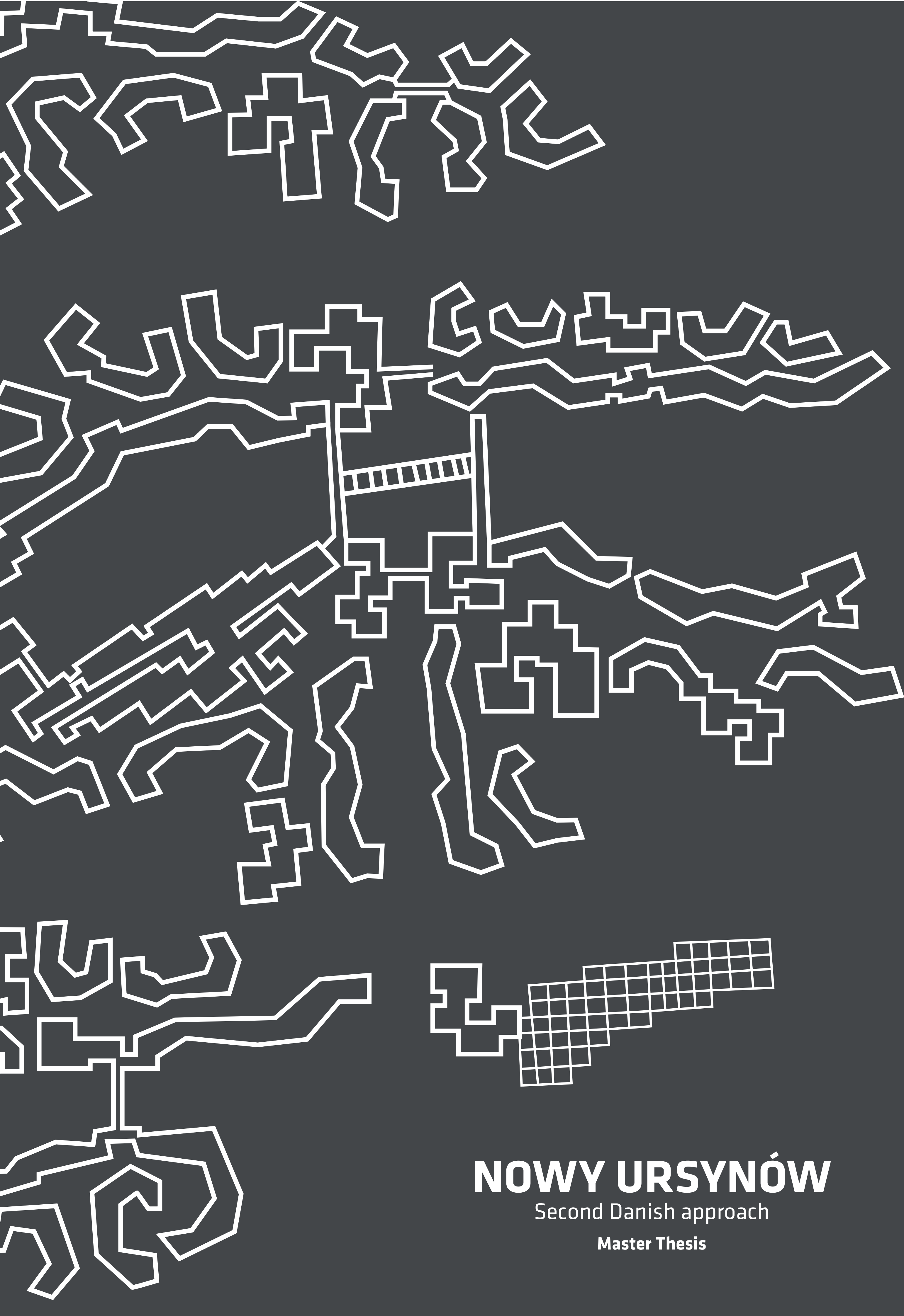

NOWY URSYNÓW

Second Danish approach

Master Thesis

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Second Danish approach

Master Thesis

Theme
Sustainability

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ABSTRACT

"Nowy Ursynów" is a master thesis focusing on the housing problems of panel block housing compounds commonly known as a characteristic part of polish city landscape. Project site is situated in one of the Warsaw's districts, Ursynów.

This paper focuses on urban development of this part of the city and architectural approach to redesigning and revitalizing prefabricated buildings as well as on social and sustainability aspects. It tries to determine universal solutions for this part of the city, that will enhance its qualities in micro scale, by providing new spatial solutions, and in macro scale, to solve social problems that are characteristic for modernist settlements.

On following pages thorough analysis of existing conditions is presented and consequently all types of issues are diagnosed. Basing on that background check authors present solutions that resolve them in terms of social, spatial and technical aspects enhancing the existing compounds.

READING GUIDE

The following text is uniquely made by the designers of this project. Nevertheless, all scientific works are based on a selection of source materials. The references will be presented in Harvard Reference style. Each time there is no reference for either picture nor the part of the text it should be interpreted as prepared by the authors of the design.

All external sources can be found in the source list on page 164 of this report. The text is divided into 6 chapters, representing different topics which were crucial to the design. Every drawing, plan or sketch is orientated with north at the top.

ill. 3.1. Panel block housing on Ursynów Północny.

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BACKGROUND

Poland is a country of a troubled history. WWII and post-war influence of USSR as a part of Eastern Block, isolated Poland from the Western Europe.

In 1918 WWI ended with a Germany's capitulation. After 123 years of partition, Poland regained it's independence. For the next 20 years country started rebuilding, Unfortunately, those peaceful times didn't last long. In 1939, Poland has been invaded, again. During WWII country's nobility and intelligentsia have been slaughter or exterminated in the Nazi death camps. Poland, with it's unfavourable geographical position, became a battlefield between Axis and Alliants. Most of the cities with a Warsaw (capital of Poland) ahead were torn down like a houses of cards. Warsaw was the one that affected war destructions the most. On Tuesday 1st of August 1944, at "W hour" (17:00) the Warsaw Uprising became. Defence of the city took 63 days and ended with only approximately 30% of the whole city left. Left side of the city was destructed in 84%, while right side "only" in 65%. The population of the city descended from 1.4 million to 400 thousands. Few months later, in 1945, WWII ended.

After the War, Poland was included in to the Eastern Block. In 1947, when things started to settle down, due to rising influence of United Soviet Socialist Republics regime in the Eastern Block, the elections were falsified leaving an open path for social communist agenda to spread over the country. Just after the war, in 1945, by virtue of "Bierut`s decree" all private properties have been nationalized. Any kind of disagreement with a new law resulted becoming an enemy of the State. The ultimate goal was to make everyone equal and to remove money from the market as goods would be produced and assigned to those in need. Theoretically the idea was beautiful yet as all utopias, take "Brave New World" by Aldous Huxley ended up more like "1984" by George Orwell. It turned out practice and theory are only the same in theory in practice in turned out to be otherwise. For nearly forty years the country, whose economy was strongly exploited by USSR, struggled with scarcity of goods of any kind. Possessing a phone, TV or a car was close to impossible throughout whole communist era and at the end of it, after 1981 the only available good in shops was vinegar.

In 1989, after the Chernobyl disaster and second Afghan war, for both of which, USSR spent billions of dollars, it`s power and influence started to decrease dramatically. As a result, iron curtain agenda was given up, making space for revolutionary movement called "Solidarność". Therefore Poland claimed it`s sovereignty an was again recognized as independent nation. One might say that freedom of all former soviet republics is a child of war and nuclear disaster.

Resulting issues regarding the history of Poland are extremely complex, yet we will try to do our best to explain the type of impact it has over Polish land and people.

ill. 9.1. "Skyscraper" made out of 18.000.000 cubic meters of rubble from WWII *(Tymek Borowski, 2015).*

ill. 10.1. Ursynów Północny under construction *(haloursynow, n.d.)*.

THESIS

Panel buildings were cheap and simple solution to solve after war housing crisis. Therefore those buildings were erected with lowest cost possible and as fast as possible. In consequence they are suffering from various problems such as distorted modernist aesthetics, massive energy loses and poor living and social conditions. They have created sad landscape of heartless "machines of living" in many cities around Europe. Those modernist compounds were also built around whole Poland and 50 years later there are still over 12 million people living in them. It has become widely discussed problem but solutions are hard to present due to political and administrative factors.

This is why the idea for the project is to make a case study, taking Ursynów Północny as our example, and develop an idea of universal way of action that can solve this massive problem. By extending existing apartments and creating external layer of the building it will be possible to ameliorate living conditions for inhabitants on multiple levels such as social, spacial, aesthetic, functional and indoor climate qualities. As all of those buildings base on the same structural plan therefore it is possible to develop thinking pattern for renovation that will veil existing constructions and will be adjusted to local issues. As relocation of 12 million people seems pretty difficult we have decided that proposal must present easy way to renovate those buildings and thus solve the problem of „expiring compounds".
Apart from revitalisation of the buildings themselves it is also crucial to introduce services and facilities that will bring life to public space between the blocks and meet the requirements of their inhabitants.

We believe that it is possible to solve those problems by coming up with the proposal that will put new, up to date, qualities in those deteriorated areas.

MOTIVATION

We live in times of mass production of all goods. Quite often things that used to be of significant value for years are now perceived as FMCG - fast moving consumer goods. This problem is also applicable to architecture.

In developing market of Poland right now around 10 percent of newly built flats are bought as investments and ca. 15 percent of those have never been seen nor visited by their owners. Condo hotels model and FIZAN models make investing in real estate possible even for those who do not have millions at their disposal. The market is drifting towards turning once one and for all flat into a thing that is a subject to financial machinery and value of which is measured by annual interest rate.

On the other side of this market there are old buildings that often occupy very expensive plots in good locations. In Warsaw those are often deteriorated panel constructions.

Topic of that thesis is somewhat personal for us, students coming from Poland. Since fall of communist regime we have been observing slow, yet gradual renovation of public institutions, spaces and habitational units. Those efforts are mostly successful nevertheless there are cases that has always been a failure. Among those there are mentioned buildings built as prefabricated blocks of flats in pre-casted panel technology that is obsolete nowadays. In consequence they were suffering from various problems such as massive energy loses and poor living conditions.

Since the communist times and revolution of building industry it has become clear that problem of those massive compounds spreaded all over the country has to be addressed. That is by far problem of 12 million people in around 4 million flats. A giant one. Those buildings are big part of the city and because of their characteristics, that are way poorer than newly built ones, they become an obstacle for investments, effectively creating areas with poor social qualities, locking city's densification and development. Both of which city needs. Tearing them down does not seem an option both due to necessary relocation and anti-FMCG agenda that is becoming more and more popular. What to do with them is the answer that we will provide in this paper.

As young architects we feel the drive and urge to make our surroundings beautiful and comfortable for people inhabiting it. This is why we have decided to touch that difficult subject.

PROBLEM/IDEA

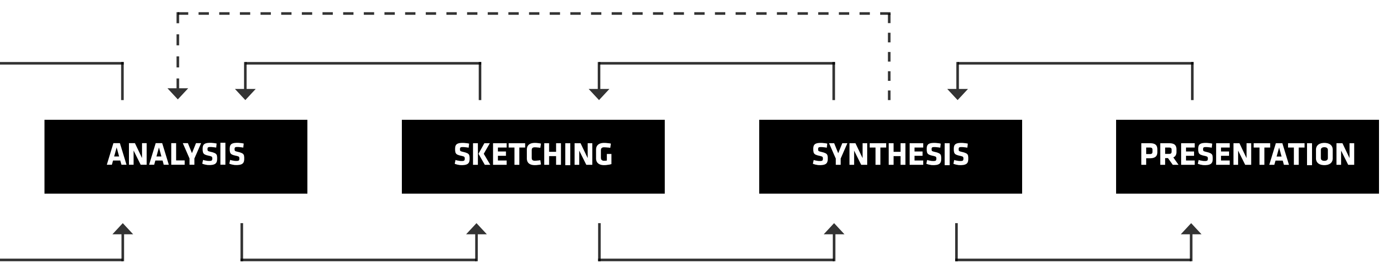
METHODOLOGY

IDP - integrated design process is a workflow model that is immanent for doing architecture of any kind. As it was necessary to give a name to this widely popular way of working (defined by Mary-Ann-Kundstrup) we will explain the basics of our approach. Whole process of designing is nothing like one-way. It is more iterative therefore it is necessary to return to some earlier phases to change design parameters in order to be able to move forward.

In this project IDP bases on thorough analysis during which different aspects of architectural, spacial and social reality are taken under observation. It was crucial to present social background for this project due to differences of perception in between Denmark and Poland. Thus apart of the historical analysis of the plot and situation recent problems have been diagnosed and typology of inhabitants was made.

Further on during the sketching phase different approaches to the problem have been studied to finally, after many iterations allow us to present a solution that was viable for further development into design phase .

Last part of the process was fine tuning of the volumes and their performance in all aspects that had been pointed out during analytic part. That beating allowed us to test the idea in order to make sure that the proposal is a fine solution for this urban and social landscape.
As the process was really complex all phases interlaced and often it was necessary to take a step back to revise initial idea in order to provide better qualities of final product.



ill. 13.1. Phases of Integrated Design Process.

BACKG

ROUND
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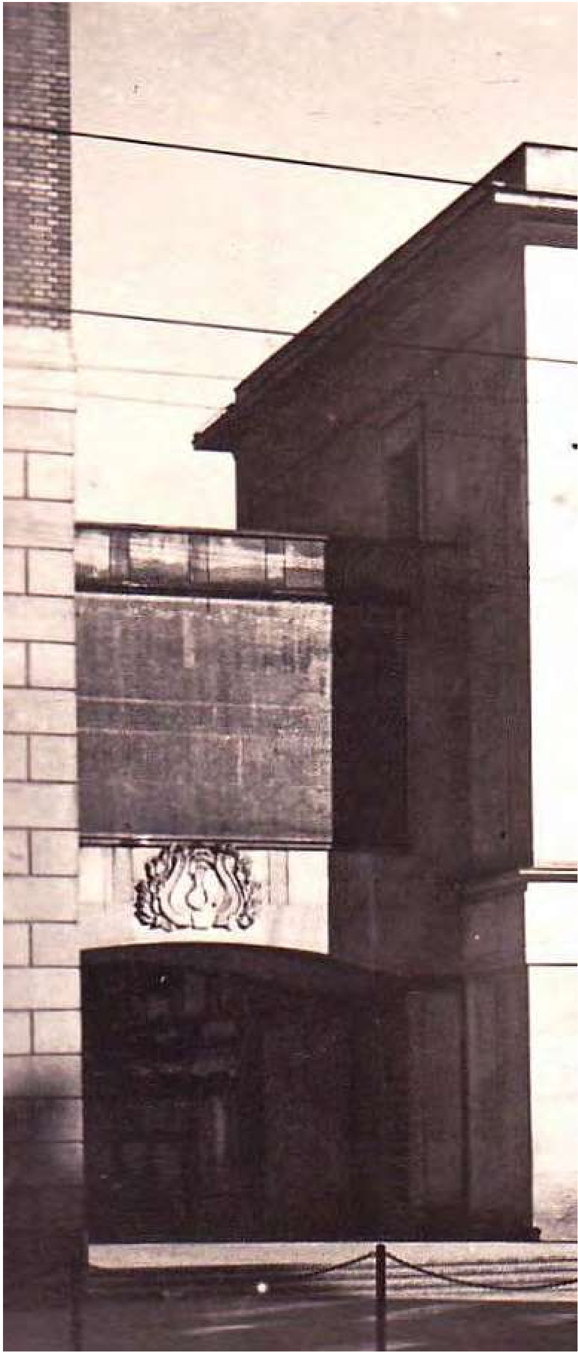
WHOLE NATION REBUILDS ITS CAPITAL



SIX-YEAR PLAN

"Basic rule of social building industry - putting an emphasis on creation of best conditions for creative development of human being - it does not end with organizing places to live and work. Isn't it uniquely important to develop education, heath care and cultural institutions in order for labour party children to develop properly? Capitalist regime has always neglected needs of working people [...]"

(Bierut,1951)

With those words Bolesław Bierut leader of Polish leading political party motivated direction of future Warsaw development in late 40'.

There were plans to leave what was left of the city in 1945 as a memorial of war disaster, but finally decision has been made. Warsaw would be rebuilt as an example of perfect socialist city.

This is why series of revitalisation plans had been introduced. They consisted of wide urban planing that was supposed to take in massive increase of city population that communist regime planned. In total there were 5 plans dealing with different city problems. Firstly during three-year plan city was cleaned from rubble. Later on Six-Year plan aimed at creating very foundation of main urban plan. Later on, the Five-Year plans followed.

Most important postulates of Six-Year plan were:

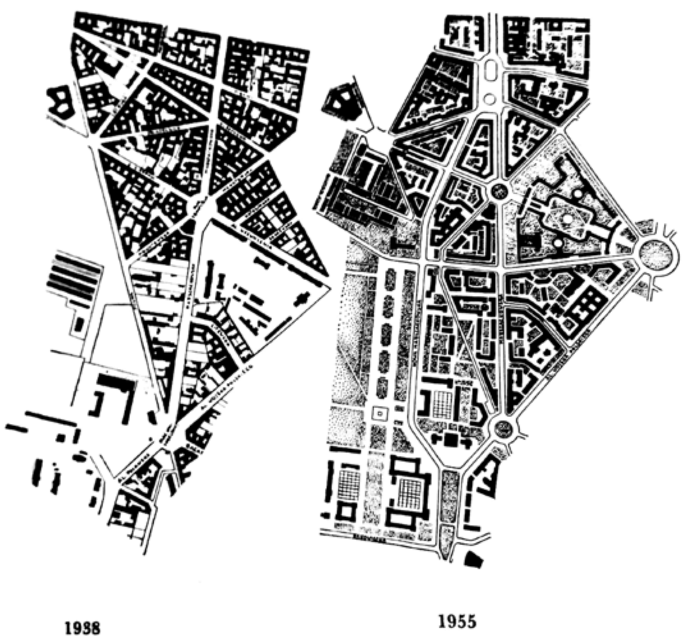
- "*using existing undergrund infrastructure laid under existing streets"*
- *"breaking down capitalist tradition of pushing workers out of downtown by building blocks for them close to it"*
- *"rule of strict connection in between newly built compounds and factories"*
- *"introducing housing into major urban plans for city center"*

(Bierut,1951)

ill. 17.1. Department Store in Warsaw with a motto in Polish “Whole Nation Rebuilds Its Capital” *(Empik Cafe, n.d.).*

In order to achieve that, an urban plans for development of Warsaw were made. Warsaw was divided into three main parts - downtown, residential circle with factories and satellite cities in forests around. That massive action had to financed, therefore there was special extra tax introduced. It was called “Warsaw rebuild fund” and was collected nation wide for three years between 1950 and 1953.
What is more, central government realised a plan of repopulating the capital with citizens from the countryside, what changed social tissue of the city for decades.

Those plans were very important in process of city reconstruction. Never before and never later has whole nation united to pursue one goal. Even though pre-war city structure wasn’t recreated, those well organised and consequent actions rose the city from ashes. The quality of that rise is however, a disputable matter.



ill. 17.2. Redesign of so-called Warsaw’s “kite” *(Bierut, 1951).*

ill. 18.1. Six-Year Plan - Central Distrocts of Warsaw *(Bierut,1951).*

TYPOLOGY

Forests

Industry

Parks

Urban Area of High Density

Urban Area of Low Density

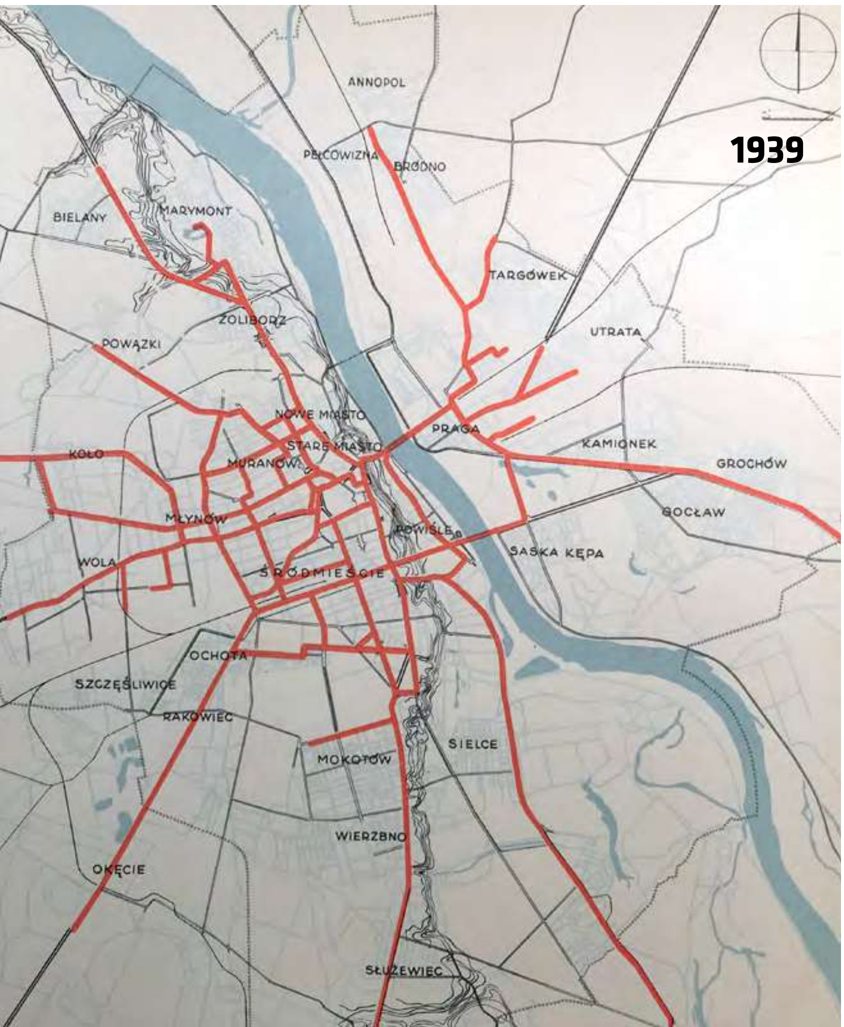
Schools

Sport Facilities

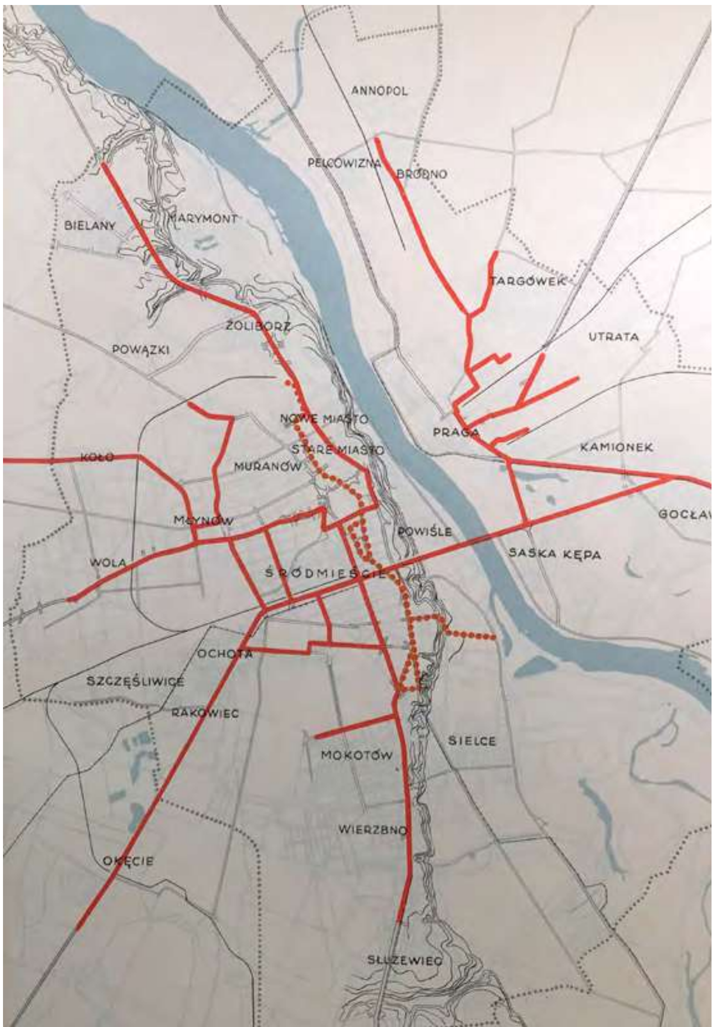
Whole rebuilding process had to reflect political agenda. Therefore streets were made wider. Parks bigger, buildings taller and the span of the city changed making it take more land. This is why urban design of Warsaw as it is today characterises with such low population density compared to other European cities. It is just 3352 people on sq. km *(Warsaw City Council, 2016)*.

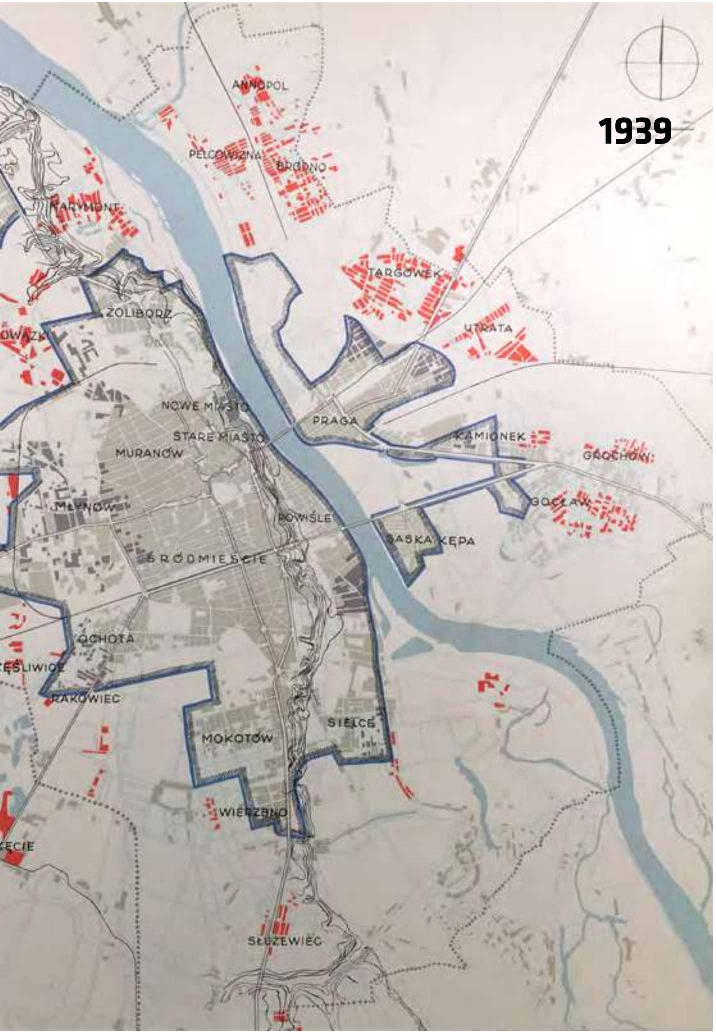
ill. 20.3. Wo

ill. 20.1. Public transportation in Warsaw before WWII *(Bierut,1951).*

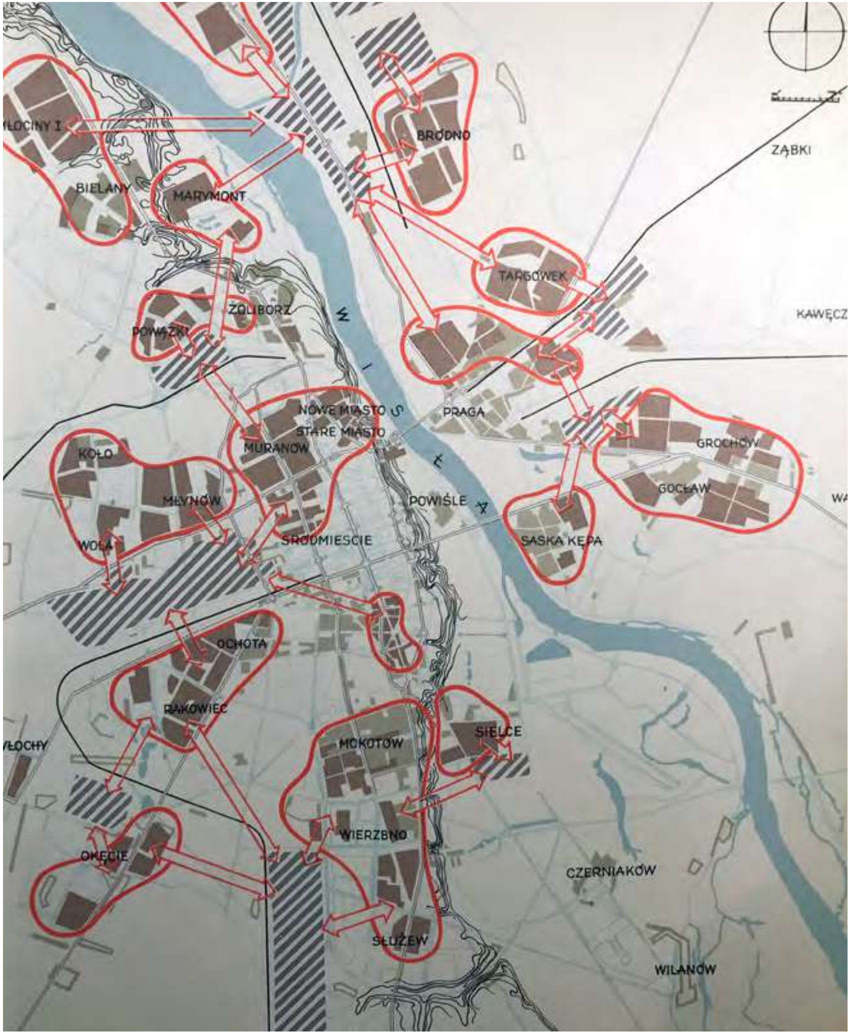


ill. 20.2. Public transportation in Warsaw after WWII





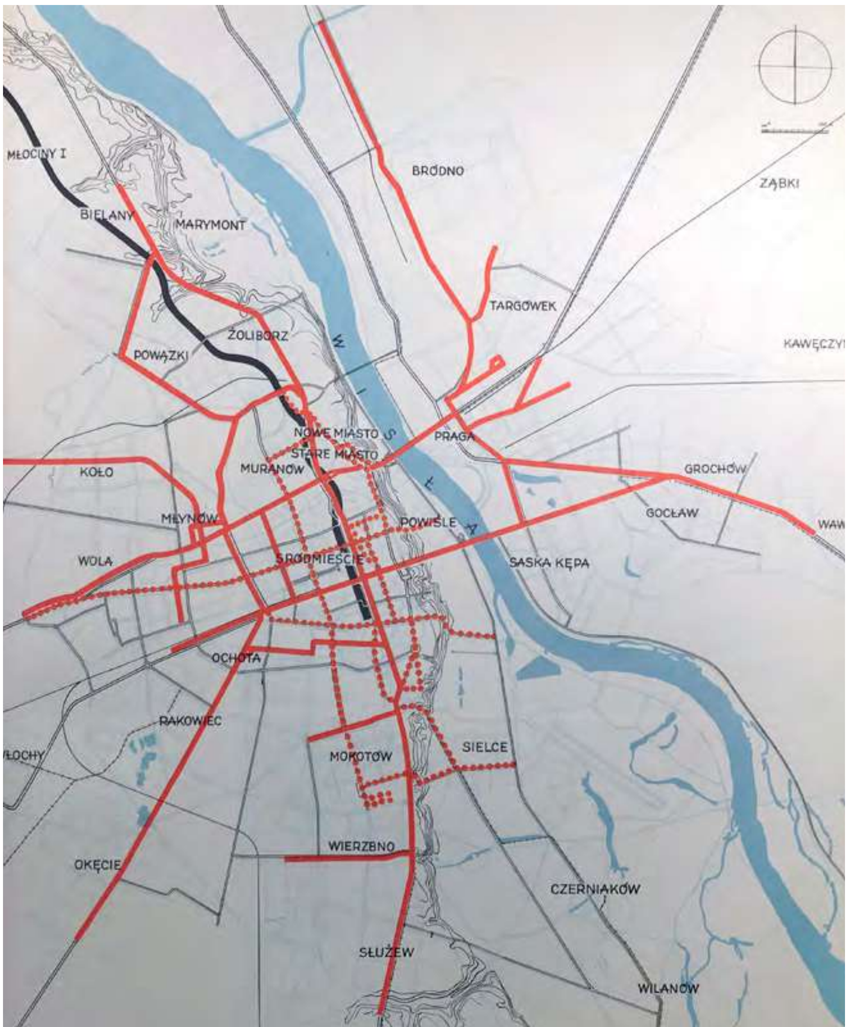
rking-class neighbourhoods before WWII *(Bierut,1951).*



ill. 21.1. Dwellings and Industry according to Six-Year Plan *(Bierut,1951).*

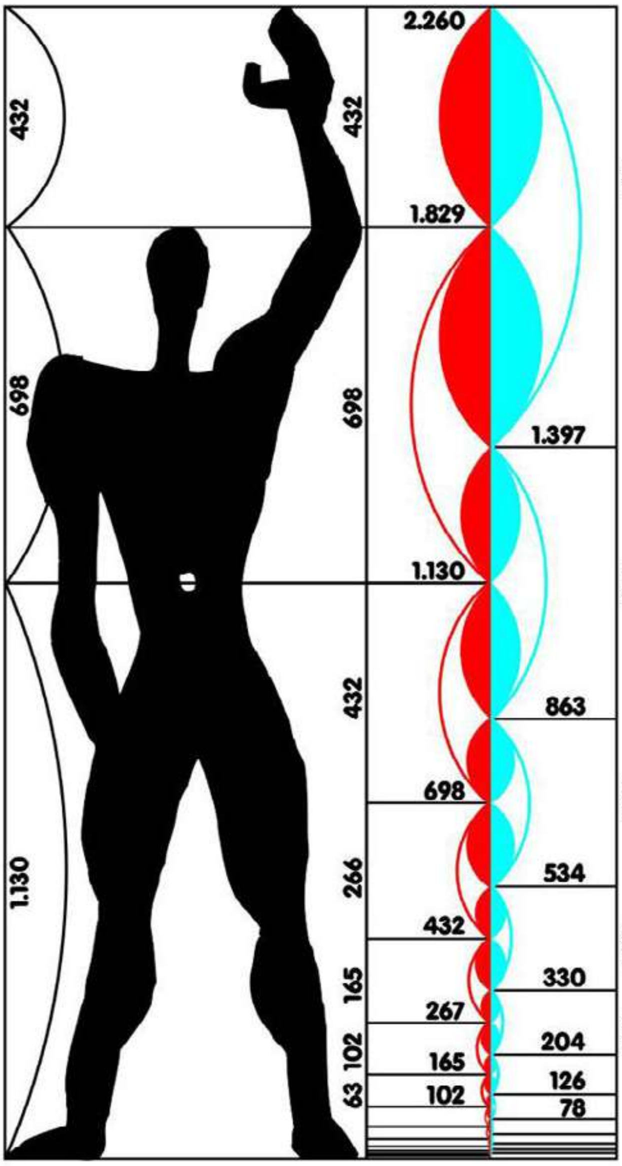
(Bierut,1951).

ill. 21.2. Public transportation in Warsaw in Six-Year Plan *(Bierut,1951).*



On the left there are 2 graphics (ill. 20.1., ill. 21.3.) that present different aproach to urban planning on example of communication grid. In 1939 it was denser and more organic as downtown of Warsaw had been naturally grown city. During the rebiulding process, due to modernist agenda, massive compounds, with lots of greenery, were introduced in place of once dense city. Narow streets were planned as big arteries and city ceter were avaliable from north by a subway line. All those attempts changed once very romantic face of city into modernist statement.

PREFABRICATION



ill. 22.1. Modulor *(Le Corbusier, 2000).*

HISTORY OF PREFABRICATION

Panel buildings were first introduced right after first world war in Netherlands and later in 1923 in Berlin, Germany on two storeys high compound of houses.

The technology found its way to architecture thanks to Walter Gropius who studied the potential of the technology of panels in 20'. Great boom for prefabrication however started after 1933 when most renowned architects and urbanists of the world signed Athens Charter containing modernist declarations. Le Corbusier's idea of "machine for living" fueled development of panel system with designs such Unite d'habitation

ill. 23.1. Ursynów Północny during the construction in late 70' *(Rutowska Grażyna, 2018).*

1956 - Marseilles, France or Habitat 67 by Moshe Safdie in Montreal, Canada *(Wikipedia, 2019).*First panel systems based in Modulor proportions with height of 183 and the same figure with raiser hand - 226 cm. All other dimension are multiplications of those dimensions *(Le Corbusier, 2000).*

Later on many systems were developed in order to meet certain expectations and requirements of local markets. First massive constructions were erected in late 30' in France, Sweden and Finland. Panel buildings got lots of attention in Germany as well. Despite the ease of construction in 70', most of the Europe gave up the idea of prefabrication mostly due to rising prices of road transportation - getting the elements to construction site has always been a problem and because of that this technology was more expensive than it seemed. When countries of western Europe abandoned the idea it still flourished in Poland where it was used till the beginning of 90' when need for more sophisticated architectural forms made prefabrication unsuitable as a system that limited architectural expression.

