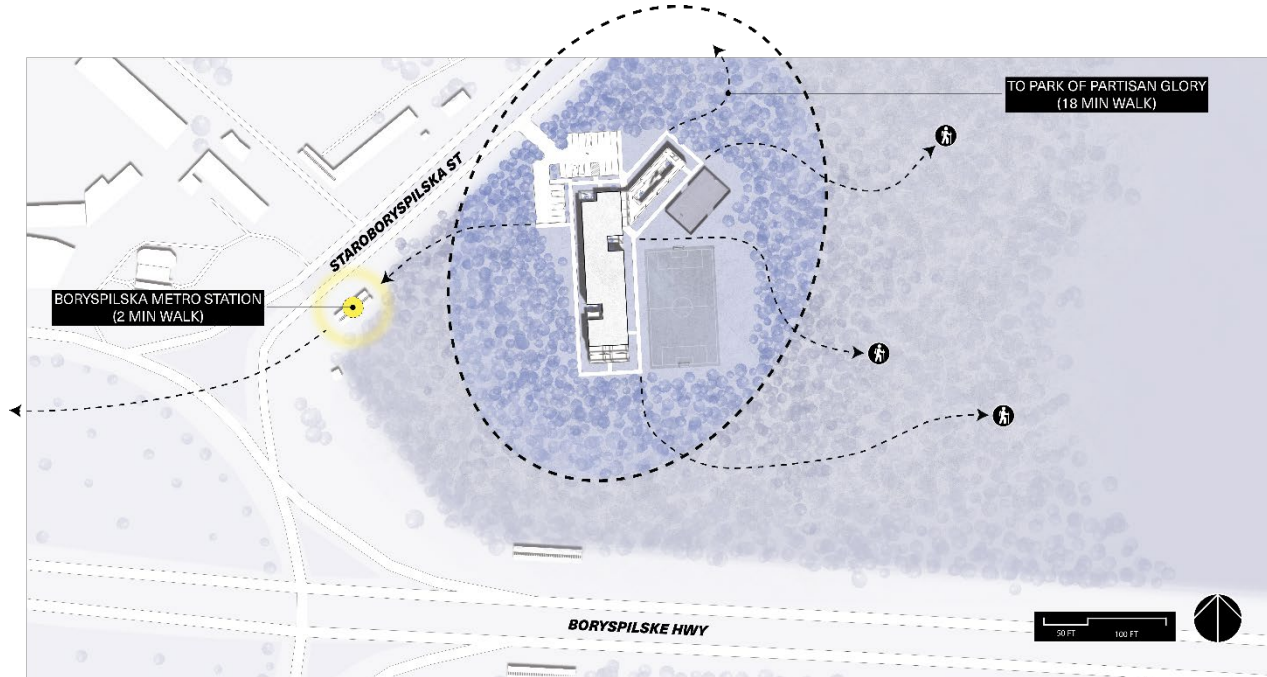


Figure 61. Site plan of Habitat Ukraine

residents to get outdoors, walk, and be among nature. Utilizing these trails is key in helping to accentuate the goal for this project to be one of healing, both within the interior and exterior environments. These trails allow residents to access the Park of Partisan Glory and the Borypilska metro station with ease connecting them to the local urban and natural environment further.

The site of Habitat Ukraine features a small parking lot, a soccer field, basketball court, and a semi-exterior amenity space that protrudes from the building itself. This space consists of three levels and features a playground located in the center on the first and many dedicated areas for leisure and relaxation. Grilling and outdoor game space on all levels help to persuade residents to enjoy this structure while on the third level planters for the cultivation of vegetables and other foods are installed. Residents can choose to be assigned a small plot of soil to grow these certain crops. Once they are harvested, each individual resident can elect to either keep the food for personal use in their residential unit or donate it to the two community kitchens present



Figure 62. Render of the playground featured in the center of the semi-exterior wing of Habitat Ukraine.

