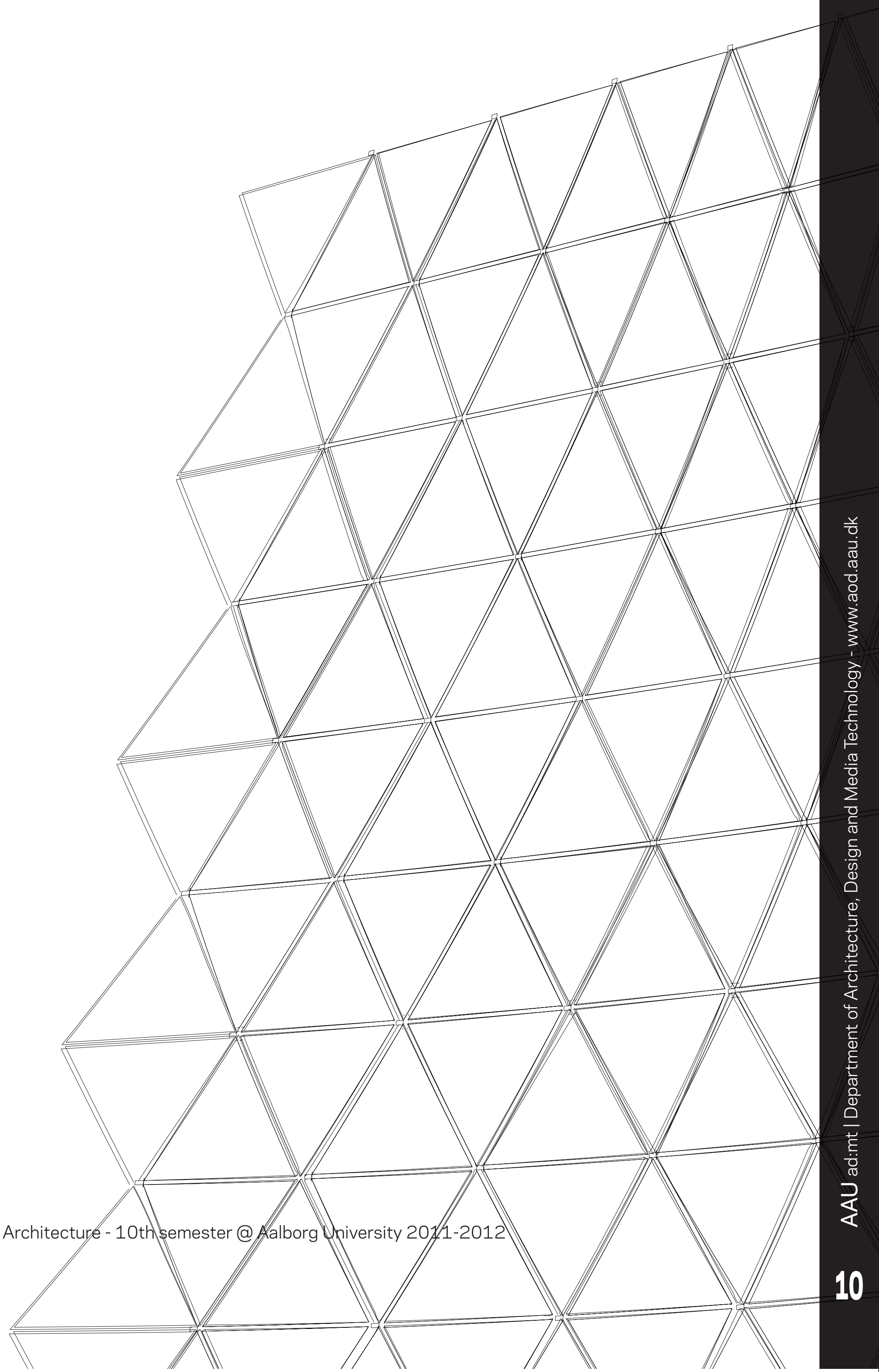


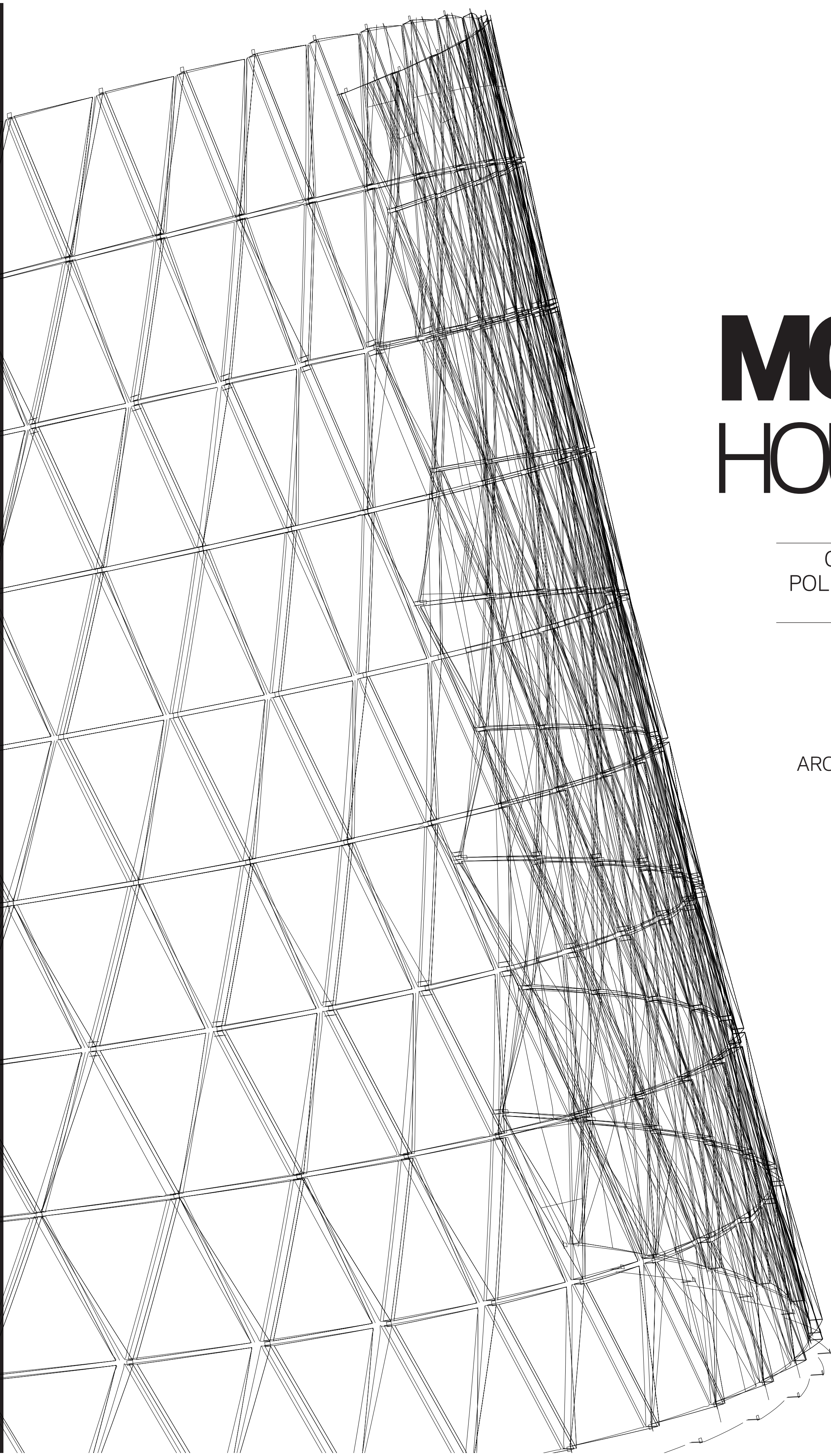
Timea Török | Msc Engineering of Architecture - 10th semester @ Aalborg University 2011-2012

AAU ad:mt | Department of Architecture, Design and Media Technology - www.aod.aau.dk

10

AAU ad:mt | Department of Architecture, Design and Media Technology - www.aod.aau.dk

10



MO$_2$RE HOUSING

OVERPOPULATION AND POLLUTION CHALLENGE IN MEGACITIES

ARCHITECTURAL FINAL THESIS
AALBORG UNIVERSITY | ARCHITECTURE AND DESIGN
2012

Residential building in Shanghai with environmental responsive facade

Timea Török
Msc Engineering of Architecture
10th semester
@ Aalborg University 2011

2 140819 840010

Synopsis

The aim of the project is to create sustainable housing complex at the most populated and polluted cities of the world.

The project would propose a possible site to develop the design, but it should be possible to implement the main idea to similar situations of conditions in different locations.
An important design criterion is to provide healthy, comfortable living environment in a sustainable building.

The design development follows a research-based knowledge during the integrated design process.

MO$_2$RE HOUSING

OVERPOPULATION AND POLLUTION CHALLENGE IN MEGACITIES

ARCHITECTURAL FINAL THESIS
AALBORG UNIVERSITY | ARCHITECTURE AND DESIGN
2012

Residential building in Shnaghai with environmental responsive facade

Author:
Timea Török
Msc Engineering of Architecture
10th semester
Aalborg University
ttorok08@student.aau.dk

Supervisors:
Main supervisor:
Claus Bonderup
Professor
Institut for Arkitektur og Medieteknologi

Technical supervisor:
Rasmus Lund Jensen
Lektor
Institut for Byggeri og Anlæg

Project period:
5. September 2011 - 2. April 2012

Printed in Copenhagen, 2012
Number of pages: 288
Number of copies: 5

Attachments:
CD

Aalborg University
ad:mt | Department of Architecture, Design and Media Technology
www.aod.aau.dk

Signature:

Timea Török
Msc Engineering of Architecture
10th semester

2 140819 840010

Preface

The aim of the project is to create sustainable housing complex at the most populated and polluted cities of the world.

The project would propose a possible site to develop the design, but it should be possible to implement the main idea to similar situations of conditions in different locations.
An important design criterion is to provide healthy, comfortable living environment in a sustainable building.

The design development follows a research-based knowledge during the integrated design process.

The project has been made as an individual thesis for the 10th semester of The Master Programme in Architecture & Design at Aalborg University in 2011.

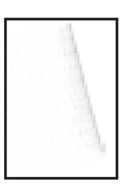
The report is a documentation of the process of the project, systematically arranged as the design was developed. Appendix is enclosed for additional information. Sources of image and quotes are referred as a list at the end of the report.

Attachments are enclosed as printed technical drawings and CD with the digital version of the drawings and the report.

FALL SEMESTER 2011-2012

Final thesis made for Aalborg University, Department of Architecture, Design and Media Technology; 2011-2012.

AAU-AOD
ARKITEKTUR & DESIGN



The cover:
Scripted building skin


EXPO 2010
SHANGHAI
CHINA

[p.1.1] Air pollution

> *The earth we abuse and the living things we kill will, in the end, take their revenge; for in exploiting their presence we are diminishing our future.*
>
> *[Marya Mannes, author and critic]*

Project formulation

The project focuses on the design of a housing complex with possible additional facilities with environmental considerations. The aim of the project would be to provide a spacious, comfortable and stimulating living environment for the people in near and far future scenarios.

The process of the design should reflect the initial goals of achieving a sustainable building solution, which makes as less negative impact on the environment as possible, and in a way it is improving its surroundings while providing comfortable living circumstances.

After the investigation of the existing sustainable solutions, it should be integrated in the design of the proposed building. The final proposal should also meet with the technical requirements and the environmental standards of a sustainable building and comfortable indoor climate. The dwellings of the housing complex should fulfil the needs of different user groups of the inhabitants both in small and bigger apartment units.

In the research part, past and future scenarios regarding population and pollution will be investigated. Several areas will be analysed in order to find a possible location, and however the final design is placed on a proposed site, the main design elements should be able to used in similar situations of conditions.

The proposed site will be chosen by three factors: population-density, pollution and living conditions. The first two factors are strongly connected to each other. Therefore the most populated and polluted areas will be analyzed according to different aspects, and overlaid to find the worst living circumstances. The possible locations will be filtered by their technological development, future projections and sustainable potential. The proposal will be developed to help and improve the certain site.

After all, the project supposes to develop a technical solution with architectural quality to provide comfortable and sustainable living environment in the cities where they need them the most.

During the design process, I would work with technical aspects, such as material use and modular systems, technical solutions with architectural quality; moreover it will deal with design solutions for renewable energy technologies and solutions for improving energy performance of the building/building unit.

Introduction

Problems of the new century, such as pollution, global warming, overpopulation, depletion of resources and health issues gained considerably high interest globally. Megacities with high population and density produces great amount of pollutants, which results in a serious environmental problems.

Humans and human activities have the most destroying effect on nature; moreover architecture has a huge impact on the environment. Daily consumption and domestic waste has major responsibility for releasing green house gases into the atmosphere.

Therefore it is a great challenge mainly for architects and engineers to make the build environment more sustainable both in the construction and operation phase. Architects has the potential to influence the way of living, they should take a part in the development, push engineers to invent more and more economical and environmental friendly solutions, and encourage consumers to choose a more sustainable design along the aesthetical quality.

The current urban areas are the main responsible for pollution and causes of environmental issues. The world's communities have to face with serious increase in both population and pollution. With the growing number of population, the number of pollutants is exponentially grown as well.

Through history, population and urbanization is growing in fact. That raises the concern of exceeding the carrying capacity of the habitable planet. Overpopulation is inevitable. Population control raises ethical consequences, and the number of birth cannot be stopped.
Pollution, especially air pollution could raise the biggest problems in the near future, causing discomfort or harm to humans.

Population and pollution growth raises the question how to deal with the negative consequences of the dense areas. How should architecture moderate the deteriorative living conditions?

It has been many efforts made to protect or at least keep the environment as the current level. Architects, engineers and developers proposed numerous ideas and dreams of a better Utopia. Several ideas suggest futuristic buildings with optimized energy performance, underground cities to protect the surface, floating complexes to avoid dense areas, skyscrapers to minimize the footprint and the impact on the ground.

To relieve the capacity of the megacities, architectural proposals suggest making the outskirts more attractive to invite new generations to a new hub. Or more radical solutions could propose new deserted areas as possible sites for future settlements; new self-sufficient complexes could be designed on spare areas, such as deserts or even floating on the oceans.

On the other hand, well-planned densely populated districts could manage the increasing problems in a sustainable way. If the problem is solved in site, by building renovations or rehabilitation to achieve better energy performance and better living situation for inhabitants and "green relieve" on the urban web. It could reduce the need for land occupancy by building higher, and it could provide obtainable services and infrastructure.

In any case, better building performance is really important, and reserve resources are significant matter.
Project should find a solution, that surrounding people admire, try to copy. Even a minor change in people's behaviour makes difference, and in a long term plan there is a hope to maintain or improve environmental conditions.

Methodology

IDP can be described as a process used for integrating engineering features early in the design process, so they, instead of becoming an obstacle later in the process, which is common in the conventional design approach, become synergies in high quality sustainable architecture.

The method utilized in this master thesis project, is the Integrated Design Process (IDP).

It contains four project phases:
- Analyse and research phase
- Sketching phase
- Synthesis phase
- Presentation phase

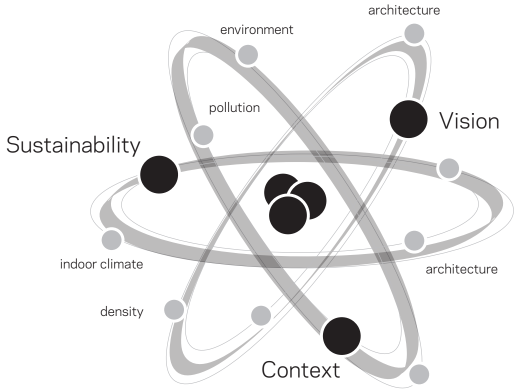
The Integrated Design Process is inspired by the roman architect Vitruvius, who argues that qualitative architecture is a result of three equally important aspects: utility, strength and beauty.

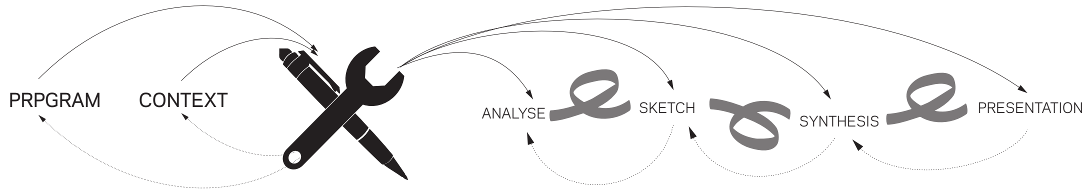
In this thesis these aspects cover sustainability, energy performance and comfort with architectural quality, the programme and the proposed location of the project, the physical context.

The final solution should integrate and reflect these aspects equally in the overall architectural design as different layers of the development, both on a functional, technical as well as aesthetic level. [Knudstrup, 2005]; [Topp, 2010]; [Jensen, 2011]

Based on the knowledge gained during research and analysis of the main principles, the method utilized a focus on architectural strategies for developing along with technical principles and technological systems.

Integrated design process will help to ensure that both technical and aesthetic parameters of the project would be solved.
This means working with architectural design, functional aspects, space, building performance, and structural systems, by mixing the two disciplines in an integrated design process through several testing.





Research/analysis phase

At the start of the project an initial problem is defined in order to find directions and fields for the research. This part will find a possible location for the proposed site. Moreover knowledge learned during the research will present a more precise problem statement; the aim of the project will be to find a solution to this problem.

Sketching phase

With the vision and goals of the project in mind, the sketching phase will achieve a design that fulfils the previously defined design principals. Information gathered during research will take shape in sketches to propose the ideas of solutions on different problems.

Synthesis

As a result of the sketching phase, the proposal, which meets with the aesthetical, functional and technical solutions, will be further detailed. In the synthesis phase, construction, expression and indoor climate will be developed. The detailing of the design is performed and different aspects are considered before the design is finally presented in the presentation phase.

Presentation

The presentation part will document the final proposal of the synthesis. The achieved qualities are presented through technical drawings, 3D renderings and visualizations.

The connection and direction between the phases are not linear, but more complex. The results are taken under consideration and they are pushing the next step forward, or interact with the previous decisions and require a step back for more improvement.

Working materials

Different tools will be used in the research, sketching and design phases, such as literature, software, sketching and modelling.
The project includes both digital and hand drawings during the development. Free hand sketches used at the first part of the project and for more detailed drawings computer applications will be utilized.
For better understanding of forms and volumes, digital models will be studies, and physical model will be made of the final proposal.
Existing models will be investigated as inspiration and study cases.

Integrated design process is based on the problem of population pressure and pollution. Through its phases, it will help to face both the architectural and engineering challenges. The structural and aesthetical parameters become important from the very beginning of the project, and they are developed together with the same amount of considerations.

"The Integrated Design Process are using the professional knowledge and design method from architecture and parameters from engineering in an integrated process."

[Knudstrup, 2005]

Part II

Population and pollution **Research**

DATABASE OF GENERAL KNOWLWDGE OF POPULATION AND POPULATION GENERATED POLLUTION ISSUES

Pollution in densly populated areas and in the mega-cities

Environmental effects of dense population and human activities

Effects of pollution on human health

Initial problem and possible location for project

Population

How can a building provide a specious and sustainable living environment for the growing population?

World's human population shows a constantly rising tendency through history. In the last 60 years the population doubled on the planet and it shows growing tendency in the last 200 years. If the trend continues Earth might reach its carrying capacity to support human life. [1]

U.S. Census Bureau keeps a 'POPClock', which consists data of 2010, and the most recent national population estimates.
Clock currently shows - in the time of the research phase – 6 961 797 296 inhabitants on the planet (on 14:34 UTC (EST+5) Sep 13, 2011) but the digits are refreshing in every minute, adding tens and hundreds to the previous value.

In addition, most of the growth in human population is taking place in developing countries, and most of the projected increase is predicted to settle in cities of these countries.
The growing world has started to become more urban; hence there is a continuing trend of growing cities as well.
Migration towards to the dense areas has started in order to find employment, educational opportunities and higher standards of living. [2]

Migration from countryside to city is not the main problem itself, since it is part of the process of economic development and diversification. Urbanization usually associated with social and economic development, but due to the rapid urban growth cities are already dealing with enormous leaks in housing and infrastructure development, they are struggling with crowded transportation systems, unsatisfactory water supplies, decaying waste management and environmental pollution.
People continue to migrate to cities in the hope of a better life, but it often results as disappointment and devastation of rural economies by land degradation. [3]

According to the assessment report of Mage et al., history tends to repeat itself, and phenomenon of the dense cities in the developed countries will be repeated in the developing areas.

Among all of the future projections, overpopulation is the most likely to happen. Even if the population growth rate [Population growth is determined by four factors, births (B), deaths (D), immigrants (I), and emigrants (E). Using a formula expressed as $\triangle P=B-D+I-E$ (wikipedia.org)] is declining in the moment, it is still remains above 0.
There are not many factors which could change the existing pattern; better technologies to prevent disasters; better medical care to expand global life span; political agreements and international cooperation to prevent mass murdering in wars. [4]

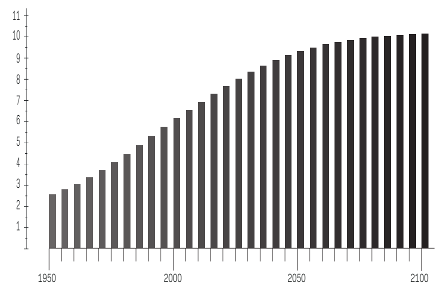
The unprecedented population growth of mega-cites around the world requires the sustained increase of urban density. The pressure of population growth was relieved with the vertical expansion of the city. To fulfil the population demands of tomorrow, growth in building density will be forced to expand in all axes.

Distribution and density is also an important aspect. Density is uneven all over the globe, and sometimes it hits extreme values. Would it be a solution to relocate the urban citizens to rarely populated regions or should the problem be solved on the spot? [5]

Population, density, pollution, social, political and economical indicators form the liveability of the given city. Although the results of different surveys regarding the likability of the settlement are very different, it is clearly visible that the most rural conditions and worst circumstances are present in the –still– most populated places.

History of population [1]

The world's human population doubled from 1 to 2 billion between 1800 and 1930, then doubled again by 1975. Today's global human population stands at 6.9 billion. At the end of 2011, it's expected to reach 7 billion. If the trend continues, we'll be on course to reach 8 billion by 2020 and 9 billion by 2050. (According to high variant scenarios, by 2050 world population could overstep 10.5 billion, and even low variants estimates 7.6 billion.)



Urban areas [2]

In around **1800** only

3%

of the population lived in cities;

by **2005**,

50%

of the world's population establish in urban areas.

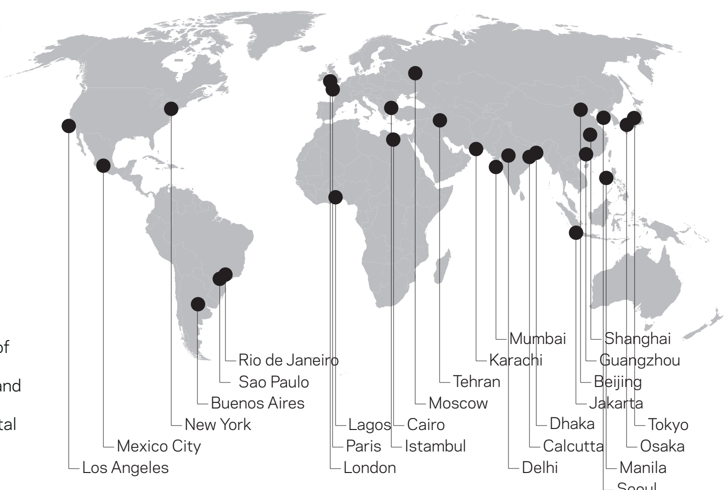
Megacities [3]

Tokyo	34 300 000
Guangzhou	25 200 000
Seoul	25 100 000
Shanghai	24 800 000
Delhi	23 300 000
Bombay	23 000 000
Mexico City	22 900 000
New York	22 000 000
São Paulo	20 900 000
Manila	20 300 000
Jakarta	18 900 000
Los Angeles	18 100 000
Karachi	17 000 000

Osaka	16 700 000
Calcutta	16 300 000
Beijing	16 000 000
Moscow	16 000 000
Cairo	15 400 000
Buenos Aires	14 900 000
Dhaka	14 200 000
Tehran	13 300 000
Istanbul	13 100 000
Rio de J.	12 600 000
London	12 500 000
Lagos	12 000 000
Paris	10 500 000

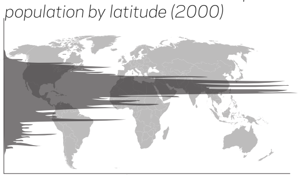
In 1950, there were just 83 cities exceeding the 1 million of their population and only New York City was the only community with over 10 million inhabitants as the first mega-city of the history.
A mega-city is usually defined as a metropolitan area with a total population at least 10 million people. Some definitions set a minimum level for population density as well (at least 2,000 persons/km2). By 1985, it was nine existing mega-cities worldwide, 19 in 2004, and 25 by 2005!

The most recent research, [Thomas Brinkhoff: The Principal Agglomerations of the World; 17 July, 2011] identifies 26 megacities, and 6 more over 9 million inhabitants; and 477 in total with more than a million people

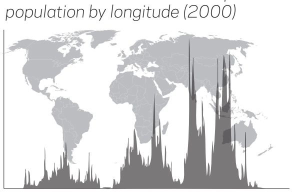


Population distribution by longitude and latitude and major area [5]

horizontal axis shows the sum of population by latitude (2000)



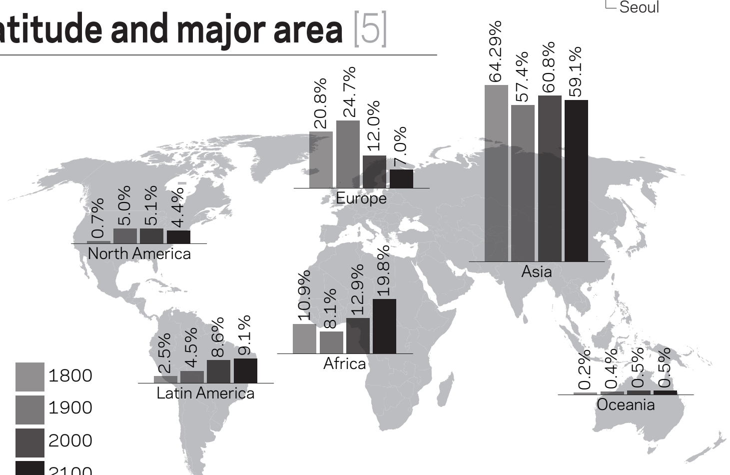
vertical axis shows the sum of population by longitude (2000)



Most populated:
China
1.34 billion
people

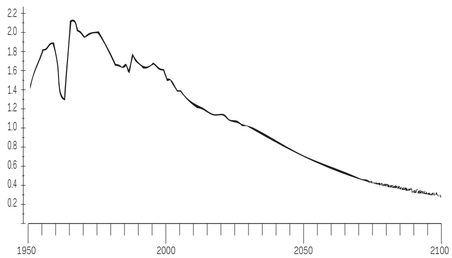
Second populated:
India
1.21 billion
people

which together takes
37%
of the
World's population



source from: DESA
[Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat]

History of population growth [1]



Population growth rates show the changes in numbers of population over time.

In demographics and ecology, population growth rate (PGR) is the rate at which the number of individuals in a population increases in a given time period as a fraction of the initial population.

The world population growth rate did rise about 1.5 % per year from 1950 until early 1960s' peak of over 2 %. After it started to decline, and it is projected to fall steady. Each region has different values, but some developing countries' rates remain above 2%.

According to the estimates, in 2011

135 million
people will be born;

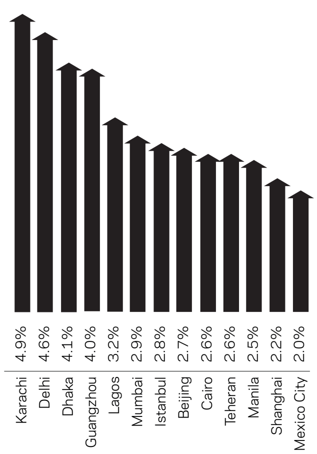
57 million
people will die; therefore

78 million
people will increase the world's population.

Population growth rate

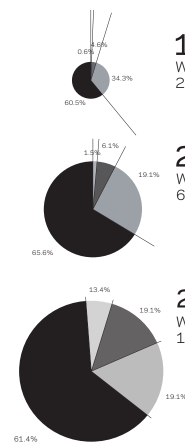
Average population growth:
World
1.092%

Average population growth:
Megacities
1.998%



Although the world's population growth rate is a little above 1% per year, the biggest annual increase in population is the most present in the largest urban areas. Projections might show that global value is descending, but growth of the cities could reach unpredictable increase.

Global life span [4]



1950
Wold's Population
2 532 229 000 000

2000
Wold's Population
6 122 77 0 000 000

2100
Wold's Population
10 124 926 000 000

The Population Division reports that global life expectancy rose from an estimated 47 years in 1950-1955 to 65 years in 2000-2005. By 2045-50, global life expectancy is expected to rise to 75 years. In developed countries, where life expectancy averages 76 years today, it is expected to reach 82 years by 2100.

Age group:
- 0-14
- 15-64
- 65-79
- 80+

Gridded population distribution (persons/km2)

Population distribution shows the pattern where people live. The global population distribution is uneven.

Some places might be sparly populated due to the severe conditions, tough climate or absent resources.
On the other hand, densly populated areas may run out from their resources to supply the growing numbers of inhabitants.

- 1-4 persons/km2
- 5-24 persons/km2
- 25-249 persons/km2
- 250-999 persons/km2
- 1000+ persons/km2

source from:
[http://sedac.ciesin.columbia.eduhttp://sedac.ciesin.columbia.edu; World's Population Density, 2000]

Most dense:
Macau
18 534
persons/km2

Least dense:
Greenland
0.026
persons/km2

Pollution

How can a building contribute to the urban air quality and act as a filter for air pollution purification, while shielding residents from the negative effect of industry and transportation?

Pollution is the emission of harmful contaminants into the natural environment. It could have numerous negative effects both on humans and nature.

Research on pollution, sources of pollutants and on their effect was made in order to be familiar with the phenomenon and to find acceptable solution for the outcome of the thesis. (Additional facts and research attached in the Appendix.) Mainly air pollution will be taken into account during the design process to achieve an environmental friendly building with the best energy classification and building performance possible. Other pollutions and their sources will be influential design shaping parameter as well.

Pollution has been a problem since humans appeared. Pollution and population cannot be separated from each other. Most of the sources of pollution are caused by human actions, and with increasing population; pollution is exponentially growing. [1] The density of human inhabitants and their activities in a relatively small area puts enormous pressure on the urban system and leads to serious environmental problems. It has major impact on local, regional and even global atmospheric chemistry. Pollution does not recognize borders; it influences the continental and global ecosystem, and has been scientifically proved significance in global climate change. [2]

Research reports show, that migration from the countryside to the cities brought higher pollutant emission to the atmosphere, increasing vehicle traffic, industrial and domestic waste causing the main problem in urban air quality.

The term ' air pollution episode' is mainly refers to a short-term increase of pollution level in the air. It could cause physical discomfort, disruption in daily life, widespread public fear, illness, and even death. Therefore air pollution episodes belong to the family of the environmental disasters, gaining as serious importance as floods, earthquakes or volcanic eruptions.

The pollutants of the urban regions are coming from variant sources, but there are 3 main sources of pollutants could be categorized as mobile and stationary sources and open burning sources. Researches show, that the major source of air pollution is coming from traffic, burning fuels. [3]

Studies using different testing models and simulations for urban air quality still have many uncertainties caused by the changing variants of local and regional values. For example, certain cities or towns may be threatened by harmful air pollution because of their particular location or climate. On the other hand pollution in megacities is influenced by many other factors, such as topography meteorology, industrial development, transportation and of course population.

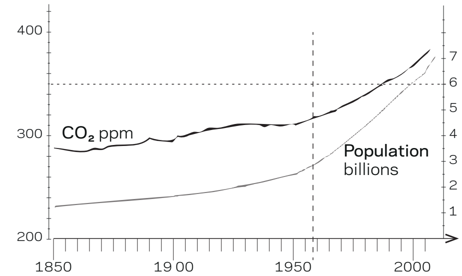
After investigating the environmental and human effects of pollution, sustainable architecture and indoor climate will find the solution to protect urban habitants.

In general, the worldwide tendency is to reduce pollution emissions. Numerous organizations and institutes work on the understanding and resolving pollution problems. Urban developments and architectural solutions could set an example to follow, to change human living behaviour or way of living. At least, make an effort to choose sustainability along aesthetics and personal comfort.

History of pollution [1]

Pollution has always existed; in fact, pollution has been a problem since the appearance of the first humans. But with increasing human actions the amount of pollutants realised to the environment is exponentially grew.

source from:
[Markham, A. 1994. A Brief History of Pollution]

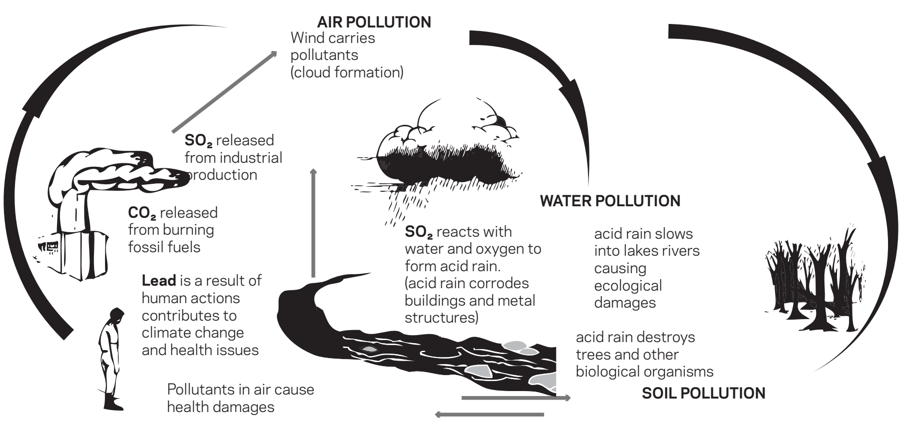


Initial problem

2.4 million
people dies each year by
water, air and soil pollution

1.5 million
people dies each year by
indoor air pollution

Air, water, soil and noise pollution



350 parts per million emitted each year
(9.1 billion tonnes/year)

30% absorbed by plants and soil
25% absorbed by ocean surface water
>1% absorbed by sediments and rocks
(5 billion tonnes/year)

44% stays airborne for a long while

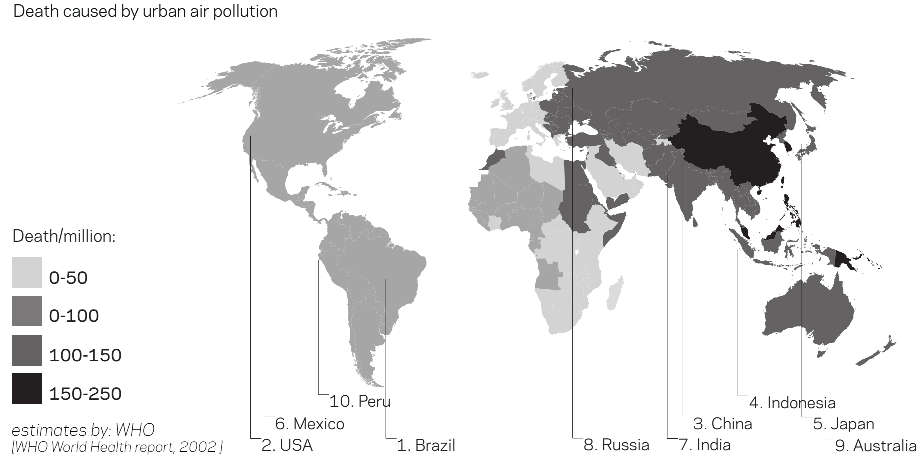
The main chemicals from the air can create acid rain, which falls to rivers, lakes and groundwater, damaging trees and vegetation, causing global warming, killing living organisms directly or indirectly.
The technological solutions are too expensive and natural process is too slow compering to the massive levels of pollutants production. Besides cleaning programs - prevention would be the easiest and should be the first act.

Environmental impact by country [2]

The University of Adelaide's Environment Institute in Australia has ranked the countries for their environmental impact. The indicators used were:
- natural forest loss,
- habitat conversion,
- fisheries and other marine captures,
- fertiliser use,
- water pollution,
- carbon emissions.

Map here shows the ranking according an absolute environmental impact index measuring total environmental degradation at a global scale.
In absolute global terms, the 10 countries with the worst environmental performance are: Brazil, USA, China, Indonesia, Japan, Mexico, India, Russia, Australia and Peru.

Death caused by urban air pollution

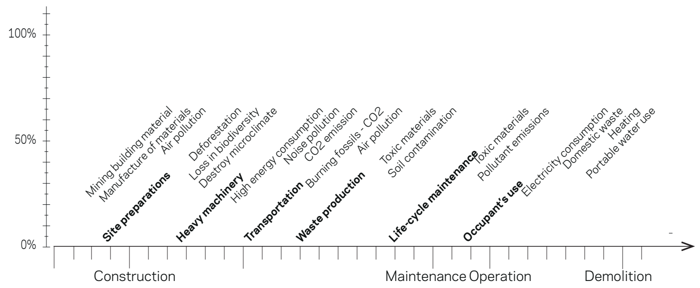


estimates by: WHO
[WHO World Health report, 2002]

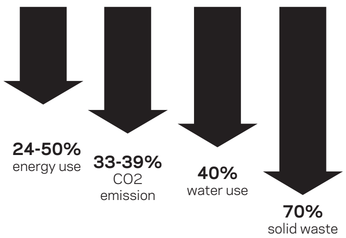
Environmental effects of buildings

Buildings are accounted for:

72% of electricity consumption;
40% of raw materials use;
39% of energy use;
38% of total CO2 emissions;
30% of waste output (136 million tons annually); and
14% of potable water consumption.*



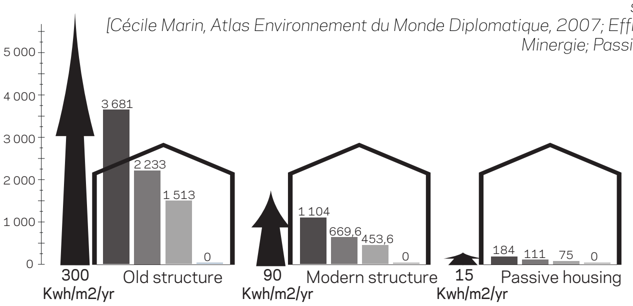
Green buildings can reduce:



*EPA *US estimates*

Pollutant emission of dwellings

CO_2 emissions for 100 m² apartment
kg of CO2 / year



source: [Cécile Marin, Atlas Environnement du Monde Diplomatique, 2007; Effinergie; Minergie; Passivhaus.]

Human effects

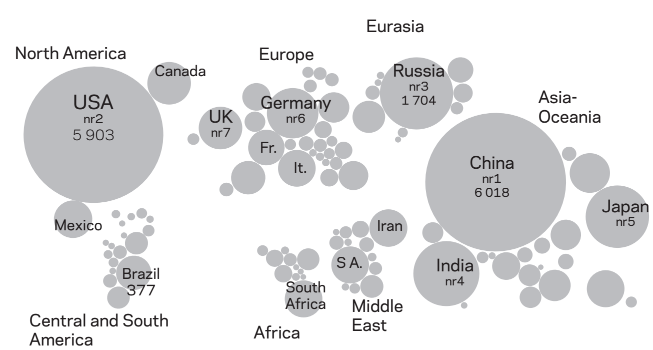
Environmental pollution threatens human health. Air pollution in urban areas causes shorter life-span for inhabitants. Urban poor air quality is more damaging than passive smoking, road traffic accidents. Some studies suggest that pollution and other environmental factors may contribute up to **40%** of global deaths.

Among many others pollution could lead to:
Cancer
Kidney, liver damage
Skin rashes
Developmental problems of children
Nervous system damage
Cough, throat irritation
Birth defect, miscarriage
Asthma, chronic bronchitis
.... etc

Pollution emission from the consumption of fuel [3]

The world's CO2 emission showing an increasing trend since scientist measures and reports it.
Although efforts have been made, there are a very few areas on the planet which shows lower tendency of carbon emission by year.
After recognizing the danger of the high level green house gasses, the Kyoto Protocol - an international agreement - sets binding targets for 37 industrialized countries and the European community .

The agreement was signed in 1997, and set the commitment period between 2008-2012 to reduce ghg emission at least by 5%. The Protocol is close to end, and due to the many negotiations and adaptations during these years it seems to fail in main points.



source from: [US Energy Information Administration report show carbon emissions from the consumption of fuel for 2007]

Middle East	1 005 million tonnes	61%
Africa	1 057 million tonnes	25%
Central & S America	1 138 million tonnes	26%
Eurasia	2 601 million tonnes	7%
Europe	4 721 million tonnes	5%
North America	6 954 million tonnes	9%
Asia-Oceania	11 220 million tonnes	64%
WORLD	29 195 million tonnes	28%

Environmental effects

How can a building have minimal impact on the environment and minimal emission/consumption?

There are numerous different kind of pollutants, and each of them has different sources. It is essential to define the exact source of the pollution in order to reduce or even stop the emission of pollutants into the surroundings. However the main sources of pollution all comes from human activities, traffic and industrial emission, and buildings act as a significant source of different kind of pollutions as well.

Residential and commerce building can act as environmental pollution source by emit dioxides and other pollutants on a high level; consume huge amount energy requiring more industrial production; and produce huge amount of domestic waste.

Buildings are accounted for nearly 40% of the total energy consumption worldwide and they contribute almost 35% of the total dioxide emission. Heat demands of the buildings can increase the peak energy demands and air conditioning costs. Building residents use about 15% of the water consumption and domestic waste takes almost half of the total solid waste.

As a main design criteria the proposed project should be improve to decrease all emission and reduce the environmental effect. Carbon emission of buildings can be reduced by recently developed technologies. Carbon neutral and carbon negative energy sources should be emphasized; renewable energy supply must be the primary source for major functions. Emission classification could be improved with use of low-emitting building materials to stop chemicals' emission into indoor and outdoor environment.

Many inventions and development were made in order to provide better and more sustainable technologies. Renewable energy sources provide better building performance and have less environmental effect.

Energy consumption can be reduced by using alternative energy sources, better insulation, more efficient building materials, better lighting conditions, more coordination of waste collection…etc.

Besides the great direct environmental impact of a construction, buildings' increased carbon dioxide emissions causes harmful climate effect.

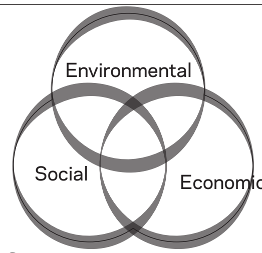
The Kyoto treaty, form December 1997, already discussed the fear of CO2 emission result in "human-caused global warming" – hypothetical severe increases in Earth's temperatures, with disastrous environmental consequences.
Many efforts have been made to achieve a worldwide agreement on the sample of Kyoto treaty, and many ideas were born of the concept of the zero emission buildings.

The main effect of the buildings on the environment already acts during the construction. The process is not just consume a great amount of energy, but it also create the most CO2 emission, and also produce the most waste, causing air- soil- visual pollution, and high machinery lead to noise pollution. Moreover, building footprint takes away many green areas, which in extreme situation could lead to deforestation.

As an architectural approach the design of the building must fit in a sustainable architectural category and in a technical point of view it must make as less environmental impact as possible.

Sustainable architecture

Sustainable architecture in a term describes environmental conscious techniques in architecture. The main aim of sustainable architecture to minimise negative environmental effect by improving efficiency of building performance with material use, energy consumption and space development. This term can be used to describe an energy and ecologically conscious approach to the design of the built environment.



Intelligent building

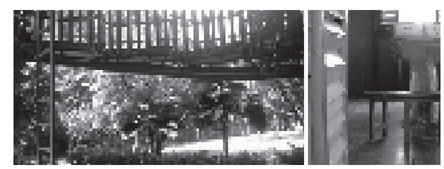
"... in the final analysis, sustainability is about good architecture. The better the quality of the architecture - and that includes the quality of thinking and ideas as much as the quality of the materials used - the longer the building will have a role, and in sustainability terms, longevity is a good thing. Obviously, if a building can be long-lasting and energy-efficient, that is even better".

Norman Foster (Edwards 2001)

Sustainable architecture categories

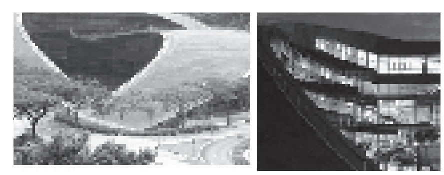
ECOLOGICAL HOUSING | focus on nature

Eco-houses are built in the best way in regarding to the nature. Mostly self-builded (low-tech) houses meant to use materials and processes that are both conscious on the environment and energy, and even contribute to a healthy indoor climate.



GREEN ARCHITECTURE | focus on nature

Green architecture using more advanced and professional approach to design than eco-houses. Green constructions are environmentally responsible and resource-efficient; designed to reduce the overall impact on the natural environment and on human health.

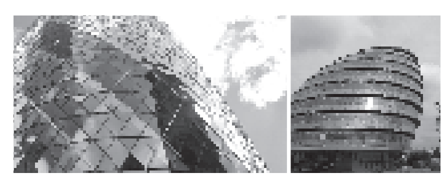


SELF-SUFFICIENT | focus on climate

Also called autonomous building, which suggests that the building is designed to be able to operate independently form infrasructural supply. Due to the independent society these - sometimes even movable - structures usually have more social than climatic focus.

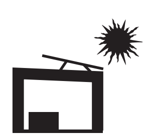
BIOCLIMATIC | focus on nature & climate

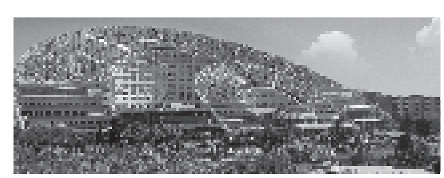
The sometimes bigger scaled structures usually have more industrial and/or commercial functions. This term refers to the close relation between design of the spaces and the local climate, to provide indoor comfort and making use of renewable energy.



SOLAR | focus on climate

Solar architecture refers to a design approach when building elements are made to collect, store and distribute solar energy. The low energy use usually paired with high technological solutions. Solar systems can be incorporated into almost any building project.

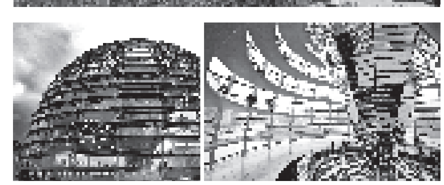




ENVIRONMENTAL | focus on climate

Environmental design emphasizes the relation between building and climate. The mostly site specifically selected design principles promote energy efficient green buildings with sustainable technologies.