PREFABRICATION IN POLAND

Development of housing prefabrication in Poland started with a rebuild of cities after WWII caused by lack of housing units. First prefabricated elements were created from a brick rubble. In the mid 1950s manufacture of bigger prefabricated elements started with a use of cranes on construction sites. It is time, when cegła żerańska (żerań brick) was developed, characterized with long ducts inside of a prefabricated element, that lowered weight of the element and was narrower than other systems - up to 150 cm wide. Few years later, at the beginning of 60s, a panel block housing started dominating prefabrication industry. All of the major construction offices were working on their own panel block systems. Housing compounds in those systems were created in perpendicular construction layouts with curtain walls created from autoclaved aerated concrete / autoclaved cellular concrete while structural elements were made

from reinforced concrete. It allowed to construct buildings up to 11 storeys. Construction of higher, 16 storey compounds were possible thanks to other systems like “OWT” (Oszczędnościowy Wielkopłytowy – Typowy | Affordable Large Panel Typical System) “WWP”, “Raje” or a “Fadom”. All of them were developed in all Polish major cities. Technologically, both longitudinal and transversal wall were structural elements, while the slabs were thicker than in Żerań Brick system, what let to cover up to 6 meters long span between structural walls. Despite all of the technological advantages, all of those systems were unable to satisfy deficiency of flats on a market, due to high construction costs *(Wikipedia, 2019).*

Later, in 1967, Technical Department of Ministry of Construction together with Association of Polish Architects announced a competition for a new complex housing system. New winning system W-70, designed by Maria Piechotka and Kazimierz Piechotka, allowed a higher diversification and flexibility in designing interior spaces. It implied 3 building heights - 5, 11 and 16 storeys and insertion of new elements and details base on proposed designs. Primary structural system characterized on transversal layout of structural walls, where inner construction walls were 15 cm thick and didn’t appear in a precinct of a flat. The system became nationwide, manufactured in so called “House Factories”, located next to the construction sites. Improved version of W-70, Wk-70, has been used in Ursynów Północny in Warsaw to construct housing compound on the chosen site for this project. It is estimated that over 35% of all panel block housing in Poland has been erected in W-70 and Wk-70 systems *(Wikipedia, 2019)*.

Prefabrication of housing compounds continued till the 1980s, when the economic crisis and political transformation led to collapse of “Housing Factories” and quit of prefabrication in favour of reinforced concrete. Nowadays prefabrication in Poland is mainly populated in road construction and large area construction such us stadiums and industrial buildings.

ill. 24.1. Workers on a construction site of Ursynów Północny *(Rutowska Grażyna, 2018).*

LIVING IN A PANEL

SATELLITE NEIGHBOURHOODS

Appointed at the begging of 1945 Office of Capital Rebuild (Biuro Odbudowy Stolicy) designated city functions and development directions, capacity of the capital and social fabric. Established Functional Layout of City Development structurized city into housing, industrial and recreation areas.

Similarly to satellite towns, where smaller metropolitan areas located near to a bigger metropolitan city, act independently, the Office of Capital Rebuild designed 3 basic spatial units: housing colony, compound and district. The city divided into Downtown (Śródmieście) with a dense urban structure and plentiful in green areas, Greater Warsaw (Wielka Warszawa) acting as a housing area filled in with greenery and Warsaw City Unit (Warszawski Zespół Miejski) with scattered colonies in forests.

Satellitte neighbourhoods (FR | grand ensemble) appeared for the first time in France in mid 1950s and became popular in other European countries in second part of XX century, especially in countries like Poland, where urbanization process was delayed and started rapidly after the war. Enormous housing need resulted in hundred of thousands housings that were cheap and poorly constructed.

Pace of development and lack of urban aspects created areas densly populated where colonies were constructed next to each other, creating indifferent spaces merging into bigger housing structures, where local communities were impossilble to emerge.
It didn't take long till those places became city's bedrooms who's inhabitant were spending their entire days in central districts of the city (Downtown) working, studying and spending thier free time. Lack of cultural places, concentration of services only in particular areas of the districts and poor public transportation strenghten the problem.

Set of major problems have been diagnosed by Andrzej Basista and are enlisted below:

- huge number of parking lots (embraces private communication)
- lack of social bounds between people living in the buildings that are too far away from each other
- massive green areas - parks, suares, gardens, meadows
- organized greenery was dominated by tall prefabricated blocks causing a feeling of empty spaces inside the neighbourhoods
- landscape monotony - all of the buildings looked alike
- concentration of services only in particular areas of the districts
- lack of cultural places such us theaters, cinemas, museums and art galleries
- availability of social facilities such us nurseries, kindergardens, elementary schools, sport clubs, libraries, post officies and health clinics
- limited public transportation in comparsion to Downtown
- distanced working places
- merging of neighbourhoods in to bigger urban structures

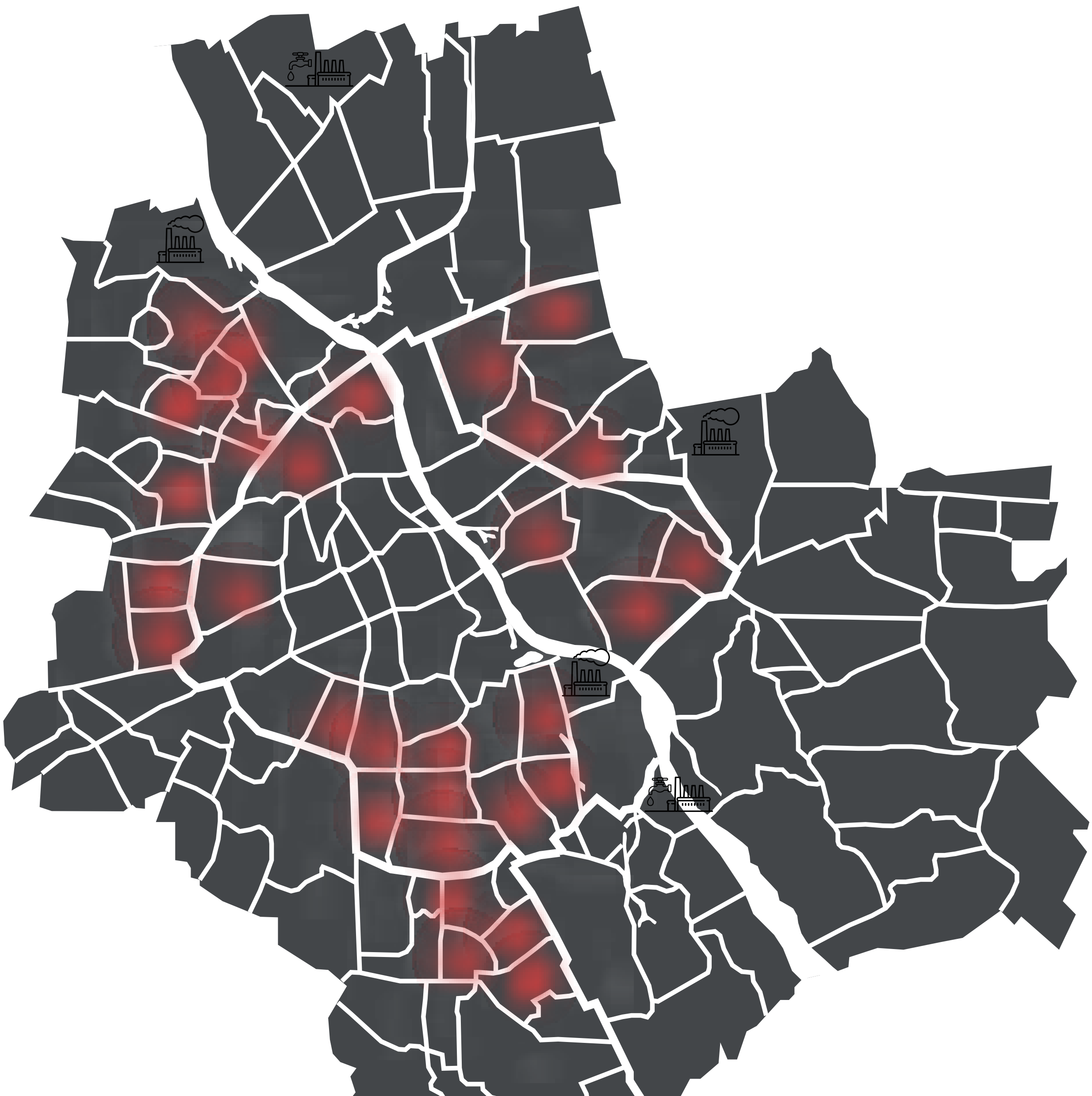
(Basista, 2001)

TYPOLOGY

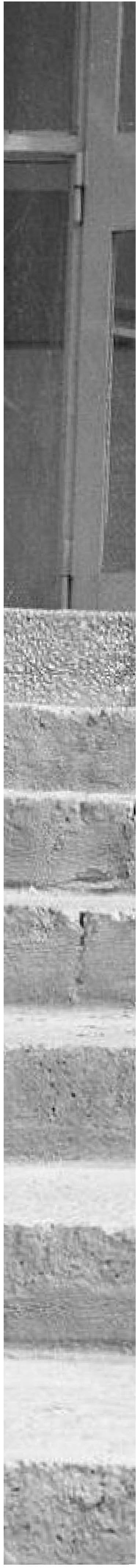
Areas with a hight density of panel block housing compounds

Power Plants

Sweage Treatment Plants



ill. 27.1. Location of panel block housing compound is Warsaw.



HARSH REALITY

Initial Danish driven ideas that were brought to the project by Marek Budzyński made a dream about future compound very romantic.

Initial ideas consisted of various types of services overlapping themselves in space of the whole enterprise. Shops and bars along with the clubs were supposed to be created. Habitants were supposed to participate in social life of the neighbourhood by organising their own spaces in within it. By the blocks greenery was given to people who were offered a chance to organize their own gardens.

Special units responsible for social background checks and surveys in order to provide people with most suitable apartments were planed. There were even plans to provide service of food and groceries delivery system from shops to flats. Big shopping passages were planned.

Flats were supposed to be a lot bigger than country's average, balconies had intriguing shapes and most of the inhabitants were people with higher education. Architects were asked to analyze their needs so the trips to city centre were hardly ever necessary. Adjacent greenery was planned to host playgrounds and whole compound was supposed to function as a village were people knew each other.

Thanks to systemic plan of populating the area keys to adjacent apartments were usually given to people of different backgrounds. Like nowhere else highly educated families were neighbours to blue collars. The factor that helped that system to work were obviously the kids. Thanks to baby boom in each block there were many families with kids that played together in the courtyard disregardless of any class divisions. Thanks to that those massive compounds did not change into ghettos like for instance in France.

Some of those ideas were successfully introduced however most of them failed. Due to scarcity of means initial plans of the district were not fully realised or were realised with great delay.

Once leaving your flat to do groceries you would have to walk for several hundred meters to nearest shop. Same problem was to be experienced while getting kids to school or going to work.
In closest neighbourhood of typical apartment there were hardly any facilities and public spaces consisted mainly of greenery with little if any facilities for kids.

Buildings themselves did not have any facilities like washing rooms, common spaces, gyms etc. Given today's standards the settlement was not meeting any basic requirements. Especially in terms of spatial qualities. Standard was to have 11m2 per person *(Nadolny, 2010)*. On Ursynów it was around 15m2 - still not much. Living a life with whole family on such small area is a struggle. In some cases one of permanent sleeping places was planned in living room on the couch. Today it is unthinkable and yet people are still living this way.

Conclusions

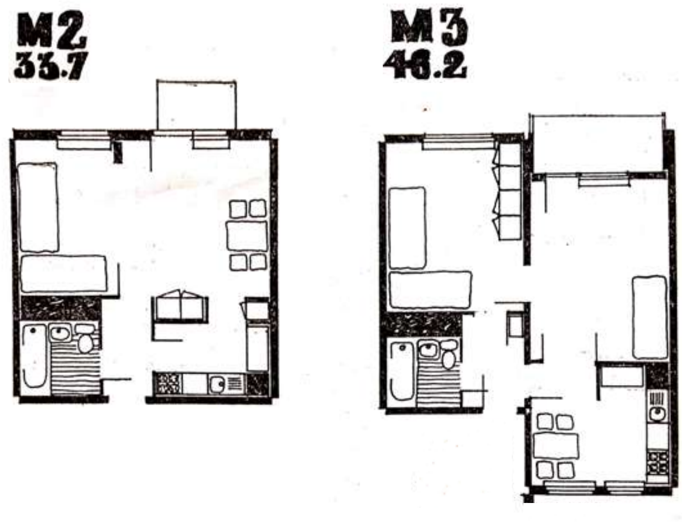
The initial idea for this district was pretty revolutionary as for it's times. A bit to revolutionary. Lacks of communist system and mentioned miss fit to polish reality of those times were the reasons for it to fail. Despite those misfortunes even though unfinished the idea behind whole concept remained valid and is asking for another implementation attempt in the new reality that has been created after 1989.

ill. 29.1. Kids playing outside *(Rutowska Grażyna, 2018).*

ill. 30.1. Children playing on beater *(Schmidt,1976)*.

"Designers planned everything as it should be, but they did not stood their ground when schools, medical h or houses were not built in time. Not mentioning cinemas or theatres. When in 1976 and 1977 first inhabitants were moving in, no one including them, did not complain that construction of the subway that was soon to be a necessity, had not yet started. Today's Ursynów is precisely that - a compound of not realised dreams and disappointed dreamers. This is no surprise that it was hard to create a micro society and they still remain mostly a lonesome gathering of families"

(Roszewski, 1983)



WHERE I LIVE?

In the city scale, the society has a massive impact, yet individual situations are the very foundation of the whole wider picture. This is why it is uniquely important to focus on qualities that are available for it.

Typical apartments were actually bigger than standard ones from that time. Blocks consisted ofM2,M3,M4,M5,M6 and M7 flats. The number after the letter M states the number of people for which the apartment was designed. State regulated areas changed many times however there were only two major laws regulating minimal and maximal area of each type. First one called "normatyw mieszkaniowy" - the apartment standard, was introduced in 1959 and another one in 1974.

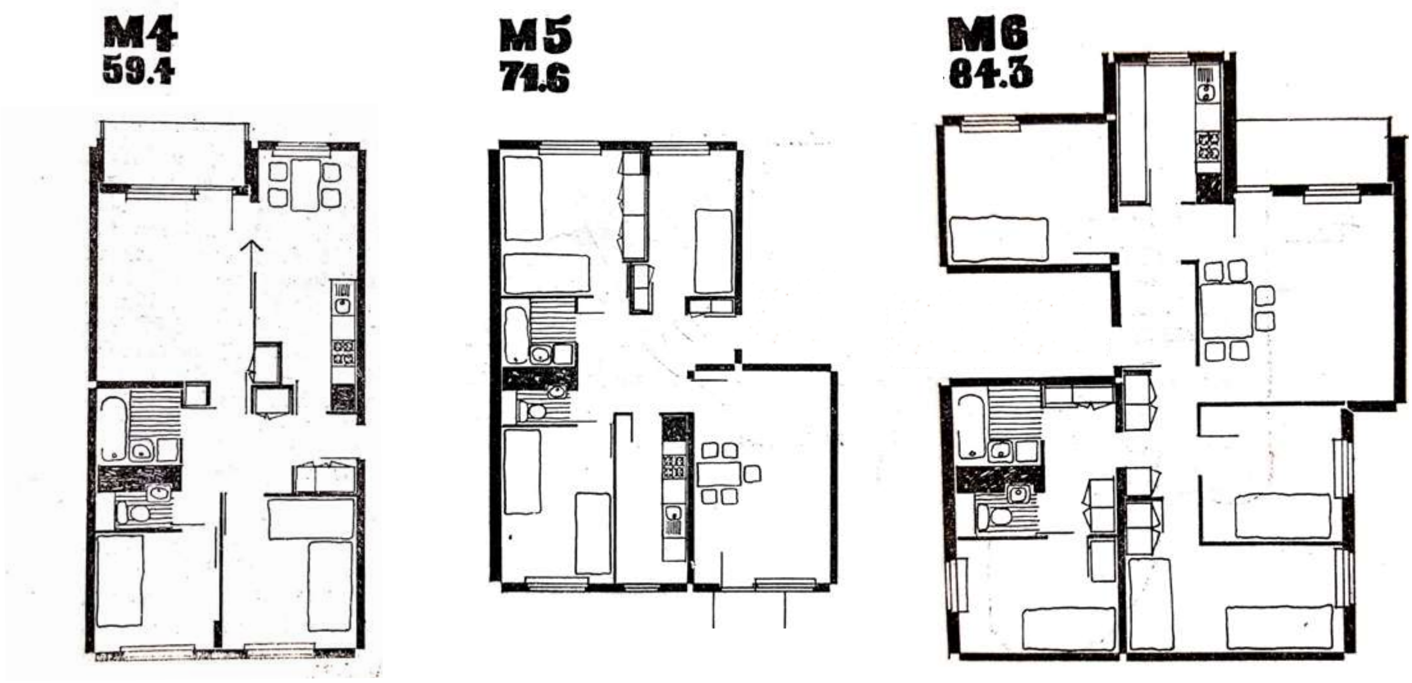
Types of apartments and their amount in total amount of flats in whole district.

- M2 - 9,6%
- M3 - 19,4%
- M4 - 50,1%
- M5 - 9,8%
- M6 - 9,4%
- rest - 1,7%

(Ursynów-Północny, 1975)

As it can be clearly seen most of units were M4. Typical family in Ursynów compound was a nuclear family that was given a flat of 61,2m2 - M4 that consisted of 2 bedrooms, living room, bathroom, WC and kitchen.

ill. 32.1. "Falowce" in Gdańsk, Poland *(Anon,1986)*.



ill. 33.1. Initial design of the apartments - never executed *(Ursynów-Północny, 1975).*

That was the standard meant to satisfy needs of standard family. Usually functionality of those flats was far from perfect. Due to limitations of prefab system interiors were cramped and small. Some of the flats had balconies, other ones had only "French balconies".

"In terms of layout flats are not very elastic. Limits of panel system effectively crippled initial idea of joining the apartments or introducing moveable divisions in between kitchen and living room.
What is more very dense grid of perpendicular construction walls and sanitary shafts make any other functional changes impossible. It is impossible to join flats and change their layout."

This is why flat's layouts were set once and for all while only achievement was that their area was bigger in order to fulfill standard of "Normatyw mieszkaniowy" law.

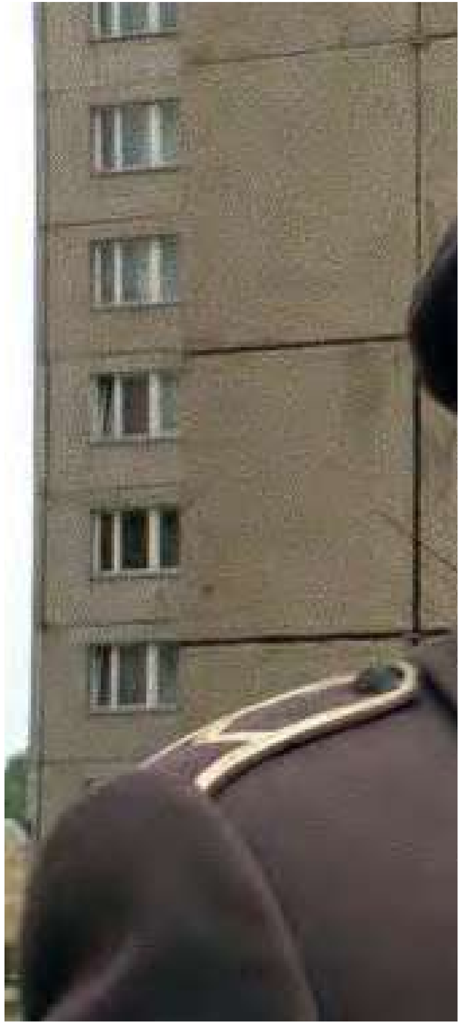
Typical areas required by law in 1974 for different types of apartments:

- M1 - 25-28m2
- M2 - 30-35m2
- M3 - 44-48m2
- M4 - 56-61m2
- M5 - 65-70m2
- M6 - 75-85m2

(Ursynów-Północny, 1975)

Conclusions

This is why extension to apartments built as outer skin for the building might be beneficial as it would enlarge the apartments by extending living rooms or providing extra room.



WHO’S MY NEIGHBOUR?

Ursynów wasn’t typical working class as it was planned from the beginning as exclusive place to live, due to Danish roots of the project the district was populated by mix of users. Around 40 percent of inhabitants were representatives of upper class while rest consisted of working class. This is why it was nothing out of ordinary that on the same floor there were highly educated families living next to worker families. Even though people were not necessarily mixing all the time compounds did not change to ghettos with social pathologies.

Obviously due to the scale whole project presented certain level of indifference as described in “*Satellite neighbourhoods*” chapter and lack of social structure but on very basic level in within buildings or sets of them social bonds were created - usually around services such as schools, clubs or shops, no matter how rare they were.

Smallest flats were called M2 and were Therefore smallest social unit that created social fabric of whole compound was a pair of people living together. As different social needs were to be met there were flats up to M6. That resulted in big families living there and as unemployment was illegal during that time and state was offering work to everyone having kids was not an economic problem. Thanks to that mix certain level of local community was created. Architects were trying to introduce places for people of different background to meet in public space creating some sort of social housing. What is more kids from different families were going to same schools and parents were meeting in process. Over the time it resulted in “social blending” as people were coupling over class divisions. All those efforts even though crooked by communist planning made a difference and for many years Ursynów was perceived as educated and desired district.

Status quo lasted for nearly 20 years but shortly after communist regime had fallen major social change started to take place. As it gradually became obvious that Ursynów no longer provides best conditions for living, representatives of upper class who mostly were successful right after system change, starting their own enterprises and consequently widening the gap dividing them from working class, started to move out leaving space for newcomers from countryside. This is why social composition of Ursynów today varies massively from initial one. From educated district it became poorer neighbourhood for people pursuing career and big city dream yet coming from simple background. That made the are vulnerable to pathologies and in late 90’ it was no longer nice place to live as level of street crime was fairly high and social bond converted from positive and creative ones to more destructive ones.

ill. 35.1. Neighbours *(Snapshot from "Alternatywy 4" TV Series, 1986).*

Right now as new parts of the city were built around it and district has been consumed by urbanization it attracted more people to the neighbourhood. Services started to appear and total level of district has been elevated. That overlapped with great general reduction of crime rate and popularisation of education. This is why social landscape looks way better than in 90' yet diagnosed issues still exist as non coordinated revitalisation (shops, services, bike lanes etc.) are merely remedy for the situation not final cure. Social tissue of Ursynów is still not very variated and people do not know each other well.

Conclusions

This is why it is so important to redefine quality of the neighbourhood and make it more attractive, so it becomes an option for all social classes, with amenities, facilities and services. All up to date and in modern standards, just like it was planned 50 years ago, but never fully realised.

IS IT MINE OR IS IT OURS?

During the war most of the city of Warsaw was demolished. The most consequent and radical destruction took place after 1944 were people of Warsaw rebelled against Nazis occupying the city. After 63 days of fights and loss of most of the city inhabitants the uprising was lost and this is when most of the left riverside city was erased from the ground as act of vengeance.

The rebuilding process started naturally as people started to clean up their plots and build something to live in. Yet the needs were massive and it was obvious that rebuilding the city was to take decades. To facilitate that in 1945 as communist regime kicked in, there were several rebuilding programs introduced. "The six and five year programs of the capital rebuild" they were called. As the land was empty and fully nationalized all past problems with buying out the plots and settling all parties issues were non existent. New urban plan was introduced against the historical city structure and with little regard for the historical scale and order of the city. From 1950 to 1965 three of those plans were executed *(Culture.pl, 2019)*.

During that time the leading style was "socrealism" which based mostly on classicist architectural motives. Therefore MDM living district and Palace of culture and science were erected. Despite it`s shiny façades the buildings did not offer perfect living conditions, however the worst was yet to come. With passing time this soviet fueled agenda that required use of massive amount of limestone and marble turned out to be to expensive to meet the requirements of the society dealing with post war population boom. This is why panel building system answering to modernist fashion were introduced. Massive compounds were built in places where there used to be dense city. White shiny buildings were supposed to be surrounded by greenery and open to light. Unfortunately the visions of the architects

ill. 36.1. *(Schmidt,1966).*

were rarely implemented and final results were mostly very rational "machines for living". Those hundred of thousands of square meters were mostly build on grounds that belonged to someone before 1945. Around 4 million of flats of that type were put to use all around the country in between 1965 and 1989 *(dzieje.pl, 2010)*.

After 1989 the nationalization of private property was recognized as unjust and the roller-coaster of ownership problems begun. People own plots under existing streets or parks. On others there are massive blocks of flats part of the apartments in which were sold to their inhabitants with exclusion of the right to the land and rest is still state owned. It is very popular that someone owns an apartment as a part of a building and does not own a part of ground underneath.

To solve that problem a remedy solution was introduced - some of the buildings that are co-ownership of private inhabitants and state are being treated as common wealth that stand on the ground that state leases to it, due to the fact that it is not yet known who it belongs to, therefore it cannot be sold.

Conclusions

In this legal landscape building something is uniquely difficult. Therefore being aware of those issues we have decided that, as this work is of a utopian and theoretical character, we will abandon this problem as to be solved in future. Let's hope that we will end up with something less gloomy than Orwell.

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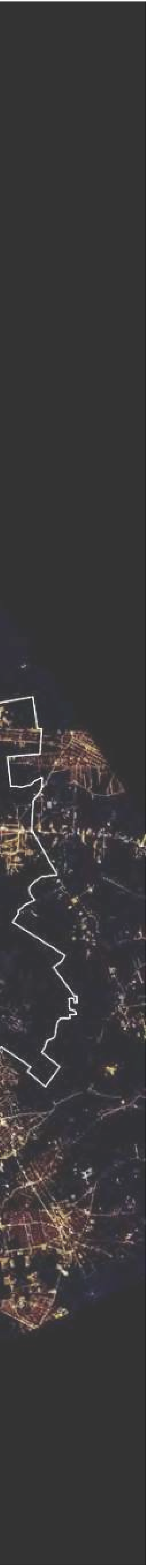
ill. 40.1. Warsaw by night. *(Eatrh Science and Remote Sensing Unit/ NASA JSC; Zespół Obserwacji Ziemi, centrum badań Kosmicznych P*



PAN, 2015)

GENERAL SITE ANALYSIS

Analysis of district characteristics, law limitations and guidelines and situation in urban tissue of the city.

SLEEPING DISTRICT OF URSYNÓW

Political agenda of those times stated that country should be ruled by working class, most of those compounds were built close to factories and heavy industry and were supposed to host workers. Ursynów Północny was planned as somewhat luxurious and elite place for 40 thousands people were living standard was supposed to be higher that in other compounds. It was to become an advertisement of communist government and proof of its success.

This uniquely big enterprise, as a part of whole “southern Warsaw development direction plan” as all the others was motivated by strong demand for new housing units that was created due to post war population boom and migration of people from countryside to more industrialized areas - cities. Decision to develop that part of land into habitational area was taken in 60’ when Central Government in Warsaw announced a competition for urban plan of Ursynów and Natolin districts. Due to massive scale of enterprise it was divided into 4 parts. Northern Ursynów, Southern Ursynów, Northern Natolin and Southern Natolin. Whole complex once finished was meant to house 140 - 160 thousands of people. Basing on the results of mentioned competition general plans and urban layout of the district were set. Communication was based on three basic arteries - streets: Jana Rosoła, KEN and Pawła Findlera. Consequently, an architectural competition basing on this layout, was held for each part.

In 1971 the first prize for first part - Ursynów Północny - was given to a team of three architects: Ludwik Borawski, Jerzy Szczepanik-Dzikowski and Andrzej Szkop. After initial phase of work tragic event of Ludwik Borawski death resulted in vacancy on general architect position in a team which was soon taken by Marek Budzyński. Beforehand, this architect practiced in Denmark in Aarhus and brought a fresh approach to the project. Leading architect Marek Budzyński’s idea for creation of the urban structure based on fractal structure were smallest units of certain functionality create bigger more complex patterns that are again fractals of bigger structure. Thanks to him final design was more diversified and innovative concept of separation of pedestrian and vehicle traffic was introduced. Buildings were placed is such a manner that pedestrian would be able to get to planned subway. Smaller internal alleys were supposed to lead people to school, cafés and kindergartens. Greenery was planned so that natural shape of the terrain was preserved *(Haloursynow.pl, 2007).*

“The concept of Ursynów bases on organising the buildings in such manner that they create inner small alleys. By them there will be houses, shops and schools. Frontage and area of those alleys compose a giant sculpture that has no resemblance to that “canions” of the city.”

(Anon, 1977)

Unfortunately socialism in Denmark looked a bit different than in East influenced Poland and this utopian vision of people living together in one big village did not work out the way it was expected. Public space was not organised, social services were poor as well as social participation. It has been effectively mostly sleeping district.

Conclusions

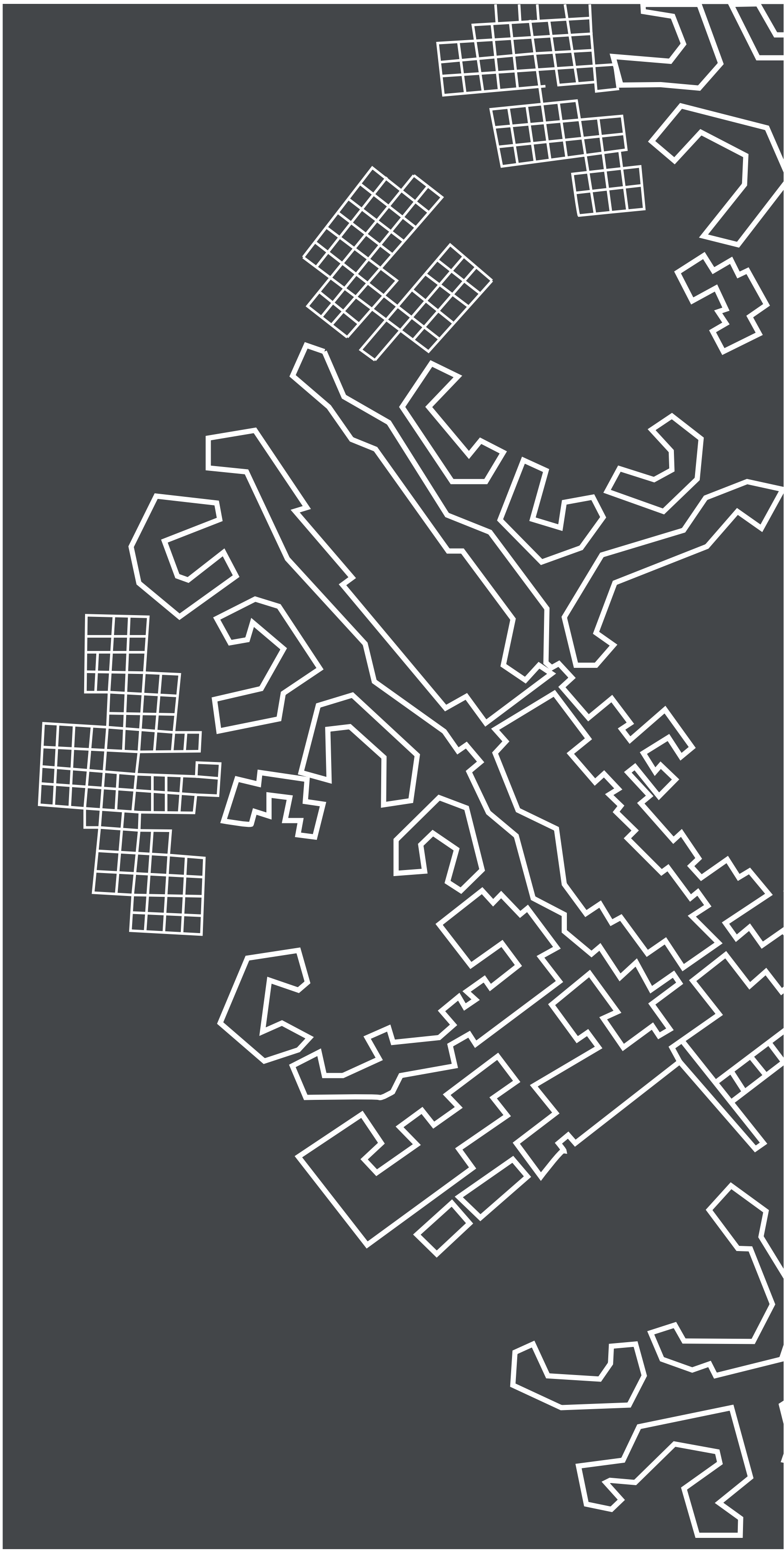
This is why we find it valid to give a second chance to that idea, in now West influenced country, taking a part of this compound as a case study for architectural and social revitalisation.

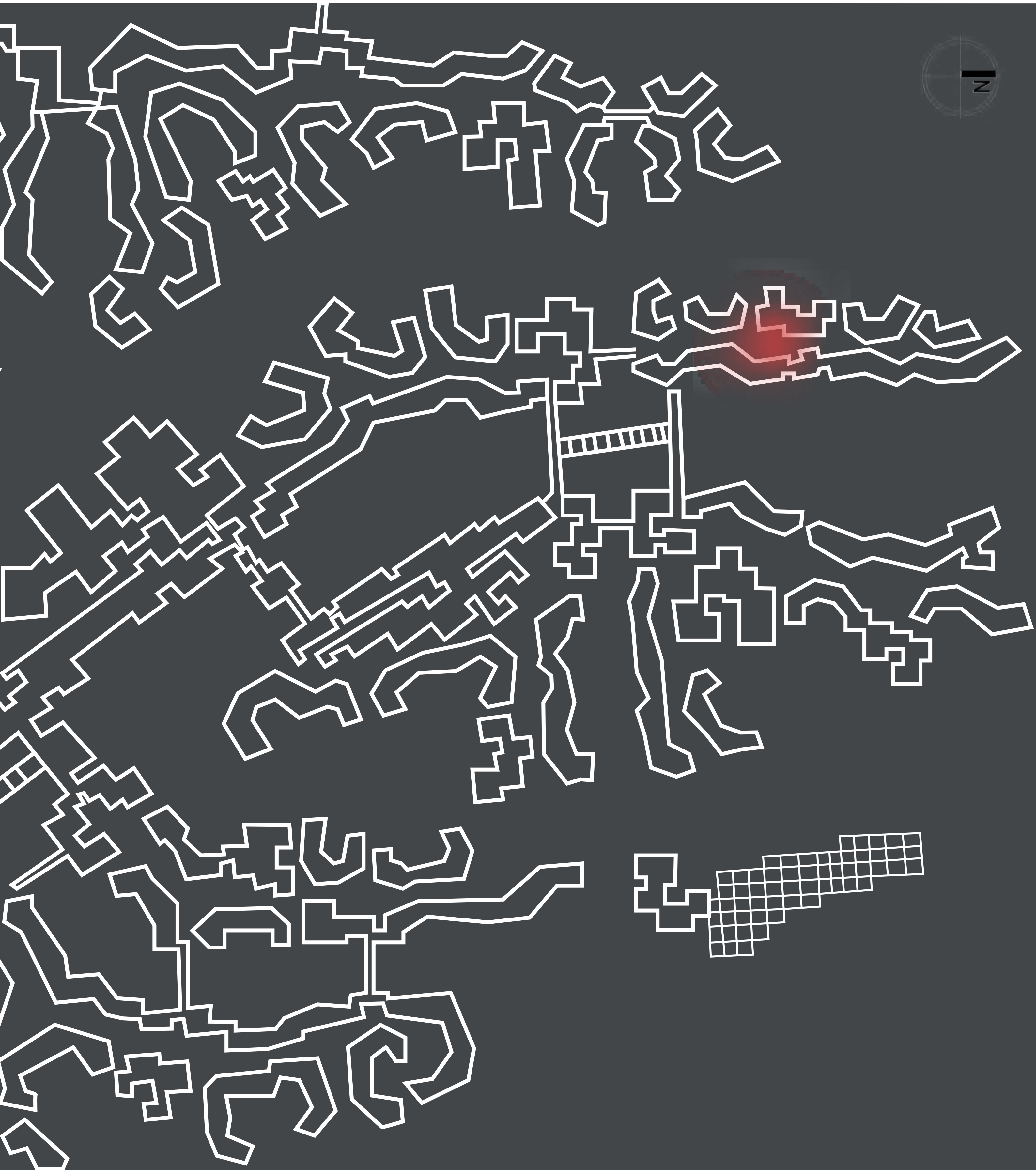
CHOICE OF A PLOT

In order to fulfil our goal of making a project that aims at creating a universal "thinking" pattern for compounds all around Poland and other states such as Romania, Belarus, Ukraine or even Germany were those types of buildings were massively erected in post war times we have decided to choose north-western part of Ursynów Północny as our case study plot.

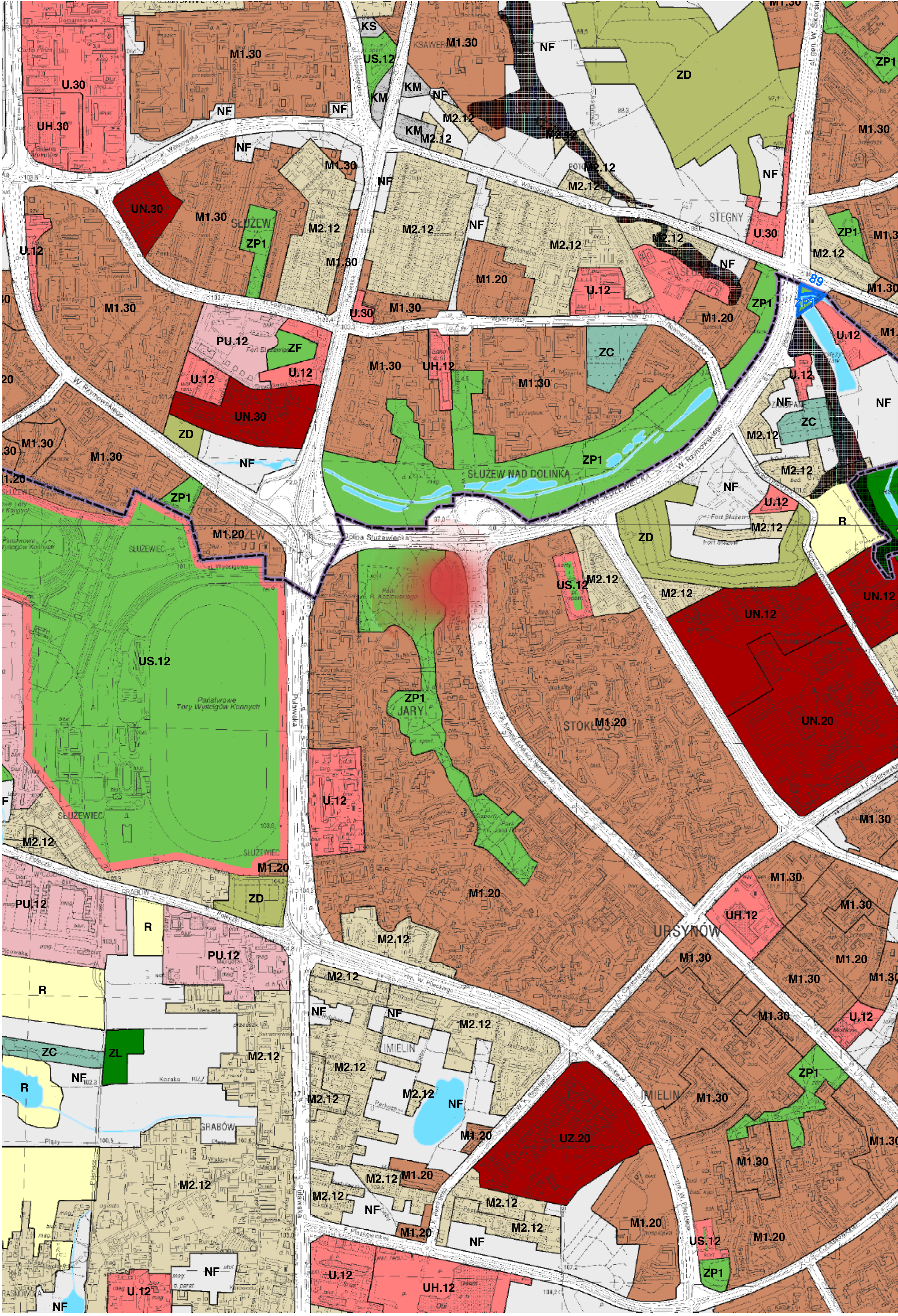
It is uniquely interesting thanks to the fact that it consists all types of buildings that appear in the neighbourhood - 11,8,7,5 and 4 storeys high units placed in long strings with adjacent greenery. What is more that set of buildings in located close to main communication artery as well as right next to a park in which there are some decayed buildings that host services. Adjacent parking lots make it even more challenging in terms of communication. However close proximity to the subway station and public bikes stations provides decent public communication.

