THE PANEL BUILDING ALGORITHM

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ABSTRACT

ENGLISH

The project *The Panel Building Algorithm* is a Master Thesis of a group 21 at Architecture & Design at Aalborg University. The labour raises a problem of prefabricated panel buildings in Poland from communism period (1952-1989) which is a significant part of polish landscape. It describes their social meaning, technical aspects and visual issues. The second part of the thesis is a proposal of improving them for better standards mainly in terms of exterior architectural quality, area of apartments and sustainability. The thesis also undertake a general reflection and conclusion upon the panel buildings future and encourages to the discussion.

POLISH

Polska to wielki kraj znajdujący się w samym centrum Europy który ma wspaniałą, lecz równie skomplikowaną historię. Po II wojnie światowej Polacy byli pod znaczącym wpływem ZSRR przez prawie 40 lat. W tym roku (2019) mija 30 lat odkąd rozpadł się Blok Wschodni wraz z Żelazną Kurtyną - od tego czasu Europa wschodnia zrobiła znaczące postępy w rozwoju i dziś przypomina świat zachodni bardziej niż kiedykolwiek. Pojawiły się nowe samochody, autostrady, lotniska, międzynarodowe imprezy, internet, fastfoody, reklamy oraz nowoczesne, piękne budynki. Niestety pomimo tego wszystkiego, wciąż jesteśmy w stanie doświadczyć bolesnego okresu jakim był komunizm poprzez czynnik który ma ogromny wpływ na nasze życie. Poprzez architekturę.

Budynki z Wielkiej Płyty były odpowiedzią na ogromne zapotrzebowanie mieszkaniowe po II wojnie światowej. Dziś w takich obiektach mieszka około 12 milionów Polaków co równa się mniej więcej 1/3 populacji całego kraju. Wielka Płyta zmaga się z ogromem problemów na czele z niskim standardem mieszkań oraz zewnętrznym wyglądem, który jest jednym z wielu czynników, jaki psuje wielki potencjał drzemiący w fantastycznym krajobrazie Polski. Na dodatek Polacy coraz mniej zainteresowani są mieszkaniami w starym budownictwie i wybierają nowsze osiedla o wyższym standardzie. Problem będzie rósł wraz z upływem lat - Polska jako kraj musi więc znaleźć odpowiednie rozwiązanie na to, co zrobić z Wielką Płytą i jak ją ewentualnie modernizować.

Opracowanie to, stanowi pracę dyplomową na kierunku Architecture & Design na uczelni Aalborg University

READING GUIDE

w Danii oraz jest badaniem na temat problemów i ograniczeń Wielkiej Płyty, ale także jej potencjalnych możliwości. Praca ta zawiera także propozycję rozwiązań, które odpowiadają na istniejące problemy funkcjonalne, techniczne oraz estetyczne tego typu obiektów oraz jest pewnego rodzaju bazą pod rozbudowę proponowanej koncepcji i ma zachęcać do ogólnej dyskusji na temat budownictwa z okresu komunistycznego.

Motywacja

Mimo że my - jako autorzy opracowania - nigdy nie żyliśmy w czasach komunizmu - ponieważ upadł on tuż przed naszymi narodzinami - to wciąż jesteśmy w stanie intensywnie go doświadczyć poprzez architekturę. Temat pracy dyplomowej jest więc dla nas bardzo osobisty, jako że niemal całe życie mieszkaliśmy w blokach i wychowywaliśmy się na typowych polskich osiedlach. Jako młode pokolenie architektów zaczynamy także powoli czuć odpowiedzialność za przestrzeń, która nas otacza, ponieważ zdajemy sobie sprawę, że to właśnie my będziemy tymi, którzy będą musieli się zmierzyć z problemem Wielkiej Płyty. Ta praca dyplomowa ma być dla nas swego rodzaju rozeznaniem oraz przygotowaniem do tego zadania.

This report is divided into 6 main parts. The first one is an introduction which is a preface for the thesis and short description of a problem. The next part is a program that presents detailed analysis upon the problem, assisted by introducing background. After that, the design presentation is featured which is an essential part of the report where the solutions for the analysed problem are introduced. Further, the design process and analysis of designed structure are being described. The last chapter is a conclusion and reflection upon the project. Additionally, at the end of the report, references that were used are attached.

TABLE OF CONTENTS

4

DESIGN ANALYSIS

5

DESIGN PROCESS

6

EPILOGUE

7

APPENDIX

INTRODUCTION

It's almost 30 years since the Eastern Bloc and Iron curtain has collapsed. After that, Eastern Europe moved forward significantly and today they resemble the western world more than ever. Nowadays one of the most developed countries of the old Eastern Bloc is Poland.

Poland is a big country that is located right in the middle of Europe. Poles have got a great but also a very complicated history which is a result of difficult geopolitical location - their lands split eastern world from the western one. After II world war for almost 40 years the country was influenced by high dominance of USSR. Nowadays, Poles are not willing to remind this period and they just prefer to enjoy the possibilities of the new world order.

However, in Poland we are still able to experience the painful time of communism by architecture. **Prefabricated panel buildings** were the answer for a great demand for housings right after World War II and they've got a huge influence on polish life.

The problem is significant as almost 1/3 of polish population lives in panel buildings so their existence is marked literally everywhere. They scare with their external look, and spoil the potential beautiful landscape of new architecture. Also the standard inside the apartments is much below European average so Poles are not willing to live in there. The problem of prefabricated panel buildings is going to be bigger over the years and Poland needs to find a solution what to do with them.

MOTIVATION

Although we've never lived in communist Poland - because it has fallen right before we were born - we can still feel it in the landscape. The topic and motivation of Master Thesis is very personal for us as we are starting to feel a great responsibility for the space that surrounds us in our homeland. The time of panel buildings existence in their today shape is coming to the end. Therefore our generation for sure will be the one that have to face the issue. This Master Thesis for us is to be a preparation for the future and deep investigation of the limitations, possibilities and hypothetical solutions of the problems with panel buildings.

METHODOLOGY

The project is supported by **Integrated Design Process** which is a significant notion of Aalborg University and Problem Based Learning. The IDP method is founded by Mary-Ann Knudstrup where the main goal is to unite functionality, aesthetic and structure. In the representing method we can indicate 5 main phases that are iterative and should be performed alternately - it means that it is possible to move between them, back and forth.

The IDP starts with the **problem phase**. In this part the topic needs to be identified and the proper approach found. In this particular thesis the social, technical and aesthetic problems that are relevant for the project were investigated. In order to recognize them, the extensive studies about them were found and they ground a crucial base for the report. An additional and helpful support for this phase is also an authors' own experience of living in panel buildings.

In the **analysis part** the building complex that reveals all of the found problems had to be chosen to be a subject of the study. The investigations were carried out in Ursynów.

Ursynów is one of Warsaw districts which is a perfect example of area where the panel buildings are the majority of housing objects and also is a place where the diversity of such buildings is very rich. Crucial factor was also to get the knowledge according to the construction schemes. The original plans of the buildings were picked in commune office of Ursynów. Based on the plans, the evaluation of architectural quality was possible, and the analysis based on them were a foundation for the modernization proposal that improved standards of the apartments.

Next step is a **sketching part** - In order to improve the buildings in terms of architectural quality, the flats, facades and building communication were analysed and improved in terms of design, daylight and functionality - including changes of the building structure. Useful software in this area were programs provided for 2d and 3d drawings like AutoCAD and Sketchup. Thanks to the realistic visualisations, the evaluation of architectural quality was possible.

All the aesthetic proposals must respect the sustainability qualities. In order to improve the buildings in terms of energy demands, ventilation

system, construction and design of apartments, the objects were analysed based on original building documentations (e.g. wall layers analysis) and site visit (their current condition). In order to find energy solutions, the sketched proposal was investigated in a **synthesis phase** where the input data from previous analysis were analysed using software like Grasshopper, BSim and Be18. Based on the outcome, the both passive and active solutions were found what led to fulfil the desired energy standards.

The last step is a **presentation phase**. The used materials based on previous steps are: physical report, posters, physical models and a power-point presentation itself. All illustrations are based on previously made drawings and edited in Adobe Photoshop supported with Adobe InDesign which is a main tool assembling this report.

Ill.1: Integrated design process

PROGRAM

The following section represents the first steps during the design process. For better understanding the theme of this project both research and initial analysis were carried out and the results are listed on further pages. The conclusions from all analysis were translated into the set of design criteria what constitutes the base for next considerations and form seeking.

2

BACKGROUND

PROLOGUE: HISTORICAL CONTEXT

The newest history of Poland starts with the end of World War I in 1918 when after 123 years of German, Austria-Hungary and Russian occupancy, Poland regained independence. However, the happiness doesn't last long - Poland is a country of many internal conflicts and very unstable political and economic condition. The main problem is irregular level of development between each of old-occupancy lands in terms of infrastructure, architecture, industry, railway network and education. The differences are well visible even until now.

Difficult geopolitical position doesn't help - Polish lands are still very attractive for adjacent countries - mainly for Russia that is looking for taking over the control of Poland. At first, directly - between 1919-1921 when Poles had to resist their military aggression. Later, with implementing their deputies in political areas that were responsible for destabilizing Polish internal situation or to spread Soviet propaganda.

Polish economic situation had stabilized after 1935 in the result of many reforms. Shortly after, in September 1939 by virtue of Ribbentrop-Molotov pact, Poland was invaded by Nazi-Germany and Soviet Union on the other side. The pact was an agreement that assumed disappearing Poland from maps, dividing Polish lands and sharing between each other. Poles never surrendered and bravely tried to resist the aggression from two sides, but they had no chance with no help from main allies - Great Britain and France, neither from the rest of the world.

During World War II 6 million (!) people in Poland were killed in the result of warfare and holocaust. Millions of Poles, Jews and other nationalities that were considered as ''subhumans'' died in Nazi Death Camps.

In 1944 Germany prepares to move away from Warsaw while Soviets are ready to take their place and take over the control of Poland. Poles were planning to liberate the capital independently before the Soviet Army would come in, hoping that it would strengthen their international position and won't let Stalin sovietise Poland. Therefore, Warsaw organised uprising against occupying Nazis with promises of help from allies. After 63 days one of the biggest and the most fierce battles in World War II - the uprising falls. In the result 200.000 civilian dies (Davies, 2006). Poland loses irrevocably hundreds of priceless monuments and

objects of high cultural, sacred or economic value as the city is demolished in 83% (Getter, 2004). In fact, Warsaw - the capital city of Poland doesn't exist. (See Ill.2)

Ill.2: Ruined Warsaw

In 1945 II world war ends with the win of Allies. The world is divided into two realities - communist and capitalist one, beginning the Cold War. Poland is acknowledged as an individual country but it doesn't mean that they are independent. USSR constitutes Poland as a satellite estate - which means that they are under heavy political and economy influence of Soviet Russia.

Communism is a type of radical socialism negating any private property. In theory the authority were to be in hands of nation - just like it was said in official name of the country - Polish People's Republic (Polska Rzeczpospolita Ludowa, PRL). In fact, the influence of Poles on decisions of their own country was reduced to minimum by communist rulers. Even though there were organised (obligatory) elections, the results were faked or only communists were permitted to be on the lists. In the result Poland was ruled by only one party - Polish United Worker's Party (Polska Zjednoczona Partia Robotnicza, PZPR).

The country was engulfed by propaganda - it's purpose was to force people believe in socialist system. It was repeated constantly about successes of countries in Eastern Bloc while capitalistic world was discredit. The friendship and alliance with USSR was strongly emphasized - Poles were being convinced and indoctrinated about greatness of one and only leader who was Joseph Stalin. He personally also wanted to be perceived as a glorious leader - like in 1952 when he sponsored Palace of Culture and Science (Pałac Kultury i Nauki) in Warsaw to stress the power of socialism, even though the capital city was still in tragic condition and demanded for example housings instead. The palace was 2nd tallest building in Eu-

rope at the time, and nowadays is a main symbol of Warsaw and the most recognizable object in Poland. (See Ill.3)

Ill.3: Palace of Culture and Science in the middle of ruined Warsaw

The economy after World War II was in catastrophic condition. European Recovery Program driven by USA called The Marshall Plan was initially accepted by polish government but soon it was rejected under the pressure of Stalin (Miller, 2000). Communists in order to save the country imposed Soviet market solutions. First with three-year plan and later with six-year plan - in the result polish companies were nationalized - any private enterprises were prohibited and international trade was monopolized by authorities.

Ill.4: Empty shelves in shop

In 70's Poland struggled with deep economic crisis. Resources of goods in shops started to disappear and people felt lack of basic articles like: meat, bread, sugar or even toilet paper. As the resources were limited, one of the most recognizable of the period of communism were incredibly long queues to shops. In the result, the money trading has been limited to minimum, introducing ''ration cards'' instead. The cards were stamps provided by a workplace and they were to ensure equal allocation of commodities to people. The actions didn't stop the crisis which was deeper and deeper. The bad condition led to massive protests in the whole country.

Ill.5: A man run over by a truck during protests. The tape was smuggled abroad and published by many news worldwide.

Ill.6: Brutally pacified protests

The strikes were breaking out for different reasons through the whole communist period. The most important were in Poznań in 1956 (known as Poznań June), in Polish shore cities in December of 1970 and in Gdańsk in 1980 that ended with creation of non-governmental trade union Solidarność (Solidarity) with Lech Wałęsa as a leader - the worldwide symbol of defeating communism. All strikes were brutally pacified by militia with the result of hundred killed people who fought for their freedom and better life.

In 1988 the government increased drastically prices of commodities what caused massive strikes on the national scale. In the result, in 1989 the communists were forced to negotiate with Solidarność so they decided to debate at ‘‘round table’’ and find the agreement. The government had to establish partly-independent elections, where communists were ensured to have 65% of the parliament - the rest was up to the nation and the decision had to be democratic.

The elections ended with a great victory of Solidarność - they took all of the rest mandates. As the new authorities weren’t able to form a new government, they were forced to give up the power to Solidarność. Their first decision was to create a new constitution, bring back the Crown to the Eagle at the coat of arms and announce a date of first democratic elections in Poland.

HISTORY OF PANEL BUILDINGS IN POLAND

During World War II Poland lost 2 million apartments within old boundaries due to warfare and massive migration people from country (Prajsnar, 2016). The housing market condition in 1945 was tragic, so the governors took the first steps to bring it to live back. About 500 thousands dwellings has been refurbished until 1950 (Madej, n.d.) what didn't improved the situation dramatically as there was still a great demand for new apartments.

The problem was being tried to be solved in many ways. Big apartments were being divided into smaller parts and were assigned to several families that didn't know one another. The solution was taken from Soviet Union. Every family had their own room - while a corridor, kitchen and bathroom were common. The idea didn't fit to polish reality as the families often fought with each other, so after 1956 the solution was no longer continued.

For this reason the authorities were trying to find an efficient, fast and cheap way of building apartments. One of the most promising method was seen in **prefabricated panel buildings** that were already very popular in Europe - first appeared in Germany and later in France, Sweden, and finally in Soviet Union.

First prefabricated panel building in Poland was built in February 1960 on Wolska street in Warsaw. The building were meant to be an experiment and a test for this method of building (Semczuk, 2018).

"I remember that I sat on the floor in the hall and cried. 50 meters, three small rooms, a tiny kitchen and bathroom - I couldn't believe it was mine. It was a happiness. Before I got this apartment, we lived with husband and daughter on ten meters" - says Krystyna Bogucka who was the first resident of the building and she lives there until today.

The building failed the test as it was being built for 3 years - it was way too much for the society expectations and reality. Additionally Władysław Gomułka (de facto leader of communist Poland) claimed that the apartments were too luxury. Wooden floors and furnished kitchens were perceived as in too high standard. He demanded common kitchens and bathrooms for the residents instead and floor just to be painted (Semczuk, 2018).

The panel buildings started to being built, but the proper, universal solution was still in request. Bigger cities like Poznań, Szczecin, Lódź or

Warsaw had their own types of systems but all of them had issues and what is the most important - they were still too expensive. In 60's in Poland there were over ten types of panel buildings - while in East Germany only two . The diversity of solutions was limiting the range of the systems and also increased investment costs (Wojtkun, 2017).

In 1967 there was organised a competition for the universal and cheap solution of panel buildings with easy implement method. Shortly after that, Soviet Union delivered 3 buildings in Leningrad system as a gift, with a hope that polish authorities would buy the method. Surprisingly it turned out to be 30% more expensive than polish solutions so the offer was declined. The competition won the solution called W-70 - named by Warsaw and year of 1970. The advantage of the method was its openness that gave a lot of freedom in terms of design - walls could be freely moved and attached. It gave a possibility of high diversity of designed buildings - even though structural-wise they were the same. (See Ill.7) (Semczuk, 2018)

5-storey there was no need of using elevators, the 11th one was perceived as an optimal in terms of technology parameters while 16th was a boundary of the W-70 technology. In terms of length of the buildings - sky was the limit. The communist authorities favoured the bigger ones as they were showing the power of socialism reality. (Wojtkun, 2017).

While in the big scale the buildings were supposed to be as most impressive as it's possible, in the human scale the apartments were limited with ridiculous regulations. Poland was the only country in the world where the regulations defined a maximum square meter ration per capita. It caused a lot of problems for architects e.g. they had to apply for acceptance to the ministry in case of exceeding allowed amount of square meters, so the designers often avoided it with enlarging a common corridor decreasing living area (Semczuk, 2018).

It's worth to notice that even though the architectural problems are very visible, the massive panel buildings production has also positive sides. The density of the settlements were

Ill.7: W-70 Large Panel system

In 1970 the era of Panel Buildings in Poland began.

In W-70 system the most common were 5, 11 and 16-storey buildings. In the

designed as very loose what makes the areas very valuable in terms of sunlight. The districts are in majority self-sufficient - they are consist of kindergartens, schools, pavements and

service pavilions. Usually the connection with the rest of the city is also very convenient. Moreover the buildings were often positioned towards the main direction of the wind to provide a better ventilation. Urbanwise the communist housing is perceived as very good - which is one of the main reason to preserve them.

The panel buildings were prefabricated in ‘‘house factories’’. There were 160 of them in Poland. With the end of the communism, the factories died and production of such buildings stopped. Poland stepped into new, better period - to the better world. Within last 30 years a lot of changed in polish reality - better infrastructure appeared. Just like new cars, modern highways, fast foods, big international events, internet and new, beautiful architecture. But the panel buildings stayed. They scare and remind of painful time long after the communist period.

Almost 12 million people in Poland lives in panel buildings. It’s 35% of population of Poland - while in Hungary it’s 29%, 26% in Romania and 27% in Bulgaria. In comparison in the countries of old European Union the percentage is irrelevant and problem doesn’t exist (Wojtkun, 2017).

Ill.8: ‘‘Behind the iron gate’’ settlement in Warsaw

PANEL BUILDINGS PROBLEMS

The Large Panel System buildings were a response to the residentaial needs after World War II. The whole districts of prefabricated housing complexes had to raise from the ground within the period of couple months. So however great the initial assumptions and expectations accompanied the whole designing process in the beginning, they are associated with rather poor production quality. After almost 50 years from their creation they are all facing similar serious problems.

It is commonly said that those types of buildings were designed to stand, and be used for around 50-60 years. It means that we are now heading to the point, where whole districts should be demolished and replaced by the new ones. In Polish reality, we are talking about 12 million people (around 1/3 population of the country) that would have to be relocated for that purpose. It is not hard to realize that this is far away from possible to happen. Therefore, the buildings has to stay for the next several decades, that's why they are renovated from time to time.

However some refurbishment movements can be seen along the history of last couple years. They were only carried out on single buildings - the ones the most destroyed, which besides the improvement of overall technical condition of the building had nothing to do with improvement of quality of living or improvement of quality of urban space.

In order to carry out a complete modernization, that will benefit not only a single building, but also the city, society and environment is necessary to point out all existing problems concerning technology, functionality, appearance and social aspect of the considered district.

Technical problems

As a technical problems we consider all the issues regarding the structure of the building, installations and necessary equipment, caused by the passage of time, weather conditions or executive errors. All these problems can be divided into two main groups:

1. Typical damages occurring in every type of the building, regarding mainly building finishing elements, flashings, roof coverings, vapour and moisture insulations, etc.

2. Damages characteristic for buildings raised in the Large Panel technology, regarding usage of materials, types of prefabricated elements, types of joints, etc. The following list gathers the problems that are the most repetitive.

- external wall slabs
  - falling off the cover layer
  - scratches and cracks
  - leakage of rainwater through the cover layer
  - excessive moisture
  - frost penetration
- thermal insulation
  - reduction of insulation properties caused by moisture or changes in material structure
  - loosening this layer from the other layers of the wall
- welds
  - defects on the top layer edges
  - bad profiling of the decompression channels
  - too large gap between elements
  - lack of joint insulation
- joints - connections between the prefabricated slabs
  - poor execution
  - leaks
  - corrosion of steel reinforcement
- floor slabs
  - slab faulting
- internal wall slabs
  - scratches and cracks
  - slab separations
- floor screeds
  - cracks
  - loosening this layer from other floor layers
  - subsidence
- windows
  - leaks
  - low thermal insulation
  - mechanical damages
- central heating, gas, electricity and plumbing installations
  - installations not adjusted to current standards
  - outdated and dangerous gas water heaters
  - huge heat losses from pipe systems
  - corrosion of steel pipes
  - low water pressure on higher levels
- elevators and garbage chutes
  - outdated and perishable elevators or complete lack of elevators
  - stinky or not used garbage chutes

(Sobczak-Piąstka and Podhorecki, 2014)

Functional problems

The problems that affect the buildings are not limited to the envelope or structure. What caused the biggest trouble, that we still feel today, was former Polish Norm, making Poland probably the only country in the world indicating the maximum amount of square meters per person in apartment ($10m^2$/person). Until 1974 the applicable law constituted that maximum area in apartment for single person is $20m^2$ and in apartment for 7 people - 71 m^2. The results of that restrictions were the plans of apartments with too many rooms to their areas, causing their bad functional organization, a need to maintain kitchens without direct exposure to sunlight and, in the most cases, extortion of a single-sided ventilation systems. However in early 70s this was a limit of expectations. The standards nowadays have changed and such apartments now occur as tight and airless. (Dębowski, 2012)

What is more, many of buildings has issues concerning adaptation to the needs of elderly and disabled people. Elevators are standard only in higher, 11-storey, blocks, remaining 4-storey buildings without possibility to use by this group of habitants.

Huge lacks of functional optimization can be seen also in the building surroundings. Not enough parking spaces or badly organized parking spaces are

natural result of the increase of the number of cars, but it is now really troublemaking.

What is even more neglected is poor building indication system. Because of organic street and building organization, the addressing system seems to be randomized and cause confusion among daily and occasionally users. This can sometimes lead to the very dangerous situations, when it delays or impede the arrival of emergency services.

Aesthetic problem

One of the basic assumptions of early modernism precursors was the visual aspect of the blocks. Huge forms of blocks had to seem to float in a greenery as an illusion of a transatlantic liners floating across the ocean. This big and simple shaped units were a real dominant in a city landscape, so thus when painted white or grey they had to constitute the background for the social life that had happed between the buildings.

Quickly came out that sometimes large areas of the city were colored grey, so combining it with harsh political situation, people started to relate this color with sadness and depression of an unpleasant time in the history. That's why years after the communism collapsed, when buildings started to be globally renovated, people felt the opportunity to add some colours to their everyday life. This was the point where the problem has started.

Once plain estates began to fill up with full range of pastel colours and patterns without any total idea. Whenever an architect or a designer tried to come up with calm project of facades renovation, he had to give up, because of disagreement with estate management or residents. In many cases the person responsible for choosing the tint was not the architect hired for the whole modernization, but a secretary working for a housing association as a representant of ordinary people's voice. People preferred to live in colours and that's why the coherent concept has turned into a set of variegated individual buildings, representing the tastes of its inhabitants. (Springer, 2013)

To see the range, how the tastes of building users differs from each other, one only need to look at the balconies. Because the local plan does not say anything, how to treat the balcony to keep the coherence within one building, as it is a part of apartment people have freedom to treat it like they want. That's why they are now forming an urban mosaic made of all covering materials available in the last decades in different colours, glazings, flowers, laundry and sometimes spare things and furnitures, that haven't found space in the interior.

Ill.9: Pastel colored facade

To make matters worse, due to the used technology and a passage of time, on many facades are visible rusty stains, coming from corroding reinforcements. Inside the building the visual perception of reality is disturbed by moisture and mold existence.

Most of the housing estates are equipped with terrifying service pavilions, often accompanied with disordered parking lots, abandoned playgrounds and neglected infrastructure or small elements of urban architecture. All of that components is usually additionally contaminated by vandalistic graffities.

Ill.10: *Variety of balconies*

Social problems

Besides the building issues that were already mentioned, the districts of panel buildings suffer many problems on a stage of social life. Fast growing concrete giants had to emphasis the predominance of socialist way of building, so the natural tendency of pushing the size of blocks to the limit occurred. The record-holder block was built in Gdansk and contained 1792 dwellings, accommodating almost six thousand dwellers. Thousands of people gathered under one roof quickly started to feel lonely and anonymous. This loosening of social bonds combined with lack of sense of ownership and responsibility, resulted, in the most extreme cases, with emergence of pathological phenomena - like vandalism, aggression and appearance of dangerous areas.

Conclusion

However bad situation the above description represents, there are still several arguments for leaving the panel buildings and keeping the renovation processes.

In the vast majority of objects, the bearing structure is in unexpectedly good condition - which is proven by expertise based on surveys, tests and calculations. The Building Research Institute estimates that it may survive even few decades more than it was initially planned. Moreover, panel buildings were designed with a thought of exploding gas installation. In case of explosion in one apartment, the structure transfers the loads to neighboring walls and keeps the whole building still, without damaging even surrounding apartments. This makes panel buildings even more solid and safe than modern housings.

Furthermore, the majority of panel estates is placed in much better locations than modern ones, that are now being constructed in suburbs. These pros and of course the prices of apartments, are still attracting new inhabitants, so that is the main argument to create the decent living conditions for them.

THE GREAT THERMO MODERNIZATION

Many buildings raised in Large Panel technology in 60s, 70s and 80s, because of a poor quality of individual elements in used panel systems, have often been facing problems since the very beginning of their existance. In others, the same problems came out shortly after starting to use. Thus is no wonder, that in 90s and early 2000 the attempts to the thermomodernizations started to appear on a massive scale.

Large-panel blocks have always been characterized by low thermal insulation. They creation falls on the time where the demanded value of U coefficient was 1,25 W/m^2K or 1,43 W/m^2K and the energy demand varied between 160 and almost 300 kWh/m^2year. This exceeded the standards applicable before thermomodernization more than twice and caused still growing costs of exploitation. The Building Research Institute, in 2000 revealed the optimal procedure for panel buildings thermomodernization in order to improve the energetic efficiency. The studies based on Warsaw most common panel systems showed:

- Insulating external walls, roofs and ceiling above unheated basements with 14 cm layer of material with $\lambda = 0,04$ W/(mK)
- Limiting the average of air exchanges number in apartments and staircases to 0,5 h^{-1}
- Replacing windows with the new ones U-valued 1,3 $W/(m^2K)$ and equipped with air diffusers.

(Ostańska, 2010) (Dębowski, 2012)

However simple this instruction can seem, throughout Poland one can see numerous ways and results of its implementation. In the vast majority of houses external walls were covered with a layer of Styrofoam insulation, finished, depending on taken method, with ligno-cement plates or trapezoidal coated metal sheets (light-dry method) or thin-layered plaster on mesh reinforcement (light-wet method). Roofs structured usually as ventilated ones, were also insulated in couple ways: by blowing the mineral wool granulate or impregnated cellulose in the space of ceiling void, or by using fiber-cement boards on external side. Basements were insulated rarely as they were supposed to have minor contribution in general heat loss. (Ostanska, 2011) (Lewandowski, 2016)

As the municipalities' and communities' renovation programs did not finance windows replacement, many of habitants did it on their own responsibility. That's

why there is wide variety of window types even within one building. The common types are: composite windows in wooden frame with double glazing, PVC-framed with double glazing, single windows in wooden frame with chamber glazing. (Ostańska, 2011)

For many buildings the only step in the process of thermo modernization was adding the insulation on external walls. In some cases, at the first attempt, the insulation was laid only selectively and were completed during the second turn. However, in overall succeed in improving the energy parameters to a certain degree and decrease a little bit the costs of exploitation, this series of renovations have left a great scar on panel settlements aesthetics. Huge amounts of Styrofoam have hidden the original irregular concrete facture of the buildings skin, leaving the plain canvas to be filled with communities' imagination about the beauty. This landscape is not only a nightmare for architects, architecture students and artists educated in aesthetic departments. It frightens also its inhabitants, regular passers and people who seemed to be in charge of choosing the colours.

Moreover, nowadays, almost 20 years from the great thermo modernization, the buildings started to reveal another or again the same problems. Despite insulating the whole building, the places of thermal bridges can be easily indicated. The intensified heat losses are found in the areas around the building plinth and in the connections of prefabricated wall slabs. Linear thermal bridges appear on a loggia/balcony joint with external wall and along the outline of window openings. Due to the wrong selection of anchors or using too thin layer of material, the heat escapes on each mounting point of insulation, making the entire façade leaky. Huge amount of general heat loss is made by still poorly insulated roofs. On many buildings rusty stains are visible.

What was never modernized is a ventilation system. The air from all rooms in apartments is extracted through kitchens and bathrooms and this is not optimized to provide the proper air conditions inside. Moreover, in many dwellings windows were replaced with also more hermetic ones, what blocks the air transition into the building and in overall leads to the moisture gathering and emergence of mold. During the summer months, the critical problem is also overheating. (Lewandowski, 2016)

Installations of central heating, gas, electricity and plumbing are also outdated. Aluminum electric wires are inefficient and should be replaced with copper ones. Installation of central heating made of galvanized steel pipes are insulated only in basements. Besides corrosion they also gain a lot of heat loss. Plumbing system has been replaced from cast iron to PVC only on a local scale, but remaining old one is in sufficient condition. Because of a dangerous medium, the gas installation is usually under constant surveillance and maintained on a regular basis. Even though the solid welded pipes are now in good condition, if situated near the water piping, can lead to accelerate the forming of corrosion. (Ostanska, 2010)

It is an irrefutable fact that the great series of thermo modernizations that was conducted massively at the turn of the century, was very helpful in improvement of panel building conditions regardless of the type of used technology. Carried out works led to the increase of energetic efficiency and by this to the decrease of maintenance costs, what was initial intention of the whole process. Although this procedure slowed down the consumption of individual building components, the fact that it didn't cover all structure aspects, led to the bad current state of panel buildings settlements. In order to guarantee the decent living conditions to all 12 million people occupying panel buildings, it is about time to undertake next projects of modernization, that will affect respectively each object, raised in Large Panel technology in Poland.

URSYNÓW - EXAMPLE OF PANEL DISTRICT

Concept

The area of Ursynów historically was a suburb farm region of Warsaw until 70's when it was decided to build there a huge, representative district for almost 40 000 people which would fulfil a great demand for housing.

The concept of a new district was chosen by a competition in 1970 that won a group of three architects - Andrzej Szkop, Jerzy Szczepanik-Dzikowski under the leadership of Ludwik Borawski. The future of the project has complicated after the death of the last one. As Szkop and Szczepanik-Dzikowski were still students and didn't have an architectural license yet (which is demanded to design buildings in Poland), they had to involve someone from outside to the concept. The choice was Marek Budzynski who was brought to Poland from Aarhus in Denmark where he taught at the Copenhagen Academy of Fine Arts' branch. (Bec, 2018)

His decision of coming back to Poland was depended on ultimatum for the governors: the district has to be fully designed on his own assumptions and decisions - otherwise he's not coming back. It's worth to remark here that during communism period, it was extremely difficult to move anywhere else than within countries of Eastern Bloc for their citizens. Residing in Denmark for Budzynski was an opportunity that very few Poles could ever afford, so the reason of coming back to Poland had to be strongly supported. Finally, governors agreed for declining the first concept, and a new team with the leadership of Budzynski was formed. (Bec, 2018)

Budzynski's dream was to put the emphasis on a social aspect of living, where the most important factors are needs and comfort of society. His proposals were inspired among others by Danish solutions e.g:

- Danish social-space solutions of settlements, market system and educational system
- Urban solutions of Køge - the southern expansion area of Copenhagen
- Technical prefabrication aspects of Askerød - a settlement of Copenhagen designed by Svend Høgsbro

(Ilmurzyńska, 2018)

The main idea of the new district was to create a living, common space which will be a huge green area penetrated with panel buildings as a space to reside, where car has a background meaning. The composition of the dis-

trict is very open and public - all spaces are accessible for people with no fences between settlements which are the smaller organisms that were meant to live in communities. The concept is designed mainly for human, so the idea was to provide people a possibility to pass the whole district without crossing any street. The designers decided to solve it by putting underground passages which became a significant solution for the project. (Obiektyw - Miasto w miescie, 1975)

As panel buildings were already perceived as rather greyish and depressing, this time they were designed to be covered with green facades. In combination with huge green spaces they would give an extraordinary impression of a ''jungle'' in the middle of the city. (Obiektyw - Miasto w miescie, 1975)

The concept of the district is concentrated in a linear composition. It means that the main alley is either transport, service and market zone. The service and market zones are mainly located on the ground floors - which is a reference to the typical historical city. Their existence was a key factor for the district, as the whole area was meant to be an independent and self-sufficient urban organism with typical features of city but in more human scale. (Obiektyw - Miasto w miescie, 1975)

One of the other wishes was to create the whole space with a close collaboration to the future inhabitants to emphasis importance of the district's social meaning. The designers wanted to give people also some space to create the area in their own way and let it live with its own life. (Bec, 2018)

For this reason, the design saved some space for minor developments with initiative of habitants. The description of the design is initiated with thesis: every resident has the right to expand his / her flat in all directions, as long as other residents who are affected by this extension agree.

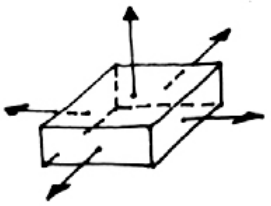
The design provided possibilities of:

- Apartment/services extensions in infill buildings
- Apartment extensions in horizontal or vertical directions
- Adding an independent room on the roof to the existing building
- Functional changes within a building
- Building standalone objects like service/market pavilions

(Ilmurzyńska, 2018)

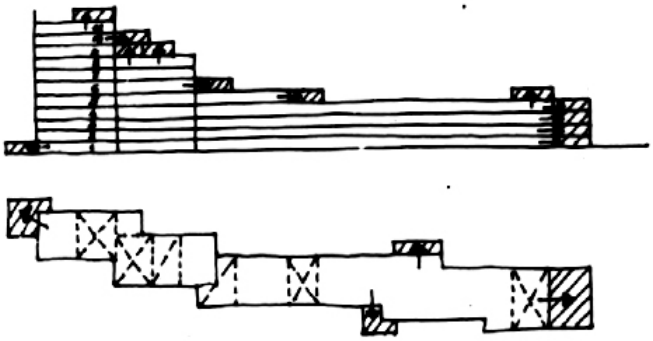
ady dobudowy i rozbudowy

Założenie

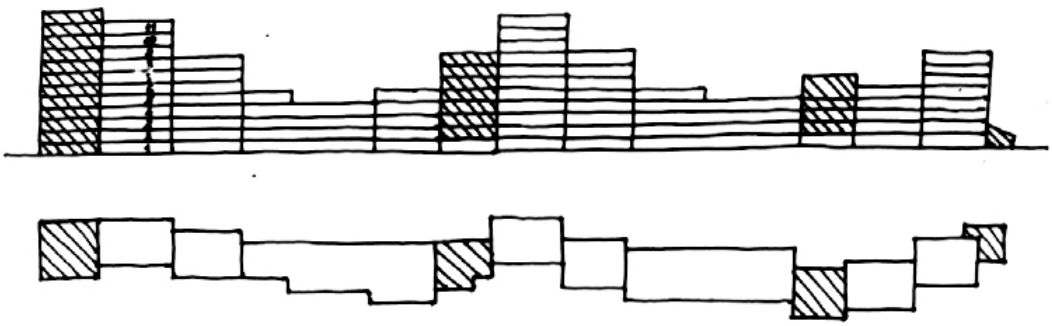


Każdy mieszkaniec ma prawo rozbudować swoje mieszkanie we wszystkich kierunkach o ile inni mieszkańcy, których ta rozbudowa dotyczy wyrażą na nią zgodę.

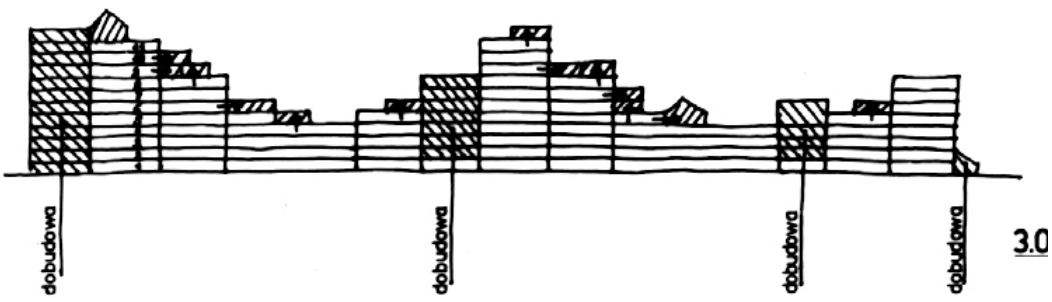
Zasada rozbudowy budynku



Zasada dobudowy nowych mieszkań – dobudowa nowych części budynku



) Możliwość przekształcania budynku



3.0

Ill.11: *Extensions possibility was one of the initial ideas in Ursynów*

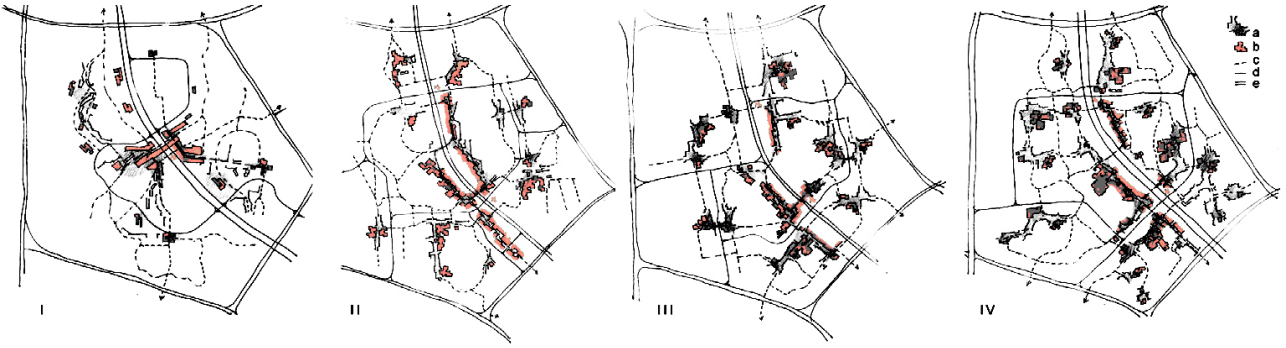
Building Process (1970-00's)

The idea of the inhabitants participation in the design process was unrealistic from the very beginning as the communist authorities cared only about building fast, cheap and a lot - in this reality there was no space for the opinion of a unit. The propaganda stream demanded a demonstration of quickness and efficiency - therefore discussions were found as irrelevant and disturbing. For this reason the designers were also moved away from the site supervisions. In the result Ursynów ended as an unfinished district without principle ideas for many years. The key solutions as the main communication alley and the whole market system were not realized. One of the main assumptions that were crucial for the connection with the rest of the city - two metro stations were also a missing part at Ursynów for a long time. In 90's Budzynski compared the design to the ''human with no head, no hand and no two legs''. By citizens Ursynów has been announced as a ''huge bedroom, a desert with no services from where you need to go to the downtown for any stupid thing'' (Bec, 2018).