Source:
[Hanne Tine Ring Hansen,2009]



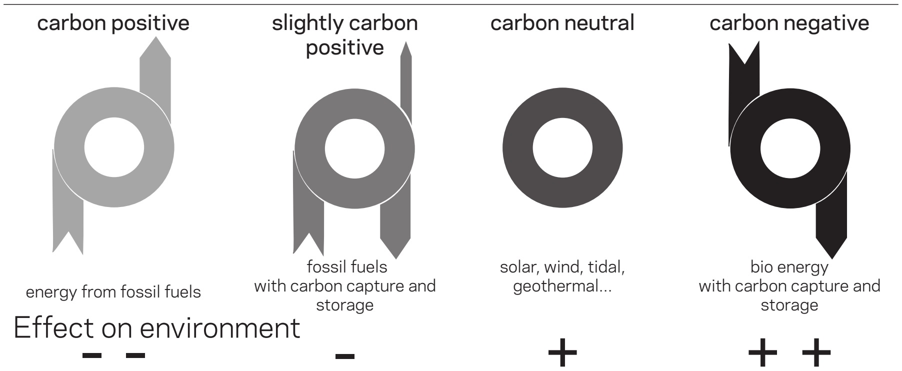
Primary energy sources

Solar architecture integrates elements which passively and/or actively use solar energy in order to gain heat and produce energy. It is goal is to achieve either zero or low energy buildings. They are also known as, energy efficient or passive houses.

Passive solar systems designed to operate without any mechanical or electrical aid. To design the best of a solar building the advantages of the local climate has to be taken into account.

Different type of system can respond at the objective.

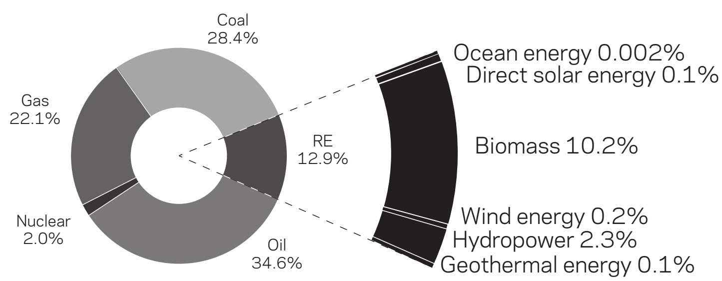
Carbon emission



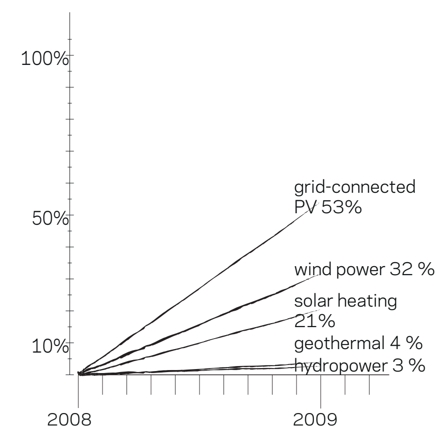
Primary energy supply

Renewable energy accounts for less than **13%** primary energy supply, but according to the SRREN report, renewable energy capacity continued to grow rapidly in 2009 compared to 2008.

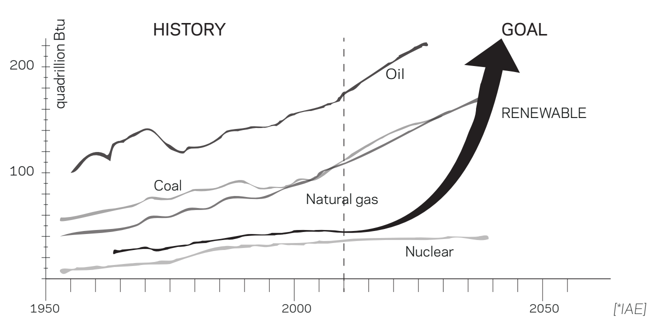
The assessment produces a best case scenario projection of **77%** of global primary energy from renewable sources by 2050.



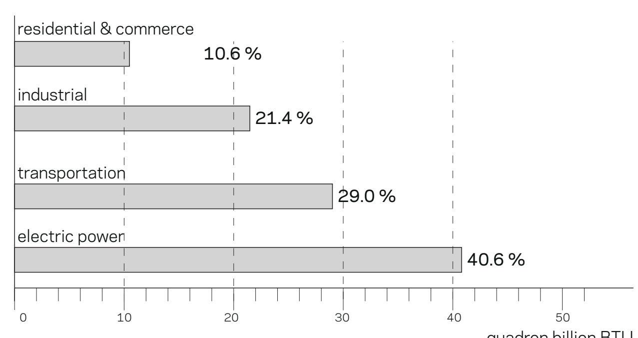
Renewable energy capacity



Worldwide energy use by type



Worldwide energy use by sector [*]



[*based on IAE estimations. 2007]

Human effects

How can the building provide a healthy living environment and protect residents from effects of industry and traffic?

Pollutants in air harm human organs in a numerous ways. Different pollutants affect different organs causing temporary discomfort or deathful disease.

Human health must be the most important design parameter in the project. Both indoor climate and building material have to provide a healthy living environment to prevent sickness in all building units for all user groups.

Humans spend about 80-90% of their time indoors. Indoor climate must accumulate the best circumstances for human health. The most dangerous chemical pollutants, infectious agents and particles often spread. Indoor air quality seriously effects health, especially in developing countries, where fuel and coal is still used as heating or cooking in crowded badly ventilated rooms.

Allergies, respiratory symptoms and asthma among children have been associated with poor indoor air quality; moisture or mould-contaminated environments and combustion sources, including environmental tobacco smoke could lead to cancer.

Emissions could come from building materials, finishing products or furniture, as well as emissions from indoor activities and domestic appliances.

As a contrast to the overloaded air of the urban area, indoor spaces must provide a 'safe' place for people to spend their time in. Indoor air quality should ensure health and comfort for the occupants.

Besides of the personal factors and preferences, indoor climate should be balanced to please the most.

The perception of indoor climate depends on several factors (such as age, sex, attire, and activity), but the primary concerns of the building design point of view are:
- indoor air quality,
- thermal comfort,
- visual comfort and
- acoustics.

Different passive systems and alternative technical solutions could solve and improve these factors.

Indoor air quality can be improved by different ventilation systems; airflow, heating and cooling also helps in thermal comfort. Airflow in balance with thermal mass/insulation or well chosen materials favour energy efficiency. Therefore ventilation is an important parameter through design process.

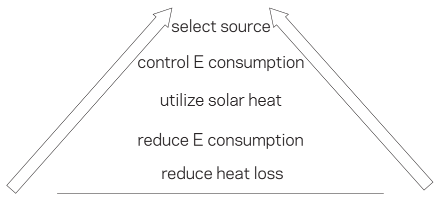
Natural daylight will be capitalized as well. The most pleasant visual conditions are given by natural daylight, and it also promotes passive solar solutions. Natural sources must be emphasised as much as the opportunities let.

Building elements have to avoid toxic materials. Many chemicals added to building materials have dangerous effects on humans. These chemicals could be found in vinyl floor, carpets, wallpapers, foam insulation, polycarbonate glazing, wall paint, polycarbonate panels... etc. During building design PVC, VOC, heavy metals must be avoided.

Use of green building materials would emphasize the concept of a sustainable building. Green materials are environmentally responsible because impacts are considered over the life of the product [Spiegel and Meadows, 1999].

Indoor climate

Perception of comfort is subjective and it is almost impossible to satisfy the needs of each individual. Instead, designers should aim at conditions that are acceptable to a majority of the users.



Human comfort

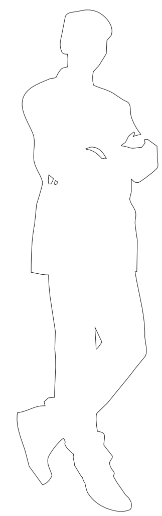
Thermal comfort:
- temperature
- humidity
- air movement
- mean rad. temp.
- activity / clothing

Visual comfort:
- adequate illuminance
- glare control
- distribution of light
- direction of radiance
- color and material use

Indoor air quality:
- ventilation
- climatic atributes ...

Acoustic comfort:
- niose from traffic
- impact sounds
- absorbing materials

Adaptive opportunity & control



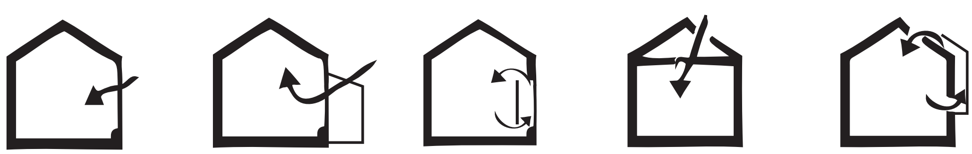
Utilizing sustainable energy sources

Sustainable energy sources:
- solar panels, solar cells
- groundwater cooling
- rainwater collection
- sunspace
- wind energy
- geothermal energy
- thermal mass storage
- heat usage

Building optimization:
- building envelope
- building space
- room height
- surface and floor area ratio
- direct/diffuse radiation
- building orientation
- insulation
- shading

Types of passive solar systems

Solar architecture integrates elements which passively and/or actively use solar radiation in order to gain heat and produce energy. Its goal is either zero/low energy buildings. They are also known as energy efficient or passive houses.
To design the best of a solar building the advantages of the local climate has to be taken into account.



Direct gain energy captured on south openings to increase the thermal mass

Sun space glazing increasing the gain of heat and distribute along the length

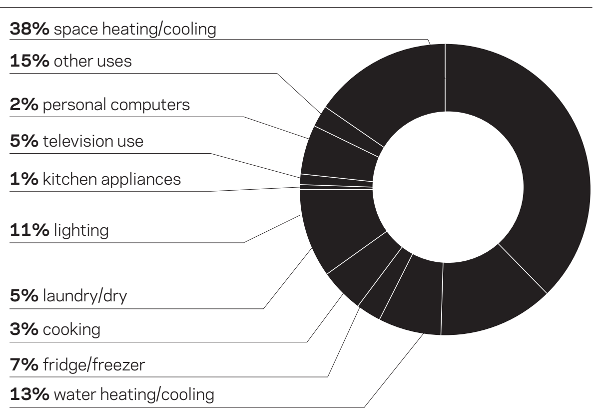
Trombe wall a heat collector-accumulator in the form of a wall, painted in a dark

Roof collector absorb solar rays and to gather heat placed on the roof of the building

Convective loops warm air rises to the upper floor setting up natural ventilation

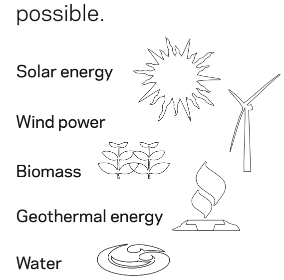
Energy efficiency

Insulation of the building envelope is the first step towards to improve energy efficiency. To optimise environmental design insulation solutions, air tightness and ventilation is the most important.
In addition, energy use in a household divided to different parts, either consumption must be reduced or renewable energy source should be used as energy supply.



Select sources

Alternative energy sources must be integrated in the design both technically and architecturally as much as it is possible.

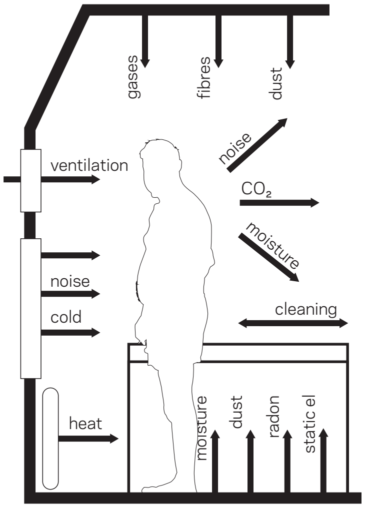


Indoor comfort

Perception of comfort is subjective and it is almost impossible to satisfy the needs of each individual. Instead, designers should aim at conditions that are acceptable to a majority of users.

Indoor climate is divided in 4 parts that describes indoor user comfort:
- thermal comfort,
- visual comfort,
- indoor air quality (IAQ) and
- acoustics.

Indoor balance



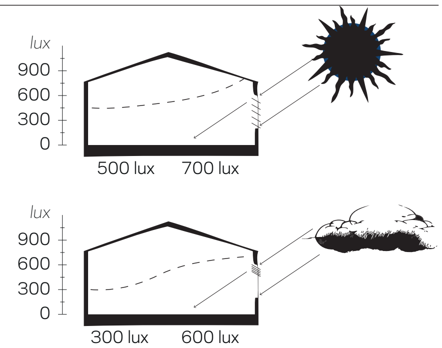
Thermal comfort

Thermal comfort is not measured just by air temperature, but it is created by many components.
These components are:
- humidity
- air velocity
- radiant temperature,
- clothing,
- metabolic heat.

In order to provide satisfaction with the thermal environment, indoor climate must be adjusted to the function and activities as well. Thermal comfort affects behaviour and productivity.

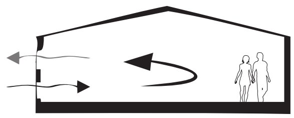
Daylight

Lighting of structures is a very important design shaping parameter. It must be considered as aesthetic element and as technical parameter in quantity, energy efficiency and cost.
Natural light has the best effect, but if it is necessary it could be improved by artificial lighting.
Different spaces, according to their usage, have different requirement for lighting.
Sometimes shading is as much important as light penetration.

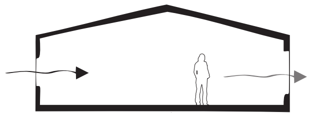


Ventilation

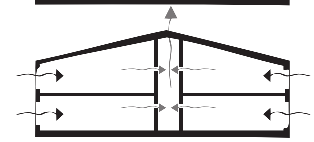
Single sided
Most often in small spaces, openings located on one side, airflow due to the outside wind.



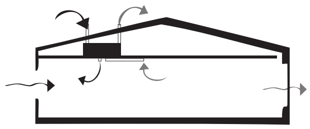
Cross ventilation
Most often in small spaces, openings located on one side, airflow due to the outside wind.



Stack ventilation
Stack vent is commonly used in office buildings. Thermal buoyancy induce airflow vertically.

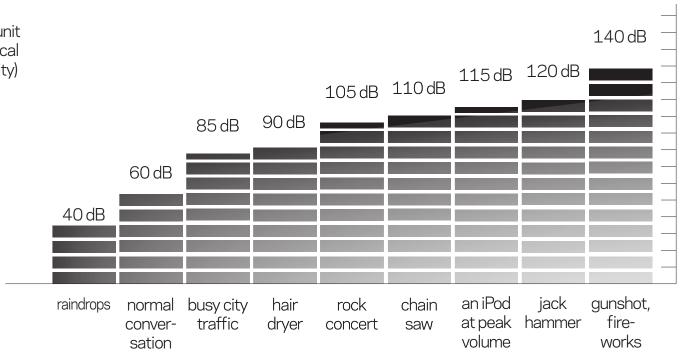


Mechanical
Mechanical ventilation is more controlled process, to help or improve window ventilation and air flow.



How loud is too loud?

decibel:
The decibel (dB) is a logarithmic unit that indicates the ratio of a physical quantity (usually power or intensity) relative to a specified or implied reference level.



source: dangerousdecibels.org; WSJ research

Conclusion

To take the starting point of the project at the problem of dense population and human generated pollution the proposal aims to find architectural and technical solutions in a sustainable way.

The population research show the most dense areas in the megacities; population distribution mainly concentrated in Asia; in the megacities of Asia, which also showing the most growing tendency. These cities are the most crowded urban areas, already dealing with tough living conditions.

Evidently, more people generate more pollutants. Packed areas are coping with air pollution issues, moreover highly used air trapped in between the densely placed buildings leads to more frequent air pollution episodes. Weather conditions and climate properties, low wind and high temperature also trigger smog.

Climate of the dense Asian megacities does not favour air quality. Seven out of the 9 densest and polluted megacities has tropical or subtropical climate according to Köppen climate classification. These cities are categorized in GROUP A: Tropical/megathermal climates. Common properties are:
- constant high temperature
- low elevation
- monthly average temperature above 18ºC
- average precipitation 60 mm/month
- no more than 2 dry months

Accordingly, similar conditions are present in most of the possible locations. Tropical, subtropical climate will be analyzed to apply sustainable solution in the design.

To deal with the air quality problems in these places, the proposed building would contribute to the surrounding environment as much as protect the inhabitants. Components of smog and green house gases are emitted into the air in huge quantities in the megacities. Harmful chemicals damage human health and vegetation as well. Trees are naturally filter the air, but naturally grown green walls and tree buffers may not be enough against today's heavily used urban air. Many inventions were made to purify outdoor air in a human scale. Is it possible to implement these inventions to the building design, or enlarge them?

The technical properties of the building should aim the requirements of carbon neutral classification, within the environmental category of sustainable architecture.

For the building itself, energy consumption must be reduced and most of the energy supply must come from alternative energy sources, using wind turbines, photovoltaic (PV), water collectors and recycle centres.

Regarding the social problems of the megacities the proposed building would mainly function as a residential complex. The additional functions must fulfil the needs of these areas. Public and commerce functions would contribute to the urban infrastructure, while separating and keeping privacy of inhabitants.

Housing units and private outdoor spaces would regard the aging society. Expanding life span propose older target groups besides families in variant apartment units.

All housing unit would provide healthy and comfortable indoor climate.

Passive house principles will be considered to reduce energy consumption and emission, such as orientation, air tightness, compactness, and prevention of heat loss, insulation to respond to the micro and macroclimate problems.

At the first stage, building complex would contribute to the close surrounding environment; but by multiplying the proposal and placing it in different locations with small adjustments to the local properties, it would improve the urban conditions.

Initial problem statement

Can architectural design become an active contributor towards the improvement of urban air quality and provide higher living conditions in the over-crowded cities at the same time?

Possible location for proposal

For comparison of the possible location, several aspects have been regarded to. A table have been made and attached in the Appendix in order to rank the cities according their population and air pollution. These aspects have been cross-referenced, shown on the illustration on the next page, to decide on the projects location.

To work with the problems defined in the Introduction, project needs to find a location where the problems are. As a first step, population, population growth and general pollution will be considered to narrow down to a focus group of cities. As an architectural project, proposal aims to contribute to a better urban air quality, reduce (domestic) pollutant emission, improve green spaces on and around the site, provide high standards of living while work with the urban context. Secondary aspects are categorizing the cities of the focus group.

According to primary factors the top 3 cities to consider are: Calcutta, Delhi and Shanghai. Secondary aspects help to choose from these locations.

Bigger dots under points indicate bigger need in order to improve, or which have the potential to be improved. These secondary aspects are also very important to note.

Although Calcutta and Delhi are more and generally polluted cities, Shanghai is the fastest growing among them, and divering the air quility from all pollution, it has the worst values.

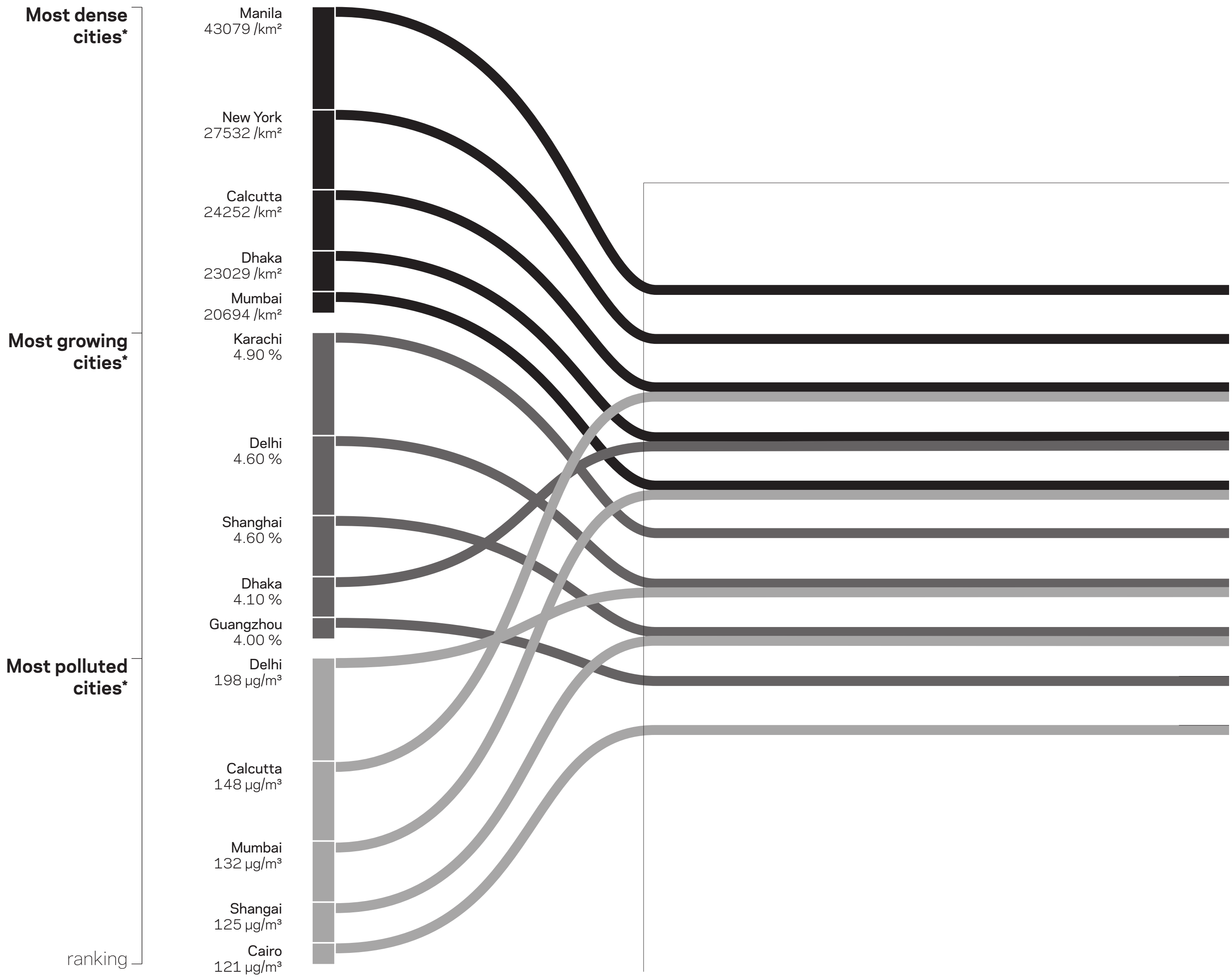
There are many cities with frequent air pollution episodes, but the causes must be reagrded as well. For example, Manila's air pollution episode is mainly caused by its location and unfortunate climate; while Shanghai is dealing with the problem due to its overcrouded center and high emission.

Shanghai is also more suitable as a location, due to its technical development, urban context and most importantly its strong will of improvement.
Hence Shanghai has the need and possibility for development, it is going to be the proposed location for the projects.

Possible location for proposal

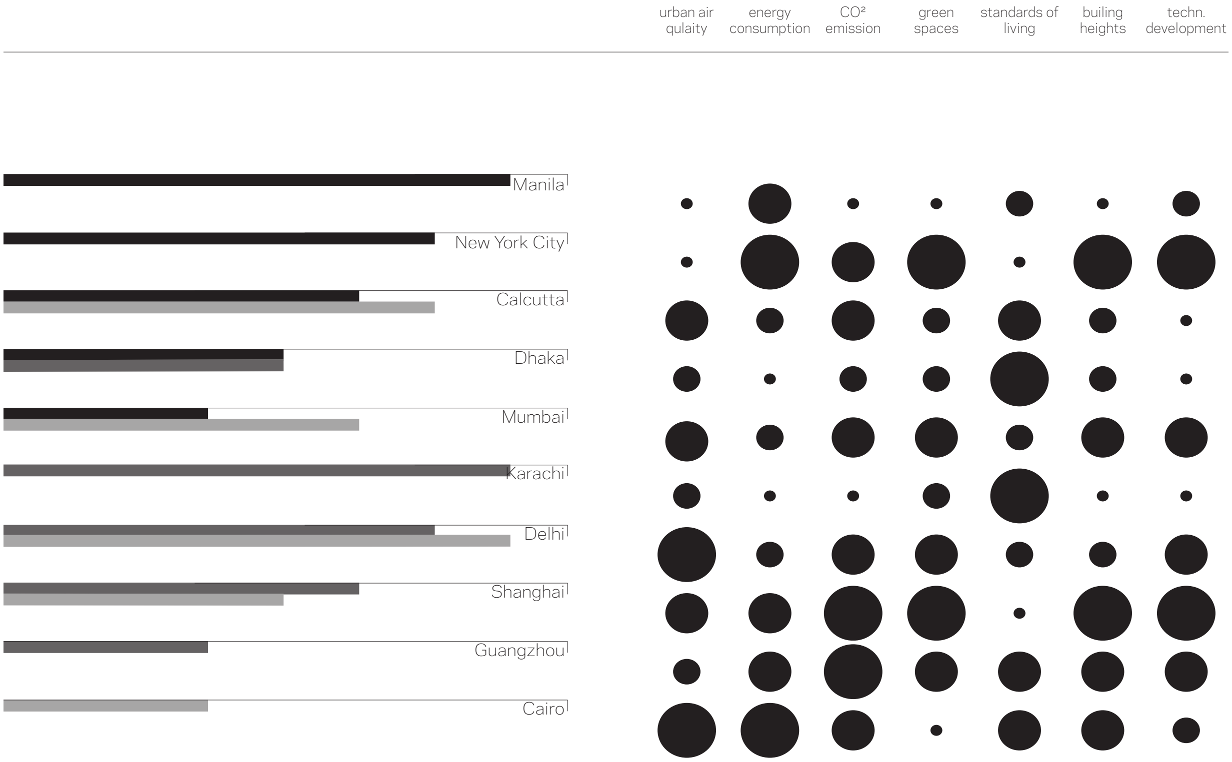
Contributing factors of location

Primary factors are density, annual growth in population and urban air quality regarding human generated pollutants. Secondary factors are considering average air quality index, energy consumption per capita, CO2 emission, renewable energy sources, standard of living, green spaces of the city, building heights in the urban region and given technical development of the country.



Why now, why there?

In 2005, for the first time in history, more people live in cities than in the countryside.
Megacities are home of almost one in ten of the world's urban population.
Places of problems, places of solutions.



Part III

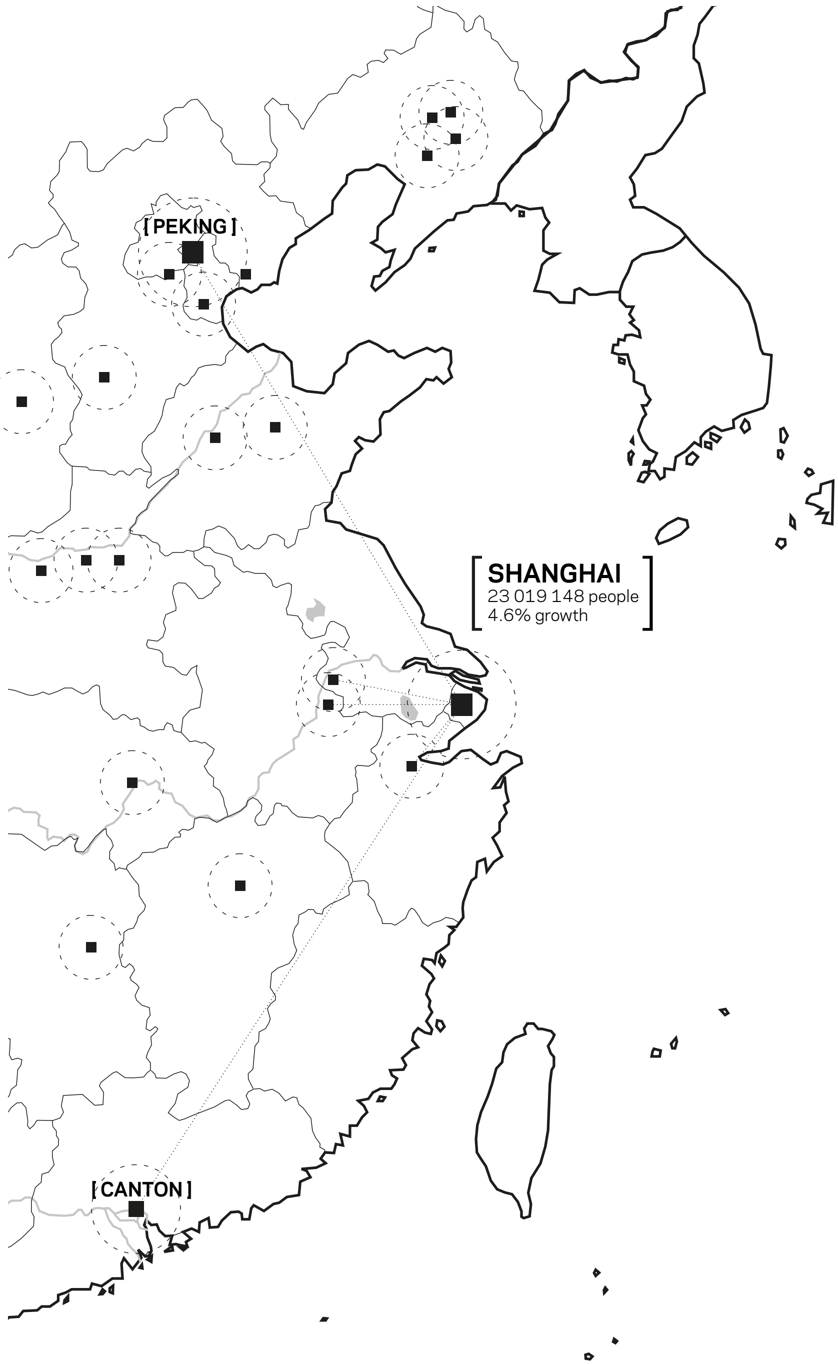
Shanghai, China
Analysis

GENERAL ANALYSIS OF CHINA AND SHANGHAI TOWARDS TO A PROPOSED SITE

Historical and demographical evaluation on population distribution and growth

Mapping of Shanghai's green areas, typologies and exploration of surroundings

Settings of the site; microclimate, functions, dimensions and viewpoints


[PEKING]
SHANGHAI
23 019 148 people
4.6% growth
[CANTON]

Acknowledgement

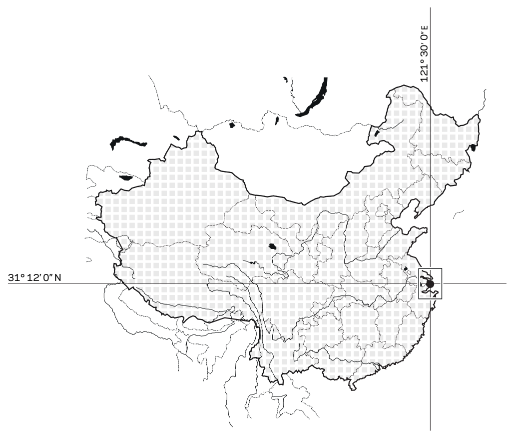
Shanghai was one of the first Chinese cities to be formally opened to the Western countries and in the following 150 years, it became an economically dynamic and politically turbulent city.
Shanghai is located midway along China, the city sits on a flat land at the area of the Yangtze and Huangpu Rivers, on the south-east edge of the Yangtze delta.

Shanghai has had, and still has, a poor environment. Water and air are heavily polluted and solid waste collection practices are inadequate in many parts of the city. Moreover, housing has been, and it still is, a major problem. In the end of 20th century, the average population density in downtown Shanghai was 40 000 ps/km2. In some densely populated areas, the density rose to 160 000 persons per km2. Average per capita living space in the city was only 5.4 m2. An official survey found that 1.8 million households were living in overcrowded conditions, including over 200 000 households in dwelling units with less than 2 m2/persons (Xiangming, 1996).

Besides the rough living conditions in the city, the financial centre grow into a global centre rapidly; the gap between poor and technically developed parts widened and modern technology building up onto cultural and traditional values.

China, and Shanghai, has the resources, the development and the power for change. Shanghai already had steps towards to environmental conscious strategies and sustainable thinking.
Housing conditions, air and water quality, and waste collection practices have all improved in the last 10 years. Current policies and projects should produce further environmental improvements.

Shanghai, China



History and location

Shanghai is one of the earliest cities in China that was opened to foreign markets. With its long history and beneficial location Shanghai developed quick and became one of the biggest global cities and the most important financial center in the Far East.

During the history of China, Shanghai developed fast and it always had an important rule. It attracted international attention in the 19th century as the major trade port of the region and it soon opened for international market.

By today, Shanghai is the largest city by population in China and the largest city proper in the world.
Shanghai is located on the Yangtze River Delta on China's eastern coast, and is roughly equidistant from Beijing and Hong Kong.
Shanghai has a humid topical climate, and four seasons with cold, sometimes freezing winter and hot humid summer.
Shanghai experiences on average 1,878 hours of sunshine per year, with the hottest temperature ever recorded at 40.2 °C, and the lowest at −12.1 °C .

Suburbans of Shanghai

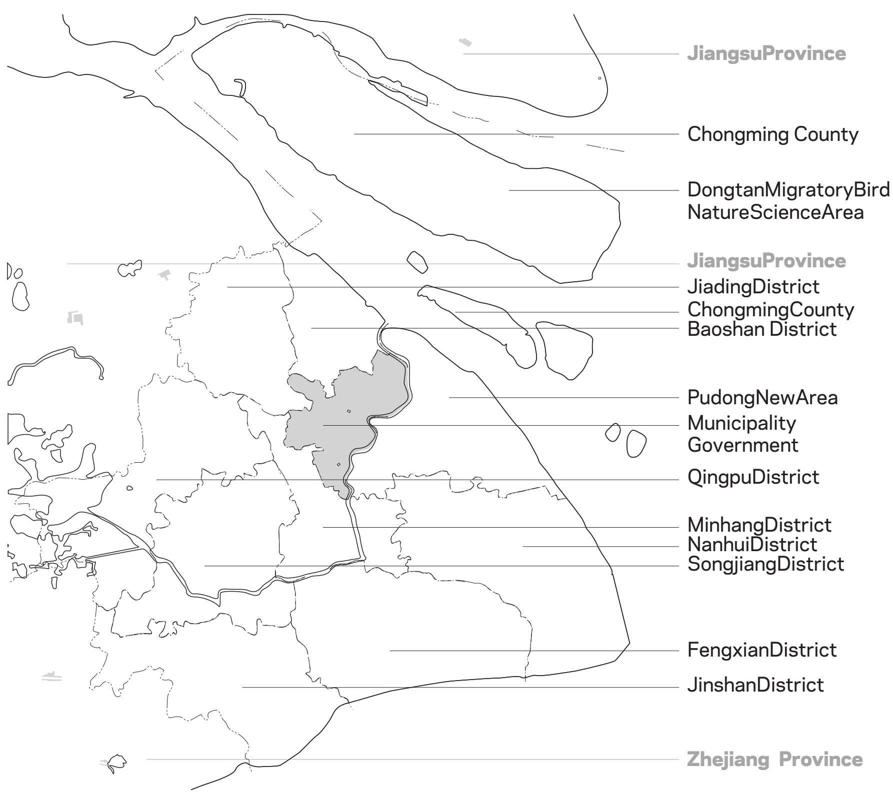
Shanghai is divided into 16 districts and 3 counties.
There are 205 towns, 9 townships, 99 sub district committees, 3,278 neighbourhood committees and 2,935 villagers' committees in the city.

The 16 districts are Hangpu, Luwan,Changning,Putuo, Hongkou,Minhang, Jiading, Jinshan, Songjiang, Qingpu, Nanshi, Xuhui, Jing'an, Zhabei, Yangpu, Baoshan, and Pudong new area. The 3 counties are Fengxian, Nanhui and Chongming.

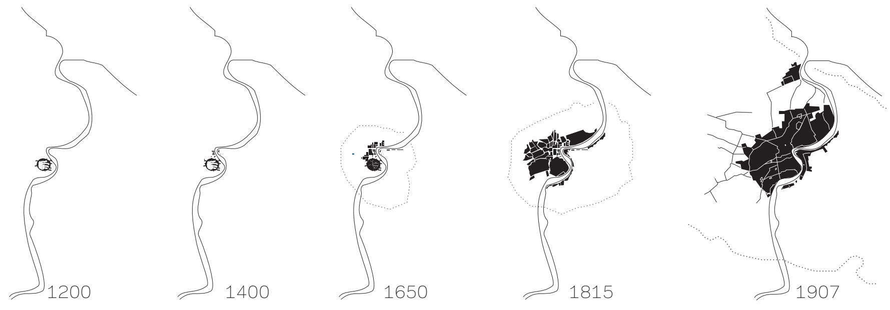
The city of the size of a country cannot be regarded as one. The differences in population density, typography, air quality, culture and infrastructure are significant.

上海

0 km 25 km 100 km



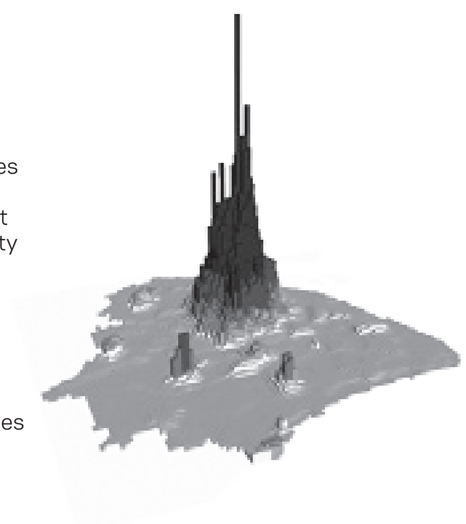
Growth of Shanghai



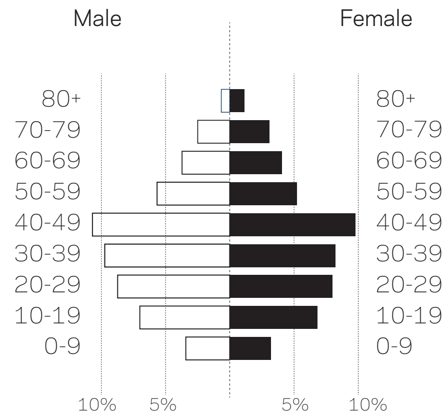
In the beginning of the 13th century, Shanghai had a status of a market town with poor administration system, settled to service market triads of the river. Bigger development of the city started in the 16th century, when the City God Temple was erected. It accelerated the town's economic importance and balanced its poor political status. The international attention focused on Shanghai just in the 19th century. Under the authority of foreign forces, Shanghai suffered many attacks, but due to the international trade market the city developed steady.

Population distribution

Between 2000-2009, Shanghai's population grew almost 40% and it is constantly growing. Within 10 years, population of 16 million reached 23 million.
Moreover 89.3% of the population leaves in the central urban area.
Since 1993, Shanghai has been the first region of China to have a negative fertility growth rate in its registered population, while the total number of registered people is increasing due to the in-migration. About 30% of the total population is non-permanent residents.
The average density is a little under 2 100/km², but in the urban areas it reaches 3900 inhabitants per km².



Age pyramid (2000)



Skyline

Typologies

In the different development periods, different housing patterns were built in Shanghai. These differences are really clear and the contrast between housing times is very strong.
During early development of Urban Housing, from 1843 to 1949, most of workers' houses were built by factories and enterprises. The densely build one or double floor houses made a packed residence areas in a squired pattern. Tight allies and crowded rooftops characterize this area.
During the recovery and self-development in the socialist planned economy, from 1949 to 1978, multi storey houses were built in a more planned pattern with more spaces around, more private spaces and more conscious design. In the reform of the planned commodity economy, from 1978 to 1990, real estates showed up and urban hierarchy separated from each other. High-rise residential buildings were built in a big quantity to keep up with the demographic growth. But with the more demanding society, during the development of the early period of the socialist market economy, from 1990 to the present, Shanghai gained a modern high-tech characteristic with its newly built skyscrapers and become a global financial city.
Today, Shanghai's population is concentrated in a minimal area that is less than 10% of its total territory creating extremely high density in the centre. On the other hand, outskirts on Shanghai have low or medium dense parts with single or semi-attached housing.

Nature

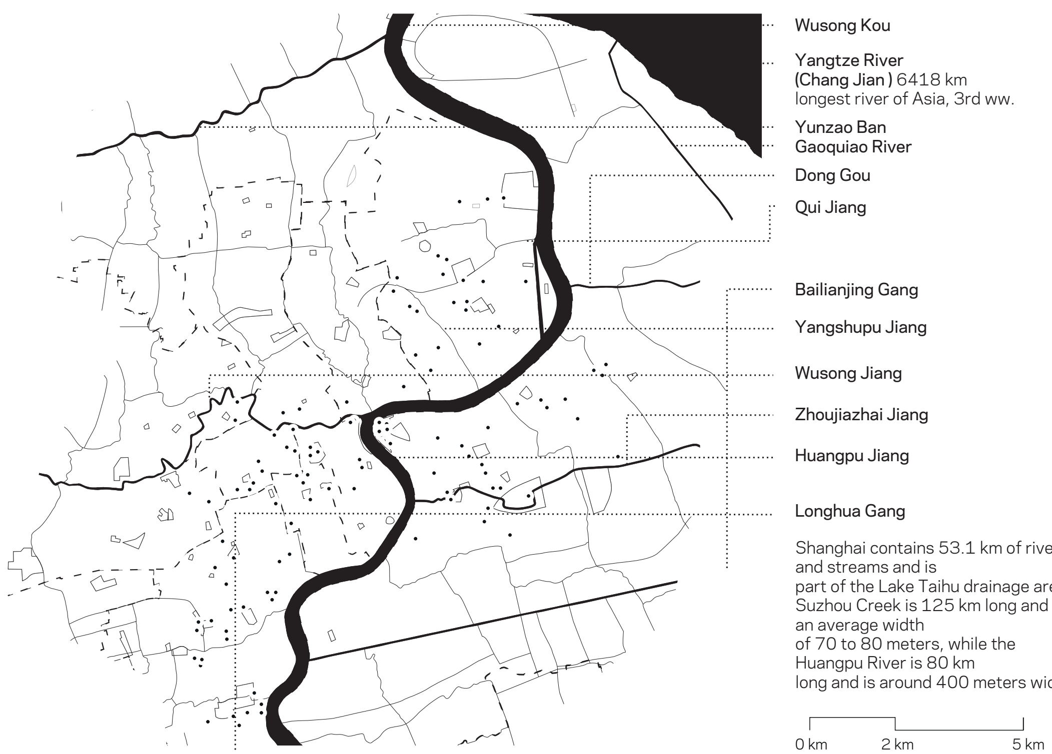
Shanghai sits at the delta of the Yangtze River in the middle part of the Chinese coast. The city has many rivers, canals, streams and lakes and is known for its rich water resources.

The groundwater is shallow (80-120 cm) below surface, and due to the humid climate and low relief, water resources are continuously supplied. But most of the surface water in and around Shanghai has a poor quality. The rivers cutting through the city has the most polluted sections.

Although many small green areas, ecological gardens and (natural) parks lies around in Shanghai, the central city still has the appearance of a 'concrete jungle'. There are plenty of green refuges for relaxing or recreational time, but the urban sprawl still dominates.

The traditional Chinese garden is famous of its solitary or social contemplation of nature. Unfortunately, by today these poetic gardens tend to disappear in the modern metropolis.

Area of interest: riverside,
Driving design principles:
- context
- infrastructure
- views
- natural elements



Shanghai contains 53.1 km of rivers and streams and is part of the Lake Taihu drainage area. Suzhou Creek is 125 km long and has an average width of 70 to 80 meters, while the Huangpu River is 80 km long and is around 400 meters wide.

Mapping sites

Shanghai Municipality is located over 6 340,5 km^2. From the 1940's the major urban planning strategy is trying to de-centralize the overcrowded population in the central part of the city, where the density was higher than 70000 people/km^2, now it is decreased under 40000 people/km^2.

The rapid growing city claims more space, and diversity for the dynamic city life. However the government supports the suburban areas but they cannot encourage people to stay in the outside towns. Industrial areas has been moved outside of the city and major infrastructural developments started in the inner area.
Living circumstances have to be improved in the centre city with more residential housing and accommodation possibilities with a sustainable solution.

Area of interest: central urban area
Driving design principles:
- culture
- development
- density
- living quality
- program

1. Historical and cultural site near Duolun Road

2. Jing'an Temple and religious sites

3. People's Square and entertainment sites

4. The Bund and the World Architecture, development sites

5. Xujahui and its entertainments sites

6. Xintiandi and Huaihai Road with turist attraction sites

7. Old Temple and Old Town of Longhua

8. Yuyuan Garden and Shanghai Old Town area

9. Lujiazui and Pudong new areas with developments

Building with a vertical constructions at least 100 m height. The continuously habitable buildings of many stories are made of a steel frame - load-bearing masonry passed their practical limit with 60 m height - with suspended walls.
In the 19th century, engineering development enabled super-tall constructions with advanced technology.
However nowadays tallest skyscrapers are built almost entirely of reinforced concrete elements.

In 1960, Shanghai had about 40 tall buildings, but today the city has about 1000 constructions with more than 100 m height. The many iconic building and the densely placed super-tall structures make Shanghai's skylines easily recognizable.

High-rise is a logical solution for accommodation the crowded urban city, and with sustainable technologies, green buildings would contribute to the environment.

Area of interest: central urban area
Driving design goals:
- habitat the quickly growing urban population
- reduce the environmental impact
- good indoor climate for the residents
- contribute to the better urban air quality
- adding more green spaced to the city
- combine the suburban living quality with the advantages of the dense city
- additional function to improve the urban infrastructure

Traffic, transportation and pollution

In the last couple of decades Shanghai grow and developed a lot.
While population tripled public transportation kept up and rail transit extended. In 2009 total of railways were about 125 km, in 2010 it was already 400, and it is planned to be more than 515 km by 2012 to serve the pressuring public needs.
Although most of the high traffic roads are circling around the central city, some of the heavy traffic is trespassing.

Bike culture is very strong in China; most of the people run with bikes with simplifies daily life and makes transportation easier and quicker.
Unfortunately due to the big commercial champagne of the last few years, the number of car owners grew more than double.

In the same time, electrical and small city cars are also very popular in the urban areas.

High traffic in the city centre accelerating air pollution and create smog. Traffic, and fossil fuels of traffic is the major cause of poor urban air quality.