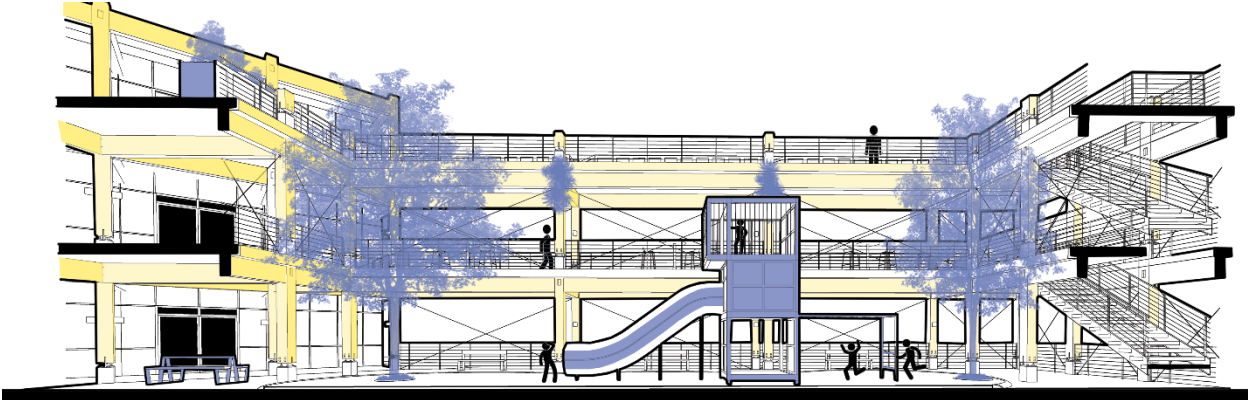


Figure 63. Section plan illustrating the design and composition of the semi-exterior wing of Habitat Ukraine.

within Habitat Ukraine. This stable feature helps to engage members of the building with a



process of collective cooperation and the strengthening of local food security through small-scale agricultural means, encouraging friendly interaction and propelling forward the cause of sustainable living.

These amenities and facilities provide ample options for recreation and sport for residents of all ages. These are all great ways to build and strengthen community bonds among those who live here to create deeper feelings of trust and peace for all. Though the site is an integral piece of Habitat Ukraine as a whole, the design of the building itself is just as important in responding to the initial objectives of this project.

4.5. The Design

Habitat Ukraine, as stated previously, utilizes a panelized modular construction technique to form the basis of its constructability and final form. These panels that are attached to the mass timber structure are of a metal paneling façade attached to a wood-frame structure. These metal panels are resilient to the colder climatic conditions of Kyiv and provide great contrast with the mass timber helping to elevate its overall visual appearance. The incorporation of natural

Figure 64. Render of the front entrance from the parking lot of Habitat Ukraine.

elements such as trees, plants, and shrubbery that are native to the site and surrounding region is a strategy of design used around the entire building. This aids in limiting the building's interference with the surrounding ecosystem and elevating the design quality of the immediate exterior environment.

Habitat Ukraine consists of a total of twenty-one residential units of varying types and sizes, shared communal spaces such as a community kitchen (one on the first and one on the third floor), community rooms, and office/study rooms, and shared restrooms along with