One might say that this plot presents perfect cross section of Ursynów.

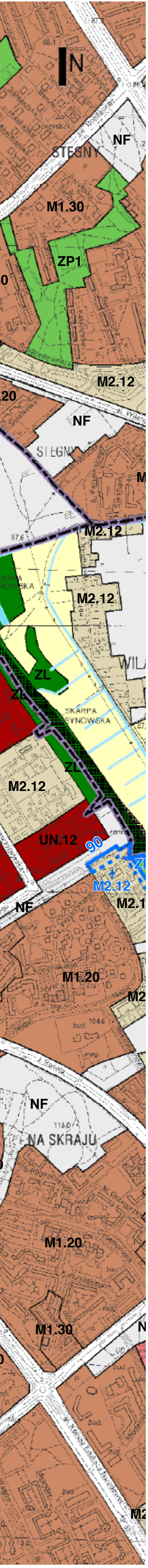




ill. 43.1. Ursynów Północny.



ill. 44.1. Excerpt from General Plan. *(Studium Uwarunkowań i Kierunków rozwoju przestrzennego m. st. Warszawy, 2015)*



GENERAL PLAN (SUIKZP)

General plan is total guidance for all city planists that is above local plans. It lays the foundations for further development of them and indicates main directions of spatial evolution for the city. In Warsaw administrative body that is responsible for preparation of it is City planing division by City Council.

General plan focuses on the aspects, such as:

- spatial order and rules of its protection
- preserving natural habitat
- protection of cultural heritage
- safety of inhabitants
- proprietorship
- possibilities and requirements for development

Chosen plot lies on two types of land. One described on the drawing of the plan as M 1.20 and ZP1. Further investigation of all peculiarities of plan lead us to conclusion that ground which we will be working with has no limitations in terms of points enlisted above different than those resulting from specific rules set for M 1.20 and ZP1.

Requirements for ZP1

- type - organized greenery areas
- it is forbidden to change area of the ZP1 function
- biologically active area must consist at least 70% of total plot area
- all types of new infrastructure related to existing function of the terrain such as cafés and bars and decorative architecture are allowed
- objects of recreation like playgrounds and outdoor gyms are allowed
- existing buildings can be refurbished
- existing private gardens can be merged with given terrain in form of organized greenery

Requirements for M1.20

- type - terrain on which housing units are dominant
- for terrains M1.1/2 it is priority to locate multifamily housing
- investments in public infrastructure, publicly available greenery, sports and basic services are allowed, however they cannot constitute more than 40 % of total building area on the described terrain.
- plan also assumes that standard of 35m^2/person of flat area is advised objects of one service type should be no further than 20 minutes long walk
- standard of 0,5m^2/inhabitant has to be satisfied for all gastronomy
- standard of 10m^2/inhabitant for all outdoor sport facilities
- standard of 4m^2/inhabitant for public swimming pools
- standard of 0,8m^2/inhabitant for cultural facilities
- standard of 0,1m^2/inhabitant for public libraries

LOCAL PLAN (MPZP)

Chosen plot is covered by a local plan therefore there are some strict limitations regarding possibilities of changes applied to buildings. Even though this paper is of conceptual character and discussion with the statements of the plan can be held, we find it crucial to conduct an analysis of possible limitations in order to direct our attention to matters that could otherwise be omitted.

In order to get complete picture it is necessary to put down to rules regarding grounds enlisted below:

- A.2.1/2.8 MW
- A.2.3/2.7 KS
- A.2.4 ZI
- A.2.2/2.9 KDW
- A.2.5/2.10 U
- A.1.2 ZP

Requirements for A.2.1/2.8 MW

- type - multi storey housing blocks
- H_{max} = 20m
- H_{min} = 16m
- biologically active area=30%
- flat roofs are required
- allowance for adapting ground floor for services
- allowance for refurbishment of façades
- facade lines given on the drawing attached cannot be exceeded
- pedestrian communication is to be prevailed
- trees marked on the plan are meant to be preserved

Requirements for A.2.3/2.7 KS

- type - parking lot
- H_{max} = 3m, no roofs allowed
- biologically active area=not regulated

Requirements for A.2.4 ZI

- type - organised/fencing greenery
- biologically active area =80%

Requirements for A.2.2/2.9 KDW

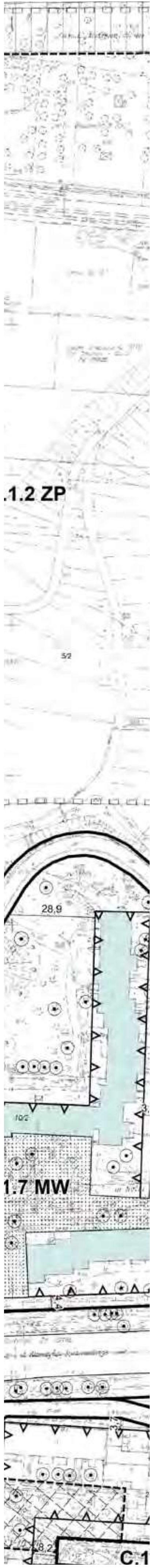
- type - inner street
- H_{width} = 5m
- obligation of paving

Requirements for A.2.2/2.9 KDW

- type - administration, schools,
- H_{max} = 12m, intensity = 0,8
- biologically active area = 30%
- flat roofs or pitched - angle 10-35 deg.
- allowance for adapting ground floor for services
- allowance for refurbishment of façades
- facade lines given on the drawing attached cannot be exceeded
- pedestrian communication is to be prevailed
- trees marked on the plan are to be preserved

Requirements for A.1.2 ZP

- type - park
- biologically active area=80%
- landscape architecture objects should be of one style
- existing objects can be adapted for services
- playgrounds and outdoor services are allowed
- allowance for location of bike roads
- pedestrian communication is to be prevailed
- trees marked on the plan are to be preserved



ill. 47.1. Excerpt from Local Plan. *(MPZP zachodniej części obszaru Ursynowa Północnego, 2015)*

ill. 48.1. Green areas nearby the site.

ill. 48.2. Sport facilities.

GREENERY AND RECREATION

Plot is covered with greenery. Courtyards, and home adjacent slopes are green. In the western part there is massive park with 40 m high hill that was created artificially from excavated ground while compound was built. What is also interesting the hill was once a skiing slope with ski lift, however it was dismantled in 90'.

On side of KEN street there is a row of trees of height up to 12m that limits noise level getting to facade. In the courtyards there are landscape architecture elements that organize the space while in adjacent park there is a playground and exterior gym for the kids. Back in the days there was also small pond located there however it has been emptied and it does not serve its purpose anymore.

Whole area has lots of greenery that is worth preserving. Fortunately, as the trees were planted according to a plan, there are no trees growing right next to façades that might collide with concept of flats extension.
Very unique feature of Ursynów are private gardens that were part of apartments on ground floor. Those pieces of land allowed people to have some influence on how their surrounding was gonna look thus creating feeling of relation to neighbourhood. That idea has to preserved in future design.

TYPOLOGY

Site

Gym

Outdoor gym

FACILITIES

The area of the plot is almost deprived of services. There is one pavilion that hosts a gym and a shop. Even though there are no services on the plot itself there are quite a few in close proximity.

Apart from communication services mentioned before there are 3 pharmacies in distance of 350m. One medical facility 300m away. Two schools not further than 500m. In newly built buildings there are facilities of different kinds. There are bike shops, grocery shops, there is small supermarket located nearby. Thanks to all that trips to the city centre are not that necessary as most of the needs can be satisfied locally.
This is why the design should be more focused on providing social functions as most of the services are available in within walking distance.

TYPOLOGY

Site

Clinic

Library

Playground

Kindergarten

Elementary School

ill. 51.1. Culture institutions and healthcare facilities.

ill. 51.2. Compulsory education institutions and kid's recreation areas.

ill. 52.1. Cycling infrastructure.

ill. 52.2. Public transportation.

INFRASTRUCTURE

The plot is located close to main communication axises for whole neighbourhood. Whole block is braced with three streets. Two of them are streets of accelerated traffic. That along with big parking lot that is adjacent from the east allows easy car communication. The spot is popular as that is location for Park&Ride service - city communication travellers might leave their cars there and take subway or bus further. Proximity of subway stations and bus stops provides excellent communication with rest of the city. There are two bike paths passing through the plot. One along KEN street and another going across green area on the west. In distance of 150m there is public bikes station.

TYPOLOGY

Site

Public bike stations and bike services

Underground

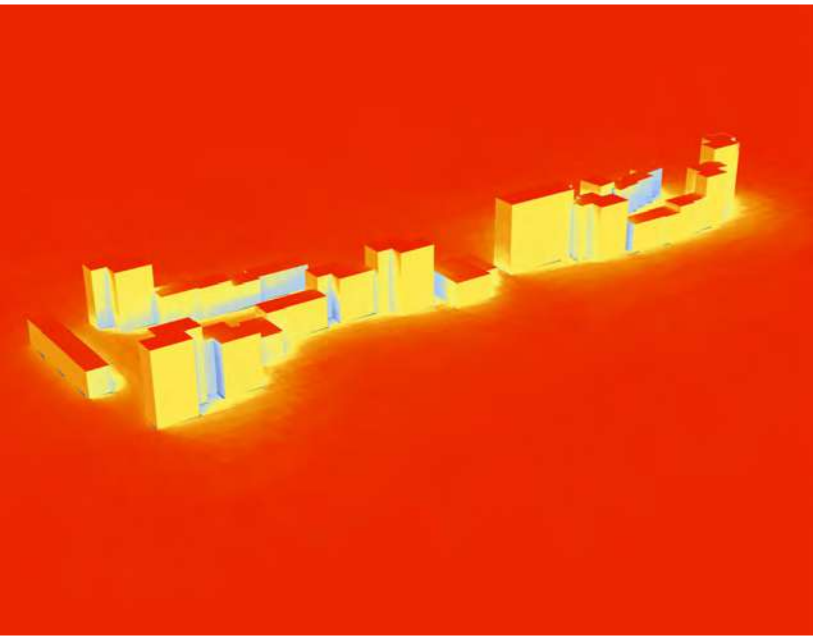
Bus stop

SITE AND BUILDING CONDITIONS

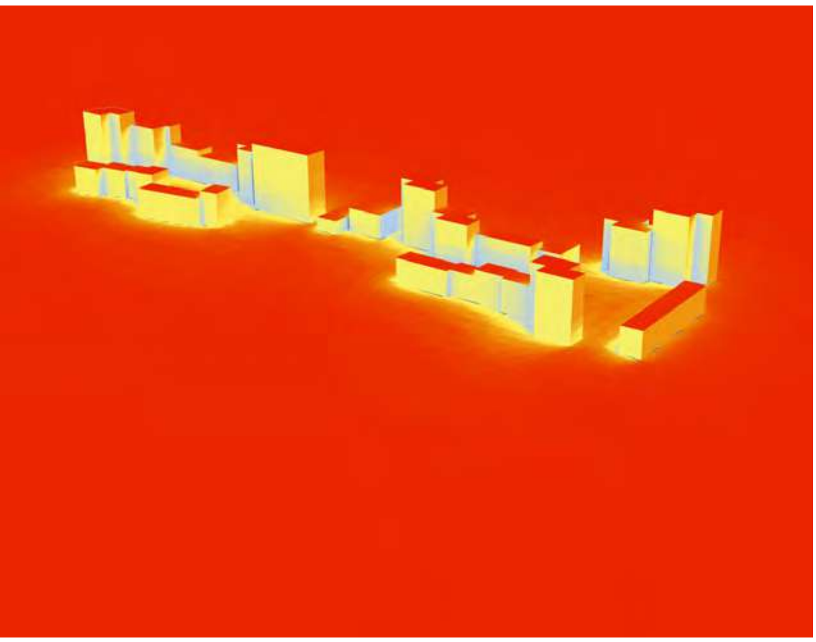
Analysis of environmental and technological situation for the plot and existing buildings.

SUN RADIATION

Buildings on the plot are oriented towards north therefore sun radiation to façades with openings comes mainly from western and eastern light. It came as a surprise that simulated radiation on those façades does not exceed **500 kWh/m²/year**. That leads to a conclusion that problem of direct radiation on surface of the facade is not that crucial. However depth of penetration of sunlight into the building, thanks to perpendicularity of sun rays towards facade, might still create problem with overheating. There is however a chance that extension of façades might create bigger eaves and dual layer of it might result in creation of thermal cushion beneficial during summer as isolating layer from the outside and during winter as a greenhouse that accumulates solar energy. That will be further investigated with simulations in Bsim.



ill. 54.1. Sun radiation - east view.



ill. 54.2. Sun radiation - south view.

TYPOLOGY

kWh/m²

950.95<
855.85
760.76
665.66
570.57
475.47
380.38
285.28
190.19
95.09
>0.00

SUN HOURS

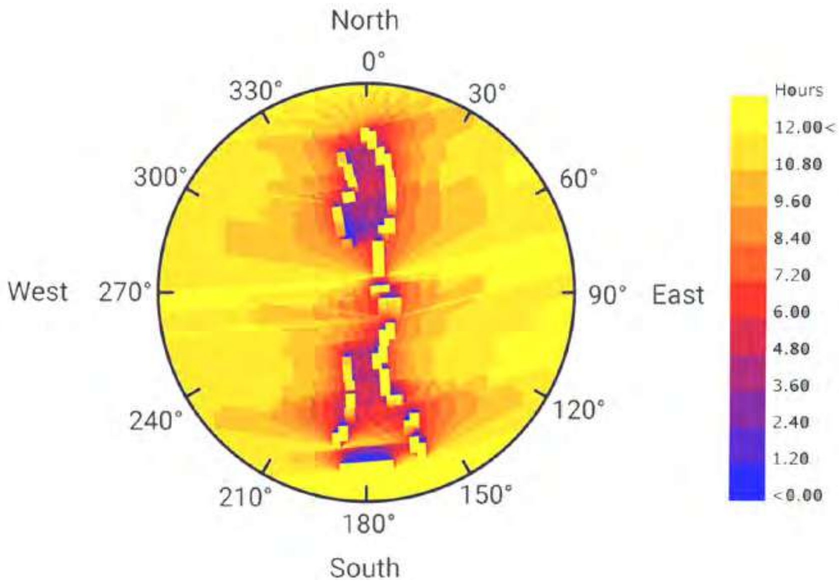
Sun hours analysis indicates that there are certain issues with the volumes. Two adjacent rows of buildings that are oriented north-south due to small distance in between them create poor sun conditions in the courtyard. As buildings consist mostly of single sided apartments around 50 percent of then suffer from lack of direct sun operation in winter months where direct sun can be seen for around 4-5 hours. There is small number of apartments in north-eastern part of complex that do not receive any direct light on 21.12.

During the equinox - 21.03 and 21.09 most of the apartments receive around 7-8 hours of sun while lowest floors get up to 4-5h.

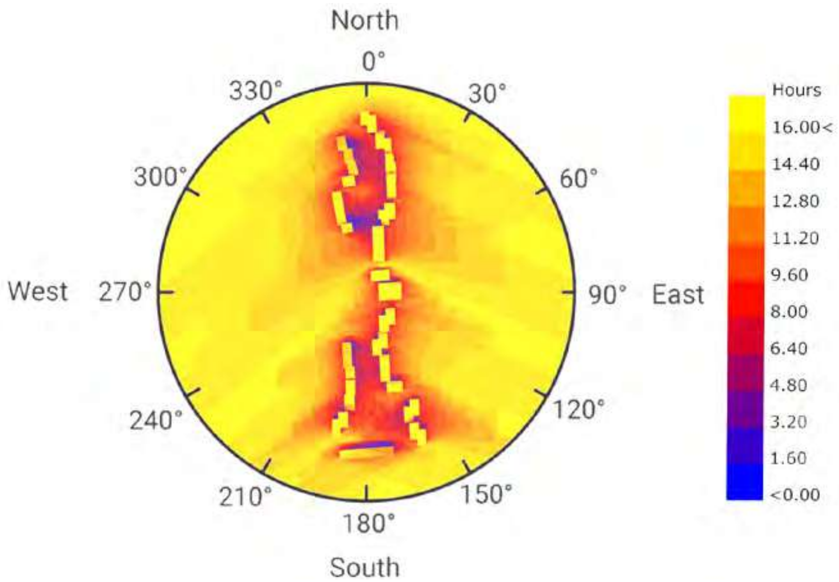
On the other hand due to orientation most of the buildings have perfect exposition to eastern and western light during summer at numbers of around 9 to 10 hours daily during 21.06. That is beneficial for daylight factor in the apartments nevertheless might cause problems with overheating what is investigated in separate analysis. Fortunately there are lines of fencing greenery along the façades stretching north-south. As they consist mainly of big trees that drop their leaves for winter structure can benefit from sun radiation in winter and is less prone to overheating in summer months.

Conclusions

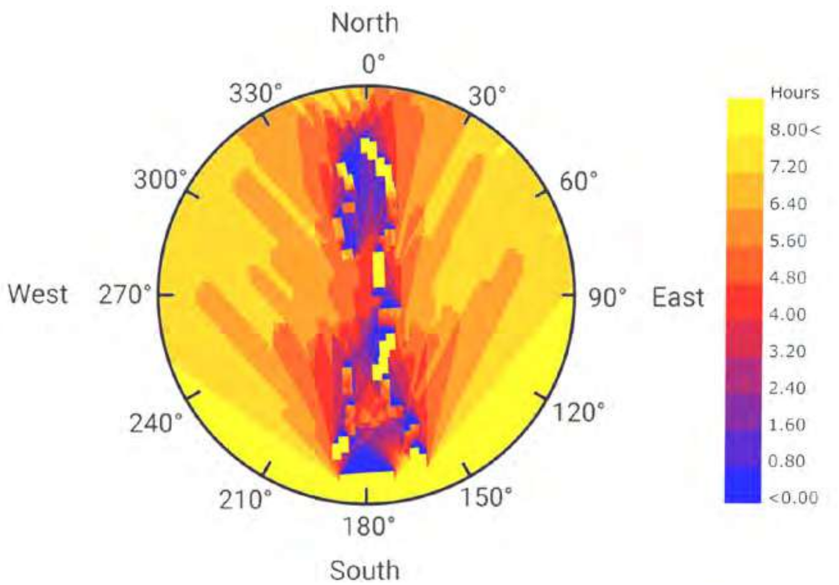
Summing up sun conditions for most of the year are however fairly satisfactory for most of the apartments especially given lack of computer analytic tools during design process. Exceptions to that however made us think of possibility of changing usage type of those spaces or offering inhabitants special places in within volume that will allow them to satisfy sun need.



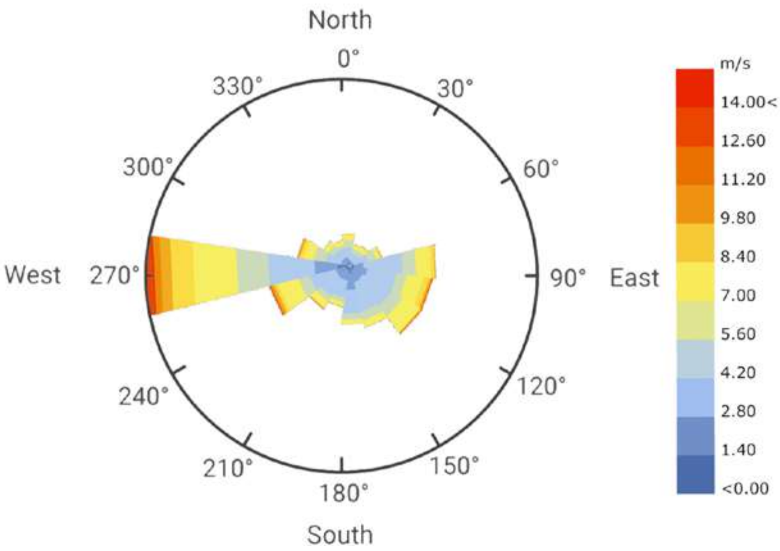
ill. 55.1. March /September equinox (21.03/21.09).



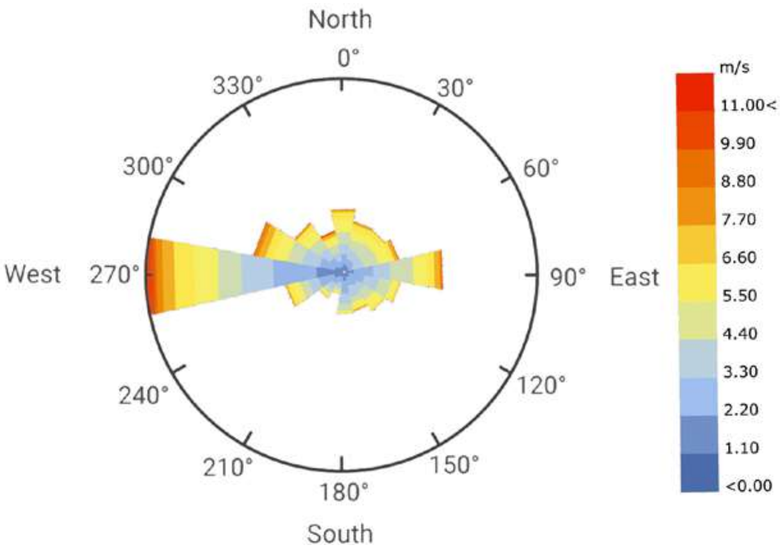
ill. 55.2. Summer solstice (21.06).



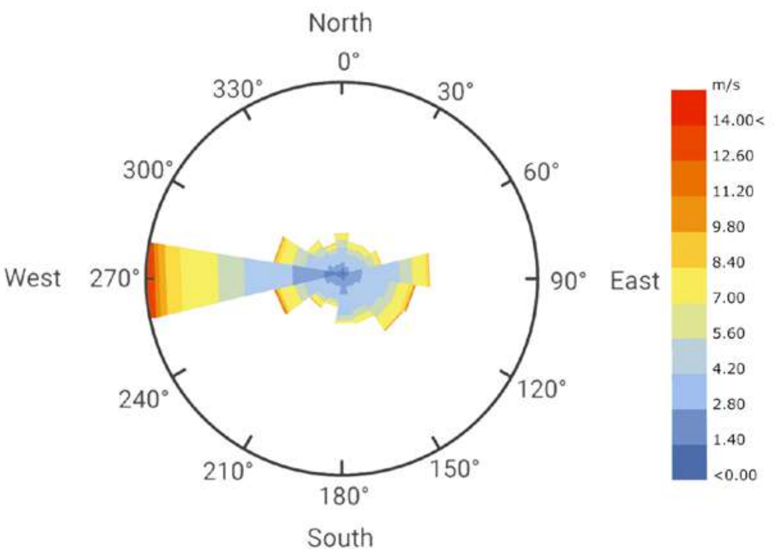
ill. 55.3. Winter solstice (22.12).



ill. 56.1. Wind rose for summer season.



ill. 56.2. Wind rose for winter season.



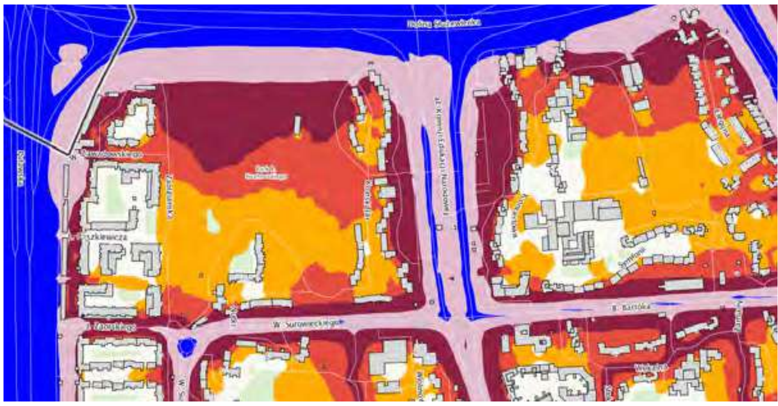
ill. 56.3. Annual wind rose.

WIND ROSE

Poland is not necessarily most windy country. On given plot fastest wind blows that have been measured were of 14m/s. That makes wind analysis less crucial however even those mild winds can be beneficial for the structure.

Data shows that there are very small differences in wind speed and direction between the seasons therefore general west wind direction with speed up to 11m/s is taken under consideration in terms of cross-ventilation.

Whole compound is oriented perpendicularly to the most typical wind direction which is west. That results in great wind conditions. Courtyards are silent as they are fenced out from the wind. What is more wind perpendicular to longer façades creates regions of higher pressure and lower on the other side therefore creates great pressure conditions for cross ventilation. Unfortunately only part of flats is open to both sides.



ill. 57.1. Car noise (daily average).

NOISE LEVELS

Noise analysis is crucial for this project as it is adjacent to two main streets. On the northern side there is a three lane road of fast traffic and on eastern side there in KEN street - two lane accelerated traffic artery. This is why noise levels can be elevated. Fortunately there is substantial amount of greenery that divides street and building volumes that works in favour of sound level reduction. Nevertheless noise of 70-75dB can be experienced in most northern outer façades of compound while whole eastern facade is subject 65-70dB exposition. Courtyards are more silent with noise levels of 55-60dB. Those levels however lower, still exceed Polish norms - 60dB during the day and 50dB during the night in urban areas *(law act: Rozporządzenie Ministra Środowiska z dnia 14 czerwca 2007 roku w sprawie dopuszczalnych poziomów hałasu w środowisku określa parametry dopuszczalnego poziomu hałasu w zależności od rodzaju terenu na którym znajduje się określona zabudowa)*.

Conclusions

That calls for being addressed in design proposal as exposition to elevated noise levels for long time is harmful for human health.

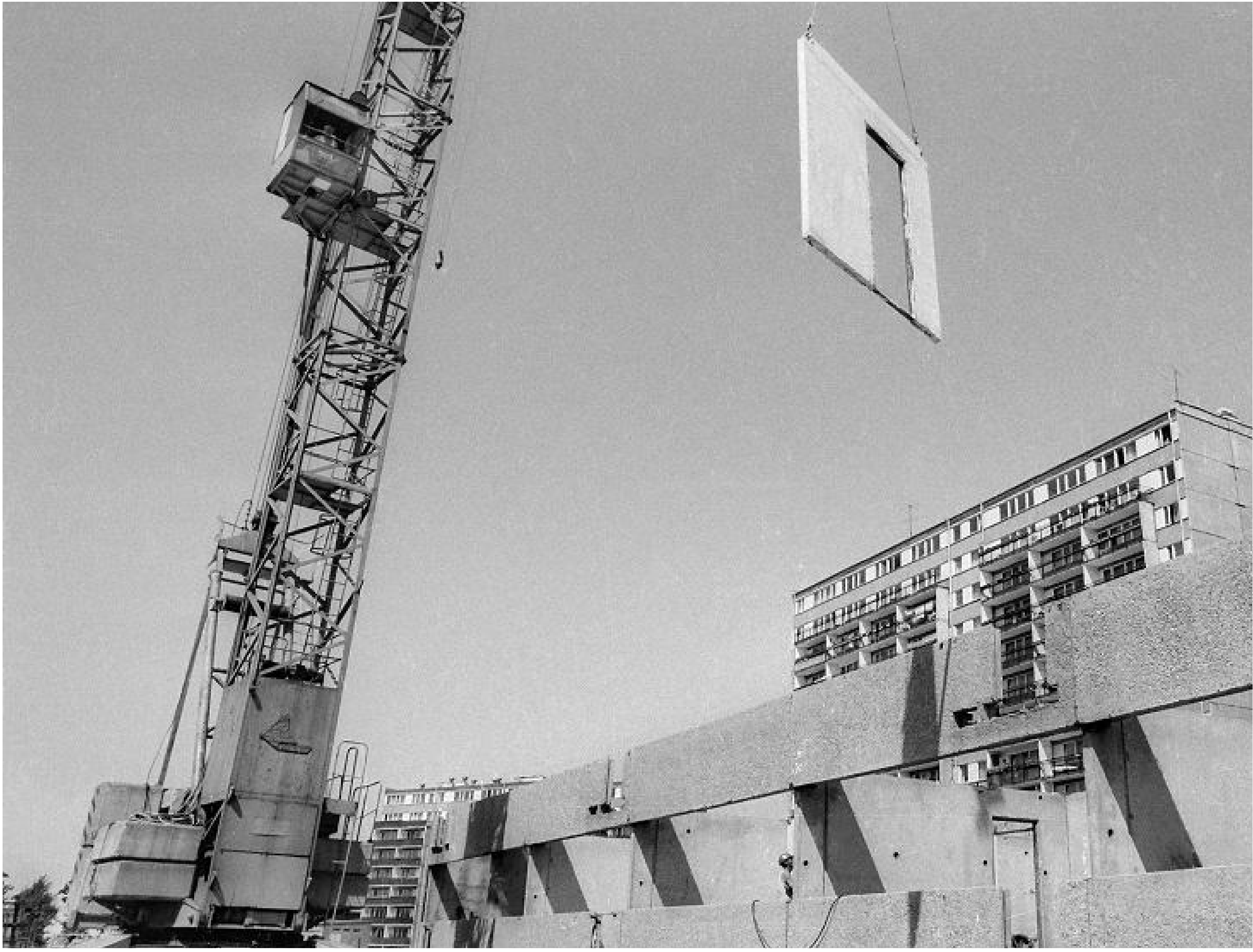
TYPOLOGY

dB (A)
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- > 75

ill. 57.2. Car noise (night-time 22.00 - 6.00).

ill. 57.3. Parking noise (daily average).

ill. 57.4. Parking noise (night-time 22.00 - 6.00).



ill. 58.1. Ursynów Poł

CONSTRUCTION TECHNOLOGY

There were many panel system used in Poland during communist times. From 60' to 90' various compounds were build in different technologies such as WUF-T, WWP, OW-T and others. Each system had its dimensional parameters and different fabrication materials.

In Ursynów district (1975), the system that has been used was Wk-70. That was "sibling" system for W-70 and was developed between 1967-1970 in "Zakład Projektowania Zjednoczenia Budownictwa Warszawie i Instytut Techniki Budowlanej" - construction engineering office in Warsaw.

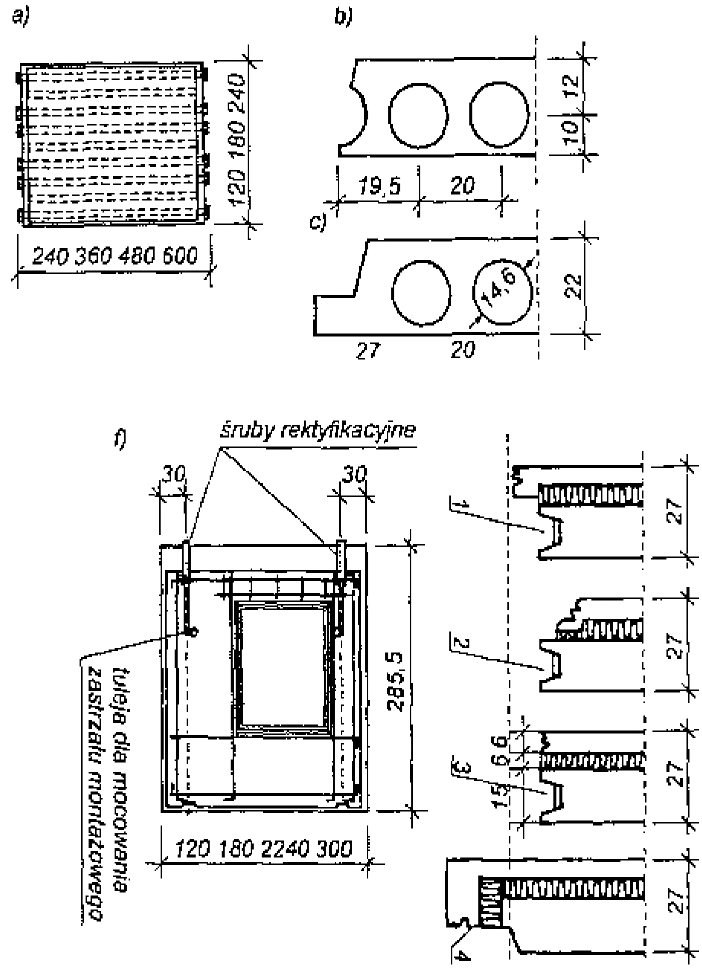
System was based on a modular grid of 60x60 cm. Most basic guideline for designers was a necessity to have a system of supporting walls that was perpendicular to long axis of building. W-70 based on basic elements: 22 cm thick concrete slabs - empty inside, dividing walls of 15 cm concrete, and three layered external walls of 27 cm out of which 5 cm was styrofoam insulation. Typical construction spans were 240, 360, 480 and 600 as multiplications of 60 cm.

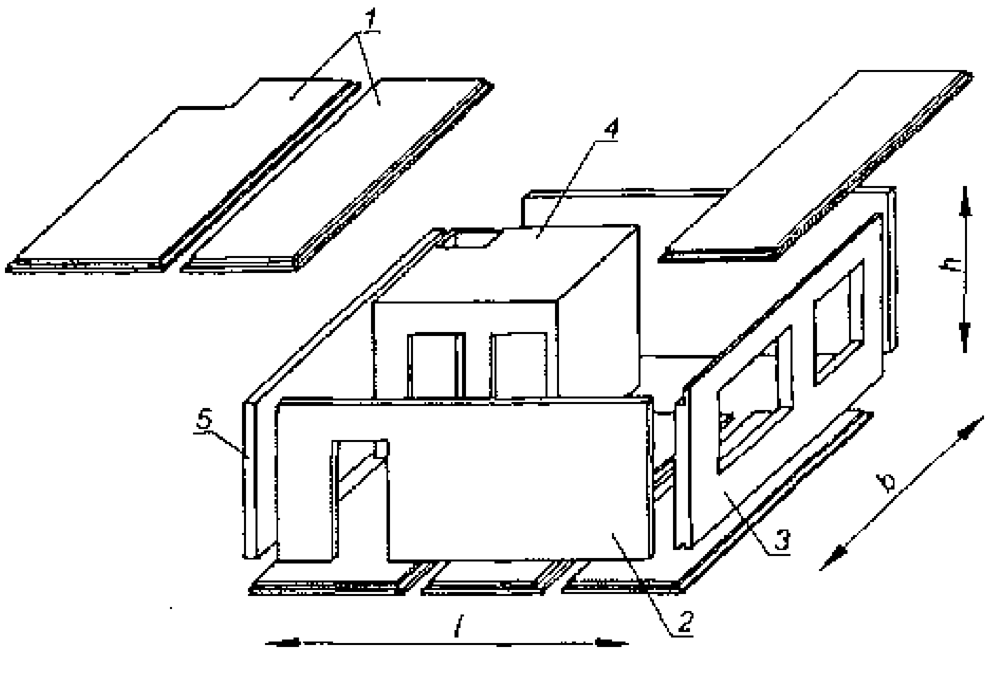
Height of typical flat was 280 cm however in Wk-70 type additional span of 300 cm and height of 330 cm were introduced mostly for services. 22 cm slabs were replaced with 16 cm solid ones *(Relaiscdo.eu, 2017)*.

In order to keep the costs on reasonable level most of the elements were produced on site in special plants that were built solely for that purpose.

Despite facilitated assembly and fair ease of erecting the buildings the system was not very elastic and had its limitations and technical faults.

nocny under construction.*(Łożyński, 2019)*.





Wk – 70
l = 120 – 600 co 60 cm
b = 240, 300, 360
480, 600 cm
h = 280 i 330 cm

W – 70
l = 120 – 600 co 60 cm
b = 240, 360, 480, 600 cm
h = 280 cm

ill. 59.1. Wk-70 panel system *(nd)*.

INDOOR CLIMATE INFILTRATION PROBLEMS

Old panel buildings present series of issues as it comes to tightness of their envelope. Even though that can be beneficial for quality of air in terms of CO_2 levels as lots of air infiltrates the building compensating poor ventilation system, it presents problems with energy consumption and drafts.

In article: *"Szczelność budynków wielkopłytowych przed i po termomodernizacji – wymóg czy dobrowolność" (Nowak – Dzieszko, Rojewska – Warchał and Dębowski, 2015)* the problem of envelope leakage has been addressed with following result.

The tests were conducted for flat of 53,4m^2. Building was constructed in W-70 technology - similar to the system used on Ursynów compound. For underpressure and over pressure of 50 Pa exchange rate was 2,36h-1 and 2,045h-1 accordingly. That gives result of 5,9l/s m^2 while normal infiltration rate should be of 0,1l/s m^2. Total volume of infiltrated air was 320m^3/h while it should not exceed 48,8 m^3/h. That enormous draft results in big thermal losses and poor indoor climate in terms of thermal comfort.