In 1989 Poland won the fight for their freedom and communism has fallen down. The long awaited time of changes has come - also in the building sector of country. That of course affected on Ursynów as well. The missing elements has been naturally filled with time - metro was built in 90's so the district has connected to the rest of the city. Also the main artery has been built (and couple times developed trough years) just like the whole services network - in a bit changed form than it was initially designed. Year by year the primary design was coming true and in terms of urban design Ursynów finally started to perform like it was supposed to.

However, some of solutions didn't come very naturally. The underground passages - even though they've been built - they have been abandoned for years and were a main accommodation for homeless people. They scared with their look and scent. The passages were refreshed about 2010 but nowadays they still don't encourage to use and don't look friendly. Also the solution of green façades has been abandoned after thermomodernization. Recently, it is possible to notice shy try of restoring the idea at some places, but still in more domestic than the global scale.

Ill.12: Kabaty - Ridiculous photo of last Metro station in Ursynów - nothing but the field



Ill.13: The evolution of design solutions

Today

It's difficult to estimate how long Ursynów was being built. The district is still being developed but mainly in other areas. However, the main part was named as Ursynów Pólnocny (Northern Ursynów) and nowadays authorities are more focused on preserving the initial urban design e.g. not building on the empty green areas that could be a tasty morsel for local developers. Certainly, we are able to indicate period 1970-2000 as the most important in terms of development for the district (Ilmurzynska, 2018).

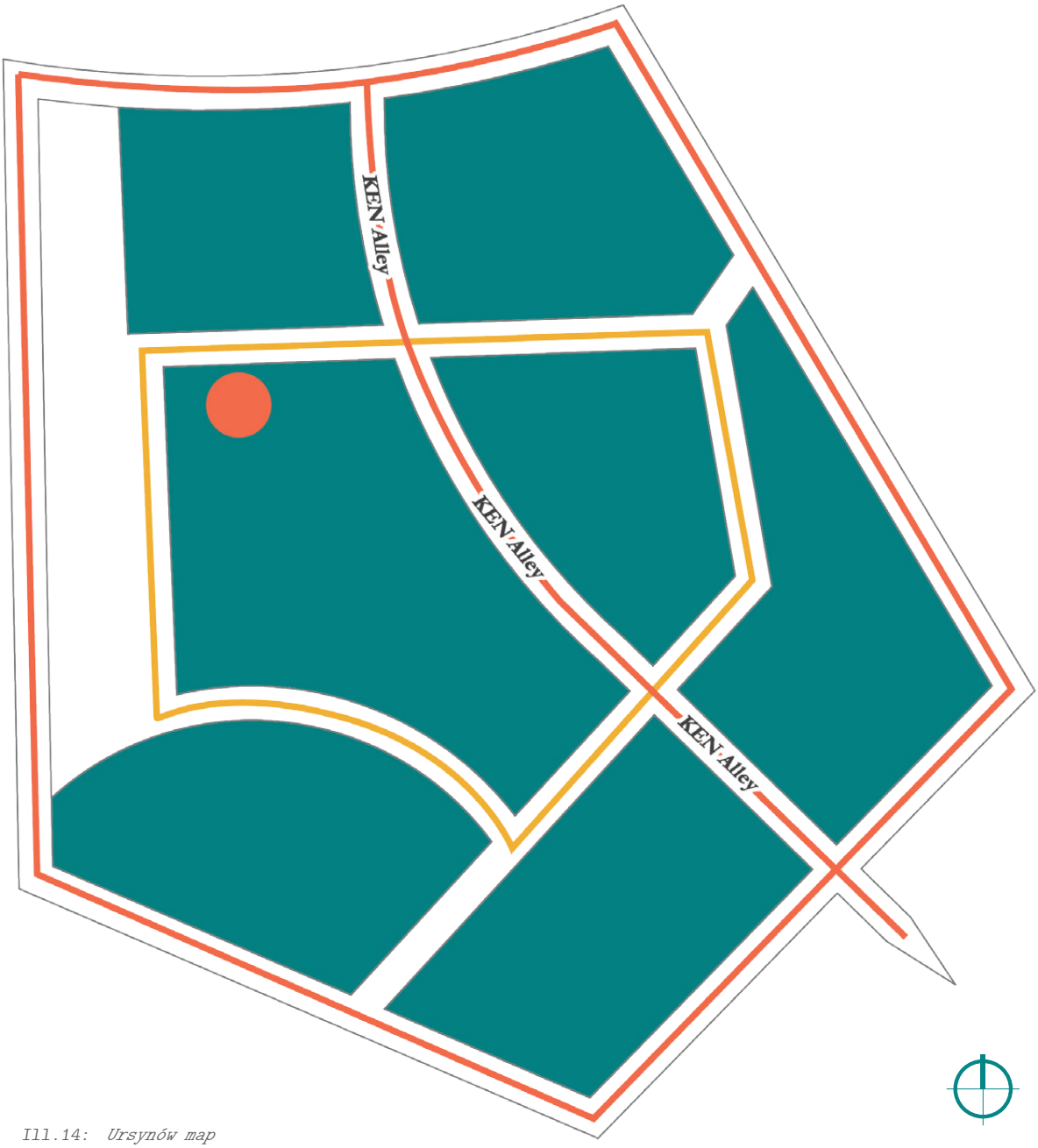
The design has been changing trough years couple times, but main principle ideas has been maintained. The crucial modification was a replacement the key alley from a highway to the less dense main local street. It means that there was no need to keep the district life away from the street anymore. Therefore due to the communication pros, it was worth to surround it with new buildings for living and markets. (Ilmurzynska, 2018)

The final, existing design contains:

- One for the whole district:
  - High school
  - Church
  - Park
  - Cultural and service center
  - Police station
- Two for the whole district:
  - Clinics
  - Metro stations
- District communication system:
  - External communication circle (supra-local)
  - Main alley (supra-local)
  - Internal communication circle (local)
  - Settlement streets

The streets divide the area into 6 settlements. Each settlement contains:

- Loosely positioned 11 storey Panel Buildings
- Loosely positioned 6 storey Panel Buildings
- Loosely positioned 4 storey Panel Buildings
- Garages and parkings
- Playgrounds
- Service pavilions
- Underground passage
- Educational unit with playing field



Ill.14: Ursynów map

Internal communication (local)

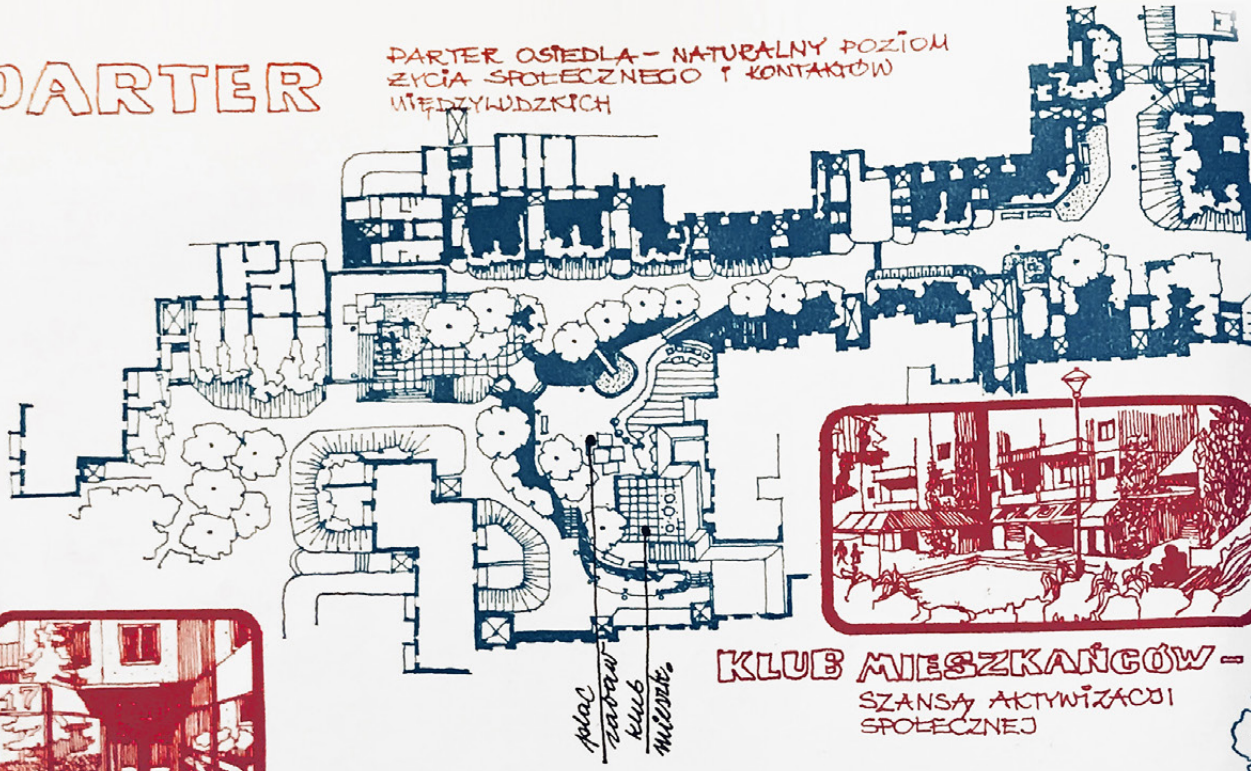
External communication (supra-local)

Settlements

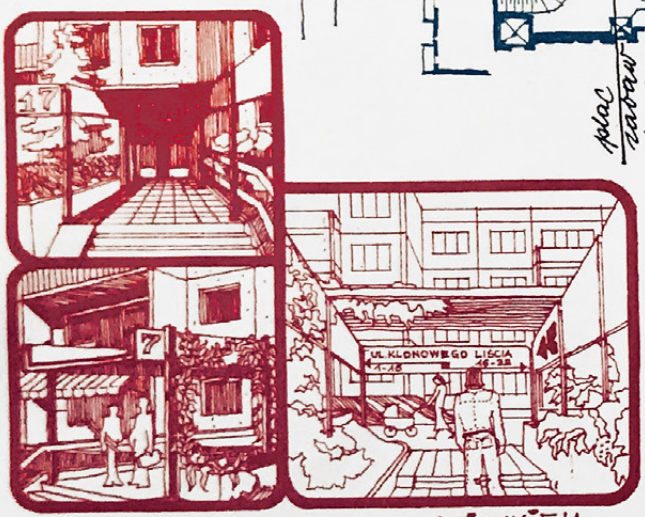
Chosen site

PARTER

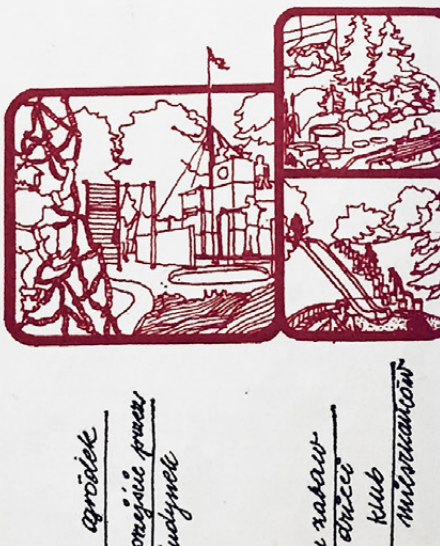
PARTER OSIEDLA – NATURALNY POZIOM ŻYCIA SPOŁECZNEGO I KONTAKTÓW MIĘDZYLUDZKICH



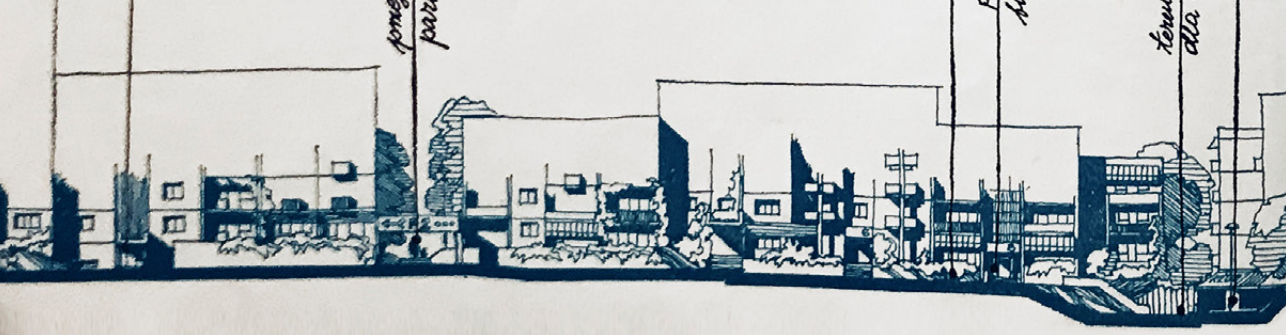
KLUB MIESZKAŃCÓW – SZANSA AKTYWIZACJI SPOŁECZNEJ

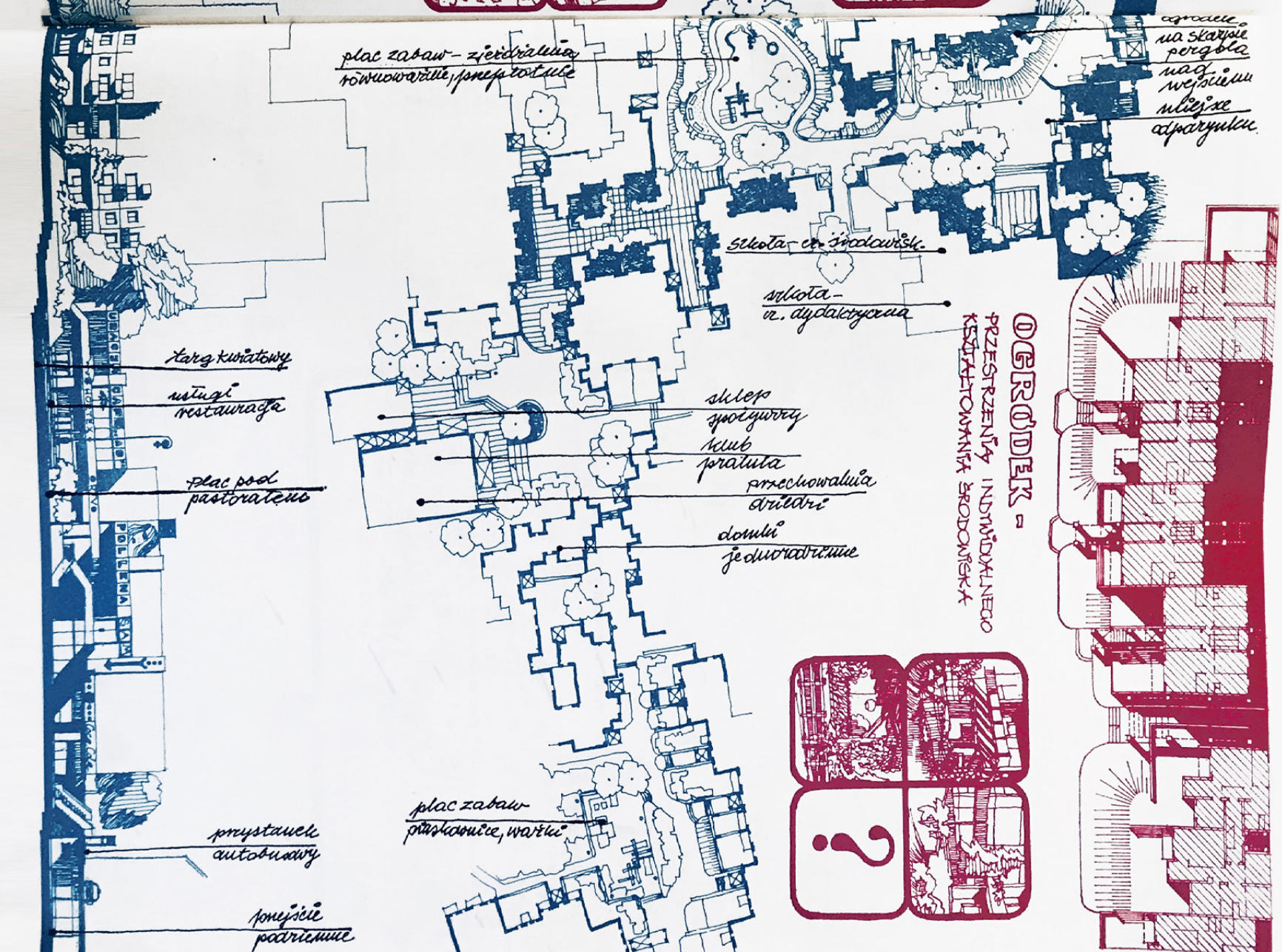


WEJŚCIE DO BUDYNKU – PRZEDSIONKIEM MIESZKANIA



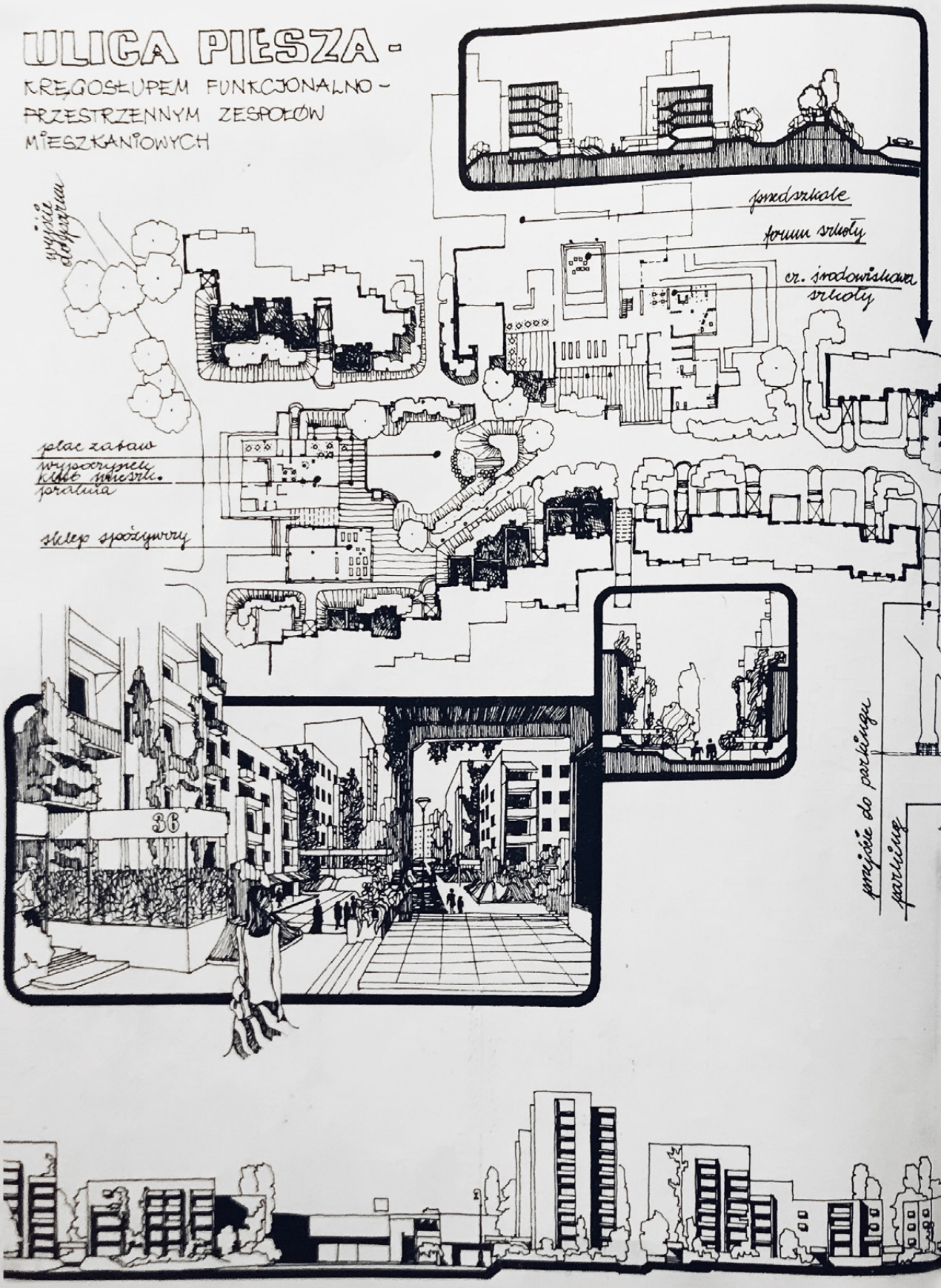
PARTER – GŁÓWNYM POZIOMEM ODBIORU INFORMACJI WIZUALNEJ

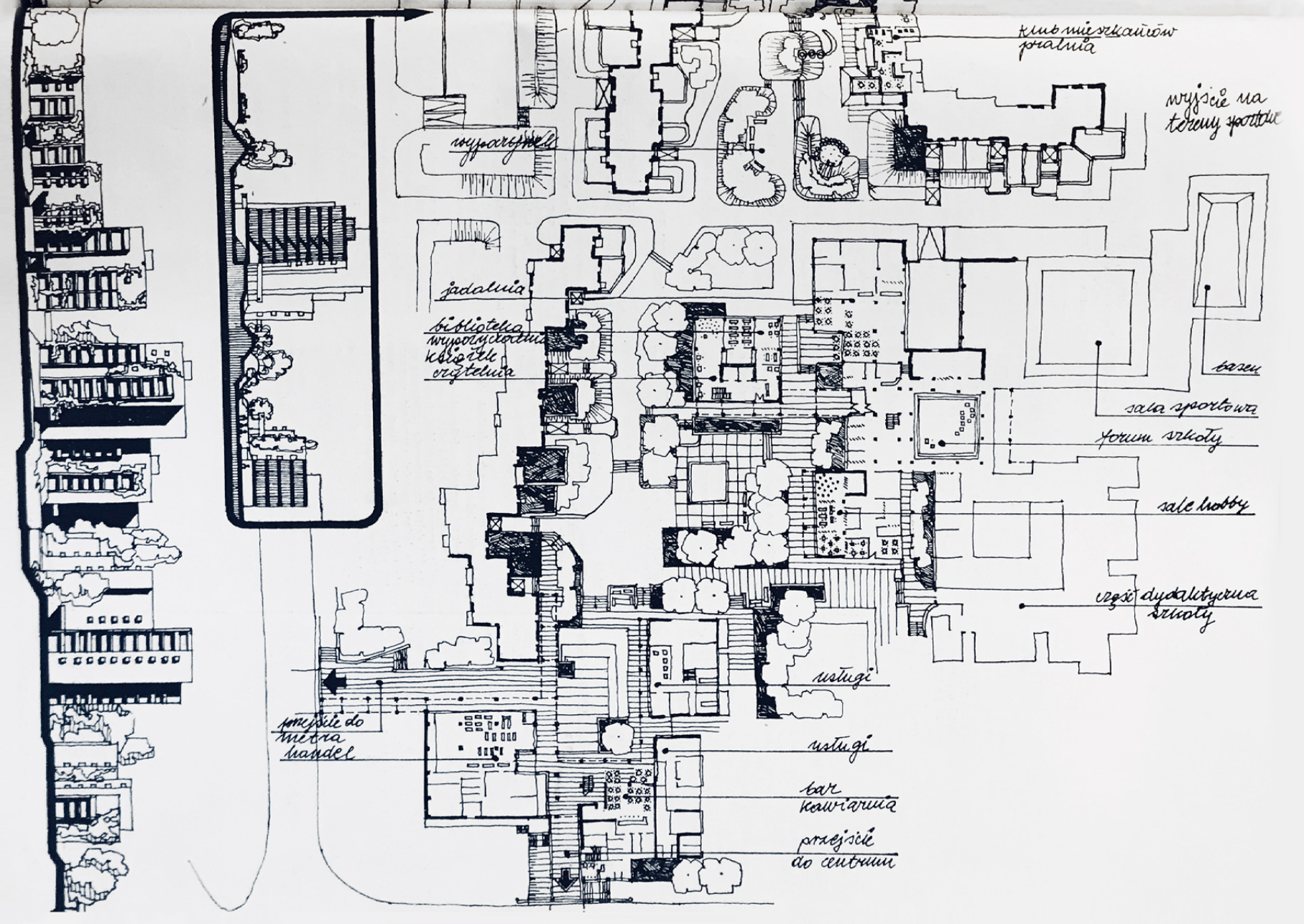



plac zabaw - zjeżdżalnia, równoważnie, piaskownica
ogrodzenie na skarpie pergola nad wejściem miejsce odpoczynku
szkoła - dr. środowisk.
szkoła - dr. dydaktyczna
targ kwiatowy
usługi restauracja
plac pod pastoratem
sklep spożywczy
kiosk prasowy
przechowalnia drobiu
domki jednorodzinne
OGRÓDEK -
PRZESTRZENIĄ INDYWIDUALNEGO
KSZTAŁTOWANIA ŚRODOWISKA
plac zabaw piaskownica, warsztaty
przystanek autobusowy
pomieszczenie podziemne
?

ULICA PIESZA -

KRĘGOSŁUPEM FUNKCJONALNO - PRZESTRZENNYM ZESPOŁÓW MIESZKANIOWYCH




klub mieszkańców
pralnia
wyjście na
tereny sportowe
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jadalnia
biblioteka
wypożyczalnia
książek
czytelnia
basen
sala sportowa
forum szkoły
sale hobby
część dydaktyczna
szkoły
usługi
przejście do
metra
handel
usługi
bar
kawiarnia
przejście
do centrum

OWN EXPERIENECE

Piotr **28/02/2019**

Before I came to Aalborg I've spent my entire life living in Ursynów in panel building. However, my case may be not the most representative as my building looks a bit different than the rest of the objects in the neighbourhood. It was considered as more ''residential'' so my own experience might differ from the typical user of the housings. The apartments here were bigger, and designed in better standard, comparable to the norms of East Germany. It was even possible to buy an apartment for the cash (only with dollars - that the average Pole didn't have anyway) what was an extraordinary situation for this period as the private property was limited to minimum. My parents managed to get the dwelling, only because of my brother problems in the childhood, when he had some small episodes of epilepsy. It allowed us to be assigned to have a bigger apartment as we were considered as a family with higher demands. However, the better standard doesn't mean of course that the apartment didn't have any defects - it had. And a lot.

Ill.15: My building

Even though my family dwelling has more space than the standard one, the height of is only 230 cm which is ridiculous - but surprisingly I've never looked at it as something wrong until I've started my architectural education. The walls are incredibly

bumpy - it is well seen during small renovations - painting rolls simply can't reach the ''valleys'' on the surface. It requires a lot of strength to do it properly, so it happened that one wall was being painted on several times as it was too exhausting, what successfully discouraged us to undertake even small refurbishments.

One of the main problems that I remember is a noise coming from the other apartments. The most distinctive and also a traumatic memory was listening to woman above us with strong coughing episodes at night. The noise was waking us up and the situation lasted for weeks, until my father bought a foam in spray and isolated the joint of the ceiling with the pipe of radiator. She died soon after that.

The radiators are accountable for the noise spreading in principle. I perceive as a normal listening to tv (or maybe radio) of neighbour in the evenings. But other times the radiators are useful communication tool between people - if someone is disturbing with too loud music or drillings, you only need to knock radiator couple times to communicate about the problem.

There is also a noise coming from KEN alley which today is a quite high-traffic road. However subjectively I perceive the sound as beautiful because it associate and reminds me warm evenings during summer - the time of freedom. Only then the noise is hearable because of the open windows.

I perceive Ursynów as my hometown - even though it's just a part of Warsaw. The truth is the district is very self-sufficient and I didn't actually know the capital very well, as we as family didn't really have any interest to take, in the other places. All what we needed was here. I've started to explore and orient in Warsaw in the high school so it took plenty of time for me to ''get out'' from the neighbourhood.

Ill.16: Me sitting in the balcony and observing rising Ursynów - at the picture can be seen the lack of KEN alley, which was meant to be the most important communication element of the district. We're talking about 90's - 20 years after first buildings in the area.

Ursynów changed a lot trough years. In 90's many of architectural aspects were already very neglected. There was absolutely no respect for public goods. Vandal graffities, common dirt, demolished trashes or benches - all of this I considered as a normal landscape. People started to live in worse and worse environment while destroyed public components were rarely repaired. In the result people cared about the things even less what enhanced the weird self-perpetuating machine.

Ill.17: *No respect for common goods (2006)*

My sister - what I forgot about - strongly indicates stinking and soaked in urine elevators as a plague of 90's. My most intense memory is underground passages where there was no actual pass as it was blocked by rubble, trash and homeless people. The reek is unforgettable. However, when I was very young I liked to play there with my friends as there was nothing else to do anyway.

Homeless people were so widespread that I perceived them as a normal part of social life. We as children even found annoying them as a great fun - what now might sound cruel, sad but also unsafe. Safety is another thing to talk about. One of the most recognizable parts of everyday life was a

Ill.18: *The underground passages next to my building (2006)*

plague of young vandals called ***dresy*** (tracksuits). They were rouges that were meeting in big groups and looking for emotions. Mostly responsible for destroying things or beating innocent people. My brother once was even beaten in front of our housing - obviously without any reason. The groups in Ursynów even established and determined polish Hip-Hop music subculture - we can find its roots actually right here. The musicians often strongly indicate panel buildings and streets as a place where they were raised.

The awareness of the common goods occurred in middle 2000's with refurbishments. The great thermo-modernization is a symbol of that changes. People started to respect modernized infrastructure and new architecture - the buildings seemed to be finally more colourful what was something opposite to the standard grayish landscape that reminded painful communism time. But people overreacted to the other extremum. The pastel colours are often combined one another on one façade without any architectural taste. When I was young I liked the changes very much and the colours were something fantastic for me, so I can actually somehow understand people who still like it - and there are a lot of them. I'm wondering if my approach to this problem changed because I matured or if it's due to getting architectural and aestethic sensitivity. I guess that both in some way.

Ill.19: Group of vandals (dresy) - (1998)

Nowadays the majority of vandalism symptoms we can observe only on the old, neglected by authorities areas. The old schemes survived then - if something is ugly - we can make it uglier. However, Ursynów (and Warsaw) transformed very noticeably in terms of that. The better architectural environment and higher respect for common goods also contributed to the safety level. It is quite difficult to meet the bunches of vandals - most of them has changed or just got old. Others were jailed or just died. One way or another - things has changed and today I perceive Ursynów as a very peaceful and safe place to live.

Karolina **28/02/2019**

I was brought to the Large Panel in Piaseczno (Warsaw suburbs) when I was around one week old. The apartment had 49 m^2, divided into 2 bedrooms, one living room, small bathroom and a kitchen. The flat was shared neatly between my father's family. My parents and I have taken one bedroom, my aunt and uncle have taken another one, and my grandmother ruled the living room. Shortly after me, we welcomed in the world my brother and my cousin, so for a while we shared this extremely small apartment between 8 people and a dog! It may now sound like we lived in an urban slums, but this was actually the reality for the vast majority of polish families. No one even thought about crowdedness or lack of the comfort, people were happy about having their own long-awaited flat in a block.

of the block construction and later the construction of the rest of the settlement.

For me the whole estate always seemed a bit unfinished. What strikes the eye are balcony windows devoid of balconies. It looks like at some point during realization of the investment there was a budget trimming, and the balconies have never been executed, leaving huge windows as a substitute for morning coffee in the open air. Those French windows are only useful for the curious community, as they provide better observation conditions towards the social life. Whenever there's an accident, a loud quarrel or emergency services are coming with sirens, each French window in the neighborhood is filled with onlookers. The curiosity of neighbors can be met

Ill.20: My block

When I was born, my family had already lived there for 20 years. As that times, having an apartment was the peak of the dreams and the lists in housing associations were extremely long, the time when my grandparents had been finally given one was such an excitement, so my granddad documented with photographs each step

on an ongoing basis through the thin walls between apartments. Because of this dubious attribute my whole family wakes up at dawn every day to the accompaniment of the neighbors' howling dogs alarm. The noises of regular refurbishments breaking through even several storeys are a normal thing. If, however, someone

finds it too annoying there's unofficial Common Problem Notification System, that each apartment had been equipped with - radiators. Couple knocks and the neighbor is informed that he produced too much noise. There is also a danger that some of neighbors can overuse this system. For example the old lady, leaving right beneath my parents, who's claiming this way anytime we move the chairs around the table. This very annoying feature of the building led my mother to wear only soft slippers, to move around the apartment without making any noise and almost to whisper to communicate with us.

Not only noise transfers through the walls so easily. The heat does it with the same success. Our apartment is on the highest - 4th floor, so our position is the hardest in the building. In winter time is really hard to heat the entire apartment equally and using the bathroom to get the long, relaxing bathe with hot water through all this time is just a wishful thinking. The complete opposite takes place during the summer months. As the apartment is facing west and uses only one sided ventilation, the temperature inside is infinite. Literally. Once we mounted the electronic thermometer, it showed ERROR instead of the result, because of having too ordinary scale. Overheating is a general problem in every building on my estate, but people are creative to deal with that. I saw several times that people covered their windows with first aid blankets.

Thus the best solution for spending summer days is not to stay at home. The outdoor space between buildings is reach of attractions for everyone. The youngest kids have sandboxes and sometime the whole playground, but during my childhood the best attraction was carpet hanger. This was the best area to compete for the most impressive somersault. As for very young child, the most dangerously appeared the teenagers, that usually were involved in trying their first cigarettes hidden in the staircases or another safer places, for example behind the garages. The benches were usually occupied by local tramps and alcoholics, so were usually places that we as kids avoided the most. Anyway, they were a part of community where people recognizes each other. This lack of anonymity has also its pros. I remember that a shop assistant in a local shop were treated us with sweets, when we assisted mum in daily shopping.

I perceive my childhood memories as rather idyllical. Nevertheless there are some pictures that I remember ugly or annoying. For example, the trash pavilion that was standing in the most representative place in the settlement - right after turning from the main road.

When talking about access to the housing area, the road for cars is of course provided, but finding the place to park is a miracle. As the official parking lot was designed to collect only couple cars, every evening cars fill the rest of the paved surface between the buildings, leaving only a small lane to drive in or out.

Ill.21: *Overcrowded parking lot*

Ill.23: *Individually added elevator for disabled person.*

The lack of needed infrastructure is our daily bread. Our settlement is consisted of buildings of the same height of 5-storeys. This means that none of them is equipped with elevator, as it wasn't demanded by then applicable building regulations. This leads to the growth of additional individual lifts, wherever a disabled person lives.

There are a lot of drowbacks concerning my hometown, but there are still things that I perceive as good ones and I'm grateful that I had a chance to experience that. For example the location of the building in relation to the basic services. I attended to the primary school located at the end of the pavement leading to my entrance door, and to the middle school located two blocks further. That gave me the great chance to get enough sleep every day. Moreover, the close connection to schools, the market place and a health center made my estate almost self-sufficient.

Nevertheless, the thing that I liked the most is the bushy greenery extending between buildings in summer. Thanks to this the view from our windows was really nice and the feeling of space, despite the amount of dwellings, was still kept on an intimate level.

Ill.22: *View from my window towards the greenery*

SITE ANALYSIS

CHOICE OF THE PLOT

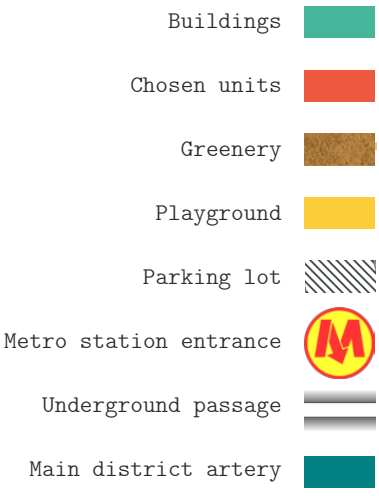
The choice of the proper plot was depended on finding the small area that contains high diversity of buildings in terms of height. Among few candidates the final plot is located on Surowieckiego Street and from the characteristic elements that each settlement contains, it includes:

- Building 1: 4 storey Panel Building
- Building 2: 6 storey Panel Building
- Building 3: 11 storey Panel Building

In the previous chapter there are indicated 8 characteristic features of each settlement at Northern Ursynów. In the surroundings we can indicate from them:

- Parking
- Playground
- Service pavilions
- Underground passage

The absence of the school unit on the list is conscious - as the topic of educational units is too wide and it is perceived as a separate problem.



Ill.24: Plot map

EVALUATION OF SURROUNDINGS

The chosen buildings lays on a settlement that is divided by Surowieckiego street. The site is in neighbourhood to the KEN Alley which is the main artery of Ursynów. It also has a direct connection to the Usynów Metro Station. 300 meters from the buildings, there is a huge park with a high hill as a one of the most important landmarks of the district called Kopa Cwila. The hill is made of ground collected from the building sites when the district was under construction.

The plot is typical for Ursynów as is characterized by wide green areas and is perceived rather as a part of a huge park where there are loosely positioned buildings that are only a background for the greenery. The buildings itself are painted with pastel yellow-grey colours what is typical for this area.

Ill.25: Surowieckiego Street

Ill.26: *Block 2 and 3*

Ill.27: *Block 1*

There is also an underground passage under the Surowieckiego street that connects two adjacent settlements and in fact it also merge the concerned plot together. The passage is in sloppy condition and aesthetically is poor as it's covered with vandal-style graffities that doesn't have any artistic value.

Ill.28: *Underground passage*

Ill.29: *Service pavilion*

Ill.30: *Service pavilion*

Ill.31: *Service pavilion and the House of Art building*

On the eastern side there is located market/service zone which is closely connected to the Metro Station. All the buildings are in poor aesthetic condition and are covered with graffities. Service zone is abandoned and not used for few years. The supermarket doesn't add any positive value to the area. The other object is a pavilion called House of Art which is a very important cultural spot for Ursynów. The building has a typical panel structure and it is in poor aesthetical condition.

The Metro station is in a perfect condition as the whole Metro network in Warsaw is kept in a very good way - either functional or aesthetical.
On the southern part of the site there is also a new, modern playground in brilliant condition standing out from the rest of the area. Right next to it there is a huge parking in very bad condition.

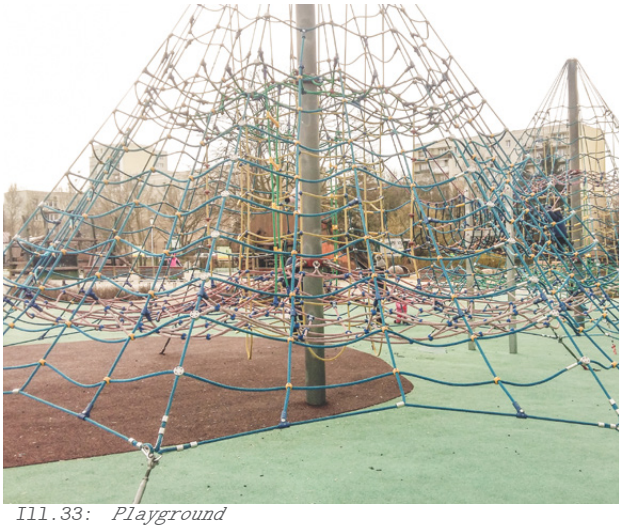
Conclusion:

The greenery areas as the greatest value of the site should be preserved as much as it is possible. The Panel Buildings should be modernized in all aspects what is the main goal of the thesis.