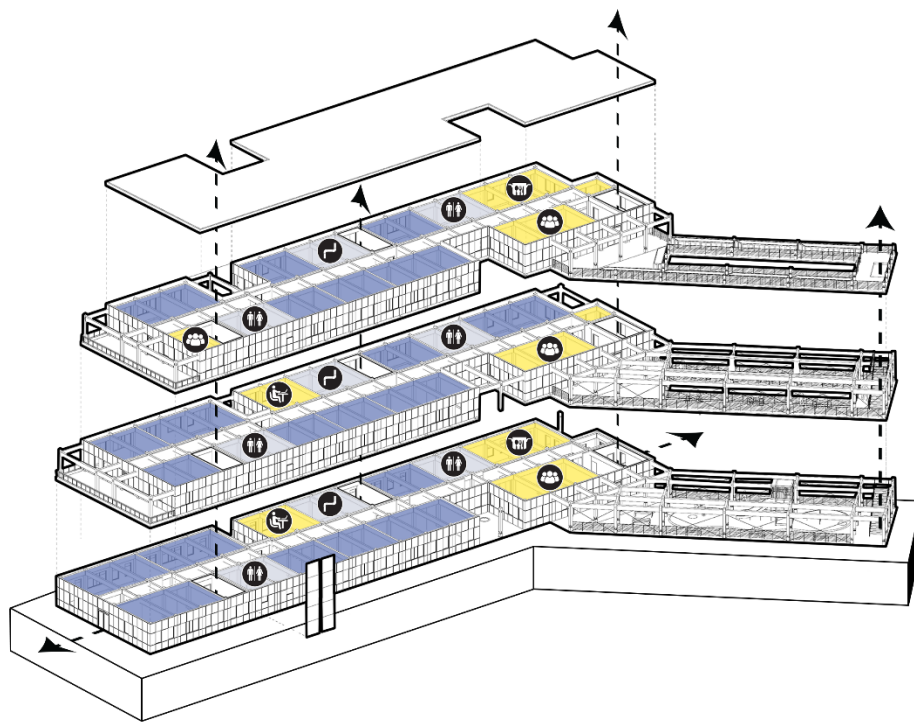


Figure 65. Exploded Isometric view of Habitat Ukraine detailing the interior layout and types of spaces within.

utility/storage space on each floor. The creation of an ample amount of shared communal spaces has been heavily emphasized throughout the design process. These spaces are instrumental in the formation of deep community ties between residents as they interact, share resources, and participate in events in them.

The community kitchen is the staple of this initiative. Designed for the preparation of large meals that can be shared among individuals and families, it aims to be a place of



Figure 66. Render of one of the community kitchens within Habitat Ukraine.

congregation, interaction, and enjoyment as people come together to take part in such an important cultural process, cooking. The kitchen features ample cooking, food preparation, and food storage space, a beverage bar, and seating options for users. It, along with every interior space throughout the building, uses the brightness of the mass timber along with the white walls to invite users inside to be among each other. All other community spaces such as the game room and the office/study space resemble this design and contribute to this design goal. Of being

spaces conducive to positive feelings and healing. This is no different with the apartment units of Habitat Ukraine.

Each apartment unit takes on the same principle. Designed to be of high quality but efficient with its limited space. Each unit (whether it is the one-bedroom or two-bed option) features a small kitchenette designated for the preparation of small meals and snacks, an enclosed balcony (normally used as storage space but can easily be utilized as a place of leisure), with operable windows, and a living room. The entrance of natural light is essential in creating these private residential settings of retreat and peace for residents. Though Habitat Ukraine is designed with the established community focus, it is recognized that residents will need to be able to return to private spaces of the same high-quality design. This assists in the mental healing process of many as it allows solitude, tranquility, and personal reflection to be able to be experienced at any time by all who live here, providing a balance between the public and private lives of each resident. A tenant can choose when to be a part of any of the two sides of this



Figure 67. Render of a two-bedroom apartment unit in Habitat Ukraine.

narrative. This increases comfort, quality of living, and community engagement as people are not forced to partake in either side at certain times but can choose at their own will. This is how Habitat Ukraine responds to the needs of users of the building through employed design strategies. From that rises an important question that needs to be answered: how is it that Habitat Ukraine is to be constructed to serve the needs of displaced Ukrainians?