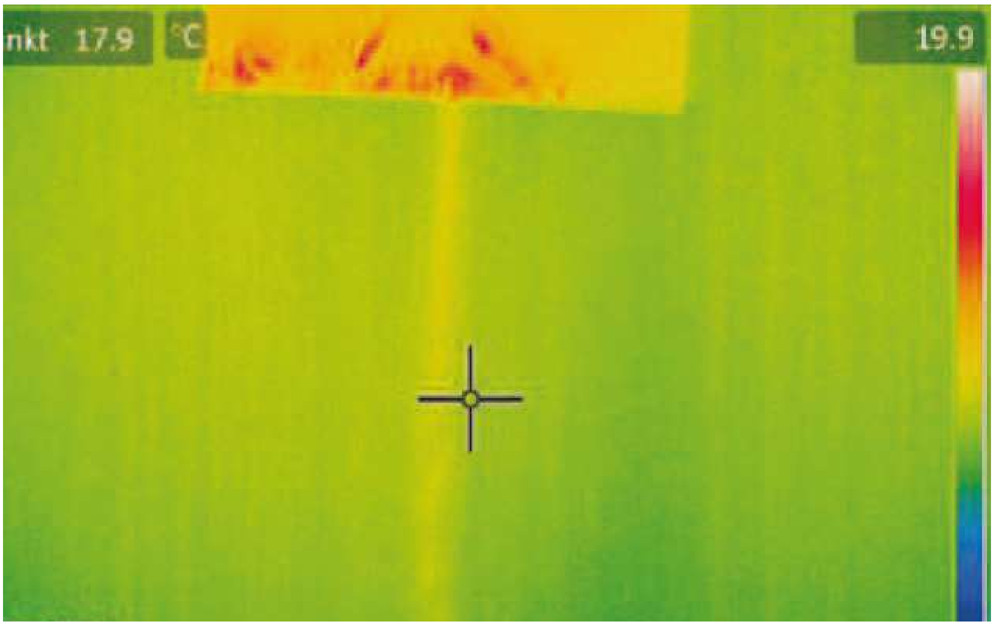
That, among with poor insulation, results in heating demand to go up to almost 250kWh/m^2.

Pictures presented on the right show tested building and air leakages in the envelope tested with thermal vision.

ill. 60.1. [from left] Analysed building. | P

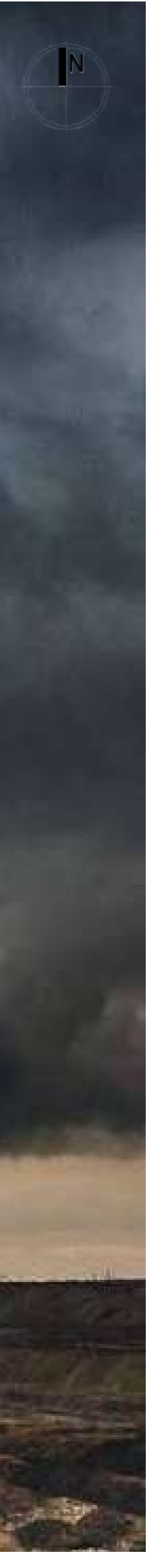
ill. 60.2. [from left] E

laces of leaking. *(Nowak – Dzieszko, Rojewska – Warchał and Dębowski, 2015)*



ffects indoors. **|** Thermal picture of the spot. *(Nowak – Dzieszko, Rojewska – Warchał and Dębowski, 2015)*

ill. 62.1. Power plant *(Stańczak, 2018).*



ENERGY CONSUMPTION

Typical problem for panel building in times of Polish Social Republic (PRL) was low quality of fabrication. Most of the elements were out of shape or form therefore work on the assembly was difficult and chaotic. Many of those problems were also appearing in already built buildings resulting in cracked outer walls or uneven panels. Most of them were solved on site with tar sealants or the panels were replaced. Even though those problems were to some extent solve by redesigning the elements there were still some weak spots to the system such as joints that were virtually impossible to fully seal resulting in extreme thermal bridges thus humidity and mold inside the buildings.

What is more, pretty often materials that were used for construction were stacked in improper way resulting for instance in placing wet wool as insulation therefore linear thermal bridges on slabs were created.

Those poorly built buildings were subject to wear and tear for many years with very if none maintenance. Due to that construction itself with its iron joints deteriorated massively. One might say that it is more reasonable to tear those buildings down yet that would require moving 12 million people out of their homes and that does not seams possible as this is 1/3 of country's population. This is why some renovation programs were introduced. They mainly based on thermal modernisation of buildings. Biggest problems that those buildings face is deterioration of façades. Those big panels are suspended on iron hangers and therefore after 50 years of use there is a valid chance for them to fall off once extra weight of styro and other finishings is applied. Reinforcing the façades with steel bolts and stabilizing whole structure is one of the options. Our proposal takes different approach. Faulty elements will be totally removed.

What is more energy performance requirements were very low back in the days when those buildings were built. There is nothing surprising in the fact that average square meter of building required 250 kWh/y of non renewable energy *(Podręcznik typologii budynków mieszkalnych z przykładami działań mających na celu zmniejszenie ich energochłonności, 2011)*. Reason for that was mostly poor insulation (just 5 cm), massive drafts and conventional ventilation.

Conclusions

Buildings built in panel technology struggle with various issues described above. All of which have to be dealt with in order to justify renovation as superior to demolition. Right now ones that were not yet renovated are extremely expensive to maintain while, those that were mainly caricaturize modernist thought that, brought them to life with their styro façades and pastel colours.

Given all the technical problems we find it relevant that our proposal addressed all of them while being compliant to social requirements of neighbourhood.

SOCIAL ANALYSIS

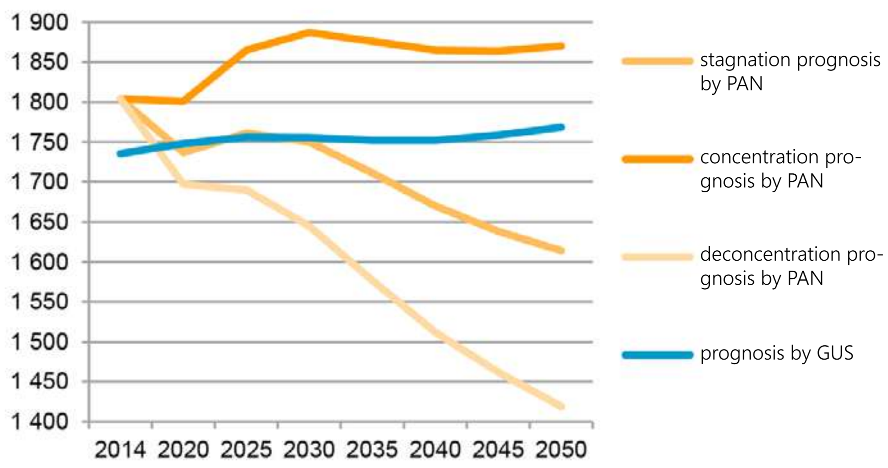
DEMOGRAPHICS

Warsaw is the biggest city in Poland. Its population is estimated to count 1,74 million people, however different surveys show some differences. It is mainly due to the fact that some of its inhabitants do not register under any address. Even though Warsaw`s population isn't that big city, its size is enormous due to low density of urbanization. That causes a problem with satellite neighbourhoods - sleeping districts.

Warsaw is also the only Polish city whose population has been continuously growing for last 69 years. Number of citizens in Warsaw has been growing since 1950. That trend had slowed down after 1988 but it is still gently rising. City council presents different statistics about future demographic situation in the city. It is clearly visible that it is hard to assess the trends in perspective of 15-30 years. Four different surveys based on for different assumption gave totally opposite results. In most optimistic one (assuming concentration of citizens, made by PAN (Polish Science Academy) population of Warsaw is to rise by 83 thousand citizens by 2030 and by 64 thousand in 2050. On the other hand most pessimistic approach provided by same institution shows that number of citizens will decrease by 154-159 thousands in 2030 and by 200-400 thousand in 2050. On top of that there are prognosis made by GUS (General Statistic Office) that show stable increasing trend.

Reports state that people tend to move out from downtown where population has decreased by 12% in last 10 years to newly urbanised areas around the city. That tells that outer districts of the city grow while central districts tend to shrink. That is also case of Ursynów where population decreased by 4% in same time period *(Warsaw City Council, 2016)*.

Changes of Warsaw's population relay strongly on migration. Factor of migration for the city is 48 per 10 thousand inhabitants, therefore it places Warsaw way ahead of country's average - (-5) and voivodeship - 25. Most of the newcomers are people attracted by possibilities of career development and higher salaries therefore young. Most of the people that are fleeing to Warsaw are between 25-35. Migration factor for people in this age is 89 for 10 thousand. Most of them settle in newly built compounds in satellite districts like Białołęka or Wawer.



ill. 64.1. *(Warsaw City Council, 2016).*

Due to data gathered by city council in 2011 *(Raport z wyników spisu w m.st. Warszawie, 2014)* more than half - 54% of city population was from outside the city. Most of the citizens are happy with living in Warsaw. In 2015 - 83% of inhabitants were satisfied with level of living. Survey by Euro-barometer states that it is even higher - 93% - what places Warsaw as number 9 among European capitals *(Węziak-Białowolska, 2016)*.

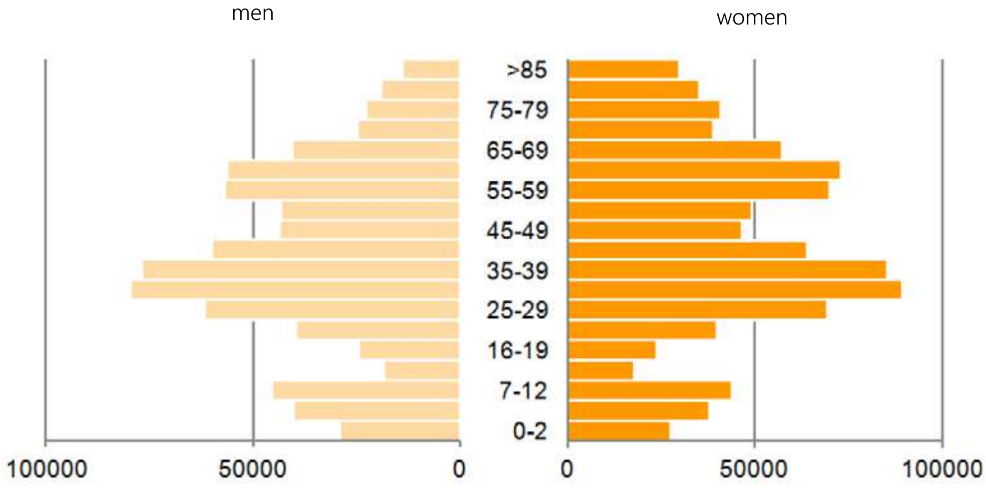
Average natural growth is low, which is characteristic for well developed societies - 0,9‰. It varies in between districts. Newly built ones inhabited mostly by young people characterize with higher levels - 0,14-0,16‰. Per 10 thousand of citizens there are 11 kids born. Level of growth relies on multiple factors such as life style, cultural patterns, level of life and apartment conditions.

Data shows that 61% of families are nuclear - two parents and one kid - 2012, however there is rising number of one person households - 37% *(Demografia - Analiza na potrzeby opracowania diagnozy strategicznej", Warsaw City Council, 2016)* while numbers for Europe are between 29-54% *(Eurostat)*.

Summary

Demographically Warsaw can be characterised as a city in which people gather. It is a city of very small natural growth of population that is interlacing with natural cycles of demographical booms and niches. It attracts new citizens who are mainly young well educated people of whom most live alone. That creates social spectrum where big part of society is in production age while there is also lost of seniors - children from after war population boom. That will most likely result in ageing population in the future.

All those factors are crucial when redesigning new compounds whose facilities and structure need to reflect future needs of society.



ill. 47.1. Excerpt from Local Plan. *(MPZP zachodniej części obszaru Ursynowa Północnego, 2015)*

TYPES OF DWELLINGS

Actual district structure in terms of dwellings didn't change much from the times when it was built. Therefore if is as follows:

- M2 - 9,6%
- M3 - 19,4%
- M4 - 50,1%
- M5 - 9,8%
- M6 - 9,4%
- rest - 1,7%

(Ursynów-Północny, 1975)

Given the demographic data and predictions for the future today's structure of apartments is obsolete and will not satisfy the needs of society throughout next 30 years. Today's standards for this area state that one individual should be living on at least 35m^2 *(Studium Uwarunkowań i Kierunków zagospodarowania przestrzennego dla Miasta Stołecznego Warszawy; Uchwała Rady m. st. Warszawy; uchwała nr. LXXXII/2746/2006)* however today's actual state is resembling communist times - 11m^2 *(Nadolny, 2010)*.

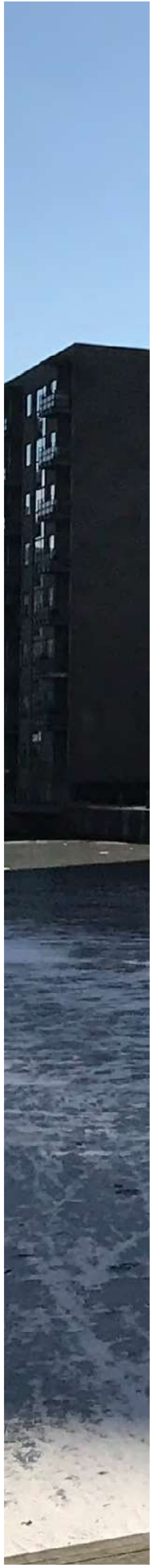
Assuming that the trends indicate that number of citizens in gonna decrease in that district it is safe to assume that number of square meters per 1 person will be rising. Given today's standards most popular type of apartment - M4 - ca.55m^2 is suitable for a couple at best. M2 and M3 are apartments are satisfying spatial needs of a single person. Even though today that poses a problem it can be seen as a great opportunity as number of single family households is rising and families tend to go towards nuclear model. That effectively means that in near future there will be big demand for apartments for couples and three people - respectively ca.60-70 m2 and ca. 100 m^2.
This is why revitalisation should focus on extending existing flats of M4 that they fully satisfy needs of two individuals by either merging M4 with M2 or extending them outwards. Smaller apartments of M2 and M3 can be joined to achieve area of around 60m2 while bigger apartments like M5 and M6 will be downgraded from 5 or 6 people to 3-4 after extension.

The fact that Ursynów has presents high variety of plans where M2 are located next M6 - result of class mix policy of communist regime - chances to maximize the use of today moderately functional spaces are big.

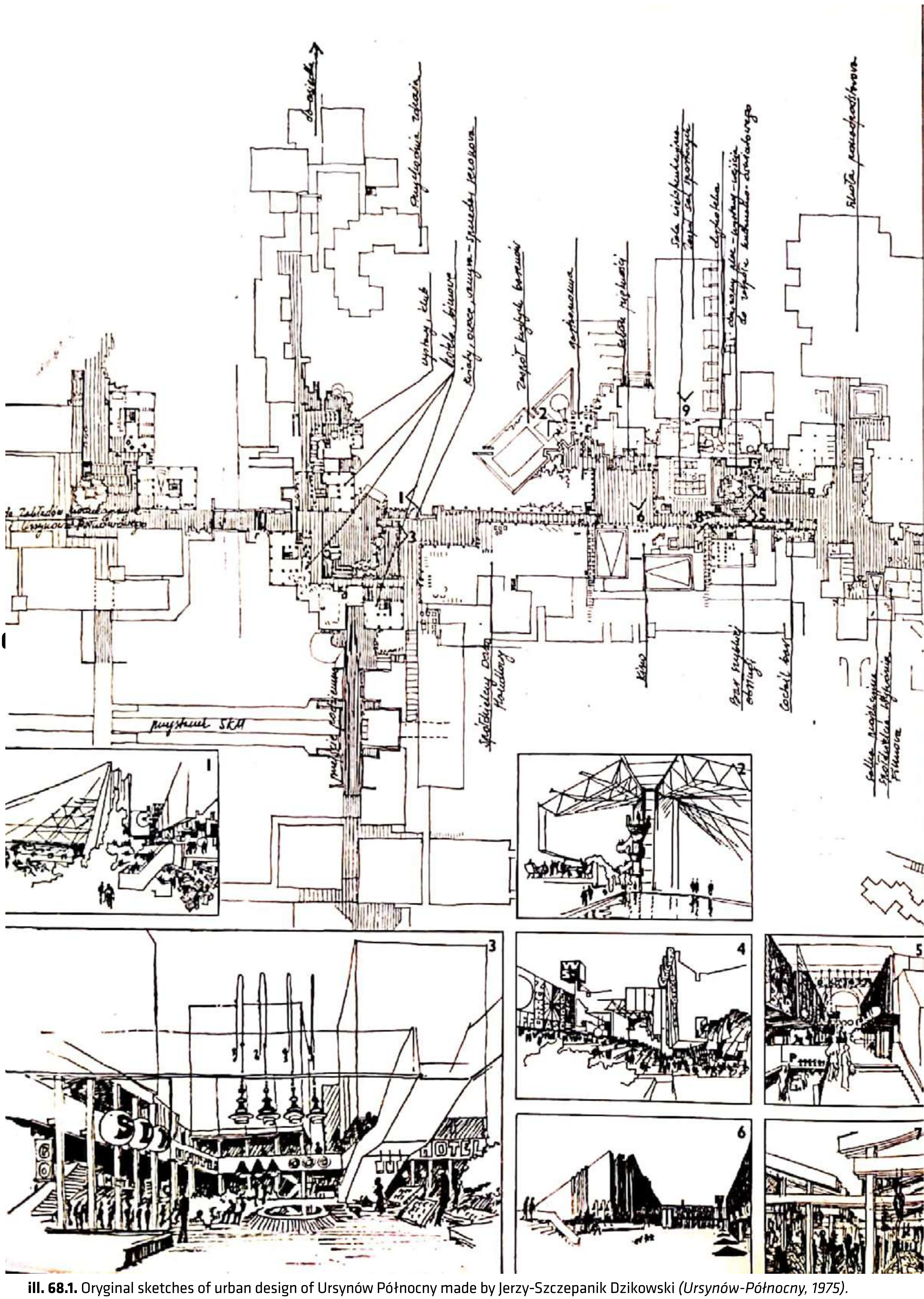
Likewise in most of developed societies, in Warsaw the number of people living alone keeps on rising. Right now it is 37% *(Warsaw City Council, 2016).*

Therefore more and more people are struggling with solitude. This is widely known problem and there are some successful actions taken in western Europe to counterbalance that trend. This is why it is necessary to "reinvent" what was already there in designing phase of Ursynów.

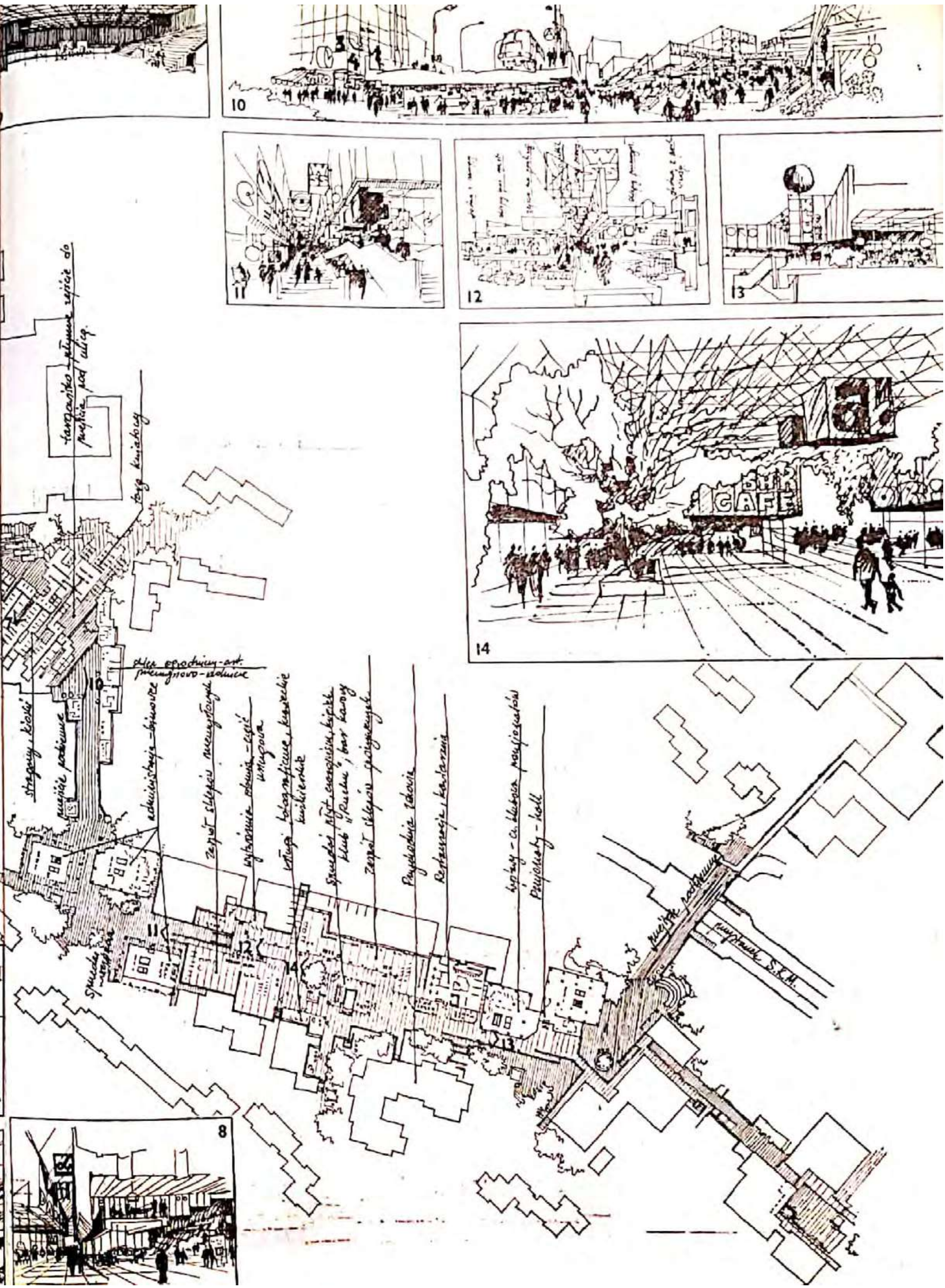
Clubs, restaurants, gathering places for all inhabitants who want to volunteer in public activities. Making spaces more individual and giving a chance to decide for people by setting "boundaries of freedom of public expression". For instance there can be parts of their apartments on the outer facade that people could adapt in order to give some identity to their own place. That would also develop great social driven system of visual communication in within bunch of blocks. What is more, some of existing flats, which will not be convertible to high quality apartments should take function of gyms, meeting places, training or snooker rooms. That will allow inhabitants of each block to do things together.



ill. 67.1. Social housing in Copenhagen.



ill. 68.1. Oryginal sketches of urban design of Ursynów Północny made by Jerzy-Szczepanik Dzikowski *(Ursynów-Północny, 1975).*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CAFE

ill. 70.1. Central Park, Sydney, Australia - Zero Energy Building *(www.sekisuihouse-global.com,2019).*

SUSTAINABILITY

POLISH REGULATIONS

Polish norms in terms of eco-friendliness are way lower than requirements of BR2020. Numbers have been changing for last 4 years, nevertheless the amount of kWh/m^2/y is as follows:

2017[kWh/m^2/y]
- single family house - 95
- multiple family house - 85
- health centre - 290
- other - 60
- warehouses, production - 90

2021[kWh/m^2/y]
- single family house - 75
- multiple family house - 60
- health centre - 190
- other - 45
- warehouses, production - 75

It is important to mention the multipliers for energy sources, as that massively influences final figures.
- electricity - 3,0
- oil, propan-butan, coal, - 1,1
- biomass - 0,2
- PV - 0,7
- municipality heat system - 1,3

(Rozporządzenie Ministra Infrastruktury z dnia 6 listopada 2008 r. w sprawie metodologii obliczania charakterystyki energetycznej budynku i lokalu mieszkalnego lub części budynku stanowiącej samodzielną całość techniczno-użytkową oraz sposobu sporządzania i wzorów świadectw ich charakterystyki energetycznej, 2008)

ZERO ENERGY BUILDINGS

The design is as well about aesthetic qualities as it is about economical and environmental quality.
In Poland law and regulations state norms that are correspondent to total cost of energy. As multipliers for primary energy are higher energy demands also need to higher. Effectively if compared, building that uses 25 kWh/m^2/y (according to Danish regulations) of non renewable energy coming from electricity (heat pumps etc.) will be calculated as 42kWh/m^2/y (according to Polish regulations).

Panel buildings were always problematic in terms of energy demand. This is why it is important to do everything possible to reduce their consumption. This is why proposal will focus on coming up with the solution that will allow once very unefficient volumes perform better than law requirements.
Achieving that goal requires integrated design process that answers to the environmental limitations and adapts to them instead of fighting them with technology.
Therefore the buildings have to be equipped with solutions assuring that they gain enough sun radiation to require as little heating as possible while not overheating in summer period. Extended cubatures can not be shaded by each other and can not shade excessively the surroundings - what is especially difficult in narrow courtyards.

As existing buildings envelopes are obsolete they should be replaced in order to provide proper tightness. That will reduce drafts and consequently help with level of energy consumption. However façades should be tight it is also important to develop well functioning ventilation system that will incorporate passive strategies in achieving good indoor climate. Finally, renewable sources of energy should be implemented to cover residual energy requirement.

All those actions have to be taken with highest regard for the users and the fact that the construction is designed solely to satisfy their needs and that all technical details merely follow.

SUSTAINABLE SOLUTIONS

To achieve the zero energy standard certain eco technologies have to be implemented.

As we are dealing with constructions that already exist and are located in within city's heat and electricity grid it seems that sustainability in active solutions department, in this case, is to be achieved only by providing solutions that will reduce consumption of electricity. Fortunately designers decided that most of the apartments have openings to either east or west, thus southern walls are solid. That creates uniquely good conditions for PV installation.

They convert solar radiation into direct current with the efficiency of 15 percent. That current is later on turned into alternating current and transformed from 12-15V to 230V.

Winter months
However in our work we would like to put emphasis on passive strategies that will allow to enhance living qualities. This is why we are aiming at solving problems diagnosed in " Energy consumption chapter". Those buildings are known for their ventilation problems. This is why we focused on solving that problem.
Whole design of façades aims at providing good stack or cross ventilation. Given wind directions that should be achievable fairly easy. However, even though, getting the air into the building might be easy due to wind pressure against façades it will cause huge heat losses. This is why merging an idea of heat chimneys with intakes of ventilation system might help the problem.

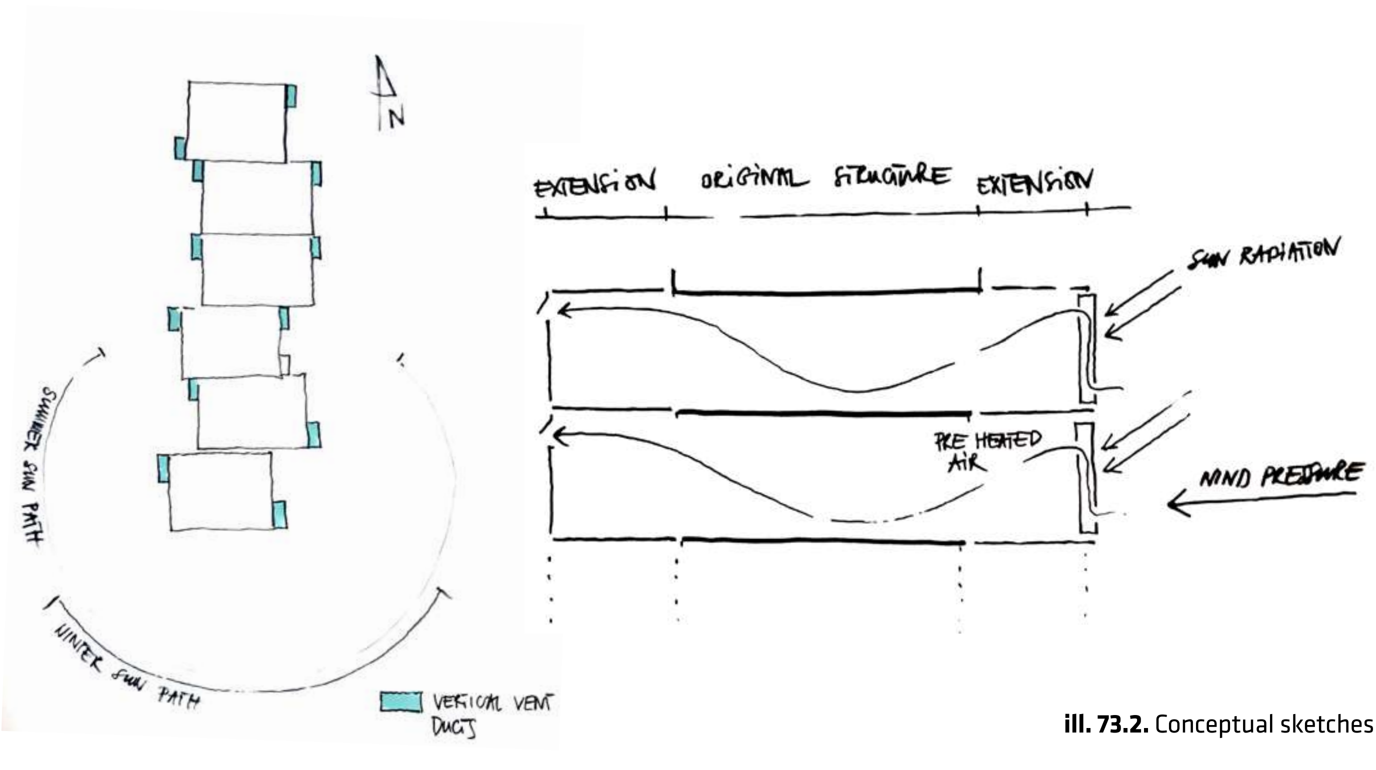
Most of technical actions have to be taken in within added volumes. After thorough analysis of existing structure and apartments plans there are possibilities of applying cross ventilation. Because use of necessity of extending the flats outwards in order to achieve bigger area of apartments it was not possible to create classic trombe walls as a function of heat accumulator. Those can be preferably located on southern façades. This is why, other trombe inspired type of sun driven preheating had to be introduced. That solution will allow to reduce heat losses through ventilation system in winter months.

Summer months
During summer biggest problem will occur due to overheating of western and eastern façades. As we have no chance to change the way buildings are oriented there will be shading by eaves and movable panels implemented. That will allow reduction of light getting deep into building during summer while in winter when sun is low over horizon will not obstruct same penetration.

ill. 73.1. *(Enrico Cano, n.d.)*

Other possibilities (not applicable)
Other ways to limit energy demand for building is to use solar panels and heat pumps for DHW and heating. First ones work by focussing solar radiation in order to heat up water that can be later used in bathrooms and sinks. Heat pumps on other hand, as name indicates, are the devices that transfer the heat from one medium to another using compression temperature rise and decompression drop in gases. Coefficient of performance COP for those devices is around 4.

Given solutions can be implemented but when taking cost of production, installation and maintenance into consideration one might say that benefits of using them are limited for inside a city locations. That is uniquely apt for heat pumps that operate on electricity therefore their consumption is multiplied by 3 in Poland and that places them very close to district heating with multiplier of 1,3 as source of heat.



ill. 73.2. Conceptual sketches.

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CASE STUDY

DEFLAT KLEINBURG

Similarly to other panel block housing compound, Bijlmermeer, a neighbourhood located in Amsterdam-Zuidoost area, based on modernist urban principals (CIAM). Designed in 1962 by a group of urban designers and led by Siegfried Nassuth, as a part of Amsterdam's spatial planning (Bijlmermeer – w kilka lat do getta, 2017). It didn't last long till this part of the city shared the fate of Pruitt-Igoe (USA). Hopefully, in contrast to Pruitt-Igoe, Bijmermeer, has not been tear down. Thirty years after the designing of the compound, in 1992, an israeli airline plane crushed on one of the buildings. This tragedy accelerated the change. New proposal established significant changes in urban and architectural design of the whole neighbourhood, demolishing many of panel blocks.

In 2017, for the first time in the Mies van der Rohe award history, a modernisation of the existing building was awarded. A new approach to the housing crisis erected in the NL Architects and XVW architectuur offices. Their proposal focused on renovation of the main structure of the deFlat Kleinburg - it's galleries, installations and elevators, leaving the apartments unfurnished and unfinished. This solution helped minimalized the costs of investment and was designed with a participation of the inhabitants of the building. Thanks to this redesign, the awareness of panel block housing increased on a global scale, starting a debate on what should be done with existing buildings instead of replacing them with new designs.

ill. 77.1. deFlat Kleiburg *(Van der Burg, 2017).*

ill. 78.1. Grand Parc *(Ruault, 2019).*

GRAND PARC

This year, a massive transformation of 530 dwellings (3 housing blocks) in French city of Bordeaux, that took only 2 weeks, gained an European prize - Mies van der Rohe Award. The whole facade of the buildings have been expanded by few meters, increasing a living space. What architects achieved, was giving an outdoor space and expanding windows size. This redesign let many users have a possibility of “going out” without leaving their apartments. The space is adjustable to users’ needs. It depends on them, how they want to arrange additional area of their dwellings. Thanks to it, inhabitants have a chance to make their own creations. What is more, new extensions improve residential qualities, both individual as well as social, as the spaces are accessible not only by inhabitants of the level, but also by their closest neighbours, thanks to the common corridor.

SPRZECZNA 4

Designed by BGGK Architekci, a Sprzeczna 4 block tries to convince Poles that contemporary prefabrication doesn't have to be like all of the panel block housings from 60s and 70s. Located in the heart of Praga, a district located in the central part of Warsaw, building tries to blend in to the brick-dominated landscape. This could be possible by colouring the concrete with a red brick colour.

Technology, that is well known and commonly used in Western Europe, is somehow an experiment in contemporary Poland. Poor manufacture of prefabricated elements, high energy consumption, overheating and bad acoustics in the apartments are still commonly associated with prefabrication among Polish society. To convince them to "new" technology, architects had to show unconventional approach to the dwelling design.

ill. 77.1. Main façade of Sprzeczna 4 housing *(Sokołowski, 2017).*

DESIGN CRITERIA

This is a set of design goals aquired thanks to analysis conducted in the previous chapters.