Additionally there are objects that should be also refurbished in a future but Master Thesis doesn't include it:
The supermarket and service zone doesn't manifest any historical value and they are in very poor condition they should be demolished and replaced with another buildings with the same function. The same applies to the parking - it should be refurbished or even upgraded to garage.
The refurbishments on the site should include the underground passage and also House of Art.

Metro station and the new playground as they are kept in perfect condition they don't need any interference.

Ill.32: *Ursynów metro station*



Ill.33: *Playground*

WEATHER CONDITIONS

The chapter presents sun, wind, rain and temperature analysis based on data gathered from Frederic Chopin Airport in Warsaw located approx. 3 km away from the site. In order to provide better understanding of the presented values, they are all compared to parallel data taken from Aalborg Airport.

SUN

The longest day in Warsaw in summer solstice lasts 16 hours and 46 minutes while the shortest in winter solstice only 7 hours and 42 minutes.

The shadow analysis were carried out using Ladybug tool. They contain sunlight hours graphs of three critical days in terms of sunpath i.e. equinox, summer and winter solstice. The graphs show level of sunlight data gathered from entire days and they indicate both shading level and sunlight areas through the daytime.

The equinox analysis are considered as an average sunlight for the whole year. However the autumn equinox is more shadowed due to the presence of leaves on the trees.

Conclusion:

The analysis prove good sunlight conditions either on the chosen plot and adjacent areas. The majority of shaded areas are sunlit between 4-7 hours on autumn and 6-8 hours on spring when the overall time of sunshine during equinox is about 12 hours.

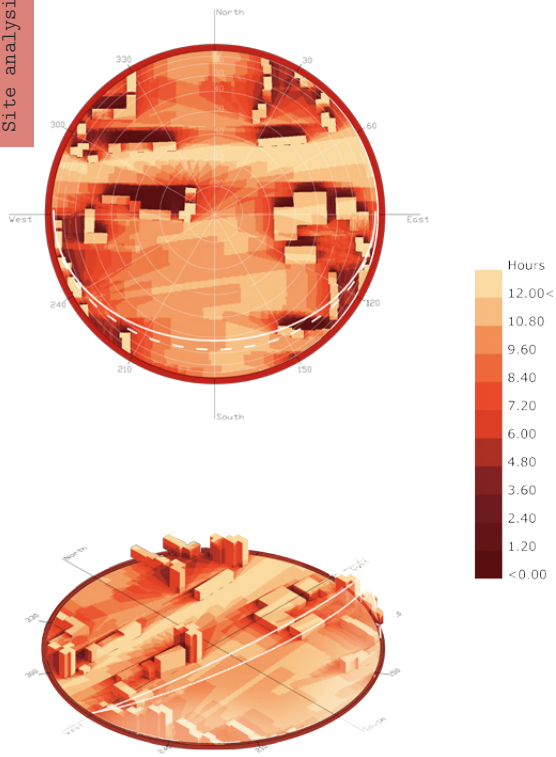
The analysis shows that every building is sunlit for the majority of the daytime on eastern, southern and western façade. During autumn equinox lower levels of the buildings are shadowed by trees while in spring equinox there is no such situation.

The results suggest possibilities in adding some new cubature into the site - either in horizontal and vertical directions. However the thinkable volumes have to be added carefully and with respect to the existing apartments and spaces. Therefore the daylight analysis on the further steps have to be carried out simultaneously with the design process.

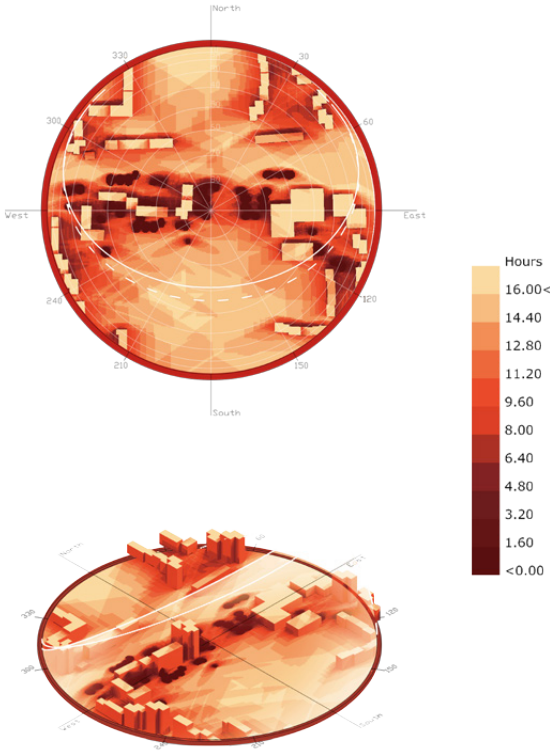
The northern side of the buildings seems to be less attractive as it is shadowed in the majority of time and it shouldn’t be used for living spaces like gardens, playgrounds etc.

The analysis also indicate perfect conditions for adding solar panels not only on the roofs but also a possibility to implement them on the ground level.

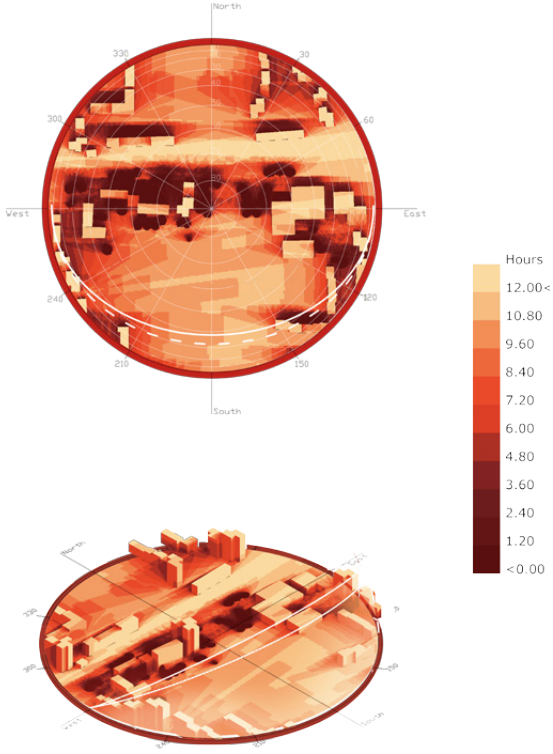
Sunpath for Warsaw
Sunpath for Aalborg



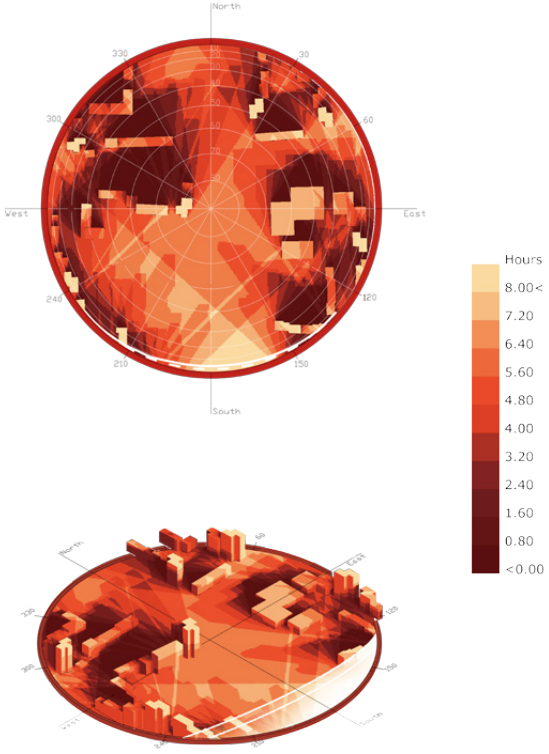
Ill.34: *21st March*



Ill.35: *23rd June*



Ill.36: *22nd September*



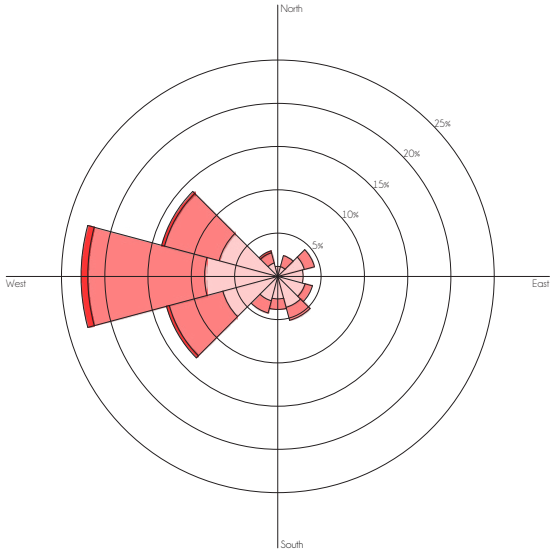
Ill.37: *23rd December*

WIND

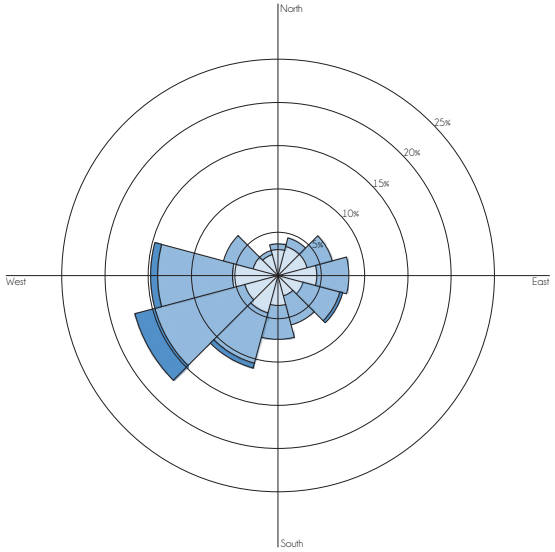
The dominating wind direction is West with values reaching to 16 m/s. The average windspeed in Warsaw is 4,1 m/s while in Aalborg it is 4,4 m/s.

Conclusion:

The second most significant wind direction is south with values reaching to 8 m/s what provides a good conditions for the apartments with cross ventilation and one-sided for apartments oriented towards south. Comparable values are for the north direction, however it occurs much less often what might causes some problems for apartments oriented towards north with one-sided ventilation.



Ill.38: Yearly windrose for Warsaw

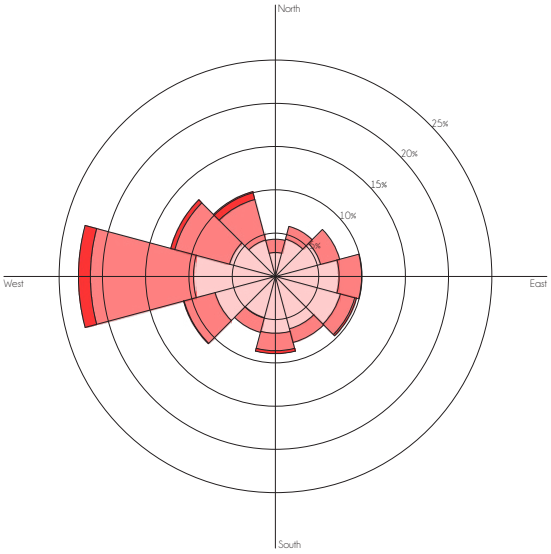


Ill.39: Yearly windrose for Aalborg

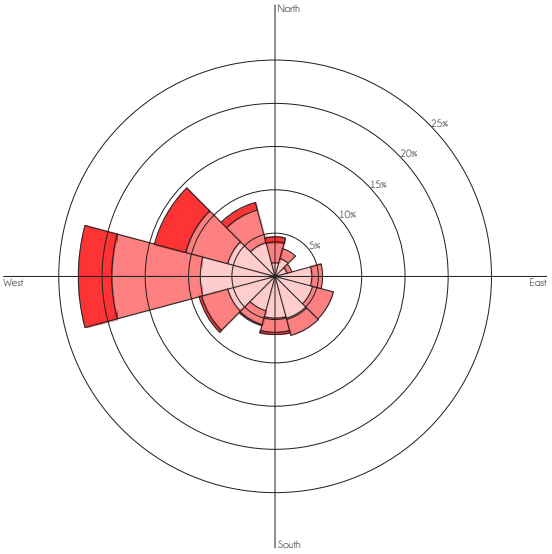
Strong winds

Moderate winds

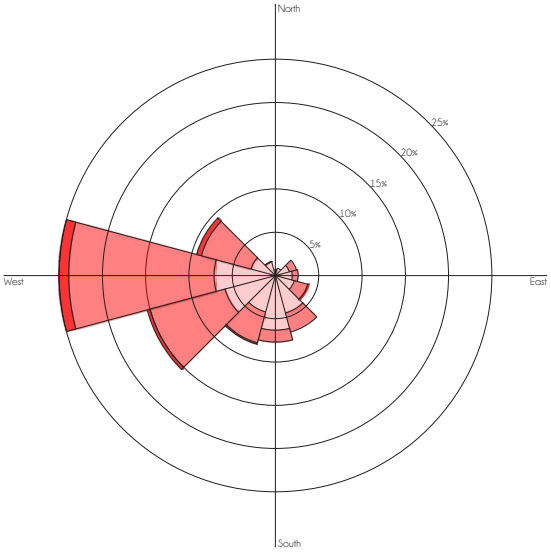
Breezes



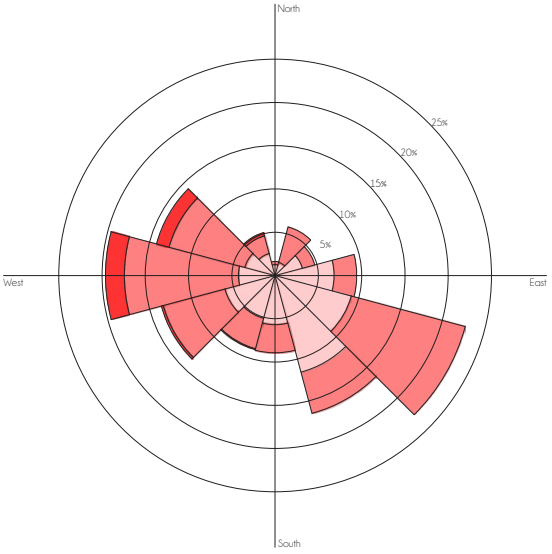
Ill.40: *Spring windrose for Warsaw*



Ill.41: *Summer windrose for Warsaw*



Ill.42: *Autumn windrose for Warsaw*



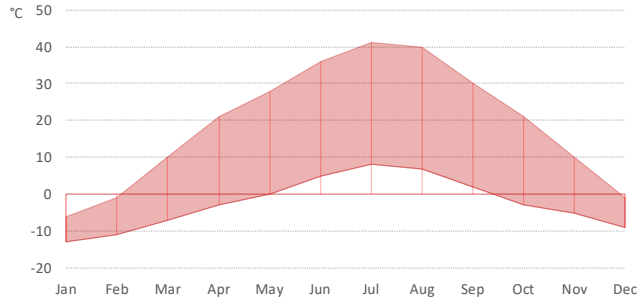
Ill.43: *Winter windrose for Warsaw*

TEMPERATURE

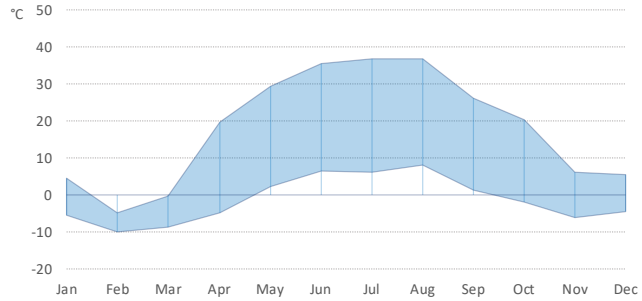
The analysis for last 12 months indicates January as the coldest when the temperature drops under -10 Celsius degrees. The highest temperatures are both on July and August and the maximum temperatures reached above 30 Celsius.

Conclusion:

The temperature analysis indicates period between April and October as a time of outdoor activities and hypothetically the highest usage of balconies. The period between May and September is indicated as a time where the temperatures reaches above 27 Celsius degrees and may cause overheating in apartments.



Ill.44: Yearly temperatures for Warsaw



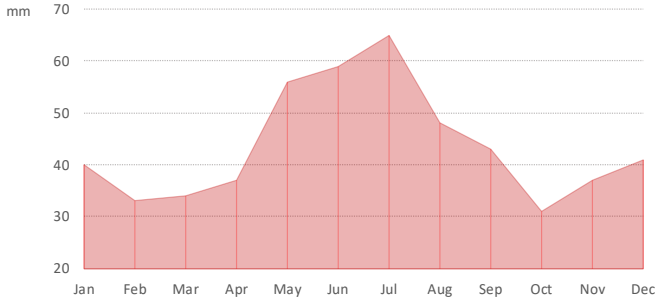
Ill.45: Yearly temperatures for Aalborg

PRECIPITATION

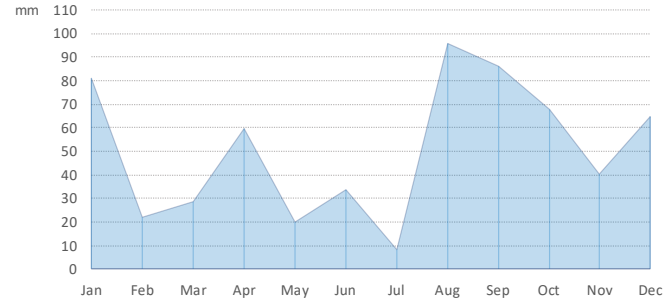
The most rainy period in Warsaw is between May and July. In the most rainy month - July the rainfall is 65 mm. In August starts drier season and it lasts to April with the driest month of October when the rainfall is 31 mm.

Conclusion:

The rainfall doesn't have any impact in the urban scale as the site is situated in area with no flood threat.



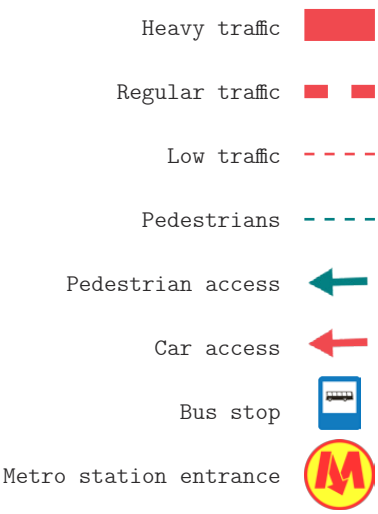
Ill.46: Yearly precipitation for Warsaw



Ill.47: Yearly precipitation for Aalborg

FLOW & ACCESS

Access to the site by car is mainly possible from Surowieckiego street with three entrances. There is also a possibility to arrive by an internal street from the southern part of the plot which is connected to the settlement network. All internal streets are mainly provided for pedestrians - only some of them are also open for cars. Due to the close location of important landmark - hill Kopa Cwila - there is also a possibility to come to the site from the north by underground passage. Pedestrians can arrive to the site by Metro - which is a very important factor in terms of communication possibilities. Just like four bus stations along the Surowieckiego street in the direct neighbourhood of the plot.



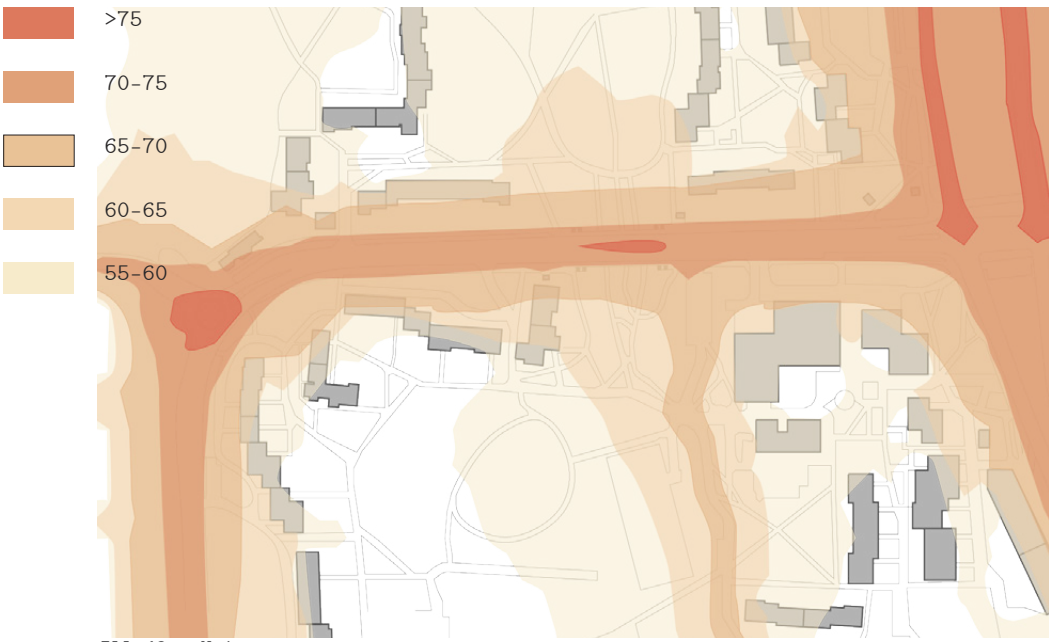
Ill.48: Flow and access map

NOISE

Due to the nearness to the KEN alley and Surowieckiego street, the considered buildings are located in the noise area with values between 60-70 dB. The higher values occur on the facades positioned towards the roads, while the lower values are present on the other ones.

Conclusion:

The noise at the louder sides might be considered as slightly inconvenient. The exposure of habitants on the noise should be lowered if possible by e.g. adding barriers in the urban scale, sound insulating in apartments, changing functions of flats or any other way with the respect for the proper ventilation solutions.



Ill.49: Noise map

EXISTING BUILDING ANALYSIS

As the panel buildings have similar principles, the analysis are carried out only on one building. The building 3 (Puszczyka 18 street) was indicated as a representative example of such building due to its tallness - it will be valuable feature to reveal the worst possible conditions in terms of overheating on the higher floors, where there are no trees to prevent the possible problem.

FUNCTIONAL ANALYSIS

The building is consist of two cores which includes staircases, halls, elevators and a trash chute. Southern core is connected to four apartments, and the northern one is connected to three. In the object, there is also a basement where there are located technical rooms and storages for inhabitants. The roofs are not available for a common user.

The apartments itself are very small comparing to contemporary ones in Europe - their area is fluctuating between **14-17 m²/person** what is much below the polish average (25 m²). According to data from 2015 worse conditions are only in Romania (15) and Latvia (18). Comparing to the rest of the Europe the average standard in Finland and Spain are 35 m²/person, Sweden and Germany 40, Luxembourg and Austria 52 and Denmark 53. (Kijek, n.d.)

The symbol M is for a word "mieszkanie" (apartment) and the number behind it indicates the number of people that the apartment was provided for.

TYPE	m²/person	Usable area
M4	16,9	**67,7**
M2	15,5	**31,0**
M4	15,6	**62,5**
M4	17,2	**68,6**
M3	15,7	**47,0**
M3	15,7	**47,0**
M4	15,7	**62,6**

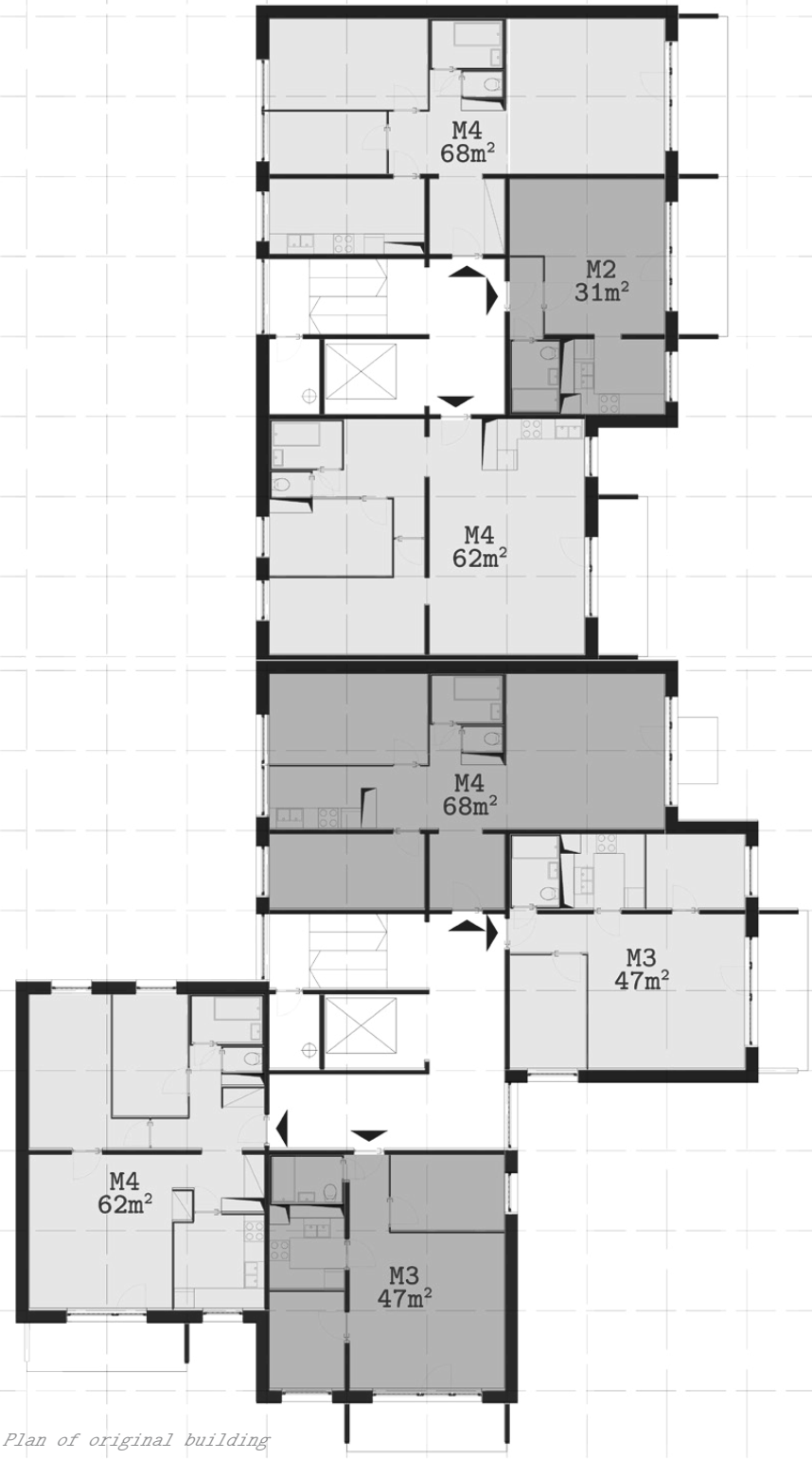
Tab. 1

The overall principles of the apartments:

- The apartments are based on a module of celling slabs which basic dimensions are 240x480 [cm] and are complemented with the smaller ones 240x240 [cm].
- The span of apartments are between 3-4 modules.
- The typical apartment is consist of:
  - Living room - they are a common space for family but also a bedroom for parents
  - Kitchen
  - Bedrooms - one for each child
  - Bathrooms
  - WC - most frequently as a separate room
  - Hall (optional)
  - Balcony (optional)

Conclusion

The average space in apartments is significantly below not only European standards but also the Polish ones. The way of enlarging areas should be found to increase it at least to the contemporary polish average **25 m²/person**, but preferably to **30 m²/person** what is an official guideline for new dwellings in Warsaw imposed by municipality for 2030.



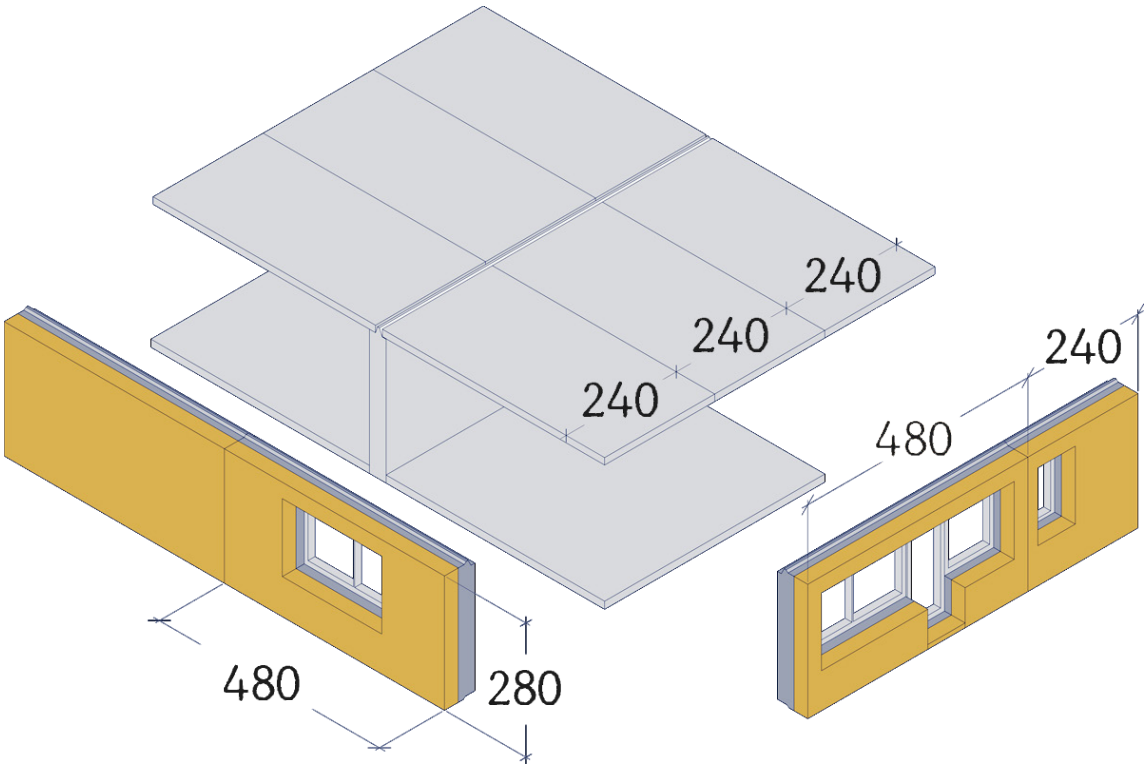
Ill.50: Plan of original building

STRUCTURE

There are different systems in which prefabricated panel buildings were raised. Although they have similar principles, they are different in such things as a module dimensions, ceiling slab thickness or layers of the external walls. The building 3 is built in ‘‘Szczeciński’’ system which was one of the most popular in Poland.

Span of walls:	2,4m and 4,8m		
Slab height:	2,8m		
Ceiling slab thickness:	14cm		
Internal walls:	14cm		
External walls:	36cm and 40cm	→	U=1,16 W/m^{2}K
after thermo modernization		→	U=0.3 W/m^{2}K
Small windows:			
PVC, single-glazed	145x90cm	→	U=3,1 W/m^{2}K
after thermo modernization		→	U=1,1 W/m^{2}K
Large windows:			
PVC, single glazed	210x90cm	→	U=3,1 W/m^{2}K
after thermo modernization		→	U=1,1 W/m^{2}K
Roof:		→	U=0.8 W/m^{2}K

The external walls had only one layer made of LECA concrete and weren’t insulated. It was assumed that the material is a good enough insulator as it’s thermal conductivity = 0,38 W/mK which is less than normal concrete. However if the wall had to keep standards for 2019 it would have to be 120cm thick. The walls were insulated shortly after they were raised with 20cm of styrofoam.



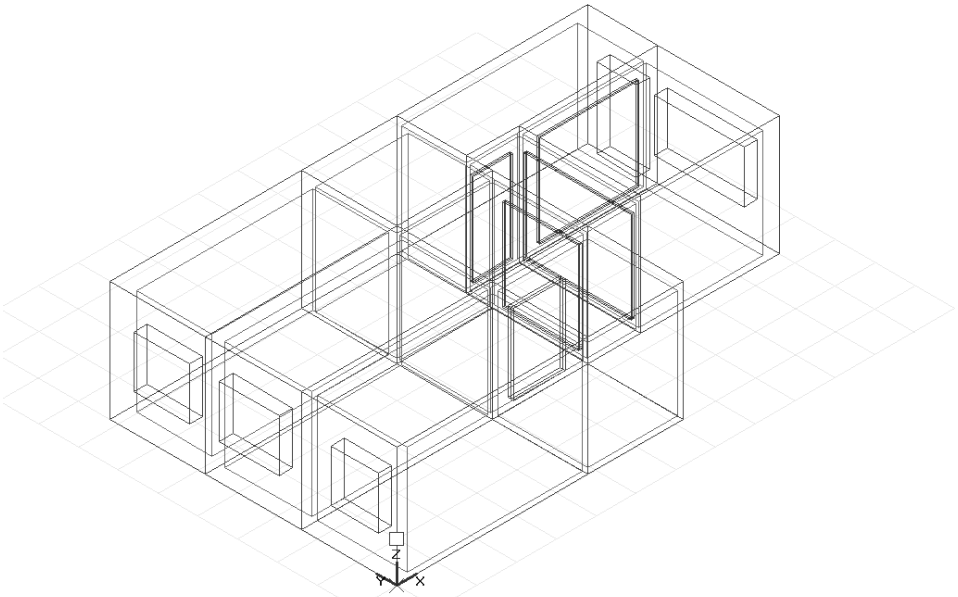
Ill.51: *Structure scheme*

INDOOR ENVIRONMENT

The BSim tool was used to investigate thermal comfort and indoor air quality. The test was carried out on the critical apartment which was chosen due to its position in the building. The dwelling is located on the last floor on the northern side. In a result it doesn't take the quantity of heat gain as the rest of apartments and additionally the apartment is exposed to the outdoor with three facades and a roof.

Ill.52: Apartment 1 indicator

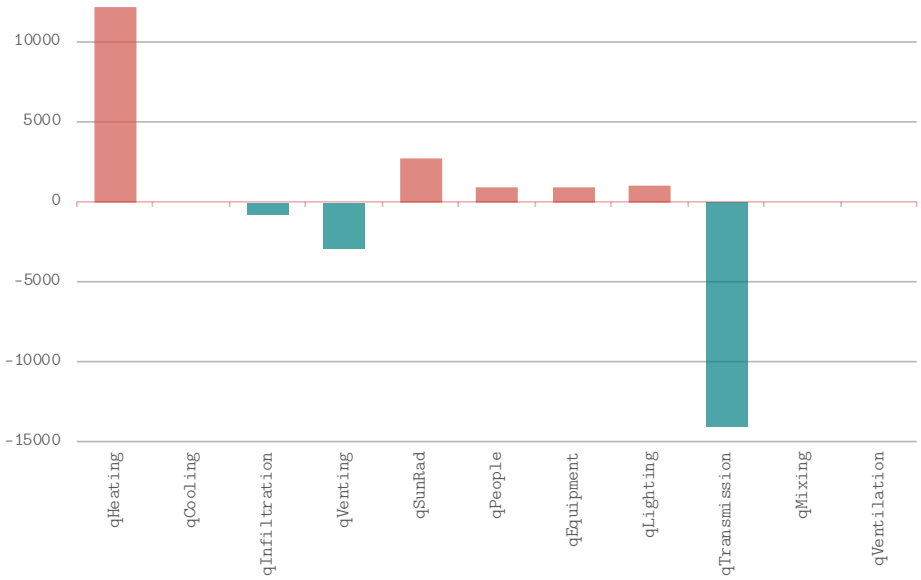
The results shows the proper CO_2 level and slight overheating in the kitchen and one of the bedrooms. The total heating demanding for the apartment is 12166 kWh what gives 194 kWh/m^2 yearly.



Ill.53: *BSim model of apartment 1*

	Bedroom 1	Bedroom 2	Kitchen	Living room	Bathroom	Overall
>27°C	77	42	72	49	39	
>28°C	29	23	27	29	9	
CO_2 max[ppm]	839	868	833	844	868	
Heating [kWh]	1439	5191	161	5075	289	**12166,1**

Tab.2



ENERGY DEMAND

According to data that describes energy frames of existing buildings in prefabricated panel technology the total energy demand are fluctuating between 105-140 kWh/m^2 yearly. (Narodowa Agencja Poszanowania Energii SA, 2011)

The investigation of existing building in Be18 tool confirmed collected data as it reveal the energy frame of 117,5 kWh/m^2 yearly of primary energy.

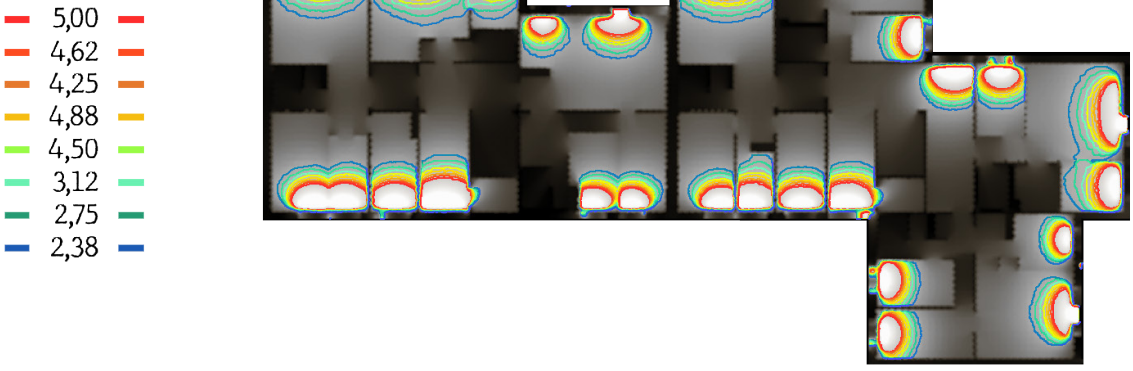
Conclusion: The energy demand must be lowered to standards comparable to Danish building class of BR2020, stating the maximum of primary energy as 33 kWh/m^2 yearly before implementing active solutions (see chapter Legislation Polish vs. Danish on page 74).

DAYLIGHT

The daylight analysis was carried out in Velux Daylight Visualiser 2 tool. The program indicates a noticeable deficiency in living spaces with average between 2,5-3,5% of daylight factor.

Conclusion

The daylight factor should be increased to at least 5% on average in living spaces.



Ill.54: Daylight analysis on existing building

THEORY

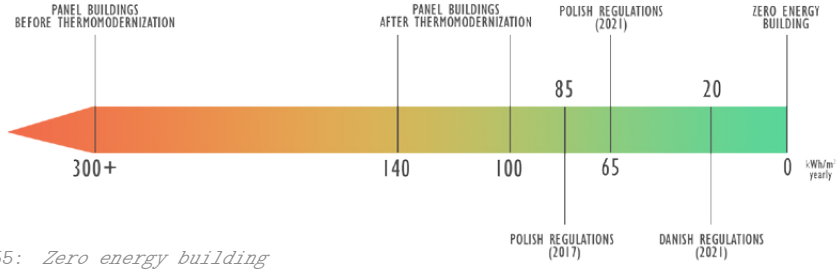
ZERO ENERGY BUILDING

In the era of galloping climate changes and global warming, where the building industry uses around 30% of world's final energy consumption each year (Iea.org, 2019) and there's no visible tendency of decrease, it is important to undertake effective actions to stop the development of harmful atmospheric phenomena.