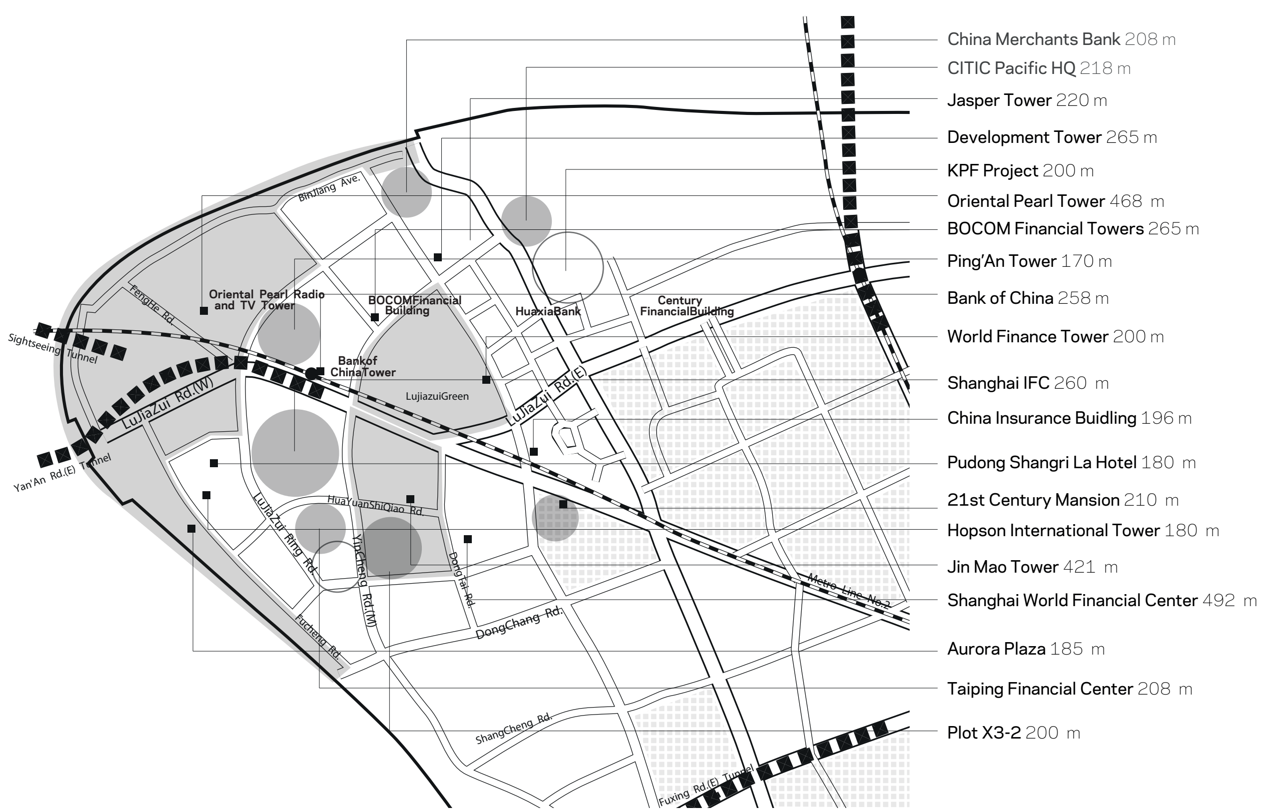
Area of interest: Lujiazui, Pudong New Area
Driving design principles:
- infrastructure
- transportation
- urban air quality

Skyscrapers of Pudong

Shanghai is famous of its skyscrapers drawing the skyline for the financial center.

Appendix shows a small collection of the 10 tallest structure of the area. The locations of the iconic buildings are shown on the map below. Map also shows height of the buildings.

Area of interest: Lujiazui, Pudong New Area
Driving design principles:
- context
- material
- height
- structure



Microclimate

Microclimate is important in order to optimize the performance of the building concerning energy use.

Thermal conditions of the site is analyzed and visualized below, to indicate some of the design parameters, which might be crucial for the energy efficiency of the building. Data visualized by Ecotect Weather Tool in annual and seasonal values.

Wind conditions analysed in relation to frequency and average temperature. As it is shown on the chart, most frequent and also the coldest wind is coming from North, Northwest. Lighter summer breeze hits the site from the South, Southeast.

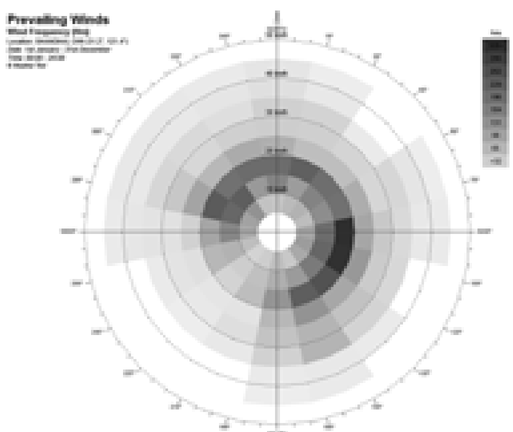


Diagram shows frequency of prevailing winds in Shanghai. The circular graph is divided up into four quadrants representing the four compass point directions, and indicate the wind direction; concentric rings representing wind velocity with increasing speed further from the center; the coloured segments show the frequency of wind occurrence for a particular speed and direction.

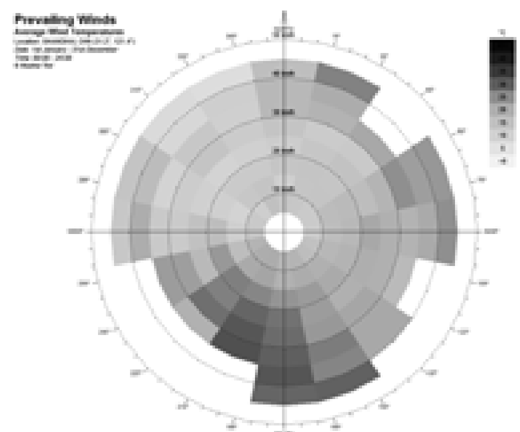
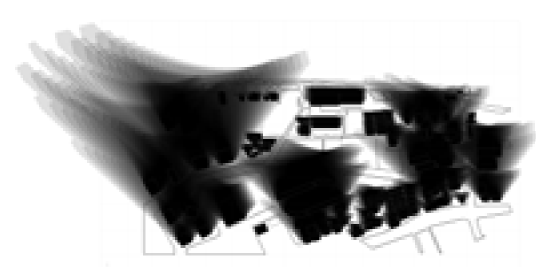
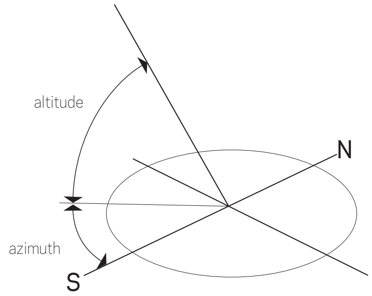


Diagram shows average temperature of prevailing winds in Shanghai. The circular graph is divided up into four quadrants representing the four compass point directions, and indicate the wind direction; concentric rings representing wind velocity with increasing speed further from the center; the coloured segments show the temperature of wind occurrence for a particular speed and direction.

Daily shadow range of context on site on 21st June.

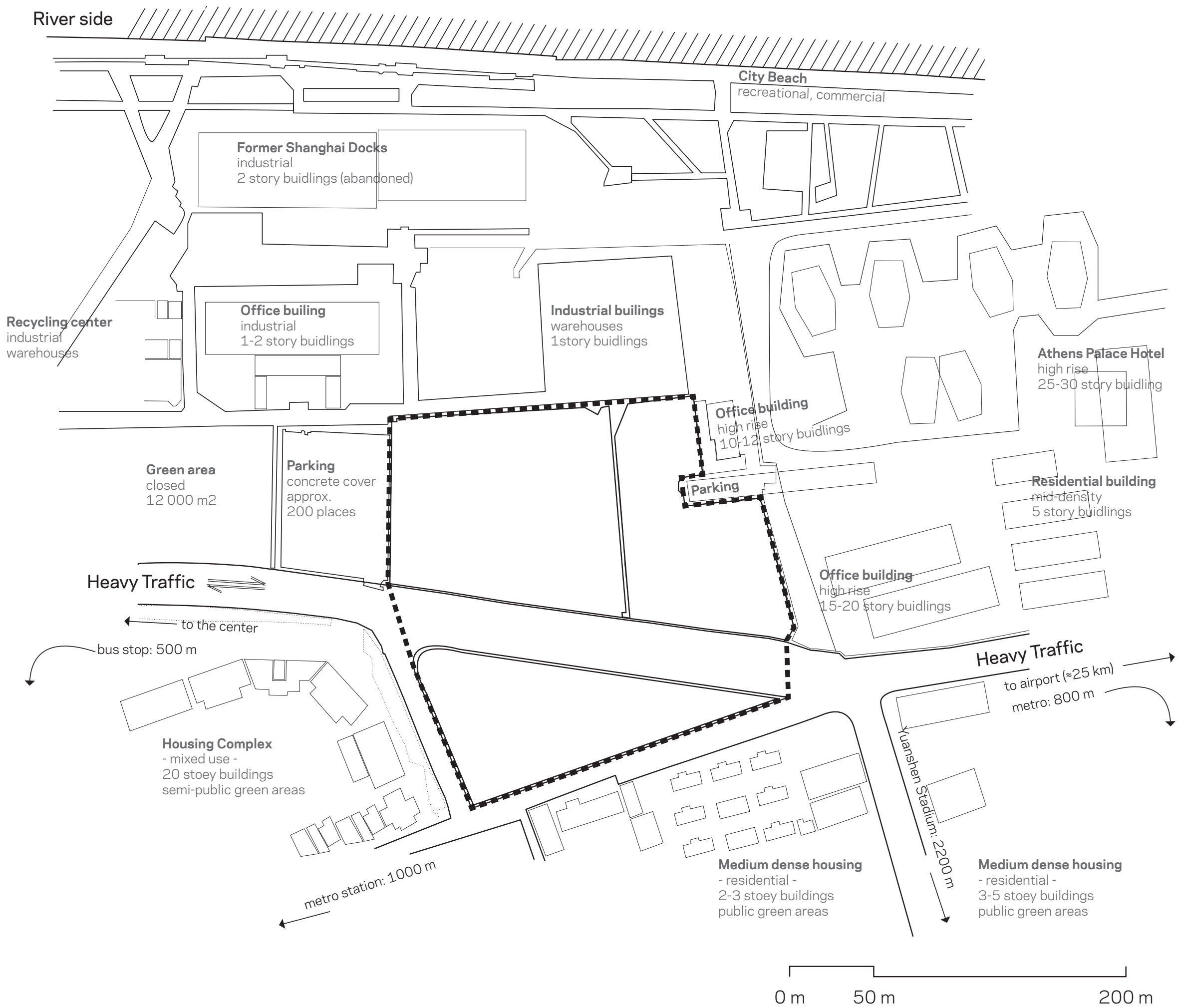


Daily shadow range of context on site on 21st Dec.



Annual sun path diagrams show the incident of solar radiation. The altitude and the intensity of the solar radiation are important in order to improve natural light indoor and the overall building performance as well.

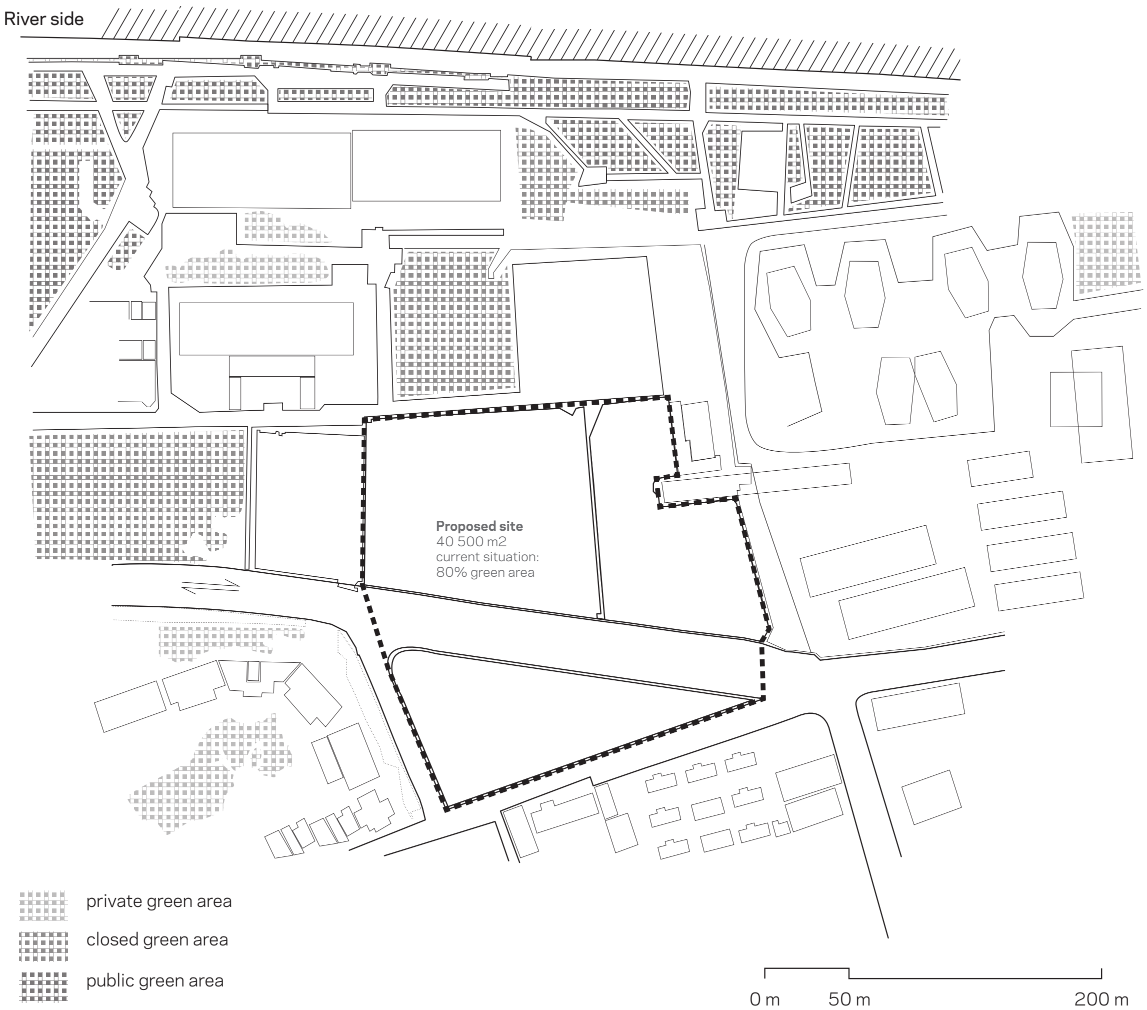
Functions around the site



Most of Pudong were built to accommodate the financial business center. Close to the site there are numerous skyscrapers serving the running city center. Many industrial building is located in the neighbourhood, and parks on the riverbank create a mixed character to the area.

In the intermediate surroundings, tall buildings are still present, but height and density is dramatically changing through the site.
Through the location, districts of different functions should be connected. The project should connect the modern development to the residential area both in expression and function.

Green areas around the site

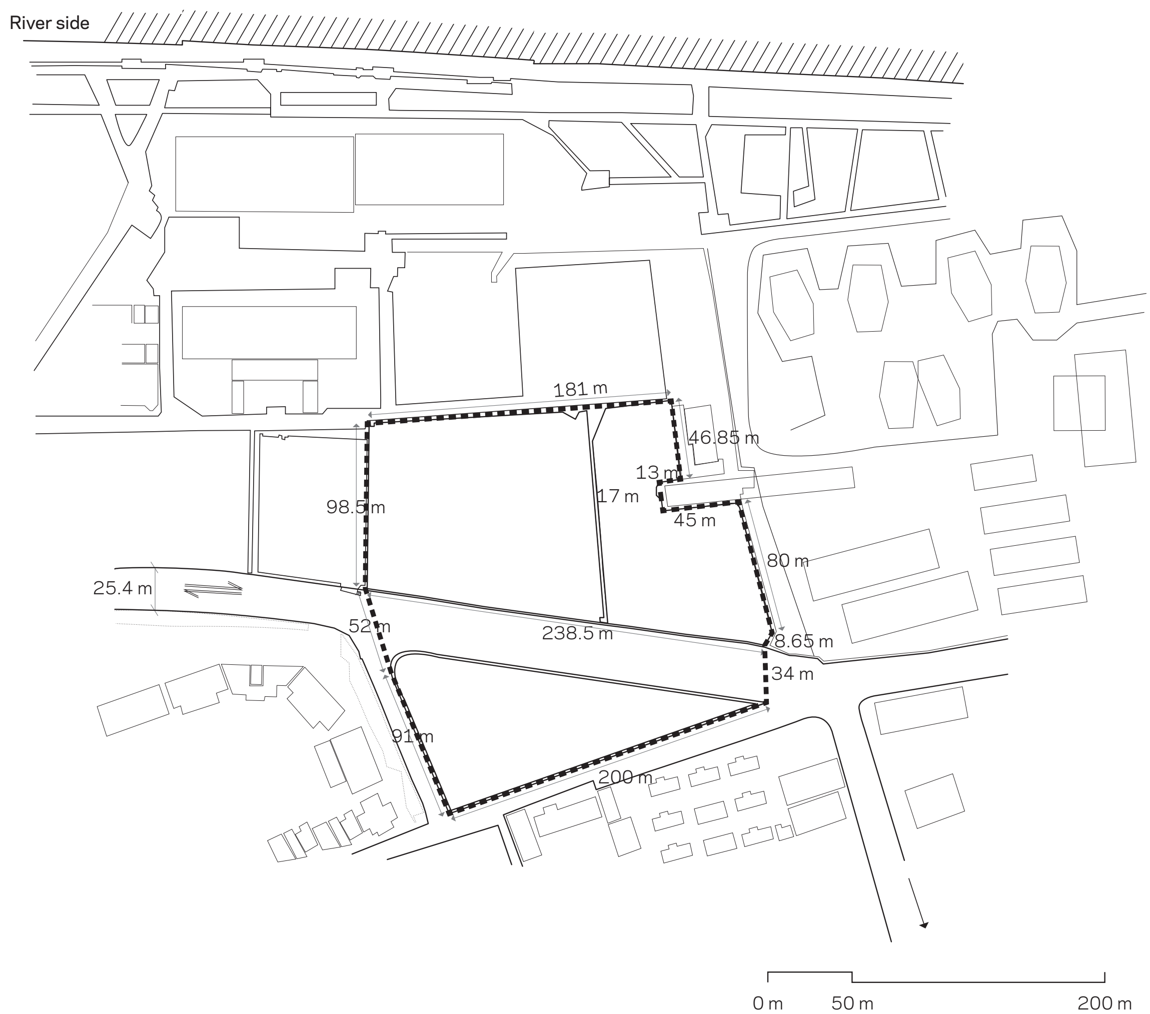


Although the location has quite much vegetation around, these green areas are quite unkempt or unorganized.
Landscaping has a small function in the crowded city.

The largest park of the district is Lujiazui Central Green is located at the entrance of a Tunnel.

It covers approx. 10 000 m^2, and more than half or it covered by evergreen turf.
The park is mainly visited by tourists and it showcases special architectures and combines Chinese and Western culture. It also reveals the past present and future of Lujiazui, which is also an important principle in designing the landscaping of the site.

Dimensions of the site

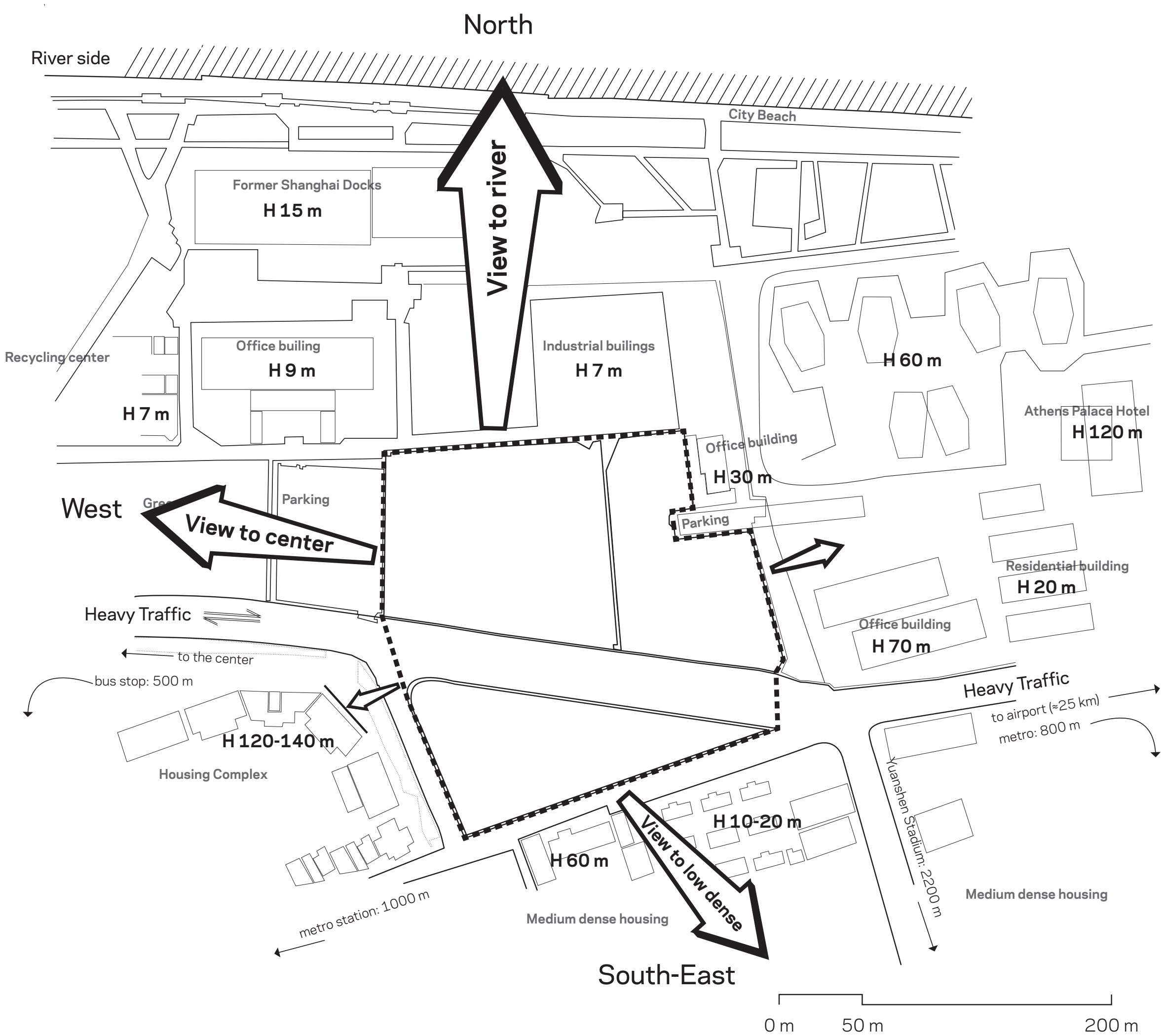


The proposed site has an irregular form. The plot is empty in the current situation, and it covers approximately 46 000 m² (but 8 500 m² of total is covered by the road).

High traffic road is cutting through the site, dividing it to two main parts. The bigger part considered as Site A and B with the pedestrian division between, and smaller part called Site C.

Site A and B covers about 26 500 m², and considered as the plot of the building, Site C is about 11 000 m² and it seems to be suitable for more open and public functions.

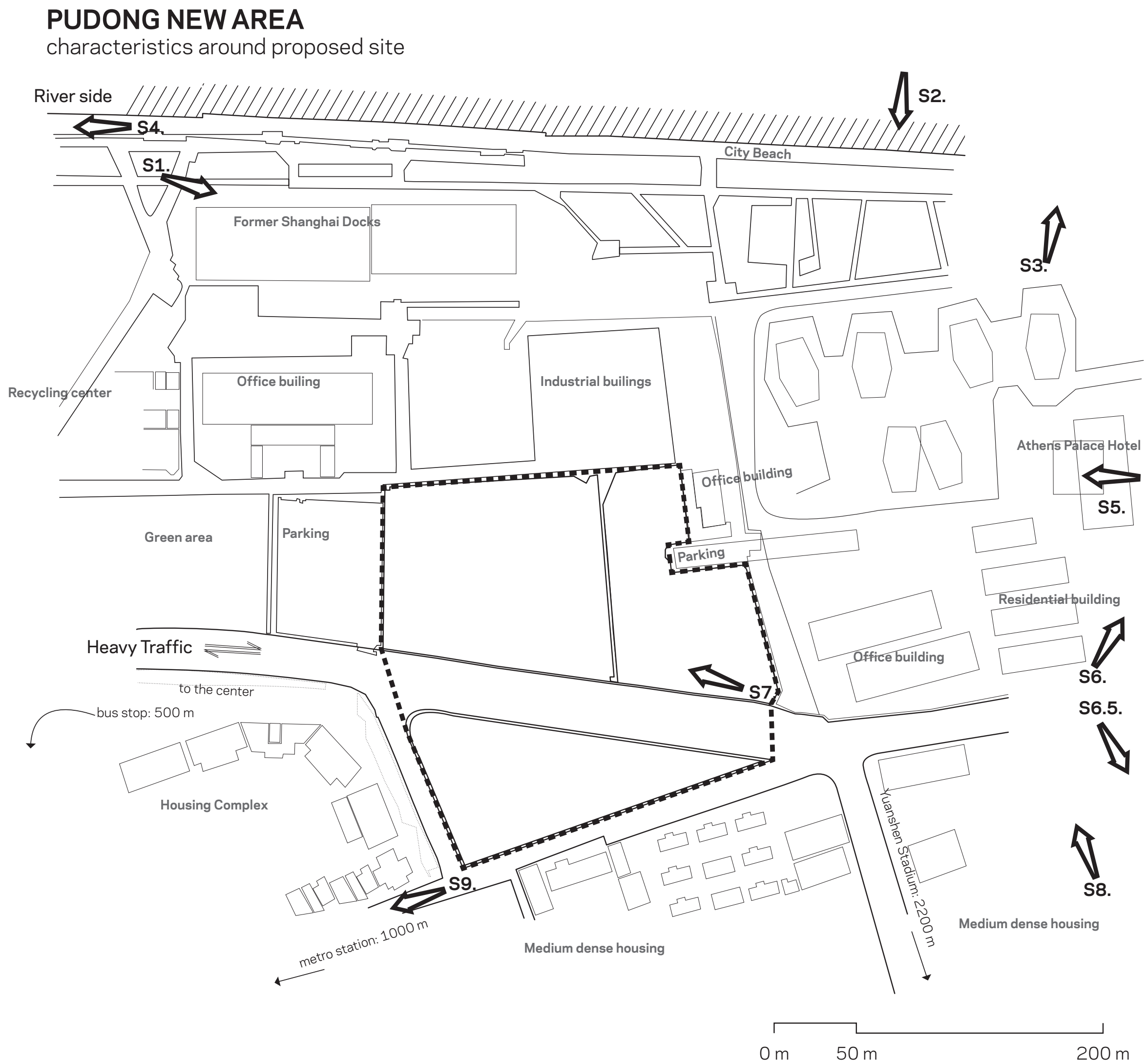
Viewpoints of the site



To follow the context and fit in the skyline, tall structure seems suitable. Opportunities of view and panorama will be increase. Building would overstep its immediate context and provides spectacular view for the residents.

Towards to the North, the river and the skyline of Hongkou provides amazing view. The iconic skyline of Lujiazui roles the view to the West.
Panorama to South, Southeast is not blocked by high-rise structures; view over the low-dense area enables long distance view. The less of the opportunities occur towards to the East and directly to Southwest.

Characteristics of the site

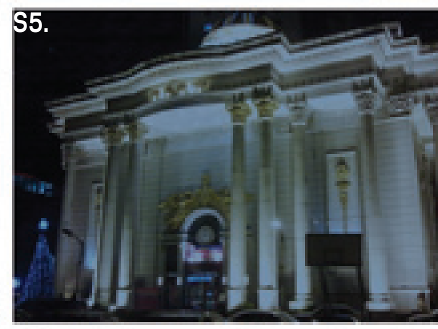



S1.


S2.


S3.


S4.


S5.


S6.


S6.5.


S7.


S8.

S9.

Part IV

Placement and functions
Program

SPECIFIC ORGANIZATION OF PROGRAM ACCORDING TO BUILING SITE AND VISION

Organization and placing of program along the building structure

Space distribution and connection of functions

Flow of transportation and communication between functions

Sustainability and social aspects

Design program

This phase is based on the sub-conclusion of previous chapters. Research and analysis gives an overall image and they already start to form the picture of the vision.

Design program states basic points for the design phase. It determines spaces, areas and functions, tools and principles to use in the later process. Interpretation of initial goals and vision will be tested and opportunities of development will be studied. Program have a more specific insight to the project, therefore more specific data and requirements will be collected in this part.

The main element of the program is to conclude with the vision, which will be the guideline thought out the design phases.

Organization of program

Organization of program and diagrams of functions are indicating the relation between the spaces of different functions.

The program of the site is based on the research part, which included that megacities and dense areas will not stop growing, and best solution of residential buildings will not explore rural areas and more space, but better ways of organizations and smarter design.

The program of the building will be divided into 4 sections vertically along the building.
The lower floors of the building above ground will serve the commercial functions; upper floors will arrange facilities according to the specific need of the site; median strips will be opened to serve as green areas and parks; higher floors, as major part of the building, will give home to the residents.

The density of functions will be arranged according to the density change along the city, from the centre to the outskirts, therefore the lower floors may have denser program, while the upper floors have more space and open areas for the inhabitants.

However, the tall building has to contain a mix of housing units, green areas and other functions, residential function must remain the main function of the building.

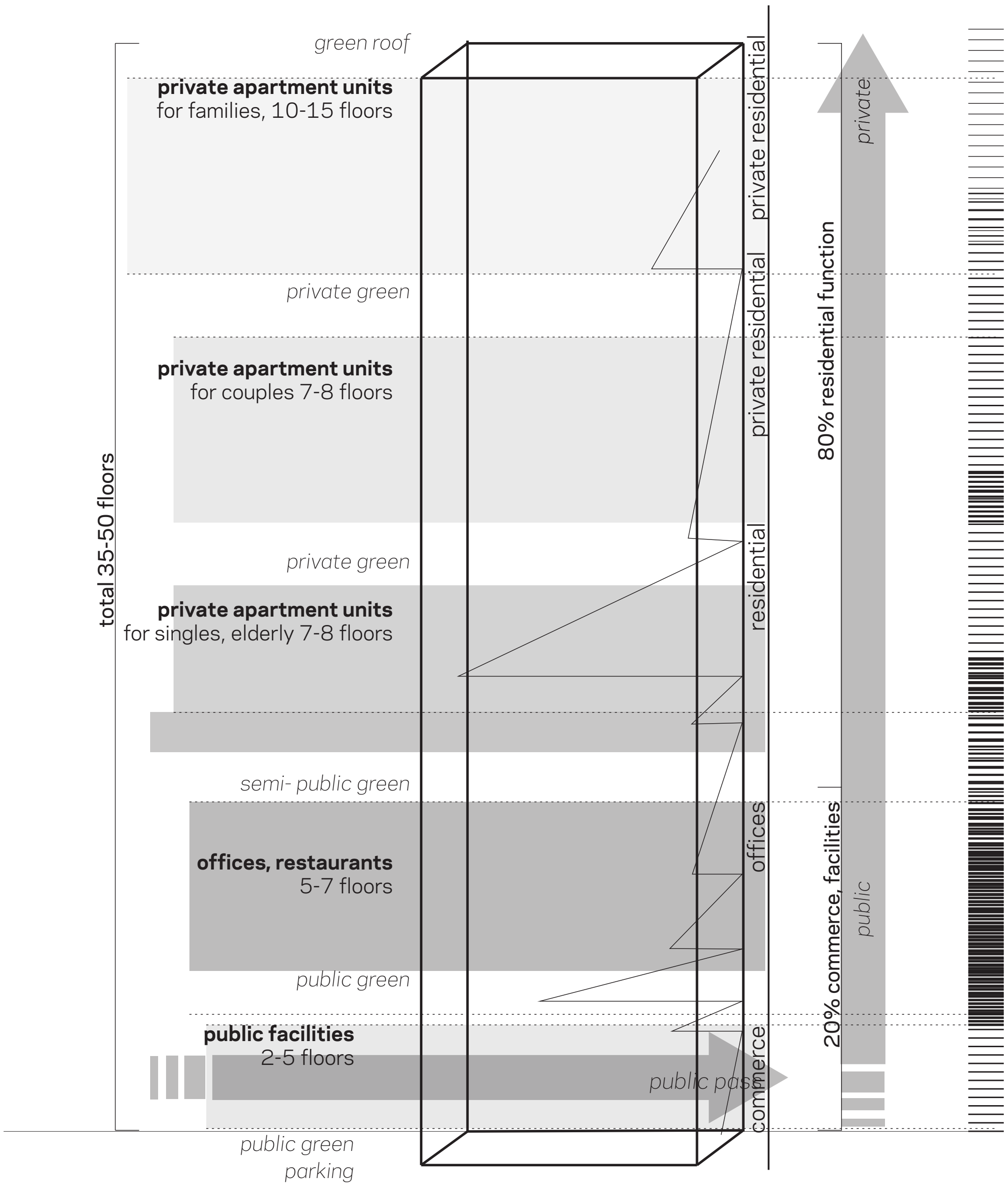
An important design criterion is to keep or even improve the green ration on the site -with small footprint and/or additional green spaces.

Lower floors:
Commerce - On 2-5 floors.
To reduce traffic and transportation some functions (such as shops, agencies, hairdressers... etc) placed inside of the building to serve residents and residents from the neighbourhood.
Public access to and through these floors must be open.

Upper floors:
Offices, restaurants - On 5-7 floors.
The semi public facilities are placed to serve the specific need of the area. As a business district, rentable offices, meeting rooms are placed to some floors to offer place to travelling businessmen and additional income for the building.

Median strips:
Open green floors - On 3+ floor
The public park above commerce functions, the semi-public greenery above the offices and the private green floor(s) for residents are designed to the section to give space for leisure and activities and to improve microclimate.

Higher floors:
Housing units - On 25-30 floors
3 different sizes of housing unit will habitat the residents along the upper floors. One-room/studio apartments for singles and elderly placed lower, closer to serving functions; two-room apartments placed above for (young) couples; the biggest apartments with more rooms will be on the highest floors for families.



green roof
private apartment units
for families, 10-15 floors
private green
private apartment units
for couples 7-8 floors
private green
private apartment units
for singles, elderly 7-8 floors
semi- public green
offices, restaurants
5-7 floors
public green
public facilities
2-5 floors
public pass
public green
parking
total 35-50 floors
private residential
private residential
residential
offices
commerce
80% residential function
20% commerce, facilities
private
public

Program

The aim is to create a habitable urban space in the overcrowded dense city with an intension to improve daily life and while fulfilling functional requirements.

There is no strict specification on the sizes of functions, but in proportion to each other, it must show the importance of the residential areas.
The floor area of the building must be divided according to the importance of the functions, so the square meters are estimated and represented in percentage.

As the most important function, residential units will occupy the major part of the building.
Shops and restaurants will fill the retail floors, to provide services to residents indoors and nearby - this may reduce private transportation around the site.
Offices and meeting rooms are placed on the business floors to fulfil of the needs of the close global financial city centre.

Green areas are really important to accommodate outdoor activities for the residents even in the overcrowded city, and to contribute to a better urban air quality by filtering the air - with photosynthesis.

Given the existing parking areas around the site, the building itself will not have parking facilities, but it will provide access to the neighbouring parking areas.
With less parking possibility, public transportation might be preferred and promoted.

Total floor area is estimated from built-in ratio and height; parameters concerning green ratio and expression of the building are made from the site analysis.

Dimensions of the site:
Total area: 40 500 m^2
The site has an irregular shape, easily divided into 3 individual parts.
High traffic road separates one of the parts of the site.

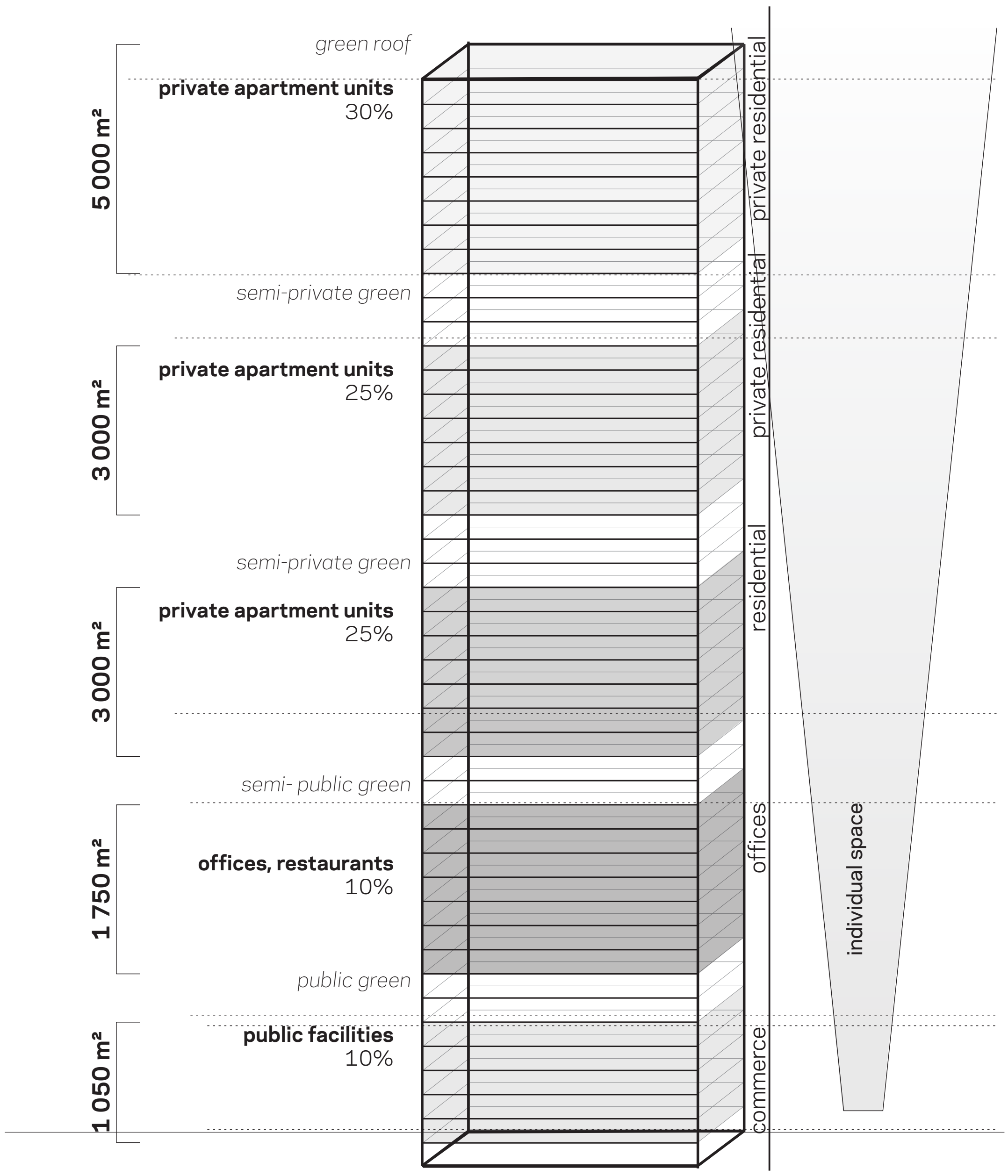
Plot ratio:
Floor area ratio: maximum
The surrounding tall buildings serve the highly dense center, hence maximized built-in ratio.

Green ratio:
Green area ratio: 100%
The original ratio of total and green areas of the site is approx. 80%. The proposal must improve this ratio and maximize the green areas.

Volume:
Maximum volume: 55 000 m^3
Giving the built-in ratio and the approximate height of the building volume will reach 200 m.
Aerodinamical considerations, and changes in building form and orientation.

Height:
Maximum height: 200 m
The average floor height of tall buildings is between 3.7-4.5 m. Floor height depends on structural system.

Outdoor spaces:
Maximum green areas: 40 000 m^2
Green roof and green terraces will supply more green areas to recover footprint impact.


green roof
5 000 m²
private apartment units
30%
semi-private green
3 000 m²
private apartment units
25%
semi-private green
3 000 m²
private apartment units
25%
semi- public green
1 750 m²
offices, restaurants
10%
public green
1 050 m²
public facilities
10%
private residential
private residential
residential
offices
commerce
individual space

Space distribution of program

Diagrams of the functions show the need of space for the different units, and indicate the relationship between functions.

The office spaces are arranged on the upper floors in two different organizations.
The office spaces are usually arranged by their organization. The main idea is to provide temporary office spaces for travelling businessmen; therefore the offices would be used just for one or few men projects. The organization of the space focuses on human relations and communication, and design of work environment has an extremely strong influence on work performance. Office spaces will provide private office - as closed working space - and open plan office room with 'cubicle' configuration.

Meeting rooms for presentation and short term stay can be placed in the middle of the building volume, since they do not have significant need of natural daylight.

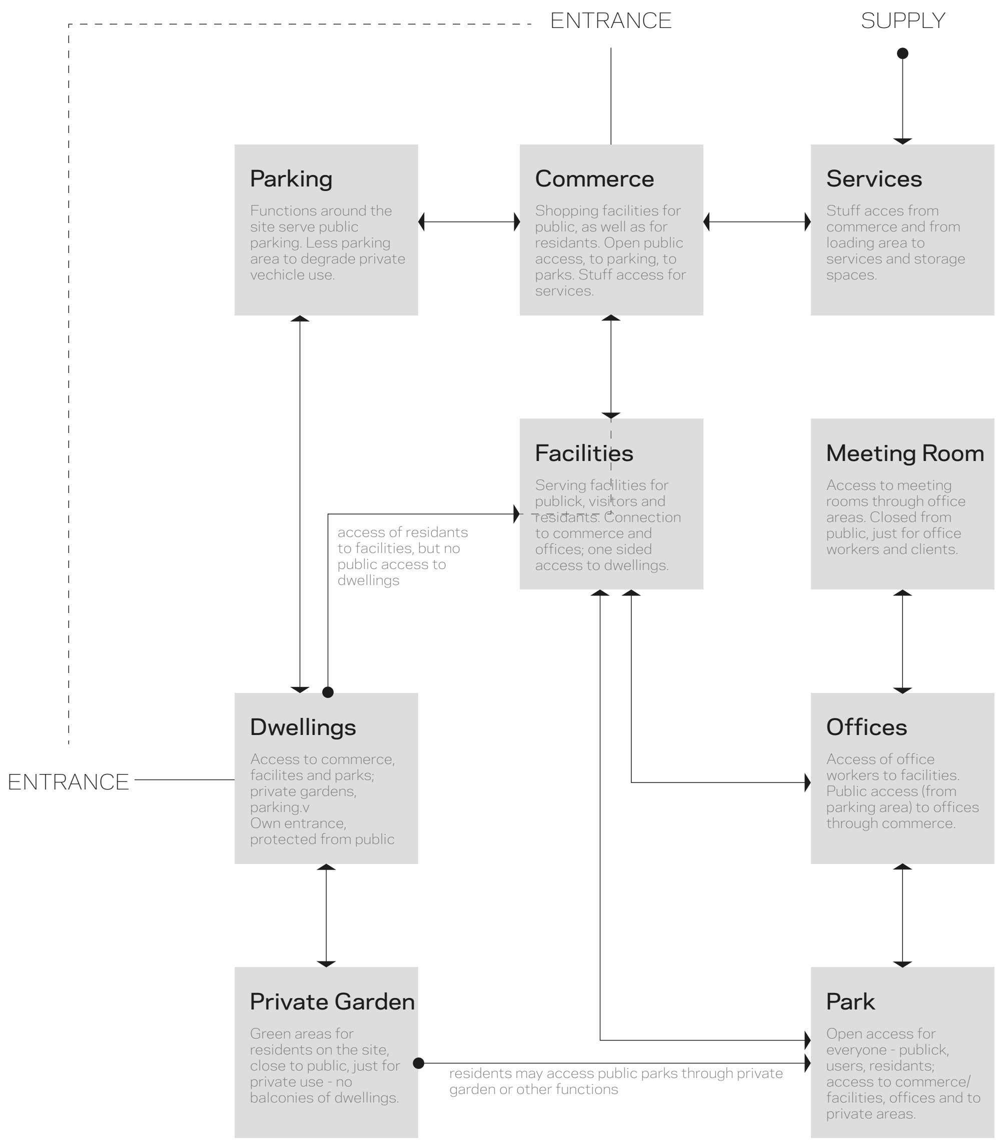
The dwelling units present 3 different sizes, for different occupants. Smallest apartments are suitable for young and old people as well; medium size apartments are suitable for couples; and the biggest size of apartments are optimal for family use.

Due to the high structure, for safety reasons, balconies are not attached to the housing units, instead open green floors and private gardens on the plot will serve the residents.

Offices - ROOMPROGRAM	Working area	Common area	Entrance, access	Wetrooms	Outdoor
Open office space					
floor area [m^2 / each]	200 - 500 m^2 *	50 - 70 m^2	30 - 40 m^2	20 - 40 m^2	public
Total (3-5)	600 - 1200 m^2	150 - 200 m^2	100 - 120 m^2	60 - 120 m^2	public
Private office space					
floor area [m^2 / each]	12 - 20 m^2	- m^2	10 - 12 m^2	10 - 12 m^2	public
Total (30-50)	500 - 800 m^2	- m^2	300 - 500 m^2	200 - 300 m^2	public
Meeting rooms					
floor area [m^2 / each]	50 - 80 m^2 **	- m^2	- m^2	15 - 20 m^2	public
Total (10-12)	500 - 1 000 m^2	- m^2	- m^2	150 - 200 m^2	public

* 7.2 m^2/person = 30 - 70 people
** 1m^2/person ≤ 60 people in theatre style
or 2.7 m^2/person in conference style

Dwellings - ROOMPROGRAM	Living area	Kitchen/dining area	Entrance, access	Room(s)	Bathroom	Outdoor
Unit 1						
Studio appartment [m^2 / each]	10 - 20 m^2	10 - 15 m^2	2 - 5m^2	6 - 16 m^2	6 - 10 m^2	private
Total (25%)						
Unit 2						
2room appartment [m^2 / each]	10 - 20 m^2	15 - 20 m^2	2 - 5 m^2	6 - 16 m^2	6 - 12 m^2	private
Total (25%)						
Unit 3						
Family apartment [m^2 / each]	20 - 25 m^2	20 - 25 m^2	2 - 5 m^2	6 - 16 m^2	10 - 12 m^2	private
Total (30%)						


ENTRANCE
SUPPLY
Parking
Functions around the site serve public parking. Less parking area to degrade private vechicle use.
Commerce
Shopping facilities for public, as well as for residants. Open public access, to parking, to parks. Stuff access for services.
Services
Stuff acces from commerce and from loading area to services and storage spaces.
Facilities
Serving facilities for publick, visitors and residants. Connection to commerce and offices; one sided access to dwellings.
Meeting Room
Access to meeting rooms through office areas. Closed from public, just for office workers and clients.
access of residants to facilities, but no public access to dwellings
ENTRANCE
Dwellings
Access to commerce, facilites and parks; private gardens, parking.v
Own entrance, protected from public
Offices
Access of office workers to facilities. Public access (from parking area) to offices through commerce.
Private Garden
Green areas for residents on the site, close to public, just for private use - no balconies of dwellings.
residents may access public parks through private garden or other functions
Park
Open access for everyone - publick, users, residants; access to commerce/ facilities, offices and to private areas.