TECHNICAL

- ZEB standard
- Energy and climate optimized dwellings (reduced need for supplied energy)
- Redesign of existing apartments with fine daylight qualities and good indoor climate
- Use of modern technologies that improve sustainable design
- Getting benefits from sun and wind
- Implementing timber as a structural material

FUNCTIONAL

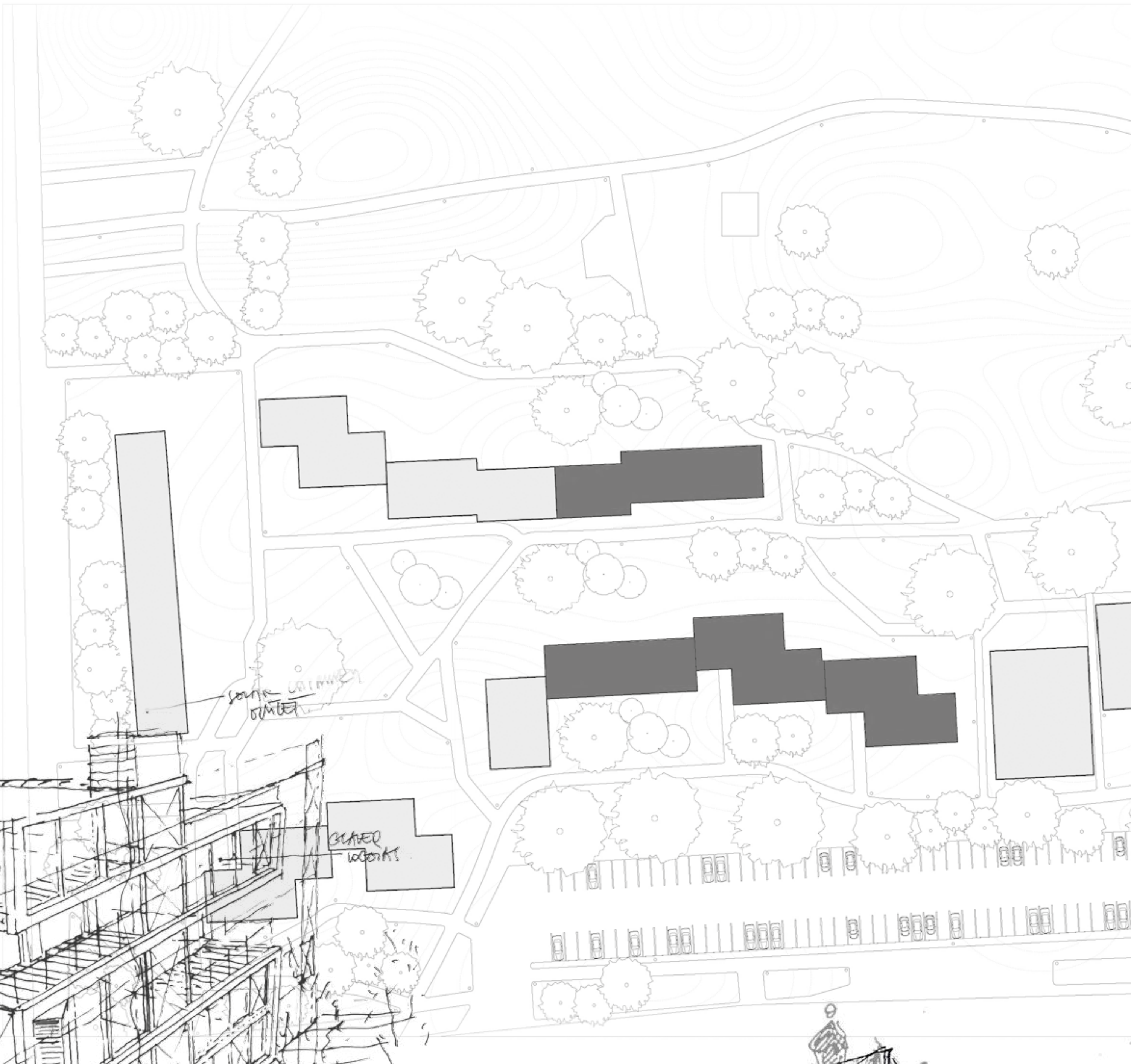
- FAR between 100%-200%
- Up to 20% of services of total FAR
- Deigned 3 different types of dwellings suitable for 3 main user groups: singles, couples and nuclear families
- Integrated bicycle parking and parking for vehicles (1/2 spot per dwelling)
- Creating different open spaces, available for public users and for inhabitants only
- Redesigning and improving existing site's values (parking zones,library)
- Creating a dense area with services (needed by inhabitants)
- Provide indoor privacy
- Adapting rooftops for semi-public and private spaces
- Implementing social zones such us integration rooms

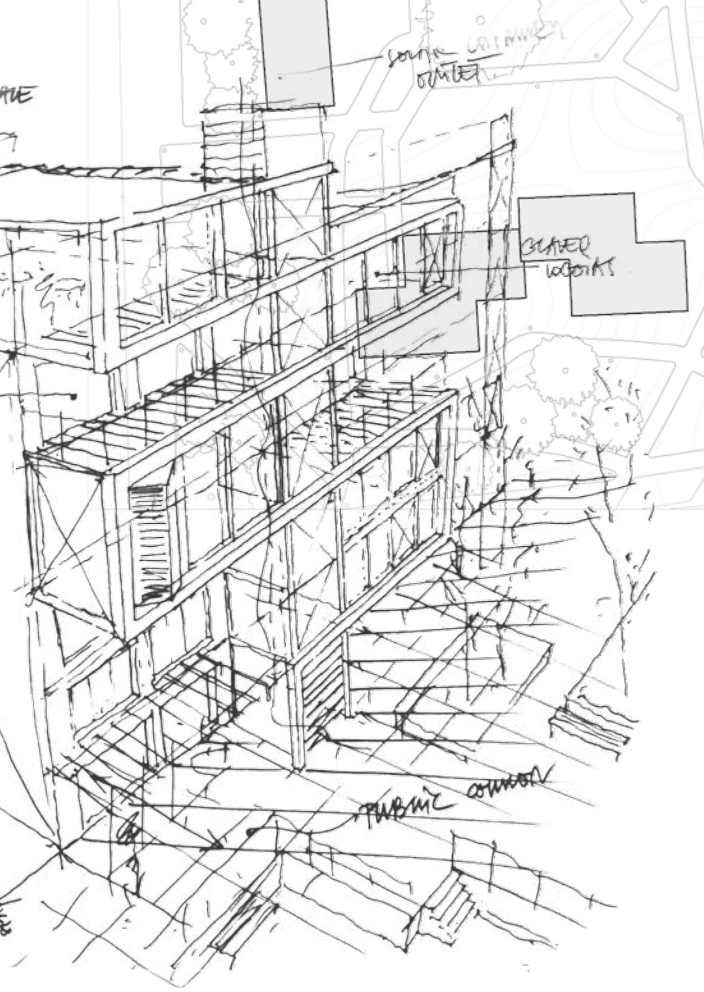
AESTHETIC

- Familiarity
- Creating an architecture that respects it's context (making an architectural dialogue between existing and planned buildings)
- Implementing a landscape design to fulfill a huge amount of free green space
- Creating good life conditions for human beings (sustainable settlement)

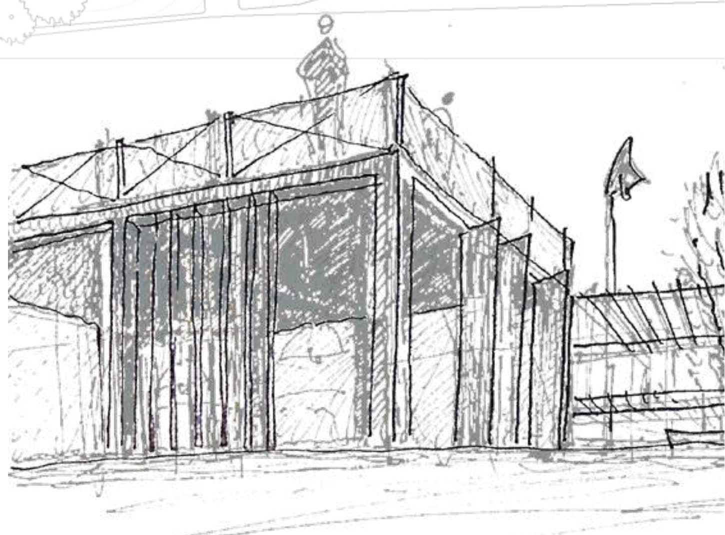
MASTER PLAN

DESIGN CONCEPT



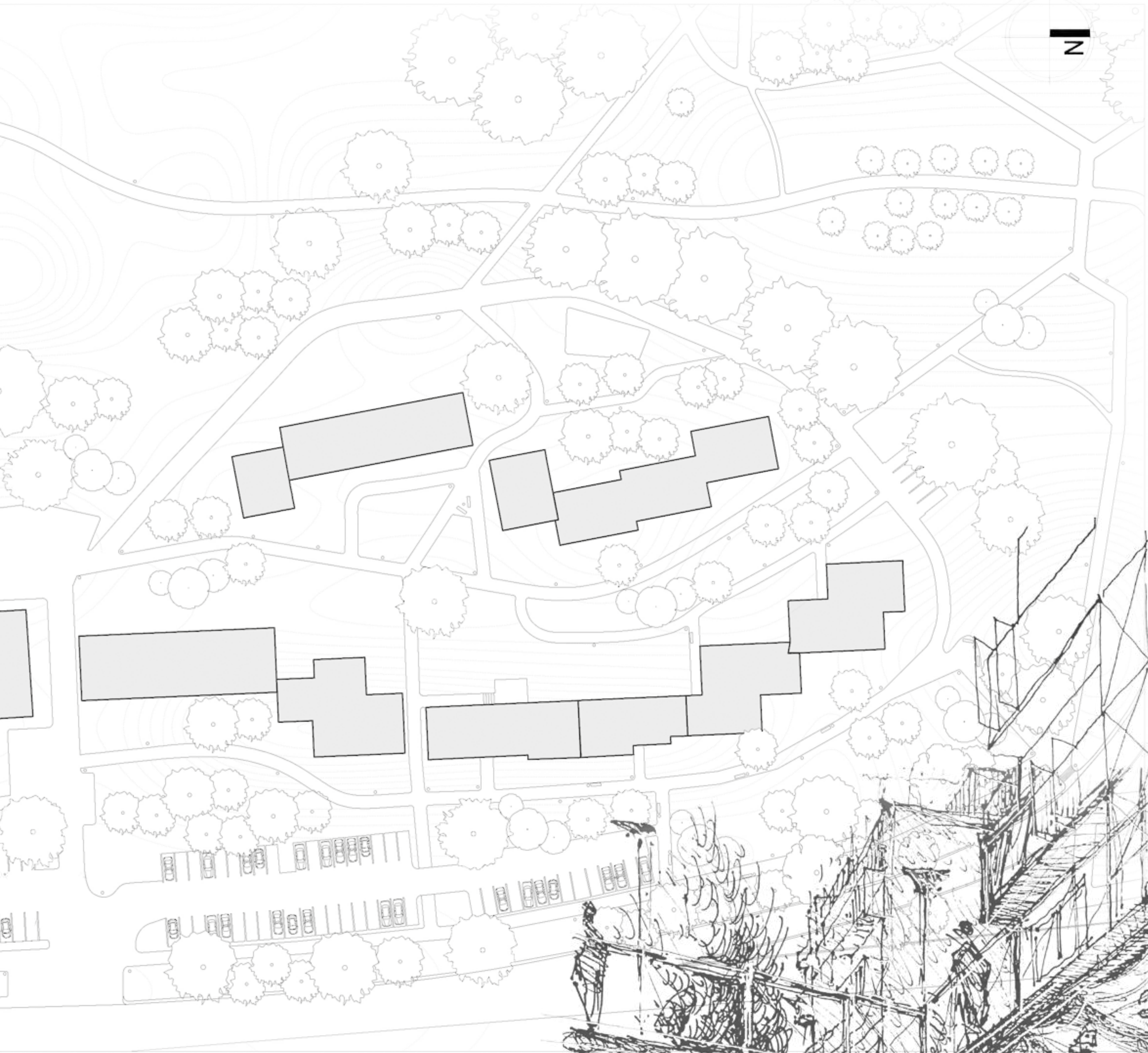


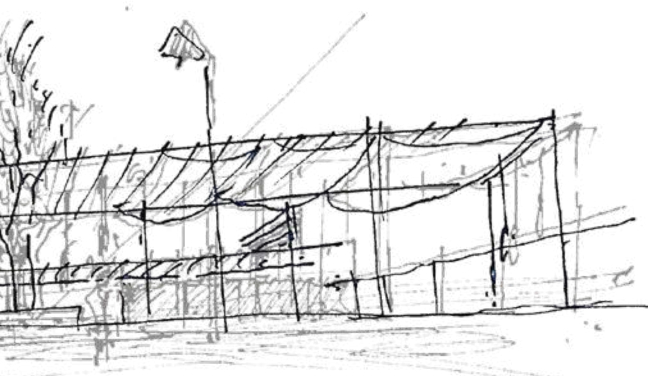
ill. 84.1. Facade design sketch.

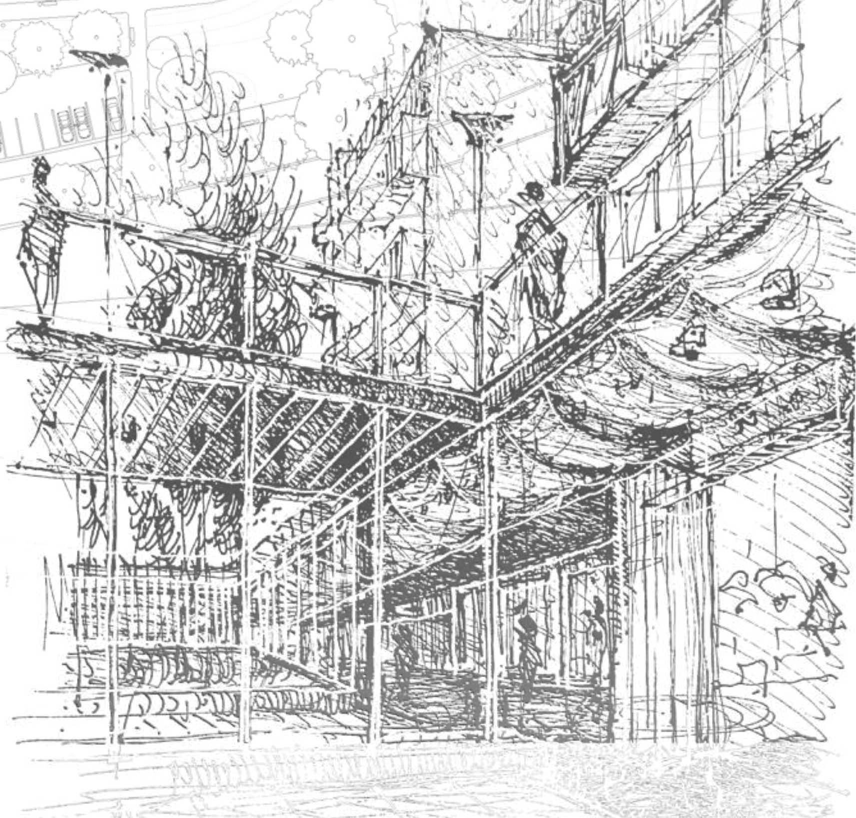


ill. 84.2. Semi-private rooftop.

EXISTING MASTER PLAN
1:1250

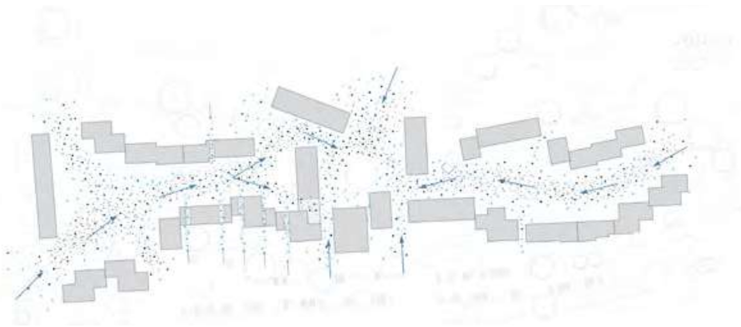


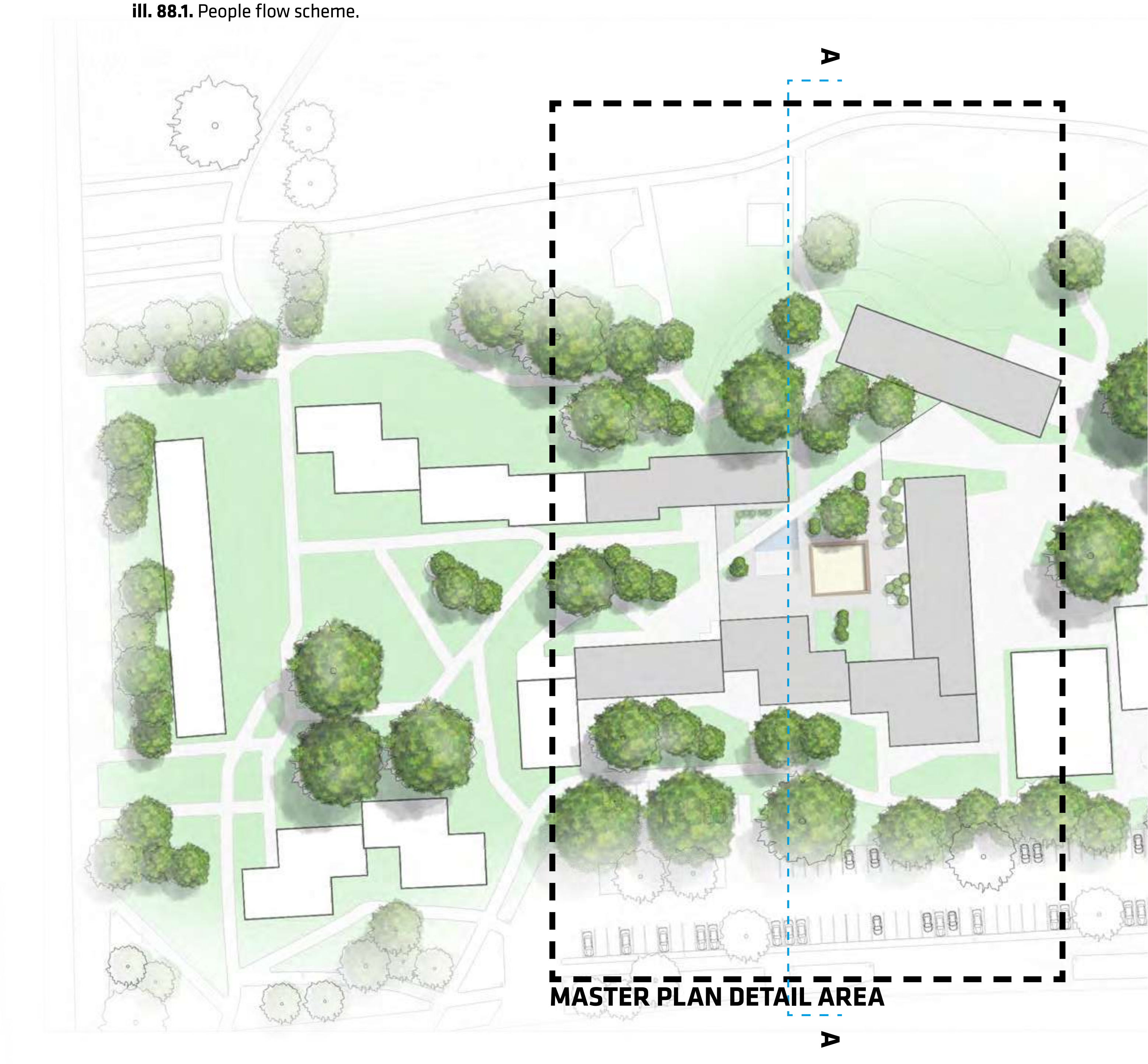




ill. 85.1. Elevated plaza concept.

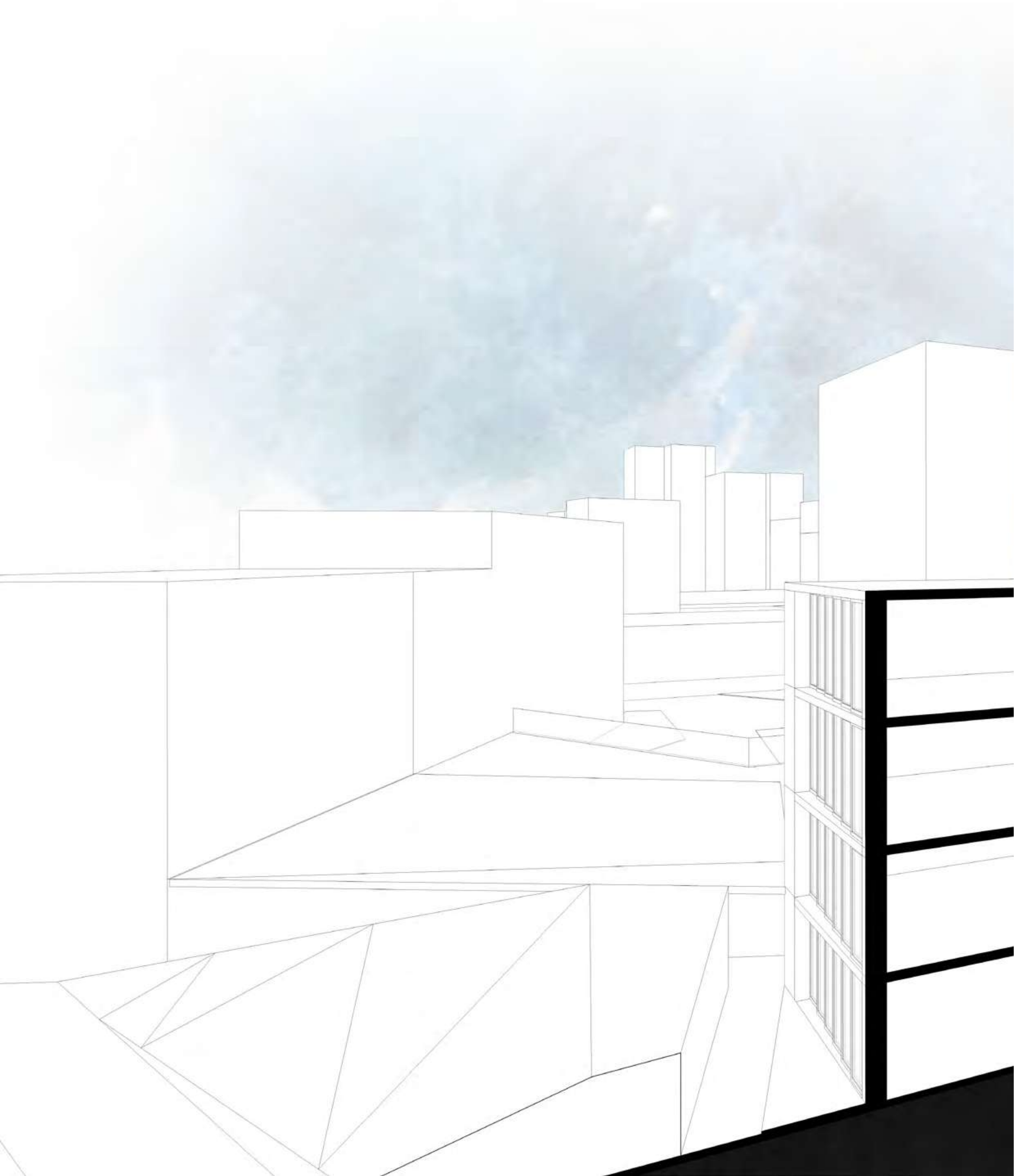
ill. 87.1. View from underneath of elevated plaza.


ill. 88.1. People flow scheme.



MASTER PLAN PROPOSAL
1:1250

SITE
3D CROSS SECTION (A-A)



MASTER PLAN DETAIL
PUBLIC LEVEL 1:500

MASTER PLAN DETAIL
SEMI-PUBLIC LEVEL 1:500

MASTER PLAN DETAIL
PRIVATE LEVEL 1:500

MASTER PLAN DETAIL
ROOFTOP LEVEL 1:500

ill. 96.1. View from the elevated plaza on redesigned buildings.

MASTER PLAN DETAIL
PUBLIC LEVEL AERIAL VIEW

MASTER PLAN DETAIL
SEMI-PUBLIC LEVEL AERIAL VIEW

MASTER PLAN DETAIL
ROOFTOP LEVEL AERIAL VIEW

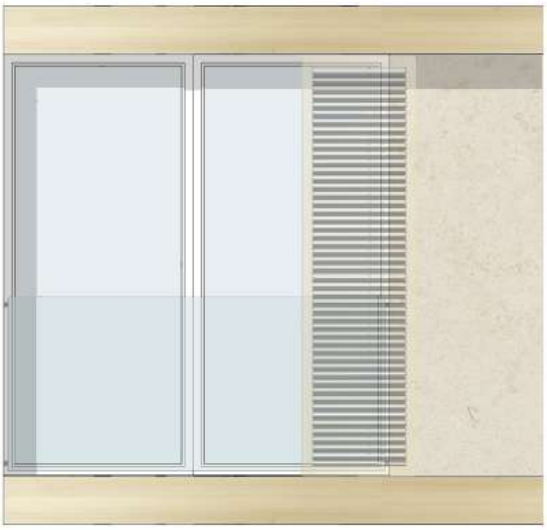
CROSS SECTION THROUGH REVITALIZED BUILDING

ill. 107.1. View from the semi-private rooftop with a football pitch ,

FAÇADE DESIGN

ill. 109.1. East/West façade.

ill. 111.1. North/South façade.



ill. 112.1. Sliding French balcony - single window by loggia.

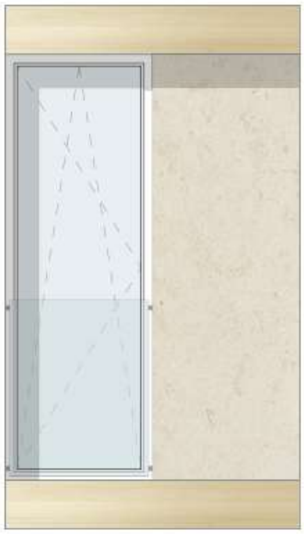
WINDOW CONCEPT

Windows design is very important for indoor air quality and light conditions. In our design most of emphasis was put of providing flexibility of use of openings. This is why among the solutions it is possible to find sliding windows, windows with tilted opening and small hatches for solar chimney ventilation. In order to provide best user-friendliness movable shadings were introduced.

Thanks to those solutions it is possible to adjust shading scenario for different times of the day as well as ventilate apartment efficiently.

During cold or rainy weather venting might be based on solar chimney while when fast exchange of whole air in the flat is needed it is possible to slide big glass panels open achieving opening area of nearly 50 percent of total window surface.

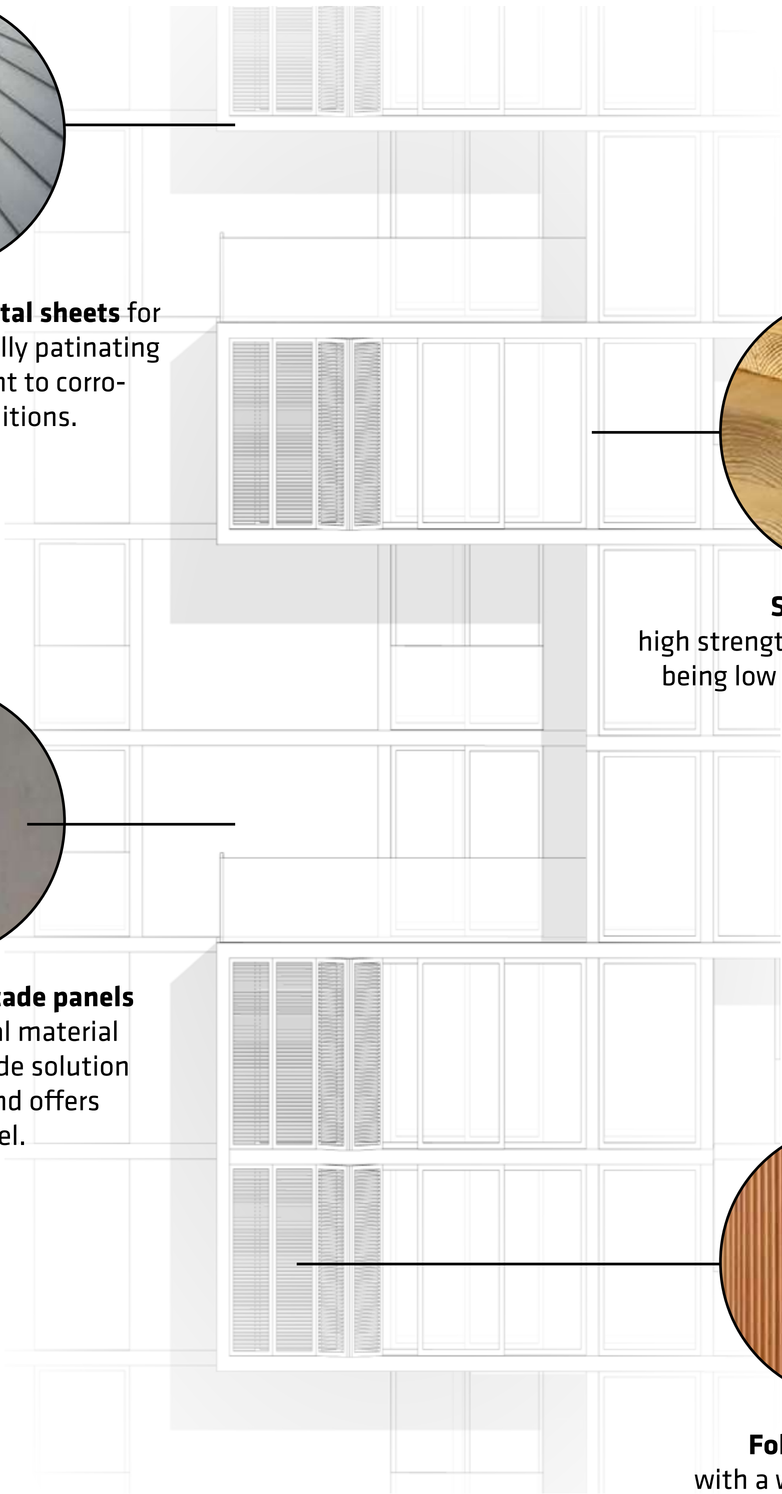
As different extension solutions are implemented on various floors windows function as terrace windows of French balconies depending on location.



ill. 112.2. French balcony - single window by loggia.

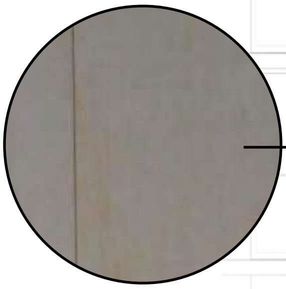
ill. 112.3. French balcony - single window by wall.

MATERIALITY OF THE FAÇADE

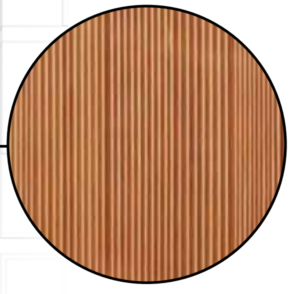


Titan-zink metal sheets for finishings offer naturally patinating surface that is resistant to corrosion and weather conditions.

Spruce CLT wood offers high strength to weight ratio while being low CO_2 footprint material.



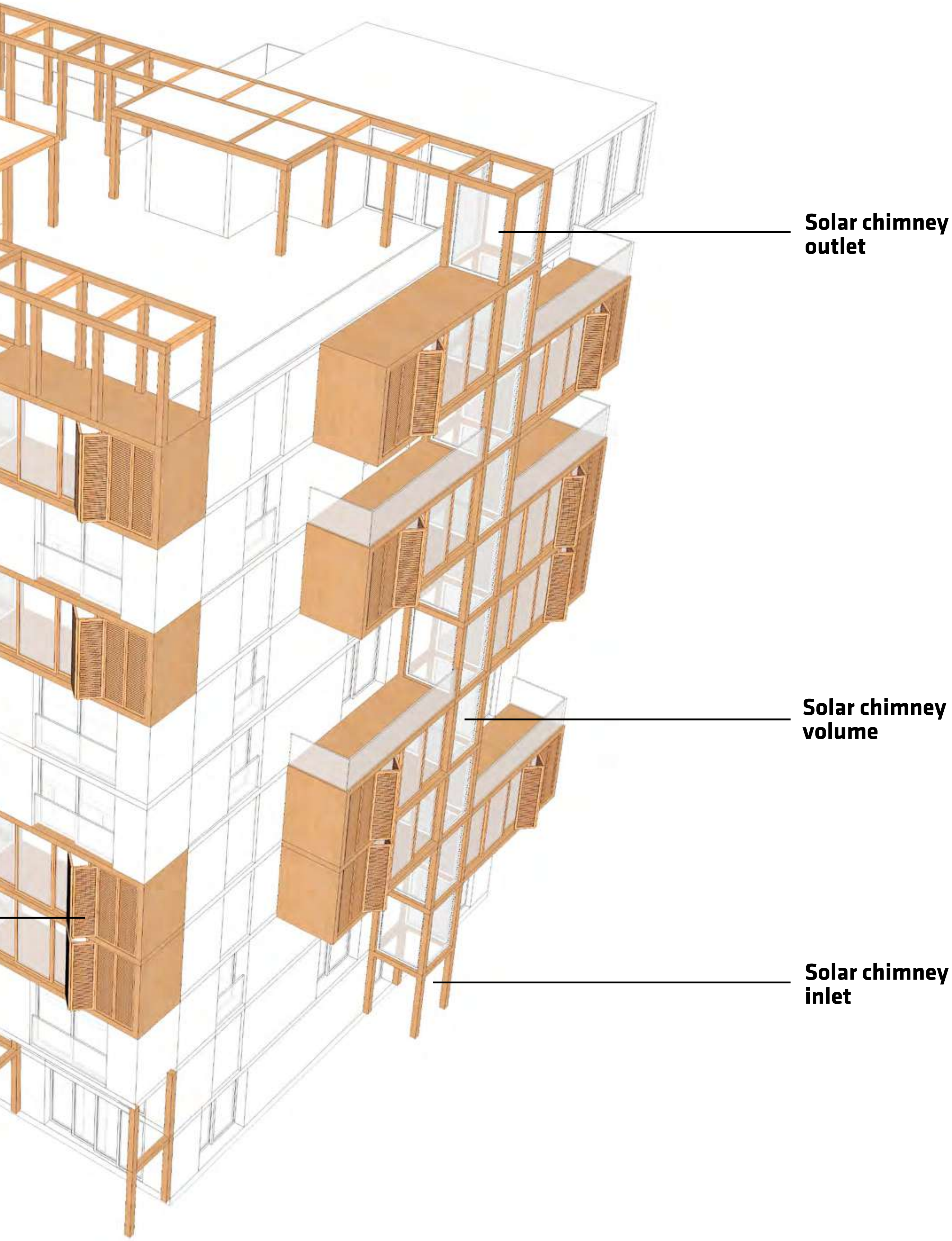
Sandstone façade panels are high quality natural material that creates light facade solution that is easy to place and offers "heavy" materiality feel.



Foldable shading panels, with a wood to air gap ratio of around 50 percent, allow to effectively adapt the building to sun conditions the way users see it fit.

EXTENSION DESIGN

Extension idea and building structure.
Functional solutions for the rooftops.


Solar chimney outlet
Solar chimney volume
Solar chimney inlet

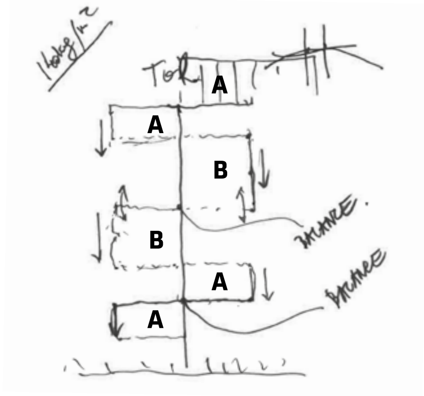
CONSTRUCTION SCHEME

Construction of extension as mentioned earlier relies on CLT wood. The idea of extensions is to generate as little momentum against existing structure as possible. Even though the buildings in Wk-70 panel system were designed for 16 floor height and therefore are capable of taking extra load. The idea of construction bases on self balancing extensions that are supported on frames enveloping the building that work only in compression. There are four shafts created by those supporting timber structures and they were adapted as solar chimney on western and eastern façades. That allows to use supporting structures to enhance living conditions in totally passive way.

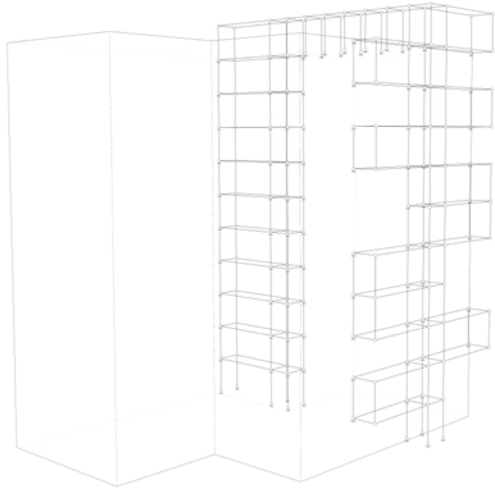
Frames enveloping the building allow to stabilize construction to concrete frame of the existing building. What is more they create natural divisions in rooftop plan that were used in order to provide semi private spaces for inhabitants there.

In detail construction is pinned to faces of slabs along one of three load-bearing beams parallel to the facade. Pinned beam consequently is not subject to high momentum on joints with supporting chimney, In order to reduce that problem in two other beams (look at the section) we decided to implement cross bracings perpendicular to the facade that will reduce structure proneness to bending.

Using all mentioned solutions allows us to assume that for lightly loaded loggias structural balance will be achievable.

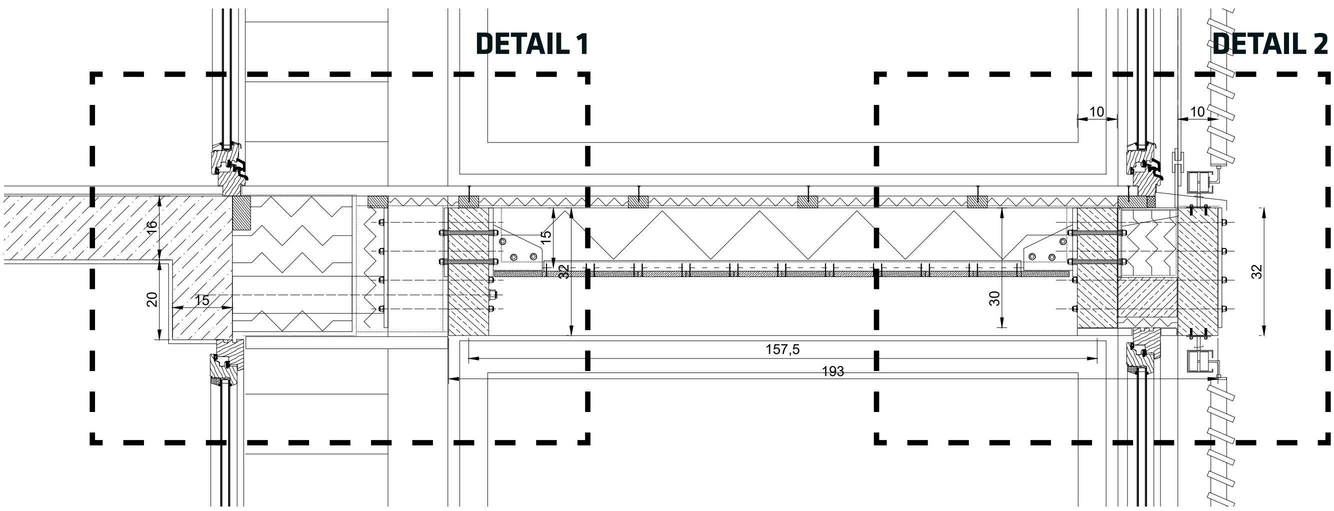


ill. 116.1. Sketch presenting achieved balance with a solar chimney in the middle.