Having the tools and technology, the solution could be to start designing Zero Energy Buildings, which by the definition of The Danish Strategic Research Centre are buildings designed with a low energy demand and that energy demand is covered by fossil free energy sources. (Bejder, Knudstrup, Jensen & Katic, 2014)

Moreover, the achievement of low energy standard should be supported by the use of numerous passive strategies in order to provide good indoor climate, good daylight, temperature and acoustic conditions. All this with a special contribution to architectural quality and the users' needs. (Bejder, Knudstrup, Jensen & Katic, 2014)

Many countries have already updated their energy legislation. In Poland from 2021 each new building and from 2019 each new public building has to present low energy performance. Although, the new demands are a big restriction for architects and building companies, they are still far from zero energy standards. This is why in this project we decided to go one step forward and challenge the building against demands comparable to Danish building class of BR2020, stating the maximum of primary energy as 33 kWh/m^2 yearly before implementing active solutions and Zero Energy Standard after implementing onsite renewable energy sources.



Ill.55: Zero energy building

DESIGN STRATEGIES

In order to provide the comfortable living conditions, there are many factors, like daylight, air quality or temperature, that need to rich a certain level. To achieve and control the proper number of each condition, the project can use both passive and active strategies. The passive solutions are the ones that affect the form and structure of the building and are preferable to use as they don't need any additional energy supply. The active initiatives can help the building regardless of the building shape, but they demand additional amount of energy to work.

Passive strategies

As this master thesis concerns yet existing buildings, it is important to acknowledge the already used strategies and their effectiveness. Thus, for example, **natural ventilation**, is the primary solution to obtain the proper air quality. Although this strategy is not effective enough, the existing structure does not provide the space for alternative mechanical solution. This is why, the existing ventilation needs to be optimized to the new standards by adjusting the size of windows and reorganizing the plans of apartments to achieve the most preferably - cross ventilation or at least single-sided.

Panel buildings are originally made of concrete slabs what benefits to the building with high **thermal mass**. Thanks to that the building presents large heat capacity, what can support effective heat gain and generate passive heating during nights or cooler days. To preserve this quality, in case of changing the building envelope, the base material should also be concrete.

Building envelope should also be complemented by thermal insulating materials, to prevent excessive heat loss and minimize appearance of thermal bridges.

In order to control the temperature inside the building depending on a season it is important to combine strategies providing **solar heating** during winter and **solar shading** during summer months, where the risk of overheating may occur. The size and orientation of windows is the primary variable to adjust passive heating. The balconies, which are going to be used from functional and aesthetic reasons will contribute to eventual overheating reduction. If overheating appears in unshaded rooms, the windows will be equipped

with manually-controlled shaders, according to the visual presentation of the façade.

Active solutions

As the active solutions require additional amount of energy they are less preferable to use in the project. However it may occur that only passive strategies are not sufficient to fulfill all the building's demands the following active solutions are considered as the most needed in this project.

Although the passive strategies should provide the proper heat collection, to allow the users temperature control, depending on their individual needs the use of additional active heaters may be inevitable. This demand can be easily fulfilled by the use of **hydronic radiators**.

Moreover, in order to achieve the Zero Energy Building it is necessary to balance the remaining energy demand with an additional strategy using renewable energy source. The strategy for this project assumes implementing **PV panels**, integrated with the design of the building.

LEGISLATION POLISH VS. DANISH

Local plan

Polish local plans are much more strict than the Danish ones and they give few freedom in the design decisions. The road to change any plan is very complicated or long-dated, and the exceptions from the rules are acknowledged relatively seldom. The local plans are also one of the main reasons why the panel buildings are not expandable, even though the architect's idea allows for it. In the result any modernisations are limited to the minor changes in the façade. The following proposals undertake discussions with existing municipality plans and doesn't look after it.

Energy requirements

The energy requirement in Poland for the maximum of primary energy decreases as time goes on. The existing law (2017) for the multi-family buildings says about the maximum 85 kWh/m^2 yearly and for 2021 its 65 kWh/m^2. However the disproportion between regulation that are in Poland and Denmark is still visible as the Danish regulations impose maximum 20 kWh/m^2 of total energy when the it comes from district heating (**33 kWh/m^2** of primary energy as the PEF=0.6).

As the Polish regulations are still disappointing and are not challenging according to the master program on AAU, the following concept adjusts to the Danish energy requirements.

Building law

Polish and Danish building law are very similar and they differ in a minor scale (e.g. way of calculating steps in staircases, door opening direction). As the project is carried out on the existing building, and local regulations are already applied, in order to keep the coherence the modernisation will also follow polish law. However, the decision shouldn't affect on understanding the concept.

Indoor Climate and Thermal comfort

The project uses European guidelines as indoor air quality regulations referring to the Class II CR1752 and thermal comfort standard according to the Class II 15251:2007.

CASE STUDIES

The following chapter presents buildings and projects that constituted the biggest inspiration for this master project. The short description accompanying each of the project, describes the qualities that had the most influence on designed form.

Ill.56: *Bosco Verticale*

Ill.57: *Villa Romera*

Project: Bosco Verticale
Architect: Stefano Boeri, Giovanni La Varra, Gianandrea Barreca
Location: Porta Nuova, Milan, Italy

The project consisted of two twin towers was a turning point in approach to the urban greenery. The balconies containing wildly shaped plants give an impression of the vertical forest. The feeling is strengthened by irregular balconies location, that enable a growth of even very high trees. Using the balconies' railings as a plant pot was the most inspiring factor that affected our project.

Project: Villa Romera
Architect: Damian Kotwicki
Location: Ursynów, Warsaw, Poland

The building located further in the same district as the master thesis project, is a contradiction to the common belief that the use of dark façade colours are too overwhelming. Contrary to this belief, the building met with a very positive reaction of people and is now a very unique point between pastel panel buildings in this area. Moreover, the use of black brick emphasizes the reception of surrounding greenery, which is a representative factor for the whole district.

Ill.58: *Henius House*

Ill.59: *Multi-storey car park*

Project: Henius House
Architect: C.F. Møller
Location: Eternitten, Aalborg, Denmark

Henius House is good example of the subtle use of intensive colours in contemporary architecture. The colours work here as a space indicators, that help in orientation towards the proper address. The entrance ‘‘gate’’ in a certain color is followed by a staircase using the same paint. Moreover, the color have also their relfection in interior design - the color of a certain part of the building is repeated on one of the bathroom walls.

Project: Multi-storey car park
Architect: Marek Budzyński
Location: Ursynów, Warsaw, Poland

The building represents one of the primary assumptions of the district - buildings should be covered with greenery and it’s one of the very few existing realizations of this quality. This project inspired us to preserve or even recreate this assumption in the renovated by us buildings.

DESIGN CRITERIA

Functionality

- Improvement of living standard by reorganizing plans of the apartments
- Preserving spacing between buildings
- Preserving greenery
- Restoring the idea of expanding building in all directions
- Restoring the idea of social areas
- Reducing noise level between apartments
- Adjusting the common areas and staircases to the needs of elderly and disabled people.

Aesthetics

- Changing motely perception of the buildings
- Soothing pastel colours
- Using colours in controlled manner
- Restoring idea of green facades
- Improving building indicator system
- Development of the coherent design for balconies and loggias treatment

Technology

- Adjusting the building to the proper microclimate conditions
- Thermal comfort:
  Summer - Class II from EN 15251:2007 standard
  Winter - 21-22°C
- Indoor Air Quality: Class II from CR1752 standard
- Preventing overheating in summer and using passive heating in winter
- Improving ventilation system by redesigning apartments and where possible changing the system to the cross
- Energy goal: 33 kWh/m2 yearly of primary energy before implementation of renewable energy sources
- To reach the standards of Zero Energy or close-to-zero energy building after implementation of renewable energy sources
- Collecting the energy from renewable sources
- Daylight goal: DF > 2% on average, but in living spaces preferably DF > 5% on average

VISION

The vision is to create a solution of Panel Buildings problems that will be applicable globally. The guideline which will be an instruction for the future and will anwser the question ‘‘how to improve living standards in such objects’’. The solution will be carried out using objects on Ursynów district in Warsaw.

In order to improve the buildings as much as it is possible, it is important to renovate them deeply, including aspects that may affect on the structure - e.g. replacing facades.

The idea is to design several strategies of renovation depending on the contemporary users’ needs of each apartment and must response to different scenarios. The strategies include also a concept of enlarging the buildings and the external solids must create a coherent object with the original block.

The concept of the renovation must also contain an idea of merging apartments together in order to increase a flexibility of the strategies. Therefore the solution needs include a possibility of relocating people what is associated with creating additional levels. These levels must also be coherent with the original building.

In summary, the solution should show a potential of existing buildings and suggest possibilities of hypothetical modernizations.

IDEA PRESENTATION

In order to achieve a better building performance in terms of energy consumption, daylight factor, indoor climate and - the most crucial - functionality, the buildings need a deep renovation with involvement of existing structure. The following chapter shows the algorithm which is a guideline for the panel buildings that are to be renovated and how they can be improved.

The presentation will be shown on example building 3 (Puszczyka 18 street) which was analysed in the previous chapter. The building 1 and 2 will be a proof of concept universalism and their plans are attached in appendix 5.

The detailed information about iterations of the design process can be found on page 168.

APARTMENT ALGORITHM

The contemporary apartments layouts are not only too small but they are often not optimized in terms of existing needs of inhabitants. Therefore the buildings need to be analysed in terms of how many people live in existing building in order to adjust them to the reality and standards.

The algorithm indicates steps of resizing apartments. **The goal is to achieve at least 25 m^2/ person, preferably 30 m^2/person**

There are 3 strategies that shows how to enlarge or optimize the layout of apartments. Except resizing them there are additionally some common principles and assumptions for all arrangements like:

- Couples don't sleep in the living rooms like it was assumed in the original apartments and they have provided own bedroom. The exceptions are the apartments for only 1 person
- The kitchen is combined together with living room in order to save space
- WC and bathroom are combined together in order to optimize space

The strategies will be shown on example apartment that was initially provided for **4 persons and includes 2 bedrooms, seperate kitchen, hall**, bathroom, WC, living room (which is also a bedroom for parents) and a balcony.

APARTMENT 1

Ill.60: Apartment 1 - original plan. 1:100

STRATEGY I

Case

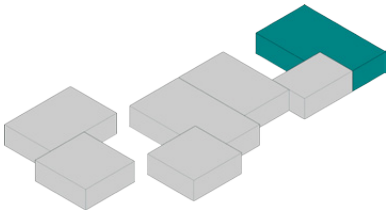
Usually the tendency is that nowadays in such apartment live less than 4 persons (e.g. 2 persons - old marriage) but the layout of the apartment remains the same as the original. It means that in fact **the dwellings meets the norm** but the plan is not optimized as there are additional, none-used rooms that takes space from the others.

Example

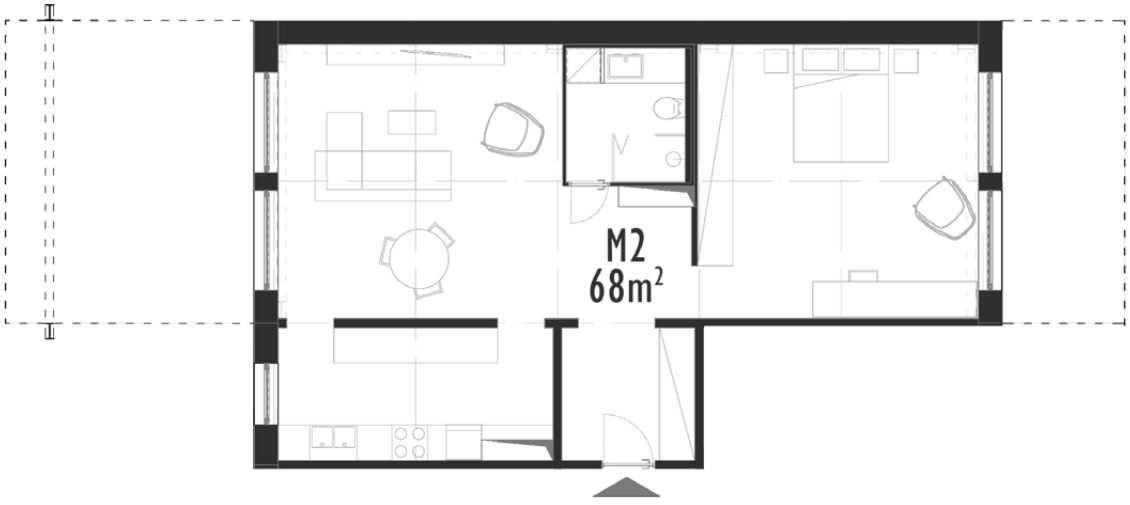
Originally	**M4**	
Area	**67 m²**	
Number of residents	**2 persons**	
Area/person	**33,5 m²**	**FULFILLED STANDARD**

Solution

Removing partition walls where needed in order to combine non-used rooms with the other ones.



APARTMENT 1



Ill.61: Apartment 1- strategy I. 1:100

After renovation	M2	
Area	67 m²	
Number of residents	2 persons	
Area/person	33,5 m²	FULFILLED STANDARD

STRATEGY II

Case

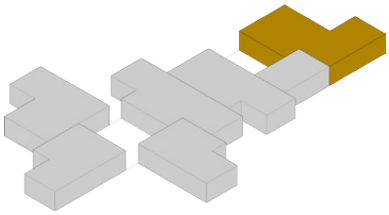
When in the apartment lives more people and the area/person doesn't meet the norm **but the lacking area is not much.**

Example

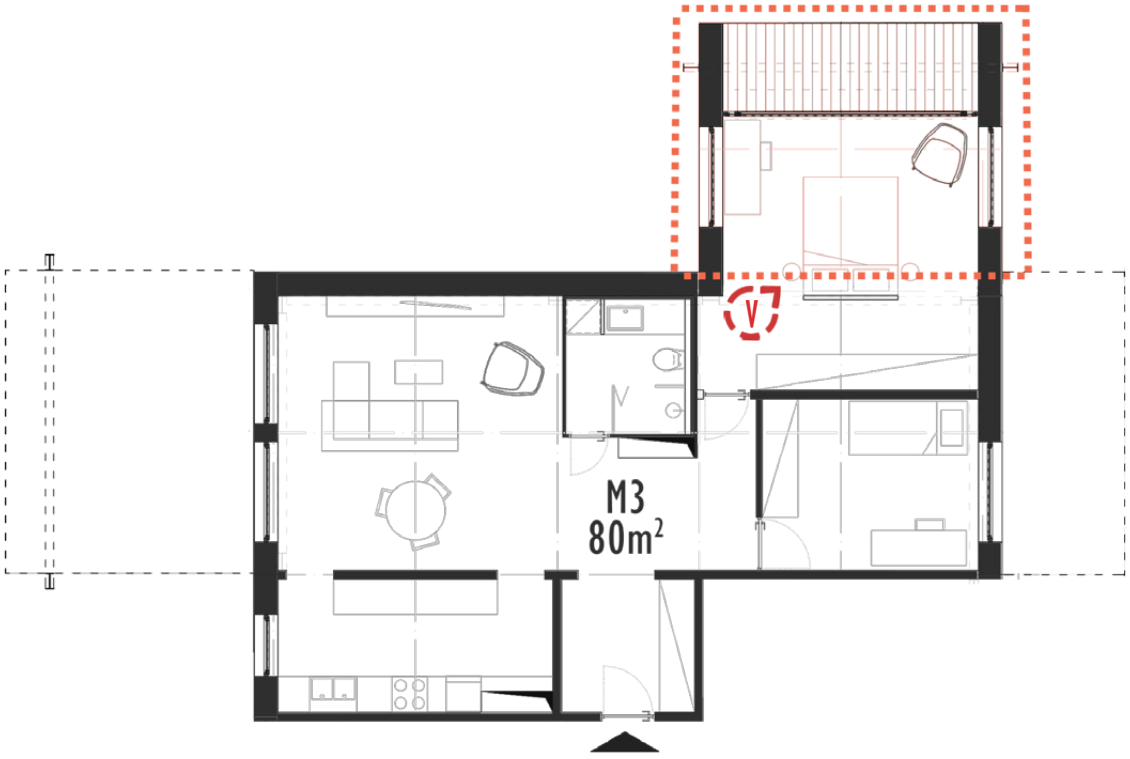
Originally	**M4**	
Area	**67 m²**	
Number of residents	**3 persons**	
Area/person	**22 m²**	**UNFULFILLED STANDARD**
Missing area	**7 m²**	

Solution

Adding the lacking additional space to the apartment with ***EXTERNAL UNITS*** in order to meet the norm + solutions from the ***strategy 1.***



APARTMENT I



Ill.62: Apartment 1 - strategy I. 1:100

- Visualization position

After renovation	M3	
Area	80 m²	
Number of residents	3 persons	
Area/person	26,7 m²	FULFILLED STANDARD

STRATEGY III

Case

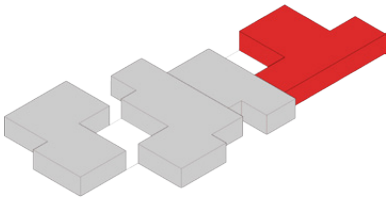
When in the apartment lives the number of persons that the apartment was provided for and **the lacking area is large.**

Example

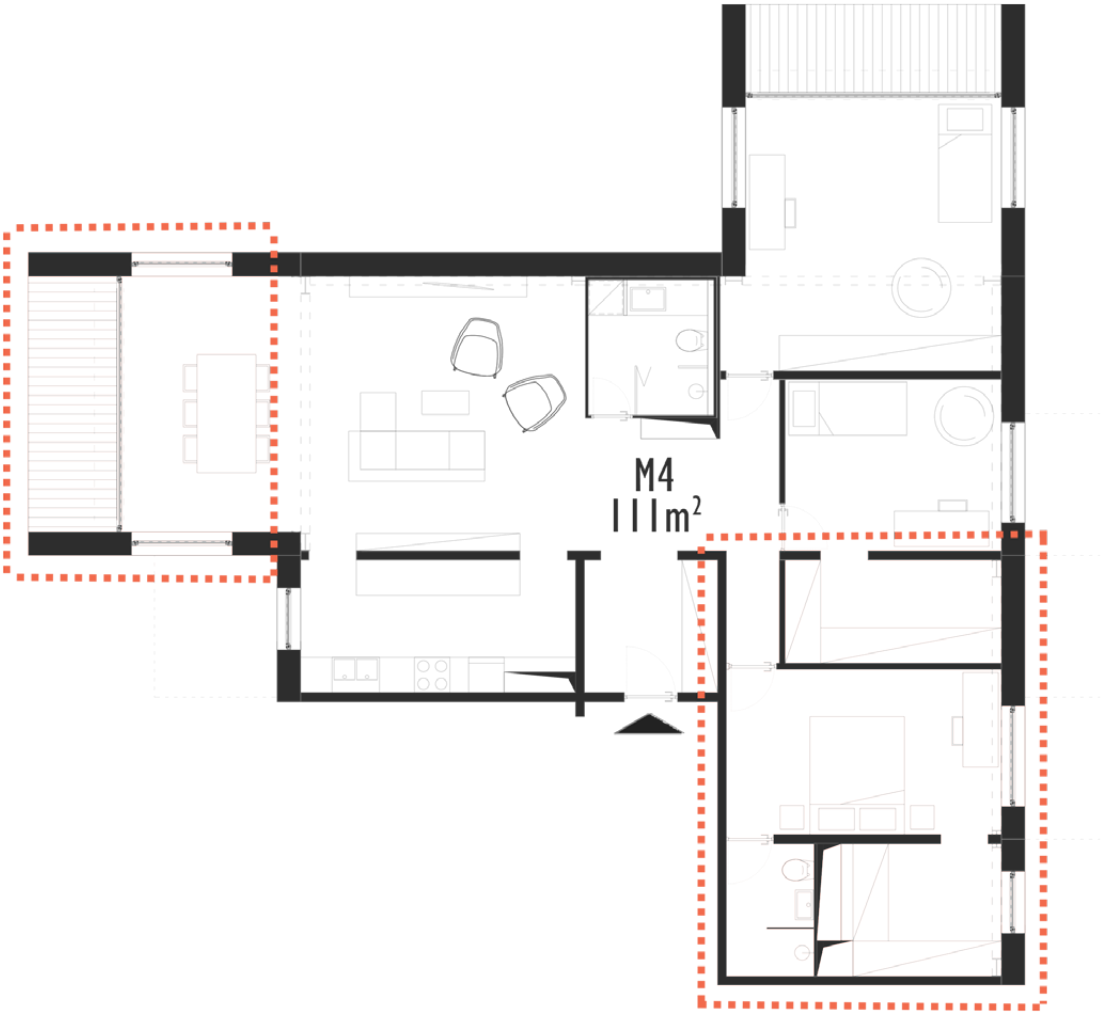
Originally	M4	
Area	67 m^2	
Number of residents	4 persons	
Area/person	18 m^2	UNFULFILLED STANDARD
Missing area	32 m^2	

Solution

Combining the apartment with another one in order to meet the norm + solutions from the ***strategy no 1***. + adding the missing additional space from ***strategy no 2***. if needed.



APARTMENT 1

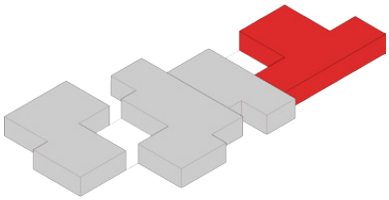


Ill.63: Apartment 1 - strategy III. 1:100

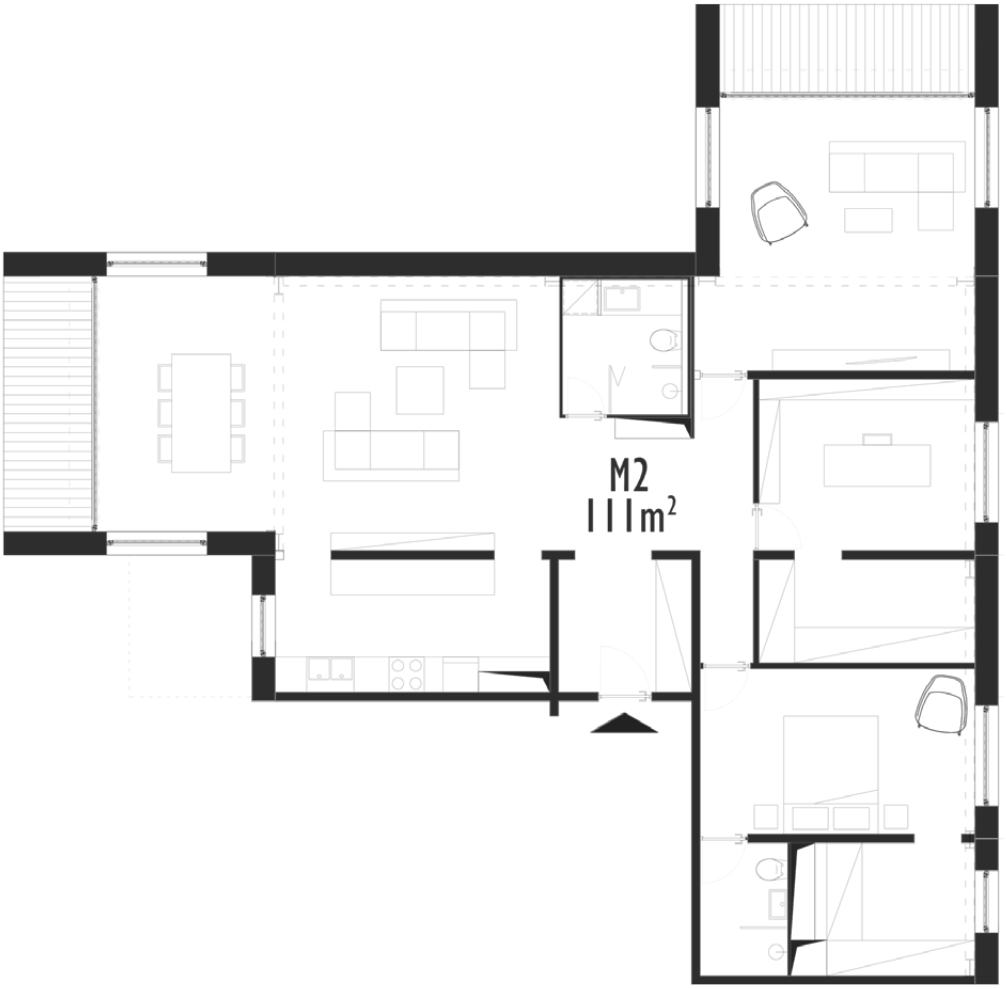
After renovation	M4	
Area	111 m²	
Number of residents	4 persons	
Area/person	27,8 m²	FULFILLED STANDARD

VARIATION OF STRATEGY III

The possibilities of changing room functions in case of decreasing the amount of inhabitants (for example when children move out). The bedrooms changes into an office and a tv room.



APARTMENT 1



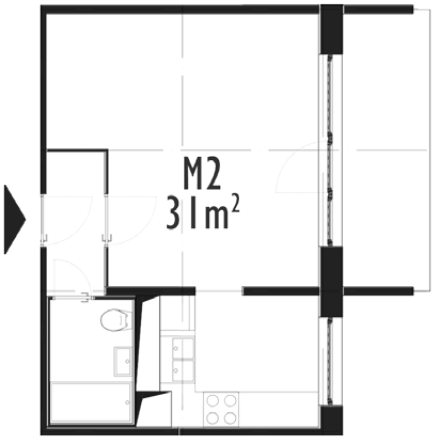
Ill.64: Apartment 1- variation of strategy III. 1:100

After years	M2	
Area	111 m²	
Number of residents	2 persons	
Area/person	55,5 m²	FULFILLED STANDARD

Ill.65: *Visualization - apartment 1*

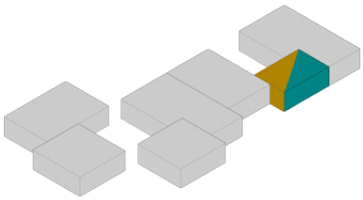
APARTMENT 2

ORIGINAL

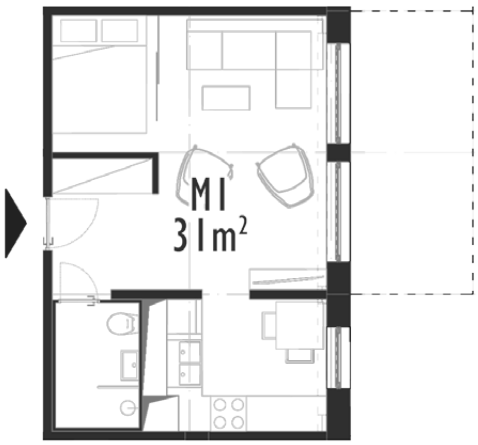


Ill.66: Apartment 2 - original plan. 1:100

	Type of apartment (number of users)	Area [m²]	Area/person [m²]
Original	M2	31,06 m²	15,51 m²
Strategy I&II	M1	31,06 m²	31,06 m²
Strategy III	merged with another apartment		



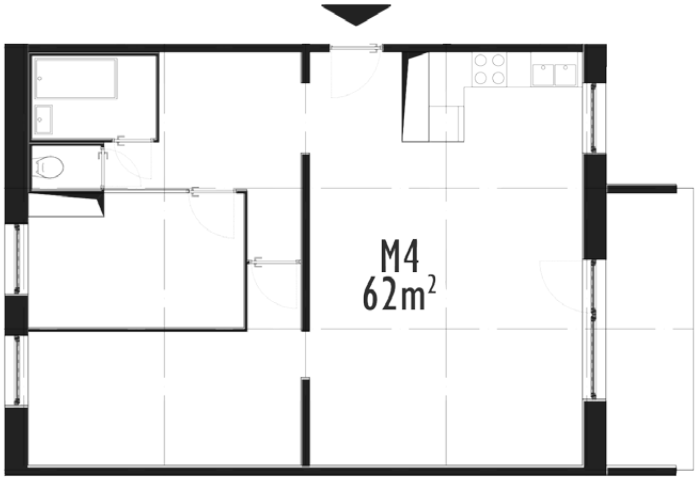
STRATEGY I & II



Ill.67: *Apartment 2 - strategy I & II. 1:100*

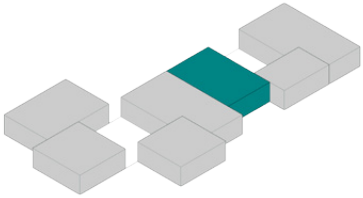
APARTMENT 3

ORIGINAL

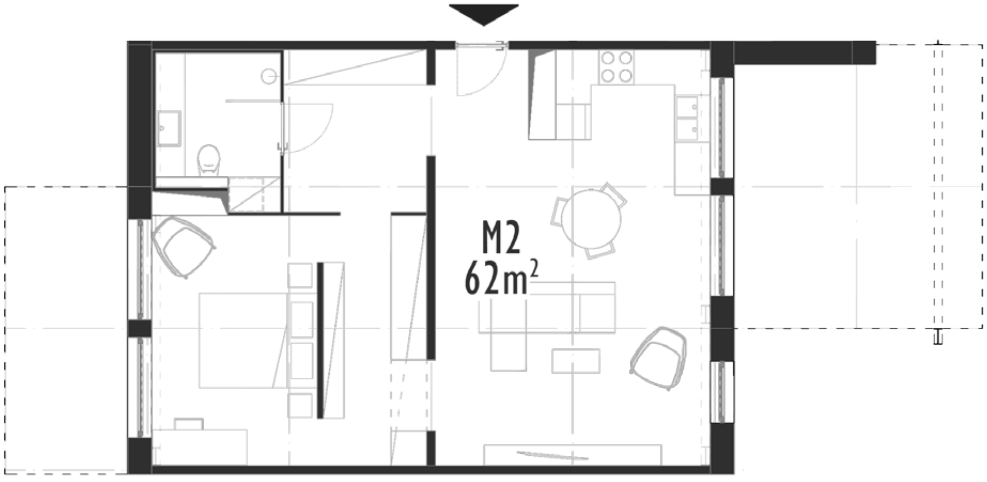


Ill.68: Apartment 3 - original plan. 1:100

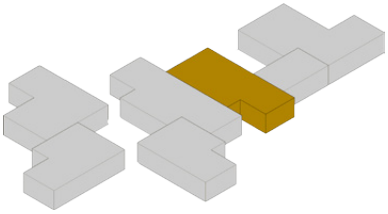
	Type of apartment (number of users)	Area [m²]	Area/person [m²]
Original	M4	62,51 m²	15,63 m²
Strategy I	M2	62,51 m²	31,26 m²
Strategy II	M3	75,50 m²	25,17 m²
Strategy III	M4	106,52 m²	26,63 m²



STRATEGY I

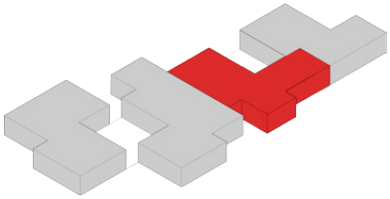


Ill.69: Apartment 3 - strategy I. 1:100

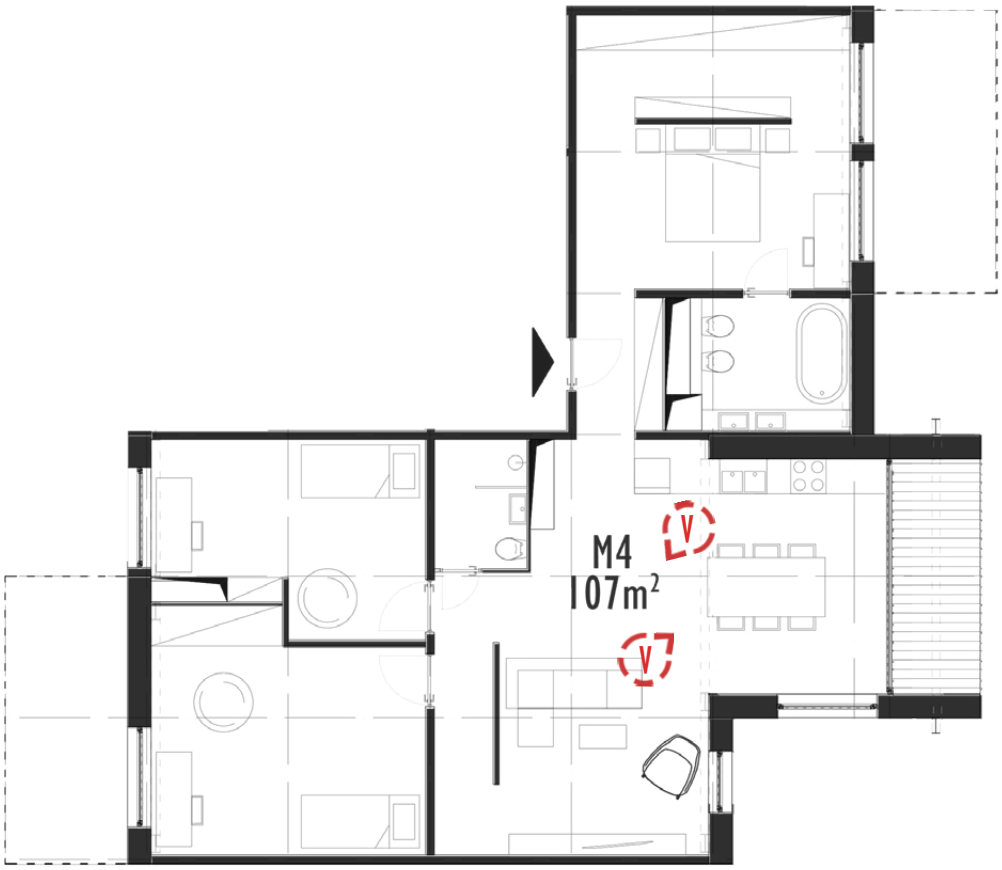


STRATEGY II

Ill.70: Apartment 3 - strategy II. 1:100



STRATEGY III



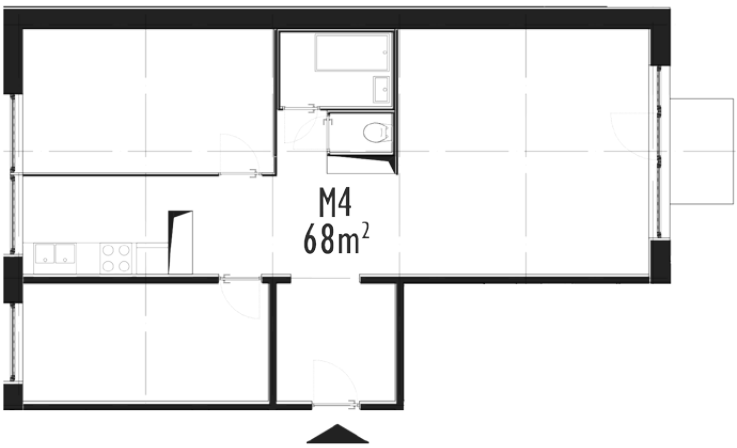
Ill.71: *Apartment 3 - strategy III. 1:100*

Ill.72: *Visualization - apartment 3*

Ill.73: *Visualization - apartment 3*

APARTMENT 4

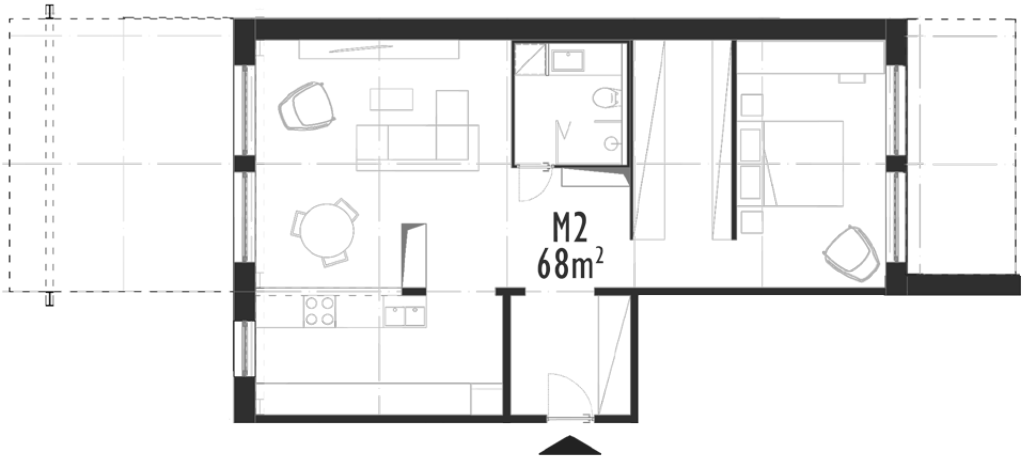
ORIGINAL



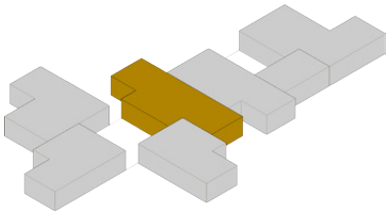
Ill.74: Apartment 4 - original plan. 1:100

	Type of apartment (number of users)	Area [m²]	Area/person [m²]
Original	M4	68,62 m²	17,16 m²
Strategy I	M2	68,62 m²	34,31 m²
Strategy II	M3	81,60 m²	27,21 m²
Strategy III	M4	141,62 m²	35,41 m²

STRATEGY I

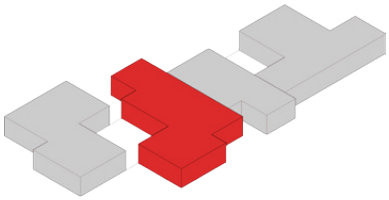


Ill.75: Apartment 4 - strategy I. 1:100



STRATEGY II

Ill.76: Apartment 4 - strategy II. 1:100

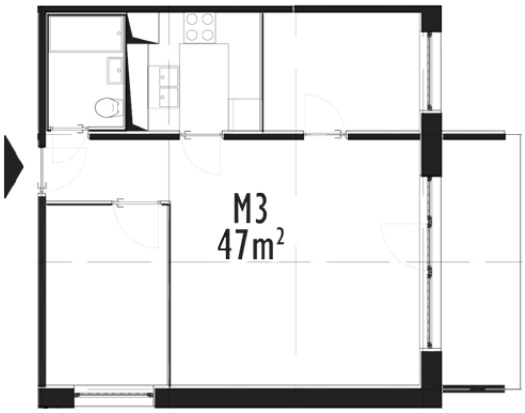


STRATEGY III

Ill.77: *Apartment 4 - strategy III. 1:100*

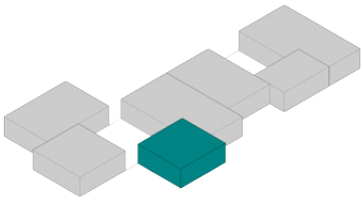
APARTMENT 5

ORIGINAL

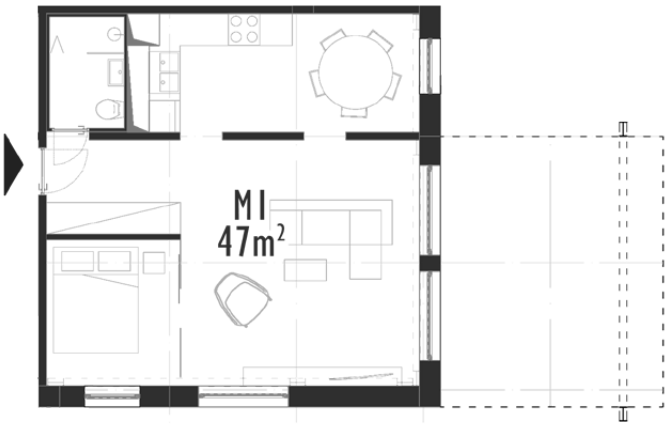


Ill.78: Apartment 5 - original plan. 1:100

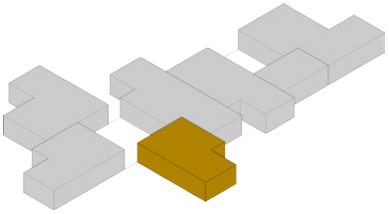
	Type of apartment (number of users)	Area [m²]	Area/person [m²]
Original	M3	47,00 m²	15,67 m²
Strategy I	M1	47,00 m²	47,00 m²
Strategy II	M2	60,00 m²	30,00 m²
Strategy III	merged with another apartment		