The challenge in design to attract all types of occupants in the building by fulfilling different needs of different people.

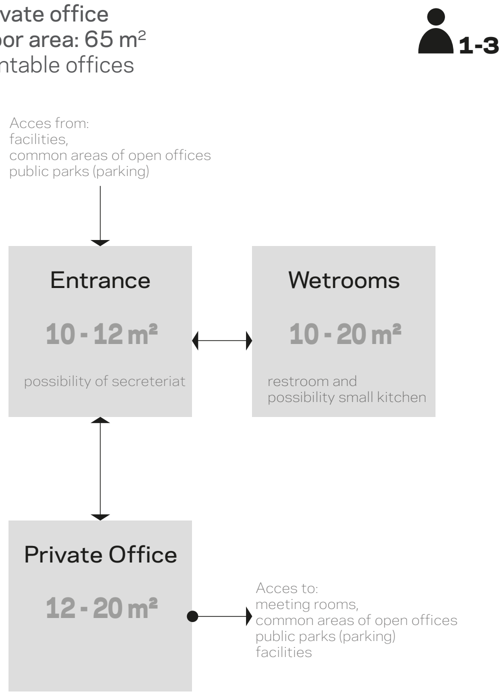
Diagrams show the building units and the connections between the different spaces within. The diagrams are also showing the approximate size and the estimated number of users of each unit.

Organization of spaces differs according to the function. There are 5 different units divided in 2 different types of functions.

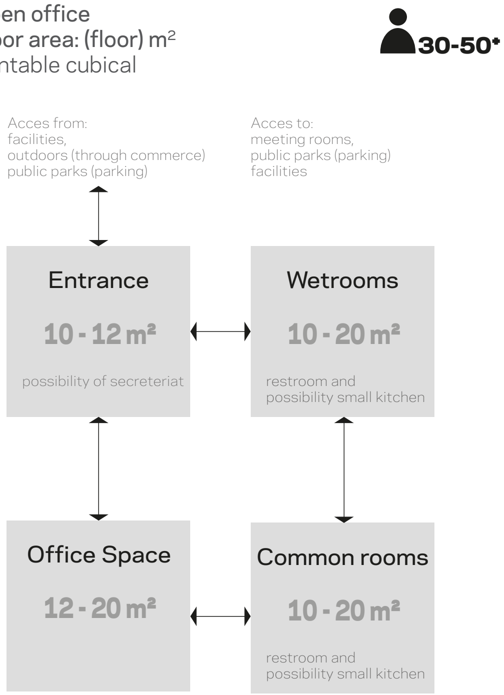
First two diagrams are showing the relations and the desirable connections of the functions inside the office unit.

The other three diagrams indicate the connections of functions inside of the 3 different sizes of dwelling units. The dwellings must be designed according to use and their need of space and light.
It is important to provide sufficient natural light in the living units, therefore geometry of dwellings, and ratio of floor - window areas must be investigated during sketching.

Private office
Floor area: 65 m²
Rentable offices



Open office
Floor area: (floor) m²
Rentable cubical



Unit A
Floor area: 40 m²
One-room/ studio partments

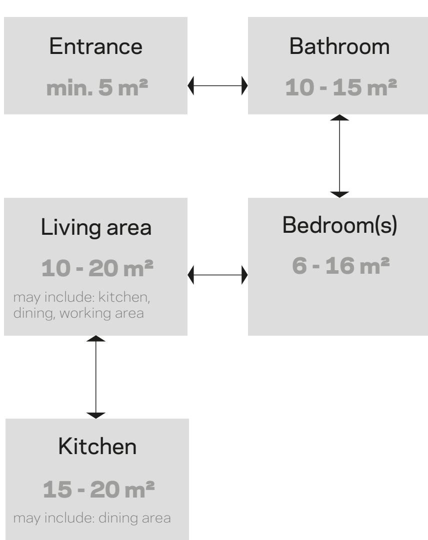
1(2)

Unit B
Floor area: 65 m²
Two-room apartments

2

Unit C
Floor area: 100 m²
Family apartments

3-5



Flow of the building

Vertical transportation systems are very important to the safety, productivity and experience of the building users.

The vertical transportation of the users in multi-storey buildings is principally solved by elevators. In tall buildings it is usual to place the elevators in the core of the building, their use and peak periods should kept in mind at the design process. The capacity and their need in the building volume is crucial issue in tall building design.

The transportation system of the building must be divided between the public and the private users, to protect the privacy of the residents.

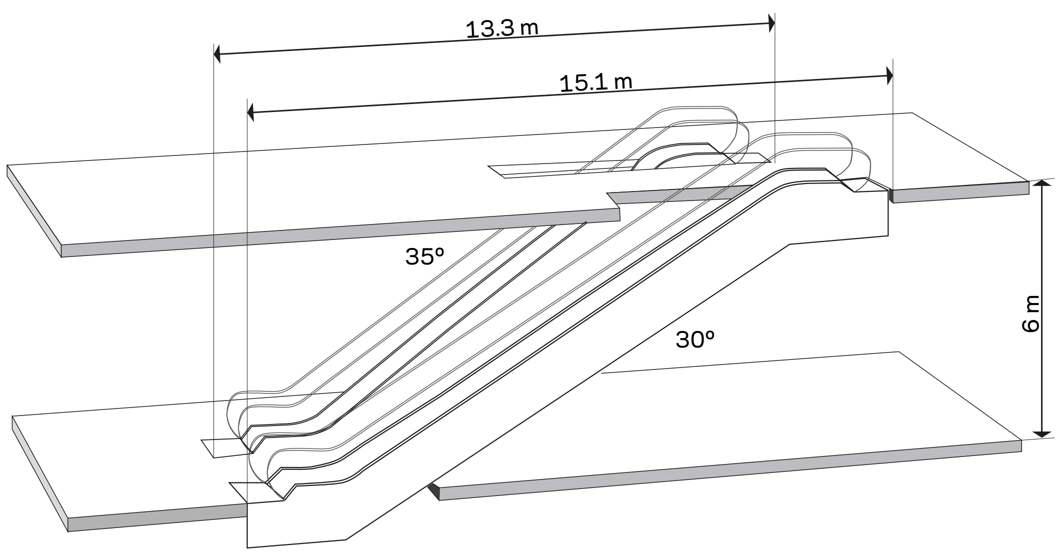
Sizes of elevators are depending on the number of elevators and the number of users.

Escalators will be also used between commercial floors for easier and more convenient access.

For more safety, fire regulations demand sufficient escape routes and fire safe stairs calculated according to the number of users.
Handicap access must be free along the building, both for users and residents.

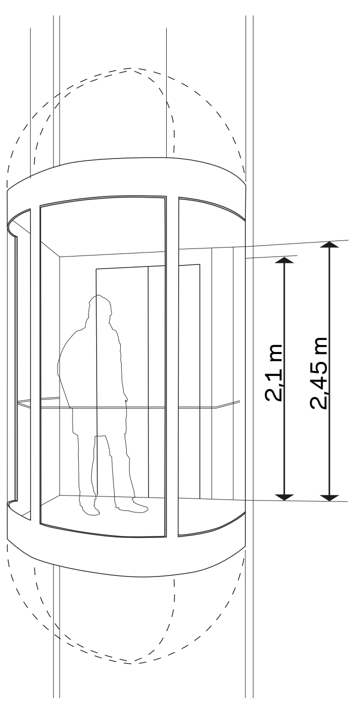
Escalators
Floor area: m2
inclination: 30º-35º (max safety)
step width: 800 mm
speed: 0.5 m/s
effective capacity: 2400-4800 pers./hr
parallel arrangement for two-ways

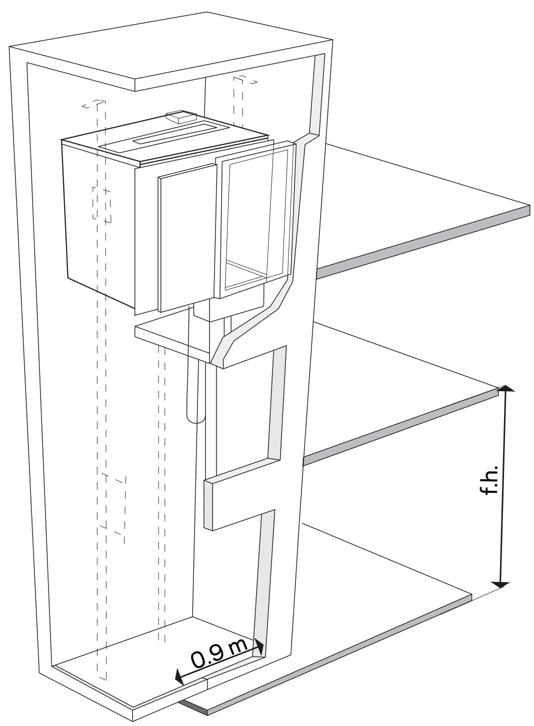
* Otis 510 PSE escalators
**Otis Flat-belt Elevator Technology - GEN2 system
flat belt enables more compact system eliminating the need for machine room, offering more flexibility in building design



Elevators
Floor area: 4 m²
For commerce and public use
(Handicap access)
observation elevator - glass
load capacity: 450-600 kg
volume: 20 m³

Elevators
Floor area: diverse
For residents in high-rise
(high speed)
max height: 150m
max speed: 2.5 m/s
load capacity: 600-1200 kg
8-16 pers.
1,6-2,4 m x 1,8-2,2 m





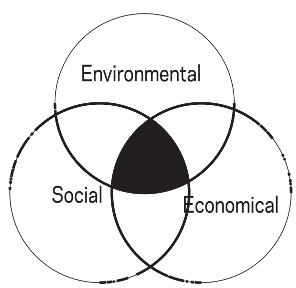
Sustainability

From a general understanding of sustainability and its categories the project is dealing with environmental, social and economical aspects of sustainability.

The project must preserve, protect and possibly improve the environment, while it is economically beneficial for the inhabitant. Social approach reflects the possibilities while the building is not creating boundaries to the users.
The concept must fulfil all three aspects in order to become sustainable.
The concept of sustainable architecture was previously divided into 6 categories: ecological, green, bioclimatic, self-sufficient, solar and environmental. There are separate approaches to each category but it is effective to mix the principles and achieve a combined approach.

The table below shows the different approaches on each category and the technical goals of the project. Dots are marking the focus on principles in each approach.
The project will not focus on the approaches of green and ecological approaches, since the given surrounding of the site the project will present a dense build-in percentage in the urban sprawl.

The approaches of the other categories, mainly the principles of self-sufficient and environmental categories will be drive the development of the design and they will be taken as design parameters.



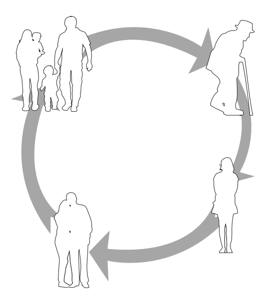
Category / **Principles**	preserve or improve biodiversity	life cycle assesment of material	reduce private transport	thermal mass of materials	insulation of building envelape	window area : orientation ratio	surface : floor area ratio	window : floor area ratio	utilization of daylight	zoning	mobility (of building)	natural ventilation	mechanical ventialtion	renewable energy sources	energy producing elements	energy efficient installation	embodied energy of material
ecological		●	●	●	•	•		•		•				●	●	•	•
green	●	●	•								•			●	●	●	•
self-sufficient				●			●		●	●	●	●			●		
bioclimatic	●	●	●			●	●		●	•		●		●	●		●
solar		•		●	●	●	●	●	•	●		•	•	•	●	●	●
environmental			•	●	●	•		●	●		●	●				●	●

Social aspects

The main idea is to provide high dense housing while keeping the advantages of the suburban living.
To fulfil the needs of the residents, different user groups must be analyzed. All groups have their requirements of spaces, and different wishes to serve their interests.

Most of the people moving in the city centre are young singles or couples in a hope to start their life and find a job.
On the other hand, the aging society must accommodate elderly people who are staying in the centre for different reasons.

The primary purpose is to secure the diverse needs of this wide range of users. Different apartment types and sizes are assuring the opportunity to move around during life span. Residents should be able to move within the complex according to their changing needs.



Users \ **Interests**	privacy	public	social	culture	parking	transportation	services	nature	private garden	public park	flexibility	diversity	activity	tranquillity	access	small dwelling	medium apartment	big apartment
young singles		●	●	•		●	●				●	•	●		•	●	●	
young couples	•	●	●	●	•	●	●		●	•	●	●			•		●	●
families	●	•		●	●	•	●	●	●	●		●	●	●	●		●	●
elderlies	●	•		●		●		●	●	●				●	●	●	●	

Aalborg Universitet | ad:mt - Department of Architecture, Design and Media Technology
Timea Török - 20081144 - ttorok08@student.aau.dk

Sustainable tools

1. Shape
The shape of the building will be optimized in proportion to reduce surface area and heat loss; and to give a compact construction.

2. Volume
The volume of the building will be determined by the footprint and height to create a compact structure with optimal surface.

3. Surface and floor area ratio
Floor area can be optimized to the surface by changing level heights.

4. Orientation
The strategy for solar gain suggests to face the mayor wall and window area towards to the south, but slightly east to expose the building for more morning sun.
[Heiselberg, 2008]
Proper orientation protects against hot summer afternoon sun, and lets the warming winter sun in. The orientation of the whole building plays an important rule ensuring the optimal solar gain during the year. In the ideal orientation the long axis of the building runs east-west direction, maximum 20 degrees of turn wont affect its results.

5. Direct solar radiation
In fact winter sun has much lower altitude angle than during the summer period. Vertical glass windows towards to south collect beneficial radiation and they are easily shaded against the high summer sun. Solar gain blocking caused of location and surroundings must be avoided.

6. Diffuse solar radiation
Flat and inclined surfaces are suitable to collect diffuse radiation when the vertical windows recieve only 50% of the diffuse radiation.

7. Shading
In a location where sunlight is present in 30-50% of the day even in winter time, shading has a huge impact in control of the solar radiation. While solar energy gain significant for the building, too much heat or bright light might be disturbing for the residents.
Mobile shades are optimal to adjust to the needs.

8. Overhangs and balconies
Overhanging elements or balconies can act as shades during the summer, when sun altitude is higher and still let more of the low winter sun in. The depth of the overhanging elements is effecting the energy consumption a lot therefore it must be chosen carefully.
As fixed shading possibility it is considered as low cost and low maintenance solution, but it is only effective enough on the south facing elevation. Bright colour flooring materials on balconies are beneficial to reflect sun and heat into the house.

9. Angled facade
Facade made in a certain slope emphasizing solar gain, especially from diffuse radiation. In a need of more daylight, the elevation can be angled to north, so the south facade facing the sun path more.

10. Atrium
By implementing atrium in the building design it could create an interesting building form; optimal for using natural ventilation, solar heating or cooling, and daylight utilization to improve energy consumption.

11. Green roofs
Besides providing outdoor garden and relaxing green environment, green roofs are contributing to microclimate. In a dense city, additional green space, more vegetation is always useful but all together eco-roofs are more than just plants. They have numerous advantages for energy efficiency, water management, filtration of pollution and isolation. Plants naturally convert sunlight to chlorophyll and water into cooling mist, balance the 'heat island effect' caused by of concrete and asphalt surfaces in urban areas.

12. Natural ventilation
The most efficient design for natural ventilation is to implement wind driven ventilation and stack ventilation to the building as well. For achieving the best results different specific areas must be included, such as location, building form, window typologies and orientation, other openings and external elements. Urban conditions are significant, and in a location of a dense city where urban air quality is very poor, sometimes unhealthy, mechanical ventilation and air filters must be considered.

13. Building form
With proper building form natural ventilation could be improved; wind flow around the building can be the solution to create a well-ventilated indoor climate. Building form and mass optimization (solar, thermal and aerodynamics) is a powerful tool in order to achieve energy efficiency. Carefully placed screens and walls also protect the residents against unpleasant wind.

14. Solar panels and cells
Solar panels will be used to collect solar radiation and transform it to energy, use for heating and hot water.

15. Rainwater collection
Rainwater from roof and facade could be collected and used covering a lot of water needs (washing, watering, cleaning...) spatially in the more rainy seasons.

16. Wind energy
Wind is one of the most powerful alternative energy sources. There is many improvement and invention in wind energy, therefore the energy generator equipments could be applied in the building design in numerous ways.

17. Thermal mass
With absorbing materials and thick walls, heat stored during the day would warm the building during night, and during day it would have the opposite effect. This could save energy spent on heating or cooling.

18. Sunspace
Sunspace can collect heat from solar radiation to submit it to the main living area of the building. However a sunroom could be an enjoyable place, it could be overheated in come cases, therefore it serves as secondary areas. A well-designed sunspace can provide 60% of the heating.

19. Heat storage
Heat (or energy) produced from passive sources must be stored to use it off-peak.

Design criteria

The design of a sustainable high-rise building will be the means of incorporating these sustainable tools strategies. The chosen site will accommodate people in 90% residential and 10% commercial spaces with 400-500% of density. Different apartment units and connected outdoor spaces will be developed and detailed.

Basic regulations for residential planning

1. Greening ratio

The ratio of centralized green area in the site should be more than 10%, ratio of the total green areas in the region of the existing township should be no less than 25%; 1/3 part of it should be out of shadow. The width of linear green space should be minimum 8m.

2. Distance between buildings

According to fire protection regulations distance of low-rise building to low-rise building must be at least 6m; low-rise building to multi-storey building at least 6m; multi-storey building to multi-storey building at least 6m; and high-rise building to any other building minimum 13m. The distance between two residential buildings has to be more than once of the height of the building on southern side in downtown area. In other areas, the distance has to be more than 1.2 times bigger.
Moreover, the distance must be calculated against shadows and at least one room per unit on the first floor can get at least one hour continuous full window sunshine at the day of midwinter.

3. Access roadway and parking space

The width of the pathway to a housing building must be at least 3m in one way direction, or 5m for two ways. The parking ratio is usually 35%, or ground parking max. 10%.

[abstract from China Building Code, Chapter 1., General; http://chinahousing.mit.edu/english/resources/BuildingCode.html]

Toolbox of design principles

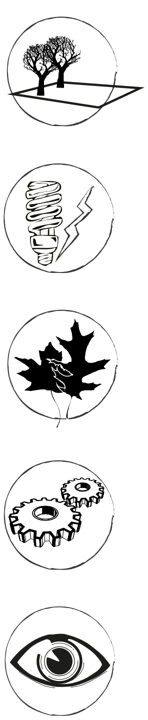
To summarize the demands and the assumptions, main parameters will be diverted as main focus during further development of the design.

The main areas of interest must be in focus of the design process. These areas are estimated to have a great part in fulfilling the vision of the building.

During research and brief, the following areas must be in focus in order to achieve the desired results:

1. Site
2. Energy efficiency
3. Building construction
4. Functionality
5. Aesthetics

Site: 40 500 m2
Building density: max
Building height: 35-55 storeys
Functions: mixed use



SITE

protect residents
avoide noise pollution (in/out)
avoide cast shadow
maximize green areas

ENERGY EFFICIENCY

utilization of daylight
improve biodiversity
contribute to better urban air quality
surface to floor area ratio - compactness

VEGETATION

summer shading and winter protection
noise reduction
evaporation
air purification - photosynthesis

FUNCTIONALITY

mixed use of building complex
high quality living conditions
attract different user groups - social aspects
good working conditions in offices

AESTHETICS

high architectural quality
green architecture
expression of the building
human experience in urban fabric

Technical goals

Technical issues must be addressed to meet with general requirements and with building specific goals.

1. For the overall building and its energy use, the building envelope must be optimized through orientation, material use and building form, and evaluated according to the potential of renewable energy use to achieve a zero energy-building concept.

2. The possibility to integrate information technology must be evaluated to produce more intelligent building components.

3. A strategy must be proposed to improve the way of high-rise building in the dense overcrowded cities and to contribute to a better urban air quality.

Vision

The idea is not to create another iconic structure to dominate the skyline, but to make a sample in the urban fabric, to stress human scale in the details and feature natural elements in urban scale.

The aim of the project is to create a tall building, which relates to the context while embraces positive elements of the urban living.

The building design focuses on the performance of the building in term of energy use and optimized construction, using the integrated design process.

It is also a goal to generate the building elements as a reflection on performance and perception of architectural experience. A responsible design process regards aesthetics together with technicality to explore a form of functionality.
This can be consolidated in the vision for this project that is clarified on the basis of the introduction and research, the site investigations and the program.

Part V

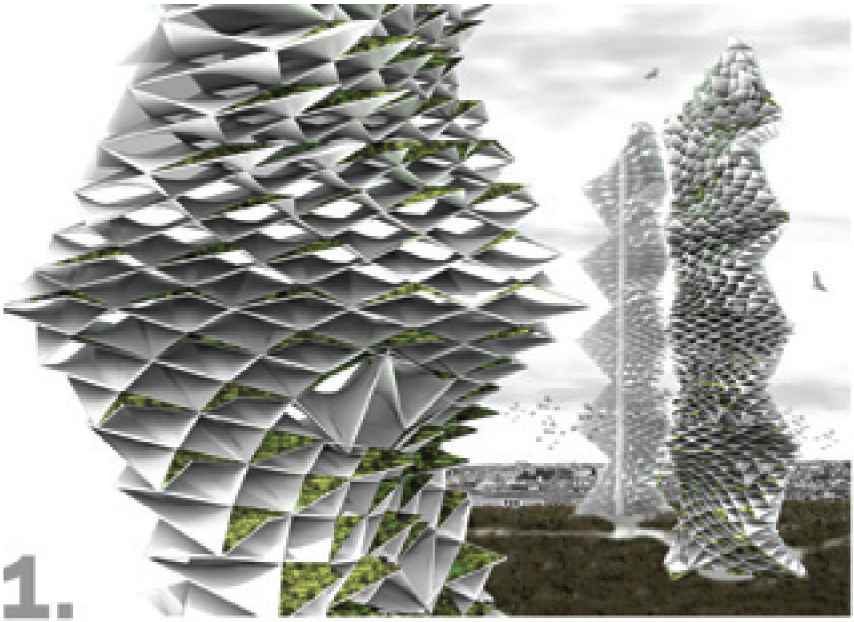
Design Process **Sketching**

EXPLORING OF CHARACTERISTICS OF HIGH-RISE BUILINGS AND ENVIRONMENTAL SOLUTIONS

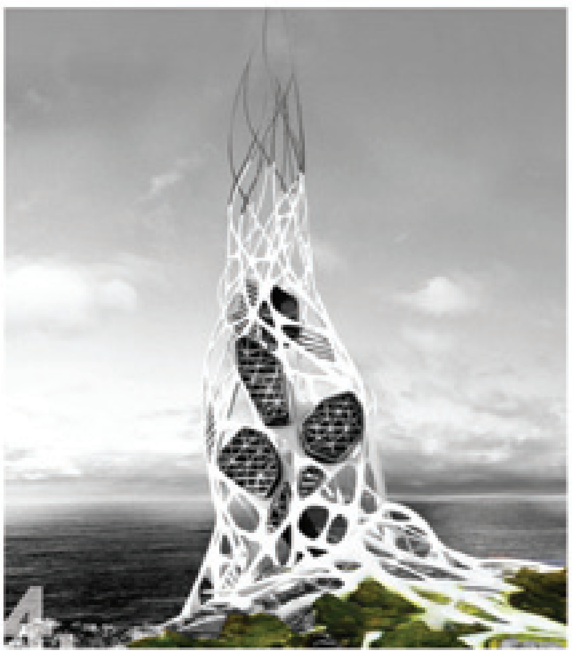
High-rise strategies and structure of tall buildings

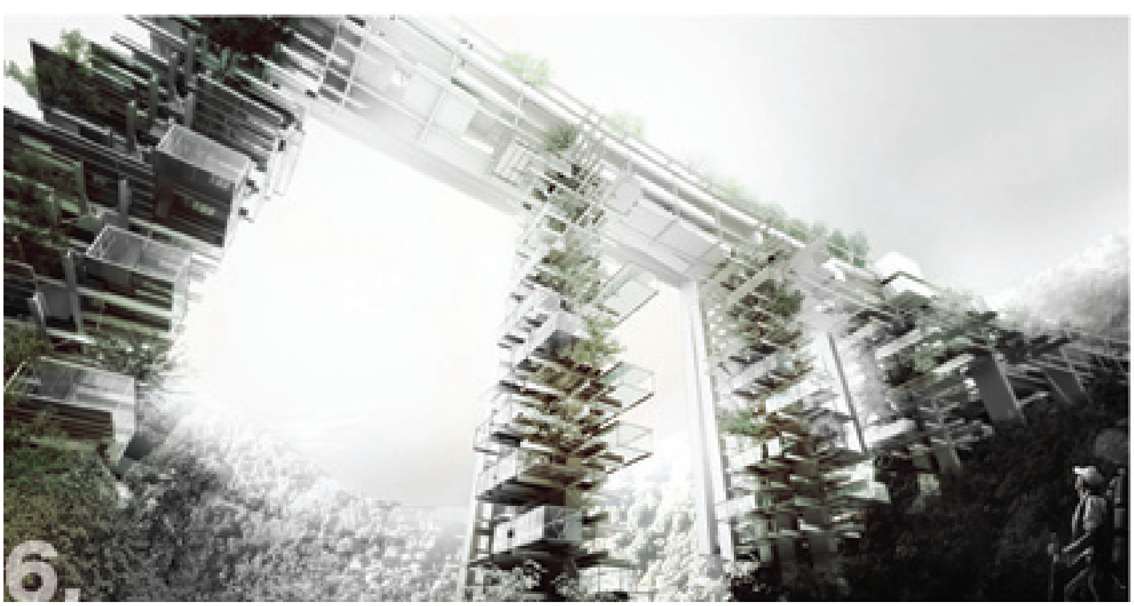
Daylight conditions and wind load investigations for orientation and form of the building volume

Sketching, modelling and testing in order to carry out the design


1.

2.

3.

4.

5.

6.

7.

Acknowledgement

The sketching phase starts with a closer look on the high rise building strategies to find inspiration; initial investigations are made on structures, systems and wind loads.

This phase is placing the volume on the site, testing different heights and their cast shadow in the context, function and orientation, volume and placement.

As a sub-conclusion of initial investigations, main concept and design parameters will be diverged, which will be followed through the development of the design. Main intentions will be explained with examples of architectural references. Initial sketches made to define images of concept and follow vision.

Design is formed through different tests form the overall building to closer details. Building volume shapes through architectural expression and functionality.
To find the necessary dimensions, floor plan layout will be developed in parallel with tests of living units. After placing the living units within the building form, apartment layouts will be detailed according to indoor comfort and daylight needs.

Placing the building on the site, master plan develops in parallel to building concept. Functions on the site will result in landscaping to connect past and future in the present.

Finding the solutions for each point, development will take an overall look on the results, adding extra elements to fulfil vision and design parameters. Facade will be detailed in order to improve design, and to reach the final form.

More details and additional material for this phase is found in the Appendix.

on the left:
Collection of conceptual projects as inspiration
1. FOLDSC(R)APE by GOMMAdesign's
2. LO2P: Delhi Recycling Center by Atelier CMJN
3. Ecocity Skyscraper, Unknown
4. Hydra Skyscraper, Milos Vlastic
5. Vertical Safari Zoo by Influx Studio
6. Contemporary Habitable Bridge
7. Urban Nebulizer by Han Jaekyu

High-rise structures

Special systems have been developed for constructing very tall buildings. The most effective systems are the tube frame and the concrete core system.

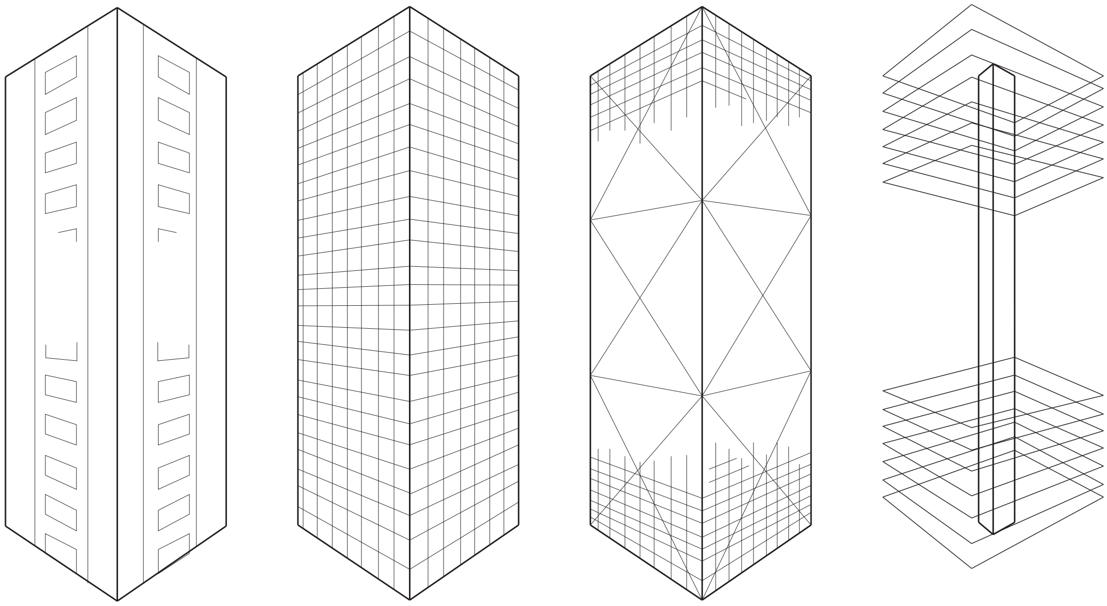
Skyscrapers were developed at the 19-20th century to minimize footprint of buildings in urban environments. Earlier bearing-wall buildings had walls up to 2 m thick at their base to support as much as 16 stories of load. These walls occupied valuable space that could be used by residents.

The tube system at high-rise buildings means that the perimeter framework of the building is composed of closely spaced columns and very rigid beams connected to form almost a solid tube with small penetrations. Variations of the tube system include shear wall system (a), framed system (b) or large-scale external X-bracing.

The concrete core (d) serves as the major load-taking element in the structure, and it provides rigidity to resist deflection caused by loads. Internal core is suitable for placing building services or vertical transportation elements.

Combinations of these systems work for specific requirements. Hybrid systems might be the most efficient in some cases.

Buildings are designed to resist loads due to their own weight (dead loads), to environmental phenomena (rain, snow, ice, wind load...), and from the occupants' usage.



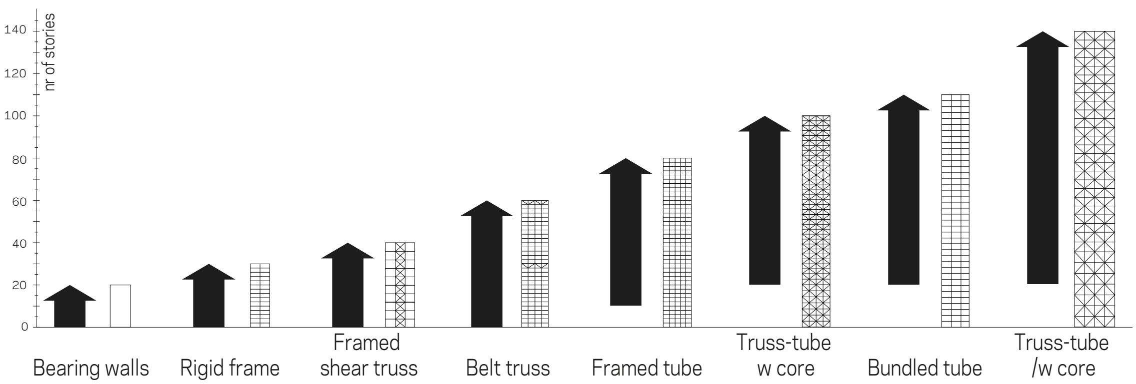
(a) Shear wall system
Load bearing structure of high strength conrete panels at the perifey.

(b) Framed system
Steel beams placed closely to each other create an outer tube structure.

(c) Braced frame
Steel truss is reinforced whit huge X-bracing to reach higher stuctural strength.

(d) Concrete core
One or more insider core

High-rise strategies



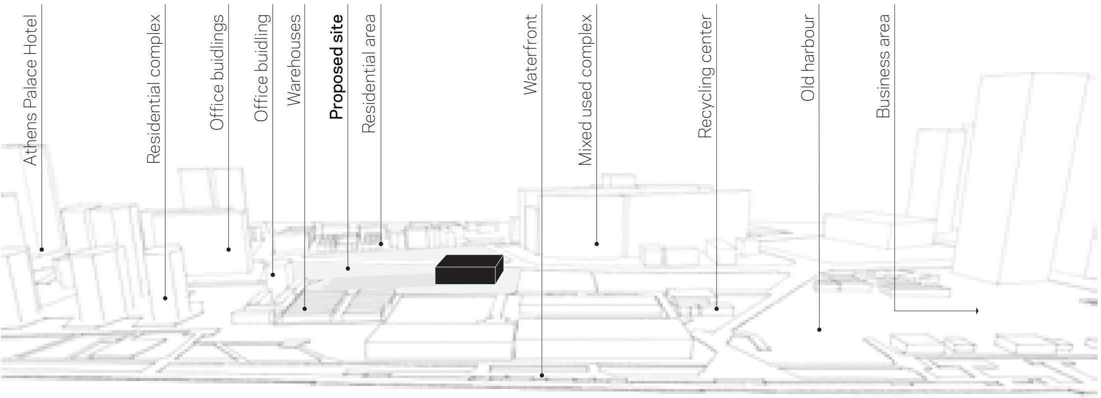
Relation between tuctural system and height:

Evaulation of placement of core in the building structure:

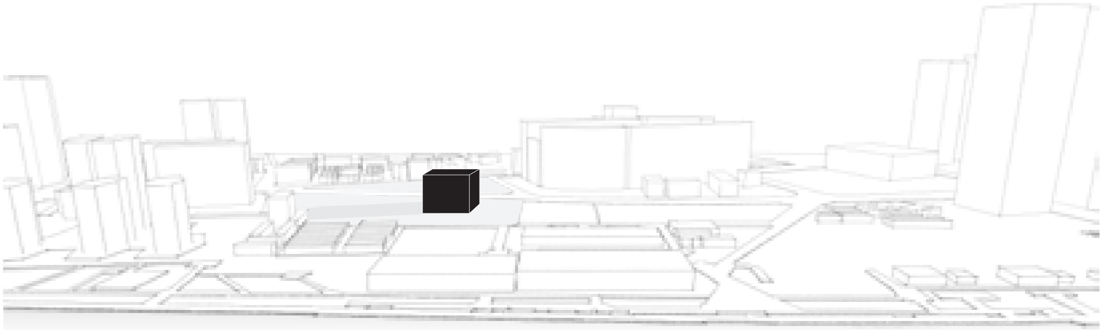
	thermal mass	daylight	view	structure	flexibility	environment
single	concrete core is suitable to keep warm or to cool down the building when neccessary.	nrej vefq no;n vneqoinv;f vneifjq ;n neoqf n; n foie nfon fieqn o.	nrej vefq no;n vneqoinv;f vneifjq ;n neoqf n; n foie nfon fieqn o.	nrej vefq no;n vneqoinv;f vneifjq ;n neoqf n; n foie nfon fieqn o.	nrej vefq no;n vneqoinv;f vneifjq ;n neoqf n; n foie nfon fieqn o.	nrej vefq no;n vneqoinv;f vneifjq ;n neoqf n; n foie nfon fieqn o.
double	big concrete core is suitable to keep warm or to cool down the building when neccessary.	nrej vefq no;n vneqoinv;f vneifjq ;n neoqf n; n foie nfon fieqn o.	nrej vefq no;n vneqoinv;f vneifjq ;n neoqf n; n foie nfon fieqn o.	nrej vefq no;n vneqoinv;f vneifjq ;n neoqf n; n foie nfon fieqn o.	nrej vefq no;n vneqoinv;f vneifjq ;n neoqf n; n foie nfon fieqn o.	nrej vefq no;n vneqoinv;f vneifjq ;n neoqf n; n foie nfon fieqn o.
core	big concrete core is suitable to keep warm or to cool down the building when neccessary.	nrej vefq no;n vneqoinv;f vneifjq ;n neoqf n; n foie nfon fieqn o.	nrej vefq no;n vneqoinv;f vneifjq ;n neoqf n; n foie nfon fieqn o.	nrej vefq no;n vneqoinv;f vneifjq ;n neoqf n; n foie nfon fieqn o.	nrej vefq no;n vneqoinv;f vneifjq ;n neoqf n; n foie nfon fieqn o.	nrej vefq no;n vneqoinv;f vneifjq ;n neoqf n; n foie nfon fieqn o.

High-rise on Site

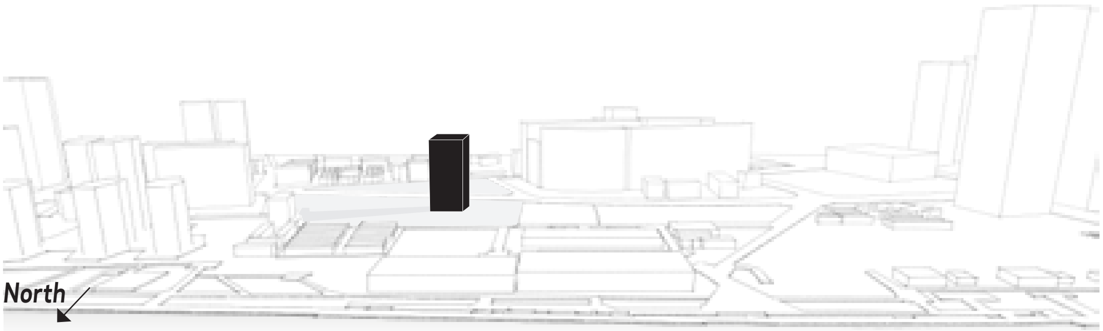
The height of the building complex is considerably depending on the height of the context and the urban scale.



(a) 10-storey high building; site: 40 500 m², building 300%.



(b) 20-storey high building; site: 40 500 m², building 300%.

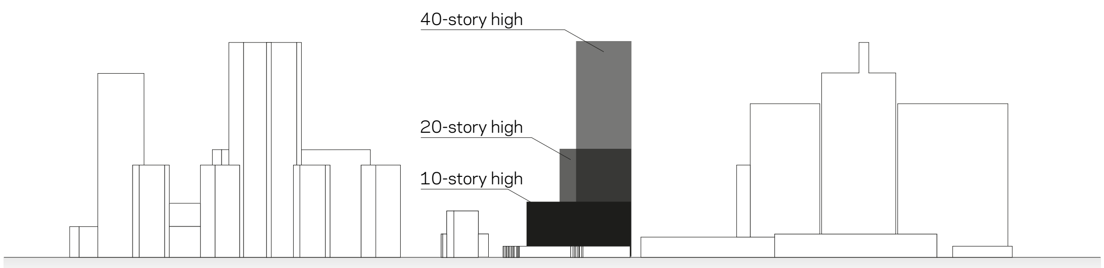


(c) 40-storey high building; site: 40 500 m², building 300%.

Wind load on tall buildings

The building volume can be arranged in the site in numerous different ways. The maximum building volume is supposed to give sufficient living space for as many people, families as it is possible on a given site. With higher building complex smaller footprint is enough to achieve the desirable volume.

Although, there is no significant shadow on the site from the context, higher building would be more convenient in order to minimize the footprint (impact) of the building and to achieve a more visible construction; to stand out from the context and to provide better view for the residents.

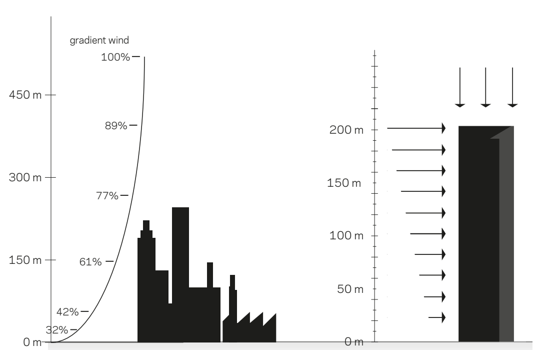


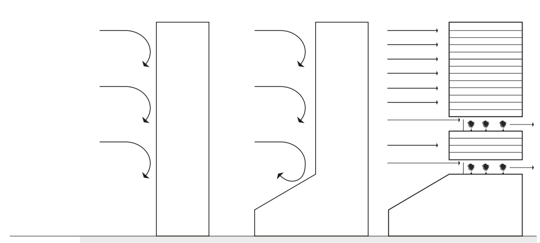
(d) Ten, twenty and fourty storey building in the context.

Wind load is one of the dominant loads in the analysis of the tall buildings; therefore consideration of wind conditions is essential during the design process. High-rise structures respond dynamically to the effects of the wind. Structure must be strong enough to bear the loads, but not too rigid to break under the pressure of the wind.

Wind conditions are dependant on specific location; climate properties and context.

In terrain with numerous, tall and closely placed building, such as city centers, roughness length, friction velocity and gradient height is much higher than it is over a plain terrain.





Cast shadow on site

Higher building volume pleases the resident by providing better view, but height and placement should not affect the surroundings; cast shadow must be considered during the design process.

To provide as many living places in the overcrowded city as it is possible, the building concept reaching for bigger height.
From site analysis is it visible that the plot is free from shadows of context, therefore it will not effect the placing of the volume.

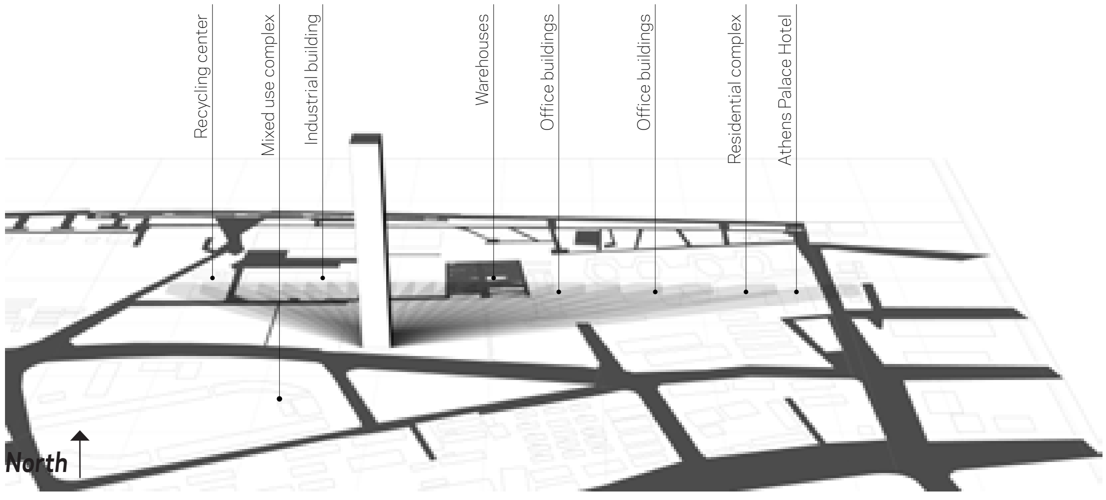
The building volume has a great effect on the microenvironment in terms of cast shadow, therefore it is considered during the process in order to determine placement, height and form.

Undesirable cast shadow is hard to avoid with high-rise building, but as a factor is must be minimized as much as it is possible. The density of the building is raised by the height, need of daylight is fulfilled by the orientation and the placing of the volume.

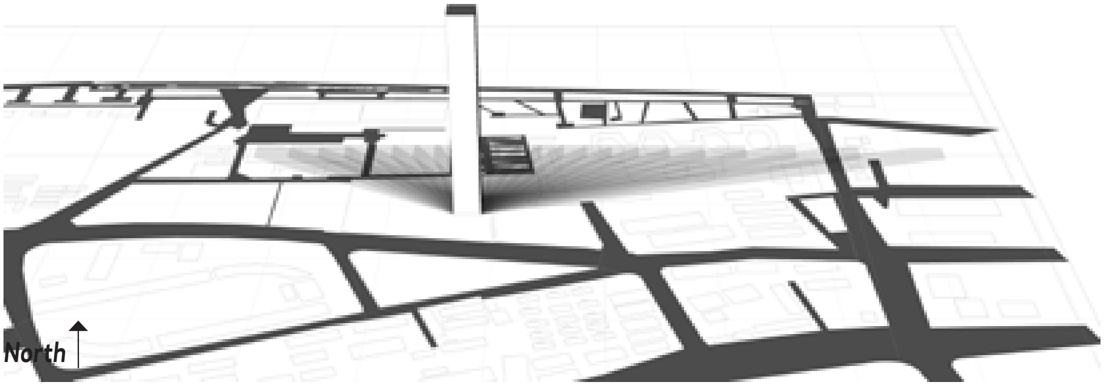
Seasonal shadow range for different height of volume are also tested, results are attached in the Appendix.
As it is visible on results, the plot is big enough to avoid cast shadow even of the high-rise structure.

In the initial investigation in relation to cast shadow on context, forty storey high regular shaped volume placed on the bigger part of the site.
To avoid shadows on neighbouring buildings, especially the residential buildings around the site, building is placed on East side on the site is the most favourable.