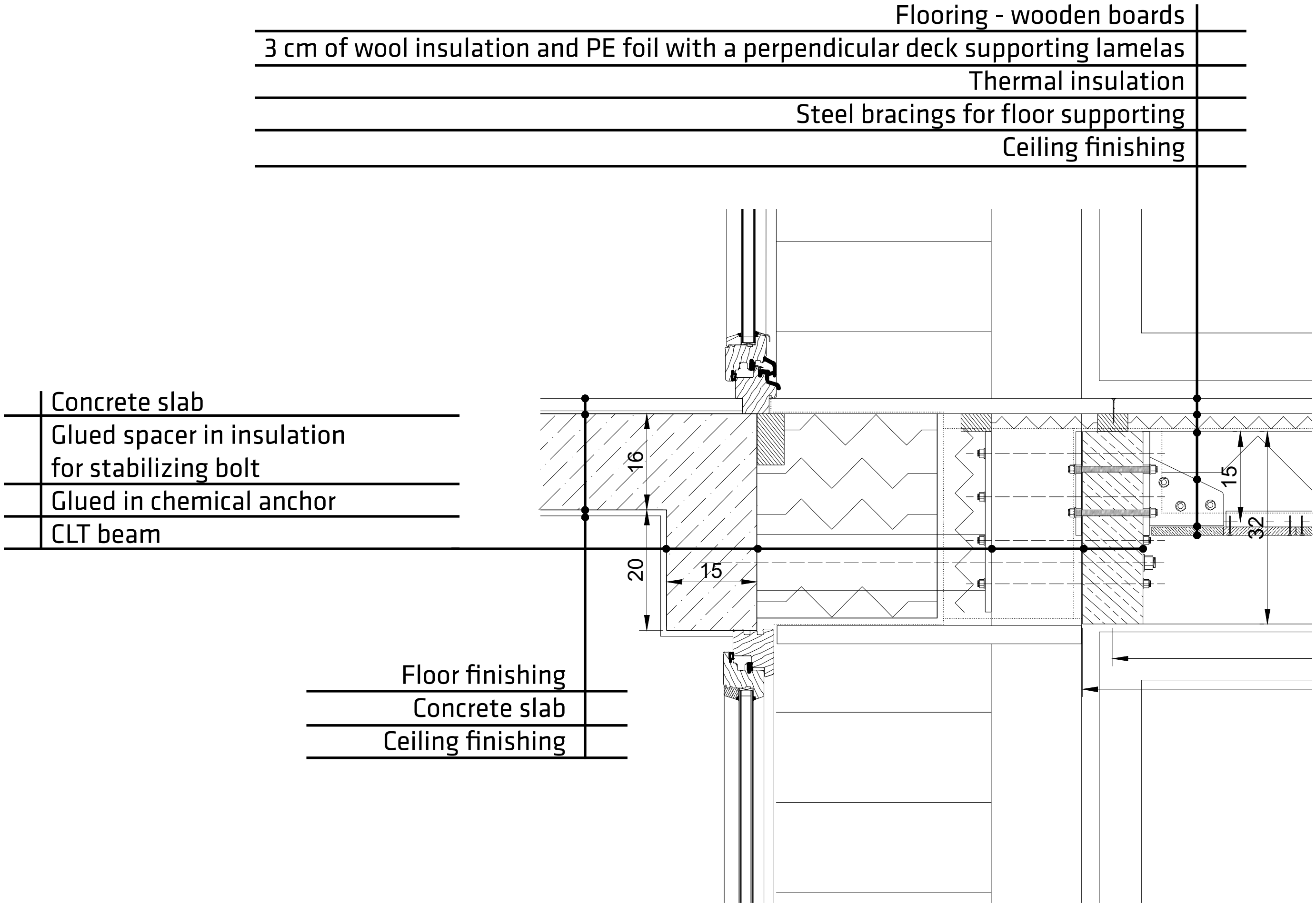


ill. 116.2. Static scheme of the structure.

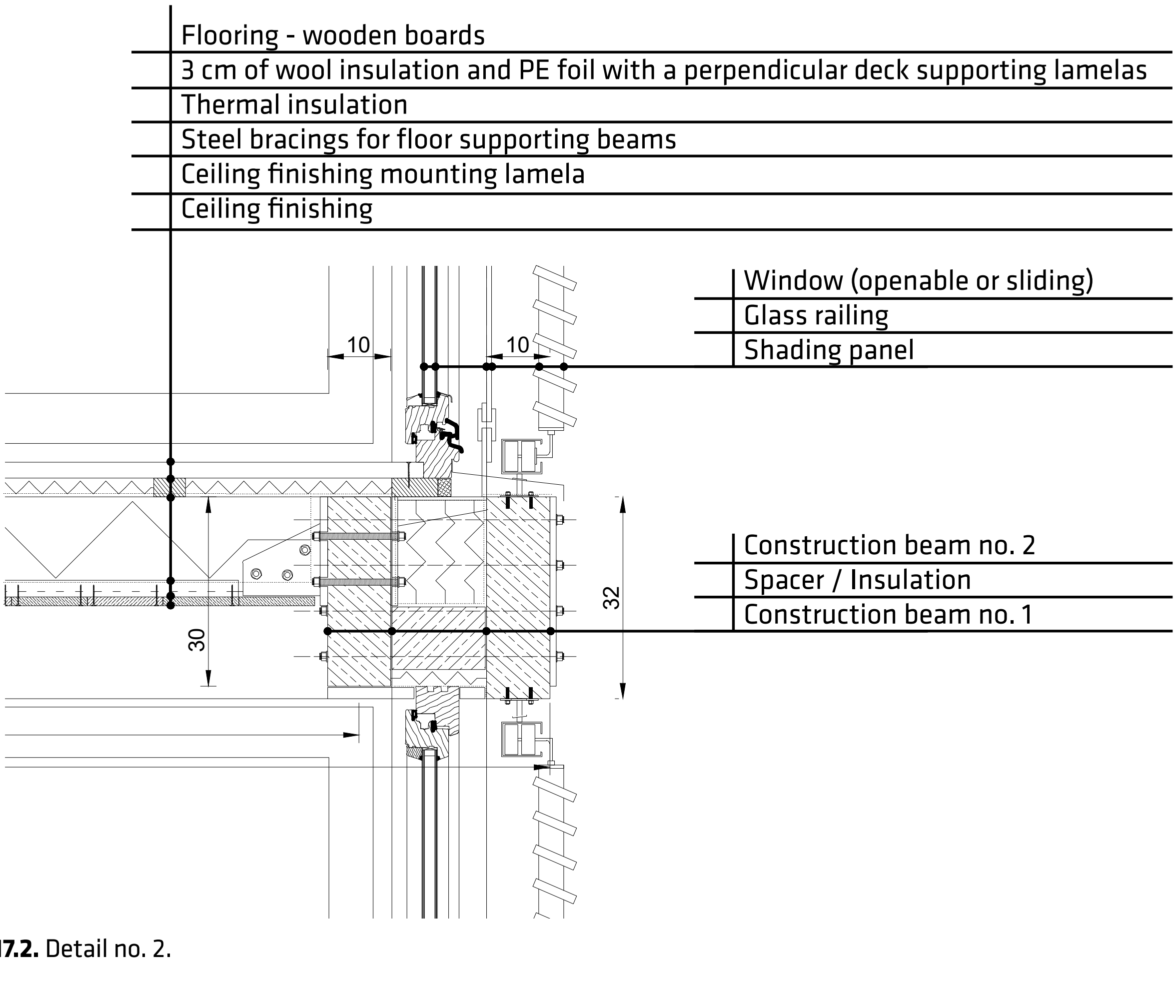
CONSTRUCTION DETAILS



ill. 116.3. Detailed cross section of the extension.



ill. 117.1. Detail no. 1.



ill. 117.2. Detail no. 2.

DWELLINGS AND USERS

USERS

Nuclear **family** is the smallest social unit creating community. In Warsaw, around 61 percent of population lives this way. Therefore we have decided to choose them as our main user group. That is why main focus has been placed to create M3 apartments - dwellings are suitable for small communities of at least 3 users. Depending on the type of family, their lifestyle and needs and limitations of existing structure we have come up with variety of different flats. We did our best to put emphasis on qualities and potential that those outdated designs have. This is why we successfully tried to change number of square meters per capita from 11 to almost 35 while maintaining same number of flats. Along with added amenities and social facilities newly created spaces will present perfect conditions for families with kids.

Couples make up 37 percent of inhabitants of Warsaw. This is why that group and effectively M2 type of flat has second greatest part in compound structure. Flats of that type are suitable for all types of couples. Couples not bounded with kids tend live more differentiated life. One might work at home while other is sleeping etc. All those needs are satisfied by small office, division of night and day zones and maximizing elasticity of plan. Apartments that suite those inhabitants - M2 - are usually flats of area from 55 to 65 m2.

Singles are those members of society who present higher level of activity. They constitute smallest part of society as they are below 3 percent in Poland. Even though they are a group not big by numbers it is also important to present proper solutions for them. Especially while looking on western European coupling trends. This is why in order to provide biggest level of flexibility we introduced M1+ apartment type. It is not to big for one user and not to small for two. It has all the benefits of M2 just without the office. That allows to minimize spacial discomfort in situation where single stops being a single.

ill. 119.1. Site and it's users.

FLAT STRUCTURE IN THE COMPOUND

Original structure of flats and their areas
- M2 - 9,6%
- M3 - 19,4%
- M4 - 50,1%
- M5 - 9,8%
- M6 - 9,4%
- rest - 1,7%

As it can be clearly seen most of units were M4.

Typical family in Ursynów compound was a nuclear family that was given a flat of 61,2m^2 - M4.
- two sleeping rooms
- living room
- bathroom
- WC
- kitchen

Typical areas required by law in 1974 for different types of apartments:

- M1 - 25-28 m^2
- M2 - 30-35 m^2
- M3 - 44-48 m^2
- M4 - 56-61 m^2
- M5 - 65-70 m^2
- M6 - 75-85 m^2

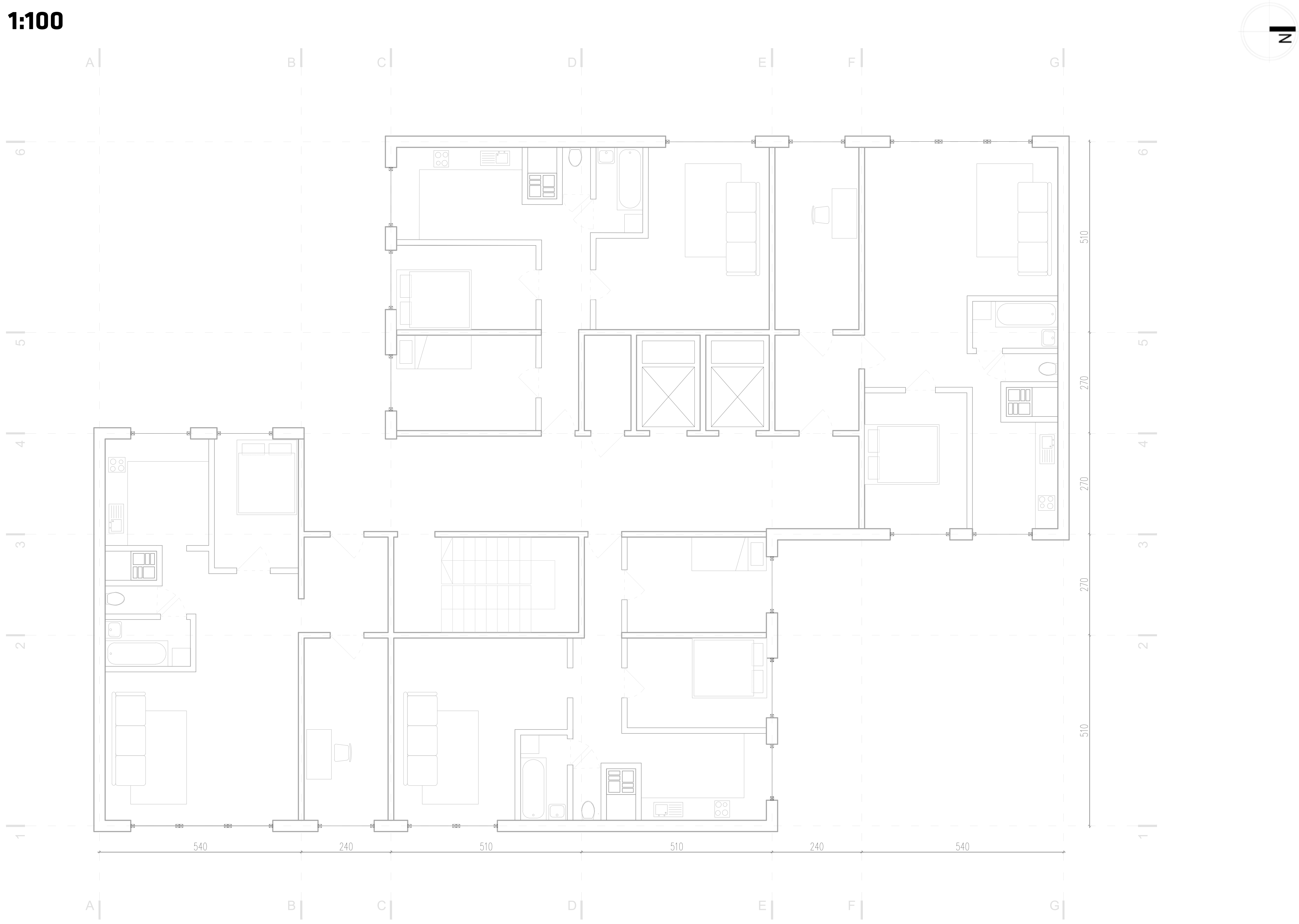
New structure of flats and their areas
- M2 - 37%
- M3 - 60%
- rest - 3%

As it can be clearly seen most of units in new proposal are M3 that reflects social structure of today's society.

Therefore in order to meet requirements of General Plan area of M3 spans from 85-95 m^2. It consists of:
- three sleeping rooms
- living room
- two bathrooms
- kitchen
- studio

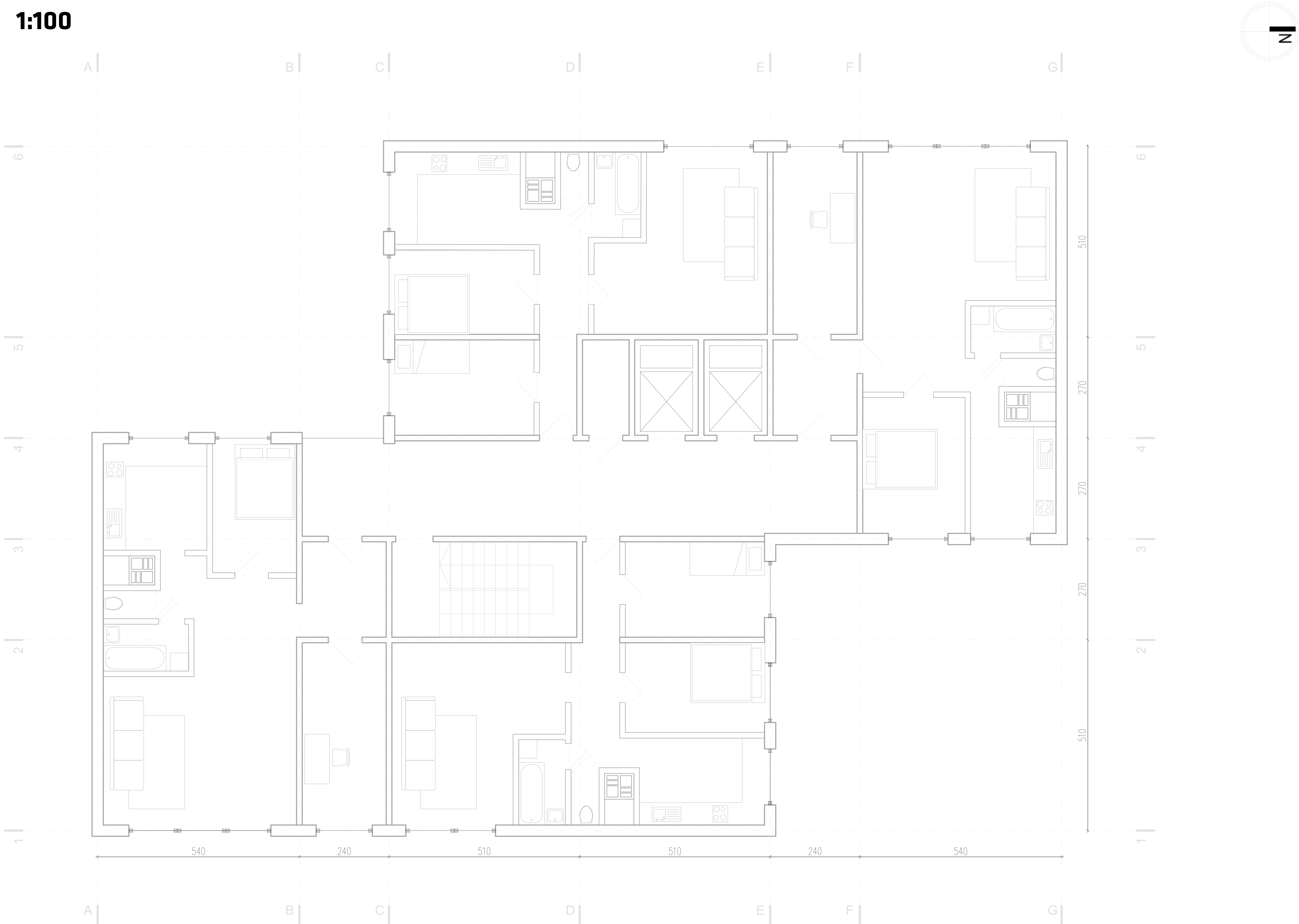
New regulations state that total area per one person should be of 30 m^2, therefore:
- M1 - 35 m^2
- M2 - 55-65 m^2
- M3 - 85-95 m^2

EXISTING GROUND FLOOR PLAN
1:100

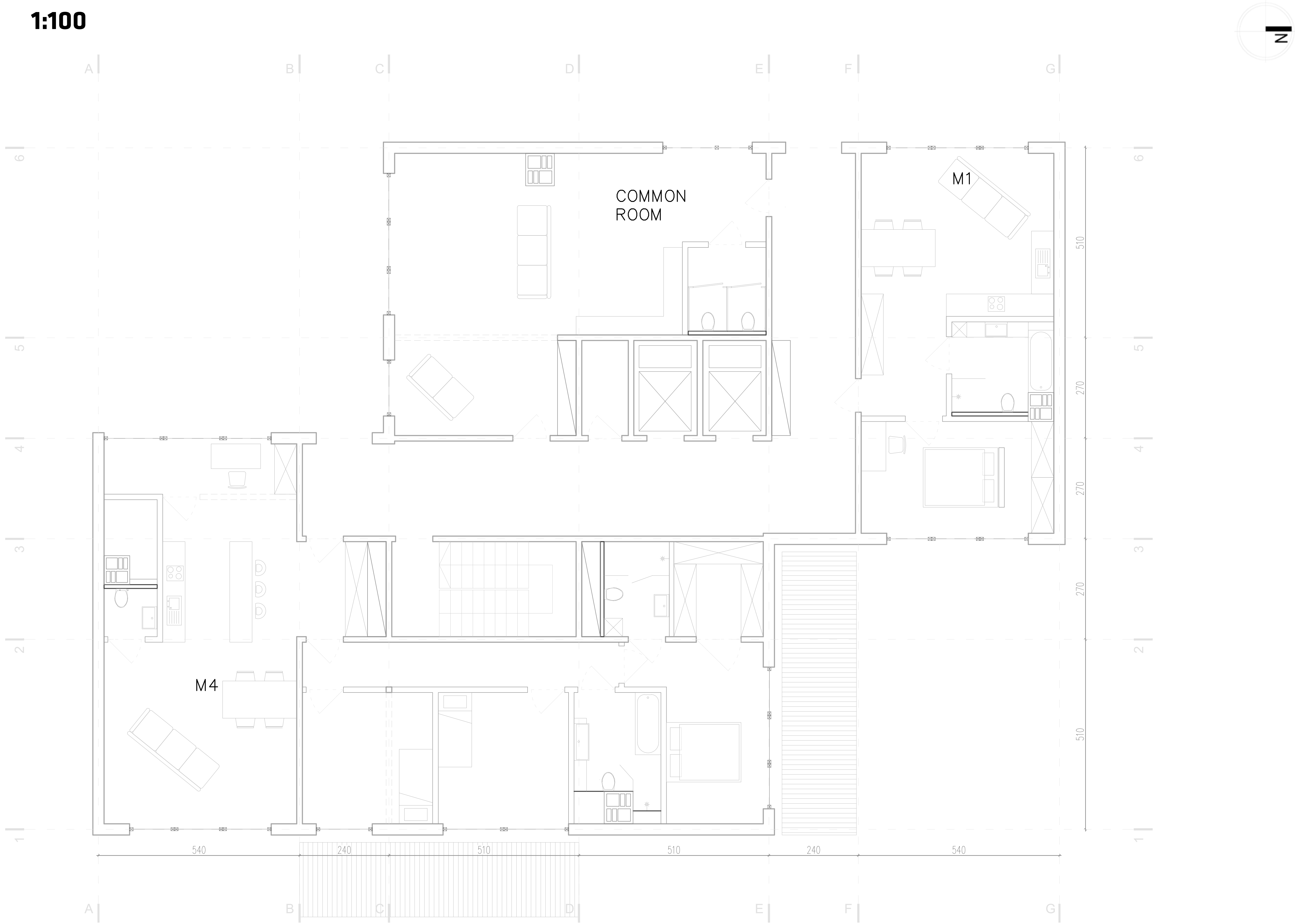


REVITALIZED GROUND FLOOR PLAN
1:100

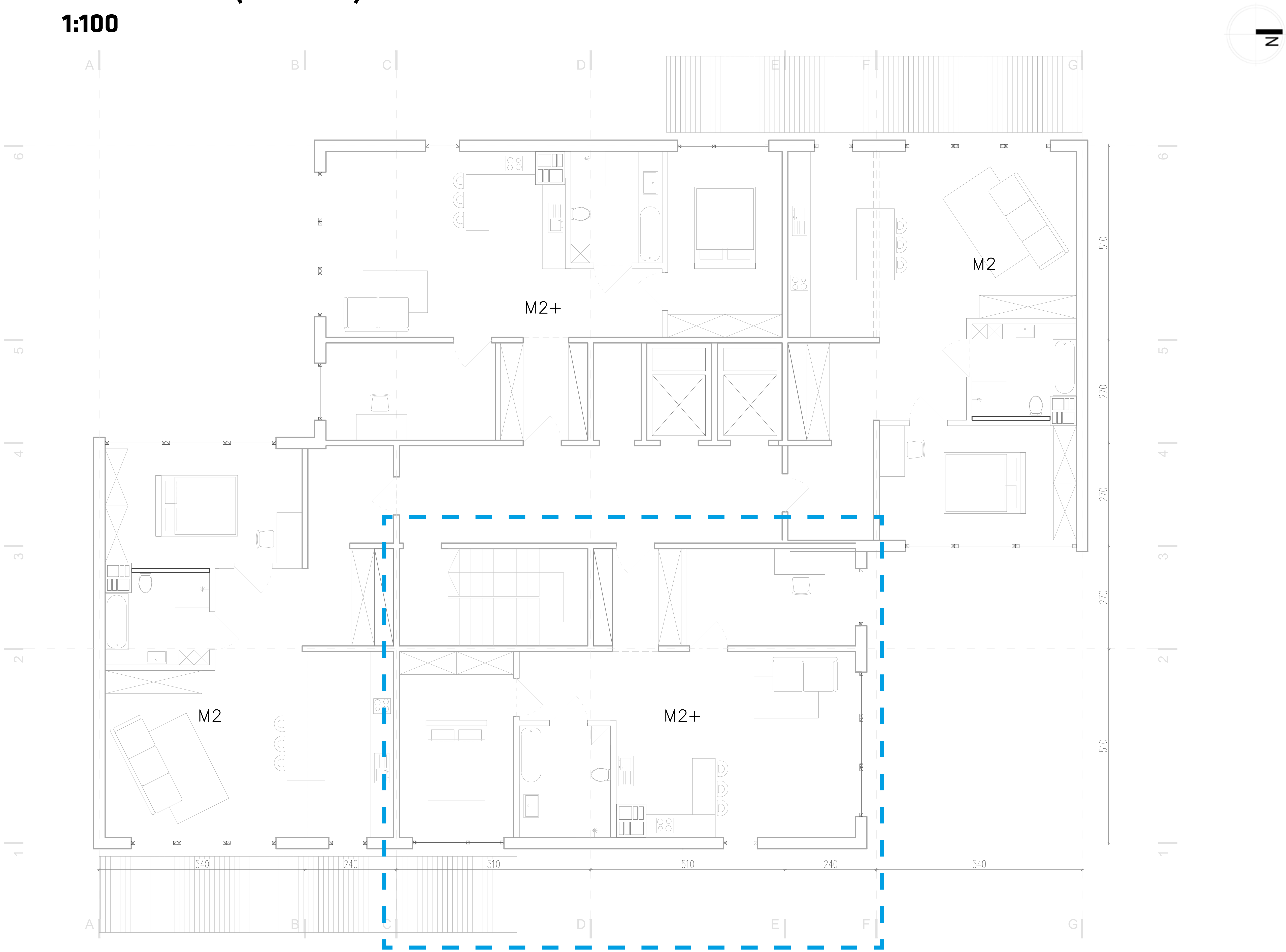
TYPICAL EXISTING FLOOR PLAN
1:100



REVITALIZED SECOND FLOOR PLAN
1:100



REVITALIZED TYPICAL FLOOR PLAN (OPTION A)
1:100



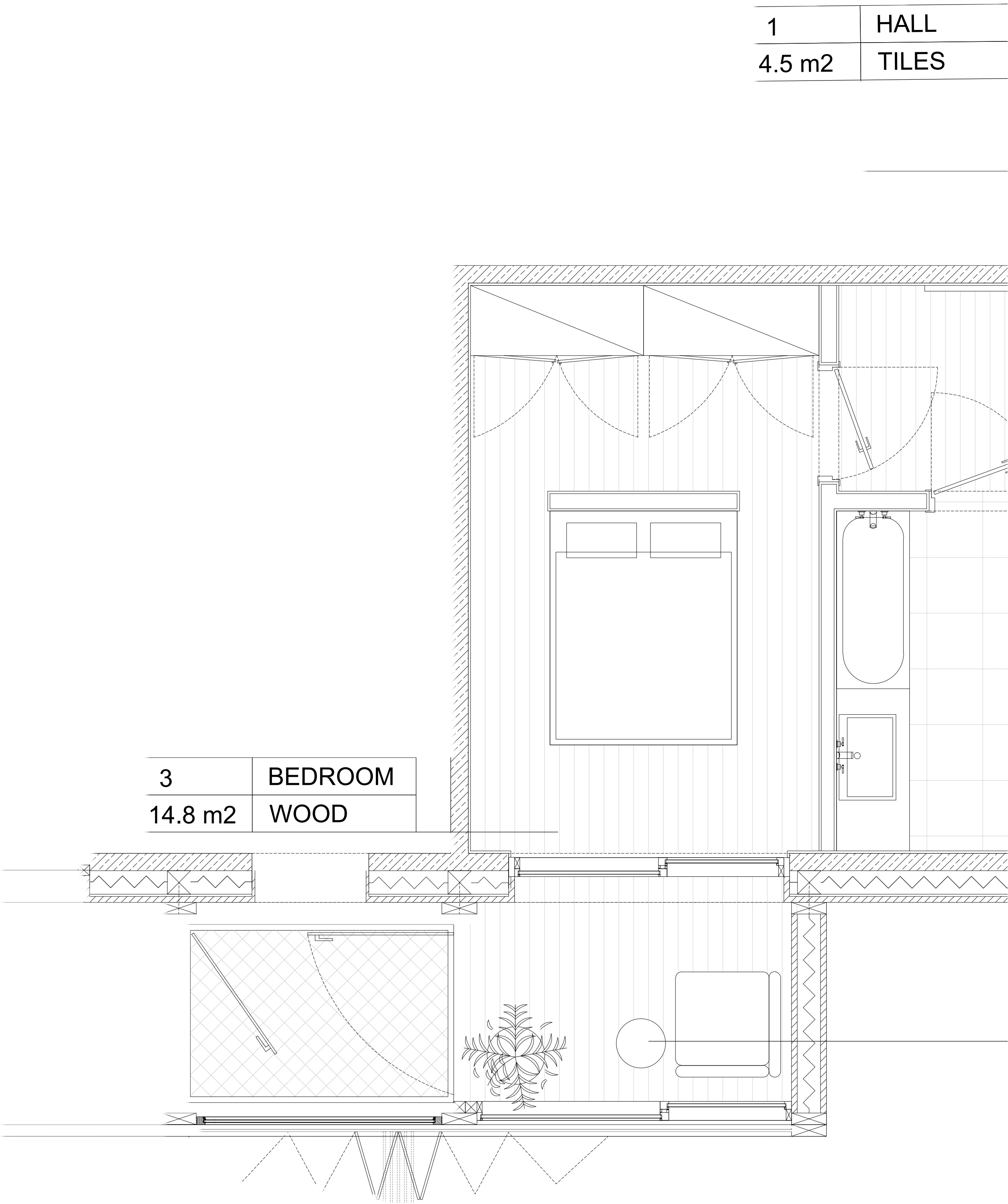
CHOSEN CRITICAL APARTMENT

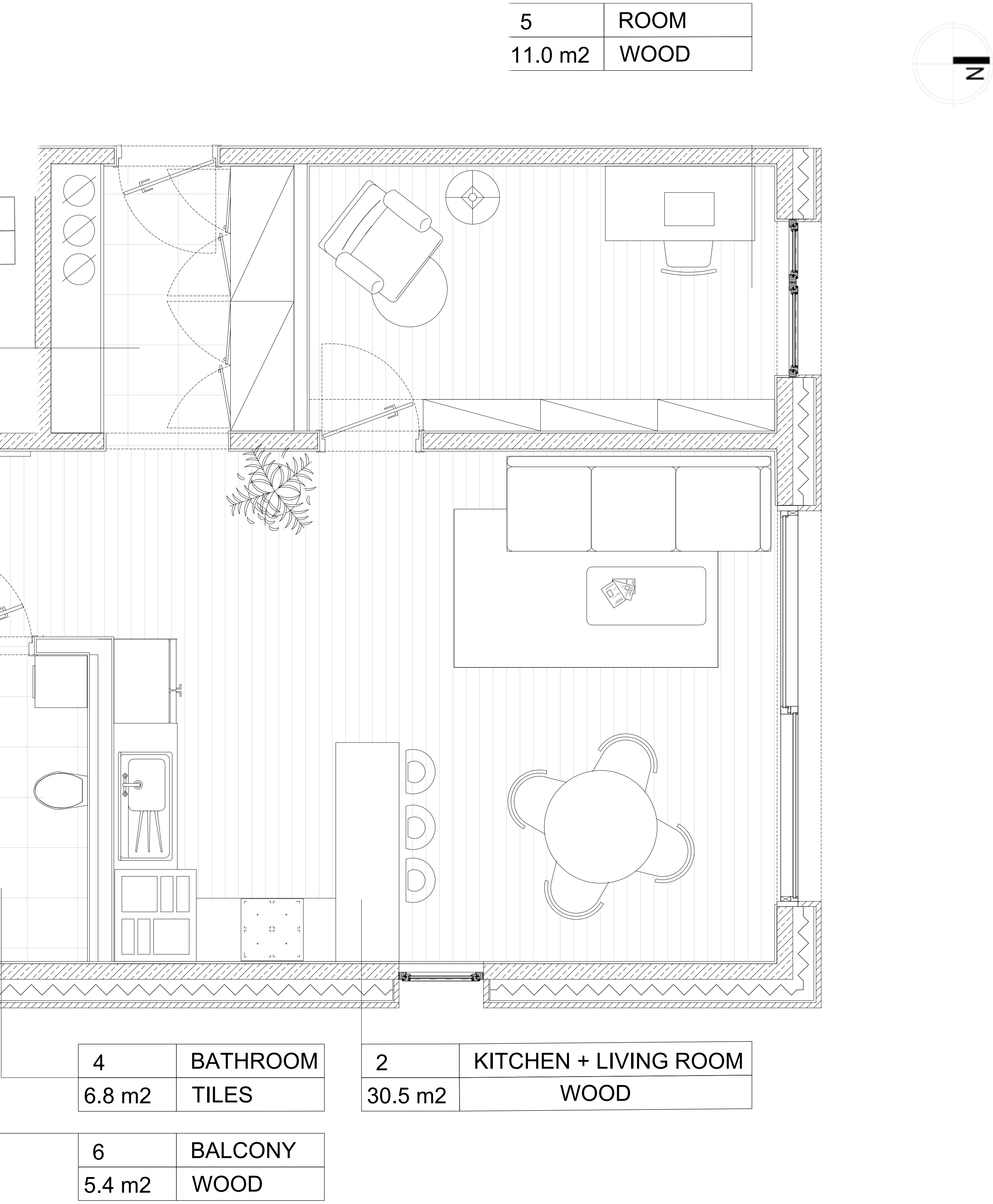
REVITALIZED TYPICAL FLOOR PLAN (OPTION B)
1:100

ill. 128.1. View from the hall on kitchen and living room.

DWELLING CALCULATIONS

Analysis of basic features of apartments and building in terms of energy and indoor climate performance.





ill. 131.1. Analysed revitalized apartment - M2 type, scale 1:50.

INDOOR CLIMATE

For the analysis we have chosen an apartment that would present biggest issues with overheating and thermal losses. This is why we have decided to aim for a flat located on western facade on highest floor with no possibility for cross ventilation.

Basic eaves and shading geometry of the building were set in window parameters.

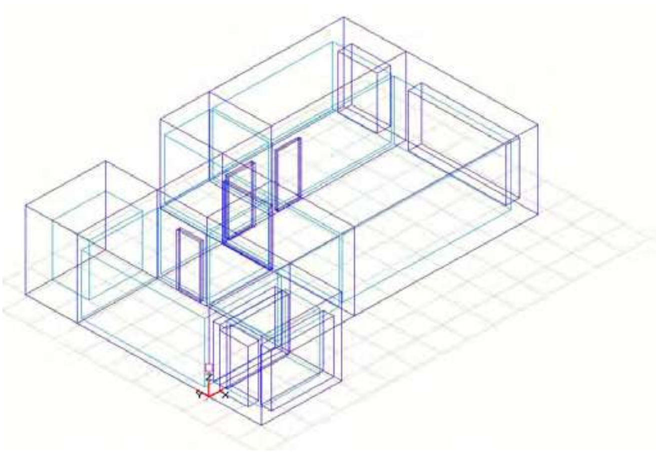
Analysis was conducted in three attempts to tune the flat and shading on the façades while in within third one four different depths of eaves were tested. Results are shown below.

Due to initial movable shading - presented in facade design of 50 percent of total window area - overheating didn't occur as a problem.

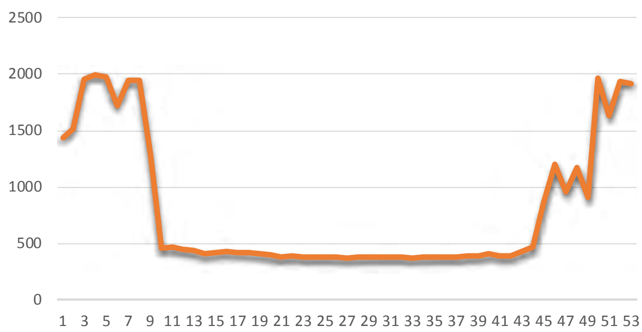
Attempt 1

First attempt was very successful in terms of energy consumption. For flat of 90 m^2 total yearly Q heating was at level of 5016kWh which equals 55kWh/m^2 in worst case scenario. Despite this satisfying result we noticed uniquely high CO2 levels>500 ppm more than outside, which is an EU norm, as building has solely conventional gravity ventilation and windows were to be opened for venting in warm season. This is why we have decided to allow venting at any time of year whenever it is needed in order to provide proper air quality at expense of energy efficiency.

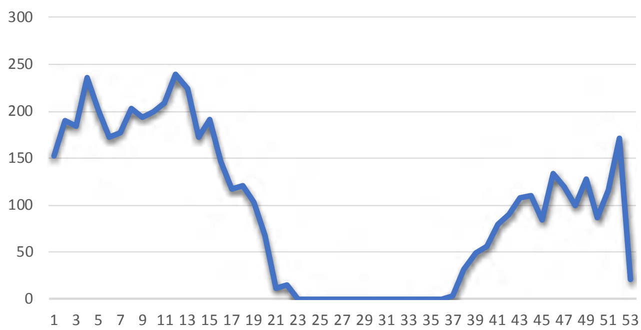
General data:
- Q total heating - 5016 kWh
- CO2 average - 799,6ppm; peak - 1993,1ppm
- Q total venting - 1797,25kWh
- Sun radiation - 3973,7kWh



ill. 134.1. BSim model.



ill. 134.2. Weekly CO2 level.



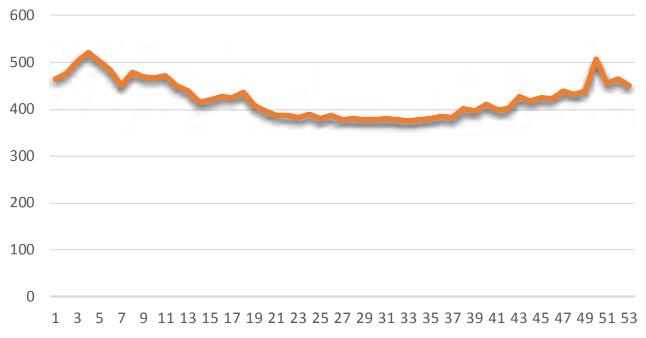
ill. 134.3. Weekly Q heating.

Attempt 2

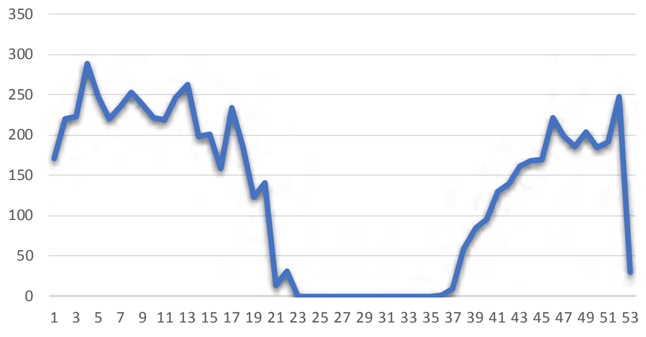
In second attempt venting was set so that windows were to be opened all year round if CO2 levels were too high. Therefore Q heating total was also higher but CO2 levels dropped radically. Consequently Q venting was higher and sun radiation as shading and eaves were not tuned in this iteration remains on the same level. Enhanced venting resulted in increase of energy demand to 75kWh/m^2.

Even though this result still fits in Polish standards and this is a worst flat in terms of energy demand and rules apply to a building as a whole not singular apartment we aimed at doing better. This is why third attempt was aimed at reducing Q transmission while maintaining good indoor climate.

General data:
- Q total heating - 6813 kWh
- CO2 average - 414ppm; peak - 531ppm
- Q total venting - 2166,8kWh
- Sun radiation - 3974kWh



ill. 135.1. Weekly CO2 level.



ill. 135.2. Weekly Q heating.

Attempt 3

In the third attempt four options were tested. Scenario, where adjacent flats have extensions of 1,5m west and 1,5 north, 2m west and 0 m north, 2m west and 2 meters north and 2,5m west and 2,5 m north.

Comparison of Q heating and Q vent and sun radiation are presented to asset an influence of extension on all of those factors simultaneously.