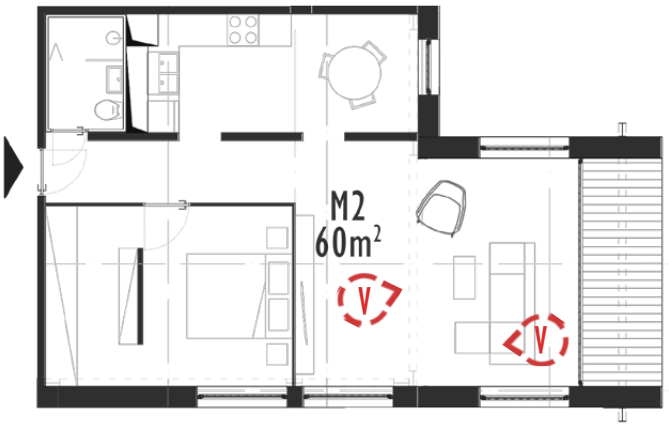
STRATEGY 1



Ill.79: Apartment 5 - strategy 1. 1:100



STRATEGY II



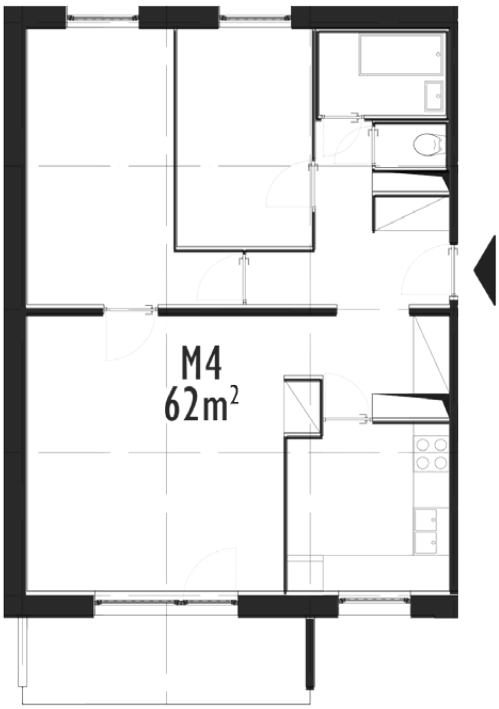
Ill.80: *Apartment 5 - strategy II. 1:100*

Ill.81: Visualization - apartment 5

Ill.82: *Visualization - apartment 5*

APARTMENT 6

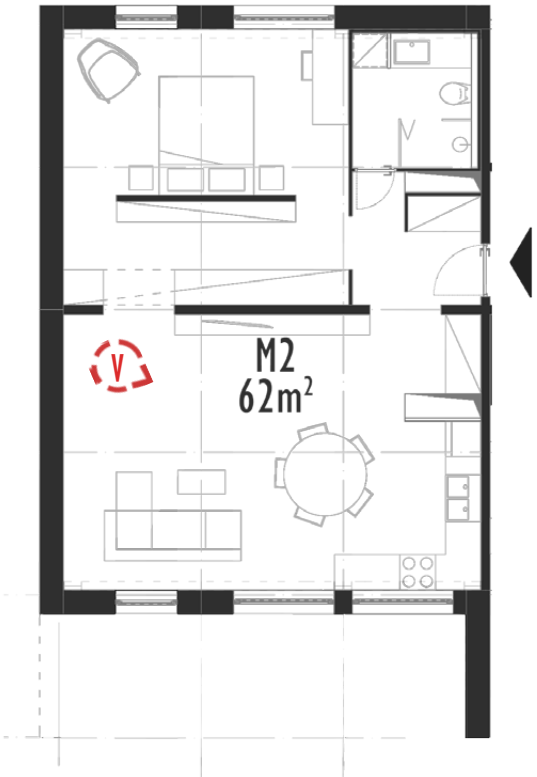
ORIGINAL



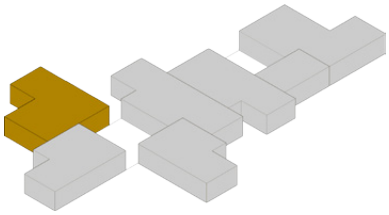
Ill.83: Apartment 6 - original plan. 1:100

	Type of apartment (number of users)	Area [m²]	Area/person [m²]
Original	M4	62,60 m²	15,65 m²
Strategy 1	M2	62,60 m²	31,30 m²
Strategy 2	M3	75,60 m²	25,20 m²
Strategy 3	M4	135,60 m²	33,90 m²

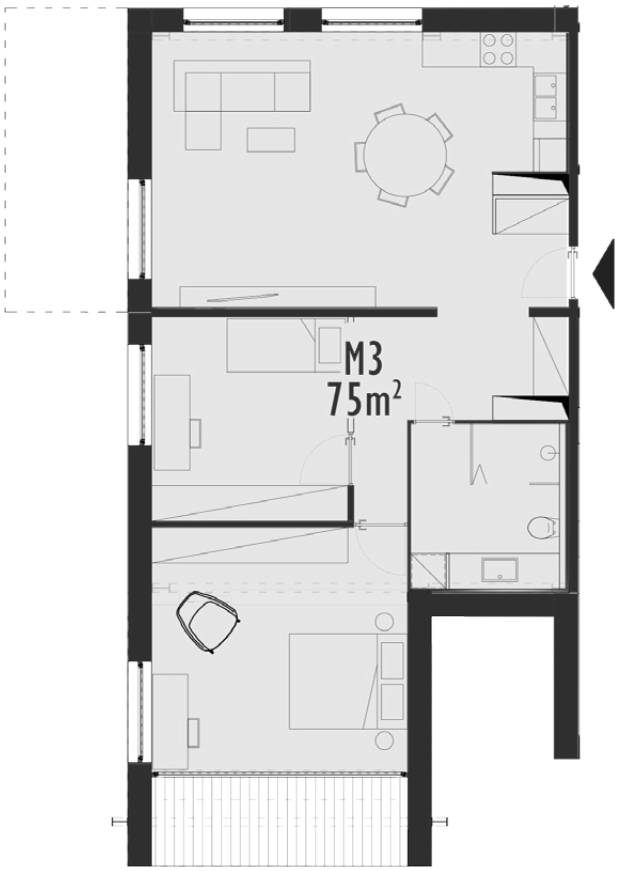
STRATEGY I



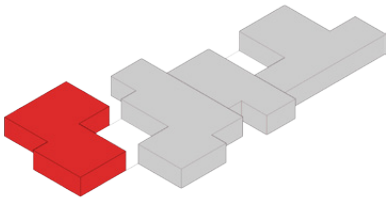
Ill.84: Apartment 6 - strategy I. 1:100



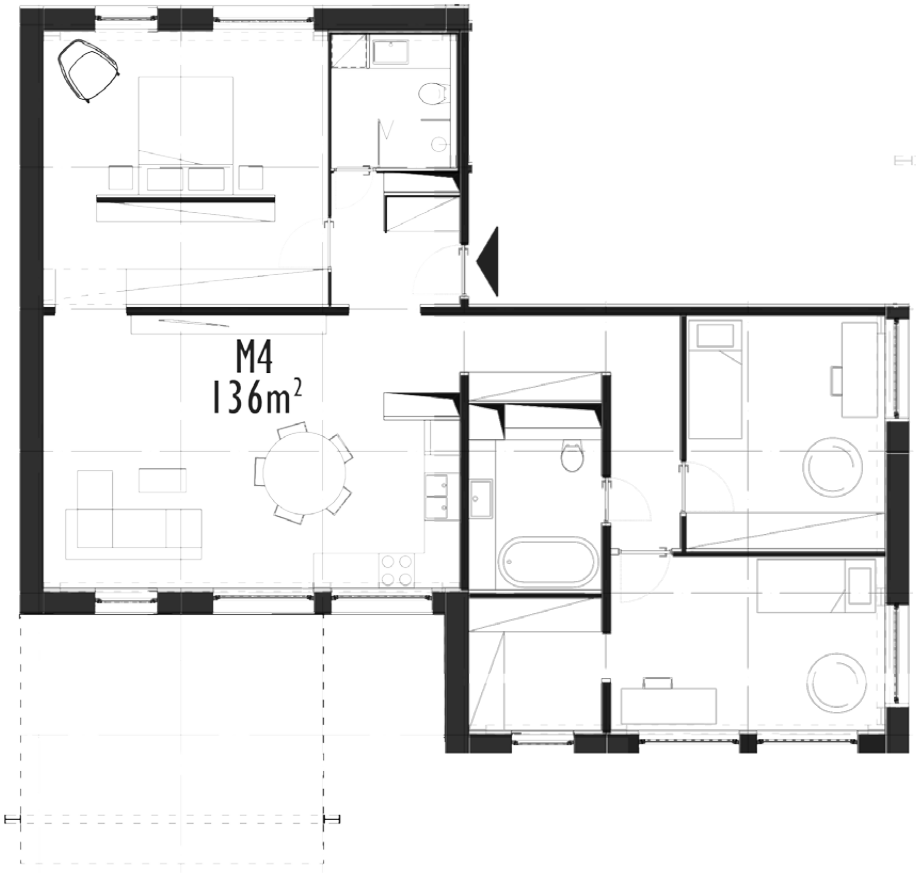
STRATEGY II



Ill.85: Apartment 6 - strategy II. 1:100



STRATEGY III

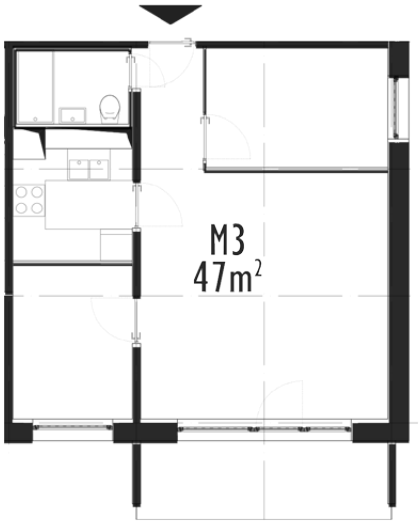


Ill.86: Apartment 6 - strategy III. 1:100

Ill.87: *Visualization - apartment 6*

APARTMENT 7

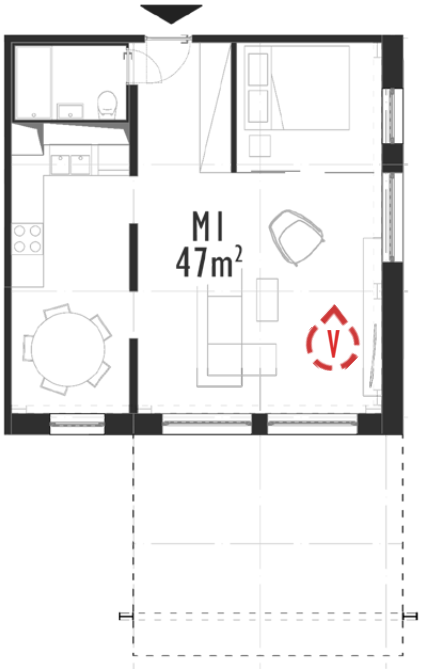
ORIGINAL



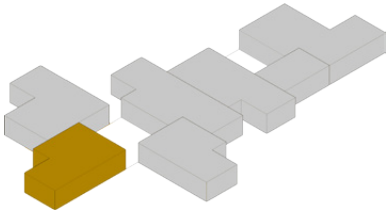
Ill.88: Apartment 7 - original plan. 1:100

	Type of apartment (number of users)	Area [m²]	Area/person [m²]
Original	M3	47,00 m²	15,67 m²
Strategy 1	M1	47,00 m²	47,00 m²
Strategy 2	M2	60,00 m²	30,00 m²
Strategy 3	merged with another apartment		

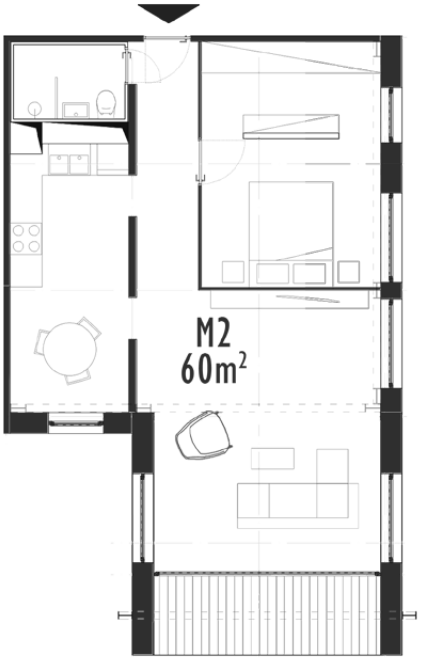
STRATEGY I



Ill.89: *Apartment 7 - strategy I. 1:100*



STRATEGY II



Ill.90: *Apartment 7 - strategy II. 1:100*

Ill.91: Visualization - apartment 7

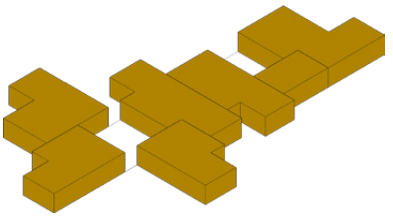
GROUND FLOOR

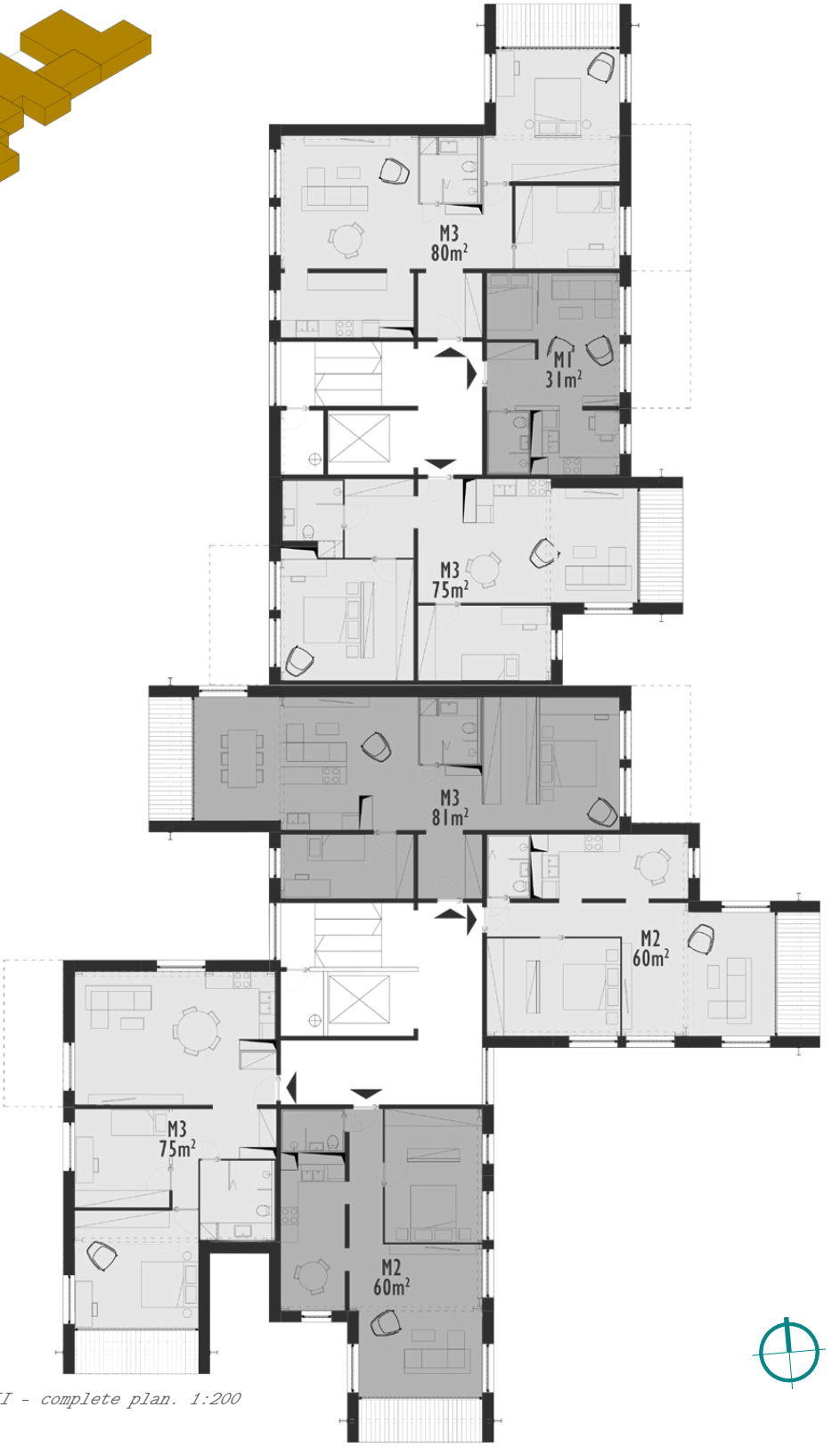
Ill.92: Ground floor. 1:200

STRATEGY I

Ill.93: Strategy I - Complete plan. 1:200

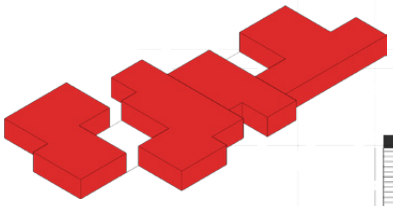
STRATEGY II





Ill.94: Strategy II - complete plan. 1:200

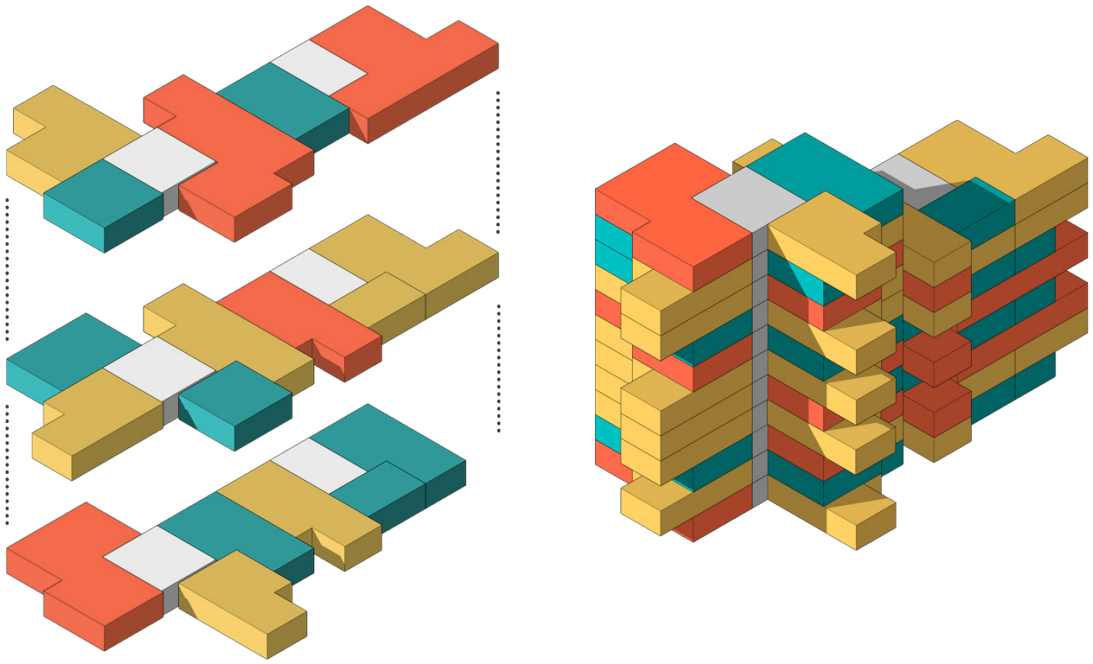
STRATEGY III



Ill.95: Strategy III - Complete plan. 1:200

BUILDING COMPOSITION

The strategies are applied apartment by apartment so in the result every single floor has its own unique flexible layout which is actually based on inhabitant needs. In the result every building that will be carried out with this method, is going to look different from outside.

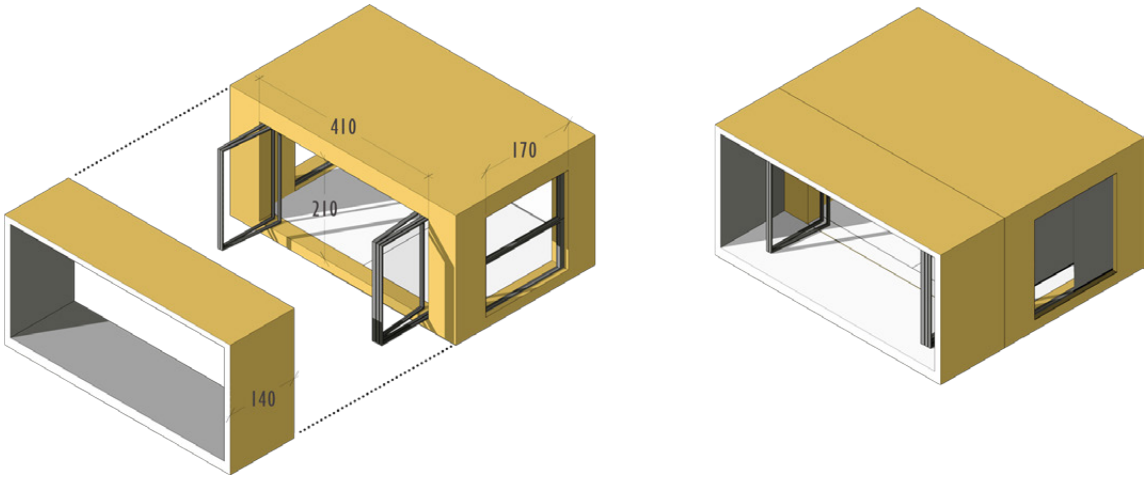


Ill.96: Building composition

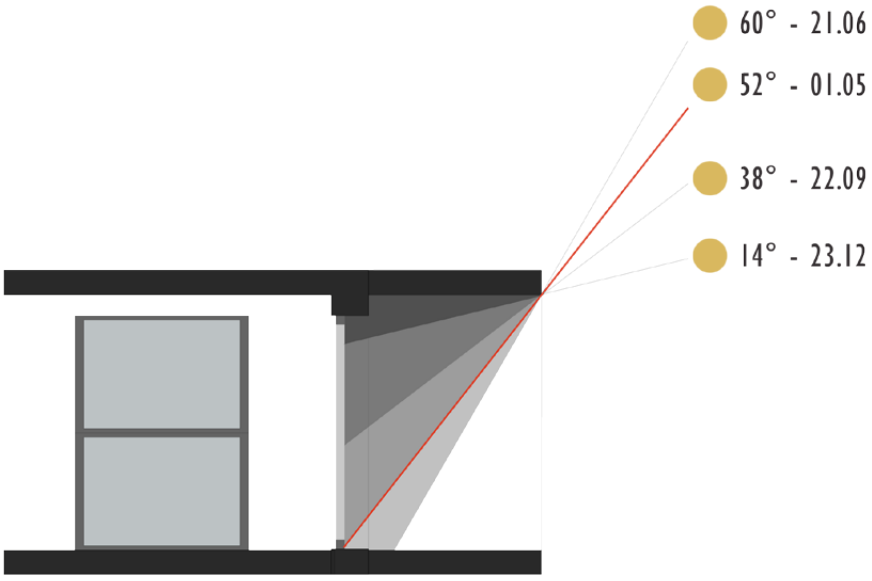
EXTERNAL UNITS

External units are additional spaces that enables enlarging apartments in strategy II/III. They are consist of 13m^2 of additional usable area, panorama folding windows with reduced heat transmittance, side windows with external (hidden above a window) and small balcony which is also an overhang for overheating prevention. The depth of the overhang is 140 cm and is adjusted to cover entirely the front windows with shadow on 01.05. It allows to have a shading during hot summer and to gain passive heating during winter (see Ill.98). The detailed design process of the overhang is described on page 175.

The balcony can also be used as an extension for the unit which in connection with opened windows in fact will transform the existing room into a huge terrace.

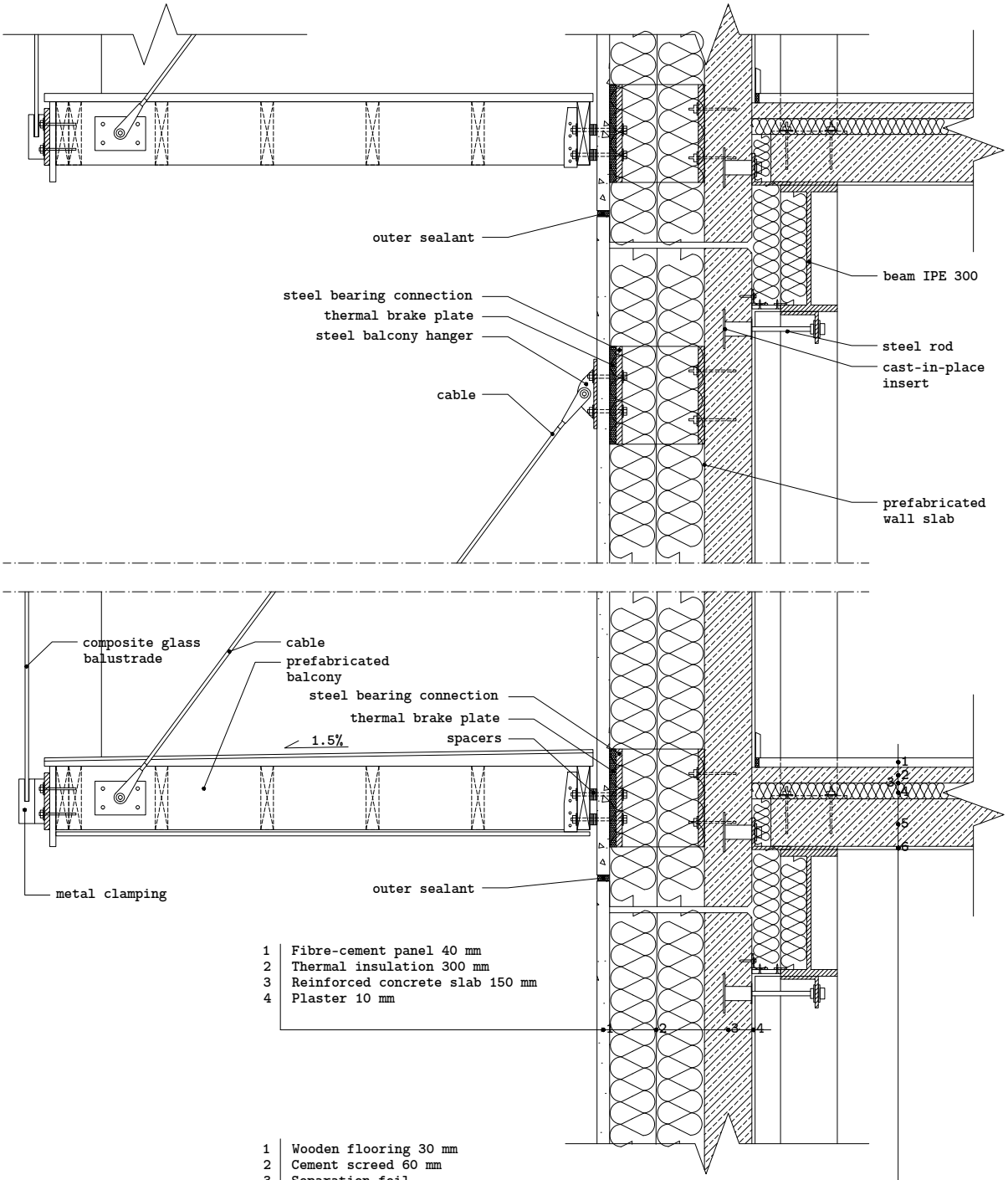


Ill.97: *External unit scheme*



Ill.98: *External unit shading*

DETAIL 1: SUSPENDED BALCONY

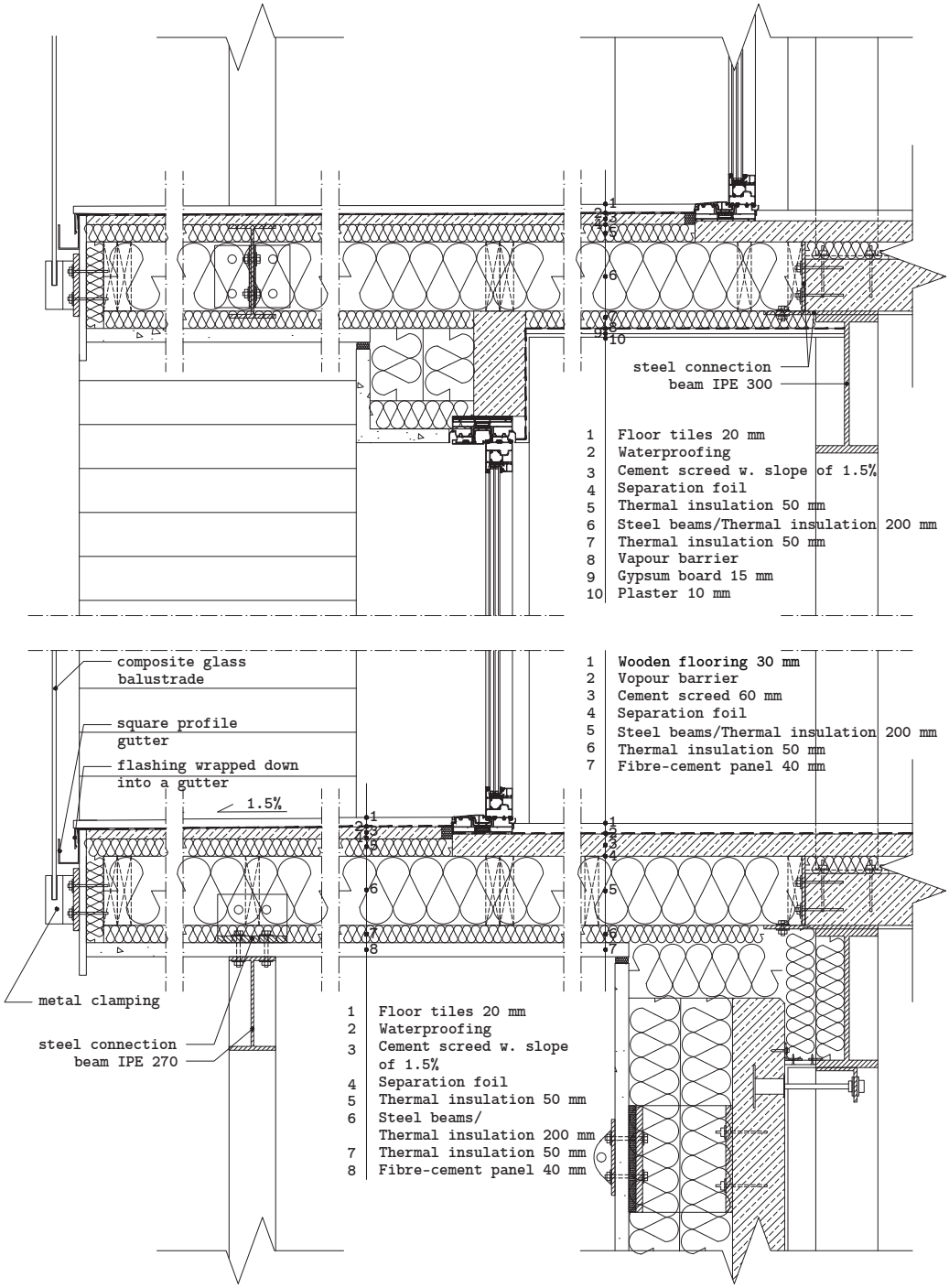


1	Fibre-cement panel 40 mm
2	Thermal insulation 300 mm
3	Reinforced concrete slab 150 mm
4	Plaster 10 mm

1	Wooden flooring 30 mm
2	Cement screed 60 mm
3	Separation foil
4	Acoustic insulation 50 mm
5	Reinforced concrete slab 150 mm
6	Plaster 10 mm

Ill.99: Detail 1: Suspended balcony. 1:20

DETAIL 2: EXTERNAL UNIT



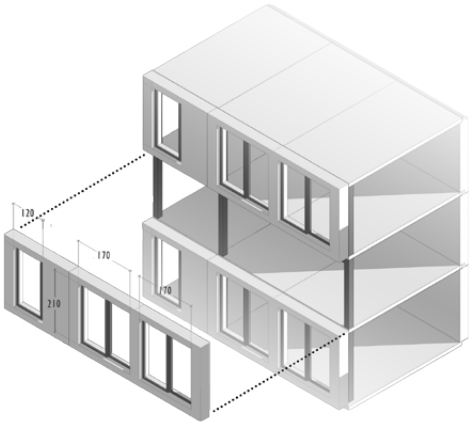
Ill.100: Detail 2: External unit. 1:20

SLAB REPLACEMENT

As it was mentioned in previous chapters, the external insulation in existing building, which was added during thermo modernization is starting to be a problem as it peels off the façade and cracks. Also the existing original external wall slabs are very leaky as their production quality is poor. They don't apply for any renovation so they should be replaced.

The new slabs are consist of 15 cm of concrete, 30 cm of mineral wool and cover layer which is 4 cm fiber-cement panel. The U-value for the new external wall is 0.11 W/m^{2}K, so it has been significantly improved compared to the previous one which was 0.3 W/m^{2}K.

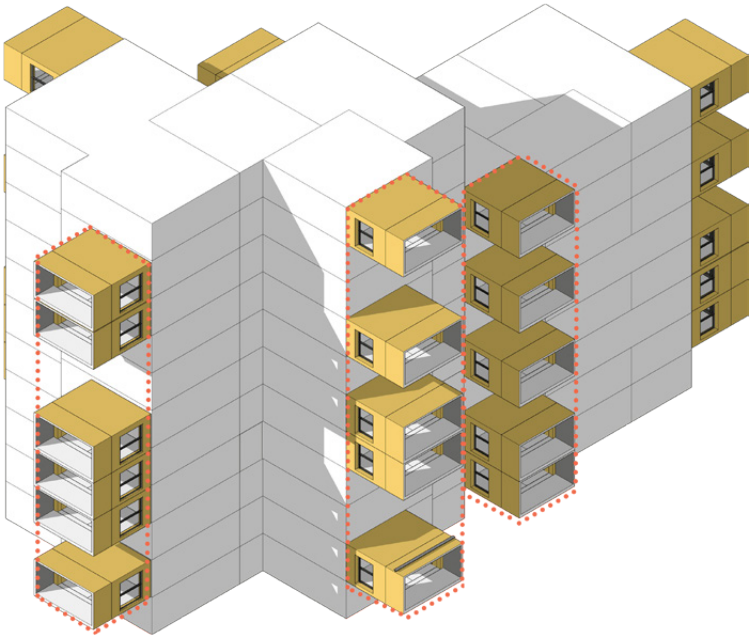
The window openings are enlarged to the floor compared to the old ones in order to improve the daylight conditions. Their dimensions are 170x210 [cm] and 120x210 [cm]. The U-value for the new windows are 0.7 W/m^{2}K.



Ill.101: Slab replacement scheme

UNIT STACKS

The units are not assumed to be on each floor and their existence is a result of implemented strategies from initial analysis of needs. In the result they form a vertical ‘‘stack’’ which is irregular and they must be supported with steel frames.



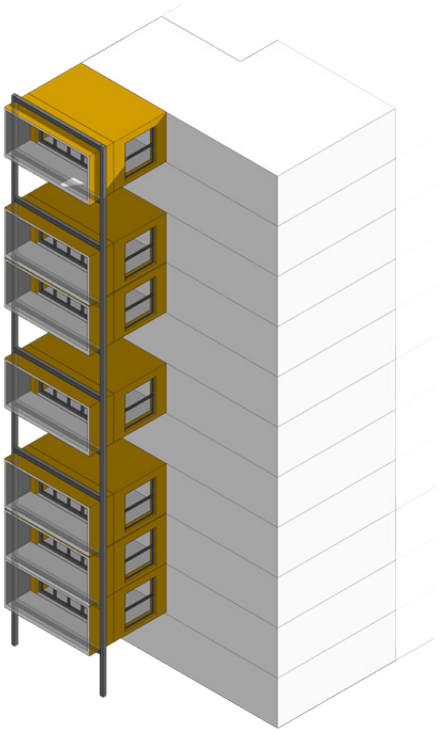
Ill.102: Unit stacks scheme

STEEL FRAMES IMPLEMENTATION

External steel frame

The external steel frame is attached in order to provide a possibility to assemble the external units. Each external unit is supported with a hidden IPE 270 beam that is a part of the whole frame structure. The exceptions are beams that are in extreme units of the ''stack'' - the lowest unit is supported from below with revealed beam. The similar beam goes above the unit at the highest one of a ''stack'', but it is only provided for aesthetical purpose in order to give a perception of a frame that encircle the units.

The calculations of the beam can be found in *Appendix 4* on page 202.

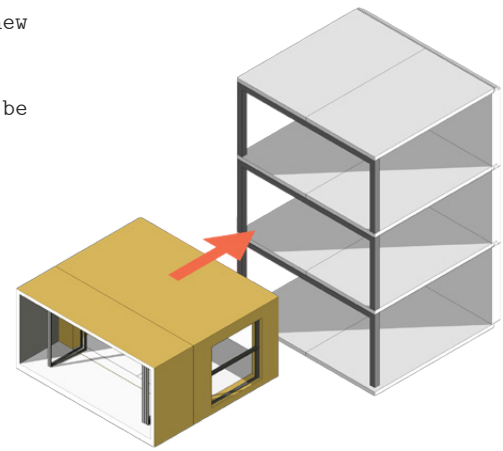


Ill.103: External steel frame scheme

Internal steel frame

The internal frame is provided for supporting not only external units but they are also a new load bearing structure for the building. Each steel frame is consist of IPE 300 beams that are revealed and can be seen from the interior. The internal steel frame is also a support for new cover slabs.

The calculations of the beam can be found in *Appendix 4* on page 202.