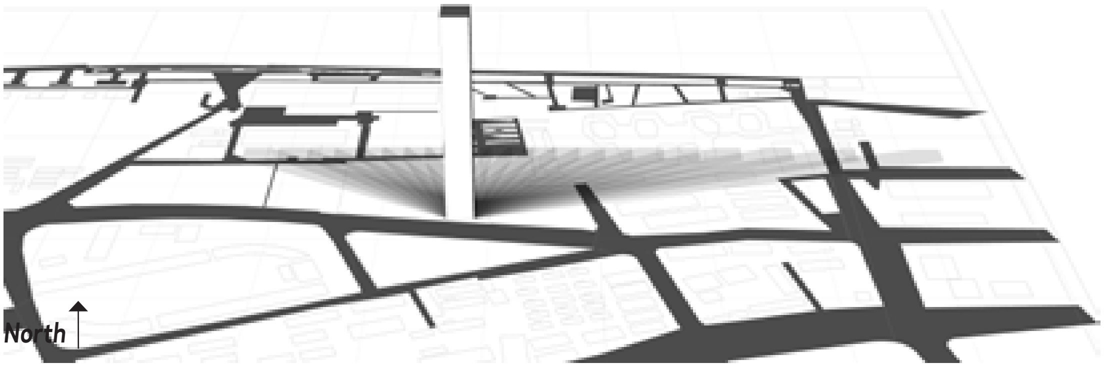
Besides cast shadow, connection and flow of the different part of the site will be also considered in order to decide on final plot.



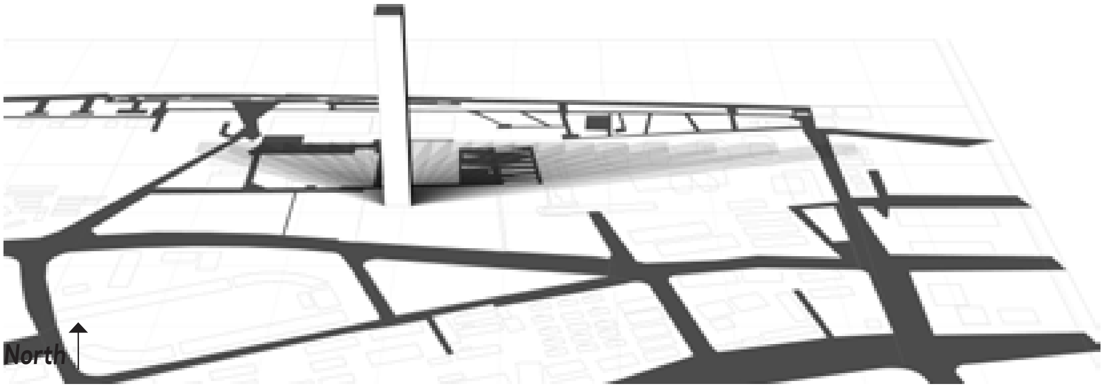
Daily shadow range of forty storey high building placed in South-East corner on 21st September



Daily shadow range of fourty storey high building placed in the middle on 21st September



Daily shadow range of forty storey high building placed South side on 21st September



Daily shadow range of forty storey high building placed on North side on 21st September

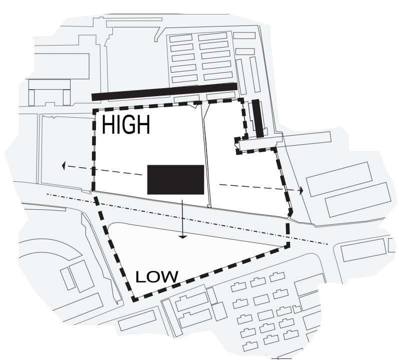
Volume and placement

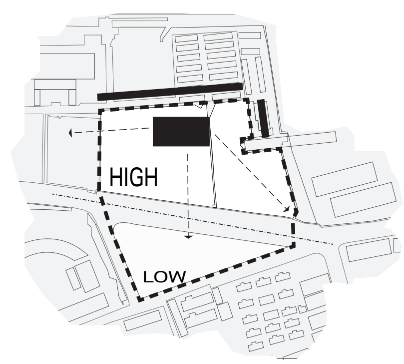
The building site is relatively large; therefore there are many options - and freedom - in placing the volume.
Placement of the volume has a huge effect on impact on the environment - both direct impact and indirect impact due to energy consumption.
Direct impact includes placement of the volume.

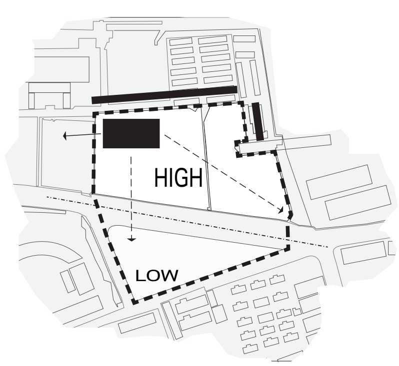
The existing neighbourhood also acts on the placement and height of the building volume. The height of the building should relate to the height of the context. The building height is also considered in relation to the view from the building towards to the financial centre, to the river, and over the low rise district.

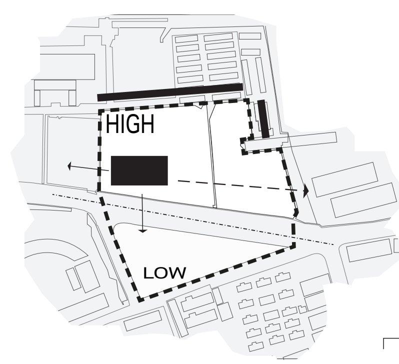
Conclusion on cast shadow analysis helps to decide on placement and sketching on site helps to determine the overall form and height of the volume. Sketching takes different parameters into account, such as context, view, urban and human scale, connections... etc.
Cast shadow also considered during placing the outdoor functions on the site.

The aim is to improve the green areas on and around the site with landscaping. The building volume can be placed differently to achieve different impact on the connection on the site, to the context and the green areas.









Daylight and shading

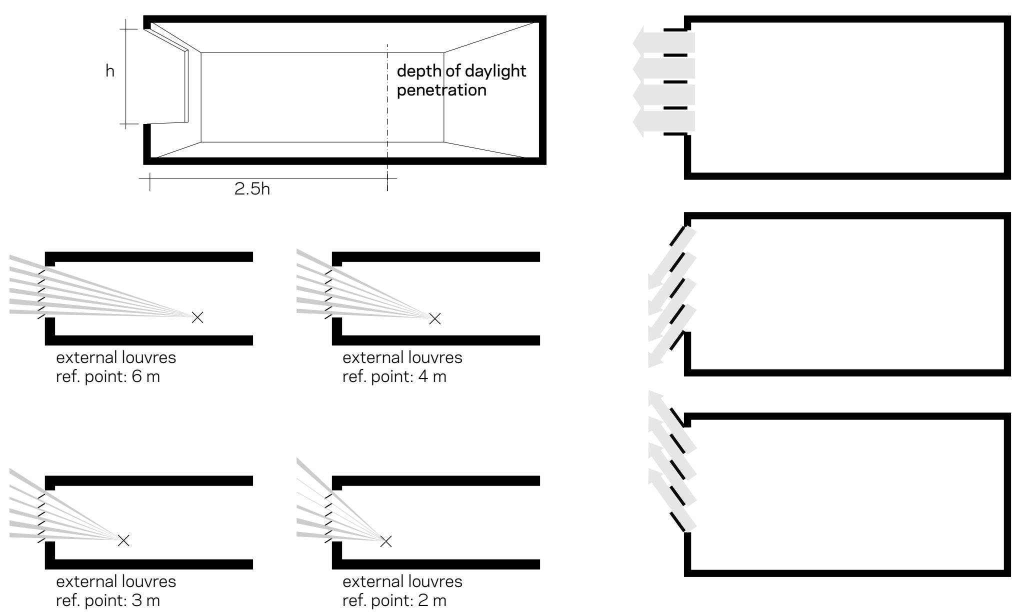
Integrated design process enables to focus on building performance from the very beginning of the design process; natural lighting and shading is very important to consider in the very early phase of the process and it must be kept in mind all along.

Correct geometry, orientation and shading improve energy consumption significantly. Investigating sun position and lighting conditions is important both on all building envelope and living units separately.

The main focus concerning daylight strategy is to improve energy consumption of the building;
to expose volume to achieve efficient daylight levels indoors, but minimize solar gain in the summer period to avoid overheating, and maximize solar gain in the winter period to reduce heating demand.

Daylight has a great impact on the indoor climate in many different aspects. Visual and thermal comfort, energy consumption due heating and artificial lighting are all depending on correct design.

External shades considered as the most efficient solution in order to avoid overheating with high sun position but allow solar gain with lower sun position. Overhangs and additional shading devices are investigated to find solution.



Study of external louvres and their impact on sun penetration

Architectural expression

"There is a duality between engineering and nature which is based on minimum use of energy" *[Adrian Beukers, 2011]*

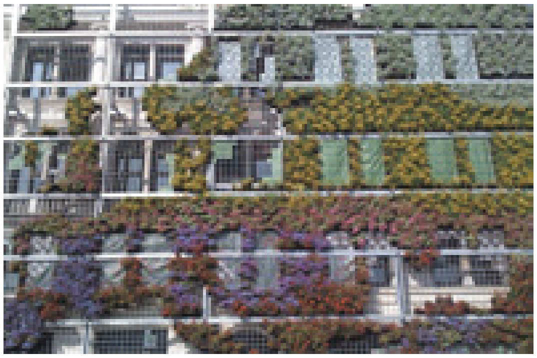
ADAPT

Sunflowers exhibit heliotropism; they follow the Sun's daily position, as responding to the daily path of the Sun. Heliotropism most likely helps to increase the development of pollen.

Baja Sun Energy plans solar panel factory and power plants to both manufacture solar panels and build a solar electric plant to harvest energy in the desert along the U.S.-Mexico border.

IMPLEMENT

Ivy is naturally growing on stone fance and walls taking over the artificially built artefacts.

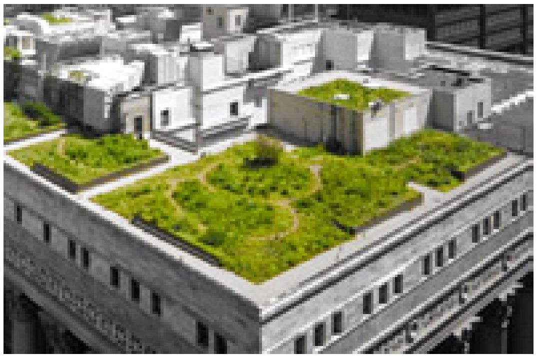


The European Environmental Agency's green wall, "Europe in Bloom", near Nyhavn, Copenhagen.

Expression of the building follows natural inspirations. Nature always find solution to most environmental problems, it evolves, it adapts to survive.
These natural inspiratons have been used in architecture before, some of the references are shown in photos, but with re-thinking them, during the process may imrpove the overal buidling concept.

An other perspective or an other way of use could create simple and effective solutions in design as well.

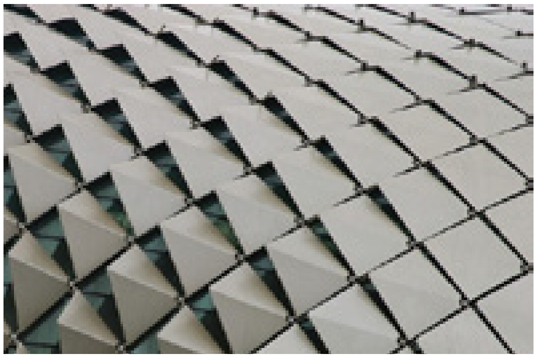
SYMBIOSE



Fungus grows on the trunk of the tree, living in perfect symbiosis. The fungus takes carbon from the plant and returns nutrients in the form of nitrogen and phosphorus.

Vegetation and plants grow on balconies and roof, insulating building, improving microclimate and biodiversity.

RESPONSE



Old timber roof cladding on masonry. Timber cladding is an attractive and sustainable option for external walls. This traditional and natural form used as an inspiration to form intelligent building skin on the facade.

Detail of aluminium sunscreens on the façade of the Esplanade, Theatres on the Bay, Singapore. The shields are set to be more open or closed depending on the angle of the solar rays.

Architectural references - Green extension

> " We must start to think about an architecture that makes environmental sense, ... Buildings designed for decades must give way to buildings designed for centuries."
> *[David Brussat, 2008]*

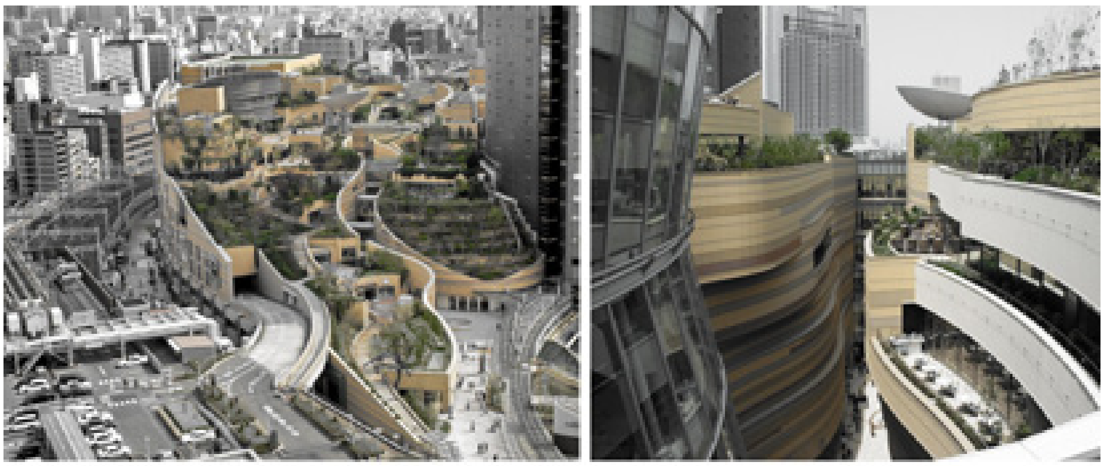
As the overall building, additional elements are also investigated for their potential of using in the design. The main focus of the investigations is on the urban landscaping and green roofs.
Initial vision tries already to extend general green roofs, and create a wide variety of landscaping on a maximised area within the site.

References of extended vegetation in an urban context shows multiple possibilities how green area can be used and design to bring out the most of it.

Namba Parks is an office and shopping centre located in Osaka, Japan. The huge park creates a new natural experience in the urban context to celebrate the interaction of people, culture and recreation. The eight floors of terraced gardens connect to the street welcoming users to enjoy natural elements and outdoors spaces.
High Line Park is an attempt to rehabilitate a historic freight rail line elevated above the streets on Manhattan. The more than 2 km long path way provides spectacular experience 9 m above ground level. It was originally built to serve and supply the industrial district, but with the new concept nature has regained a vital piece of urban infrastructure.

Almere Train Station landscaping design combines organic natural element into the new business district. The park is situated above the underground car parking as the hugest rooftop in the Netherlands. The square mediates the area towards to the train station introducing a green oasis in a highly urban environment, a landscape with water features, grasses, and perennials and flowering shrubs.

All these examples have valuable points in design. Many idea of how nature can be implemented in an urban design acts on the process, inspiring elements, forming the concept and following inspirational principles.



Namba Parks, Osaka, Japan

High Line Park, Manhattan, NY, USA

Almere Train Station, The Neitherlands

Architectural references - Overall building

"Draw the right picture and you can literally transform the way we see the world." *[By BBC STAFF - BBC]*

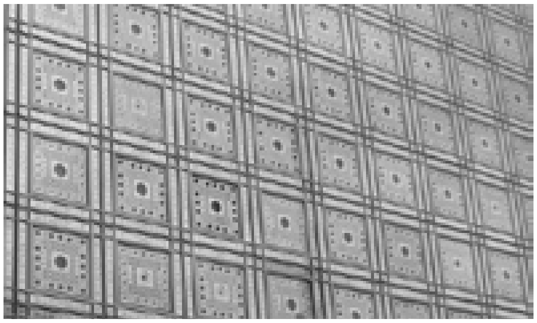
Study cases are investigated in Appendix, to gain general overview of the buildings. Marina center was studied for form and arrangement, Urban Cactus was studied for green implementation in the design, and Arab Word Institute shows opportunities in architectural expression and light usage.

In the close surrounding are there are many high-rise building. Pudong is a global financial centre, which is wildly known of its skyscrapers and its skyline. Surrounding skyscrapers and tallest buildings of the area are collected in Appendix C, in order to find a general picture and overview of the neighbourhood.

Concept does not aim to stand out in the skyline, nor to create a new signature building between the very famous towers, but it does work with the context.

Besides existing samples on environmental design there are many conceptual design ideas were found during the research and analysis.

Each inspirational reference will create a picture regarding to the design, to find architectural values and implement them into the overall building. Initiative sketches improve creativity, sketches on each theme and keyword helps to improve and add details to vision.
This collection of sketches and pictures helps to keep creativity, while forming the final proposal for the design. This catalogue is constantly growing during the process.



Toolbox of design parameters

1. Urban fabric
As a high-rise building, the concept fits in the context. Following the skyline of the global financial centre and providing the view for the residents structure reaches convenient height.
Urban elements are implemented in big scale.

2. Cultural elements
Traditional design principles are implemented in the human scale. Expression and sense of the plot must suggest historical....

3. Indoors and outdoor spaces
Living in a highly dense area, indoor comfort is very important, moreover residents must have sufficient outdoor spaces for activities and recreation.

4. Vegetation
As a sound buffer, as a natural air purifier, as a protective 'shell' design maximize green areas in the plot.

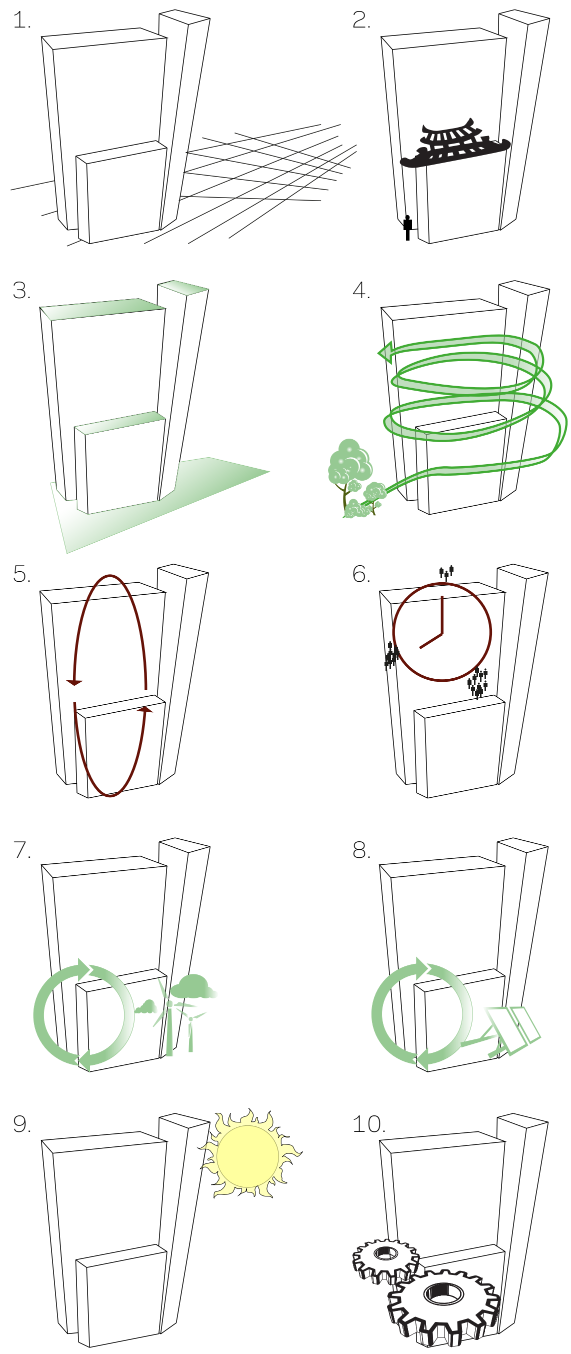
5. Vertical transportation
High zone, middle zone and public elevators help vertical transportation for thousands of users and residents. Retail floors have additional escalator systems. Fire escape provided in protected staircases.

6. Usage
Different part of the building will be used in different times of the day/year. Daily and seasonal peaks might occur in different functions.

7-8. Renewable energy
Huge facade surface allows plenty of opportunity of placing PV panels. Solar energy gain serves building's energy needs. Location favours wind energy generation; height allows to use wind turbines on roof. Noise levels must be considered.

9. Daylight and shading
The openings on the facade and the building for must favour daylight conditions indoor, while addition outdoor shades help to avoid overheating. Investigation on apartment depth and building core gives widths of the volume.

10. Placement of functions
The placement of function must respond to usage and flow of the building. It is very important to separate public and private use to protect residents.



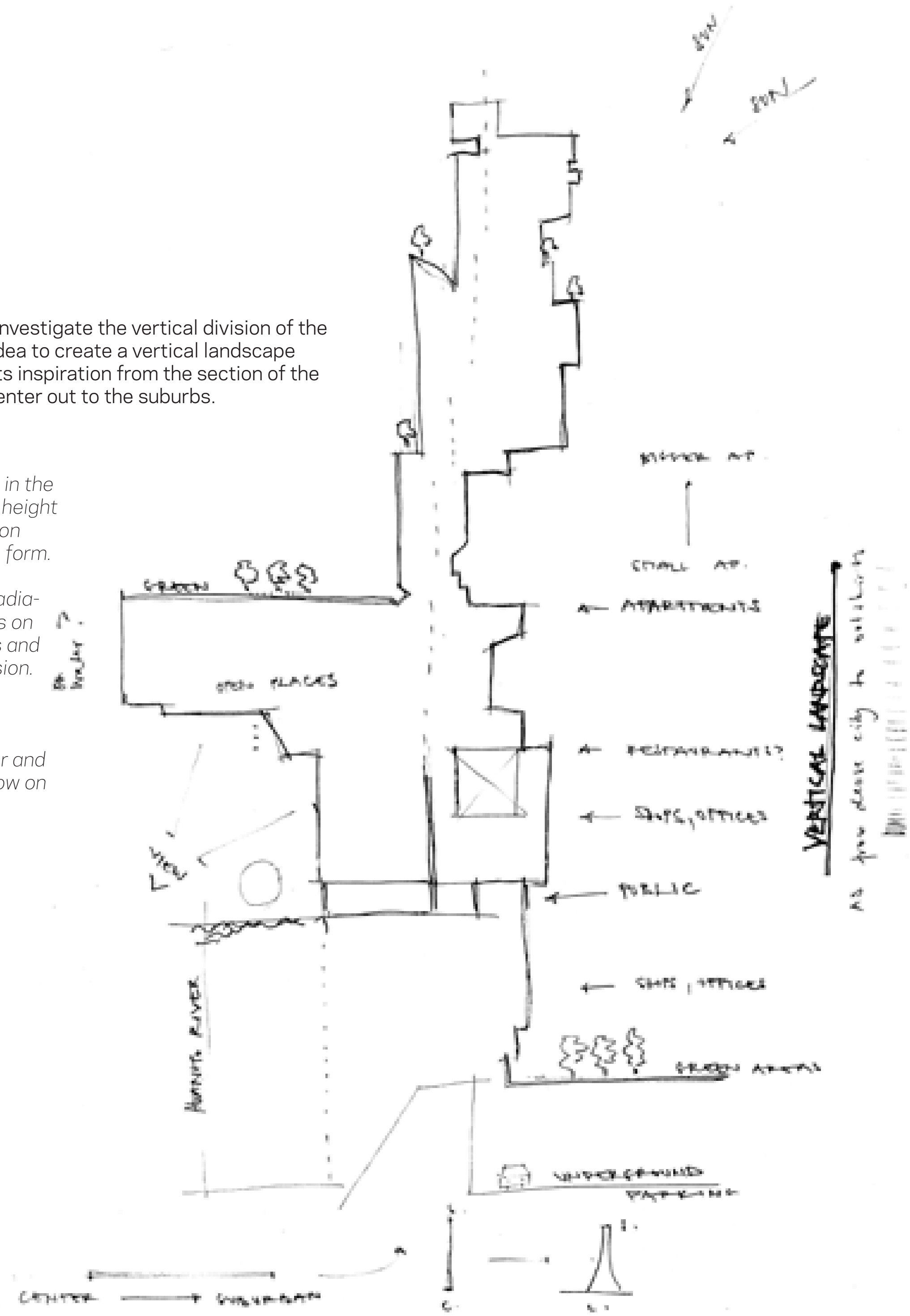
Initial sketching

Initial sketches investigate the vertical division of the building. Initial idea to create a vertical landscape and building, gets inspiration from the section of the city - from the center out to the suburbs.

Placing program in the form will finalize height and adjustment on layout will shape form.

Consider solar radiation, connections on site, green areas and external impression.

Modification to improve daylight conditions indoor and avoid cast shadow on surroundings.



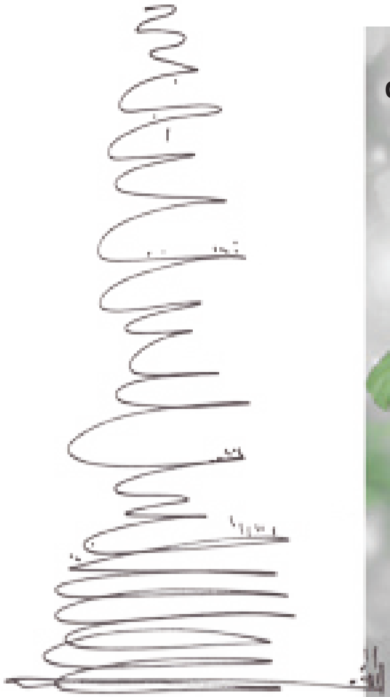
Landscape and vegetation

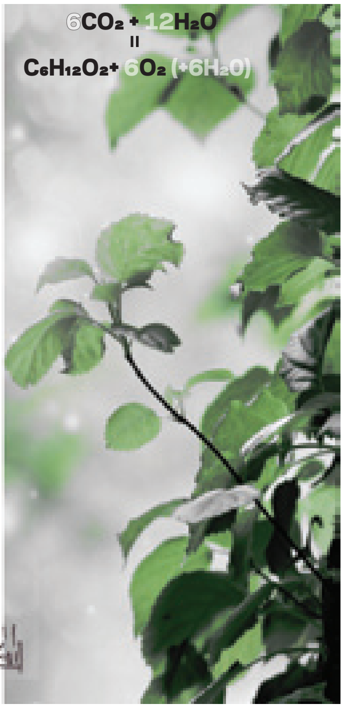
The site occupies more than 36 000 m2 in the centre of the urban area. The original site, as it is introduced in the Analysis phase, has 80% of green areas. According to the program the concept must keep, preferably increase this ratio.

The building plot occupies about 10-15% of the site, but with green roof and open green floors this area will be considered as a part of the greenery.

Investigations of the Chinese tradition, in Appendix D, studies cultural elements. These elements will be used to add qualities into the outdoor areas. The elements of the famous Chinese landscaping and gardening will be used during designing the outdoor spaces. These cultural values help to provide relaxing outdoor areas in the running and crowded city.

Vegetation is also important to contribute to a better urban air quality. Plants and vegetations are natural air filtration system; rapidly and efficiently remove airborne toxins. With the action of the sunlight, plants convert carbon dioxide from air, and water from soil, into organic matter and pure oxygen.
The best-performing plants are quite common. They include Spathiphyllum (spath or peace lily), Dracaena marginata (red edged dragon tree), Chlorophytum comosum (spider plant) and Aloe Vera.





Connection on site

High traffic road will be untouched, building construction must create a connection between sites without disturbing ground level traffic.

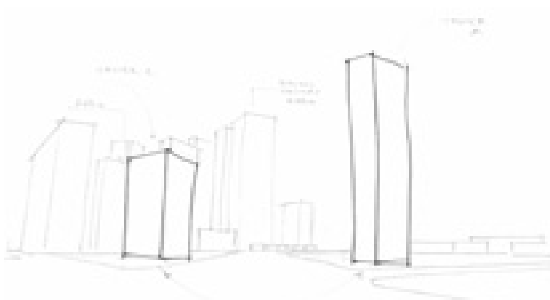
1. Buildings placed on both side of the road without (visible) construction between them. Although detached towers protect users the access is difficult through the road. Even with underground tunnel connection, there is no visible interaction between towers or strong concept for contribution to UAQ.

2. A bridge connection between the ground level of the volumes spanning over the road. It protects pedestrians and not disturbing vehicle traffic, but the connection might not be sufficient for large amount of users.

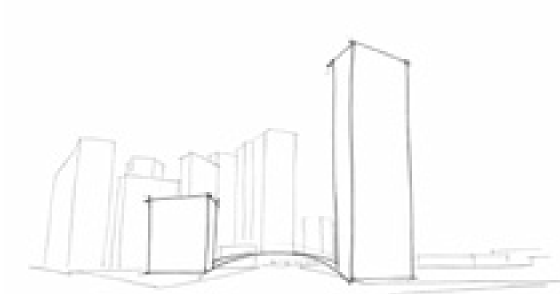
3. Multiple bridges connections connecting several levels between the functions of volumes have the potential to be used as green walls or suspension points for vegetation; air filters or integrates solar/wind power (s. a.: Bahrain WTC). Tubes or entire floors spanning over the ground level, solution does not favour compactness, and building envelope is exposed to leaks.

4. The major part of the site can be elevated to a higher platform, meters above the original ground level. This green platform protects the users by lifting them out from the street-level smog.

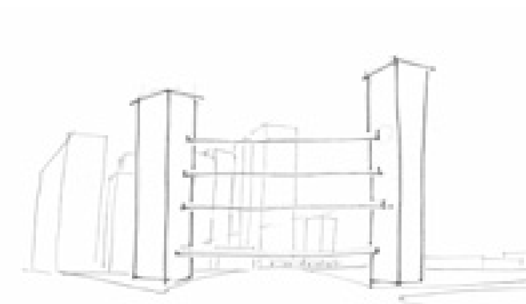
Although connecting the site is very important, functions have a point on deciding connections. Key words still remain: access, protection, green areas, and building envelope.



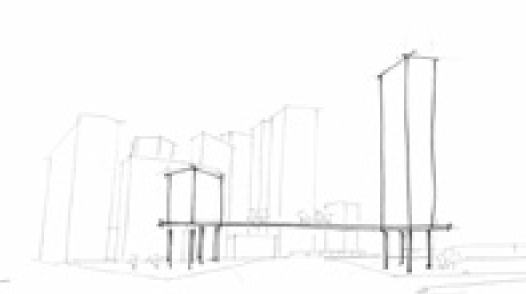
1. No connection of sites



2. Connection with bridge over road



3. Conenction on different levels

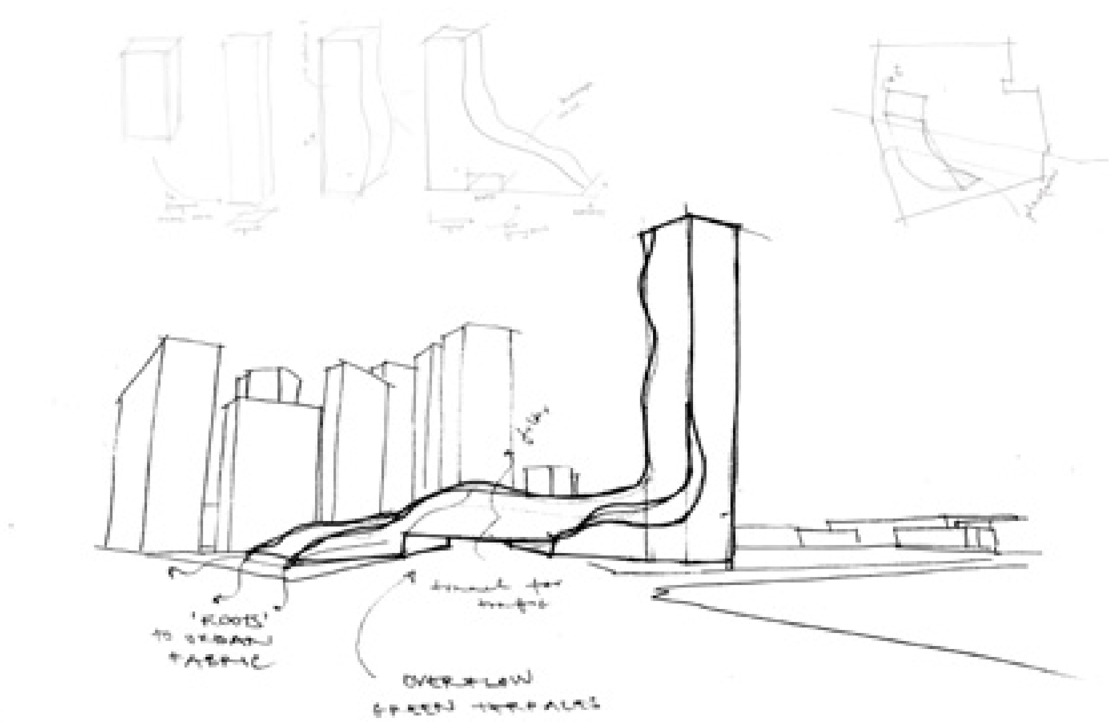


4. Conenction with elevated platform

During form development and initial sketching building form changes and shows potential for an extension over the road.
A green, organic "bridge" spans over the road, elevating and protecting the users.
A tunnel placed under the artificial landscape to allow access for vehicle traffic.
Although parts of the site will be public, and it allows public pedestrian and bike access, the tunnel must consider trespassing pedestrians and bikers, and secure their path.

The artificial "mountain" is flowing down from the elevation of the building, extending the green areas of the site, providing pleasant outdoor spaces for users. Extensions starts from the top of the retail floors, to avoid cover elevation of functions where natural daylight needed.

As a public park, extension tends to improve connections from and around the site, vegetations of the site and the are, microclimate and urban environment; as outdoor environment, extensions tends to contribute to outdoor human comfort in the urban climate and to urban air quality by providing a piece of green relief.

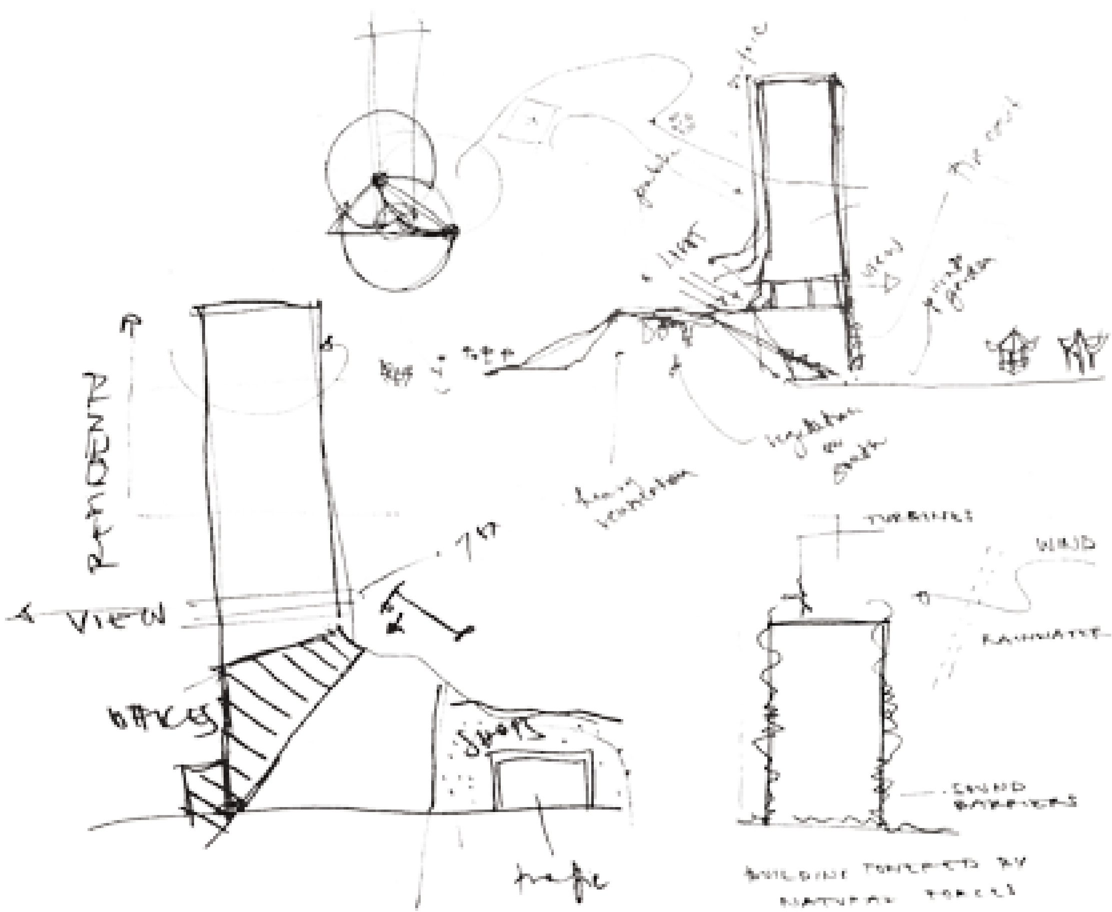


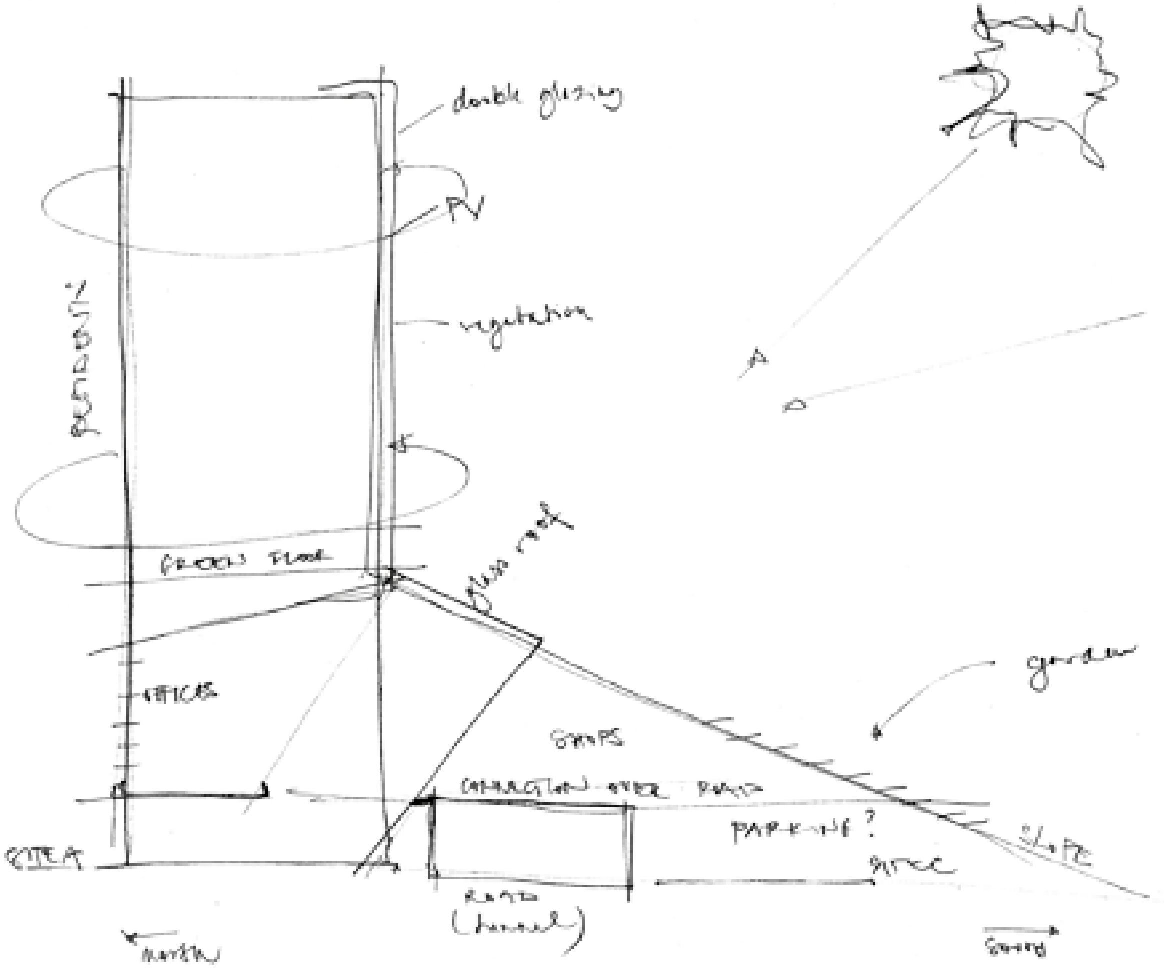
Main concept

Previous investigations already resulted in high-rise structure as the optimal structure of the concept. Site and shadow analysis gives an idea about the placement of the building, program states functions and initial concept gives an idea about placement of the functions.
Energy use and green design still have a big emphasize on the project, indoor climate and daylight conditions must kept in mind.

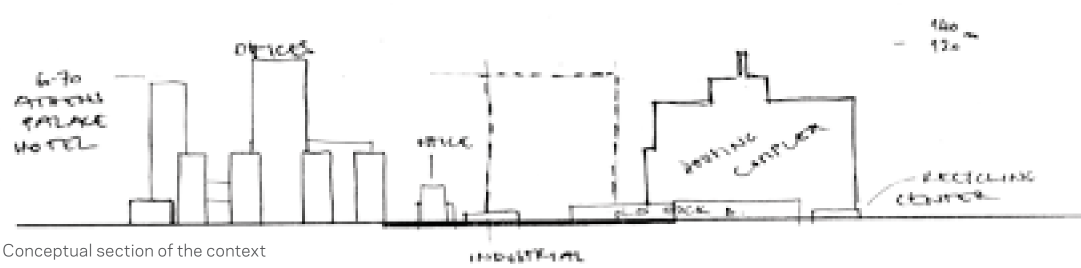
Residential building must be developed in order to fulfil the needs of the area. Due to the high density of the city, density of the site reaches the same values. Besides apartments, building provides functions for specific local needs in a form of rentable offices, and retail functions placed in the first floors to serve residents and the close surroundings, and to try to reduce transportation needs.

Some elements are implemented into the design and they are going to be in focus through improvement. Green facade on North side helps to maximize the green areas, while secondary skin on South facade uses PV elements to fulfil energy needs of the building. Sketching on site connections, building placement, form and materials gives a general idea about the design, and to get direction for detailing.





Conceptual section of the builing



Conceptual section of the context

Building placement and orientation

Orientation is one of the most important sustainable tools to reduce energy consumption and keep comfortable indoor climate.

The situation of the building on the plot, its placement and orientation provide significant opportunities in order to reduce direct and indirect environmental impacts - direct site impacts and indirect impacts in relation of energy consumption.

Close relation to the specific site and its microclimate maximizes opportunities for passive solar gain when heating needed, solar heat gain avoidance when cooling needed, high quality daylight indoors through all year and natural ventilation if needed.

Due to the poor urban air quality and the height of the building, mostly mechanical ventilation used for fulfil the requirements for indoor climate, therefore natural ventilation is not considered in this decision.

Optimal orientation will be investigated for different scenarios;
- for optimal energy consumption,
- for maximized solar gain of PV panels,
- for best situation of green wall and
- to achieve best indoor comfort.

Each scenario is investigated and the results will be compared to determine a compromise for optimal orientation.

This investigation results in orientation of the axis of the building, while optimization of building form and materials will further improve the overall building performance.

1. Orientation for ENERGY CONSUMPTION

Summer sun path is much higher than in the wintertime; orientation of the building must consider solar heat gain, but avoid overheating to reduce energy need due heating or cooling.
ECOTECT v.2011is used to conceptualise building design and it is used to simulate data for cumulative incident solar radiation on vertical surfaces on a daily and monthly basis. All simulations are calculated based on the available hourly direct and diffuse horizontal solar irradiance data from ECOTECT Weather Tool for Shanghai, China (31,12ºN; 121,30ºE).

3. Orientation for VEGETATION

Most of the vegetation does not have need for direct solar radiation in order to photosynthesis. Wind protection, summer shading and urban comfort to avoid heat islands define the orientation for vegetation.

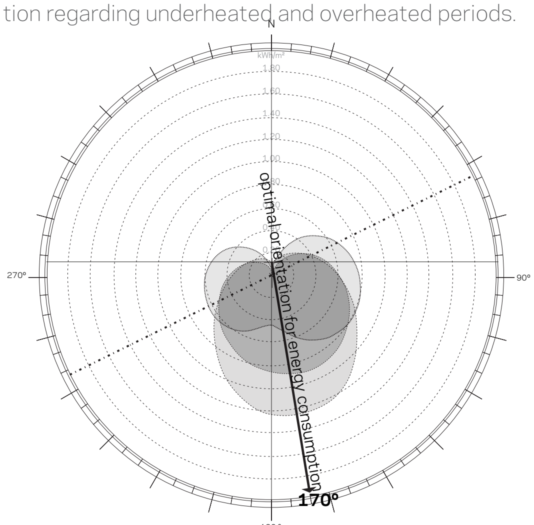
2. Orientation for RENEWABLE ENERGY USE

Wind turbines and PV panels are considered as renewable energy potentials.
Wind energy use could be achieved by the rotation of the turbines, and solar panels must placed carefully to achieve maximum efficiency. Orientation for renewable energy use is estimate from wind directions and Solar North.

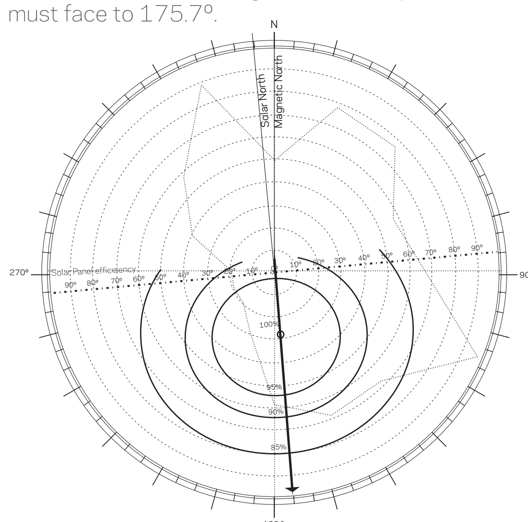
4. Orientation for INDOOR COMFORT

Orientation of the building must consider solar heat gain, but avoid overheating to reduce energy need due to cooling; moreover it must provide high quality natural lighting.
Orientation for indoor climate is optimized on an initial model by PHPP calculations using month average spreadsheet to calculate energy consumption for heating and cooling and 24 hour average spreadsheet to calculate average and maximum temperatures in July.

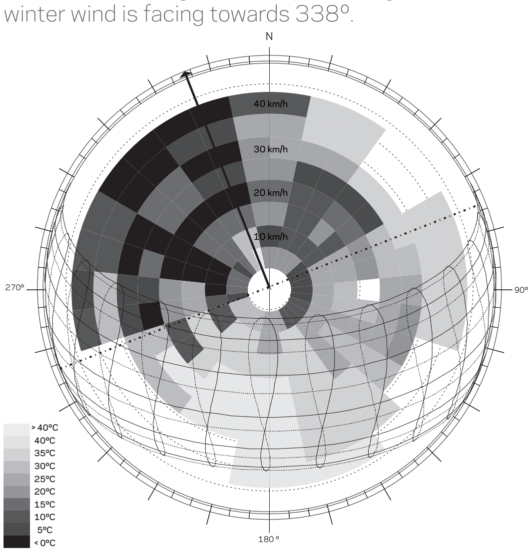
Orientation for energy comsumption is defined at 170º, as a compromise with best and worst loocation regarding underheated and overheated periods.