1,5 meters west 1,5 meters north
General data:
- Q total heating - 6493 kWh
- Co2 average - 434ppm; peak - 567ppm
- Q total venting - 2072kWh
- Sun radiation - 3446,5Wh

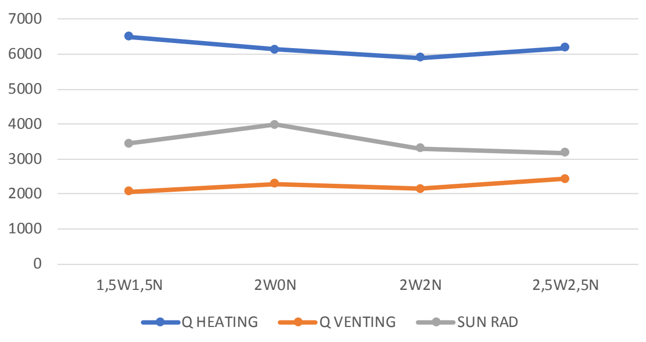
2 meters west 0 meters north
General data:
- Q total heating - 6128 kWh
- Co2 average - 435ppm; peak - 573ppm
- Q total venting - 2285kWh
- Sun radiation - 3975,5Wh

2 meters west 2 meters north
General data:
- Q total heating - 5902 kWh
- Co2 average - 433ppm; peak - 579ppm
- Q total venting - 2146kWh
- Sun radiation - 3295,5kWh

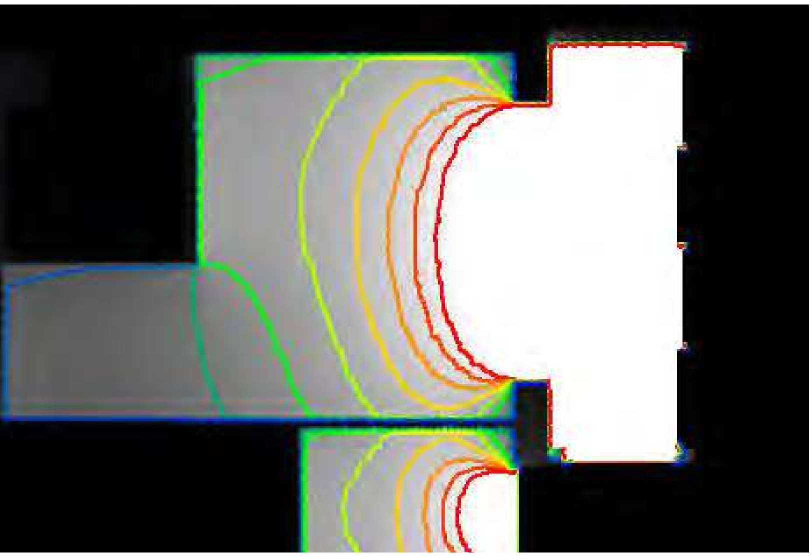
2,5 meters west 2,5 meters north
General data:
- Q total heating - 6185 kWh
- Co2 average - 434,6ppm; peak - 579,5ppm
- Q total venting - 2430kWh
- Sun radiation - 3173,2kWh

Comparison of the loggias

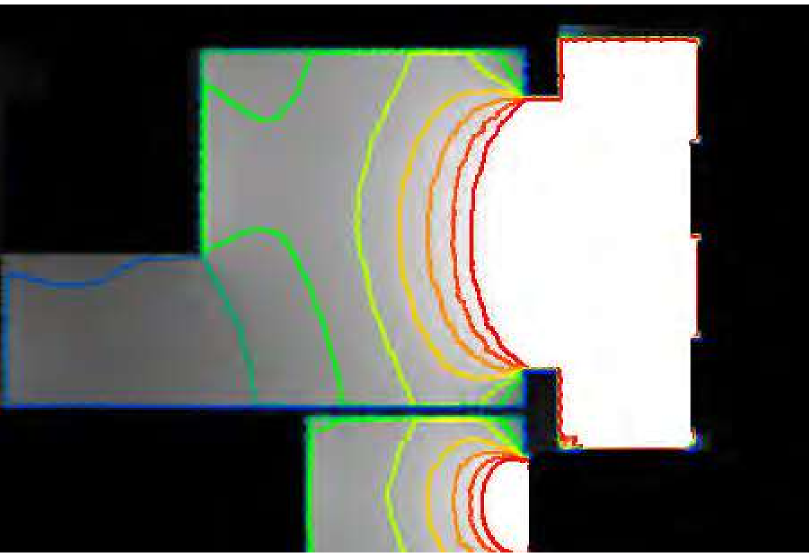
Basing on those results option 2W2N presents best qualities with energy demand for heating of 65kWh/m2 - good for worst apartment in the building. What is more numbers indicate that during summer time northern-west light can cast on openings resulting in numbers worse for 2W0N than for 2W2N.



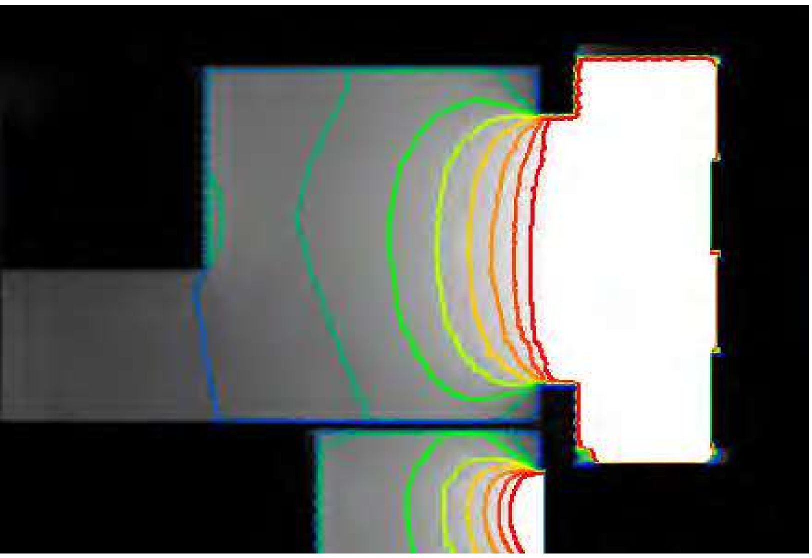
ill. 135.3. Juxtaposition of Qvent, Qheat and Sun Radiation.



ill. 136.1. Case no. 1 - extension of 1.5m.



ill. 136.2. Case no. 2 - extension of 2m.



ill. 136.3. Case no. 3 - extension of 2.5m.

DAYLIGHT

Designing an extension for existing flats rose some questions regarding daylight factor in the interiors of new flats due to shading. That solution, however beneficial for shading on western and eastern façades that would prevent overheating, had to be investigated in terms of indoor light quality. This is why three analysis had been carried out for different depth of extensions. Functional wise the most apt dimensions would be of around two meters and therefore that was initial starting point for analysis. Further on we tested apartments for 1,5 and 2,5 extension depth. It can be clearly seen that light conditions in case no 1 and no 2 are similar while exceeding the limit of 2 meters lowers light quality massively leaving inner corridor with light factor below one.

Conclusions

Due to minor differences in between extension of 1,5 and 2m we have decided both for the sake of indoor climate and functionality to implement that depth of 2 meters in our proposal. It will allow to keep good light factor up to the depth of 6,5 meters while tests in Bsim show that extension of 2 meters gives decent protection against overheating.

BE18 PERFORMANCES

Initial calculation for the existing building shows energy demand of 159,2 kWh/m^2. Parameters of envelope were calculated on basis of layers type for external walls U value=1,4W/m^2K while windows were estimated to have U value of 2. One of the crucial factors was excessive heat in the rooms as those buildings are known to overheat - calculation showed number of 9,6kWh/m^2.

In order to reduce overheating problem extensions and shadings were introduced. Windows U values were reduced to 0,7W/m2K while insulated wall were calculated for value of 0,11W/m^2K. Thanks to those changes and modifications of piping system from non insulated to pre-insulated it was possible to achieve result of 13,7kWh/m^2. Excessive heat in the rooms was also vented out.

It is important to mention that those results are calculated for Danish multipliers and therefore if Polish ones were applied it would mean that all electrical consumption would be multiplied by 3 instead of 1,8 and whole heating by 1,3. Consequently number would be closer to 30kWh/m^2 yearly and harsher climate would probably rise them even more.

From that point on we managed to reduce energy demand further by implementing solar cells what is explained in following chapter.

Conclusions

Proposal, even though struggles with achieving ZEB standard due to Polish regulations and climate presents radical drop in energy consumption that might have huge environmental impact if introduced ion larger scale.

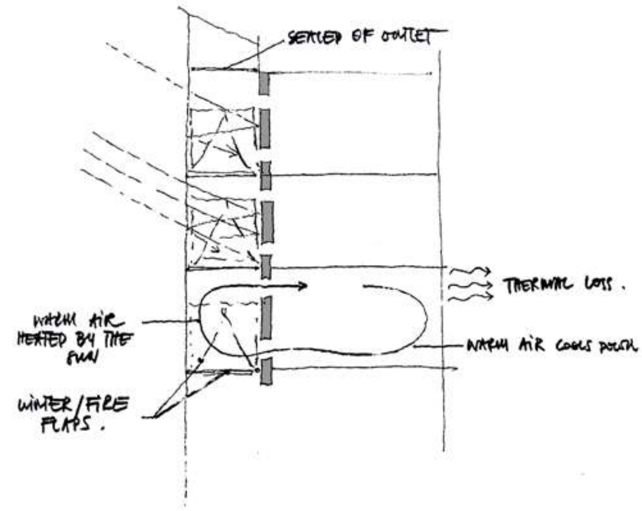
VENTILATION

Existing buildings are not equipped with any type of mechanical ventilation. Base for maintaining indoor climate are gravitational ventilation from kitchen and bathrooms and venting. Due to possible technical and structural problems and electricity consumption we have decided to pursue a goal of developing passive ventilation strategy supporting existing systems.

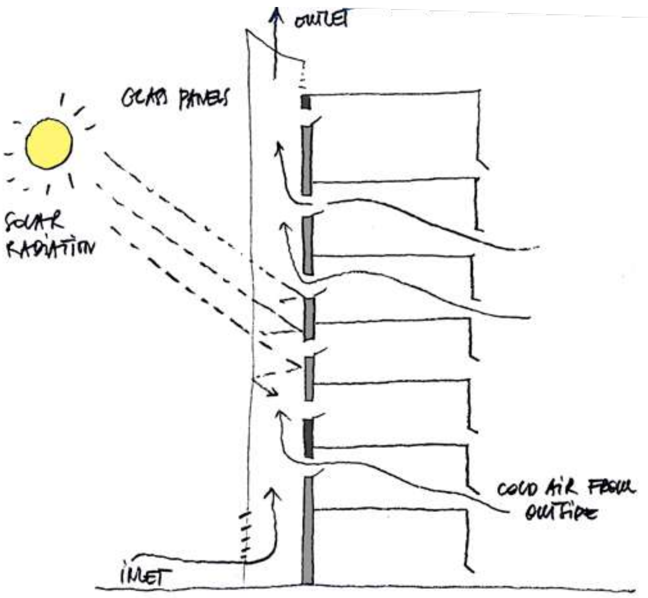
Designed floor plan layout offers two types of ventilation strategies - single sided and cross ventilation. Despite introducing the extensions, basic rule of a thumbs for both types of ventilation are valid and conditions maintained. Room height is of 2,5m in all cases. For sing side ventilated flats depth to height ratio for vented rooms is not bigger than 2,5/1 and is always smaller than 10 meters - total designed depth is up to 6 meters.

For cross ventilation total depth is no greater than 10 meters therefore less that 12,5m that is the limit for this solution at room height of 2,5 meters.

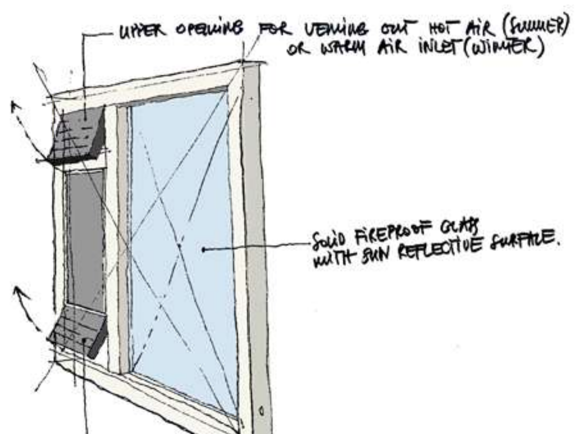
In order to provide better indoor comfort and passive solutions enhancing the performance of the structure we have decided to introduce solar chimneys to ameliorate ventilation in single sided and corner apartments. Those, by use of thermal buoyancy and stack effect allow to ventilate apartments more effectively during summer when they work as cooling solution allowing cold air to be vented in while hot is sucked out. In winter due to introduction of horizontal chimney divisions each part of the chimney works like trombe wall allowing circulation and compensation of heat loss.



ill. 138.1. Solar chimney - winter season.



ill. 138.2. Solar chimney - summer season.



ill. 138.3. Solar chimney - window concept proposal.

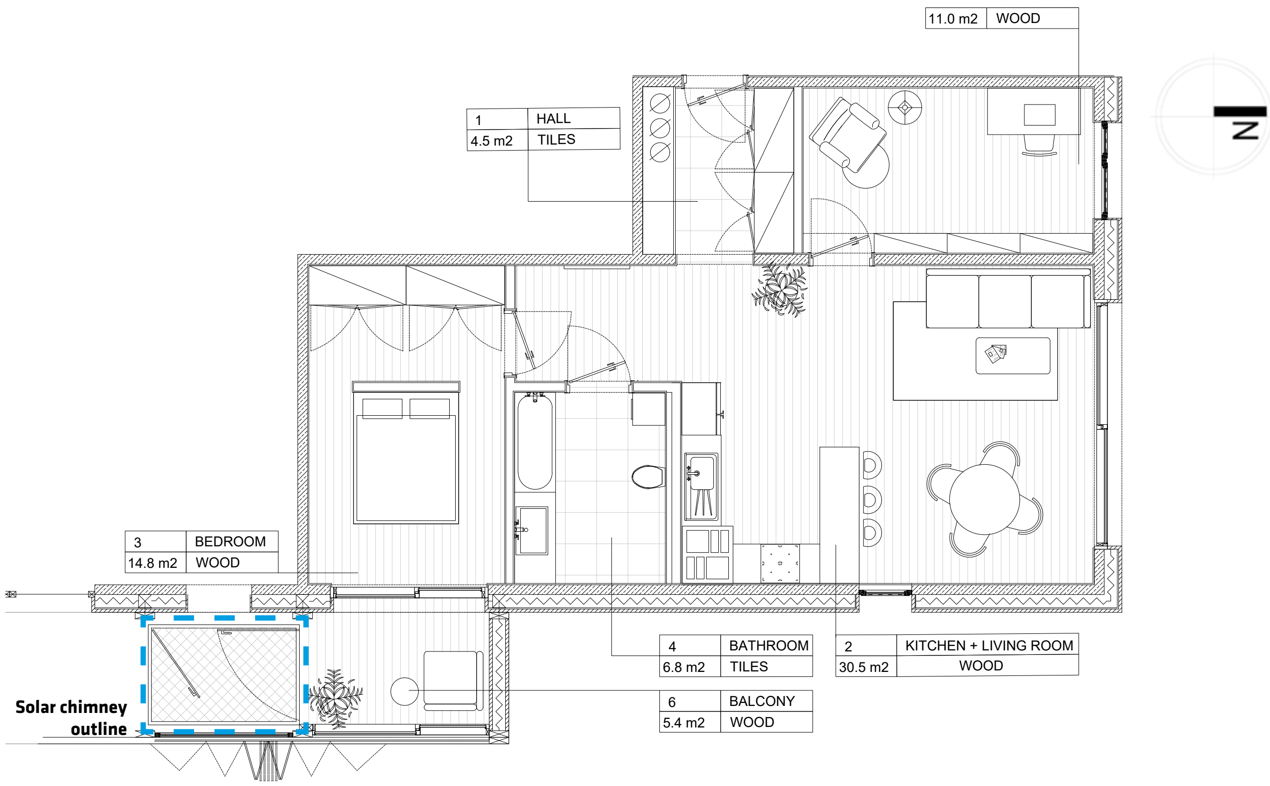
SOLAR CHIMNEY

In order to asses efficiency of designed solar chimney following calculations have been performed. Assumptions were made for idealized model with omittance of turbulences that have to result from uneven inside of the chimney. Nevertheless calculations present general idea of how the chimney should function.
We aimed at assessing amount of air that will be sucked out of the apartment due to pressure difference created in between apartments and chimney, which results from Bernoulli's law.

Therefore we started with calculating volume of air passing through the chimney. As described in „Experimental and Numerical Studies of Solar Chimney for Ventilation in Low Energy Buildings"; Xinyu Zha, Jun Zhang, and Menghao Qin; 22 October 2017, Jinan, China.

For our calculations we assumed that exterior temperature for summer will be of 20 degrees Celsius while interior temperature inside the chimney will be 50 Celsius degrees. Average radiation on those parts of façades throughout summer is around 100 W/m2 (calculation based on radiation test run in Grasshopper). Therefore chimney of area of 30x 1,6 meters will be receiving 4,8kW of solar power for it's volume of 76,8 m^3. Given Cp of air at [1396kJ/m^3/K] and delta T = 30 deg c and summed ventilation and transmission loss of 35% we will need 4948,3 MJ which equals 4,9kW. That allows us to assume that temperature assumptions are right.

After calculation of volume of flow, we had to calculate the speed and that would allow to estimate pressure drop. As draft in chimney was calculated for 5,03 m/s. We were able to determine static pressure fraction reduction at level of 339,42Pa. Basing on that pressure difference we were able to calculate air flow from apartment to the chimney. The result was 2,35 m^3/s and exchange rate for whole flat of 80 m^2 at level of 1,89h-1. Those digits do not include discharge coefficient of window into the chimney however as those vary from 0,6 to 0,7, even if applied,



ill. 139.1. Functional scheme - cooling plan.

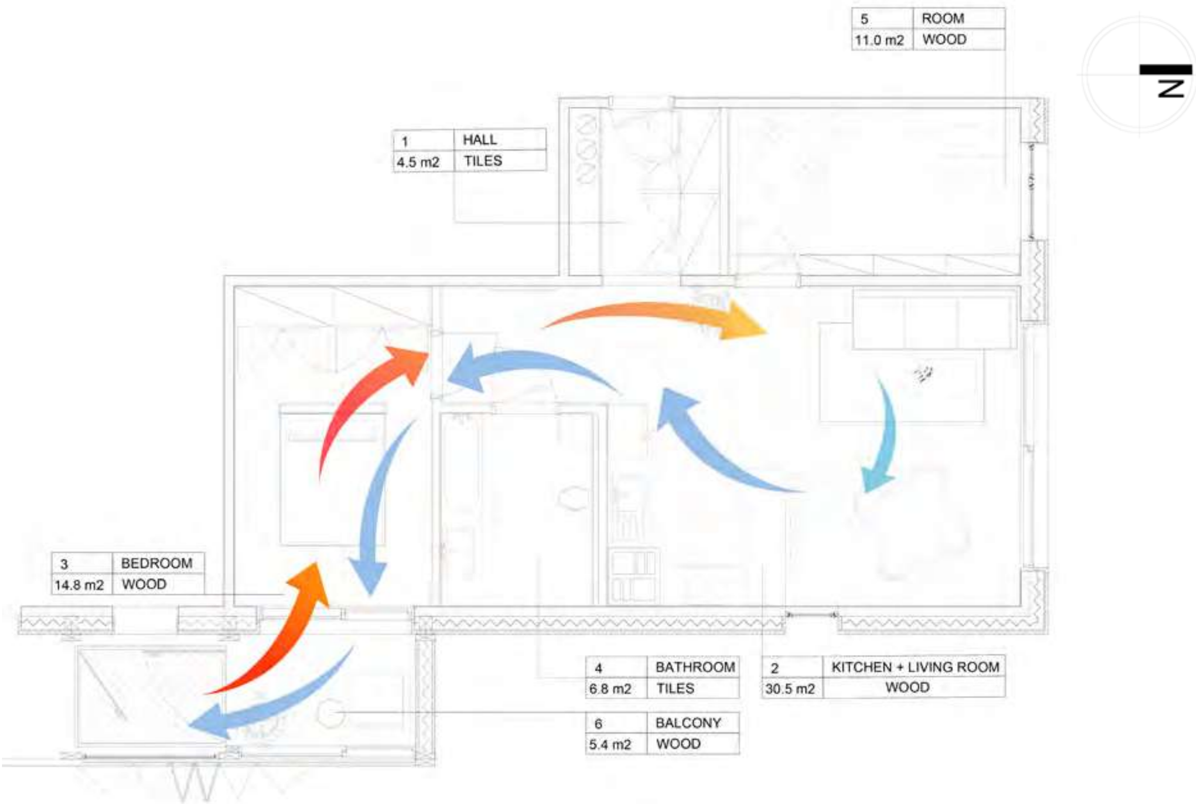
ill. 140.1. Solar chimney - functional scheme.

would reduce those numbers consequently only by 30-40% still allowing for more than 1 full air change extra per hour.

In order to solve fire problems that might occur due to having such long duct along the facade we are aiming at introducing automatic both upper and lower chimney openings as well as flaps between the levels. That will allow to separate levels in terms of fire safety and will block fire spread.

What is more closing of levels of the chimney might be a solution for solar heating in winter. That solution with introduction of openings on floor level and just below ceiling on each level will allow natural circulation known as Trombe wall solution.

We are fully aware of possible acoustic bridges due to openings nevertheless we decided not investigate the problem due to scarcity of time.



ill. 141.1. Functional scheme - heating plan. Red arow - intake circulation - ceiling level. Blue arrow - return circulation - floor level.

CALCULATION OF AIR FLOW IN THE CHIMNEY

$$Q = C \times A \times \sqrt[2]{2gh \times \frac{Ti - Te}{Te}}$$

where:

Q – flow rate

C – discharge coefficient = 0,6-0,7

A – section area of the chimney – 2,56 [m2]

g - gravitational acceleration = 9,81 [m/s2]

h - height of the chimney = 30 [m]

Ti – temperature inside the chimney – 323 [K]

Te – temperature outdoors – 293 [K]

$$Q = 0{,}65 \times 2{,}56 \times \sqrt[2]{2 \times 9{,}81 \times 0{,}1023}$$

$$\boldsymbol{Q = 12{,}9\, m^3/s}$$

AIR SPEED CALCULATION

$V = \omega \times A$

V – volume of air passing through the chimney = 12,9 [m3/s]

ω – velocity of air in the chimney [m/s]

A – section area of the chimney – 2,56 [m2]

$12{,}9 = \omega \times A = \omega \times 2{,}56$

$$\boldsymbol{\omega = 5{,}03\ m/s}$$

FORMULA FOR STATIC PRESSURE DROP DUE TO THE FLOW VELOCITY – BERNOULLI EQUATION

$$\frac{\rho v^2}{2} + \rho g h + p = const = 1013hPa = 101300Pa$$

ρ – density of air in the chimney – 1,062 [kg/m3]

v - flow velocity = 5,03 [m/s]

g - gravitational acceleration = 9,81 [m/s2]

h - height of the chimney = 30 [m]

p – static pressure fraction [Pa][N/m2}

$$\frac{1{,}062 \times 5{,}03^2}{2} + 1{,}062 \times 9{,}81 \times 30 + p = const = 1013hPa = 101300Pa$$

$26{,}87 + 312{,}55 + p = 101300Pa \qquad p = 100960Pa \qquad \boldsymbol{\Delta p = 339{,}42Pa}$

AIR FLOW FROM APPARTMENT TO CHIMNEY THROUGH OPENING OF 0,5M2

SPEED:

$$\frac{\rho v^2}{2} = \Delta p$$

ρ – density of air in the appartment at 20 deg C – 1,225 [kg/m3]

$$\frac{1{,}225\ v^2}{2} = 339{,}42$$

Δp =339,42 Pa

$$\frac{1{,}225\ v^2}{2} = 339{,}42$$

$$\boldsymbol{v = 23{,}54 m/s}$$

VOLUME:

$Q = A \times v$

Q – flow rate

A – section area of the opening – 0,1 [m2]

v - flow velocity = 23,54 [m/s]

$$\boldsymbol{Q = 2{,}35 m^3/s}$$

RESULTING AIR EXCHANGE PER M2 IN FLAT OF 80M2

$$\boldsymbol{Q \times \frac{1000}{flat\ area} = 2{,}35 \times \frac{1000}{80} = 29{,}375 \frac{l}{m2}/s}$$

RESULTING AIR EXCHANGE AS VOLUMES PER HOUR IN FLAT OF 80M2

$$\boldsymbol{number\ of\ exchanges\ per\ hour = \frac{80 \times 2{,}5 \times 1000}{29{,}375 \times 3600} = 1{,}89 h^{-1}}$$

DRAFT PRESSURE DIFFERENCE – CROSS CHECK

$dp = g(\rho_o - \rho_r)h$

g - gravitational acceleration = 9,81 [m/s2]

ρ_o - density of air in outdoors at 20 deg C – 1,225 [kg/m3]

ρ_r - density of air in the chimney at 50 deg C – 1,062 [kg/m3]

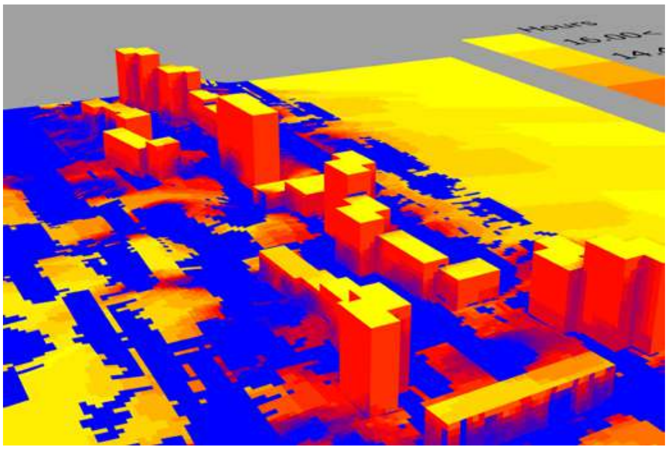
h - height of the chimney = 30 [m]

$dp = 9{,}81(1{,}225 - 1{,}062)30$ $\boldsymbol{dp = 47{,}9 Pa}$

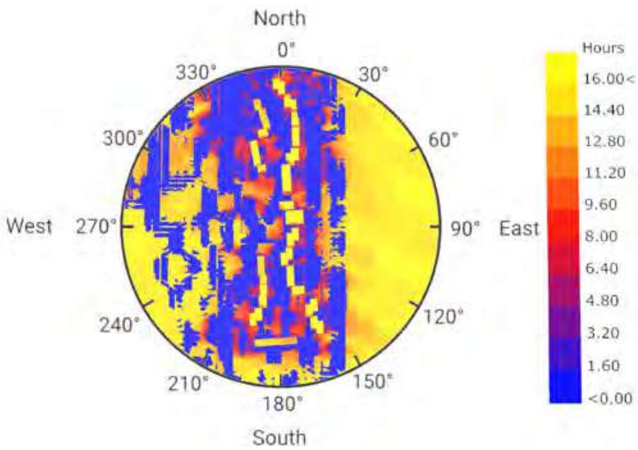
SITE CALCULATIONS

SUN HOURS

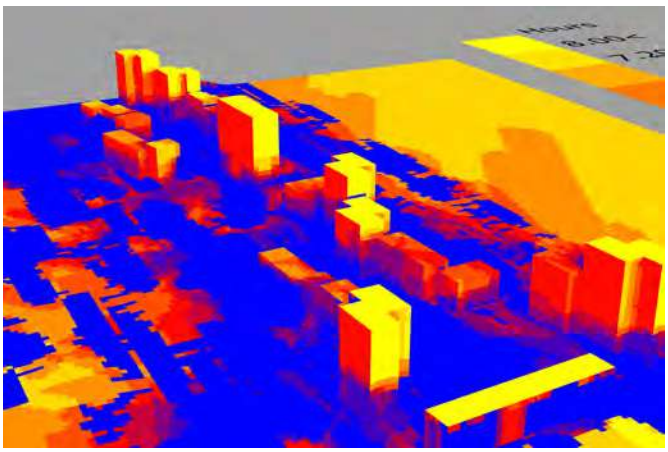
ORIGINAL DESIGN OF THE PLOT



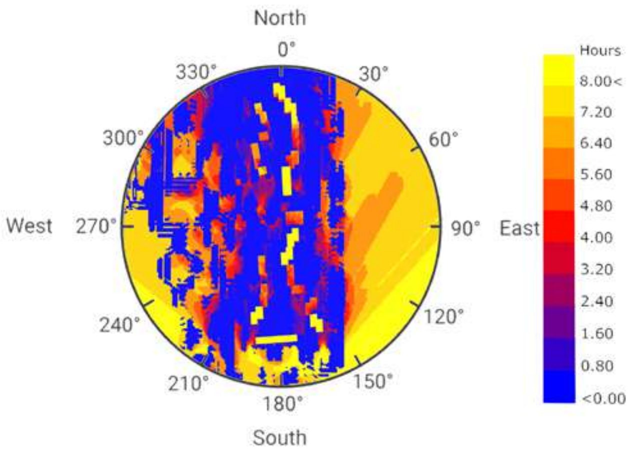
ill. 144.1. Sun hours 21.06 - North-East perspective view.



ill. 144.2. Sun hours 21.06 - Top view.



ill. 144.3. Sun hours 22.12 - North-East perspective view.



ill. 144.4. Sun hours 22.12 - Top view.

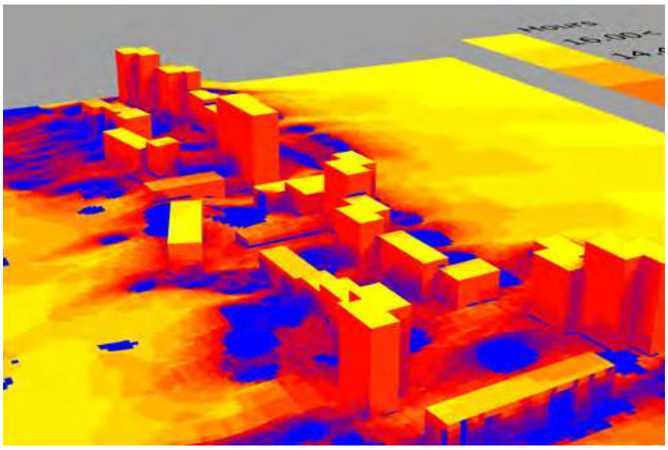
Main goal while designing spaces in between was to maintain the level of solar hours on the plot despite changing the urban plan. Most of the sites volumes are there and are not subject to change as they are fully habituated. What is more initial analysis presented in the program has been conducted with ommitance of the trees. In the one here they were included. Even though they have good effect in terms of fencing out the sound from adjacent artery and reducing overheating they cast a lot of shadow on common spaces. This is why instead of removing the trees we decided to move some of common areas to non shaded rooftops. That should answer to the need of sun during winter time, while during summer season shade casted upon ground level will provide pleasant cool for pedestrians.

Conducted sun analysis also suggests the need for shading the façades on east and west and presents great opportunities for PV panels installation of solid southern gable walls. Results obtained in analysis in Be18 for existing structures confirm those assumptions.

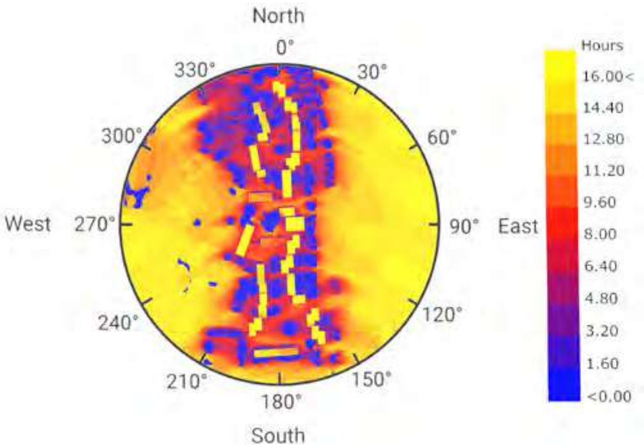
Conclusions

Even though spaces in between are shaded during the winter season we have decided to introduce other solutions that will allow them to be used - such as elevated plaza were sun conditions will be enhanced and covered ground level for artificial lightning and reduced drafts in winter. Rooftop facilities should complete the needs of inhabitants in terms of availability of spaces of different character suited for all seasons.

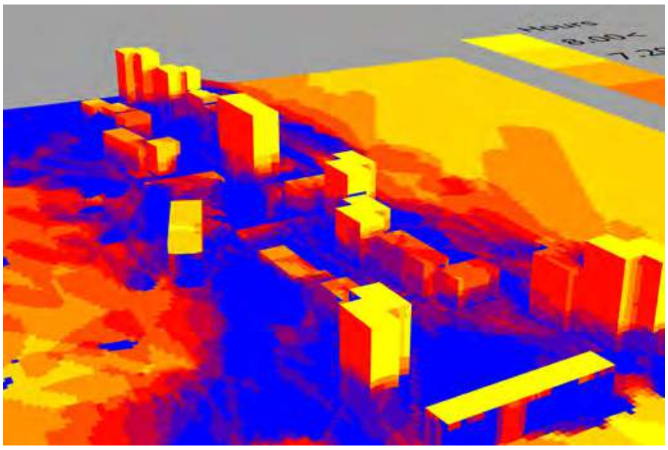
NEW DESIGN OF THE PLOT



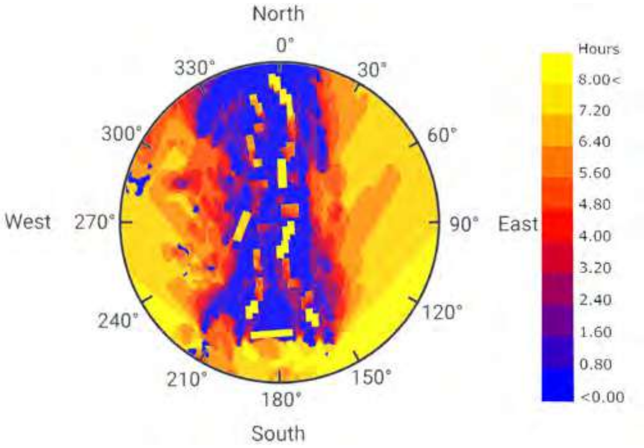
ill. 145.1. Sun hours 21.06 - North-East perspective view.



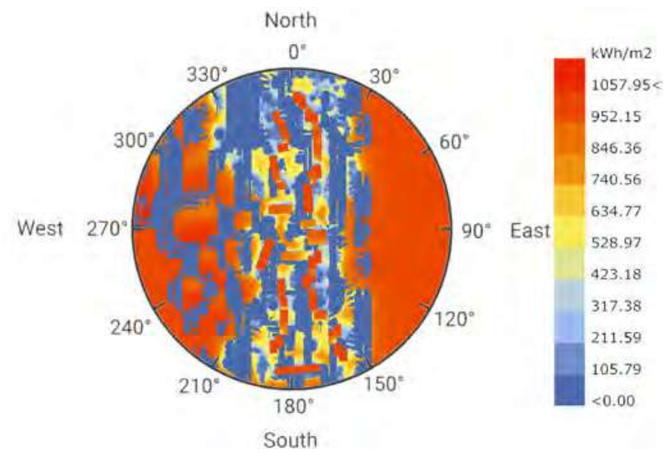
ill. 145.2. Sun hours 21.06 - Top view.



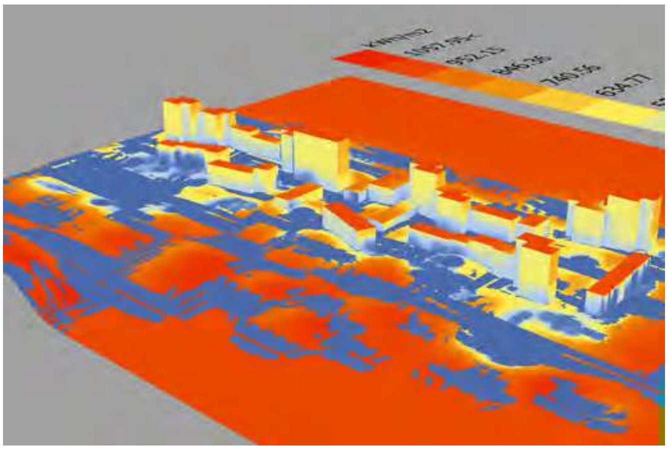
ill. 145.3. Sun hours 22.12 - North-East perspective view.



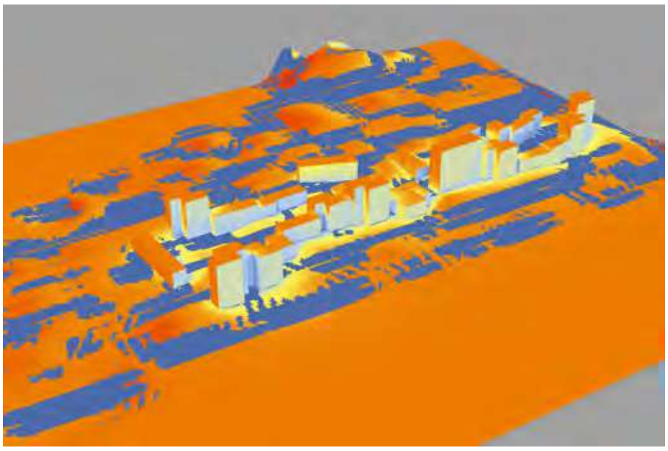
ill. 145.4. Sun hours 22.12 - Top view.



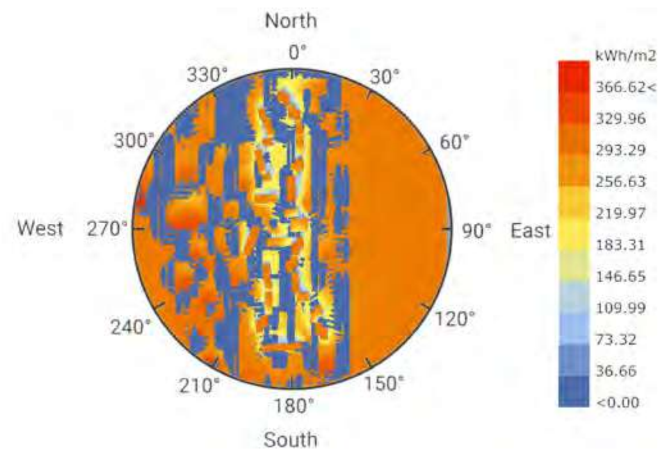
ill. 146.1. Annual sun radiation - North-East top view.



ill. 146.2. Annual sun radiation - North-East perspective view.



ill. 146.3. Sun radiation winter - North-East perspective view.



ill. 146.4. Sun radiation winter - North-East top view.