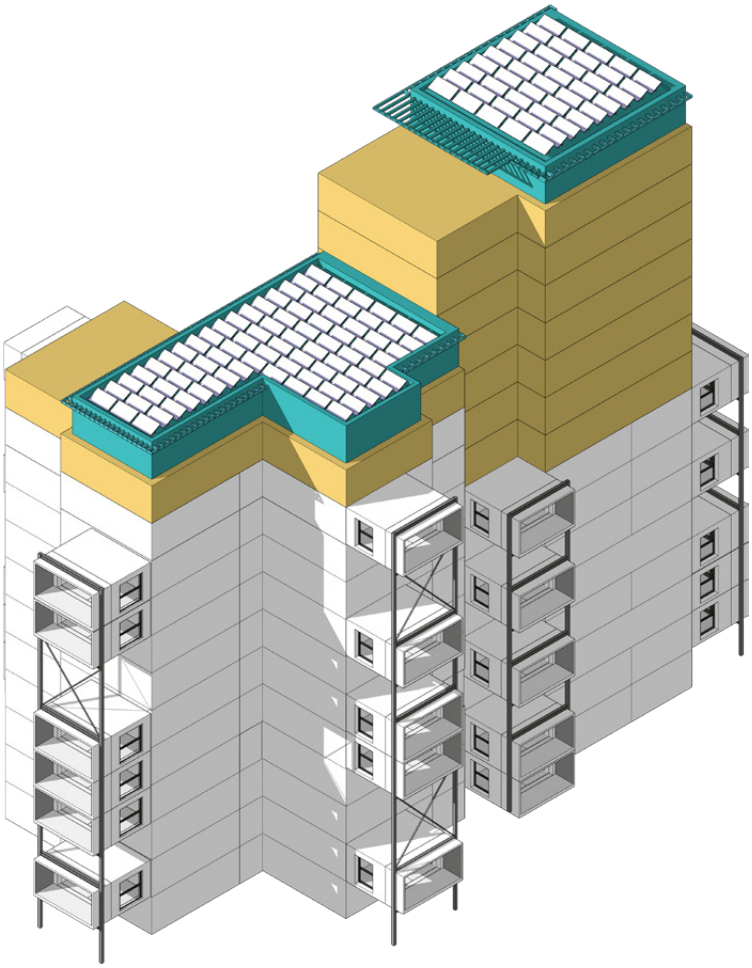
Ill.104: Internal steel frame scheme

ADDITIONAL LEVELS

The strategy 3 assumes combining apartments. It means that the family from one apartment have to move out in order to provide a new space for adjacent one. The families are relocated to the additional levels that are built on a roof where there are provided new apartments for them. The amount of the new levels is based on the initial need analysis, when the strategies for each apartment are determined.

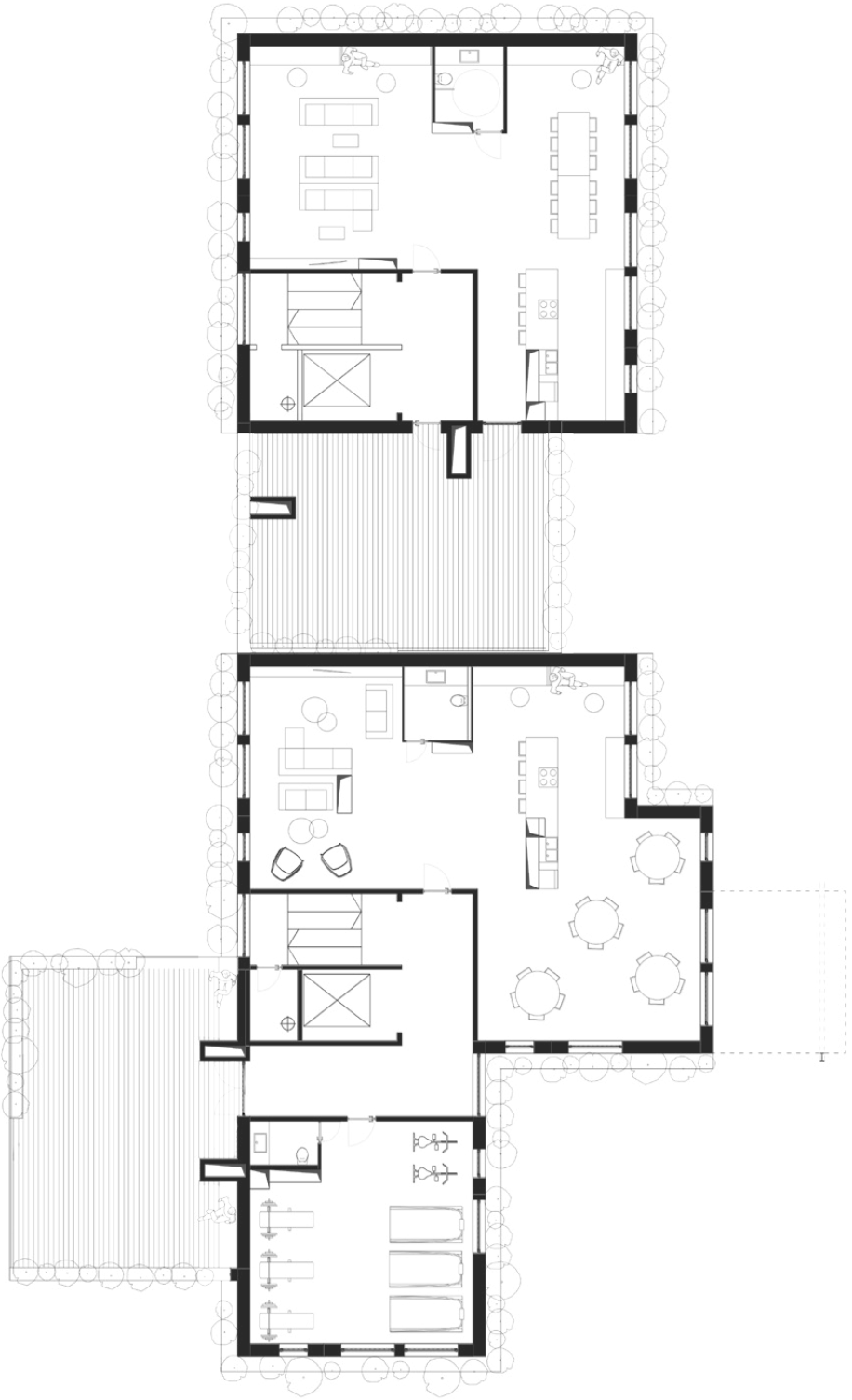
Last floor is always provided for common rooms with a terrace. They create a semi-private area for inhabitans, as such space is missing in the existing building, even though it was designed in the initial idea in 70's. The common room includes a lounge, kitchen, dining room, bathroom, and a relax space and is also offset 50 cm from façades in order to create a space for greenery that surrounds the last floor

The whole roof is used to provide PV panels in order to reduce the energy requirement.



Ill.105: *Additional levels scheme*

COMMON ROOMS



Ill.106: Common rooms. 1:200

ADDITIONAL APARTMENTS

Ill.107: Additional apartments. 1:200

NEW BALCONIES & TERRACES

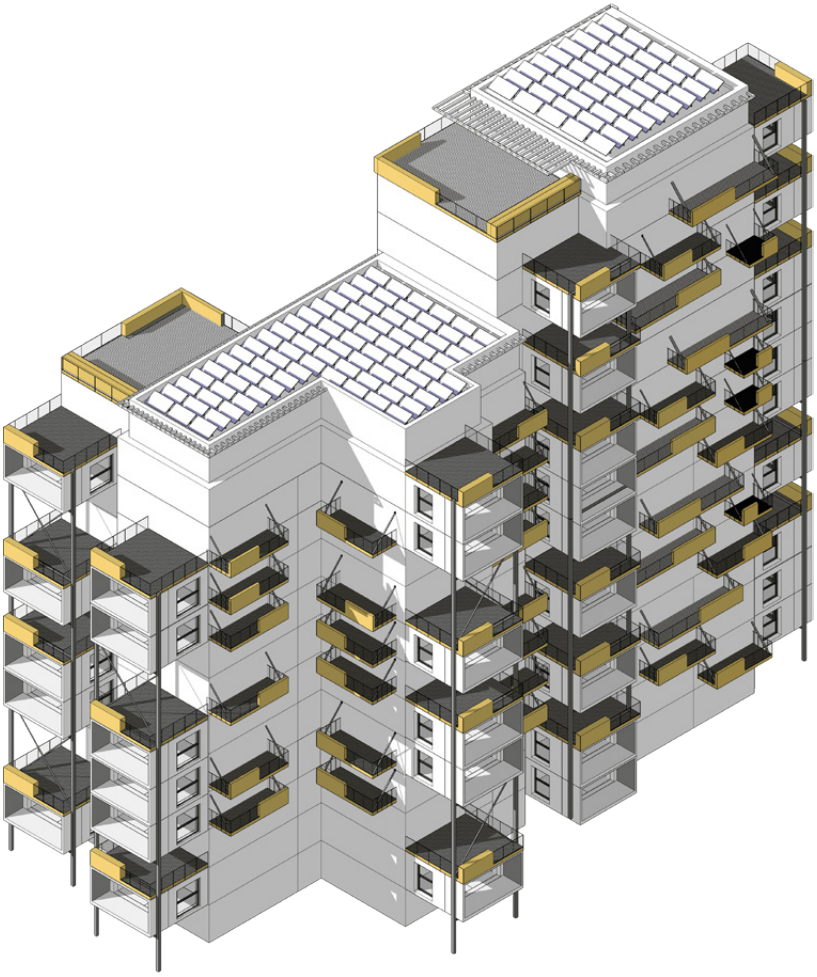
The concept is complemented with module balconies. Inhabitants are free to choose from designed ‘‘slots’’, if, where and how wide they want to have their balcony. In the result the façade is irregular what gives a different look to all buildings. All balconies are suspended and they consist of flowerpots with greenery which is a very important factor for the project as it is to be a dominant aspect of the facades.

The roof of external units were also found as a suitable space to provide large-area terraces for the apartments from strategy 1.

In the support of the balcony there is a thermal bridge. However there are used thermal brake plates that reduce the heat flow significantly and provide low thermal conductivity.(see detail on page 132)

The comparison of the thermal bridges:

Thermal conductivity of steel (without plate)	Thermal conductivity of the thermal brake plate
56 W/m*K	0.2 W/m*K



Ill.108: *New balconies and terraces scheme*

INDICATING SYSTEM

The concept contains an identification system.

Building identification

One of the settlements pros of panel buildings are huge spaces between buildings that contain greenery and park pavements between. However, a lot of these paths are considered as a full-fledged streets with its own name and address. It leads to a lot of misunderstandings in orientation, when the building stands right in front of the main street but the address is something totally different. Exactly such situation we can observe on the site and the neighbourhood, where the building is located just next to the main Surowieckiego street, but the address is Puszczyka 18. This is not only annoying but also dangerous - especially during emergency situation when the fast intervention is critical.

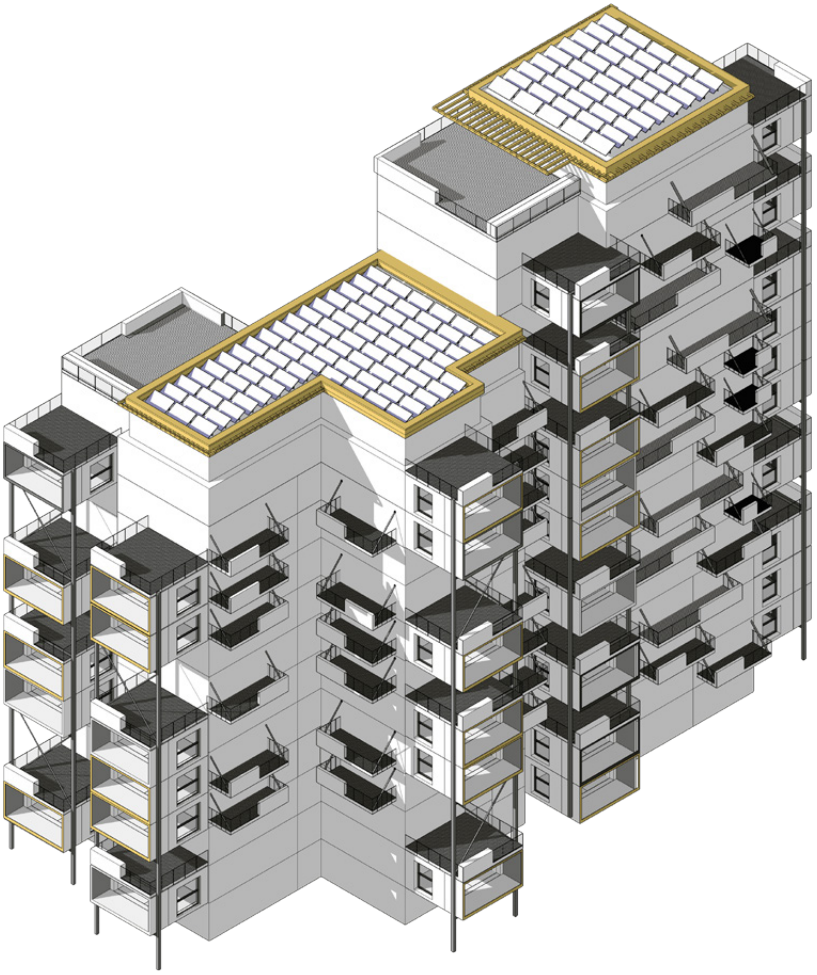
‘‘We need an ambulance on Puszczyka street - red building’’

The idea is to assign a colour to the building as a main theme which will be unique in the neighbourhood. It will not only help and improve fast recognizing system, but will also be in some measure an architectural translation of the society demand of having colourful buildings. The demand that was created spontaneously in 90’s-2000’s from the bottom up, in the form of the weird pastel colours. The main colour occurs at the front of external units, but also on attic and pergolas that encircle the top floor. The pergolas fits well with the greenery and enhance the garden look to the building.

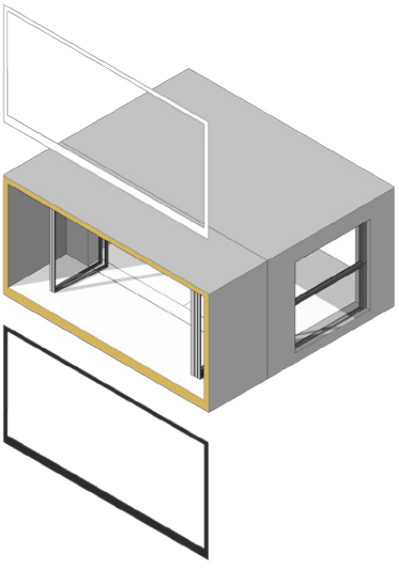
Apartment identification

One of the other problems of the existing buildings is incoherent look of the balconies (see Ill.10 on page 25). It is a result of identification need of people that want to indicate the individual look of their balcony.

The answer for that need is to take control of it and to provide people a possibility to choose a colour of the external unit front. They can choose from 3 colours: the main theme colour, white or black. The option with a choice of more colours can be seen in a chapter *Alternative solutions* on page 180.



Ill.109: *Building identification*



Ill.110: *Apartment identification*

MATERIALS

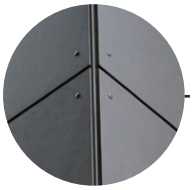
Although, during the design process there is always an accompanying image of the building's envelope and its texture, there are multiple conditions that have to be fulfilled to choose the proper material. Besides durability, ease in maintenance or environmental friendliness, which can be common for each building there are also factors of adaptation to the local architecture, fitting in the neighborhood, users' association and a price, which will differ according to the building location and the owners' budget for renovation. This is why, when creating the global guideline for revitalization, it is impossible to choose the right material applicable to each panel building. As the different communities have different financial condition, they should choose the most suitable façade material by themselves. However, the latest Polish history shows, that this solution results with huge urban chaos, colored with various pastel patterns, it is necessary to provide the guideline stating the most important qualities that needs to be fulfilled.

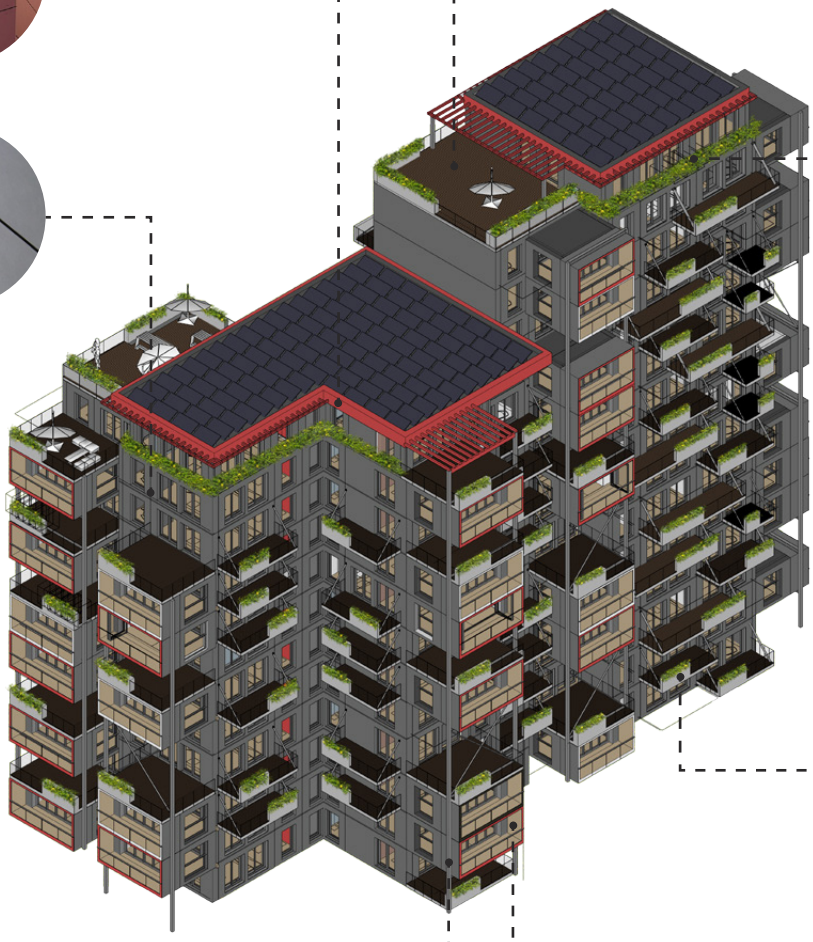
First of all, panel buildings were initially designed plain as being a background for everyday life and this impression needs to be preserved. This is why the dominating colours should be white or from a scale of grey. The exception can be made for materials which usually have its own patterns as wood, stone, brick or concrete. To reflect their honesty, such materials should stay in their original pattern and tint.

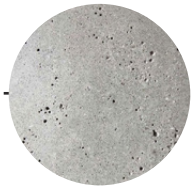
Although the buildings can now differ between each other, to maintain the overall coherence of the districts, some smaller details should stay the same. The internal finishing of the additional units, when cladded with wood can give the impression of warmth independently from material used as a main cover. Moreover, the balconies should all have glazed balustrade with a solid part containing a flower pot in a contrasting color.

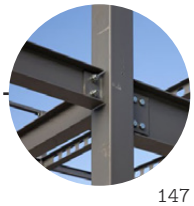
As a proposal of the façade in this project, the dark grey fiber-cement panels are used to cover the main part of the building. As the material is plain it gives a perfect background for the local greenery, and by creating visible grid pattern on the façade it prevents from painting it later in an uncontrolled manner. What is more, it's easy in maintenance and light, so does not create an excessive load for the structure.

Nevertheless, besides the form of the designed building, the façade materials have one of the biggest impacts on the reception of the building, its surroundings and in further perspective - the whole cities. This is why the choice of the proper material should always be a responsibility of an architect, and not what happens sometimes -an unqualified activist of the municipal board. This privilege should be also guaranteed by a certain legislation rules.

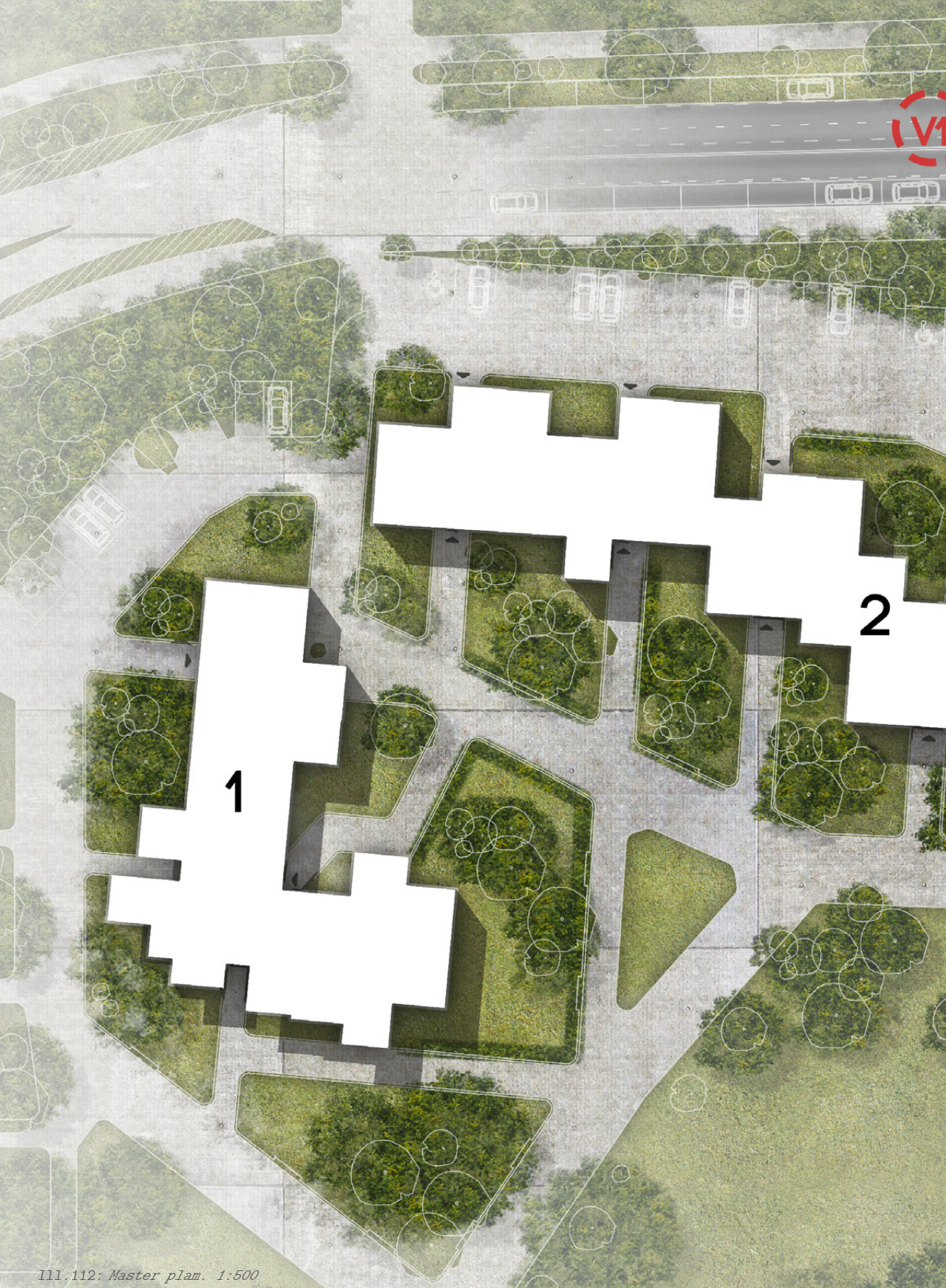




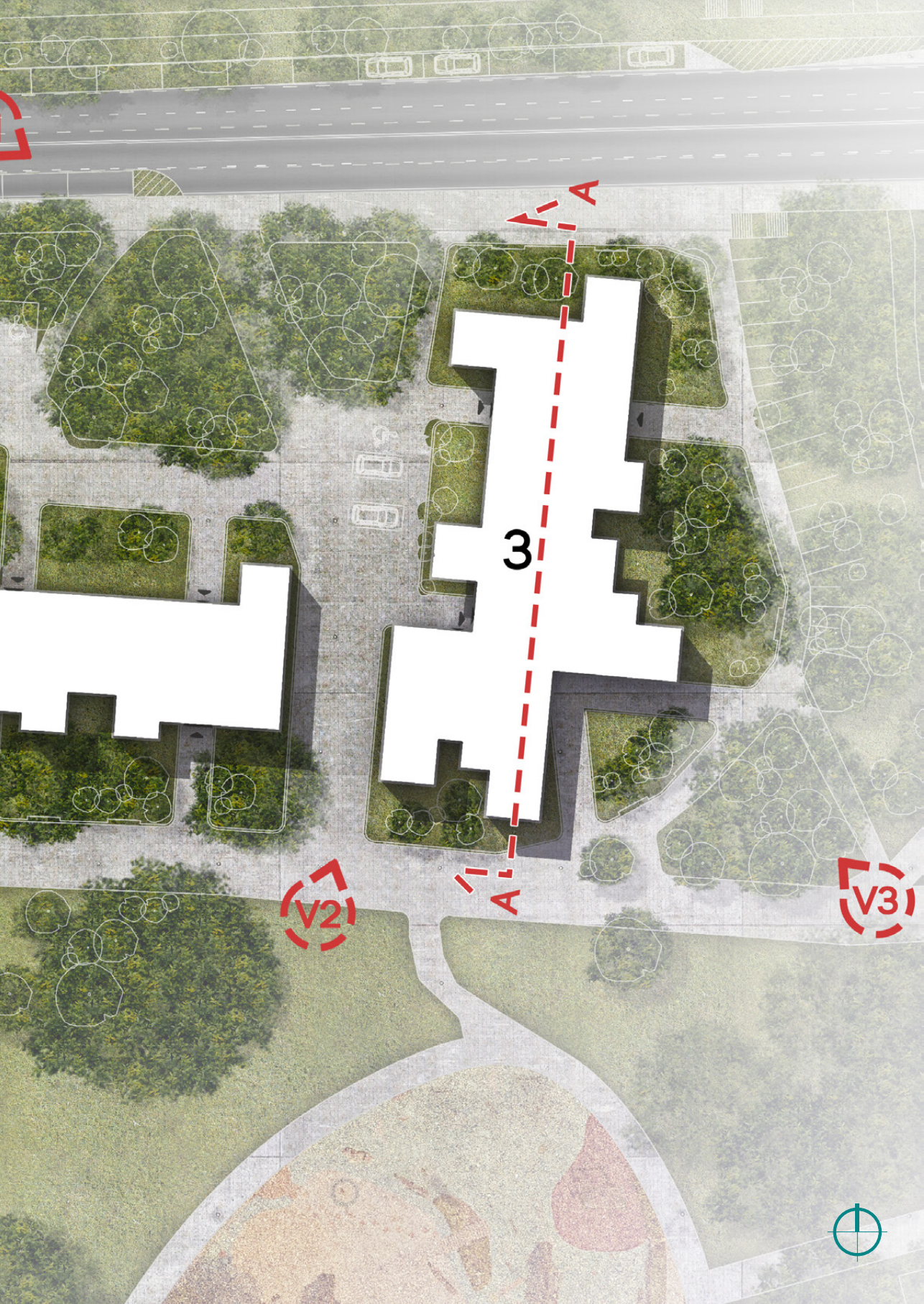




Ill.111: Noise map



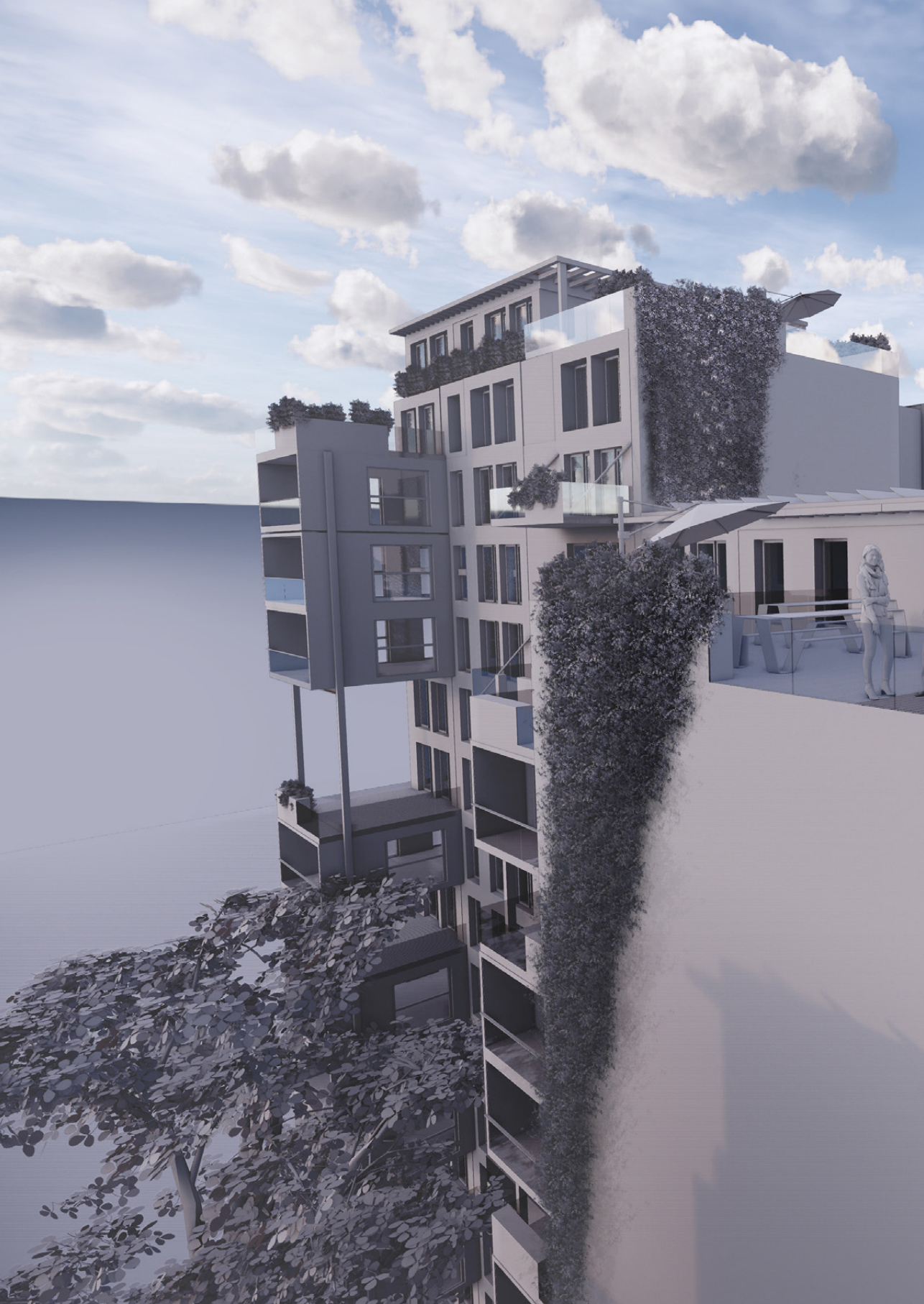
Ill.112: Master plam. 1:500


A
A'
3
A
A'
V2
V3

Ill.113: V1 external visualization

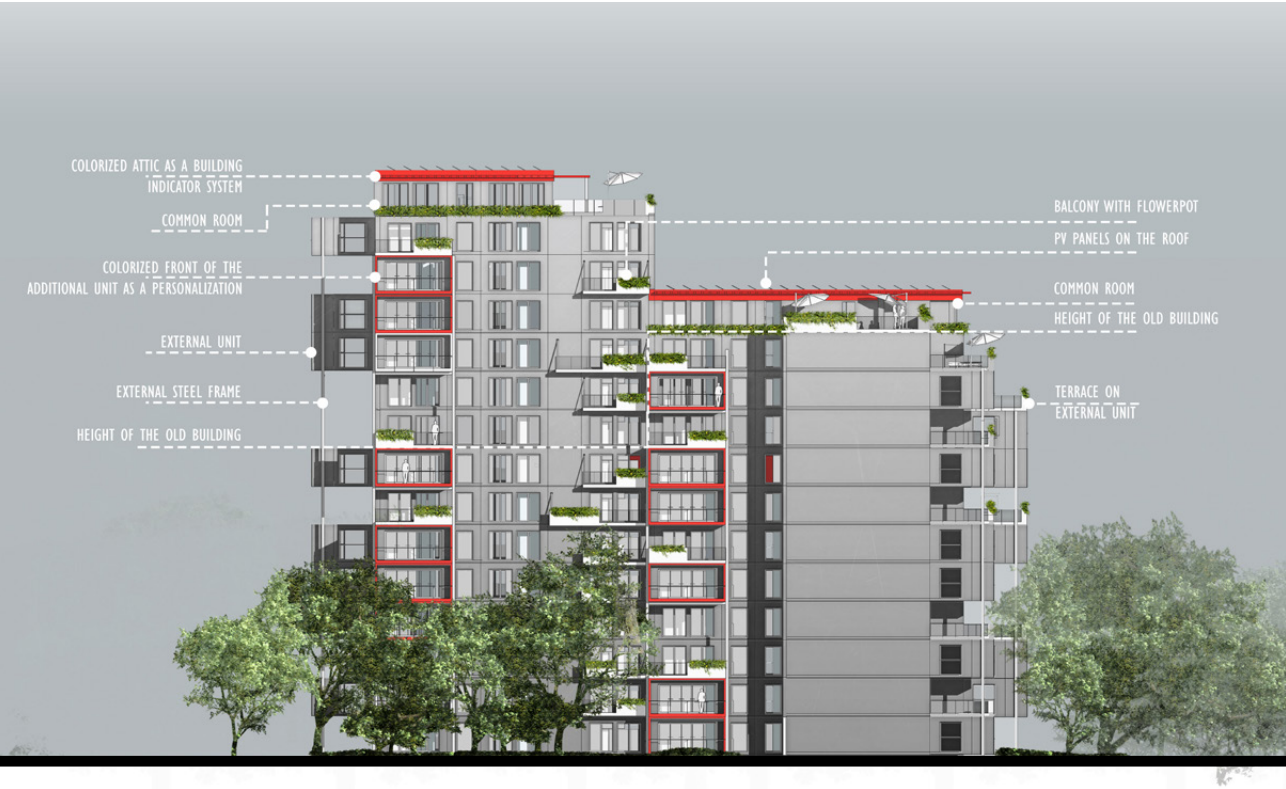
Ill.114: V2 external visualization

Ill.115: V3 external visualization



Ill.116: *Aerial view*

Ill.117: Closer look to the external unit



Ill.118: *Western facade. 1:500*

Ill.119: *Eastern facade. 1:500*

Ill.120: Section A-A. 1:500

Ill.121: Northern facade. 1:500

Ill.122: Southern facade. 1:500

DESIGN ANALYSIS

In following chapter the design analysis and its technical aspects will be presented. The detailed information about iterations of the design process can be found on page 168.

The design will be analysed on building 3 which was presented in the previous chapter.

VENTILATION

As the project is designed on existing building, the whole object perform with only natural ventilation, as there is no technical space for applying mechanical one. Every apartment uses both - single sided and cross ventilation. Moreover kitchen and the bathrooms uses stack ventilations which is used with existing chimneys.

Detailed calculations about the ventilation can be found in Appendix 1 on page 196.

Ill.123: Ventilation scheme

ENERGY DEMAND

One of the main goals of the project is to reduce the energy consumption to minimum. In order to analyse the building performance the Be18 tool is applied.

As the building has astronomical amount of different possible configurations, it was assumed that the analysed building contains 50% of available external units and 50% of balconies, evenly spread on each façade.

Primary energy requirement of the building is **32,9 kWh/m²** yearly what in the result gives **39,4 kWh/m² yearly** of total energy requirement in Polish reality. The same building in Denmark in 2020 would perform with **19,38 kWh/m² yearly** (as PEF for district heating in Poland is 1.2 and in Denmark 0.6 for 2020) which means that the BR2020 standard is fulfilled.

	Primary energy
Before thermo modernization	307 kWh/m² year
After thermo modernization	117,5 kWh/m² year
Panel building algorithm	32,9 kWh/m² year

Moreover the roof is used to provide PV panels in order to reduce the energy requirement to zero. The detailed calculations are presented in *Appendix 2* on the site 200.

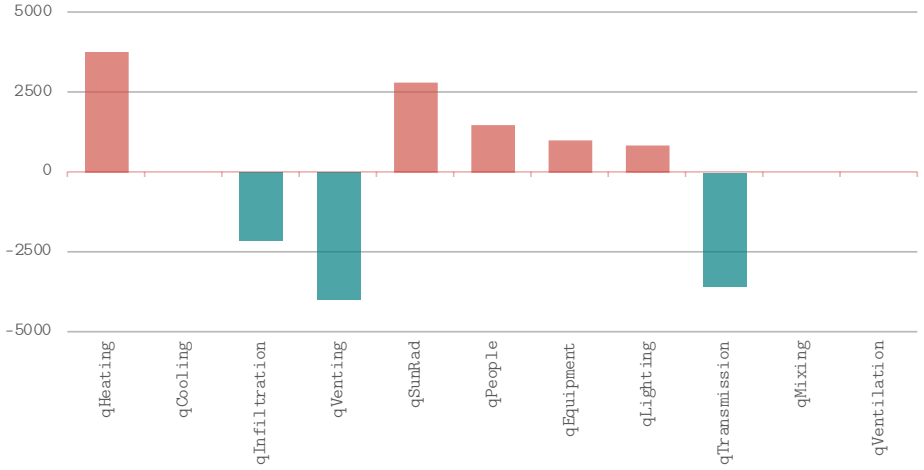
BSim

In order to analyse the building in terms of indoor environment the BSim tool was used. The test was carried out on the same critical apartment which was chosen in the existing apartment analysis. The dwelling is located on the last floor on the northern side. In a result it doesn't take the quantity of heat gain as the rest of apartments and additionally the apartment is exposed to the outdoor with three facades and a roof.

The results shows the proper CO_2 level and overheating that is acceptable in terms of regulations. The total heating demanding for the apartment is 3766 kWh what gives 42 kWh/m^2 yearly.

	Bedroom 1	Master bedroom	Living space	Bathroom	Overall
> 27°C	56	96	22	23	
> 28°C	23	13	8	2	
CO_2 max[ppm]	831	853	829	887	
Heating [kWh]	1439	5191	5075	289	**3766,14**

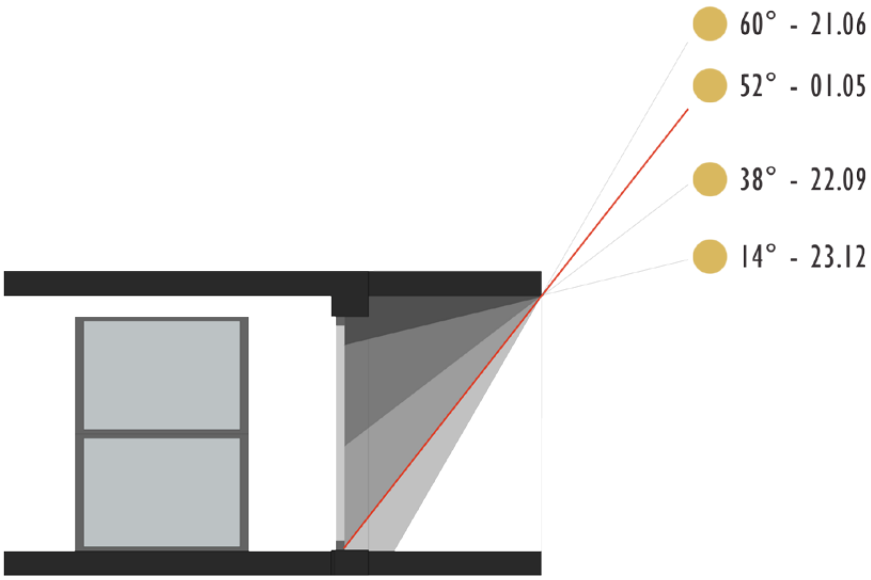
Tab.3



OVERHANGS - SHADING

The most sensitive area in terms of overheating, temperature drops and the daylight factor is the external unit. The reason is its exposition - it contains 3 facades unsheltered and additionally (in the worst case) roof and floor is also exposed. What's worse, the design demands it to be glazed as much as it is possible.