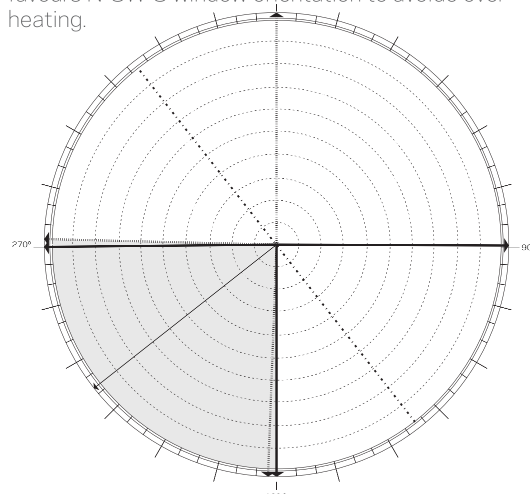
Orientation for renewable energy use determined by solar north; to achieve highest efficiency PV surfaces must face to 175.7º.



Orientation for vegetation to protect against cold winter wind is facing towards 338º.



Orientation for indoor confort suggests larger window area towatds SW-S-SE, but average temp. favours N-SW-S window orientation to avoide overheating.



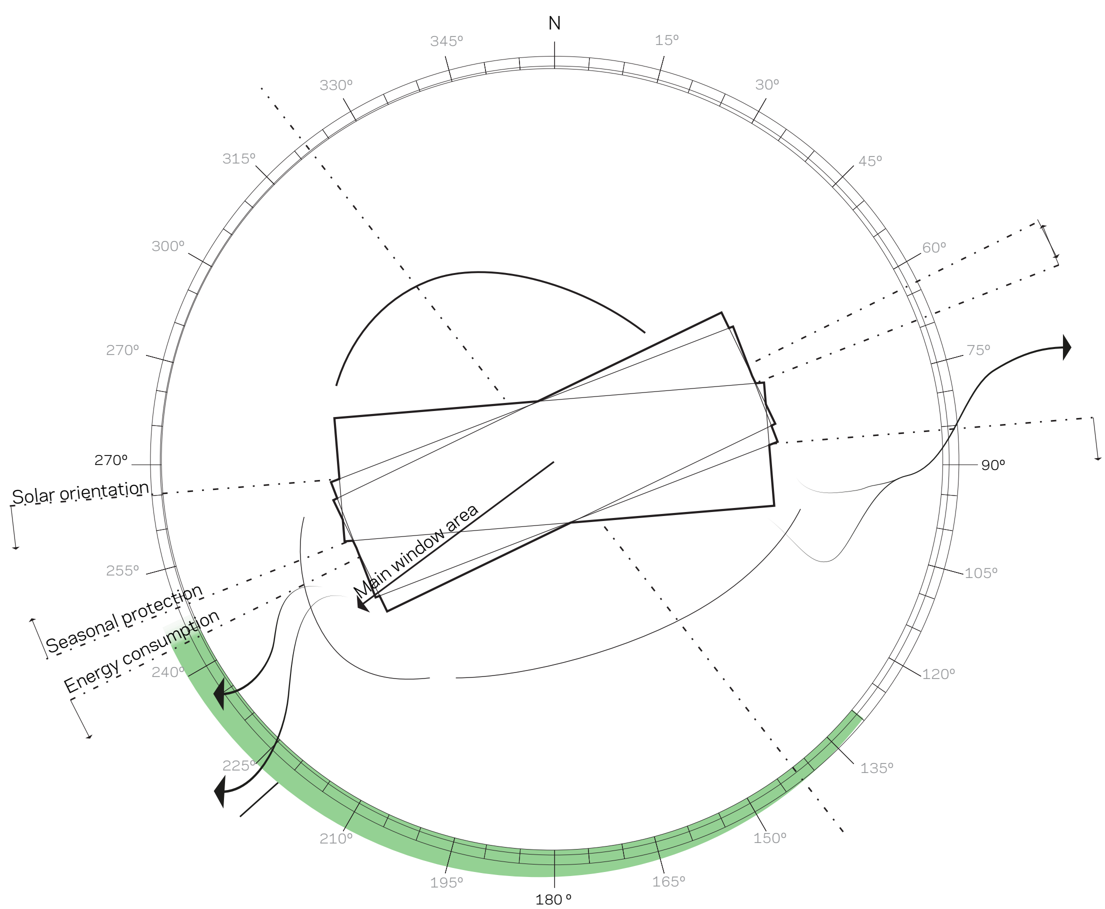
Sub-conclusion on orientation

Regarding the technical goals, building orientation must make a compromise between the best and worst scenarios.

As a result of the investigations on building orientation the main characteristics must be followed during further process.
Building mass and main window areas are orientated to South, Southwest, while stretching, maximizing the usable surface for solar gain, while overheating could be corrected by additional elements and exterior shading solutions.

Natural ventilation is not the main concern since majority of the indoor ventilation is provided by mechanical solution.

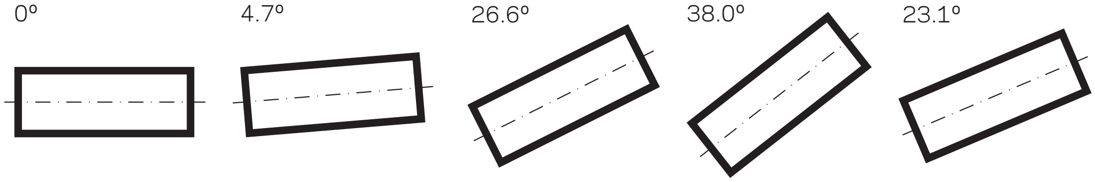
Vegetation and protective materials/elements are placed on the North, Northwestern side to protect against cold and strong winter wind, and to provide cooling opportunities during overheated periods.



Orientation of the building has a huge impact on energy consumption. Appropiate rotation of building would result with energy save per m2.

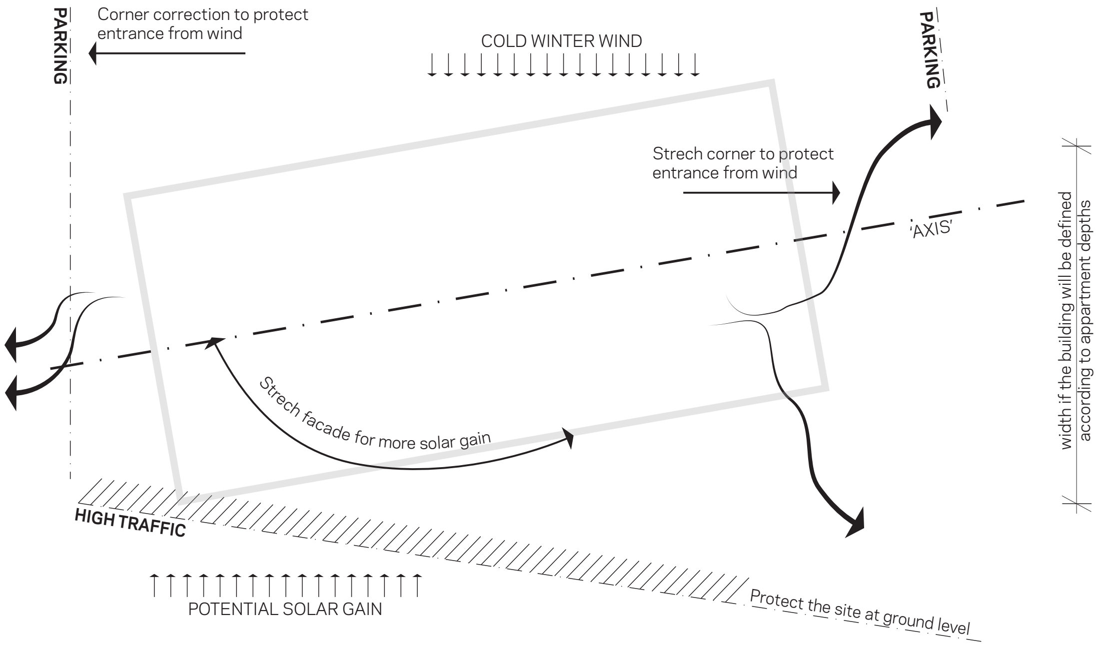
The most important angle in building orientation is to reduce energy consumption. But besides orientation, many other aspects can improve the energy needs.

Rotation from E-W axis

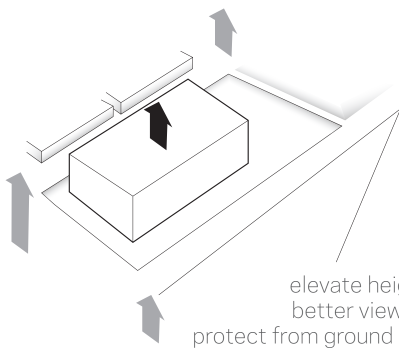


NORTH FACADE - protection from cold wind;
SOUTH FACADE - solar gain, as much as possible

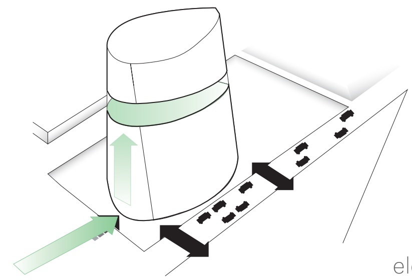
AERODYNAMIC MODIFICATIONS TO THE SHAPE OF THE BUILDING
Aerodynamics of tall buildings.
Rotation and corner modifications.



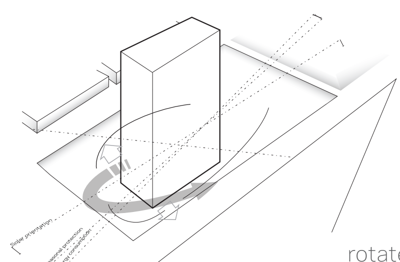
Summery of concept development



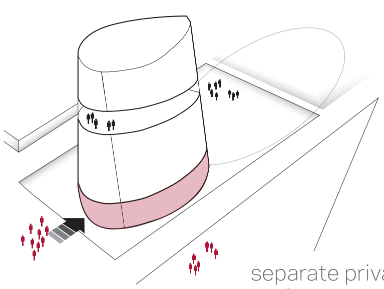
elevate height in context
better view for residents
protect from ground level pollution



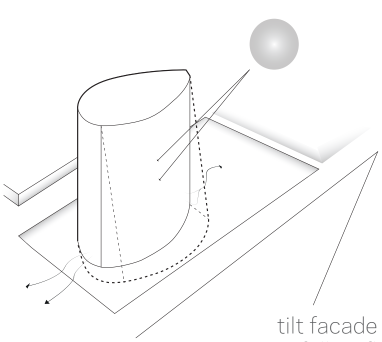
elevate greenery
outdoor greenery for residants
protect from height traffic road



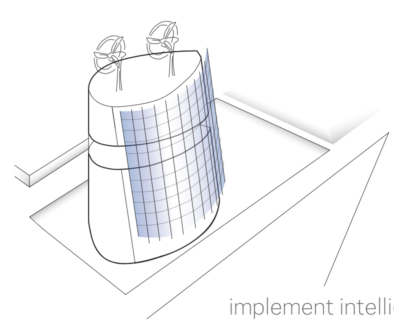
rotate volume axis
better building performance
stretch facade for solar gain and protection



separate private from public
access for public on ground floor
private outdoor garden for residants



tilt facade for solar gain
follow flow of the site
optimize PV efficiency



implement intelligent technology
solar energy generation on facade
wind turbines on rooftop

Delimitation

The complexity of the project requires different detailing levels between different phases of the design process.

As a purpose of the project is to provide sufficient amount of living units on the given site in the crowded dense city centre of Pudong, Shanghai. Project also proposes to place additional functions within the building volume -, such as retail and shopping facilities to serve residents and the neighbouring areas, and offices to fulfil local needs; but the detailing will extend just on the residential units.

Regarding building regulations and demands, euro-code will be used for most of it. Basic guidelines for necessary spaces and general data will be used from Ernst Neufert: Architects' Data [2002; 3rd edition, © Blackwell Publishing], and Chinese regulations will be involved if there is a reference in translated to English.

Handicap accessibility is not detailed; fire escape routes are provided on a basic level.

As an issue concerning the structural detailing of the project, engineering calculations for load bearing system are disregarded. Considerations of structural design will be made, but detailing is not taking place during the process.

The project development also disregards cost and fees. Expenses of the material and construction will not have determinative act on design. Architectural expression and functionality have more emphasis on decision-making.

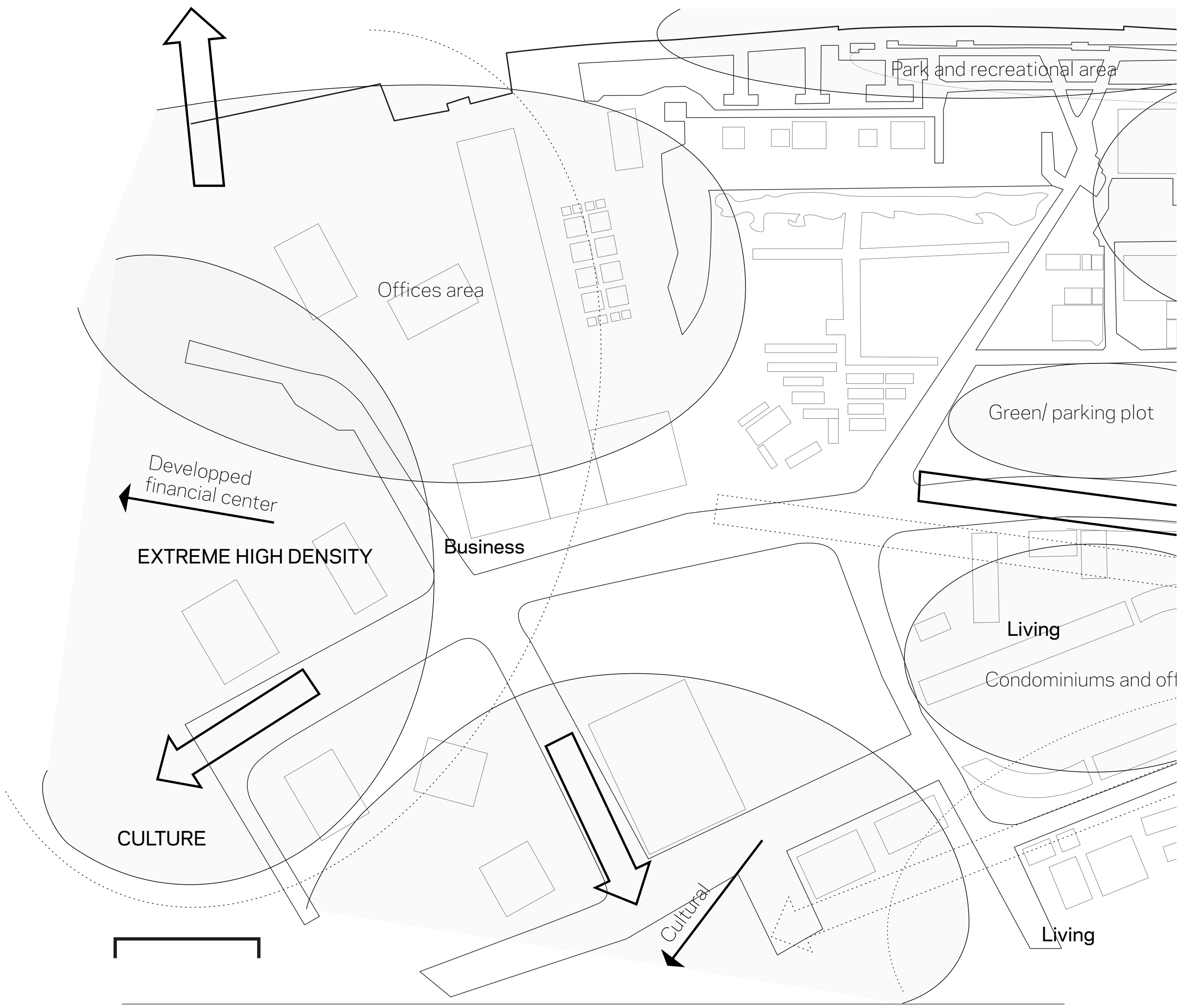
The site is surrounded with many parking areas; therefore there are not designed parking facilities on the site. It is also an attempt to reduce private transportation means and promote public transportation systems and pedestrian usage.

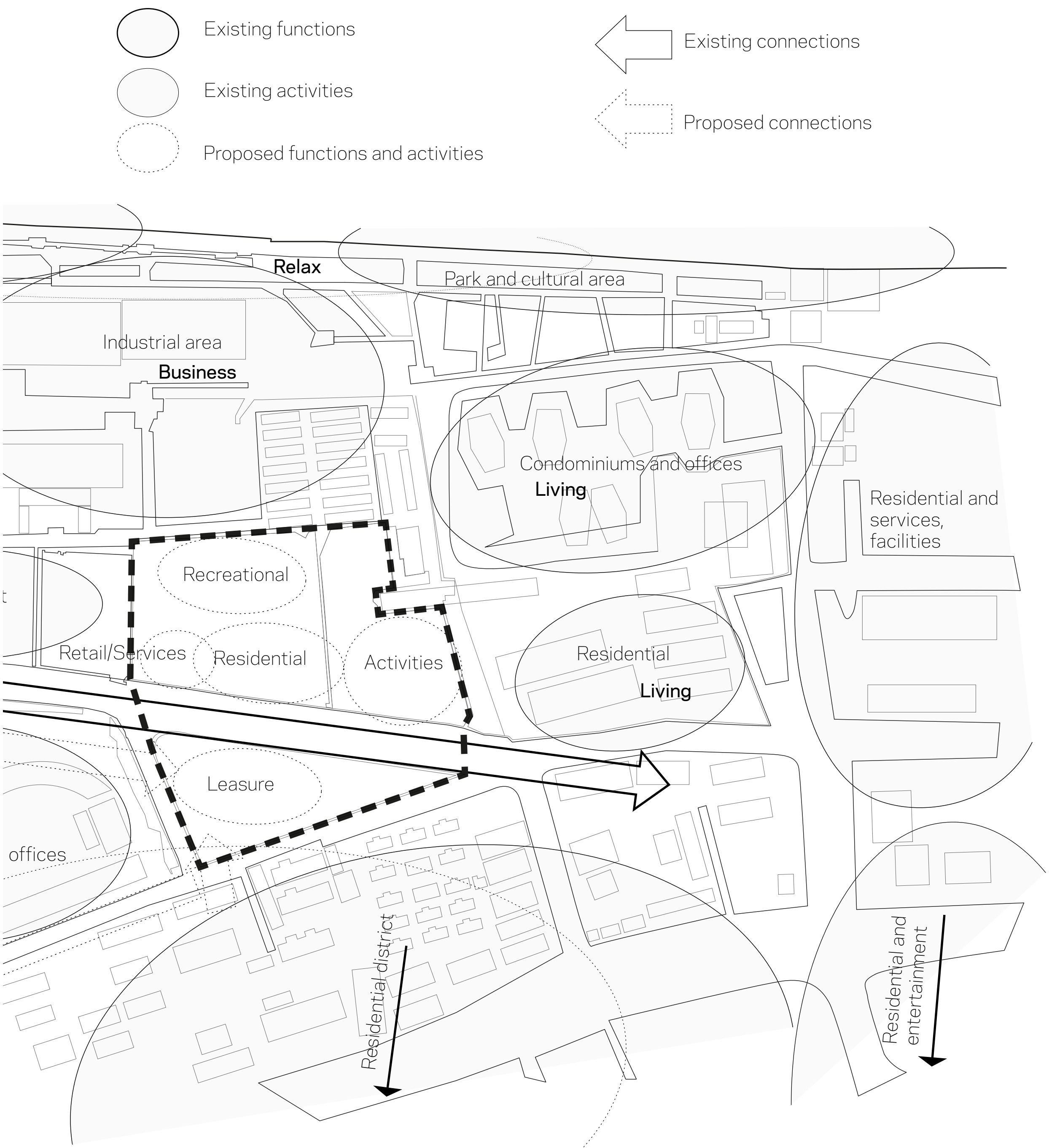
Site layout

Follow analysis and program, and as a conclusion of the initial tests, building volume is placed on the South-East corner of the biggest part of the site fulfilling residential and retail functions; while the major part of the site programmed for outdoor activities, recreational functions, cultural areas.

Program on the site considers existing functions of surroundings; existing connections kept, but proposed connections explores possibilities of more active flow with context.

Placement considers cast shadow, connections, flow, and accessibility. Footprint of the building follows results on tests of orientation, day lighting and form.




Existing functions
Existing activities
Proposed functions and activities
Existing connections
Proposed connections
Relax
Park and cultural area
Industrial area
Business
Condominiums and offices
Living
Residential and services, facilities
Recreational
Retail/Services
Residential
Activities
Residential
Living
Leasure
offices
Residential district
Residential and entertainment

Outdoor spaces

Design should implement the adventages of the suburbs or the possibilities for outdoor activities into the living conditions in a dense crouded city.

High-rise building does not allow balconies or even operable windows in many cases. Therefore it is very important to create outdoor spaces for resident in some other ways.

Besides indoor comfort, comfort in outdoor spaces is also important. Choice of materials, dimensions and exterior elements are able to improve experience of the outdoor area, help thermal and visual comfort, and reduce noise levels, humidity. Among all the effects in the dense city, weather conditions, climate, it is important to provide attractive outdoor environment.
Outdoor areas provide for different recreational activities such as sports and cultural events, outdoor exhibitions, recreation. Outdoor areas counteract noise, pollution and the stress of city life using vegetation as a buffer.

It is hard to control outdoor spaces but many solutions contribute to the microclimate and biodiversity. Green roof and green median floors will be implemented into the design to investigate their opportunities. Green wall used as a buffer and protection between the running city and the recreational environment. Vegetation also used as natural air filtering system to protect users of ground level smog. Additional elements in landscaping helps to improve outdoor spaces; such as water, vegetation, trees improves outdoor comfort feeling. Features and decorations of the public urban landscapes also help to create a more inviting environment.

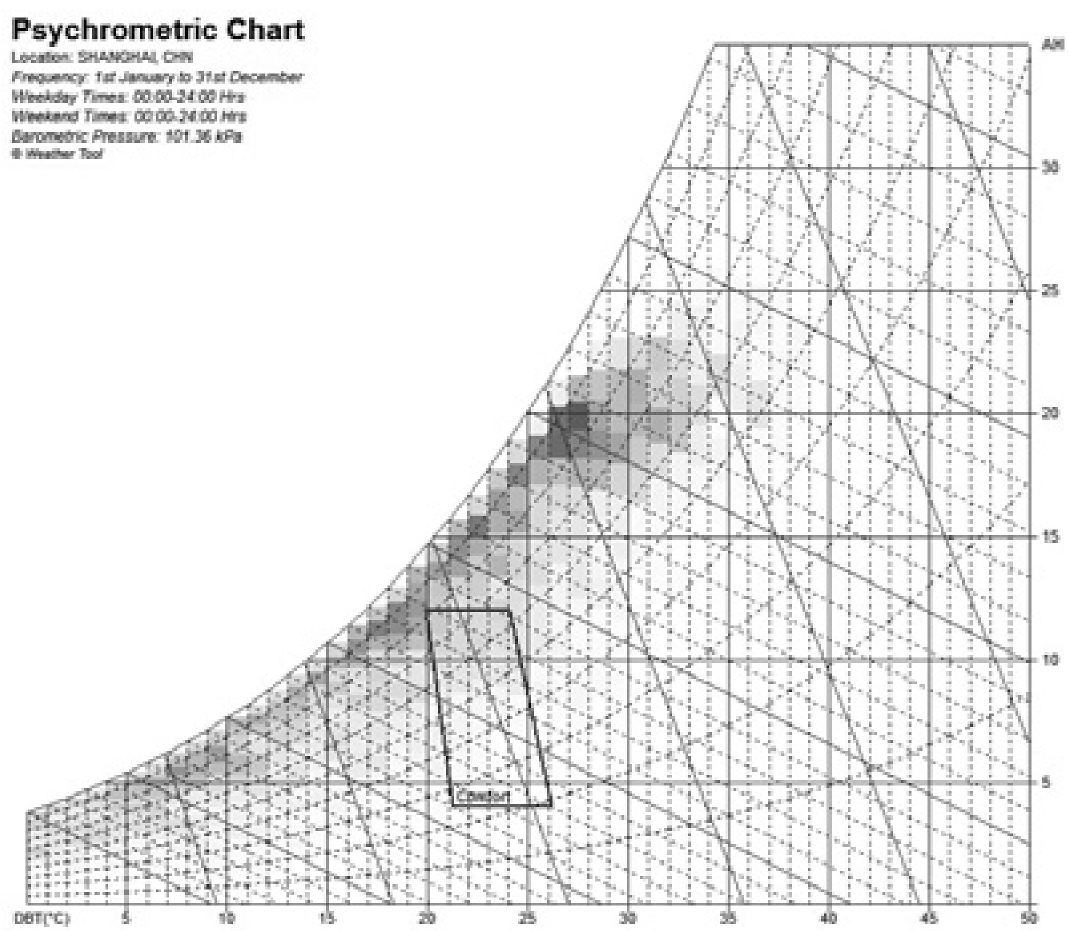
Design of outdoor spaces is following the guidelines given in the report and research Comfort in outdoor spaces [of Oxford Institute for Sustainable Development by Fergus Nicol, Elizabeth Wilson, Anja Ueberjahn-Tritta, Leyon Nanayakkara and Maria Kessler Oxford Institute for Sustainable Development, Oxford Brookes University, UK] revised for local settings.

Indoor comfort

Indoor comfort is one of the driving design principles in residential design.

Besides indoor lighting, other components are also very important in order to achieve good indoor climate.
Indoor temperature and relative humidity take big part in human comfort.

ECOTECT Weather Tool was used to display psychometric chart and determine comfortable indoor temperature between 20-26°C indoors, and relative humidity between 5-23%.



Room geometry for natural light

To understand room geometry in relation to energy use is important to balance energy needs and indoor environmental quality.

Before starting the design process, it is important to understand the principles regarding indoor spaces to create comfortable indoor environment. Needs and requirement are different for different usage and activities. Residential units have other needs than the offices.
Besides daylight levels and factors, the importance of view, air change (will be provided with mechanical system) and indoor temperature have been determined as well.

As natural light is one of the main factors in forming interior spaces, Ecotect analysis have been made in order to find optimal geometry for the apartments. Although general rate of daylight penetration ratio is 3 times more than the height of opening, analysis shows how deep the apartment could get with different widths of dwellings in the given location.
Illustration of investigation is attached in the Appendix.

Areas and dimensions of the different functions have been stated in the program; requirements regarding daylight are shown in the table below.

Offices - REQUIREMENTS	Working area	Common area	Entrance, access	Wetrooms	Outdoor
Open office spaces					
Daylight [lux]	500 lux	> 200 lux	> 50 lux	> 100 lux	-
Daylight factor	> 2 %	> 2 %	-	-	-
View (in/out)	in/out	in/out	-/-	-/-	-
Air change [l/person]	20 l/p	20 l/p	20 l/p	10 l/p	-
Temperature - winter [ºC]	23-26 ºC	23-26 ºC	23-26 ºC	23-26 ºC	-
Temperature - summer [ºC]	20-24 ºC	20-24 ºC	20-24 ºC	20-24 ºC	-
Temperature - summer [ºC]	20-24 ºC	20-24 ºC	20-24 ºC	20-24 ºC	-

* working hours in the office soaces are assumed to be 8-15 hrs

Dwellings - REQUIREMENTS	Living area	Kitchen/dining area	Entrance, access	Room(s)	Bathroom	Outdoor
Living Units						
Daylight [lux]	500 lux	> 200 lux	> 50 lux	> 100 lux	> 100 lux	-
Daylight factor	> 5 %	> 2 %	-	-	-	-
View (in/out)	in/out	in/out	-/-	-/-	-/-	-
Air change [H^{-1}]	0.5 H^{-1}	0.5 H^{-1}	0.5 H^{-1}	0.5 H^{-1}	0.5 H^{-1}	-
Temperature - winter [ºC]	23-26 ºC	23-26 ºC	23-26 ºC	23-26 ºC	23-26 ºC	-
Temperature - summer [ºC]	20-24 ºC	20-24 ºC	20-24 ºC	20-24 ºC	20-24 ºC	-
Temperature - summer [ºC]	20-24 ºC	20-24 ºC	20-24 ºC	20-24 ºC	20-24 ºC	-

Energy need in apartments

The window-to-floor area ratio is important to balance energy and in-door environmental quality.

After investigating the room geometry in order to get a better understanding on day lighting, apartment depth is tested in relation to orientation using an initial model in basic PHPP calculations.

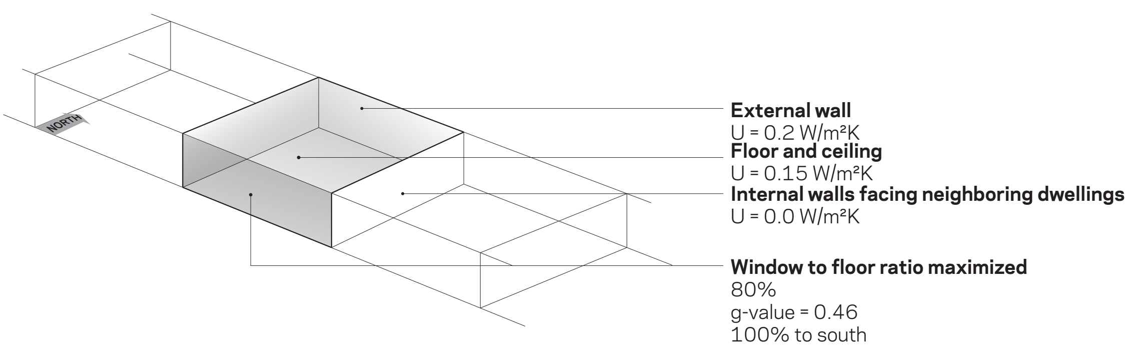
Month average spreadsheet is used to calculate energy consumption for heating and cooling; 24-hour average spreadsheet to calculate average and maximum temperatures in July.

The initial model does not have any shading. Relative values are tested and results are used to compare to each other.

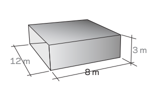
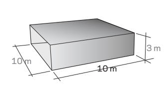
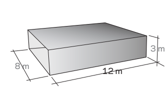
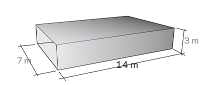
In first step apartment depth is tested on 4 proposals, with 8 - 10 - 12 (- 14) m.

Results show energy demands according to apartment depth with maximized window area facing to South.

Overheating in these apartments is expected, but external shading will be added later in the design process to improve final results.



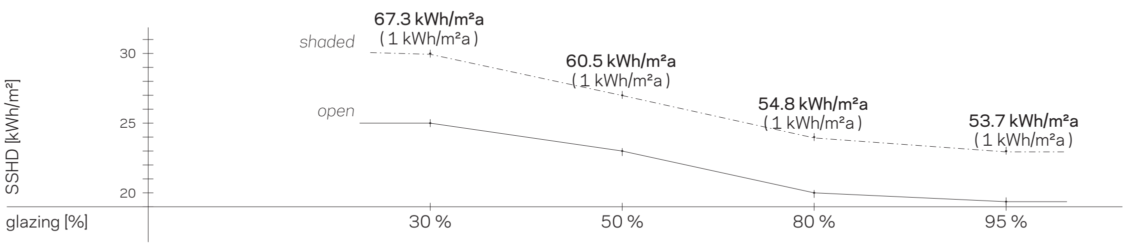
Reference apartment for initila tests

Appartments - Test 1				
Ref. appartment				
Energy c. [kWh/m²a]	55.9	53.3	58.3	60.8
SSHD [kWh/m²a]	18	19	22	23
Temperature [ºC]	18.2 (23.2)	18.2 (23.2)	18.2 (23.2)	18.2 (23.2)
Utilization factor	69 %	73 %	77 %	80 %
freq. of overheating	100 %	100 %	100 %	100 %

Test 1: Relation of apartment depth and energy consumption

For further testing, 10 m deep apartment is tested for 30 -50 - 80 (- 95%) glazing.
It is important to let sufficient daylight in to the apartments while overheating is avoided.
In case of overheating extra shades must be added, to avoide extra energy consumtion of cooling.

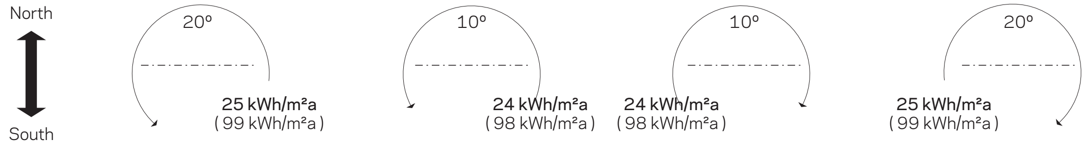
Indoor temperature rises in proportionately to increasing the window area. The energy consumption decreasing with bigger window surfaces, as need of heating would be less.
On the other hand, overheating increases total energy consumption due to need of cooling.



Test 2: Relation of apartment window-floor area ratio to indoor temperature

Orientation of windows has a huge impact on energy consumption. Result of convinient apartment depth and glazing ratio is further improved with adjustments in window orientation.
Ten meter deep apartment with 80% of window-floor area ratio and shading is tested for energy consumption and maximum temperature.

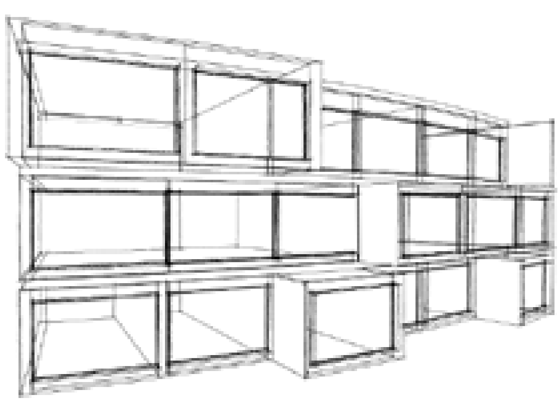
Energy consumption decreases as the windows are looking toward to South. Optimal orientation suggest Sout-East, South, South-West facing windows.
However 10-15º of rotation does not have signifficant effect on heating demant, therefore elevation line has enough freedom to create an organic shape for the building.

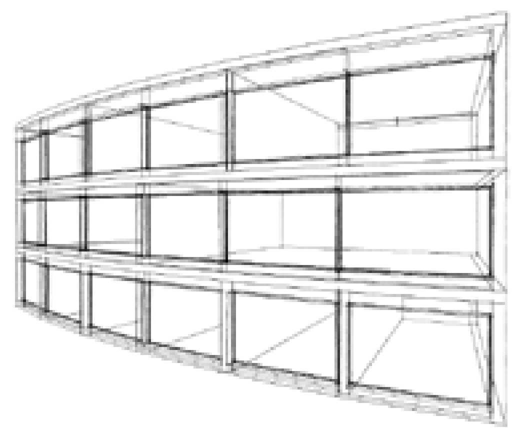


Test 3: Relation of window orientation to energy consumtion

Dwelling to envelope ratio has an other great impact on energy consumption. Surface area towards to other dwellings helps to avoid heat loss.

Energy consumption decreases significantly with more compact setting. Neighboring dwellings keep temperature better, hear does not escape easily, therefore compactness has a huge impact on energy consumption.





Test 4 : Relation of compactness to energy consumtion

The above mention tests are very simple, they are using initial values, but following process will be built upon these experiences to find optimal organization of apartments on the site and in realtion to each other. The main goal to lower energy need, and to achieve a great architectural space and indoor experience.

These tests combined imply apartment depth with 10 m, 85% of glazing, 50% of exterior shading on the South, South-East and South-West side; while apartments with 10 m depth and 85% of glazing need 20% of shading on the North-East, North and North-West side.

After finding solution for orientation, depth, glazin, shading and compactness, all test return to the basic point to contrast the suggestions given from energy consumption, and match with initial daylight requirements.

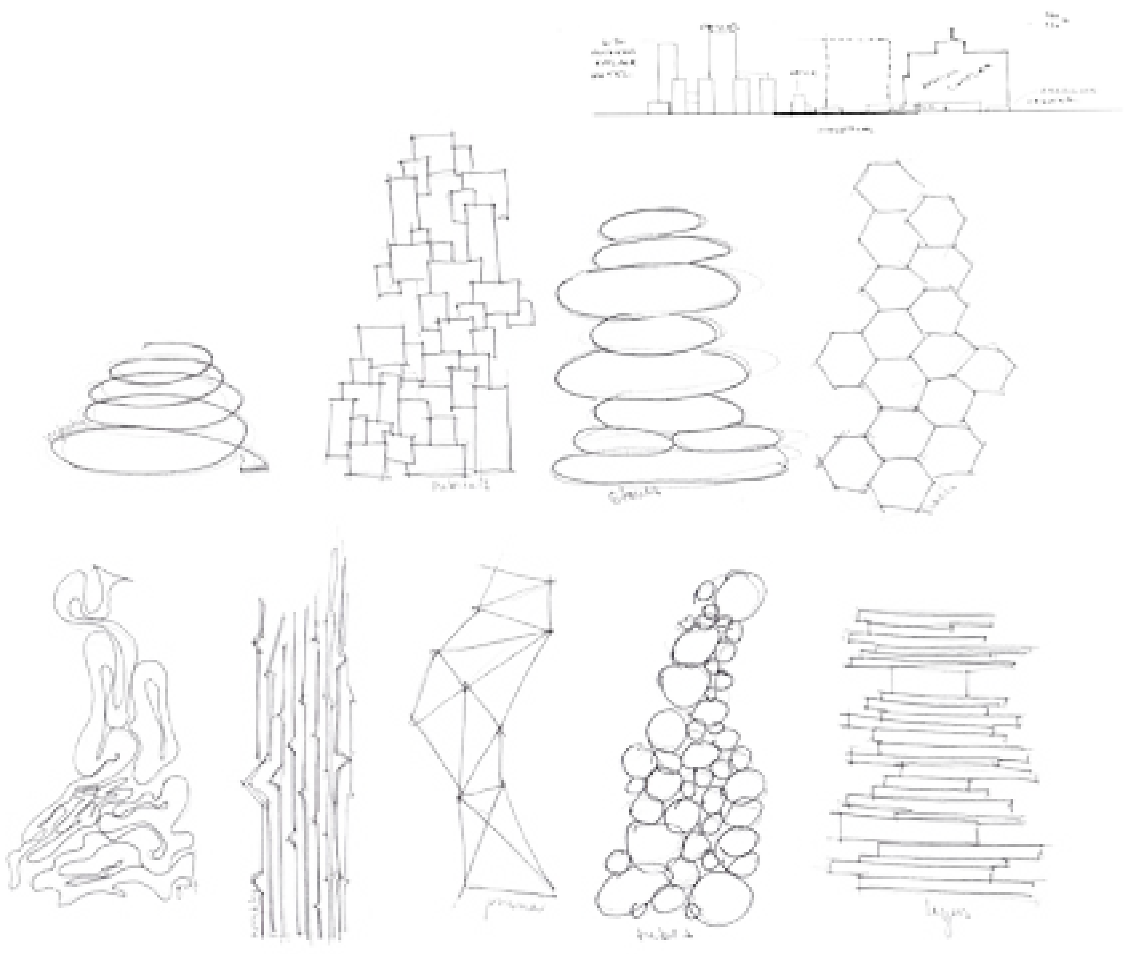
Shaping building form

Initial sketching on organization of program, connection of sites, and on main concept works with high-rise structure. But form of volume was always considered simple. This brainstorming aims to find a special identity to the building form.

During sketching and shaping building form many surrounding elements are inspirational; any form or detail can be moving.
In the process to create a tall building on the site, sketching have been made regarding to external impression. Given the huge surfaces of the building it is important that the elevation is not becoming boring.

The building is not aiming to be the new icon of the area, but it must be designed to give a unique expression.

Elements of context must be taken into consideration and results of initial test must be followed. Sketches were made with the program in mind; form is already trying to accommodate functions.



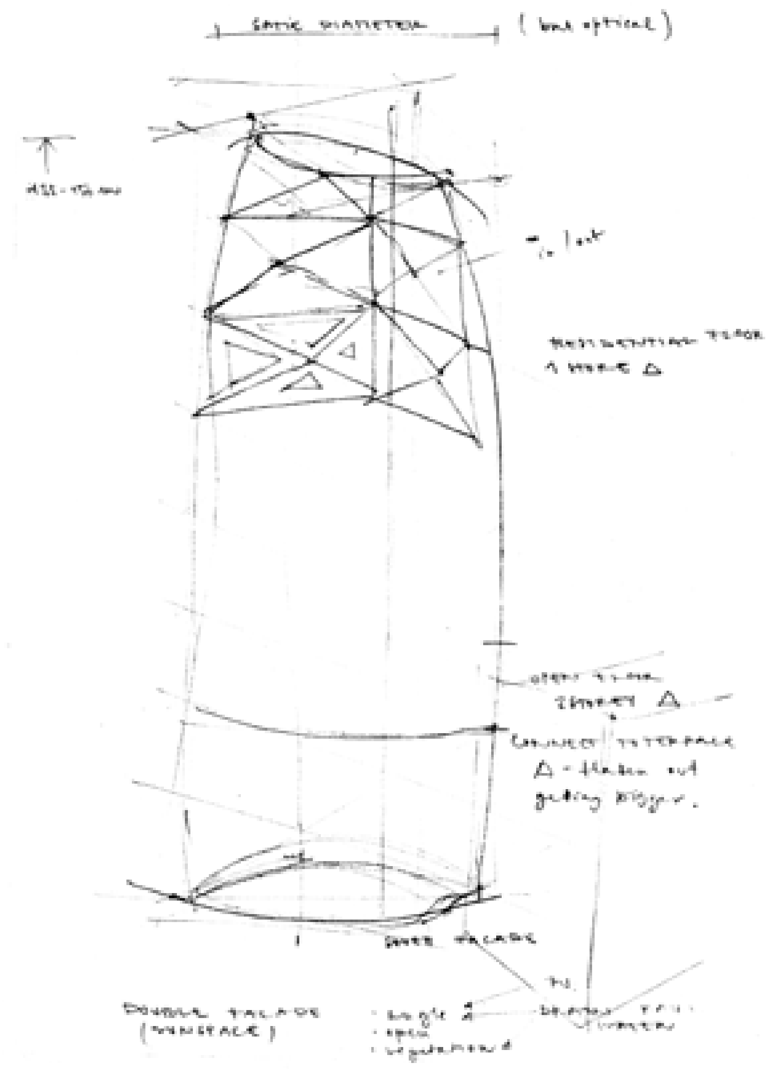
Sketching on building form (elevations of different ideas)

External expression

During sketching on building form, many different volumes have been generated. Design chooses to develop a volume with a simpler form, which works together with previously stated concepts.

Expression of volume developed due outside divisions but it does not significantly changed. Volume has been kept moderately simple, but exciting expression is achieved mainly optically rather than structurally.

Just as it is in human body, where skin is the largest organ, building skin is also the largest part of the structure. Therefore it is important that building volume project architectural qualities through its external settings. Facade express modernization of the area, hence outlook will become an articulation of technical development.

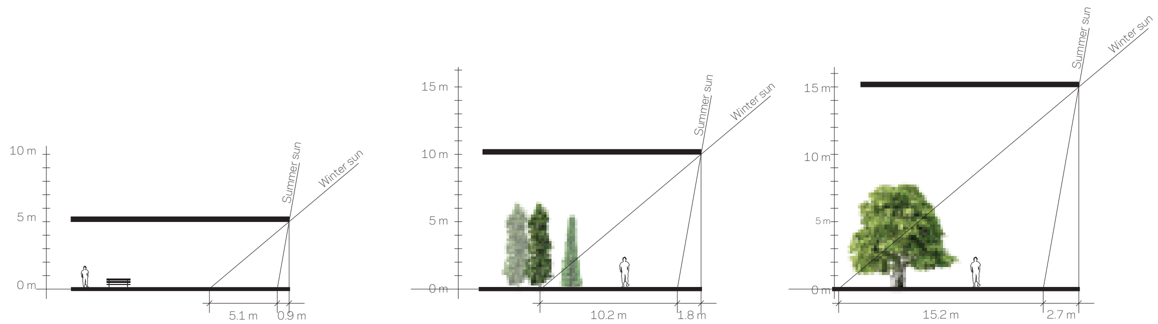


Open floors

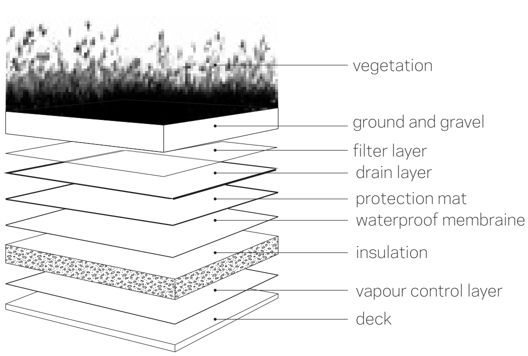
Median open floors are placed in the volume to separate functions and to provide extra outdoor spaces for users.
Open floor, located above retail floors, acting as an urban landscape connecting site over the high traffic road and for leisure and outdoor activities for public use; while higher open floors are used just by residents.

Height of open floors is determined according to sun altitude in summer and winter position, and distance between overhang and core.

Open floors are shaded against strong incident of sun with high position in the summer period; while low sun angle in the winter period lets more light through.



Altitude of sun is 80º in summer and 40º in winter period [Sherical projection of Ecotect Water Data Tool].



Open floors layered as green roof, different layers are added up to a much thicker section than partition slabs. Width of ground and gravel decided according to needs of the vegetation. Plans, which require more than 30 cm of ground, must be planted within a higher flowerbed.