4.6. How it is Done

How is Habitat Ukraine able to be realized? It starts with the structure of the building, the mass timber. The mass timber elements are sourced from sustainably managed forests in Austria which is a leading global exporter in the industry. The wood is collected, fabricated into structural elements based on specific dimensionalities, and is refined to ensure high quality function and appearance. These elements are then shipped to Kyiv via road and rail means of transportation. Being that Austria and Ukraine lie on the same continent, there is no requirement to ship these materials over large bodies of water such as an ocean. This helps reduce a large sum of potential costs that are typically associated with intercontinental trade and lowers the duration

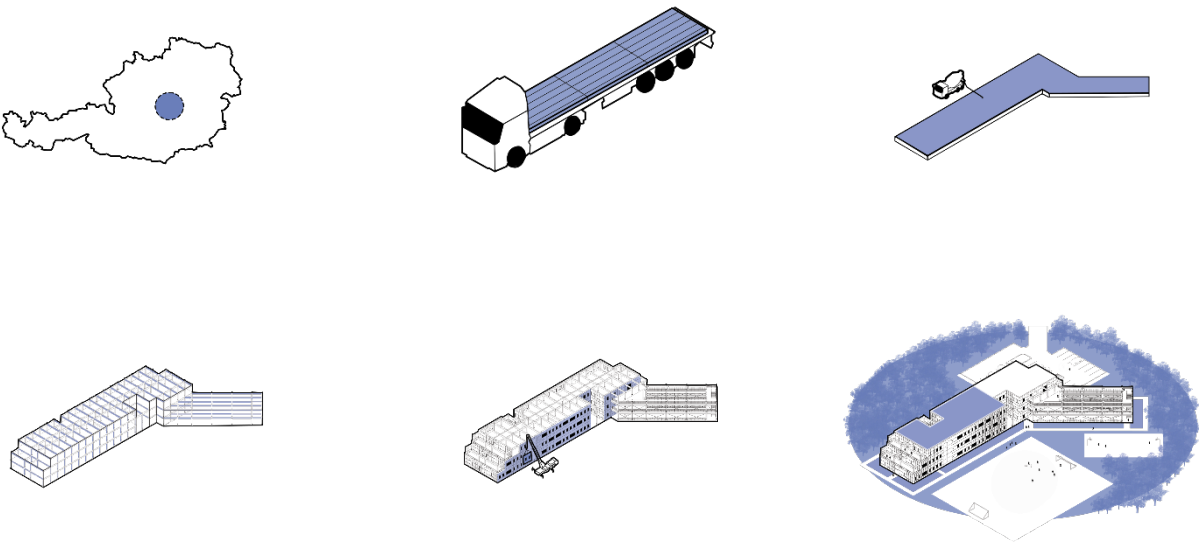


Figure 68. Graphic highlighting the key phases of the realization of Habitat Ukraine.

of transportation. While the mass timber is being fabricated and shipped, construction crews in Kyiv begin to prepare the site for the construction of Habitat Ukraine. This includes grading work and the pouring of the foundation of the building which aims to utilize recycled concrete from damaged or destroyed buildings around the region of Kyiv. Once this work is complete and the materials arrive on-site, the erection of the structure begins. Crews take extreme caution to ensure that the quality of the mass timber elements, many of which will be exposed, is not affected. This may result in this step lasting longer than normally expected, but it is a necessity to take this precaution. When the structure is constructed the process of hoisting the exterior wall panels into place and securing them to the structure begins. After the building is enclosed, the details are to be added. The interior walls are to be constructed, the mechanical systems installed, the furniture assembled, and the finishing touches to complete Habitat Ukraine and make it what it is destined to be, a habitat. A way for Ukrainians to return to their homeland, to a new Ukraine.