In order to prevent overheating, the overhang with a depth of 1,6m has been applied to the unit, which is also a balcony. The depth is a result of calculations based on a sun path when the sun is in the zenith. The overhang starts to cover the front panorama windows entirely on 01.05 - the first day of the year when the overheating occurred on a raw model (before implementation any passive heating prevention).

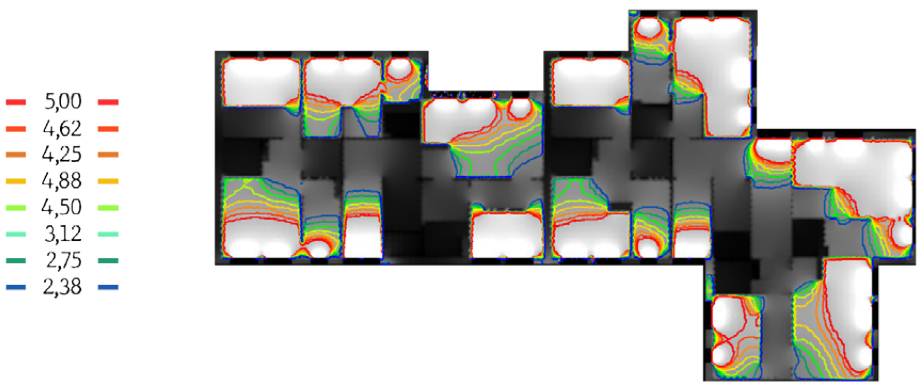


Ill.124: External unit shading

DAYLIGHT FACTOR

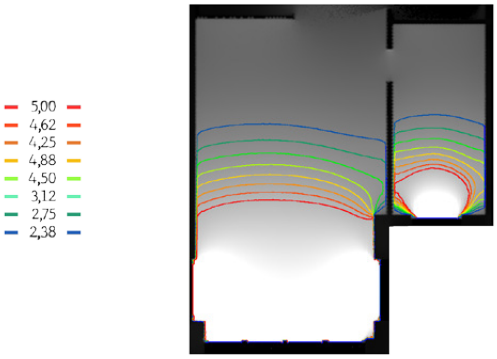
The daylight factor analysis were carried out on the worst possible scenario which is a whole floor designed with strategy 1 that is below the level which is designed with strategy 2/3. In the result the analysed floor is covered with every possible overhang from above which are external units and balconies.

The daylight factor is above 5% in average in all possible living spaces in the building.



Ill.125: Daylight analysis after modernization

Additionally the deepest room on strategy 2 - which is the worst possible scenario in this case - has been also carried out.



Ill.126: Daylight analysis after modernization

The daylight factor standard is fulfilled with 7,1% in this room.

Detailed iterative process can be found on the appendix on page 176.

DESIGN PROCESS

In the following chapter the iterative design process will be presented. The described steps are milestones that affected the final design the greatest.

5

FINDING STRATEGIES AND THE ORIGIN OF EXTERNAL UNITS

The most significant phase of the panel buildings modernisation was to find a way of enlarging the apartments - as the deficit of the usable area per person is perceived as the most visible problem.

The building 3 was analysed in terms of usable area and investigated how the apartments are related to the desire minimum goal standard of 25 m^2.

					Minimal goal area/person [m^2] 25
Type of apartment (number of users)	Current area [m^2]	Area/person [m^2]	Type of apartment (goal standards)*	Request number of users for strategy 2	Missing area to meet the new standard [m^2]
M4	**67,68**	16,92	2,7	3	7,32
*M2***	***31,02***	*15,51*	*1,2*	*1*	*-6,02*
M4	**62,51**	15,63	2,5	3	12,49
M4	**68,62**	17,16	2,7	3	6,38
M3	**47,00**	15,67	1,9	2	3,00
M3	**47,00**	15,67	1,9	2	3,00
M4	**62,60**	15,65	2,5	3	12,40

* maximum number of users that the apartment now should be used by - according to the goal standard of 25m2 [current area/goal standard]

** the apartments that were originally provided for 2 people are exception and they are not being enlarged in strategy 2

Tab.4

The analysis shows that the apartments not only don't meet the standards for the original amount of users, but they also wouldn't if the number of inhabitants was reduced by one. It means that the number of users must be reduced by two, and only then the standard can be met.

In order to fulfil the contemporary standards with the original amount of users, three strategies were prepared.

Strategy I assumes keeping the area of apartment when the number of present users is reduced by 2 in relation to the original amount

			Minimal goal area/person [m2] 25
Type of apartment originally (number of users)	Type of apartment strategy 1 (number of users)	Strategy 1 area [m²]	Strategy 1 area/person [m²]
M4	M2	**67,68**	33,84
M2	*M1*	***31,02***	*31,02*
M4	M2	**62,51**	31,26
M4	M2	**68,62**	34,31
M3	M1	**47,00**	47,00
M3	M1	**47,00**	47,00
M4	M2	**62,60**	31,30

Tab.5

Strategy II assumes enlarging the area **outside the building** when the number of present users is reduced by 1 in relation to the original amount. The area of resizing apartments is based on the minimum amount of space that would provide fulfilling the standard and the result is **at least 13 m²** (see Tab.4)

			Minimal goal area/person [m2] 25
Type of apartment originally (number of users)	Type of apartment strategy 2 (number of users)	Strategy 2 area [m²]	Strategy 2 area/person [m²]
M4	M3	**80,7**	26,89
M2	*M1*	***31,0***	*31,02*
M4	M3	**75,5**	25,17
M4	M3	**81,6**	27,21
M3	M2	**60,0**	30,00
M3	M2	**60,0**	30,00
M4	M3	**75,6**	25,20

Tab.6

Strategy III assumes enlarging the area by **combining apartments** when the number of present users is the same as the original one.

			Minimal goal area/person [m2] 25
Apartments combination from strategy 2	Type of apartment strategy 3 (number of users)	Strategy 3 area [m^2]	Strategy 3 area/person [m^2]
M3 + M1	M4	**111,70**	27,93
M3 + M1	M4	**105,63**	26,63
M3 + M2	M4	**141,62**	35,41
M3 + M2	M4	**135,60**	33,90

Tab.7

The external units that are outside the building, were found as a way of providing the extra space for the strategy 2. Its dimensions are based on the module width of 480cm and the demand of having at least 13 m^2 of additional area to meet the standards. The width was reduced to 4,32m^2 of usable area as the rest consumes the wall of the unit.

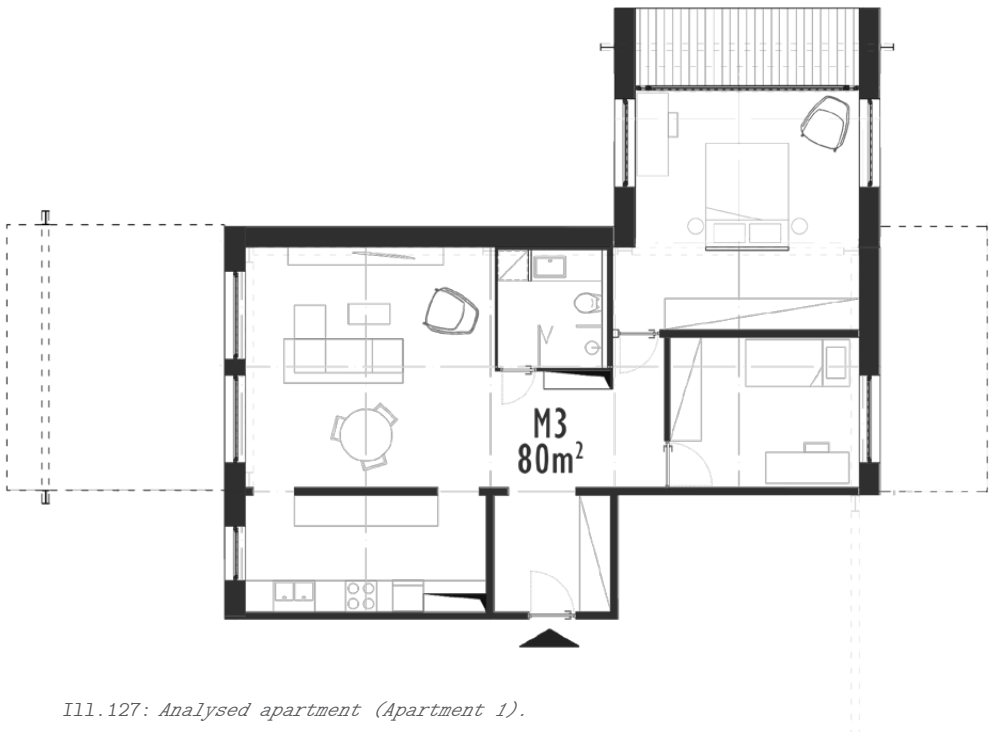
$$4{,}32m \cdot a = 13m^2 \quad \rightarrow \quad a = 3m$$

The final inside dimensions of the external unit is 432x300 [cm]

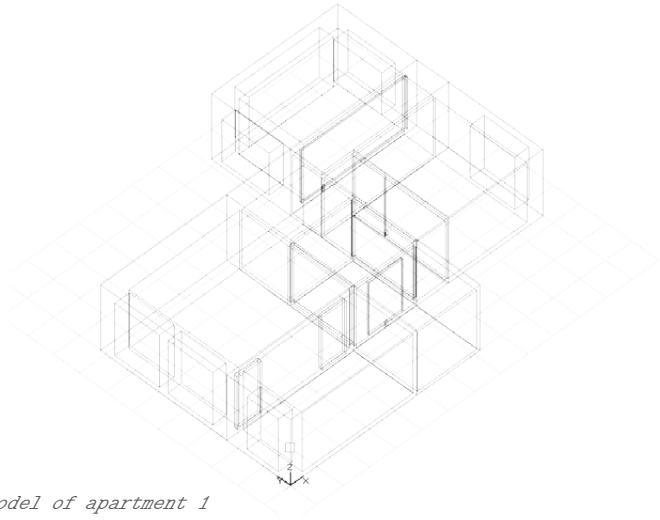
ITERATIVE PROCESS OF INTEGRATING INDOOR CLIMATE, DAYLIGHT FACTOR AND ENERGY REQUIREMENTS

Indoor climate - apartment

The dwelling is located in the building 3, on the last floor on the northern side. The model of BSim is based on the sketched apartment layout for strategy 2. The project assumes that the windows are enlarged to the floor in relation to the original one. On this phase the U-values of windows, walls and ventilation system were found and applied to the tool.



Ill.127: Analysed apartment (Apartment 1).



Ill.128: BSim model of apartment 1

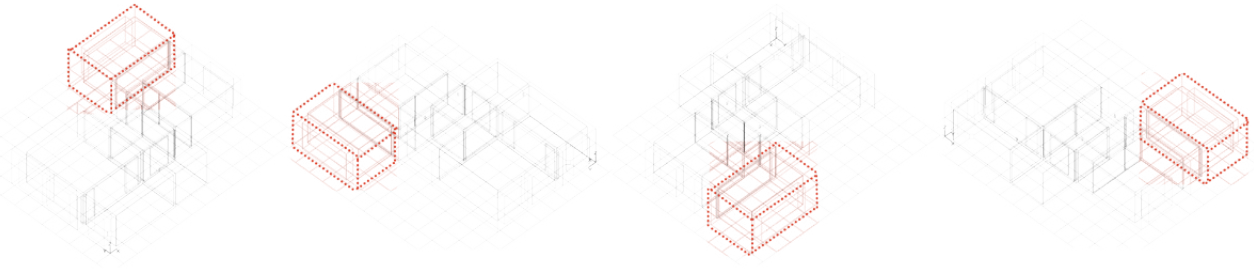
While the heating demand for the apartment and CO_2 level was acceptable, the apartment was struggling with enormous overheating in the master bedroom where the external unit was applied.

Iteration 1 (north + side windows)	>27 °C	>28 °C
Master bedroom	1093	651

The decision was to remove side windows - after that move the overheating decreased significantly but it was still visible.

Iteration 2 (north)	>27 °C	>28 °C
Master bedroom	194	71

However, the conclusion from this investigation was that the external unit is very susceptible for the overheating. The analysis was carried out for the apartment with the position of the external unit on the north, so the orientation prevented overheating itself. It is assumed that the unit can occur on each façade on the other apartments according to the concept, therefore it was decided to analyse how much the orientation of such space would affect on presumptive overheating.



Ill.129: Apartment 1 in different directions

External unit - overheating problem

Iteration 3 (south)	>27 °C	>28 °C
Master bedroom	818	388

The suspicions were correct. We can indicate significant overheating when the apartment is rotated and the unit is oriented towards east, west or south. From this moment, it was decided to analyse the unit when it's rotated towards south.

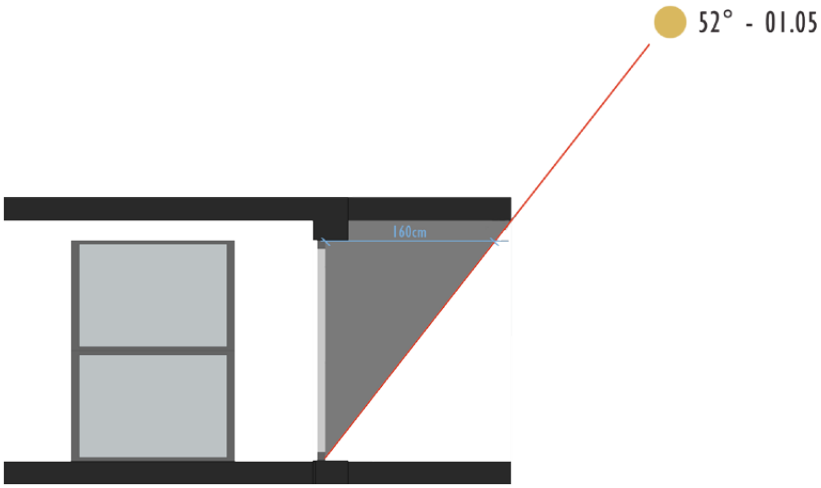
The large dimensions of a window in the unit was found as a factor responsible for the overheating. As the panoramic view is very valuable theme in terms of design, it was assumed that the overheating has to be reduced in other way.

First step was to apply an overhang that will cover windows during sunny days. The depth of the overhang was found by analysing a sun path. Along the year the first day when overheating occurs is 18 week (approximately 01.05). Using a grasshopper tool, **1,6m** was found as the depth of the overhang, based on the angle of the sun when the shadow covers the whole window on 01.05 when sun is in the zenith.

Iteration 4 (south)	>27 °C	>28 °C
Master bedroom	258	73

Overheating has been reduced significantly but it was still present, however in much lower scale. Second step was to decrease the heat transmittance of the window. The level was reduced to 0.5. The overheating decreased to the acceptable values after this move according to the Class II 15251:2007 standard.

Iteration 5 (south)	>27 °C	>28 °C
Master bedroom	96	13



Ill.130: Shading on 01.05

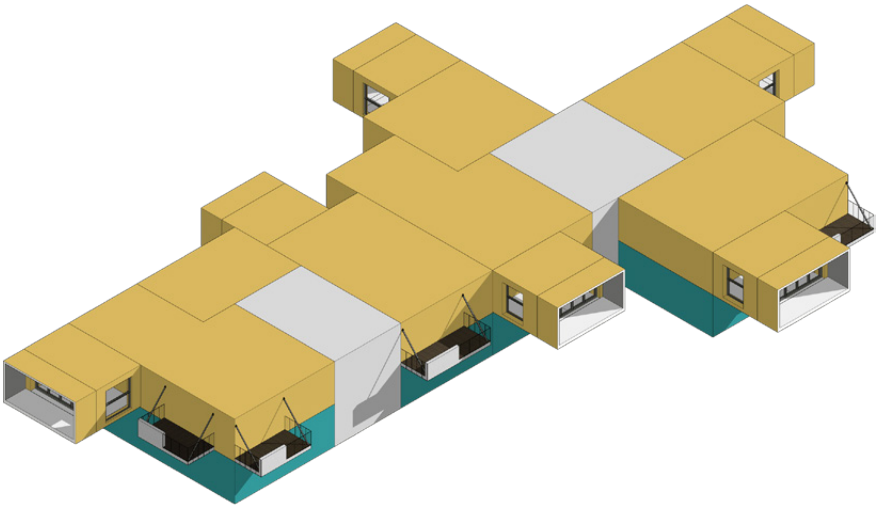
This investigation of the external unit was carried out on the same apartment - it was assumed that the unit itself is essential here, and the rest of the flat just perform as an example model, which has a less important (but still existing) contribution in mixing between rooms. According to the design proposal, the external units also have various purpose - it was assumed that for this analysis the most representative would be the function of bedroom as the volume of it is the most compact so it works bad in terms of overheating.

Daylight factor - apartment

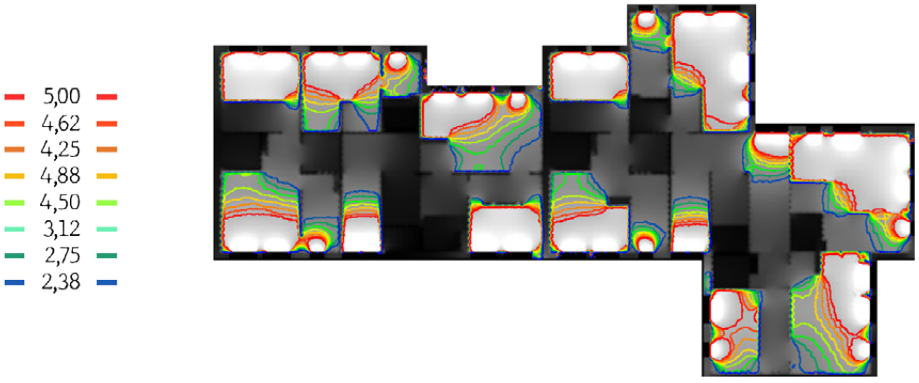
The next step was to check how the new size of windows affect the layout of apartments. The daylight factor analysis were carried out on the worst possible scenario which is a whole floor designed with strategy 1 that is below the level which is designed with strategy 2 or 3. In the result the analysed floor is covered with every possible overhang from above which are external units and balconies. The purpose of the investigation was to check if the huge overhangs (the external units above) are problem for the daylight.

The analysis shows that the suspected lack of the daylight caused by overhangs is not a problem in any apartment. The only element that had to be corrected was a slight lack of light in the spaces, where cover slab is placed as a single module, therefore in some cases the average daylight was slightly below 2%. In such single-module wall the width of the original windows were 90 cm so they has been enlarged into 120 cm which was a maximum - as the slabs are mainly provided in kitchens - the dimension gives a possibility to put cabinets with a depth of 60cm on the both side of windows.

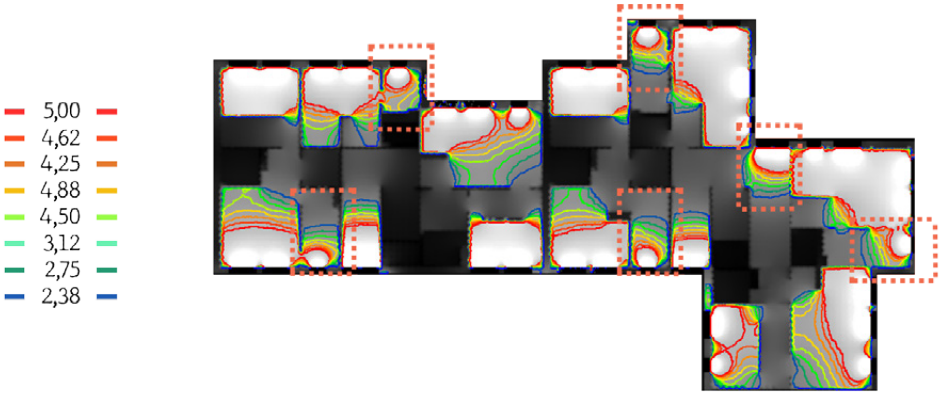
Enlarging windows gave a desired result - the daylight factor in critical rooms increased significantly what gave an average 2,1% in the worst case.



Ill.131: *The worst possible daylight combination. Blue - analysed level.*



Ill.132: *Daylight analysis - iteration 1.*



Ill.133: *Daylight analysis - iteration 2.*

Indoor climate - kitchen

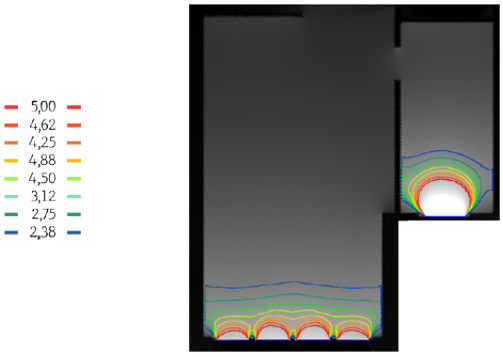
The changes in dimensions of the single window forced to check in BSim if there is a doubtful possibility of overheating and how it affected into heating demand of the apartment. As it can be seen on the table the modification didn't have a very big contribution to any of that factor.

Window dimensions in kitchen (single wall slab)	Overheating in living room (kitchen included)		Heating demand (apartment)
	>27 °C	>28 °C	
90 cm	0	12	3759
120 cm	8	22	3766

Tab.8

Daylight factor - deepest room in strategy 2/3

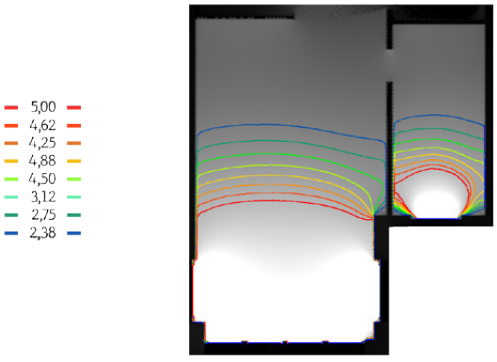
The previous daylight factor analysis was carried out for the strategy 1, but in strategies 2/3 due to the external units some rooms became very deep and the lack of the light are possible in such places. The deepest room in the building without any side windows was taken into consideration to the analysis. Moreover it was assumed that the room is oriented with windows towards north in case of occurrence of such situation in the other buildings.



Ill.134: Daylight analysis - deepest room. Iteration 1

We can indicate a serious problem with a daylight in such case as the average level is 1,3%. Therefore a decision of bringing back the side windows in external unit has been taken. The windows are not only providing a daylight, but they also extend the desired panorama view from the inside and they are important from the aesthetical point of view.

The windows are assisted with external blinds that absorb 100% of light. In case of high temperature inside the apartment, one of them should be used to prevent the overheating. After providing the side windows, the daylight factor has been improved significantly up to 6%.

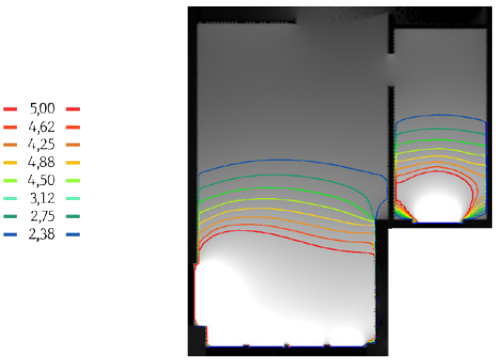


Ill.135: Daylight analysis - deepest room. Iteration 2

Iteration 2

In the project, in strategy 2, there is a situation in such room, when one of the side windows is oriented straight towards another window of the other apartment. In order to provide intimacy, such window need to be removed.

After removing one of the side window, the average daylight factor decreased to 4,8%. As the hypothetical situation is seldom (it is not even a case in this project - as the windows are not towards north like in the investigation), and the goal of 5% is almost achieved, it is suggested to leave it as an exception, or assume to cover internal walls with a high-reflective paint or to use some reflective material on a floor.



Ill.136: Daylight analysis - deepest room. Variation

Energy requirements

The data from BSim tool has been imported to Be18, adjusted for the whole building and corrected in small extent as the converting tool includes some mistakes in terms of e.g. wall measuring.

After implementing all necessary data, the energy requirement for the primary energy turned out to be 32,9 kWh/m^2 yearly and it meet the standard.

Key numbers, kWh/m² year

Renovation class 2

Without supplement	Supplement for special conditions	Total energy frame
70,4	0,0	70,4
Total energy requirement		32,9

Renovation class 1

Without supplement	Supplement for special conditions	Total energy frame
52,8	0,0	52,8
Total energy requirement		32,9

Energy frame BR 2018

Without supplement	Supplement for special conditions	Total energy frame
30,2	0,0	30,2
Total energy requirement		32,9

Energy frame low energy

Without supplement	Supplement for special conditions	Total energy frame
27,0	0,0	27,0
Total energy requirement		32,9

Contribution to energy requirement

Heat	32,3
El. for operation of bulding	0,3
Excessive in rooms	0,0

Net requirement

Room heating	18,8
Domestic hot water	0,3
Cooling	0,0

Selected electricity requirements

Lighting	65,0
Heating of rooms	0,0
Heating of DHW	0,3
Heat pump	0,0
Ventilators	0,0
Pumps	0,0
Cooling	0,0
Total el. consumption	13,3

Heat loss from installations

Room heating	13,4
Domestic hot water	0,3

Output from special sources

Solar heat	0,0
Heat pump	0,0
Solar cells	0,0
Wind mills	0,0

The heat supply is set to "boiler" only in order to obtain the total energy frame with PEF=1.0

Ill.137: Key numbers from Be18

ALTERNATIVE PROPOSALS

This chapter can be considered as a part of design process as all of these proposals at some point were taken into account as a hypothetical final solution. In fact, these solutions are just iterations of the process.

There are over 20 thousand prefabricated panel buildings in Poland. The project that has been already presented is one of possible variations, but there are plenty of various developments that are based on designed principals. They not only change the external perception of the project but also show its potential. In the reality, the usage of other designs would be recommended in order to provide a diversity of such buildings and to prevent the oppressiveness in scale that we can observe nowadays. In the following chapter, some of possible-alternative solutions will be presented in the form of quick, undetailed sketches with a short description.

FREE SYSTEM OF APARTMENT IDENTIFICATION

The proposal suggest usage of all possible colours for individual apartment identification. The colours could be chosen by users.

Pros:

- Interesting look
- More freedom to the users in terms of personalization the apartments.

Cons:

- Too much chaos in a bigger scale – fits only if used once per several dozen buildings.
- Adding so many colours may be seen as infantile

Ill.138: Free system of apartment identification

Ill.139: The stack of units stand-alone on the ground

THE STACK OF UNITS STAND-ALONE ON THE GROUND

Pros:

- Easy solution – units just stay on each other as an independent structure.
- More compact shape – better energy performance

Cons:

- Necessity of use only strategy 2 or 3 even if there is no such need. Limited flexibility of the apartment layouts.
- Boring look

SUSPENDED EXTERNAL UNITS

This proposal removes the frame and use cables to suspend the external units instead.

Pros:

- No need of using any other structure
- Purity of the project

Cons:

- Some potential difficulties with existing structure and its durability
- The depth of the unit is limited due its weight

Ill.140: Suspended external units

UNITS ON EXTERNAL PYLONS

This proposal replace a frame into huge pylons that sustain the external units which gives the building a slender and dynamic look.

Pros:

- Individual, extraordinary look
- Dynamic shape

Cons:

- Fits only to high buildings
- The pylons can be used once or maximum twice per building. Otherwise the pylons would become oppressive.
- Such pylons are much more expensive than simple steel frame.

Ill.141: *Units on external pylons*

EPILOGUE

6

REFLECTION & CONCLUSION

The social problem of panel buildings will grow with time.

Nowadays, we can observe a tendency that young people are not willing to live in panel buildings. Currently the apartments are inhabited mostly by elderly people, but in case of their death, children don't want to take their places. The reason is that Poles are just getting richer. They choose new estates with much higher standard of living - where the size of apartment is essential. And this standard is the biggest problem of panel buildings. They can't compete with the new ones anymore as they are not a suitable place to start a family for young marriages. The marriages in most cases have to take a loan for a new apartment anyway, so they prefer to take it bigger to provide higher standard of living.

The answer for the social problem of panel buildings is to make them competitive with new estates from young people point of view.

Western Europe is struggling with refugees relocating problem. Nowadays, people from Middle East escape to richer country than Poland like France, Germany, UK or Belgium. But it is just a matter of time when they find a better life also in polish cities. There is also another war - the one in eastern Ukraine in Donbass area. Since 2014 Poland took over approx. 1 million people from Ukraine - they don't have a status of refugees but in most cases, the reason why they migrate is that they lost their jobs due to war. In both cases, the place where they will settle down naturally must be as cheap as it is possible - as they usually cannot afford for the higher standards. The ideal candidate for such places in Poland are just Panel Buildings in a current shape because - as it was mentioned before - Poles are not willing to live in there. There is a big threat that the settlements from communism period will naturally transform into large areas inhabited only by immigrants, where they won't have any chance to mix with natives and assimilate. It already happened in bigger cities of Western Europe where immigrants live in ghettos and they don't feel to be a part of native society.

***

The specific of student architectural projects is that it doesn't involve (or it does but very shallow) very important factor which would be crucial for the project proposed in this master thesis. It's money factor. It is difficult to estimate how much money the designed proposal would cost. Currently housing associations that are responsible for budgets of panel buildings, can afford only for minor changes on the façades. They'll never afford for any bigger renovation so the money need to come from another source.

The solution might be private developers with creating some kind of system where they invest in modernization. However, it would have to be profitable for them as the financial aspects are the most important factor for them. The other solution might be transferring somehow expenses to the apartment owners - in some part, at least. But the most likely would be a great government program for modernizations. The program can be divided for many years and be executed building by building. Some help can come also from EU money.

But first, the authorities need to notice the upcoming serious problem. Also society have to see that Panel Buildings can be a very attractive place to live after modernization and start to pressure for changes. This master thesis project can be an inspiration for further developments and a good starting point to the discussion.

REFERENCES

Bec (2018). *Ursynów: Architekci kontra Edward Gierek. Historia powstawania kultowego osiedla.* [online] Bryła. Available at: http://www.bryla.pl/bryla/1,85301,16911745,Ursynow__Architekci_kontra_Edward_Gierek__Historia.html [Accessed 28 Feb. 2019].

Bejder, A., Knudstrup, M., Jensen, R., & Katic, I. (2014). *Zero Energy Buildings - Design Principles and Built Examples: for Detached Houses* [pdf] (1st ed.). SBI forlag.

Davies, N. (2006). *Powstanie '44*. Wydawnictwo Znak.

Dębowski, J. (2012). *Cała prawda o budynkach wielkopłytowych. Przegląd budowlany*, [online] pp.28-35. Available at: http://www.przegladbudowlany.pl/2012/09/2012-09-PB-28_debowski.pdf [Accessed 24 Feb. 2019]

Getter, M. (2004). *Straty ludzkie i materialne w Powstaniu Warszawskim.*

Iea.org. (2019). *Buildings*. [online] Available at: https://www.iea.org/tcep/buildings/ [Accessed 1 May 2019].

Ilmurzyńska, K. (2018). *Ewolucja przestrzenna Ursynowa Północnego*. *Przestrzeń Urbanistyka Architektura*, [online] 1. Available at: http://www.ejournals.eu/PUA/2018/Volume-1/art/12000/ [Accessed 28 Feb. 2019].

Kijek, Ł. *Mieszkanie w PRL - normatyw mieszkaniowy - Leksykon - Teatr NN*. Retrieved from http://teatrnn.pl/leksykon/artykuly/mieszkanie-w-prl-normatyw-mieszkaniowy/

Laska, M., & Dudkiewicz, E. (2017). *Research of CO2 concentration in naturally ventilated lecture room* [pdf]. Wrocław. Retrieved from https://www.e3s-conferences.org/articles/e3sconf/pdf/2017/10/e3sconf_asee2017_00099.pdf

Lewandowski, M. (2016). *Termomodernizacja wielkiej płyty. Najczęściej spotykane problemy techniczne.* [online] Muratorplus.pl. Available at: https://www.muratorplus.pl/technika/izolacje/termomodernizacja-wielkiej-plyty-najczesciej-spotykane-problemy-techniczne-aa-nWWS-6gZ9-kWkr.html [Accessed 24 Feb. 2019].

Madej, K. (n.d.). *IPN - MIĘDZY MODERNIZACJĄ A MARNOTRAWSTWEM - O gospodarce PRL.* [online] Niniwa22.cba.pl. Available at: http://www.niniwa22.cba.pl/komunizm_gospodarka_prl_ipn.htm [Accessed 28 Feb. 2019].

Miller, R. (2000). *To save a city: the Berlin airlift.* College Station: Texas AM University Press, p.16.

Narodowa Agencja Poszanowania Energii SA. (2011). *Podręcznik typologii budynków mieszkalnych z przykładami działań mających na celu zmniejszenie ich energochłonności* [pdf]. Warszawa. Retrieved from http://episcope.eu/fileadmin/tabula/public/docs/brochure/PL_TABULA_TypologyBrochure_NAPE.pd-

f?fbclid=IwAR16956JV9lowjFBQzxypQx-IKf40VoLwD81a1xyBKyvCXrN7eNocRDXgNyM

Norma PN-EN 12831. *Nowa metoda obliczania projektowego obciążenia cieplnego*. [pdf]. Retrieved from http://www.is.pw.edu.pl/~michal_strzeszewski/ioiw/12831_PW.pdf?fbclid=IwAR2MZ5W-WCTbGWxIPtlsHJ3IX7cQOXHujwAiERkbpDLrn9HvnqnkbHNOeovM

Nowak, K., & Nowak-Dzieszko, K. (2015). *Szczelność budynków wielkopłytowych przed i po termomodernizacji - wymóg czy dobrowolność*. Przegląd Budowlany. Retrieved from http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.baztech-8f1d9afe-0f35-49c3-99da-1092ab1bf54b/c/Nowak_Szczelnosc_6_2015.pdf

Obiektyw - Miasto w mieście. (1975). [video] Directed by J. Kwapich. Warszawa: Telewizja Polska.

Ostańska, A. (2009). *Problemy rewitalizacji zespołów prefabrykowanej zabudowy mieszkaniowej na przykładzie osiedla im. Stanisława Moniuszki w Lublinie*. [pdf] Lublin. Available at: http://wbia.pollub.pl/files/83/attachment/1925_4_6.pdf [Accessed 16 Feb. 2019].

Ostańska, A. (2010). *Wpływ dotychczasowych termomodernizacji budynków mieszkalnych na oszczędność energii i planowanie programów rewitalizacji na przykładzie jednego z lubelskich osiedli*. [pdf] Available at: http://wbia.pollub.pl/files/83/attachment/1965_7_7.pdf [Accessed 24 Feb. 2019].

Ostańska, A. (2011). *Ocena dotychczasowych termomodernizacji wielorodzinnych budynków prefabrykowanych i propozycja poprawy stanu energetycznego w osiedlu mieszkaniowym. Przegląd budowlany*, [online] pp.68-74. Available at: http://www.przegladbudowlany.pl/2011/09/2011-09-PB-68-Ostanska.pdf [Accessed 24 Feb. 2019].

Prajsnar, A. (2016). [online] https://rynekpierwotny.pl/wiadomosci-mieszkaniowe/50-polakow-mieszka-w-lokala-wybudowanych-w-prl/5960/. Available at: https://rynekpierwotny.pl/wiadomosci-mieszkaniowe/50-polakow-mieszka-w-lokala-wybudowanych-w-prl/5960/ [Accessed 28 Feb. 2019].

Semczuk, P. (2018). [online] Newsweek Polska. Available at: https://www.newsweek.pl/wiedza/rok-1970-wielka-plyta-zaczyna-budowac-polske/h0c1vp1 [Accessed 28 Feb. 2019].

Sobczak-Piąstka, J. and Podhorecki, A. (2014). *Problemy diagnozowania stanu technicznego i modernizacji budynków z wielkiej płyty*. Inżynier budownictwa, [online] (114), pp.78-86. Available at: https://www.piib.org.pl/pliki/ib/ib_02_14.pdf [Accessed 16 Feb. 2019].

Springer, F. (2013). *Wanna z kolumnadą* (1st ed.). Wołowiec: Wydawnictwo Czarne.

Wojtkun, G. (2017). *Panel housing at the edge of the Iron Curtain*. Szczecin.

ILLUSTRATIONS

All photos and illustrations in the above report were produced by the authors of the project or come from their private collections. The exceptions are listed below.

Ill.2. *Ruined Warsaw*. (2018). [online]. Available at: http://slowopolskie.org/wp-content/uploads/2018/08/3107_wwa.jpg [Accessed 15 May 2019].

Ill.3. *Palace of Culture and Science in the middle of ruined Warsaw. (n.d.)*. [online]. Available at: https://kazdaulica.pl/pl-d57-pkinjak-palac-ruin-i-pojednania/ [Accessed 15 May 2019].

Ill.4. *Empty shelves in shops*. (n.d.). [online] Available at: http://www.mamakreatywna.pl/codziennosc-prl/ [Accessed 15 May 2019].

Ill.5. *A man run over by a truck (2009)* [online] Available at: https://www.youtube.com/watch?v=4yewJ8xCnQ8&fbclid=IwAR3IUcHsRitcMgVukpAfea_0oYWo5yuhpjfqXz1lftdOzYGqYFpeo1im_8g [Accessed 15 May 2019].

Ill.6. A. Rybczyński. *Brutally pacified protests* (1983). [online] Available at: https://dzieje.pl/aktualnosci/60-lat-temu-24-grudnia-1956-r-powstalo-zomo [Accessed 15 May 2019].

Ill.7. Mazur, M. (n.d.). W-70 Large Panel system. [online] Available at: http://ursynow.org [Accessed 15 May 2019].

Ill.8. *"Behind the iron gate" settlement in Warsaw*.(2015). [online] Available at: http://osiedlezaciszewaw.pl/?tag=osiedle-za-zelazna-brama [Accessed 15 May 2019].

Ill.11. Ilmurzyńska, K. (2018). *Extensions scheme*. [online] Available at: http://www.ejournals.eu/PUA/2018/Volume-1/art/12000/ [Accessed 28 Feb. 2019].

Ill.12. Mazur, M. (n.d.). *Kabaty metro station*. [online] Available at: http://ursynow.org [Accessed 15 May 2019].

Ill.13. Ilmurzyńska, K. (2018). *Evolution of design solution*. [online] Available at: http://www.ejournals.eu/PUA/2018/Volume-1/art/12000/ [Accessed 28 Feb. 2019].

Ill.17. Mazur, M. (n.d.). *No respect for common goods*. [online] Available at: http://ursynow.org [Accessed 15 May 2019].

Ill.18. Mazur, M. (n.d.). *The underground passage*. [online] Available at: http://ursynow.org [Accessed 15 May 2019].

Ill.19. *Group of vandals*.(2008) [online] Available at: https://www.youtube.com/watch?v=WCfAAw4-WDU [Accessed 15 May 2019].