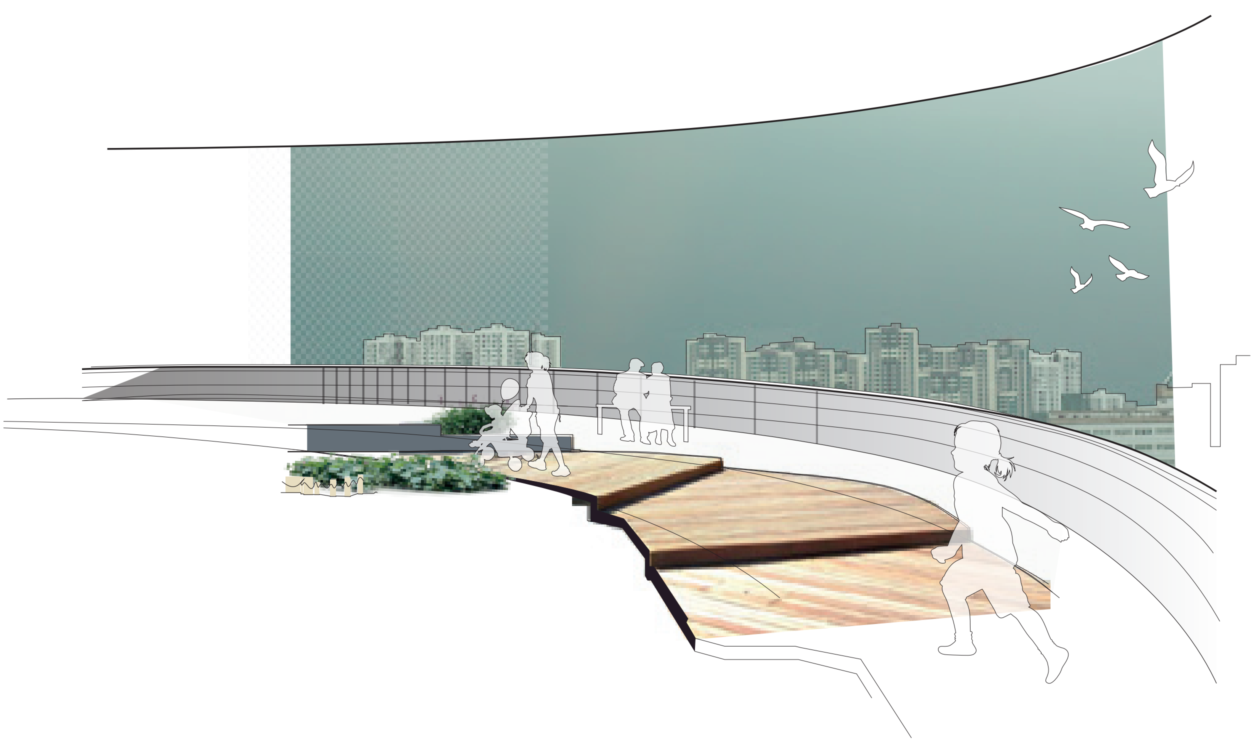
Green roofs

Although open floors cutting into the building volume and breaking compactness, open floors considered as green roofs, adding extra insulation to the volume and improving microclimate.
Green roofs display perfect symbiosis between nature and architecture.

Green roofs provide place for park features, path-ways, benches, sitting and social gatherings. Open floors provide similar experience as plateau and landscaping of the site in a more private manner. The design follows the elements of the traditional oriental gardening.

Use of the open floors (except first open floor) is semi-private, they provide opportunities for resident to feel closer to nature; arrange outdoor activities or family gatherings.

Green roofs have access to elevators and fire stairs.



Conceptual collage of open floor

Green extension

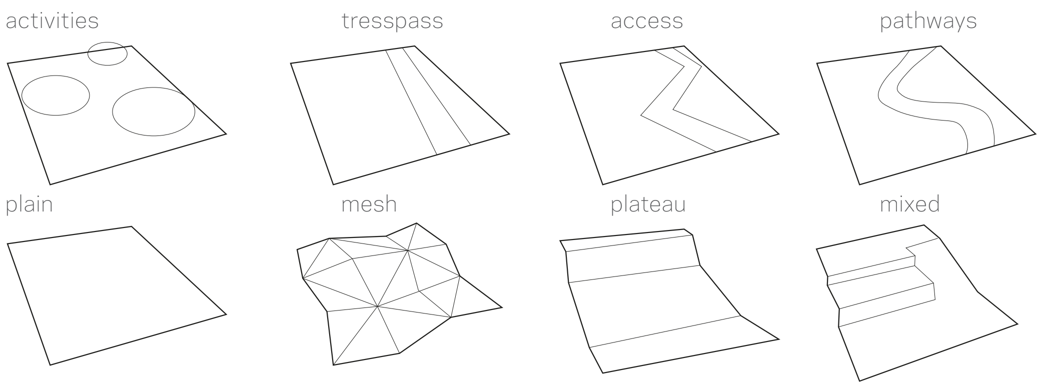
Site plan development explores the possibility of a green extension from the first open floor spanning over the road to connect the site.

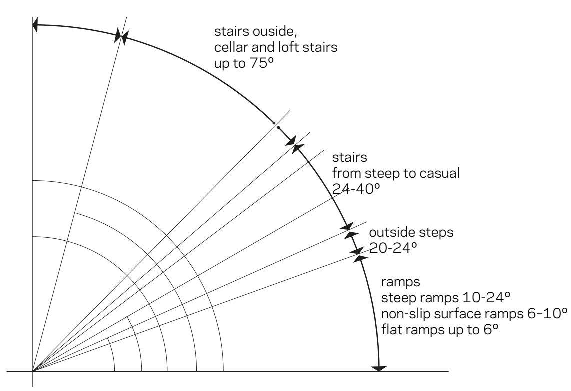
Green extension follows form of the building, connections from and through site.

Open floor located about 20-25 m above ground level, extension spans about 100 m. Hence maximum slope would be 14° which is already considered as steep ramp, therefore it will be broken into plateau, flat ramp and stairs.

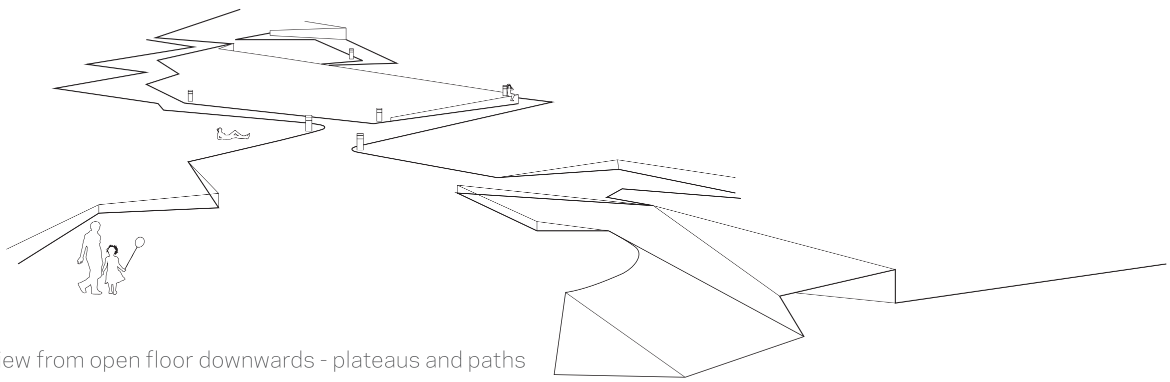
Plateau gives place for activities, trespassing, access, and walkways. Landscaping combines these flows while providing spots for activities.
Plateau protects users from height traffic as elevate pathways over the road, but it must provide sufficient space under for vehicles. Widths of the road will not be touched, and height requirement for low speed traffic will be kept as 4.5 m.

Bike and pedestrian lane is also provided in the tunnel for short access, protected from traffic.

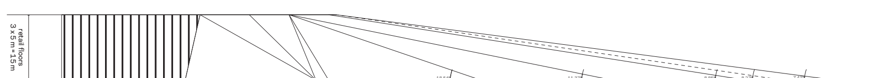




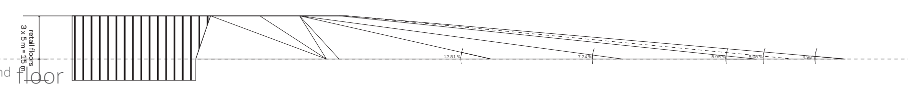
Plateau will mix plain surface, different slopes, steps and stairs. Ramps should be provided for wheel-chair access and bikes. Changing angle will create different experience and diversity between places. Incline will define use according to guidelines from Ernst Neufert: Architects' Data[2002; 3rd edition, © Blackwell Publishing].



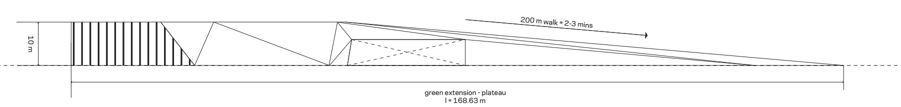
view from open floor downwards - plateaus and paths



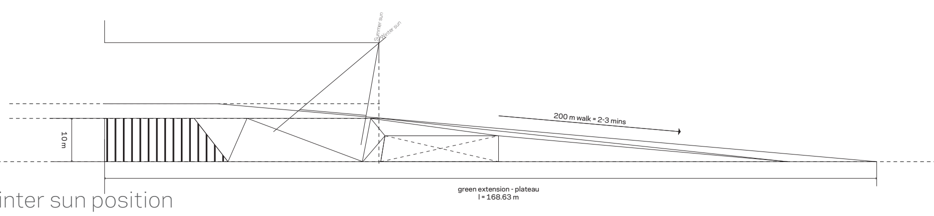
extension from 3rd floor



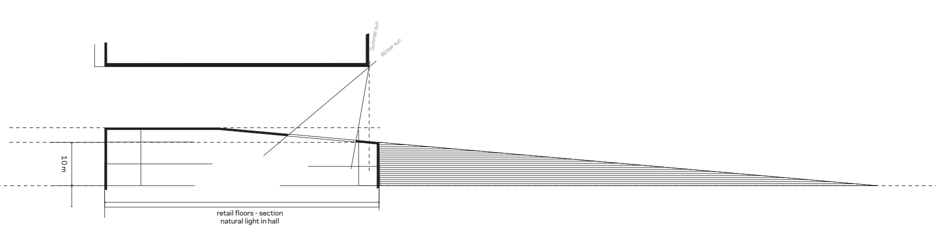
extension from 2nd floor



maximum incline

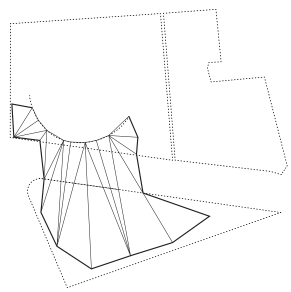


summer and winter sun position

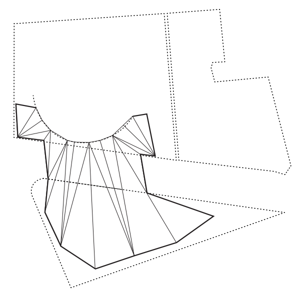


skylight to provide natural light in retail hall

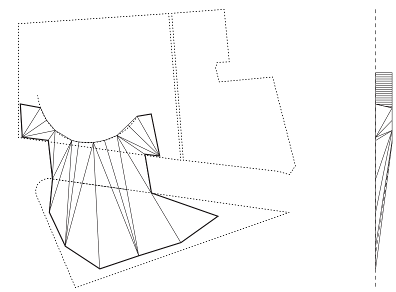
Aalborg Universitet | ad:mt - Department of Architecture, Design and Media Technology
Timea Török - 20081144 - ttorok08@student.aau.dk



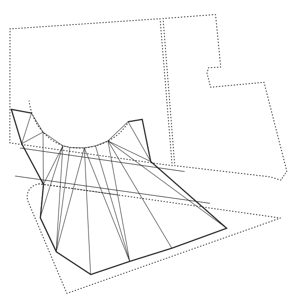
extension from open floor spans over the road to connect sides



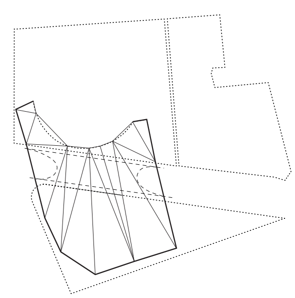
correction of extension to decrease incline



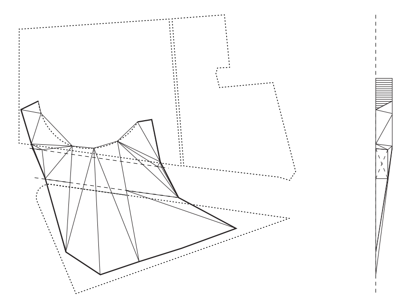
lower open floor to decrease incline more



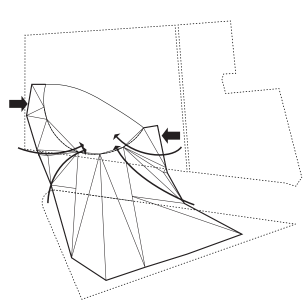
tunnel cut through



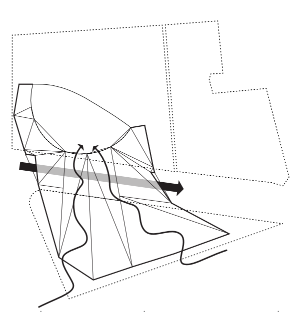
hight of tunnel cuts planes



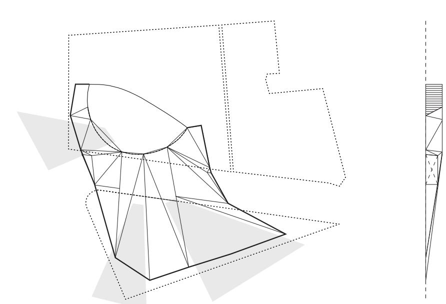
correction of tunnel, and planes



short routes up from the streets for quick access ectrance points to retail floors



longer pathways up to the open floor for slow walks vehicle traffic and tresspassing in tunnel



viewpoints from extension, some places to stop, relaxing, activities.

Sketching on section

Quick models and sketches were used to investigate the placement of the functions to improve the concept.
Changes of cross-section are displayed with small diagrams below to show the development of the process step by step.

Cross section has been cut through building core in South-North Direction.
Along the steps North facade remains vertical, while South facade changes about 4°.

[1.] [2.] [3.]

[4.] [5.] [6.]

1.
Section stated in program to indicate space distribution along the building height.

2.
Functions are flipped to place small apartments on the higher floors, and big apartments under. As families are the focus group of users for large apartments, for convenience, they are relocated closer to ground floor.

3.
Access to functions is solved by zone-programmed elevators. Building core, and also service shaft requires more and more place from the top to the bottom.

4.
South facade is tilted for the intention of placing PV collectors on the surface. Angle helps to improve PV panel efficiency with a better orientation.
Apartment depths are changing in order to follow the angle of the facade.

5.
To avoid big difference between apartments for the same user groups, depths of the apartments remain the same, while they are pushed in towards the core as facade tilted.

6.
To improve compactness and avoid steps on facade and heat loss at slabs, exterior wall of apartments are also tilted together with the facade.

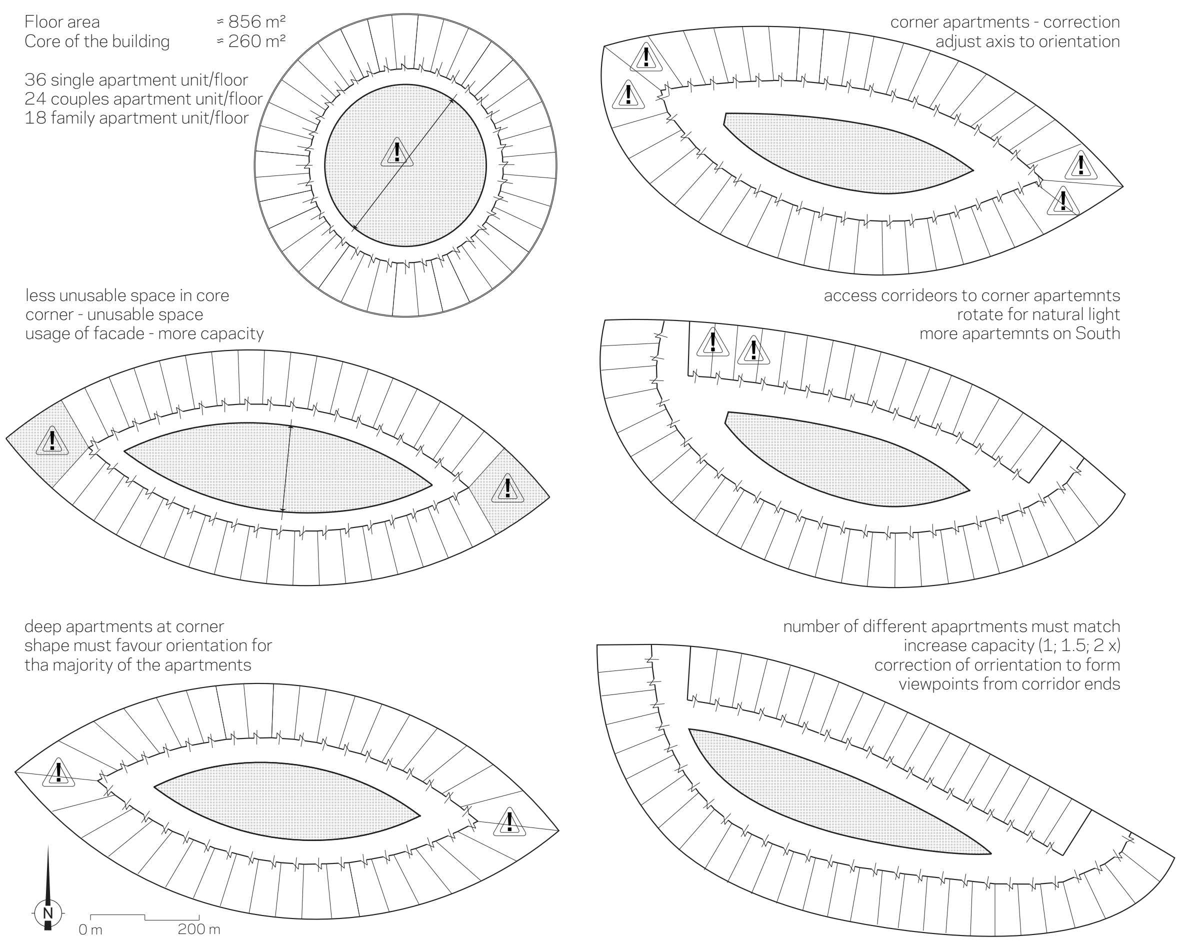
Sketching on floor plan layout

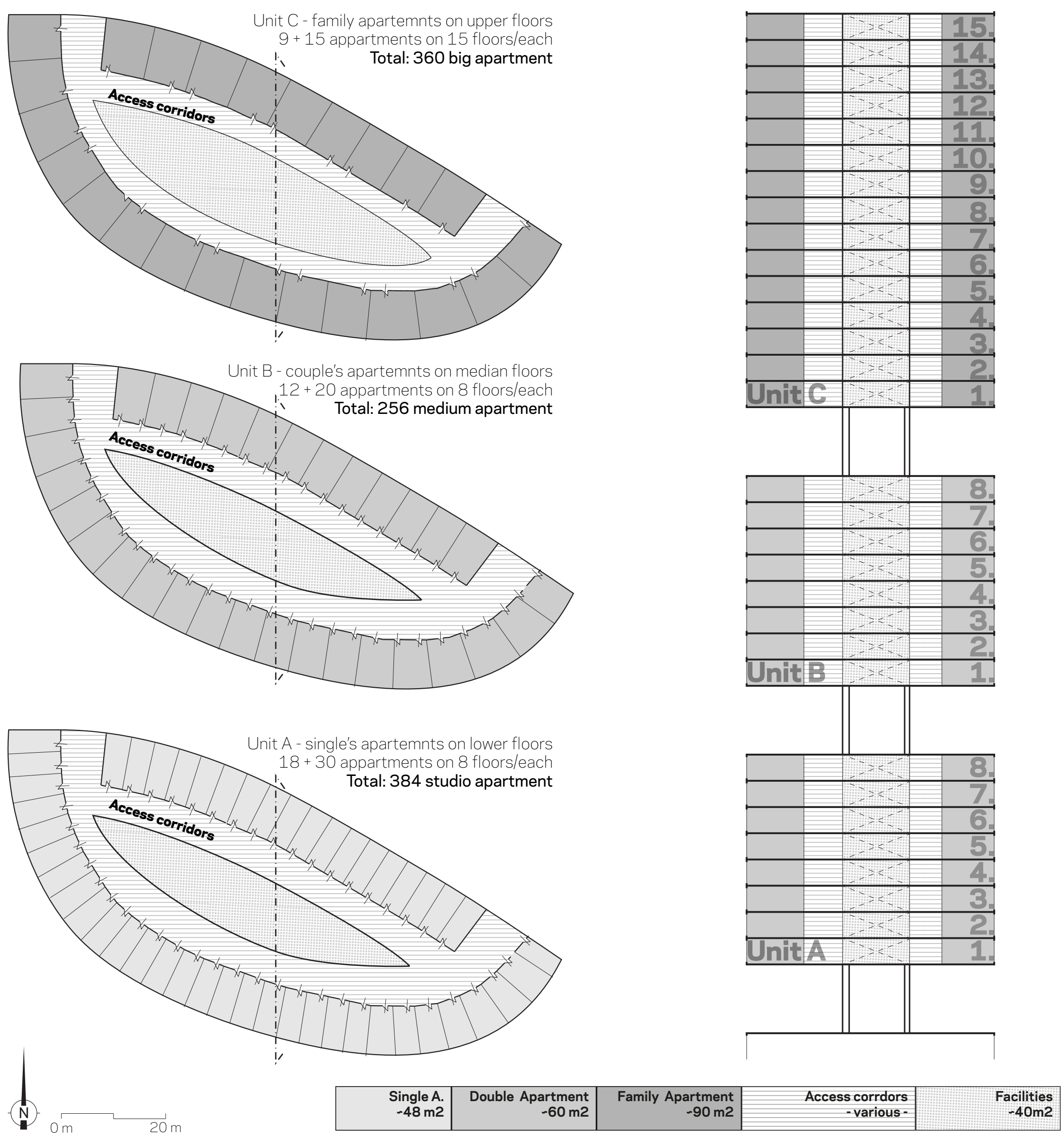
To understand floor plan layout within the building, apartments must be placed within the form. Each living unit has entrance from the corridor, accessible from the core. Each living unit has windows on one side, therefore facade has been elongated and interior space opens up from the inner part towards to the outer perimeter. Living units does not have perpendicular sidewalls, but they are radial from out of the center of the core.

Initial sketching intended to find optimal angle while keeping dimensions and areas determined in the program.

From the basic circular form, where core occupies huge inner are, to pointed oval shape where facade line is adjusted to natural light gain and views, footprint evolves to an optimal layout where core slimmed down and problems of the apartments of the corners eliminated.

It is important to make apartment layout possible with all sizes while keeping the form along the building.

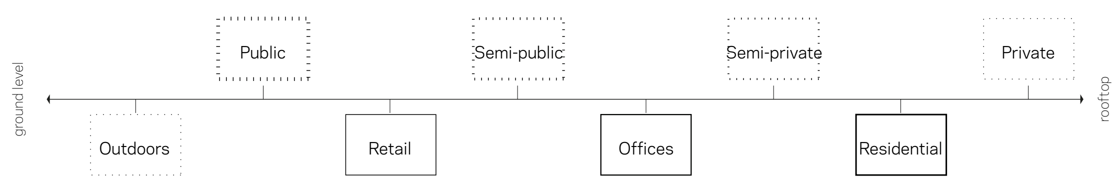


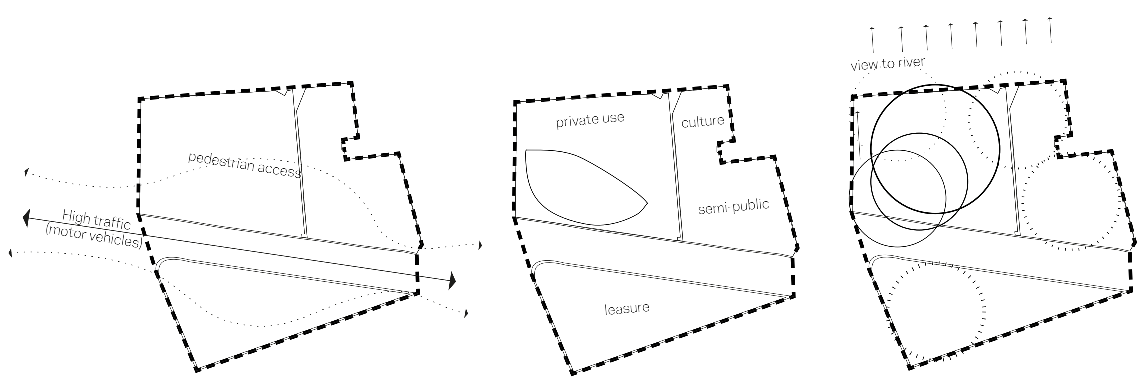

Unit C - family apartemnts on upper floors
9 + 15 appartments on 15 floors/each
Total: 360 big apartment
Access corridors
Unit B - couple's apartemnts on median floors
12 + 20 appartments on 8 floors/each
Total: 256 medium apartment
Access corridors
Unit A - single's apartemnts on lower floors
18 + 30 appartments on 8 floors/each
Total: 384 studio apartment
Access corridors
15. 14. 13. 12. 11. 10. 9. 8. 7. 6. 5. 4. 3. 2.
Unit C 1.
8. 7. 6. 5. 4. 3. 2.
Unit B 1.
8. 7. 6. 5. 4. 3. 2.
Unit A 1.
N
0 m
20 m
Single A. -48 m2
Double Apartment -60 m2
Family Apartment -90 m2
Access corrdors - various -
Facilities -40m2

Building capacity

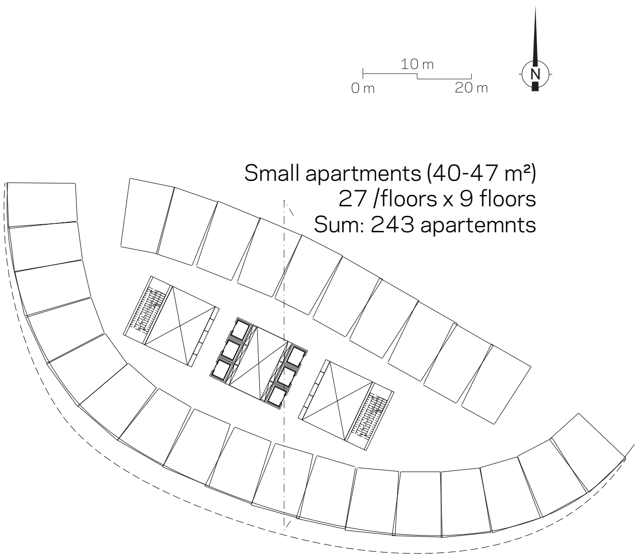
As a reference point for comparison average population density will be regarded.
Average population density in China exceeds 139 ps/km². Shanghai stands out among China's cities by its sheer size of 6340 km² and its population density of 22 700 ps/km² in the central city, in fact, city high spots like Huangpu and Pudong had a population density over 60 000 ps/km².
Urban infrastructure in shanghai calculates with 8 m² living space and 1.7 m² open space per capita.
[Source: State Statistical Bureau (1995, 1996).]

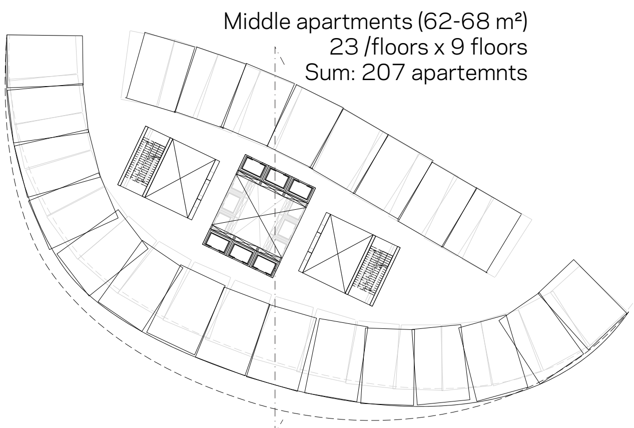
Summarizing the building capacity these numbers must be regarded as bottom limit, but improvement is expected.
In 29 floors, about 3 700 residents live on total 8 200 m² floor area. Density along the building, just as density along the city's section, is changing; average living area per person under 25 m² on lower floors, between 25-30 m² on middle floors, and above 40 m² on upper floors.
Outdoor areas provide almost 40 000 m² green spaces for about 7 000 users.

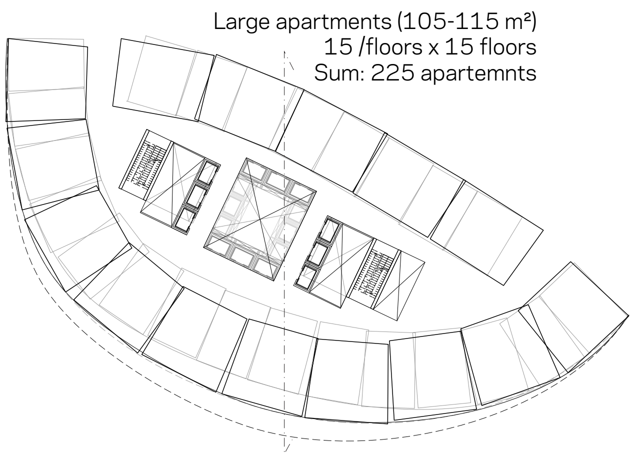


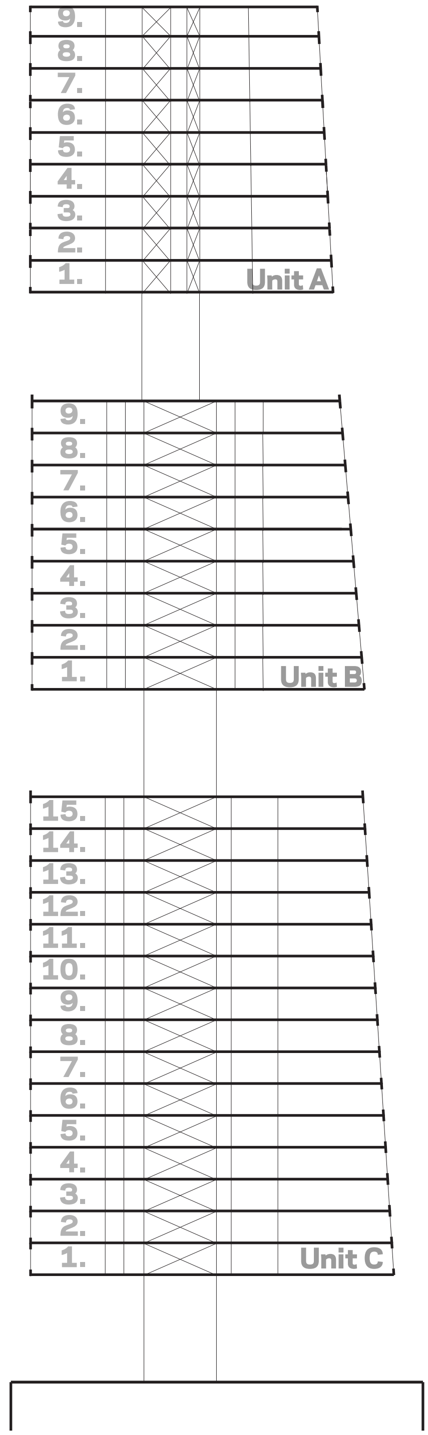


FUNCTIONS	Retail	Office	Residential	Open	Private	Public
Area	13 500 m²	23 500 m²	82 000 m²	10 900 m²	8 500 m²	14 500 m²
Large [m²]	3500 - 3200	2700 - 3200	2600 - 2700	3200	8500	10500
Medium [m²]	-	-	2500 - 2550	2700	-	10500
Small [m²]	-	-	2350 - 2400	2500	-	3500
Percentage	10 % of volume	20 % of volume	70 % of volume	30 % of site	23.5 %	40 %
Total built-in area	119 000 m²					33 900 m²
built-in ratio	400 %					95 %


10 m
0 m
20 m
N
Small apartments (40-47 m²)
27 /floors x 9 floors
Sum: 243 apartemnts


Middle apartments (62-68 m²)
23 /floors x 9 floors
Sum: 207 apartemnts

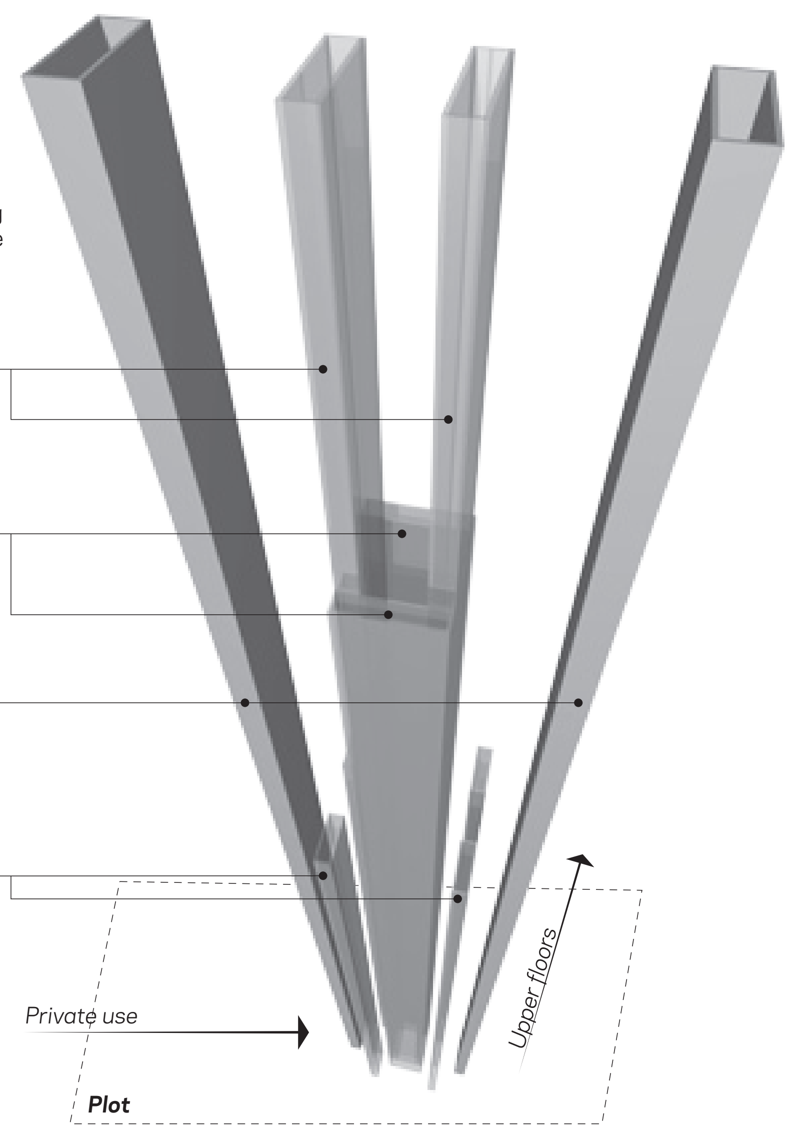

Large apartments (105-115 m²)
15 /floors x 15 floors
Sum: 225 apartemnts


9.
8.
7.
6.
5.
4.
3.
2.
1.
Unit A
9.
8.
7.
6.
5.
4.
3.
2.
1.
Unit B
15.
14.
13.
12.
11.
10.
9.
8.
7.
6.
5.
4.
3.
2.
1.
Unit C

Sketching on building core

Building core of a high-rise structure takes up a considerably big place of the floor areas; therefore it must be designed judiciously.

Core of the high rise structure acts as a backbone of the building. Besides determining stiffness and bearing most of the loads of the structure, it gives place for the vertical transportation system, building services, all plumbing and electrical cabling, and fire escape routes.



High Zone Elevators
private access to single apartments on upper floors

Middle Zone Elevators
private access to couples' apartments on middle floors

Fire Escape Routes
insulated emergency stairs meet with widths calculated according users

Low Zone Elevators
private access to families' apartments on lower floors

on ground floor all elevators must be acccessable

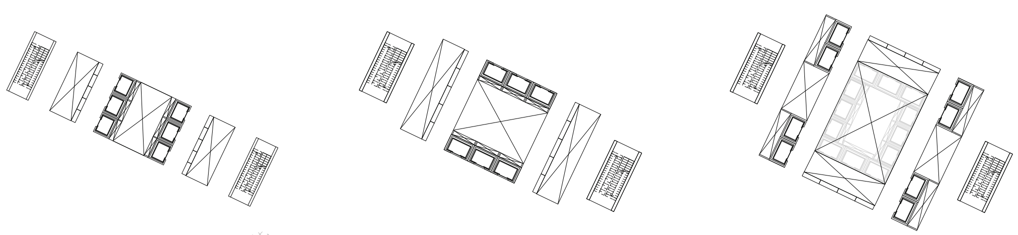
All elevators must be accessible from the fist level in the same time.
High zone elevator programmed to stop on 9 floor and highest open floor to serve residents of single units.

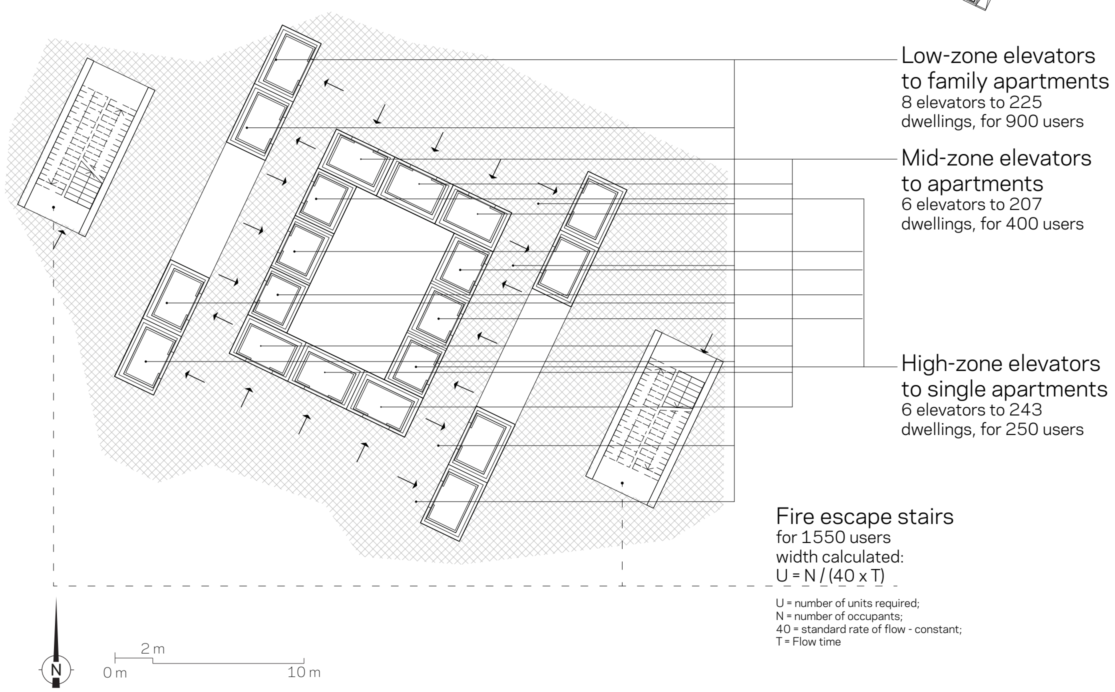
Mid zone elevators transport between floors of couple's apartments and open floors.
Low zone elevators transport to lower floors with family apartment and open stories.

Higher core: 300 m²
Floor area: 2 350 m²

Midle core: 435 m²
Floor area: 2 600 m²

Lower core: 635 m²
Floor area: 2 700 m²





Aalborg Universitet | ad:mt - Department of Architecture, Design and Media Technology
Timea Török - 20081144 - ttorok08@student.aau.dk

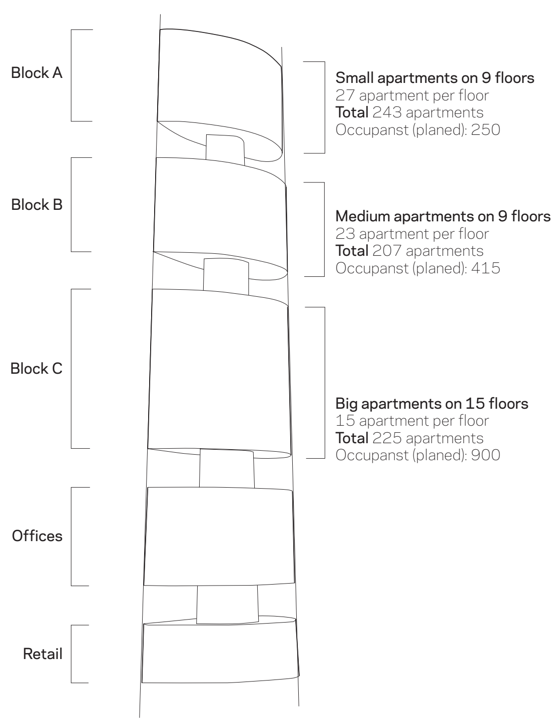
Detailing of concept

With initial values, correct orientation and form, overall building has initial PHPP results. During the process, the main goal is to fulfil the technical goals stated in the end of the analysis phase; and to reduce energy needs while keeping the architectural values.
It is important to provide good quality natural light indoors, to calculate specific heat and cooling demands while evaluating architectural expression simultaneously.

PHPP calculation confirms technical solutions for the reference block. These tests mainly focus on specific heat demand and specific primary energy demand for reference block; with 24 hours average and month average spreadsheets. These calculations also help define the threats of overheating and daily temperature swings. After each significant change in building elements, calculation will be made to check on the influence in the PHPP results.

ECOTECT and VELUX used in parallel to simulate the quality and quantity of natural light inside the reference apartment. Different layouts, window dimensions and shading systems will be tested in order to find the best solution to fulfil energy demands and indoor comfort requirements, while keeping a nice exterior expression of the facade. The amount of luminance, daylight levels and daylight penetration is considered during detailing. ECOTECT is also used in the same time in order to analyze indoor comfort and chart indoor temperature and humidity.

Development on concept placed open floors in the volume and it break compactness; three separate blocks are defined. Further detailing will calculate blocks as separate building volumes.



Test 8:

Specific Space Heat Demand: 17.40 kWh/m^2a
Specific Primary Energy Demand: 53.00 kWh/m^2a
Frequency of Overheating: 85.4%
Daily temperature swing due to solar load: 1.7 K

Test 7:

Specific Space Heat Demand: 15.60 kWh/m^2a
Specific Primary Energy Demand: 51.00 kWh/m^2a
Frequency of Overheating: 86.5%
Daily temperature swing due to solar load: 1.6 K

Test 6:

Specific Space Heat Demand: 13.20 kWh/m^2a
Specific Primary Energy Demand: 50.00 kWh/m^2a
Frequency of Overheating: 86.6%
Daily temperature swing due to solar load: 1.5 K

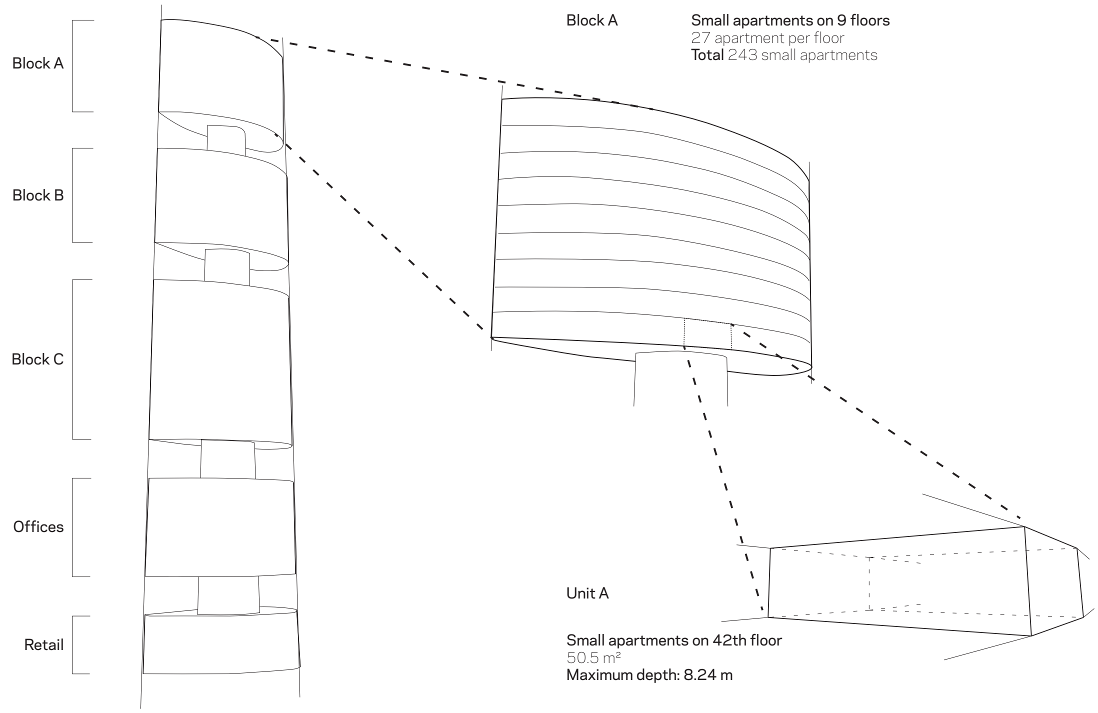
*For more precize results, climate data has been changed from preset values to climate specific values.
[METEONORM Version 6.1.0.23]
Results have been calculated for total buidling envelope and for separate blocks individually. Results are displaying values with preset building elements and without specific U-value calculations.

Block A consists 27 small apartment units on 9 floors, total 243 living units. Small apartments are designed for single resident; only one occupant planed per unit. Calculation was made for the whole block, with volume of 88 641 m3, and 2 345 m2 of treated floor.

Block B has medium size apartments, 25 living units on 9 floors gives 207 apartments. Medium size apartments are designed for couples; therefore the number of planned occupants is two per unit. Calculation was made for block, total 95 634 m3, and 2 530 m2 treated floor area on each floor.

Block C has big size apartments, 15 living units on 15 floors provide 225 apartments. Big size apartments are designed for families; therefore minimum 4 occupants are planned per unit. Calculation was made for whole block, as 168 588 m3 of total volume, and 2 676 m2 treated floor area.

Overheating is expected; hence initial calculations are made without external shading device. However overheating appears in all blocks, Block A has the highest frequency for overheating and highest daily temperature swing.
Therefore Block A has been selected for further detailing of exterior shading.
If its results fulfil the requirements in this division at the end of the detailing phase, than all blocks considered with acceptable values.
Among all apartments of this block the bottom floor's middle apartment has been chosen for indoor comfort testing. This apartment has the largest depth and it is the most exposed for overheating.