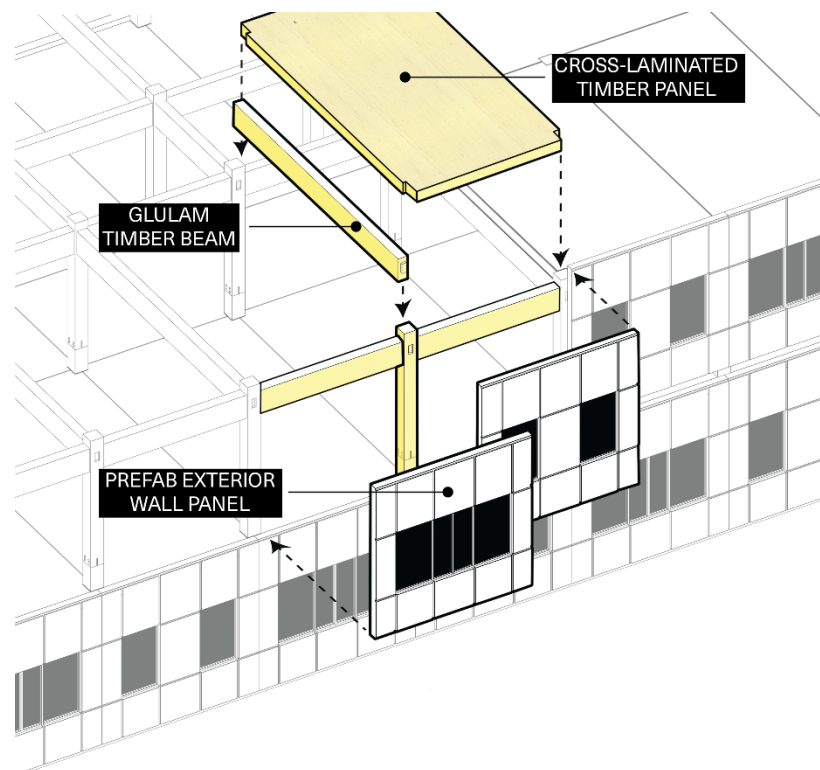


Figure 69. Graphic illustrating the process of construction of the mass timber structure and a typical exterior wall panel.

To find some semblance of their past lives which are no more. To live in quality conditions within environments conducive to healing. To form new, unbreakable community bonds among each other. And to find the peace which they so desire. It is their right to live in safe places of refuge, and Habitat Ukraine seeks to provide those places for them, through means of intentional and quality design.

5. CONCLUSION

Though at the time of writing this the conflict that Ukraine has been forced to face still rages on, taking with it many lives of men, women, and children; it will eventually draw to a close. Many migrants who have fled will desire to return to their native places of origin, and many veterans who have bravely fought both on and off the frontlines will require quality places in which to live. Many urban and rural environments across the nation have been damaged and even completely destroyed rendering the eventual reconstruction process to be lengthy. But Ukraine will be rebuilt. This conflict is truly horrific, but from the suffering, anguish, and pain arises the opportunity to rebuild Ukraine anew. Destroyed urban environments provide a blank slate for the implementation of new and even experimental urban design strategies of the future. New technologies and new ways of facilitating community interaction through design can be tested out for the benefit of all who live in Ukraine and around the world. Ukraine can be propelled into a future based upon the development of quality and safe places for all to live, work, and play. To be themselves and to live peacefully as they so desire. Habitat Ukraine is only one approach of many that seeks to respond to the unique needs of these victims of war. Based upon principles of quality design, community engagement, and affordability; it seeks to serve as a model to allow Ukrainians to return to their own country. It also seeks to serve as one that can be implemented around the world, not solely in the nation of Ukraine. Regions and

countries that are prone to natural disasters, political instability, and conflict have the great potential to benefit from the model Habitat Ukraine employs. There is no single answer to the effective response to the impending housing crisis in the nation, but this is one answer that puts the people who will be inhabiting it and their wellbeing first.

Though the present is grim for Ukraine, the future is bright. With the help of the West and other nations all around the world, the people of Ukraine can rebuild their places of origin and get back on their feet. This opportunity to redefine Ukraine itself for the better must be acted upon swiftly. With the help of others, the nation's construction industry can modernize, democracy can be strengthened, and the quality of life for all can be raised. Ukrainians, as do any people around the world, deserve to live in quality, stable, and peaceful environments. Their best interests in the reconstruction process must be the primary priority of all who desire to help. The opportunity to demonstrate to them and to the world the resolve and unity of humanity in these tough times is ever present. They need all the help that they can receive, and much help they can receive. It is imperative that governments and organizations around the world do their part to lend a helping hand to these people because in the end it begs one question: what if you were in their shoes?

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