APPENDIX

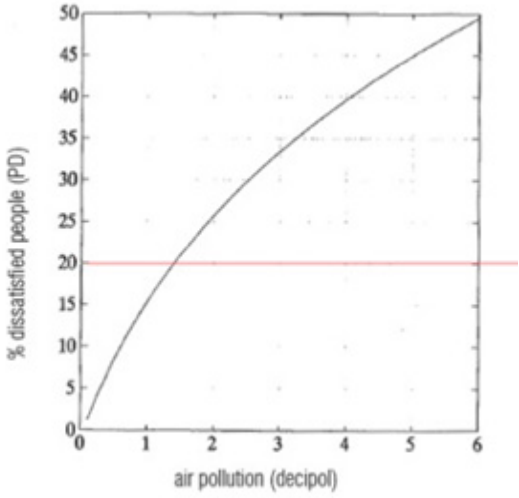
APPENDIX I: NATURAL VENTILATION

1. AIR CHANGE RATE BASED ON AIR POLLUTION

The calculation is done to check how high of air change rate is necessary to achieve air quality of Class II standards. The analysis are based in the building 3 on the example apartment provided for 3 persons.

$$c = c_i + 10\frac{q}{V_l}$$

c - experienced air quality (dp)
ci - experienced air quality outdoor (dp)
q - the pollution load (olf)
Vl - necessary air flow supply (l/s)



$$q = 1\,olf \cdot 3\,person + 0,2\frac{olf}{m^2} \cdot 89\,m^2 = 20,8\,olf$$

According to Class II standards, a percentage of dissatisfied people must be on maximum PD = 20% level. Thus c = 1,4. The outdoor air quality is estimated to be ci = 0.05 dp (see the graph).

$$1,4 = 0,05 + 10\frac{20,8\,olf}{V_l} \rightarrow V_l = 154,04\,l/s$$

Air change rate:

$$n = 1 + \frac{V_l \cdot 3600}{1000 \cdot V_{rum}} = \frac{154,04\,l/s \cdot 3600}{1000 \cdot 222,5\,m^3} = 2,49\,h^{(-1)}$$

2. AIR CHANGE RATE BASED ON CO_2 LEVELS

The maximum air change rate based on CO_2 according to class II building from DS/EN 15251 is determined to be on maximum level of 500 ppm higher that outside, which for Poland it is assumed to be 400 ppm. Average, single person exhales about 10 liters per minute, where 4% consist of CO_2.

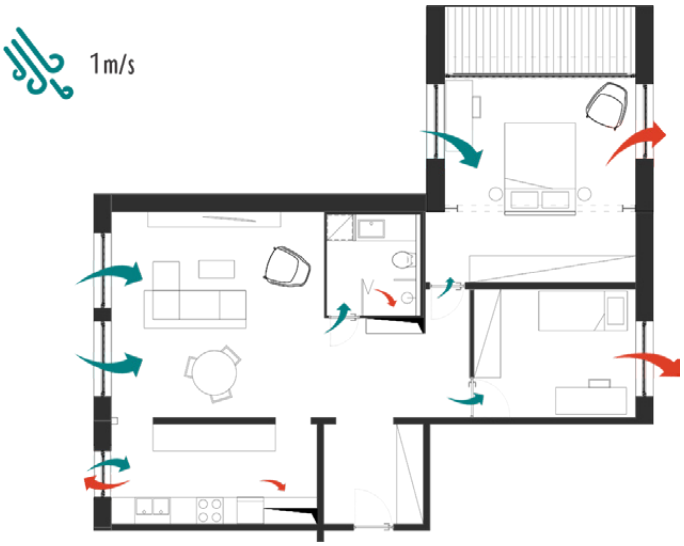
$$c = \frac{q}{nV} + c_i$$

$$q = \frac{4}{100} \cdot 3\,person\,\frac{10\,l/min \cdot 60\,min/h}{1000\,l/m^3} = 0,072\,m^3/h$$

The air change rate is:

$$900\,ppm = 1000000\,\frac{0,072m^3/h}{n(222,5m^3)} + 400\,ppm \qquad \rightarrow \qquad n = 0,58\,h^{(-1)}$$

CROSS VENTILATION CALCULATION



Calculations done with the excel sheet which were provided on ZEB course, show that even mild 1 m/s, non-direct, northern-west wind is sufficient to fulfill demands in all possible rooms where cross ventilation can be performed.

$$t = \frac{n_{max}}{n_x} \cdot 60\,min$$

Living zone (Kitchen + Living room)

Air change rate = **36,98 h^{-1}**

Pressure coefficient			Windfactor	0,57		Pwind	0,2	Pa	
Windward	0,2		Vmeteo	1	m/s	Pmin	-0,1	Pa	
Leeward	-0,5		Vref	0,57	m/s	Pmax	0,0	Pa	
roof									
Location of neuttral plan,Ho	2,0	m				Buildingvol.		m3	
Outdoor temperature	15	°C				Volume		m3/section/floor	
Zone temperature	22	°C							
Discharge coefficient	0,7					Internal pressure, Pi	Pa	0,01	0,01
Air density	1,25	kg/m³							

	Area	Eff. area	Height	Thermal Buoyancy	AFR (thermal)	Pres Coefficient	Wind pressure	AFR (Wind)	Wind pressure	AFR total
	m²	m²	m	Pa	m³/s		Pa	m³/s	Pa	m³/s
1.floor	7,14	4,998	2	0,000	0,00	0,2	0,028	1,066	0,028	1,066
1.floor	3,57	2,499	2	0,000	0,00	-0,5	-0,114	-1,066	-0,114	-1,066
				Massebalance	0,00		Massebalance	0,00		0,00

Room height [m]	Room area [m]	Room volume [m³]	[l/s m²]	AIR CHANGE RATE [h^{-1}]
2,5	41,5	103,8	25,69	36,98

$$\frac{2,49\,h^{(-1)}}{36,98\,h^{(-1)}} \cdot 60\,min = 4,04\,min$$

Hence the demand can be executed in about 4 minutes of room airing, assuming full-open windows or should be open in 6% for one hour.

Bedroom

Air change rate = **146,18 h^{-1}**

Pressure coefficient			Windfactor	0,57		Pwind	0,2	Pa	
Windward	0,2		Vmeteo	1	m/s	Pmin	-0,1	Pa	
Leeward	-0,5		Vref	0,57	m/s	Pmax	0,0	Pa	
roof									
Location of neuttral plan,Ho	2,0	m				Buildingvol.		m3	
Outdoor temperature	15	°C				Volume		m3/section/floor	
Zone temperature	22	°C							
Discharge coefficient	0,7					Internal pressure, Pi	Pa	0,01	0,01
Air density	1,25	kg/m³							

	Area	Eff. area	Height	Thermal Buoyancy	AFR (thermal)	Pres Coefficient	Wind pressure	AFR (Wind)	Wind pressure	AFR total
	m²	m²	m	Pa	m³/s		Pa	m³/s	Pa	m³/s
1.floor	7,14	4,998	2	0,000	0,00	0,2	0,028	1,066	0,028	1,066
1.floor	3,57	2,499	2	0,000	0,00	-0,5	-0,071	-1,066	-0,114	-1,066
				Massebalance	0,00		Massebalance	0,00		0,00

Room height [m]	Room area [m]	Room volume [m³]	[l/s m²]	AIR CHANGE RATE [h^{-1}]
2,5	10,5	26,25	101,52	146,18

$$\frac{2,49\,h^{(-1)}}{146,18\,h^{(-1)}} \cdot 60\,min = 1,02\,min$$

The demand in bedroom can be executed in about 1 minute of room airing, assuming full-open windows or should be open in 1% for one hour.

Master Bedroom

Air change rate = **60,67 h^{-1}**

Pressure coefficient			Windfactor	0,57		Pwind	0,2	Pa
Windward	0,2		Vmeteo	1	m/s	Pmin	-0,1	Pa
Leeward	-0,5		Vref	0,57	m/s	Pmax	0,0	Pa
roof								
Location of neuttral plan,Ho	2,0	m				Buildingvol.	m3	
Outdoor temperature	15	°C				Volume	m3/section/floor	
Zone temperature	22	°C						
Discharge coefficient	0,7					Internal pressure, Pi	Pa -0,03	-0,03
Air density	1,25	kg/m^3						

	Area	Eff. area	Height	Thermal Buoyancy	AFR (thermal)	Pres Coefficient	Wind pressure	AFR (Wind)	Wind pressure	AFR total
	m^2	m^2	m	Pa	m^3/s		Pa	m^3/s	Pa	m^3/s
1.floor	3,57	2,499	2	0,000	0,00	0,2	0,071	0,843	0,071	0,843
1.floor	3,57	2,499	2	0,000	0,00	-0,5	-0,071	-0,843	-0,071	-0,843
				Massebalance	0,00		Massebalance	0,00		0,00

Room height [m]	Room area [m]	Room volume [m^3]	[l/s m^2]	AIR CHANGE RATE [h^{-1}]
2,5	20	50	42,14	60,67

$$\frac{2,49\,h^{(-1)}}{60,67\,h^{(-1)}} \cdot 60\,min = 2,46\,min$$

The demand in bedroom can be executed in about 3,5 minutes of room airing, assuming full-open windows or should be open in 6% for one hour.

APPENDIX 2: PV PANELS

The project assumes that the building has to reach zero energy requirement. In order to meet the expectation, the solar cells are provided.

Total electricity consumption converted to primary energy and heat:

$$13,3\,\frac{kWh}{m^2year}\cdot 3 + 32,9\,\frac{kWh}{m^2year} = 72,8\,kWh/m^2$$

$$\frac{72,8\,kWh/m^2year}{3} = 24,26\,kWh/m^2year$$

$$24,26\,kWh/m^2year \cdot 5577\,m^2 = 135335\,kWh/year$$

$$e_{consp} = i_{eff}\cdot f \cdot sr$$

e_{consp} - Energy consumption the solar needs to cover: 135335 kWh/year
i_{eff} - installed effect
f - assessment of system factor: 0.8
sr - solar radiation: 999 (horizontal positioned, south direction)

$$135335\,kWh/m^2 = i_{eff}\cdot 0,8\cdot 999 \quad \rightarrow \quad i_{eff} = 169,38\,kW$$

$$peak\,power = \frac{169,38kW}{550m^2} = 307\,W/m^2$$

SunPowerTM E20 Solar Panels is able to reach the solar cell performance. Its peak power ranging is 327W

APPENDIX 3: WALLS U-VALUE

U-value is calculated by following formula:

$$Uvalue = \frac{1}{Rse + \frac{l_1}{\lambda_1} + \frac{l_2}{\lambda_2} + ... + \frac{l_n}{\lambda_n} + Rsi}$$

Rse - external transition value
l - length of material layer
λ - heat transfer coefficient

New layers of external wall consist of: 150 mm of reinforced concrete slab, thermal insulation 300mm - mineral wool, and 40 mm external layer of fiber-cement panel.

$$Uvalue = \frac{1}{0,04 + \frac{0,15}{2,1} + \frac{0,3}{0,036} + \frac{0,04}{1,2} + 0,13} = 0,12$$

λ Concrete = 2,1 W/(m·K)
λ Mineral wool = 0,036 W/(m·K)
λ fiber-cement = 1,2 W/(m·K)
Rse = 0,04
Rsi = 0,13

APPENDIX 4: BEAMS CROSS-SECTION SELECTION

To find the proper parameters of the designed construction extensions, the basic examination was carried out on the two most critical structural elements using Karamba tool for Grasshopper. The chosen beams have significant meaning in terms of construction, but also strongly affect visual and functional aspects of the project.

Based on demanded inputs, such as length of the beam, supports, loads, initial cross-section and material, the algorithm results in showing the size of displacement. Then the cross-section had been changed back and forth until achieving the maximum displacement ratio of 1/350 of the beam length taken from Polish Standard PN-90/B-03200.

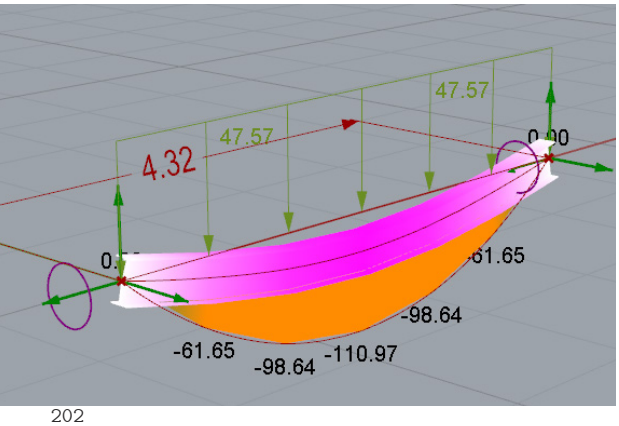
INPUT DATA

Length of the beam:	4,32 m
Max.displacement:	0,012 m
Supports:	2 degrees of freedom
Cross-section:	Shape: I Family: IPE Size: Variable
Material:	Steel S355
Loads:	BEAM A: 47,57 kN/m BEAM B: 33 kN/m

RESULTS

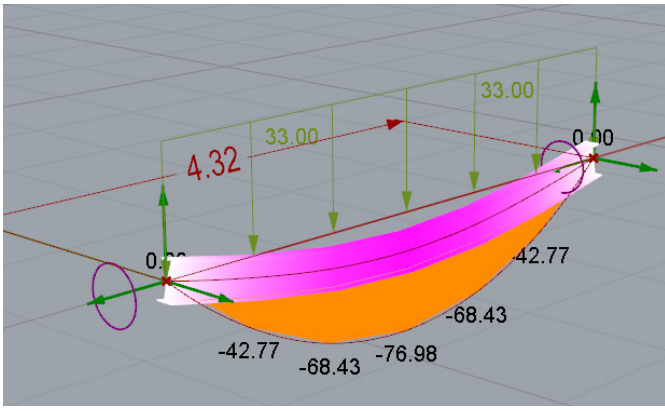
BEAM A

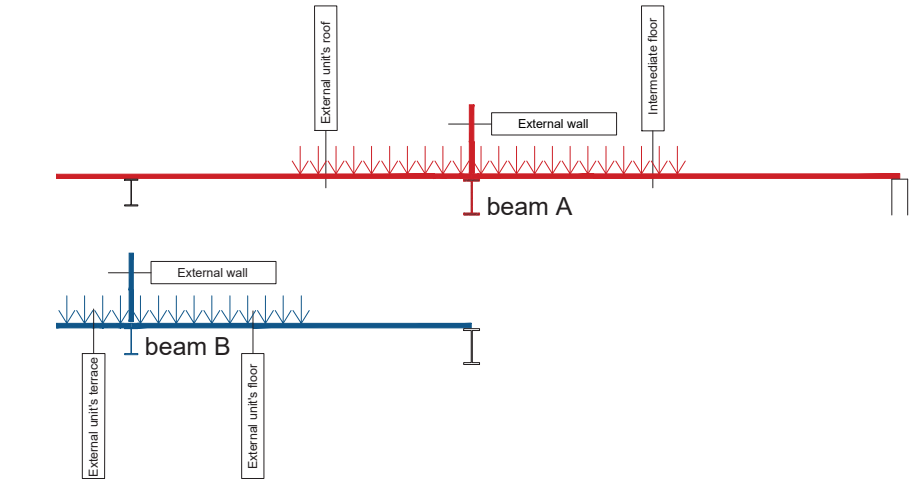
Cross-section: IPE 300
Displacement: 0,012 m

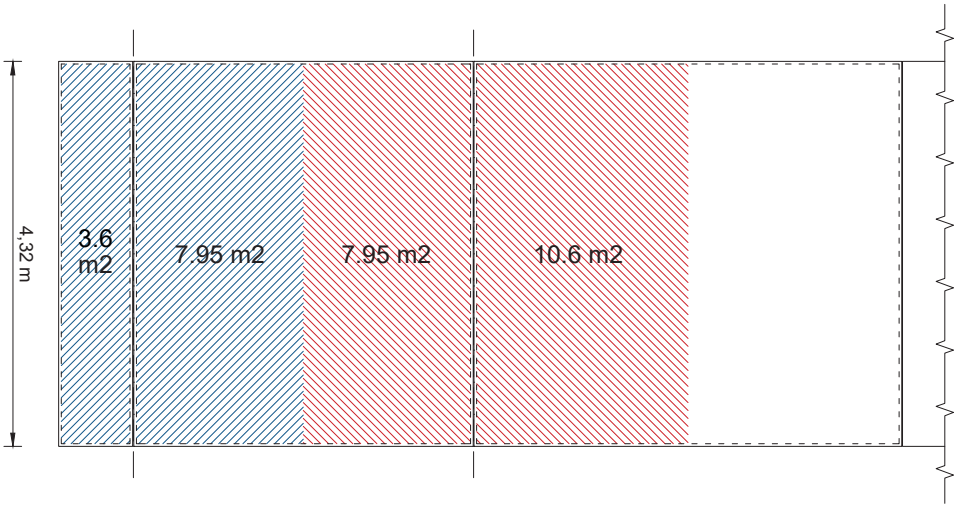


BEAM B

Cross-section: IPE 270
Displacement: 0,012 m







BEAM A:

Intermediate floor load	10,6 m^2 * 9,99 kN/m^2	=	105,89 kN
External unit's roof load	7,95 m^2 * 6,76 kN/m^2	=	53,74 kN
External wall linear load	4,32 m * 10,66 kN/m	=	46,05 kN
			205,51 kN
	205,51 kN / 4,32 m	=	**47,57 kN/m**

BEAM B:

External unit's floor load	7,95 m^2 * 6,95 kN/m^2	=	55,25 kN
External unit's terrace load	3,6 m^2 * 11,46 kN/m^2	=	41,26 kN
External wall linear load	4,32 m * 10,66 kN/m	=	46,05 kN
			142,56 kN
	142,56 kN / 4,32 m	=	**33 kN/m**

INTERMEDIATE FLOOR

Load description	Thinckess (m)	Density (kN/m³)	Service load (kN/m²)	Load coef. γ_f	Factored load (kN/m²)
Static load					
Wooden flooring	0,02	7	0,14	1,35	0,19
Cement screed	0,05	24	1,20	1,35	1,62
Separation foil	-	-	0,02	1,35	0,03
Polystyrene foam	0,05	0,3	0,02	1,35	0,03
Reinforced concrete	0,15	25	3,75	1,35	5,06
Plaster	0,01	19	0,19	1,35	0,26
					7,19
Live load			2	1,4	**2,8**
					9,99

EXTERNAL UNIT'S ROOF

Load description	Thinckess (m)	Density (kN/m³)	Service load (kN/m²)	Load coef. γ_f	Factored load (kN/m²)
Static load					
Floor tiles	0,02	21	0,42	1,2	0,5
Cement screed	0,08	22	1,68	1,3	2,18
Separation foil	-	-	0,02	1,35	0,03
Polystyrene foam	0,3	0,3	0,09	1,35	0,12
Steel substructure beams	-	-	0,50	1,35	0,675
Gypsum board	0,013	12	0,16	1,2	0,19
Plaster	0,01	19	0,19	1,35	0,26
					3,96
Live load			2	1,4	**2,8**
					6,76

EXTERNAL UNIT'S TERRACE / FLOOR

Load description	Thinckess (m)	Density (kN/m³)	Service load (kN/m²)	Load coef. γ_f	Factored load (kN/m²)
Static load					
Floor tiles / Wooden flooring	0,02	21 / 7	0,42 / 0,14	1,2	0,5 / 0,19
Cement screed	0,08	22	1,68	1,3	2,18
Separation foil	-	-	0,02	1,35	0,03
Polystyrene foam	0,3	0,3	0,09	1,35	0,12
Steel substructure beams	-	-	0,50	1,35	0,675
Fibre-cement panel	0,04	17,65	0,70	1,35	0,95
					4,46 / 4,15
Live load			5 / 2	1,4	**7 / 2,8**
					11,46 / 6,95

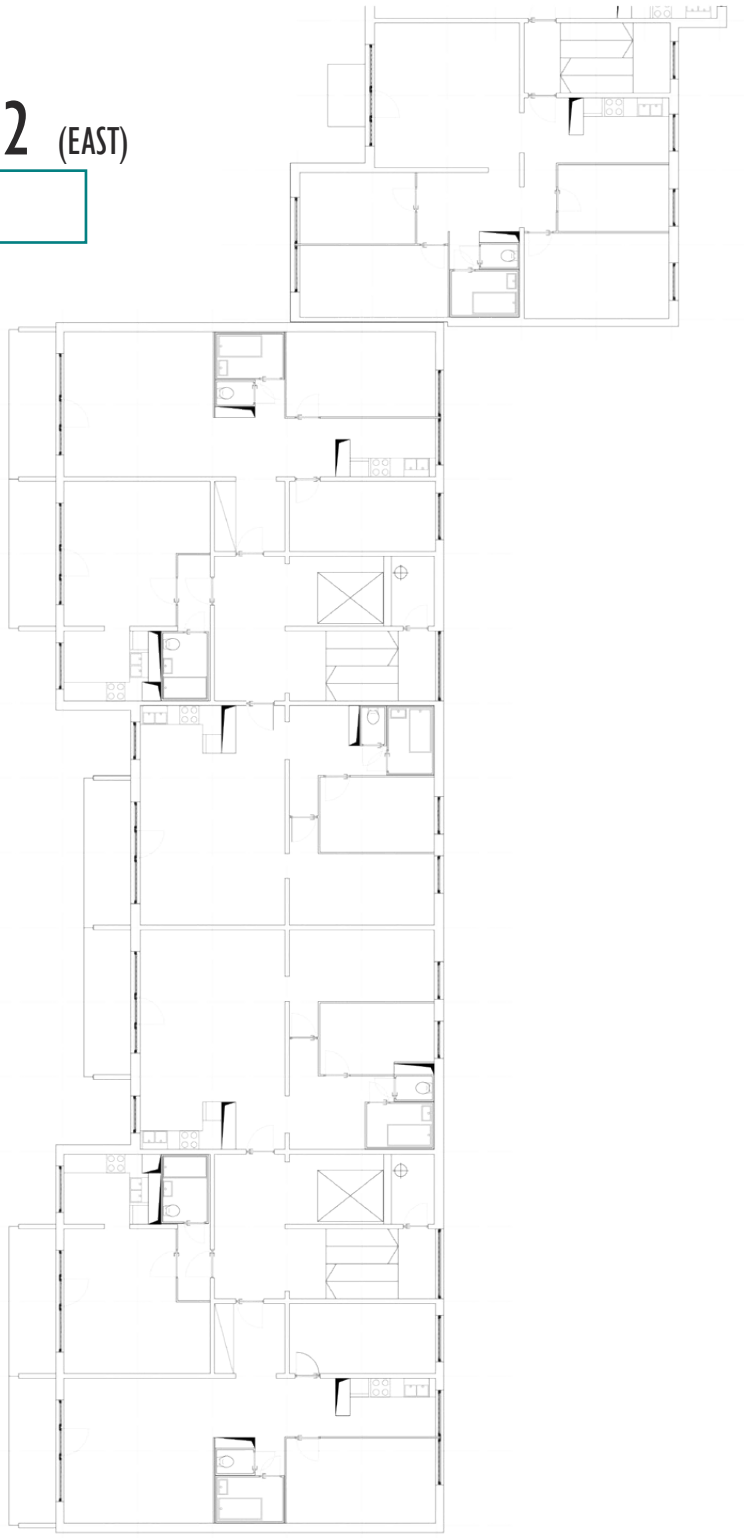
EXTERNAL WALL

Load description	Height (m)	Weight (kN/m²)	Service load (kN/m)	Load coef. γ_f	Factored load (kN/m)
External wall linear load	2,8	3,34	9,35	1,14	10,66

APPENDIX 5:
BUILDING 2 (WEST)
ORIGINAL

BUILDING 2 (EAST)

ORIGINAL



BUILDING 2 (WEST)
STRATEGY 1

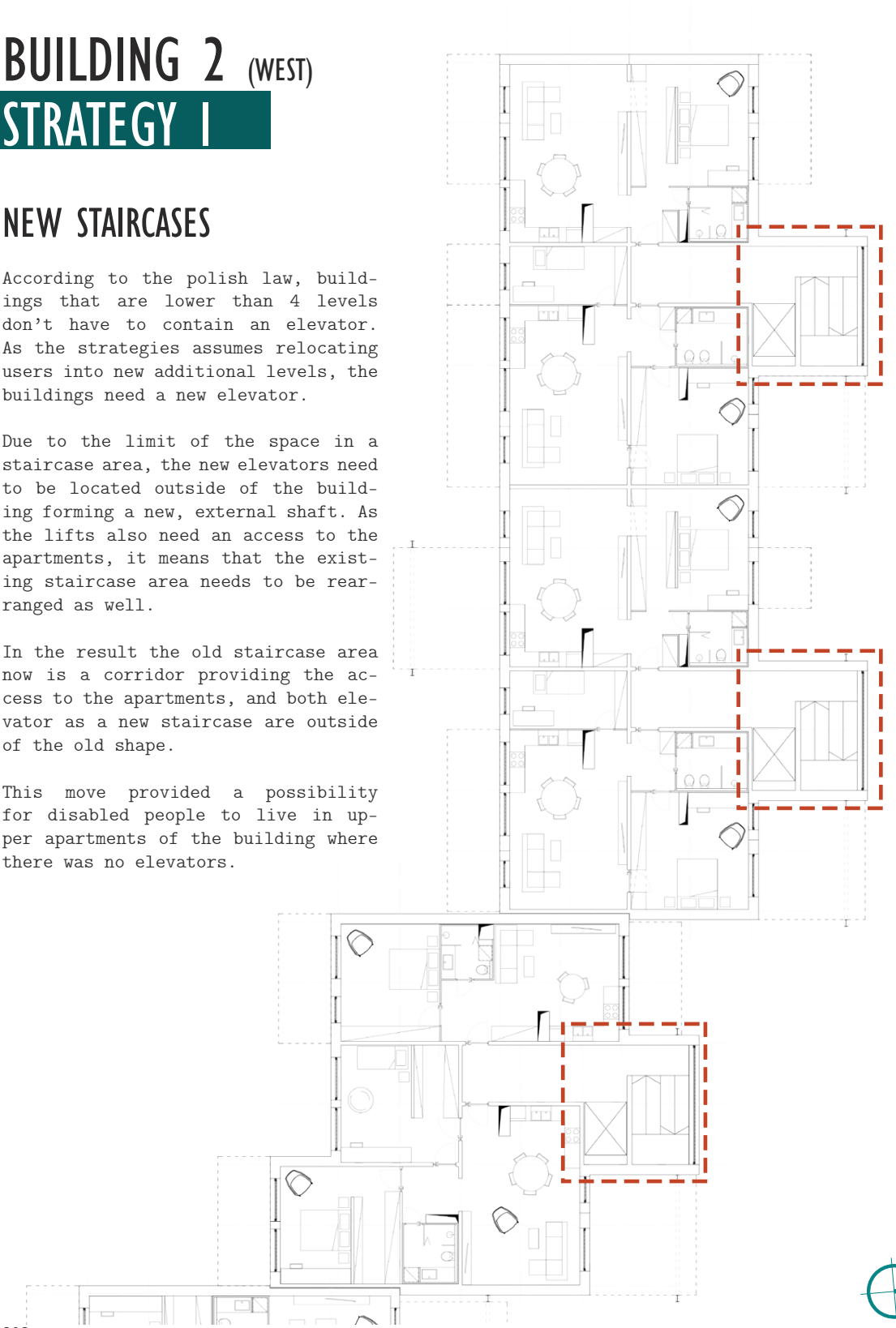
NEW STAIRCASES

According to the polish law, buildings that are lower than 4 levels don't have to contain an elevator. As the strategies assumes relocating users into new additional levels, the buildings need a new elevator.

Due to the limit of the space in a staircase area, the new elevators need to be located outside of the building forming a new, external shaft. As the lifts also need an access to the apartments, it means that the existing staircase area needs to be rearranged as well.

In the result the old staircase area now is a corridor providing the access to the apartments, and both elevator as a new staircase are outside of the old shape.

This move provided a possibility for disabled people to live in upper apartments of the building where there was no elevators.



BUILDING 2 (EAST)

STRATEGY 1

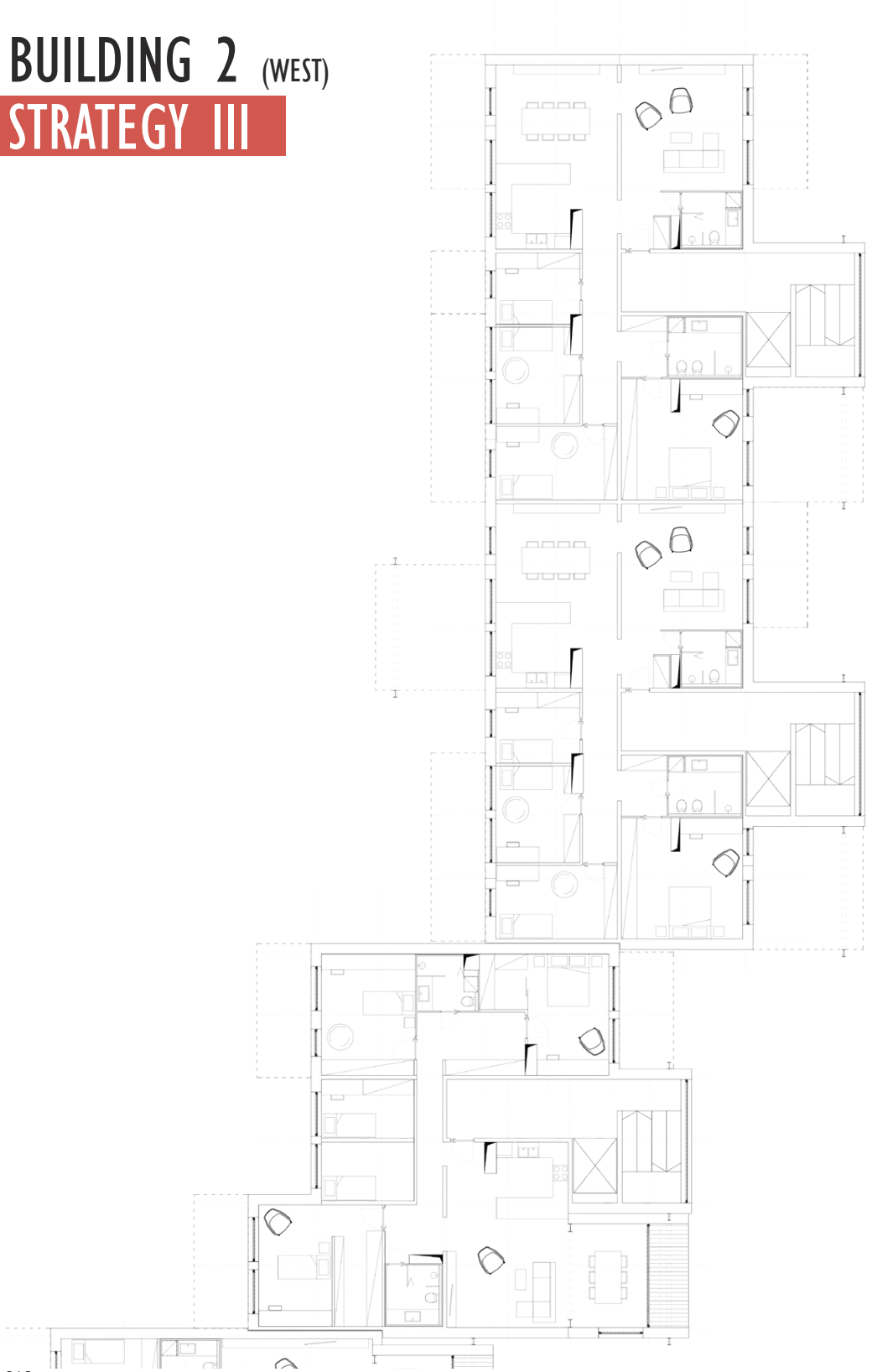
BUILDING 2 (WEST)

STRATEGY II

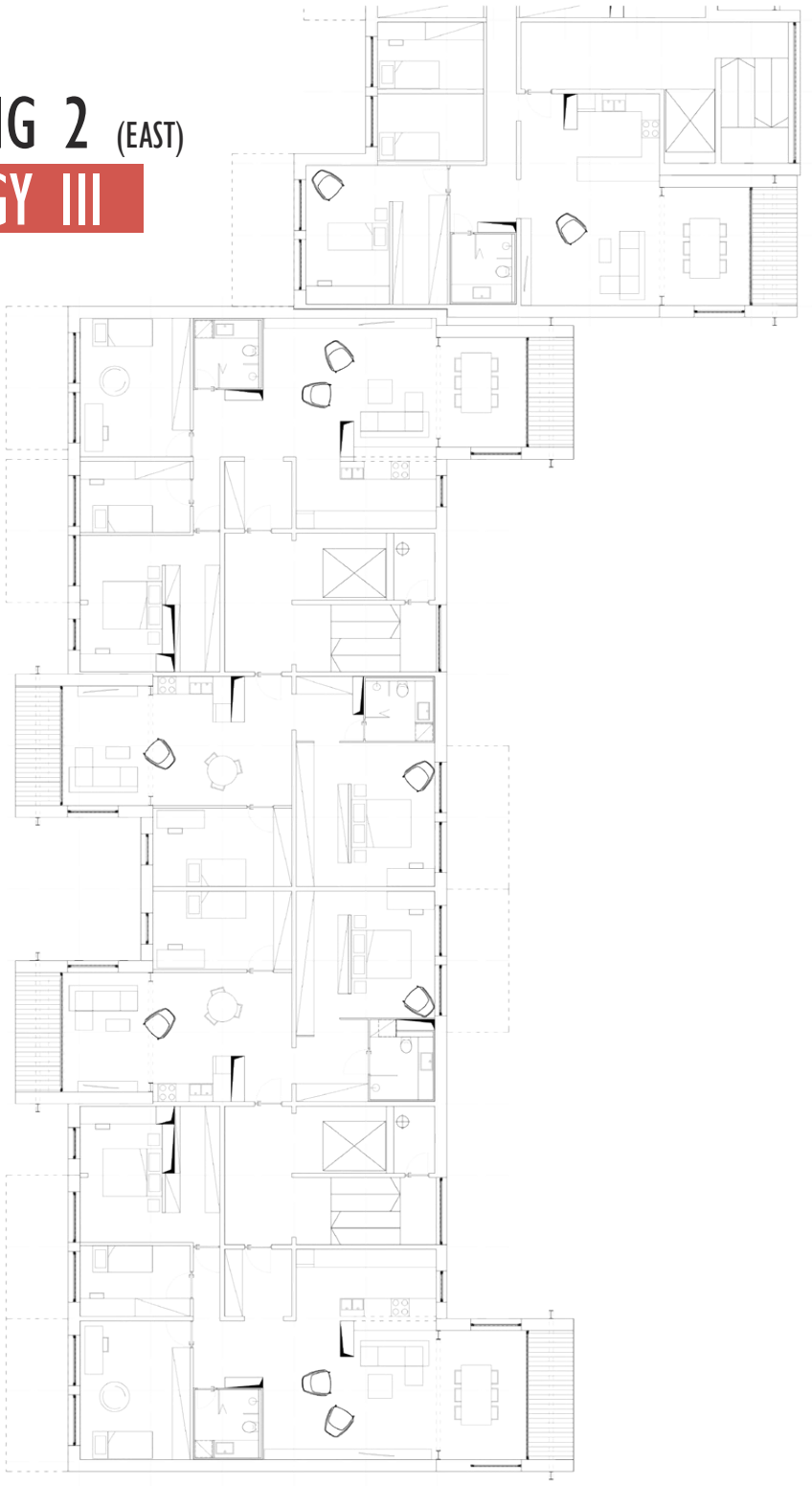
BUILDING 2 (EAST)

STRATEGY II

BUILDING 2 (WEST)
STRATEGY III



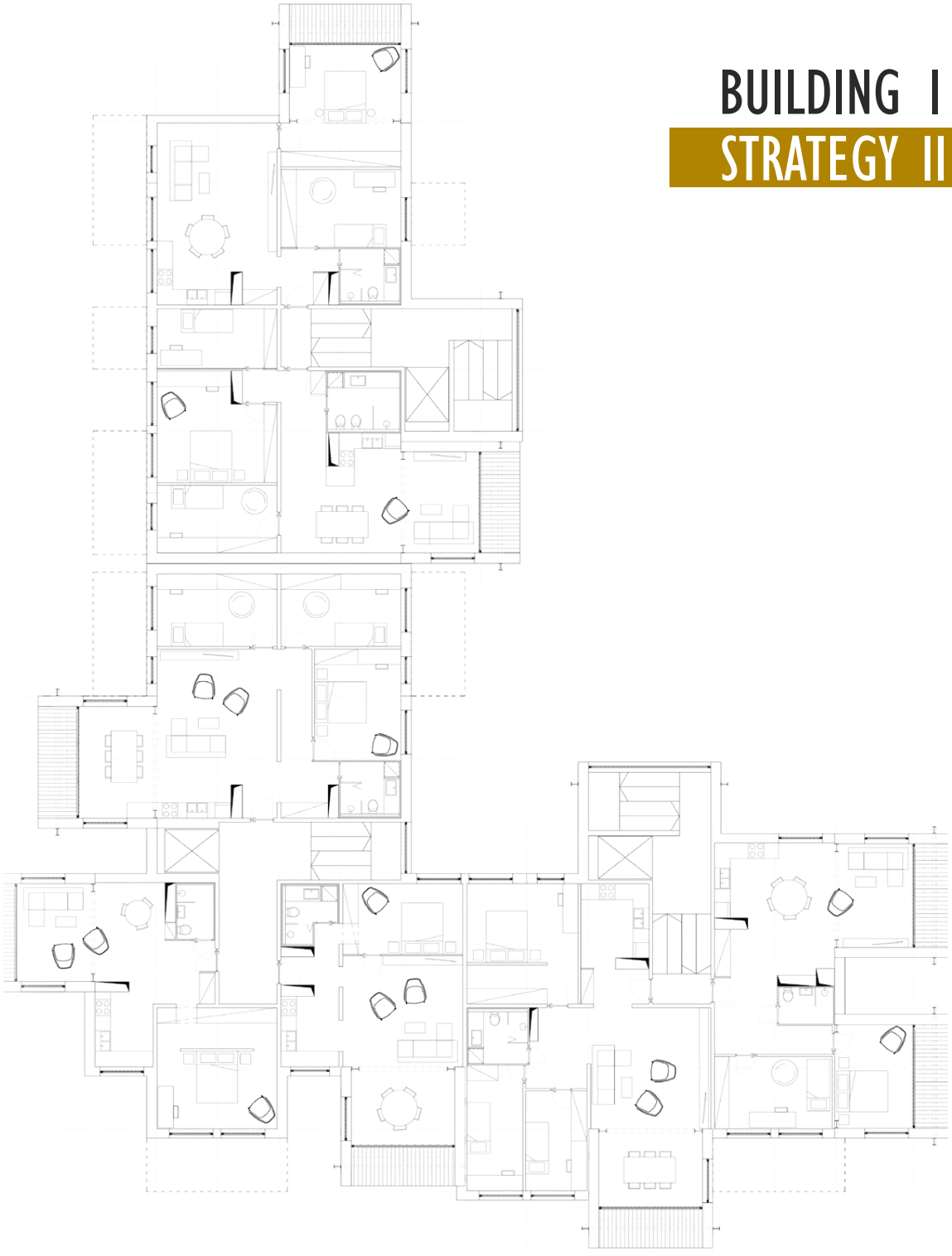
BUILDING 2 (EAST)
STRATEGY III



BUILDING I
ORIGINAL

BUILDING I
STRATEGY I

BUILDING I
STRATEGY II



BUILDING I
STRATEGY III