SUN RADIATION

Above simulations show results for all year round radiation as well as for radiation in winter time. Interesting figures were radiation on southern gable walls - discussed in PV panels segment and radiation on western façades, which might be the reasons for overheating.

Winter time analysis showed that amount or beneficial solar energy is at level of 150-180 kWh/m^2 in winter months. This is why design had to be working with maximizing solar gain from low sun. On the other hand total amount of radiation on those walls through whole season equals 550- 630 kWh/m^2. Therefore solar energy received during warm season - when it is not needed - is at level of 400 kWh/m^2.

Conclusion

Due to obtained data it was crucial to provide elastic facade system with geometry reflecting both aesthetic and environmental expectations. Therefore analysis in be 18, Bsim and Velux daylight calculator along with solar chimney calculations and functional demands were critical factors shaping the design.

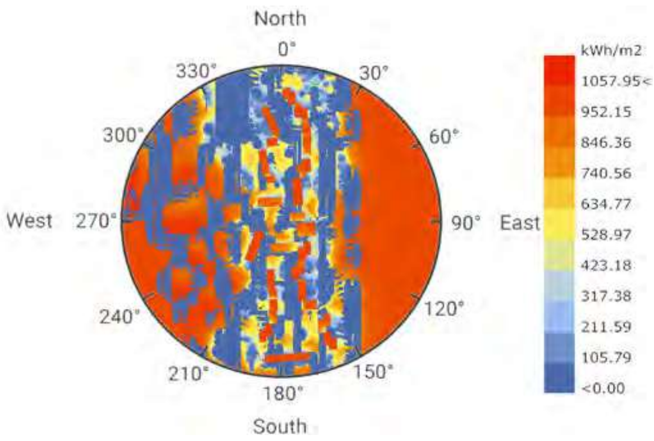
PASSIVE AND ACTIVE SOLUTIONS

Including photovoltaic cells into the design allows to reduce amount of non renewable energy that is necessary to operate the building. As most of the building have at least partially full southern façades and cut out of the horizon in not over 15 deg. It creates very good conditions for solar panels installation.

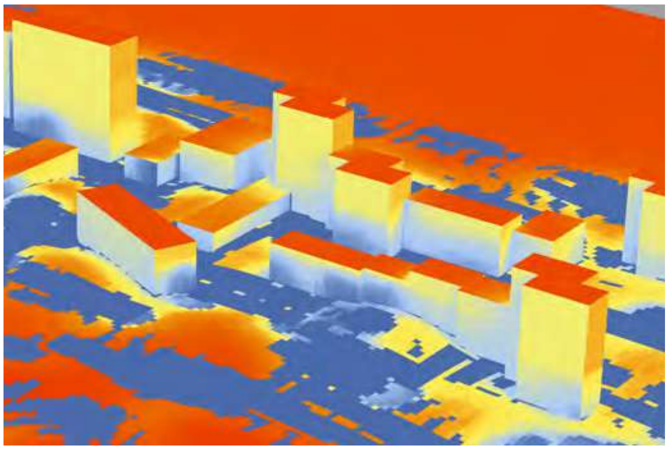
In scale of the compound whole calculation would be unequalled hard to conduct nevertheless we assessed impact on the energy demands of chosen building as an explanatory case for most of the compound. Introducing PV cells at surface of merely 200 square meters allowed us to reduce energy demand from 30 kWh/y/m^2 to 5 kWh/y/m^2. Therefore we assume that on southern gable walls in our example case (example can be seen on the bottom of this page) area of good exposition to the sun will be of around of 70 percent out of total 650m2. In calculation on the left side there is total possible gain presented for typical building on the site and average area of flats in it (do not represent precisely designed building)

Conclusion

Basing on the figures it seams that installation of PV cells are crucial to provide zero energy building standard as other solutions as heat pumps and solar panels would either interfere with functionality of rooftops or will be unefficient due to availability of district heating.



ill. 147.1. Annual solar radiation - North-East top view.



ill. 147.2. Annual solar radiation - North-East perspective view.

$$Energy\ [kWh] = A \times Radiation \times solar\ panels\ efficiency \times \frac{DC}{AC} system\ efficiency$$

$$Energy\ [kWh] = 500m2 \times \frac{850kWh}{ym2} \times 0{,}18 \times 0{,}85 = 65025kWh/y$$

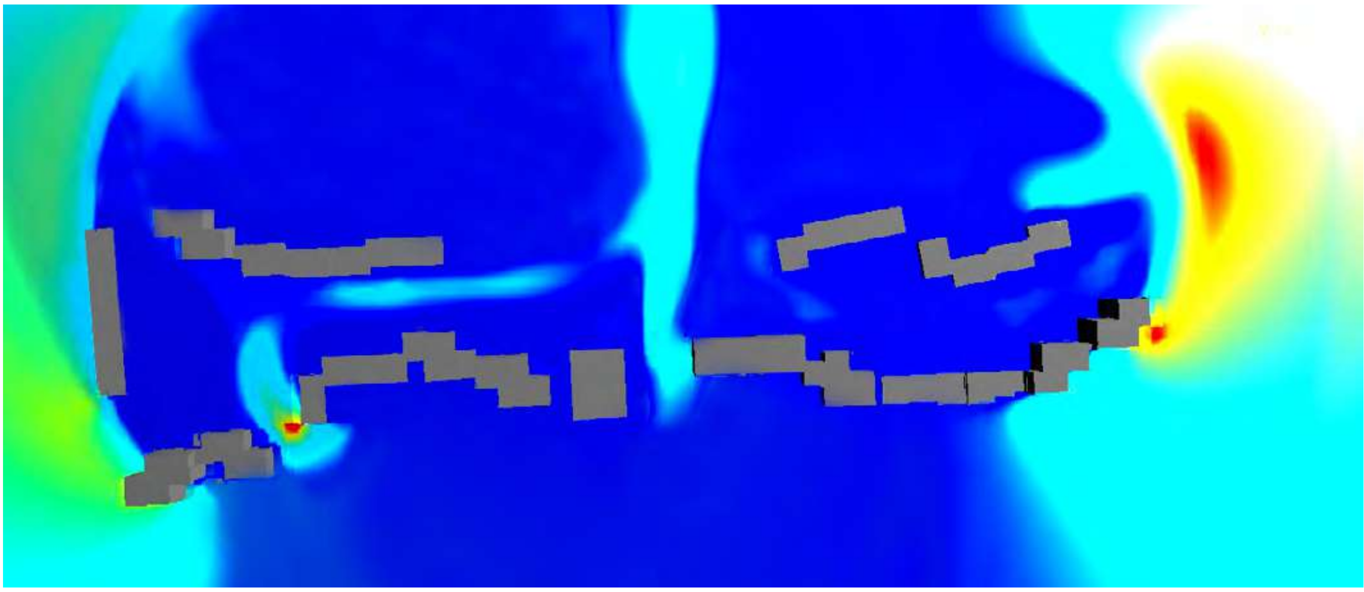
$$\frac{Energy}{Avarage\ of\ total\ apartments\ area} = Energy\ in\ kWh\ per\ m2\ of\ flat$$

$$\frac{65025}{2440} = \frac{\mathbf{26,6kWh}}{\mathbf{m2}}/\boldsymbol{y}$$

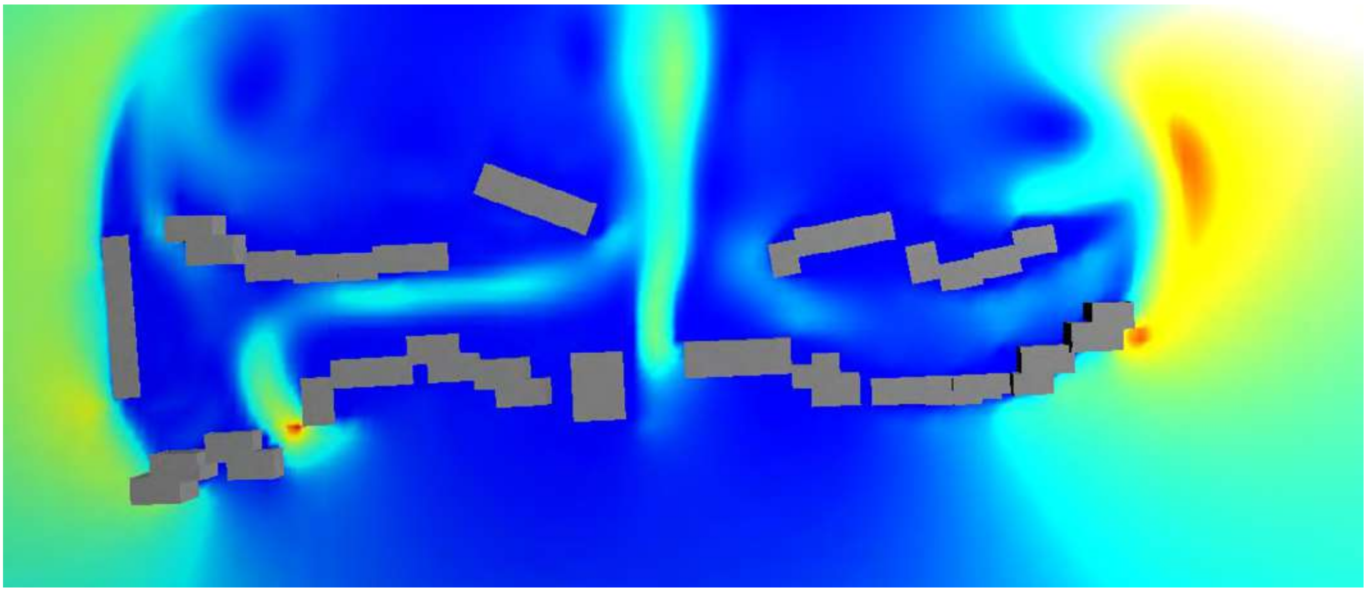
WIND ANALYSIS

Main wind direction for the plot is east to west. In a result wind analysis shows two narrow necks for the wind that are there for both urban proposals. The analysis was conduct for second floor level as parts of ground level are covered plazas. Therefore it is possible to assume that drafts in south-north relation will be smaller when measured on ground level.

As design proposals do not differ a lot therefore wind performance of both is very similar.



ill.149.1. Wind flow - original design.



ill.149.2. Wind flow - new design proposal.

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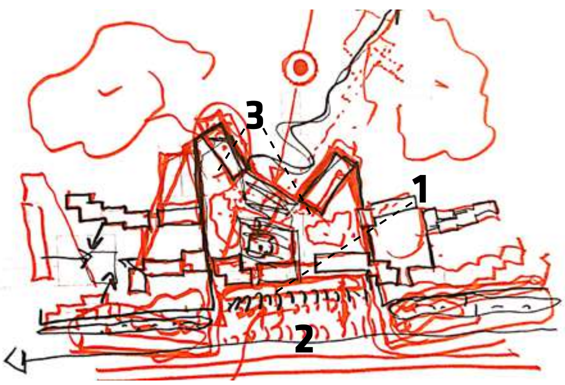
DESIGN PROCESS

Design process was conducted on multiple levels. In order to satisfy all diagnosed needs and expectations we introduced IDP to the full not only in terms of technical solutions but also on functional and social level. Therefore, even though factors of influence overlap we decided to divide design process chapter into three parts - urban design, functional design and elaborated above in calculation chapters technical one.

URBAN DESIGN

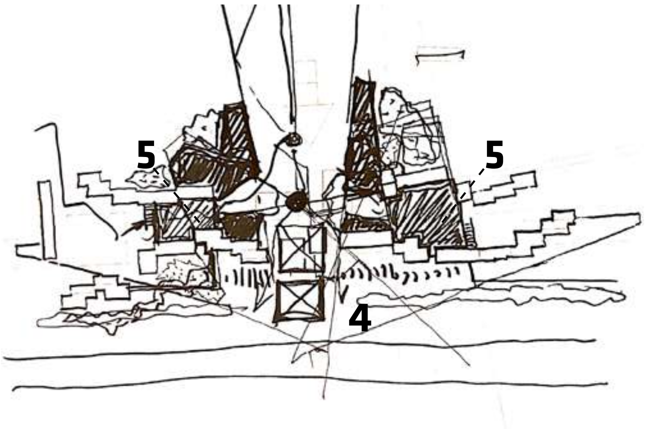
In urban scale we made analysis of all facilities and connections to public transport. This is why we were able to build our plan from ground up - by providing lacking facilities to all type of users. What is more we diagnosed that existing urban design does not reflect natural people flow and spaces in within the compound are abandoned most of the time. In order to counterbalance that problem we decided to introduce focal points in whole plan - places of unique attractivity gathering social life.

First try-outs of urban plan organisation were focused on directing the traffic to centre of the plot. Removing services (1) pavilions and introducing parking area (2) closer to the central plaza was aiming at helping that. Pavilions were moved to park side in order frame the opening towards greenery (3).



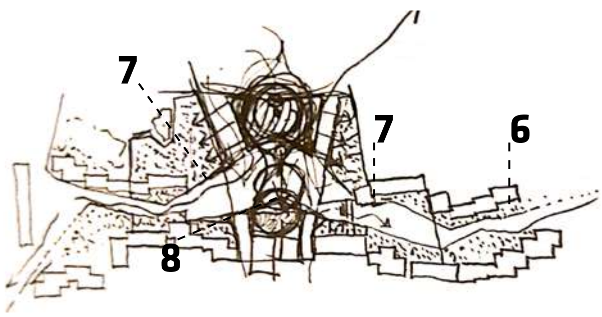
ill. 152.1. First attempt to indicate important points on plan.

Later on we understood that maintaining privacy and cosiness next to big artery was impossible with such big opening to parking - due to noise problems (site analysis chapter) therefore we reinstated the pavilion in their original place (4). What is more in order to make plaza more defined the idea of elevated adjacent semi public plazas in between buildings appeared (5). That solution apart from it's spacial qualities enhances sou conditions in courtyards where shading is high due to greenery.

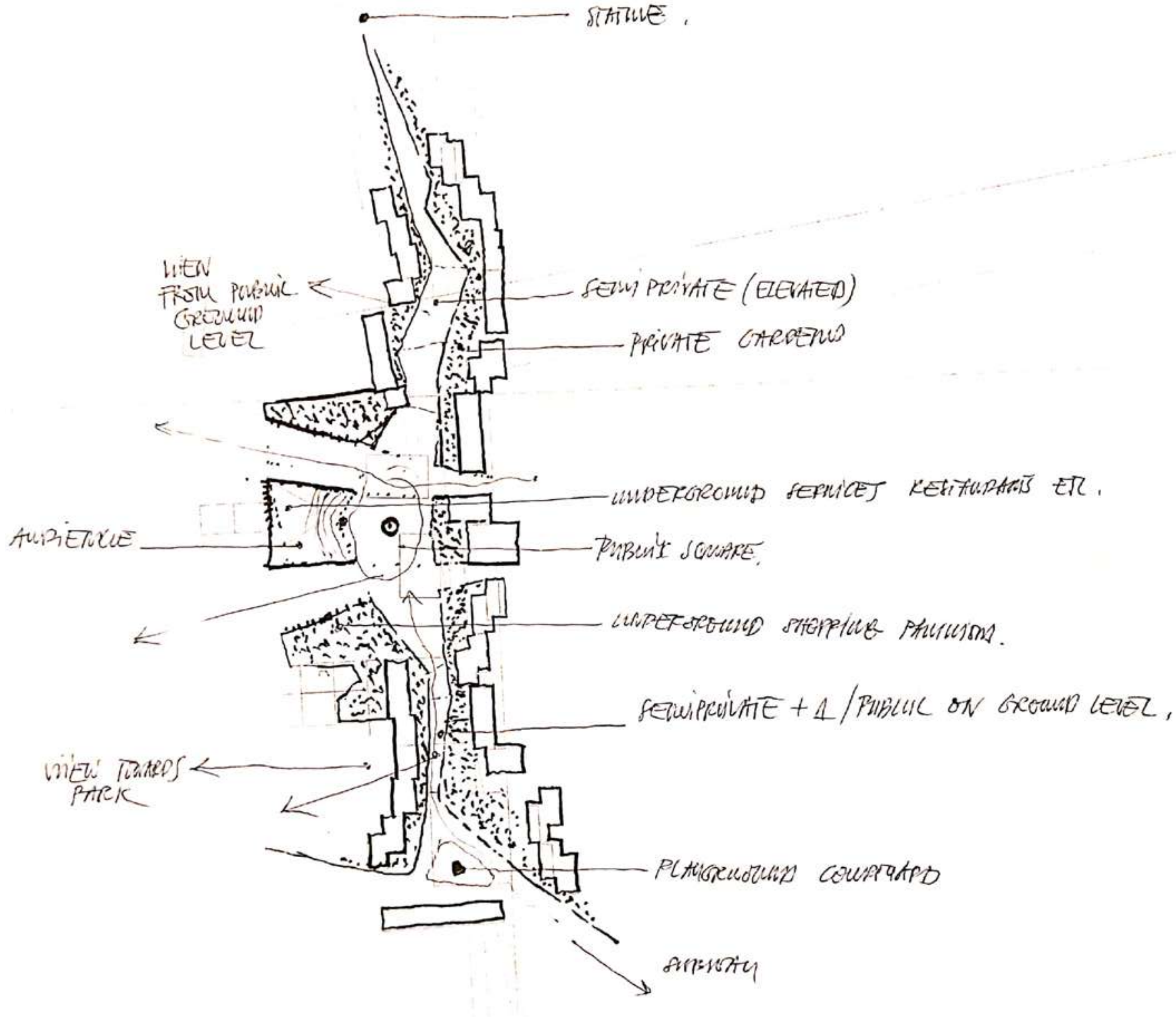


ill. 152.2. Reinstated pavilions, elevated plazas appear.

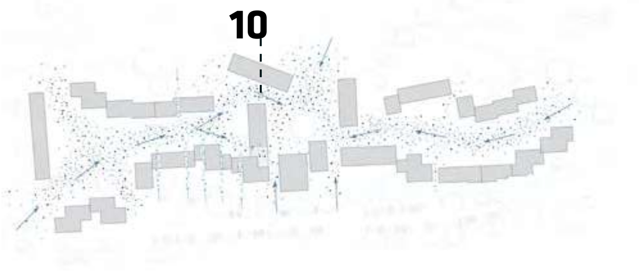
As plot is adjacent to subway station and public transportation we decided to introduce transversal communication (6) therefore elevated plazas became walkable through (7) on the ground level. In order to provide more services we decided to create free standing pavilion in the opening towards park (8).



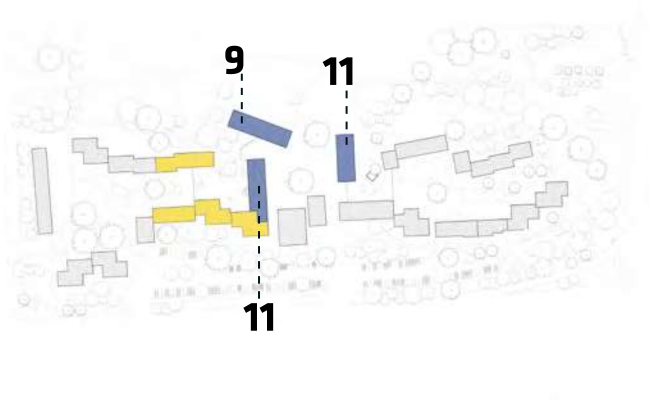
ill. 152.3. New communication, park side pavilion.



ill. 153.1. First plan incorporating all mentioned solutions.



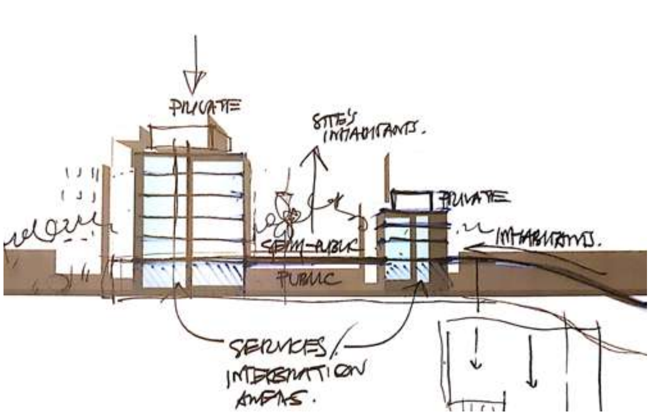
ill. 154.1. People flow.



ill. 154.2. Final urban plan.

Presented plan solved all the issue that we anticipated in the beginning however once we dug further into local issues with apartment structure (refereed to in apartment structure on compound chapter) we understood that because of area demands of General plan we will be experiencing problem with sufficient number of flats (problem addressed in social analysis chapter) this is why finally we decided to converted park side pavilion into residential building (9) dimensioned in a way that it does not shade central plaza excessively. It was angled and pushed leftwards in order to direct people flow (10). In order to meet dimensional standards of two sided apartments building it grew to large to be located as fourth façade of the plaza. 2 out of 3 remaining façades grew up in order to counter-react to draft in semi public elevated plazas as well as to provide more privacy to those spaces (11).

Section shows functional division of levels in relation to surroundings and renovated buildings. Emphasis is placed on separating the spaces of different level of privacy. This is why semi-public plaza is available through building's staircases. Those spaces are to serve inhabitants of all adjacent buildings. Common rooftops on other hand are serving only to inhabitants of building on top of which one is located.



ill. 154.3. Sketch of urban plan section.

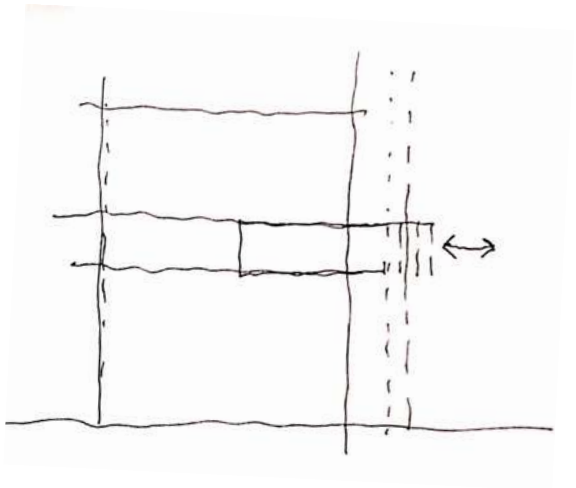
FUNCTIONAL DESIGN

That chapter follows urban plan part nevertheless decisions made during analysis and design process on functional level were strongly influencing urban plan decisions as mentioned before.

On functional level building plans reflect functional division of privacy. This is why lowest levels are assigned to services, first level is a mix use of common spaces with direct access to semi private plaza and apartments on more private side.

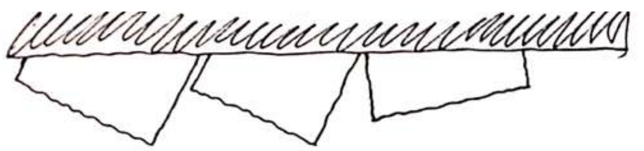
Due to the fact that buildings are already standing elasticity of plan is fairly low. During redesigning process we were driven by functional aspects of their layout, possibilities to extend them, construction constraints, general plan in terms of living area and technical performance of solutions.

ill. 155.1. Initial layout of semi-public floor plan with incorporation of elevated plaza.

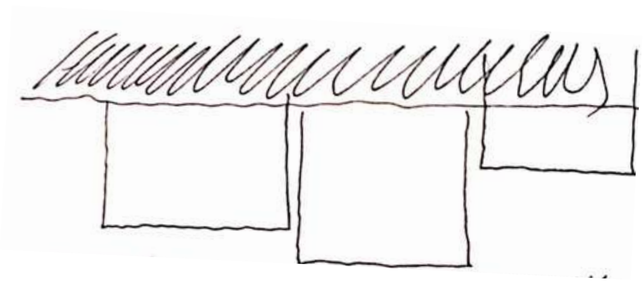


ill. 156.1. Extensions direction - section.

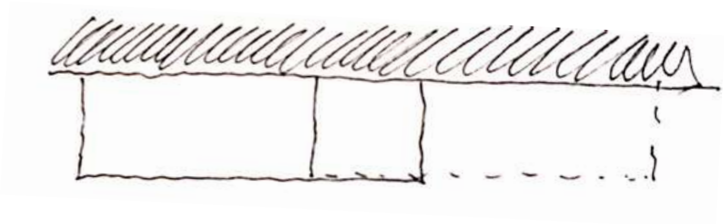
We were working with different extension plan schemes. Angled windows were designed to ad buildings more vividity and catch extra light.



Overheating and structural issues regarding construction integrity made us lean towards perpendicular solution.



That solution offered better overheating protection however structural issue remained a problem. This is why we came up with solution that instead of hanging extensions on facade it will be better to come up with self supporting system. That lead us to final solution that we tested for different depths in terms of light factor (see chapter **DWELLING CALCULATIONS** p.132).



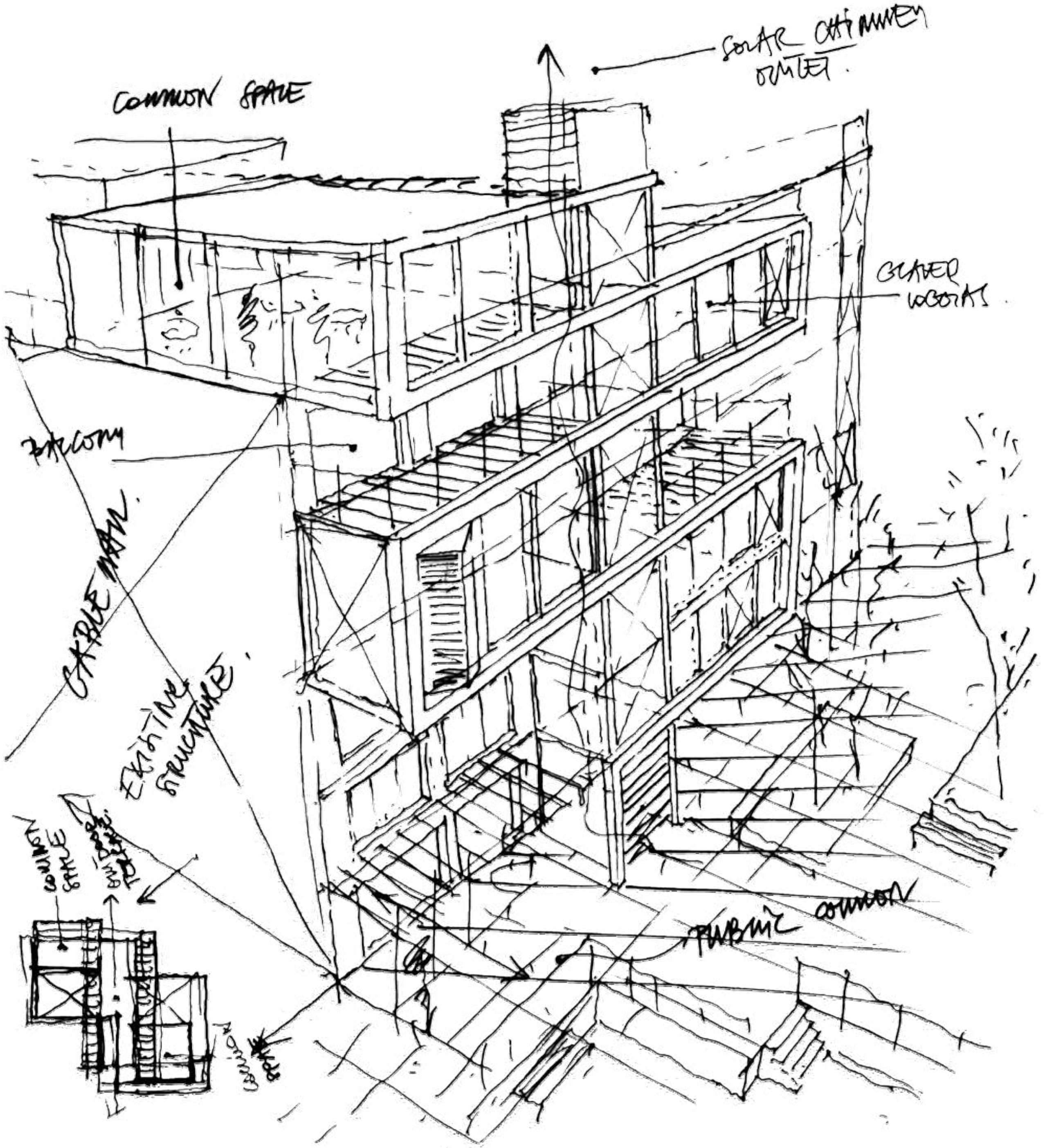
Key part of the proposal was to extend apartments in order to provide more square meters and better plan functionality. This is why we investigated different scenarios of that solution.

General directions for designing process were:

- Extensions have to shade existing facade
- Provide decent flat area enlargement
- Show architectural expression
- Create double facade to benefit from sun
- Be used for passive heating
- Be used for passive cooling

Analysis of flat's plans and facade solutions allowed us to fulfil all requirements stated as goals in the beginning. Introduction of solar chimneys and trombe walls allowed us to use those solutions for heating and cooling (see solar chimney chapter). Extension of 2 meter span has been proven to be most efficient in terms of daylight and indoor climate as well as in terms of plan functionality.

Technical tuning process was incorporated in **SITE CALCULATIONS** chapter (p. 144) and **DWELLING CALCULATIONS** chapter (p.132) and was presented there.



ill. 157.1. Sketch of final facade solution.

COMPL

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REFLECTION

Subject of renovation and restoration of qualities of panel buildings compounds is very complex problem. Due to overlapping of different factors of influence finding proper solution might be a difficult task. Most important things in questions were social aspects of the space, it's familiarity and friendliness, qualities for local communities were driving factor for creation of spaces "to be together". Furthermore, spatial qualities from single inhabitants perspective were very important. Energy demand and indoor climate problems had to be addressed as well.

Basing on the puzzle of those influential elements we built our proposal. Apartments got bigger, social spaces were introduced on multiple levels of privacy. Shopping area and services of different type were introduced to lure pedestrians in and make space more lively. Loggias and balconies offer new facade dynamics as they shading panels are moved. Solar heating and cooling keeps indoor climate in shape. That is how this hybrid of functions and different types of use was created. To satisfy everyone's needs. That was our main goal.

Revitalisations always bring surprises. So did this one. From easy looking project it turned out into maze of interweaving scenarios and demands. It was hard and challenging - IDP in it's best form. Not focusing only on technical details but also holistically trying to grasp common denominator for it all.

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REFERENCES

REFERENCES

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Appendix 1 – U-values calculation for building envelope element

λ – lamba - heat conductivity of material [W/mK]

d – thicknes of material [m]

R – thermal resistance as d/λ

U – thermal transmitance [W/m2K]

Case study - External wall

Wall layers and materials

- Sandstone panels – $d = 0{,}05m;\ \lambda = 3{,}5$
- Wool panels – $d = 0{,}3m;\ \lambda = 0{,}033$
- Concrete wall - $d = 0{,}15m;\ \lambda = 1{,}5$

Windbraker layer and plaster layers were intentionaly ommited as their thermal resistance is minuscule therefore contribution to total U-value is neglectable.

Sandstone panels:

$$R_p = \frac{0{,}05}{3{,}5} = 0{,}0143$$

Wool insulation:

$$R_i = \frac{0{,}3}{0{,}033} = 9{,}09$$

Concrete wall:

$$R_c = \frac{0{,}15}{1{,}5} = 0{,}1$$

Total resistance calculation:

R_{si} – thermal resistance in between air inside and wall material = 0,13

R_{se} – thermal resistance in between air inside and wall material = 0,04

$$R_t = R_{se} + R_p + R_w + R_c + R_{si}$$

$$R_t = 0{,}04 + 0{,}0143 + 9{,}09 + 0{,}1 + 0{,}13 = 9{,}374$$

U-value calculation:

$$U = \frac{1}{R_t} = \frac{1}{9{,}374} = \mathbf{0,1067}\ [\frac{\boldsymbol{W}}{\boldsymbol{m^2K}}]$$

Appendix 2 – Solar Chimney Calculations

In order to asses efficiency of designed solar chimney following calculations have been performed.

Assumptions were made for idealized model with omitance of turbulences that have to result from uneaven inside of the chimney. Nevetheless calculations present general idea of how the chimney should function.

We aimed at assesing amount of air that will be sucked out of the appartment due to pressure difference created in between apartments and chimney, which reults from Bernoulli's law.

Therefore we started with calculating volume of air passing through the chimney. as described in *„Experimental and Numerical Studies of Solar Chimney for Ventilation in Low Energy Buildings"; Xinyu Zha, Jun Zhang, and Menghao Qin; 22 October 2017, Jinan, China.*

For our calculations we assumed that exterior temperature for summer will be of 20 degrees Celsius while interior temperature inside the chimney will be 50 degrees Celsius. Average radiation on those parts of facades throughout summer is around 100 W/m2 (calculation based on radiation test run in Grasshopper). Therefore chimney of area of 30x 1,6 meters will be recieving 4,8kW of solar power for it's volume of 76,8m3. Given Cp of air at [1396kJ/m3/K] and delta T = 30 deg c and asummed ventilation and transmition loss of 35% we will need 4948,3 MJ which equals 4,9kW. That allows us to assume that temperaturę assumptions are right.

After calculation of volume of flow, we had to calculate the speed and that would allow to estimate pressure drop. As draft in chimney was calculated for 5,03m/s. We were able to determine static pressure fraction reduction at level of 339,42Pa. Basing on that pressure difference we were able to calculate air flow from apartment to the chimney. The result was 2,35m3/s and exhange rate for whole flat of 80 m2 at level of 1,89h-1. Those digits do not include dicharge coefficient of window into the chimney however as those vary from 0,6 to 0,7, even if applied, would reduce those numbers consequently only by 30-40% still allowing for more than 1 full air change extra per hour.

CALCULATION OF AIR FLOW IN THE CHIMNEY

$$Q = C \times A \times \sqrt[2]{2gh \times \frac{Ti - Te}{Te}}$$

where:

Q – flow rate

C – discharge coefficient = 0,6-0,7

A – section area of the chimney – 2,56 [m2]

g - gravitational acceleration = 9,81 [m/s2]

h - height of the chimney = 30 [m]

Ti – temperature inside the chimney – 323 [K]

Te – temperature outdoors – 293 [K]

$$Q = 0{,}65 \times 2{,}56 \times \sqrt[2]{2 \times 9{,}81 \times 0{,}1023}$$

$$\boldsymbol{Q = 12{,}9\, m^3/s}$$

AIR SPEED CALCULATION

$V = \omega \times A$

V – volume of air passing through the chimney = 12,9 [m3/s]

ω – velocity of air in the chimney [m/s]

A – section area of the chimney – 2,56 [m2]

$12{,}9 = \omega \times A = \omega \times 2{,}56$

$$\boldsymbol{\omega = 5{,}03\ m/s}$$

FORMULA FOR STATIC PRESSURE DROP DUE TO THE FLOW VELOCITY – BERNOULLI EQUATION

$$\frac{\rho v^2}{2} + \rho g h + p = const = 1013hPa = 101300Pa$$

ρ – density of air in the chimney – 1,062 [kg/m3]

v - flow velocity = 5,03 [m/s]

g - gravitational acceleration = 9,81 [m/s2]

h - height of the chimney = 30 [m]

p – static pressure fraction [Pa][N/m2}

$$\frac{1{,}062 \times 5{,}03^2}{2} + 1{,}062 \times 9{,}81 \times 30 + p = const = 1013hPa = 101300Pa$$

$26{,}87 + 312{,}55 + p = 101300Pa \qquad p = 100960Pa \qquad \boldsymbol{\Delta p = 339{,}42Pa}$

AIR FLOW FROM APPARTMENT TO CHIMNEY THROUGH OPENING OF 0,5M2

SPEED:

$$\frac{\rho v^2}{2} = \Delta p$$

ρ – density of air in the appartment at 20 deg C – 1,225 [kg/m3]

$$\frac{1{,}225\ v^2}{2} = 339{,}42$$

Δp =339,42 Pa

$$\frac{1{,}225\ v^2}{2} = 339{,}42$$

$$\boldsymbol{v = 23{,}54 m/s}$$

VOLUME:

$Q = A \times v$

Q – flow rate

A – section area of the opening – 0,1 [m2]

v - flow velocity = 23,54 [m/s]

$$\boldsymbol{Q = 2,35m^3/s}$$

RESULTING AIR EXCHANGE PER M2 IN FLAT OF 80M2

$$\boldsymbol{Q \times \frac{1000}{flat\ area} = 2,35 \times \frac{1000}{80} = 29,375 \frac{l}{m2}/s}$$

RESULTING AIR EXCHANGE AS VOLUMES PER HOUR IN FLAT OF 80M2

$$\boldsymbol{number\ of\ exchanges\ per\ hour = \frac{80 \times 2,5 \times 1000}{29,375 \times 3600} = 1,89h^{-1}}$$

DRAFT PRESSURE DIFFERENCE – CROSS CHECK

$dp = g(\rho_o - \rho_r)h$

g - gravitational acceleration = 9,81 [m/s2]

ρ_o - density of air in outdoors at 20 deg C – 1,225 [kg/m3]

ρ_r - density of air in the chimney at 50 deg C – 1,062 [kg/m3]

h - height of the chimney = 30 [m]

$dp = 9,81(1,225 - 1,062)30$ $\qquad$ $\boldsymbol{dp = 47,9Pa}$

Appendix 3 - Solar Cells Output Calculation

$$Energy\ [kWh] = A \times Radiation \times solar\ panels\ efficiency \times \frac{DC}{AC} system\ efficiency$$

$$Energy\ [kWh] = 500m2 \times \frac{850kWh}{ym2} \times 0,18 \times 0,85 = 65025kWh/y$$

$$\frac{Energy}{Avarage\ of\ total\ apartments\ area} = Energy\ in\ kWh\ per\ m2\ of\ flat$$

$$\frac{65025}{2440} = \boldsymbol{\frac{26,6kWh}{m2}/y}$$