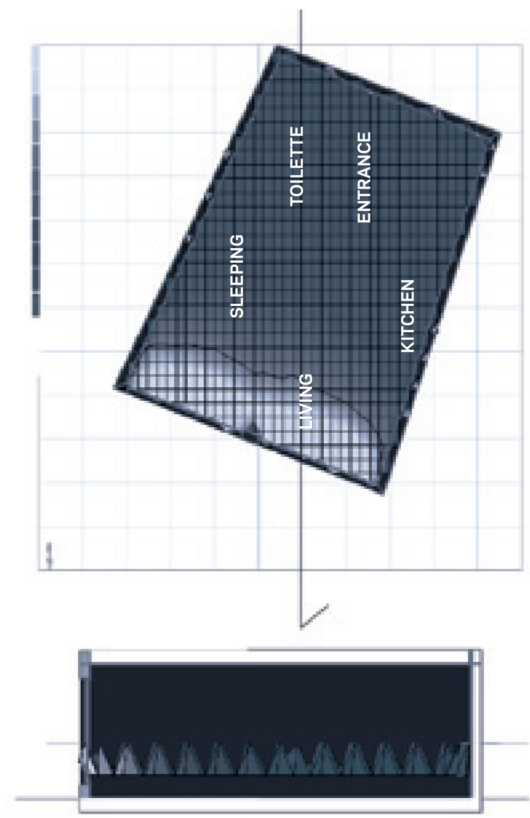


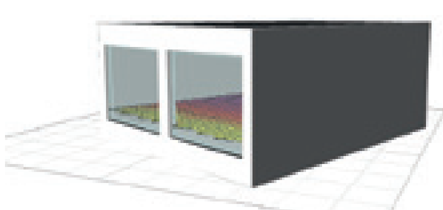
Reference apartment

A small living unit on the upper section of the building was chosen to introduce living circumstances as a reference apartment. Apartment has windows just on one side, and surface area is relatively small. It is important to investigate daylight levels indoor, whether there is enough natural light for the different functions or is it necessary to improve the quality of luminance in order to achieve a better indoor environment.

For further detailing on the layout, small apartment is tested with empty interior to understand measures and dimensions, and to gain a general overview of the possibilities of functions layouts.

Human scale detailing, improvement on indoor climate and for better experience, sketching, Ecotect, Velux analysis and working models were used in decision making.





Apartment layout

During sketching on apartment layout space requirements, daylight needs, indoor comfort factors are very important to keep.
As a first step daylight needs of different functions must be fulfilled; while keeping indoor comfort human perception from inside in mind.

Natural light within the apartment is very important for more reasons; therefore small dark places and unnecessary corners are avoided. Functions requiring more daylight are placed closer to openings; entrance and bathrooms placed at the back of the apartment.
Although building services not in the focus, wet rooms are placed consciously.
Two different layouts has been tested with large window areas to make sure if there is enough daylight for residents.

Room usage:

1. Entrance 5.87 m²
2. Bathroom 5.48 m²
3. Kitchen 7.44 m²
4. Bedroom 8.86 m²
5. Living 22.05 m²

Total: 50.5 m²

Layout A for small apartment

Layout B for small apartment

Light conditions in small apartments

According to natural light needs, daylight levels in reference apartment have been tested with several settings (seasonal results for both layouts attached in Appendix E).

Comparison between layouts is displayed. ECOTECT tests show illuminance levels 21st September with intermediate sky conditions. Given the fact that the reference apartment facing to East, it is more expressive to investigate autumn equinox when altitude angle of the sun is average. This way, general results would show difference between layout solutions.

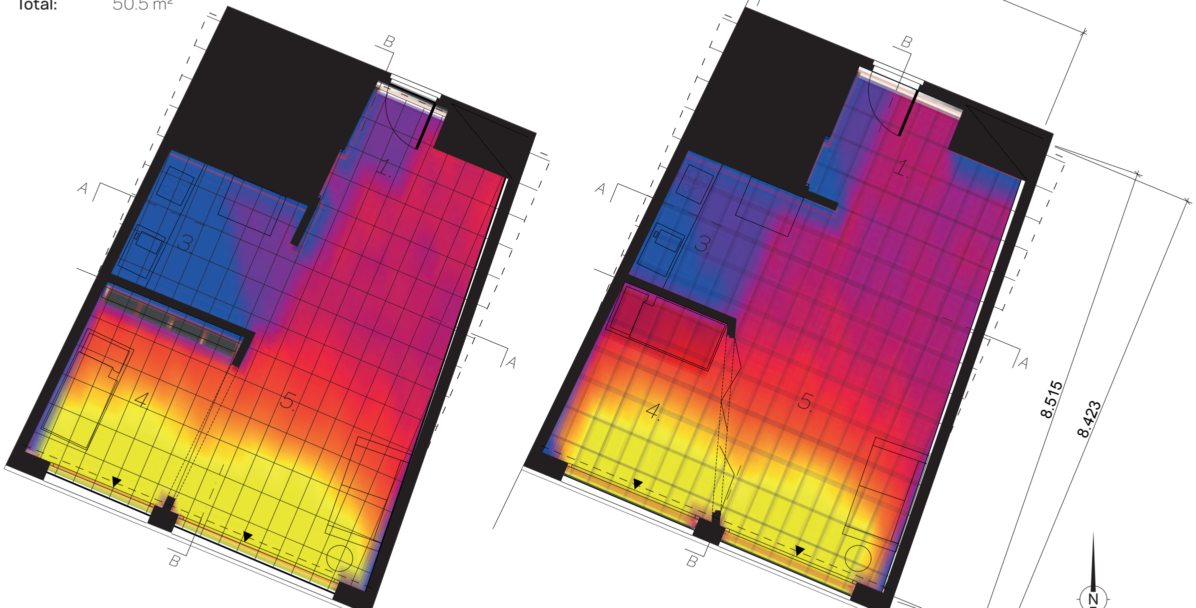
Layout A has smaller bedroom area, partition wall follows angle of the side, and space opens up towards to the window. Layout B has bigger bedroom area; kitchen gets more natural light, but view is framed and limited.

Although bedroom area is not necessarily closed in either of the layout, impression of window division is very important. Division must provide nice view of panorama and sense of space.
Final layout follows version B, but further improvement of window sizes and division.

Room usage:

1. Entrance 5.87 m²
2. Bathroom 5.48 m²
3. Kitchen 7.44 m²
4. Bedroom 8.86 m²
5. Living 22.05 m²

Total: 50.5 m²



Testing window sizes

Daylight levels during some period and in certain conditions are extremely bright. Huge window area facing towards to South, Southeast, also results in overheating in summer period. Overheating is much over 10%, which means it must be corrected.
PHPP calculations are used to define window area in order to avoid high energy needs due to cooling. Starting with maximized window surface until minimal required window-floor ratio, tests show specific heat demand, daily temperature swing and frequency of overheating.

According to requirements, minimum window areas are must be at least 1/8th part of the total floor area. Given 50 m^2 floor area of the reference apartment - result is minimum 6.3 m^2 window surface on the facade.
Maximizing the window on facade gives 12.5 m^2 clear window area.
Although adjustments on window sizes lowered frequency of overheating a bit and daily temperature swing has been reduced significantly, shades and summer shades are required for further improvement of the design.

Max. window areas 3.00 m by 2.50 m (2) [12.50 m^2]
Test 9:

Specific Space Heat Demand:	18.3 kWh/m^{2}a
Cooling Load	74.00 kWh/m^{2}a
Frequency of Overheating:	84.7%
Daily temperature swing due to solar load:	2.1 K

Med. window areas 2.00 m by 2.50 m (2) [10.00 m^2]
Test 10:

Specific Space Heat Demand:	17.40 kWh/m^{2}a
Specific Primary Energy Demand:	74.00 kWh/m^{2}a
Frequency of Overheating:	85.4%
Daily temperature swing due to solar load:	1.7 K

Min. window areas 1.25 m by 2.50 m (2) [6.25 m^2]
Test 11:

Specific Space Heat Demand:	16.40 kWh/m^{2}a
Specific Primary Energy Demand:	73.00 kWh/m^{2}a
Frequency of Overheating:	85.5 %
Daily temperature swing due to solar load:	1.1 K

*For improvement on results, reference block has been used for tests. On nine storeis two windows per unit was counted with different angles along the facade. Window type has been changed from double glazed to double low-e glazed windows to improve their U-values. Layers of details have been improved and updated. Ventilation has been added, and now shades were calculated with window size-tests.

Apartment layout and window area

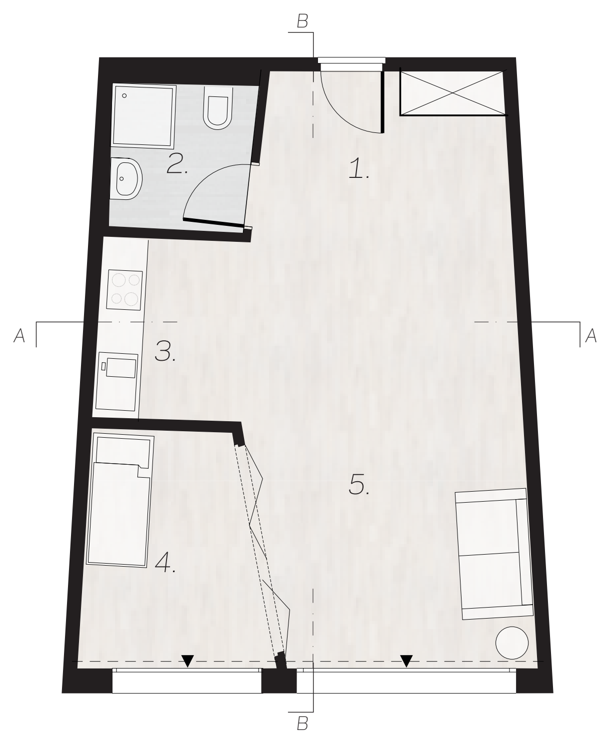
As it was already researched and stated in the previous parts, material use inside the apartment is important for human health, for indoor climate and also for overall building performance.
Colours and textures, reflective index of material can improve or downgrade interior lighting significantly.

Given the structure of the building, lightweight walls used inside, with proper insulation between dwellings and towards to the corridor. The finish of the internal walls are mostly matt, to avoid glare, but more glossy at the entrance to get more light.
Wooden floors are cosy and well insulating at the floor partitions.
Colours have huge influence in experiencing spaces; different colours have been identified with psychical comfort. Colour use inside are warm, bright colours to project calmness and welcoming feeling.

Dwelling units are only required to have operable windows up to 5th floor; above that indoor air quality requirements can be provided by mechanical systems. With height wind pressure can be large and dangerous, moreover fixed windows also protect against poor urban air quality or pollution episodes.

Design will follow moderate size windows, but further improvements are required. Apartment depth needs light, but overheating must be solved. Living room has wide window area to provide view over the city,

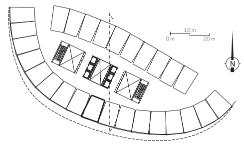
Moreover residents still have responsibility in forming their living space. It is important to keep principles, furnish consciously and follow advices, guidelines (e.g. plants).



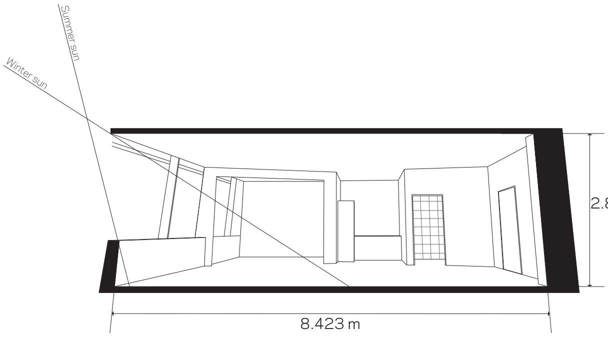
Room usage:

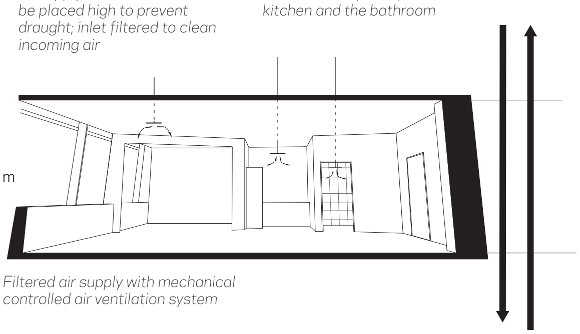
1. Entrance	5.87 m²
2. Bathroom	5.01 m²
3. Kitchen	7.44 m²
4. Bedroom	8.83 m²
5. Living	23.35 m²
Total:	50.5 m²

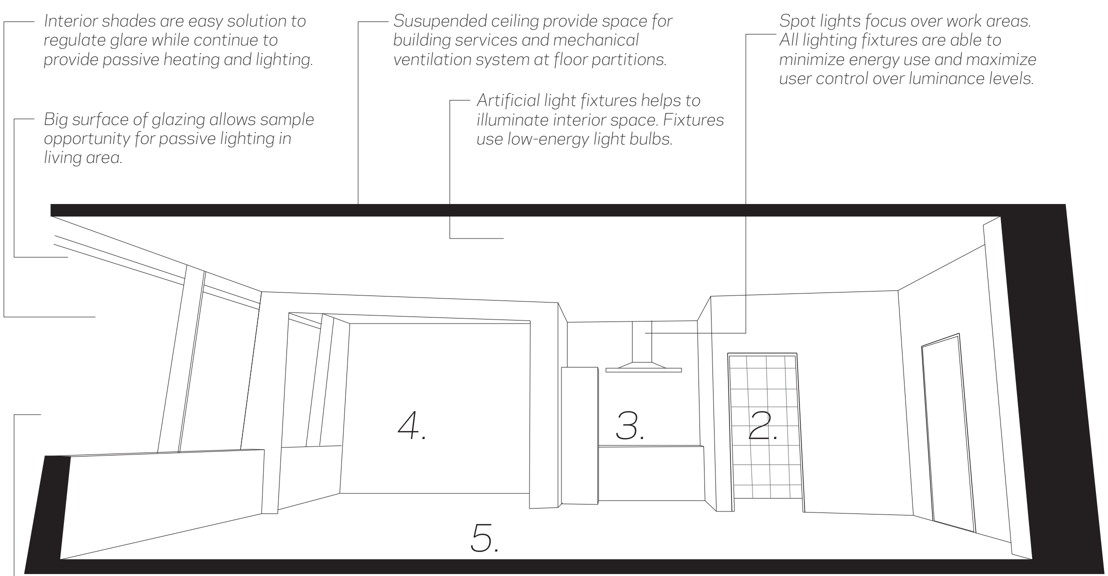
Small apartments (50 m²)



Plan REFERENCE APARTMENT
Scale 1:100


Summer sun
Winter sun
2.80 m
8.423 m


air supply in the room has to be placed high to prevent draught; inlet filtered to clean incoming air
suction takes place from at least the kitchen and the bathroom
Filtered air supply with mechanical controlled air ventilation system


Interior shades are easy solution to regulate glare while continue to provide passive heating and lighting.
Big surface of glazing allows sample opportunity for passive lighting in living area.
Sususpended ceiling provide space for building services and mechanical ventilation system at floor partitions.
Artificial light fixtures helps to illuminate interior space. Fixtures use low-energy light bulbs.
Spot lights focus over work areas. All lighting fixtures are able to minimize energy use and maximize user control over luminance levels.
4.
3.
2.
5.
Exterior shades, fixed and temporary, regulate heat gain and reduces overheating of the apartment.
High efficiency and high energy classified appliences.
Glossy white surface increase luminosity at the entrance.
Moderate glossy, bright colored flooring reflects light upwards to illuminate living area.
Ventilation system according to program, use and number of users in each zone.

Window frame and shades

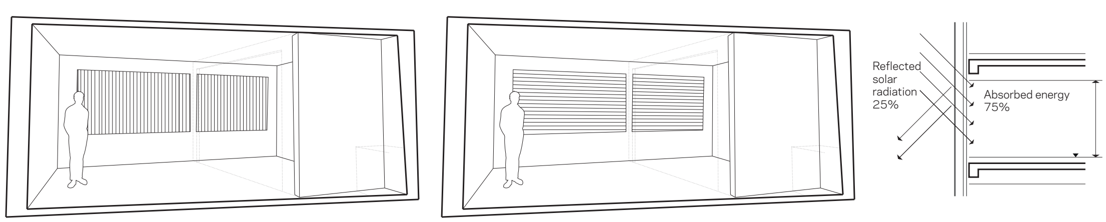
After deciding on window sizes, window frames and divisions must be considered as well. Frame and division is very important in order to achieve good experience for resident and it must not disturb the view to outside.
Division must avoid disordered position and height. Frames have a huge role in building performance; type, material, and length of perimeter influence energy need significantly.

Shading is important to calculate for protecting against overheating, but in the same time human perception, natural light levels and expression must be considered simultaneously.

Shutters shade and filter light. The perception of light inside the apartment is changed; expression of the facade is redefined by adding extra shading systems. Shading system are also lower the risk of overheating; and according to previous result on PHPP calculations, shades are necessary to implement into the design.

Material and form of shades are very important also for expression and for performance. Permanent or temporary, fixed or mobile shading system could be used according to needs.
Shutters placed outside are more effective in a sense that they prevent already the glazing to heat up and further transmit the heat to the interior. Moreover they provide privacy, help glare control and insulation.

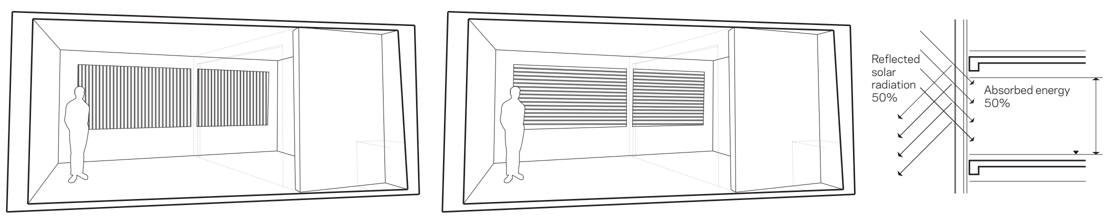
PHPP tests are continued to test different density of shading. Tests with different percentage of shading shows that 50% of shading already improves overheating, but to further reduce overheating, additional summer shades are introduced to the design.



25% of shading

Test 12:

Specific Space Heat Demand:	81.8 kWh/m²a
Cooling Load	116.0 kWh/m²a
Frequency of Overheating:	18.8 %
Daily temperature swing due to solar load:	0.5 K



50% of shading

Test 13:

Specific Space Heat Demand:	79.2 kWh/m²a
Specific Primary Energy Demand:	114.0 kWh/m²a
Frequency of Overheating:	18.8 %
Daily temperature swing due to solar load:	0.5 K

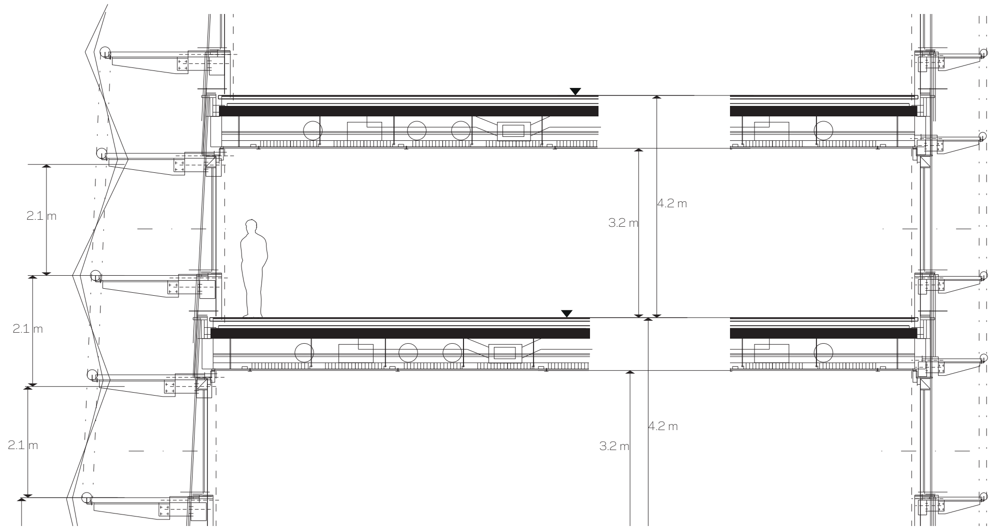
Appropriate shading practices reduce the chance of exposure to harmful UV rays; planting is a low cost, low energy provider of shade that improves air quality by filtering pollutants.

The shading device depends on the orientation and the solar altitude. Horizontal shading device is the most efficient when the solar altitude is this high; usually horizontal overhangs used on South facade, but towards to the West and East vertical shades better when solar incidence occurs early or late hours of the day.

Working with a high structure, balconies are not commonly used. As shading system external solar panels has been chosen.
Fixed device has several advantages; longer lifetime, lower maintenance, less user effort, lower costs.

Angle and position of the panels are determined by the sun path.
Perforation and density of the panels are determined according to the program of the space behind.
Size and fixture of the panels are defined according to structure.

As summer shading, green wall has been developed on the facade. Given the extreme height and the waste conditions, local specific vegetation is placed on different levels, and it does not expected to grow high.



View to South
External shading system | panels

View to North
Summer shades | greenwall

50% of shading and summer shading

Test 14:

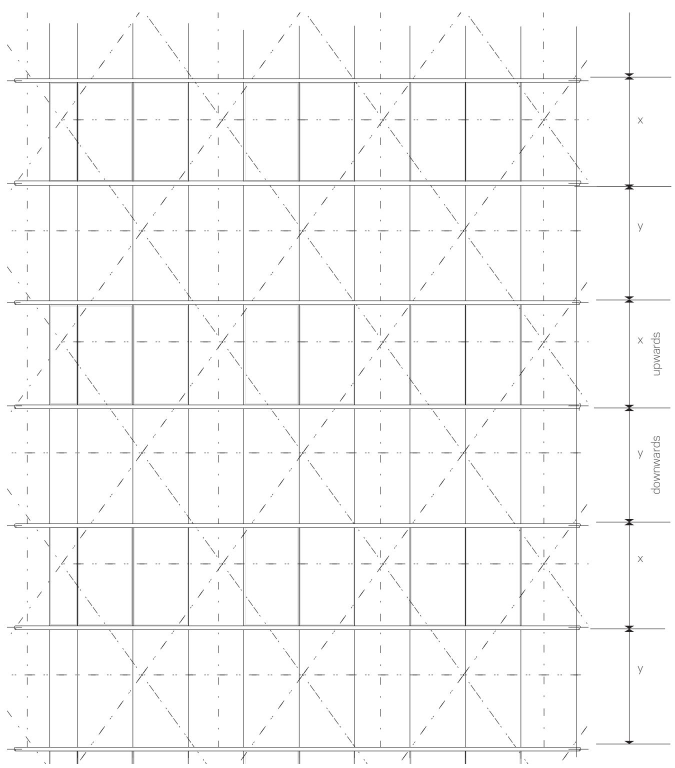
Specific Space Heat Demand:	75.6 kWh/m²a
Specific Primary Energy Demand:	112 kWh/m²a
Frequency of Overheating:	17.6%
Daily temperature swing due to solar load:	0.0 K

*For improvement on results, reference apartment has been used for tests. As a continuation of the tests on window sizes, two window has been used per unit. To find a solution for overheating, the ventilation has been improved and additional shading was added to the calculation, moreover temporary shades have been applied.

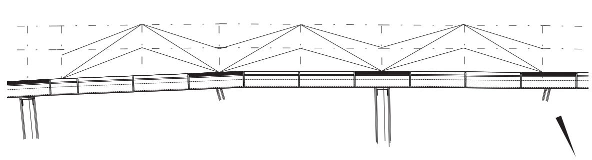
Shading panel study

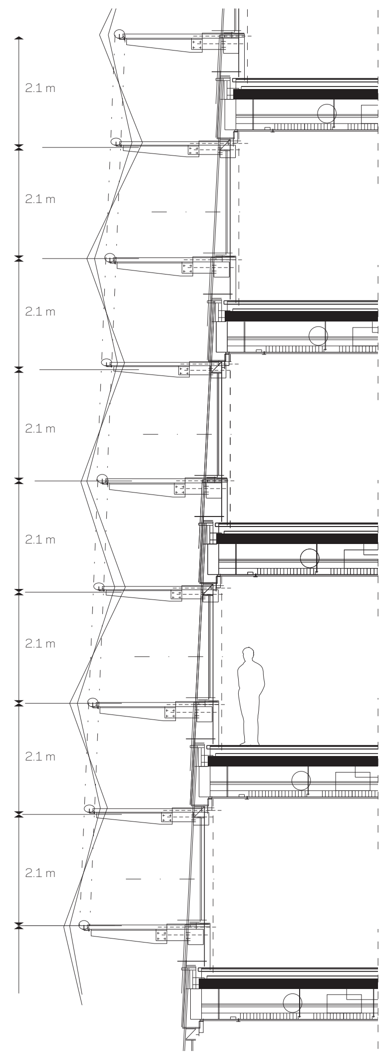
South facade of the building covered with triangulate shading panels.
Perforated panels have been added to the existing structure. Steel grid structure is mounted on the load-bearing system to support the panels.

Two rows of panels are placed on each floor; division considers view; horizontal lining tends to break vertical length of the building.
Pattern of facade is given by the position of the elements. Each surface component reacts to solar radiation in position. The density of the perforation provides texture to the facade; perforation pattern made according to the program type behind the panel.

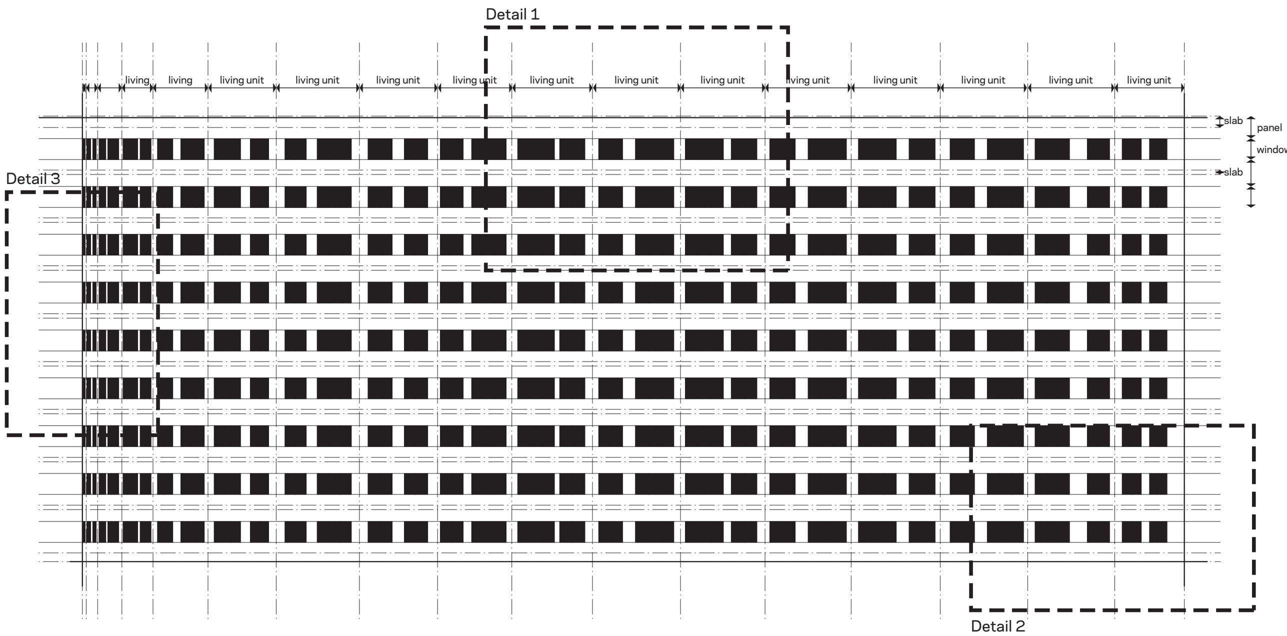


Front view of South Facade | Panel division

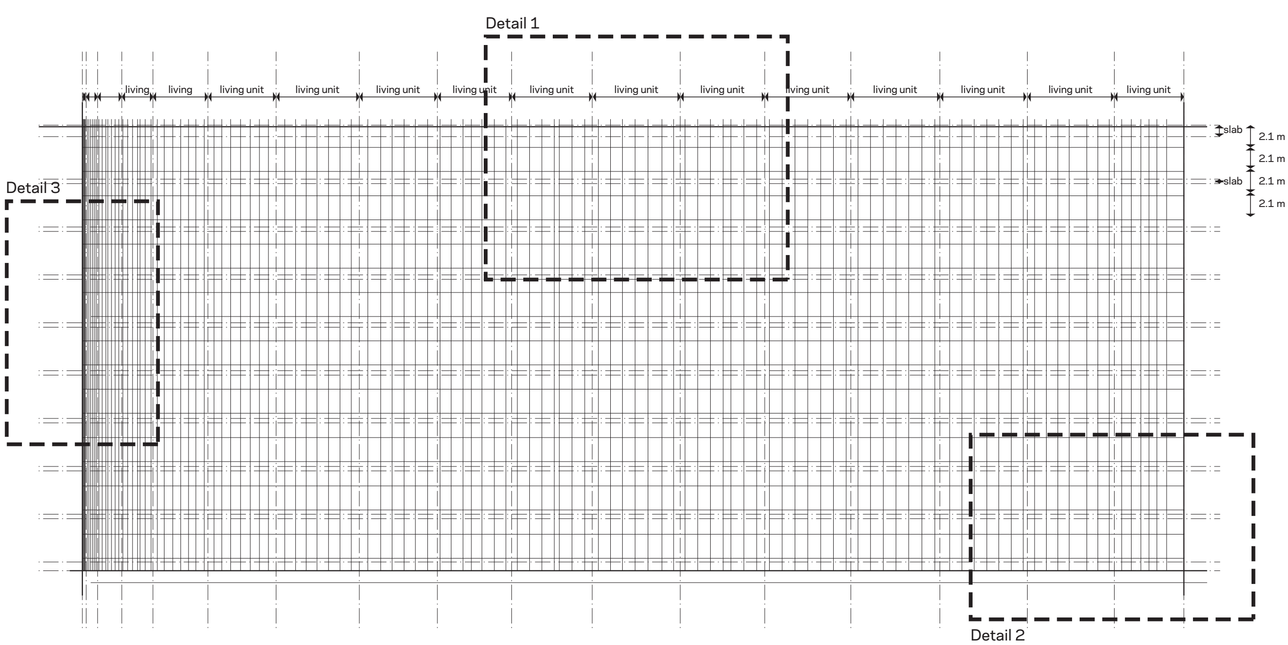

Plan detail of North Facade | Fixing system



Section of North Facade | Shading



Window pattern on South elevation of reference block



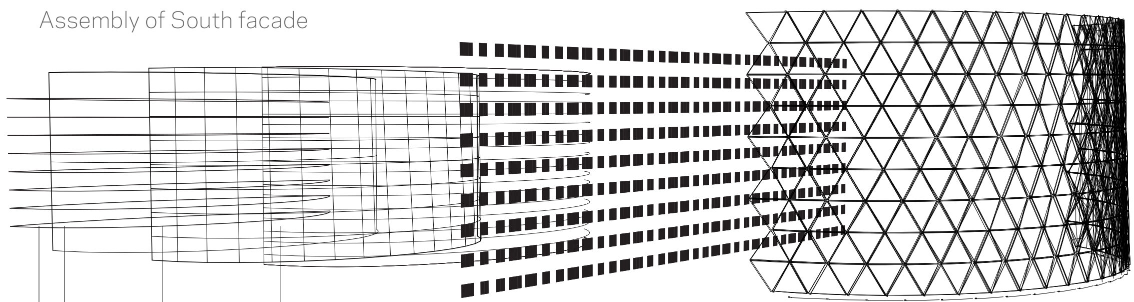
STructural system on South elevation of reference block

Shading panel study

In first phase, four different types of panel pattern have been defined. The panels had 90, 75, 50 and 25% of shading factor. Initial tests showed too big difference in expression, texture was broken at connections and overall expression was not flawless.

For further development, to make texture more homogeneous, pattern is not divided for panels, but for whole surface. More and less densely perforated areas are changing each other according to the window pattern. Where window located behind the panel, perforation is more open, but if panel covers structure, perforation is less.

Assembly of South facade



Window division
Lines of top and bottom of openings

Window pattern on primary facade generates shading coifficeincy, therefore density of perforation of the panels.

Grid of panels is fixed on load-bearing structure.
Panles fixed on grid; all surfaces are flat, and streched, not scaled.

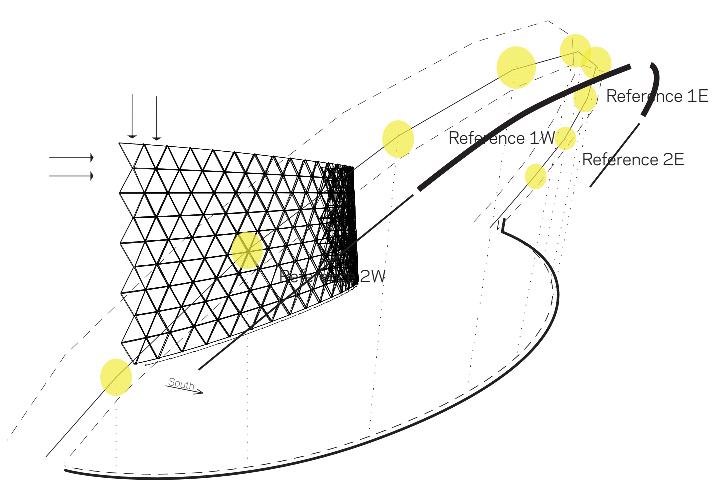
Load-bearing structure
Floor slabs

Primary facade
Curtainwall - already angled

Load-bearing structure
Floor slabs

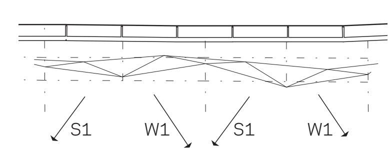
Perforation of panels depends on thetype of program behind; it is more dense if it coveres structure, and less dense if it is front of opening.
The unique texture creates a nice expression.

[surface-loft: rebuilt (18x34)ptOn_mesh_ptGridSurfaceDistance_dense]

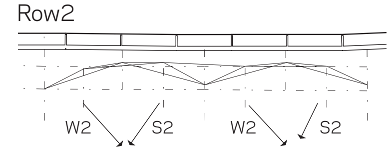


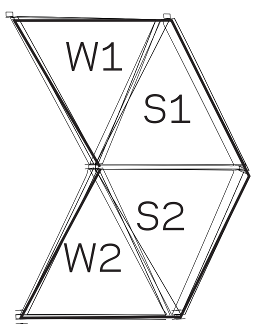
Position of panels is generated by the sunpath diagram. Sunpath is devided into 4 part, as 4 reference curve of the positioning.

Row1

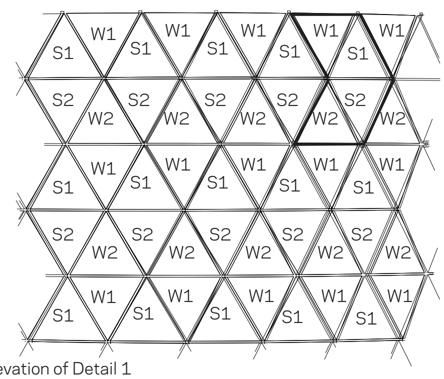


Row2



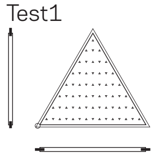


Surface component with four tyes of position

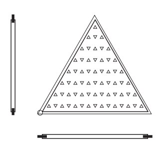


Elevation of Detail 1

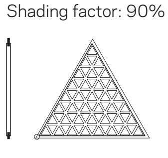
Test1



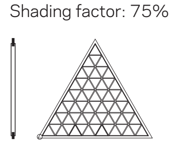
Shading factor: 90%



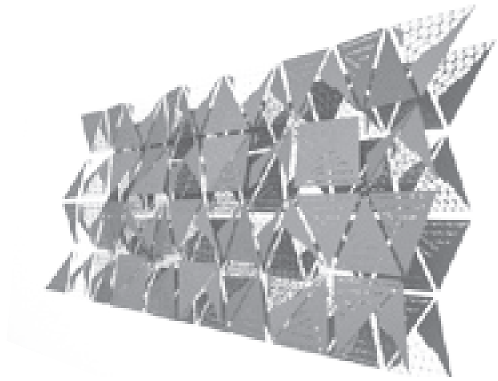
Shading factor: 75%

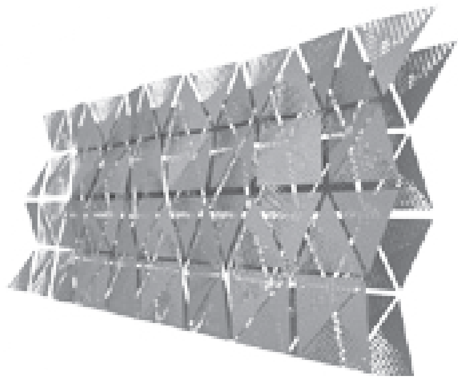


Shading factor: 50%

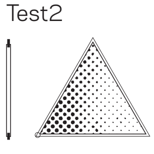


Shading factor: 25%

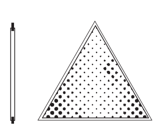




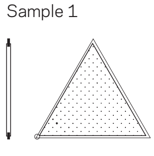
Test2



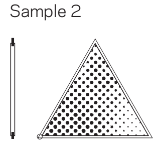
Sample 1



Sample 2



Sample 3



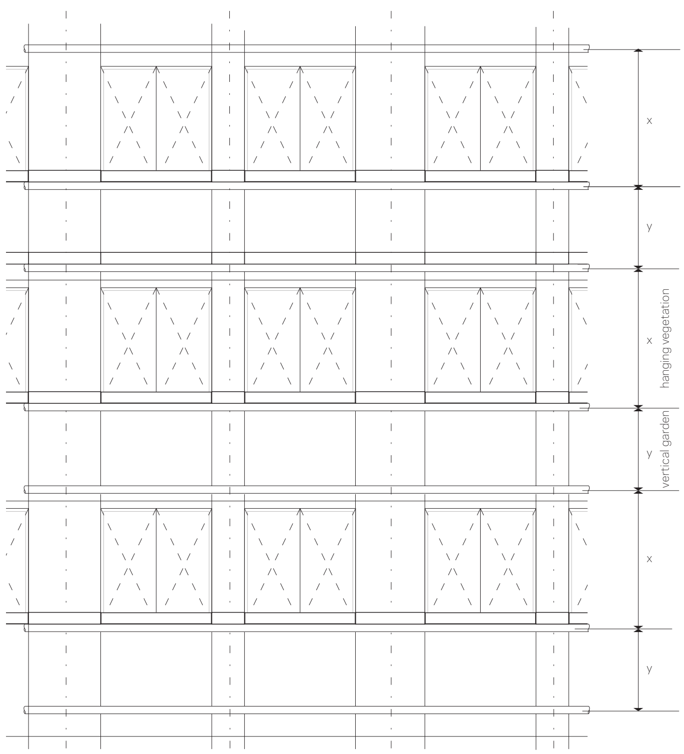
Sample 4

Green wall study

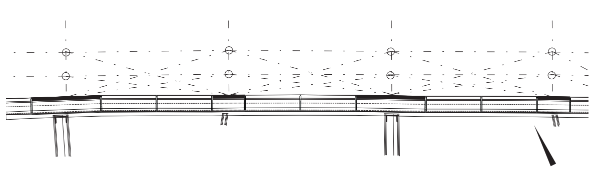
Besides developing shading panels on South facade; North facade has vertical green wall as secondary “skin”.

As the semi-private garden is situated at the North part of the site, with nice landscaping, green wall will be a continuation of the vegetation giving a natural flow and organic expression to the complex.

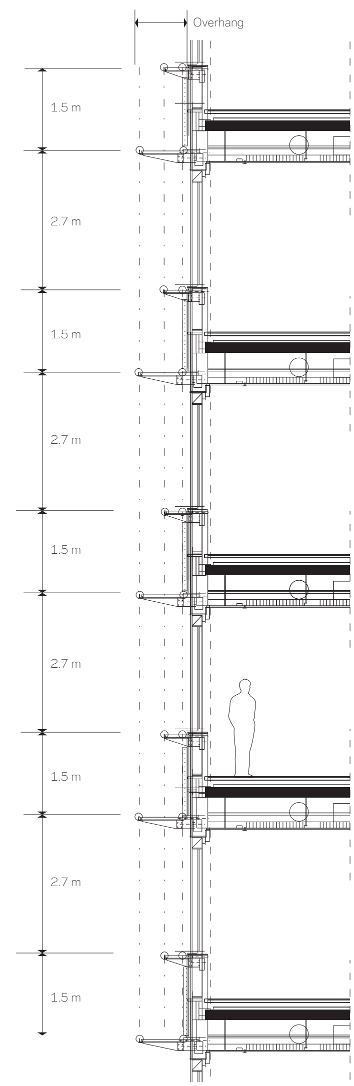
Structure for supporting plants is divided into two rows on each floor, in a way not to disturb the view. Truss structure fixed on load-bearing system.



Front view of North Facade | Green wall with vegetation



Plan detail of North Facade | Wall support system

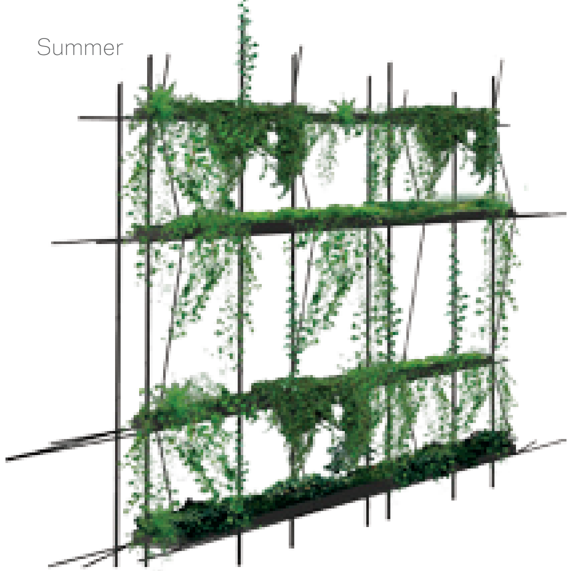


Section of North Facade | Summer shading

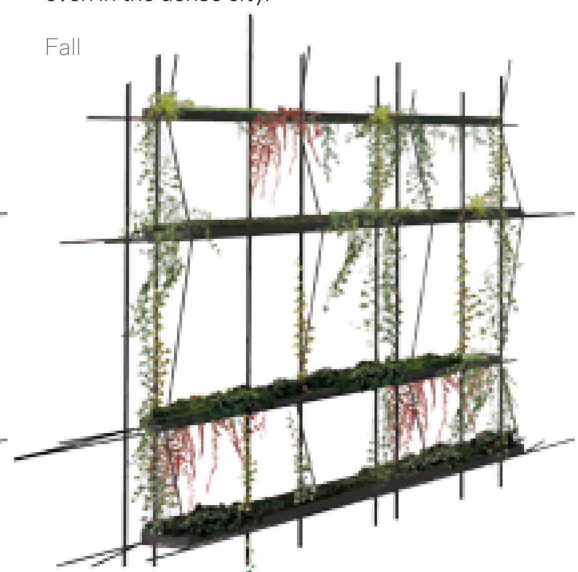
Seasonal experience on green facade

To create an artificial landscape in the heart of the running city, green areas has been emphasised with green wall on facade. High rise structure not commonly using natural materials; therefore maximized green areas must act as a connection to the nature.
Besides improving on microclimate and contributing to the urban air quality, green wall provides certain diversity to the building, which would change with the seasons.
Green wall have a more organic and natural presence in the high-tech city center.
Vegetation is good for summer shading, air purification; it brings residents closer to nature even in the dense city.

Summer

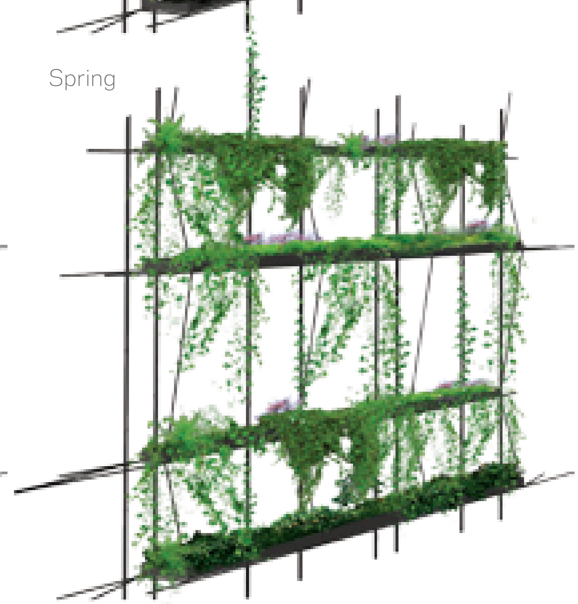


Fall



Winter

Spring



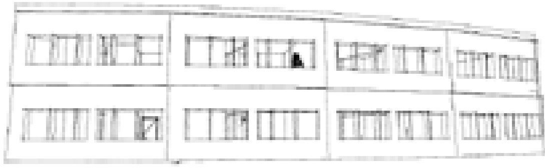
Adjusting windows

After adjusting the secondary facade, window openings must be adjusted on primary facade.

Different size of windows is placed on primary facade to fulfil requirements of the different size of apartments; it creates a disorganized look. Although it can be improved and organized better, secondary facade covers windows' grid.

Panels of secondary facade will give a different expression to the building, emphasizing architectural values. Texture is provided by the shading coefficient of the panels, and pattern is given my structure.

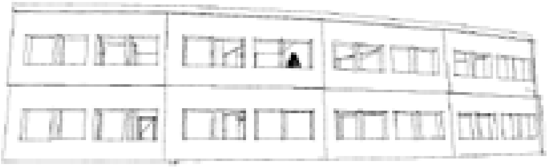
Therefore window sizes and frames are adjusted just according to the calculations. Division is not acting on expression of the facade, but divisions are affecting energy needs.
Window area did not change, but the length of the perimeter grew.
PHPP calculations have been made in order to check energy needs and frequency of overheating.



Window frames of 1.0 m by 1.25 m

Test 15:

Specific Space Heat Demand:	74.8 kWh/m²a
Cooling Load	111 kWh/m²a
Frequency of Overheating:	16.0 %
Daily temperature swing due to solar load:	0.1 K



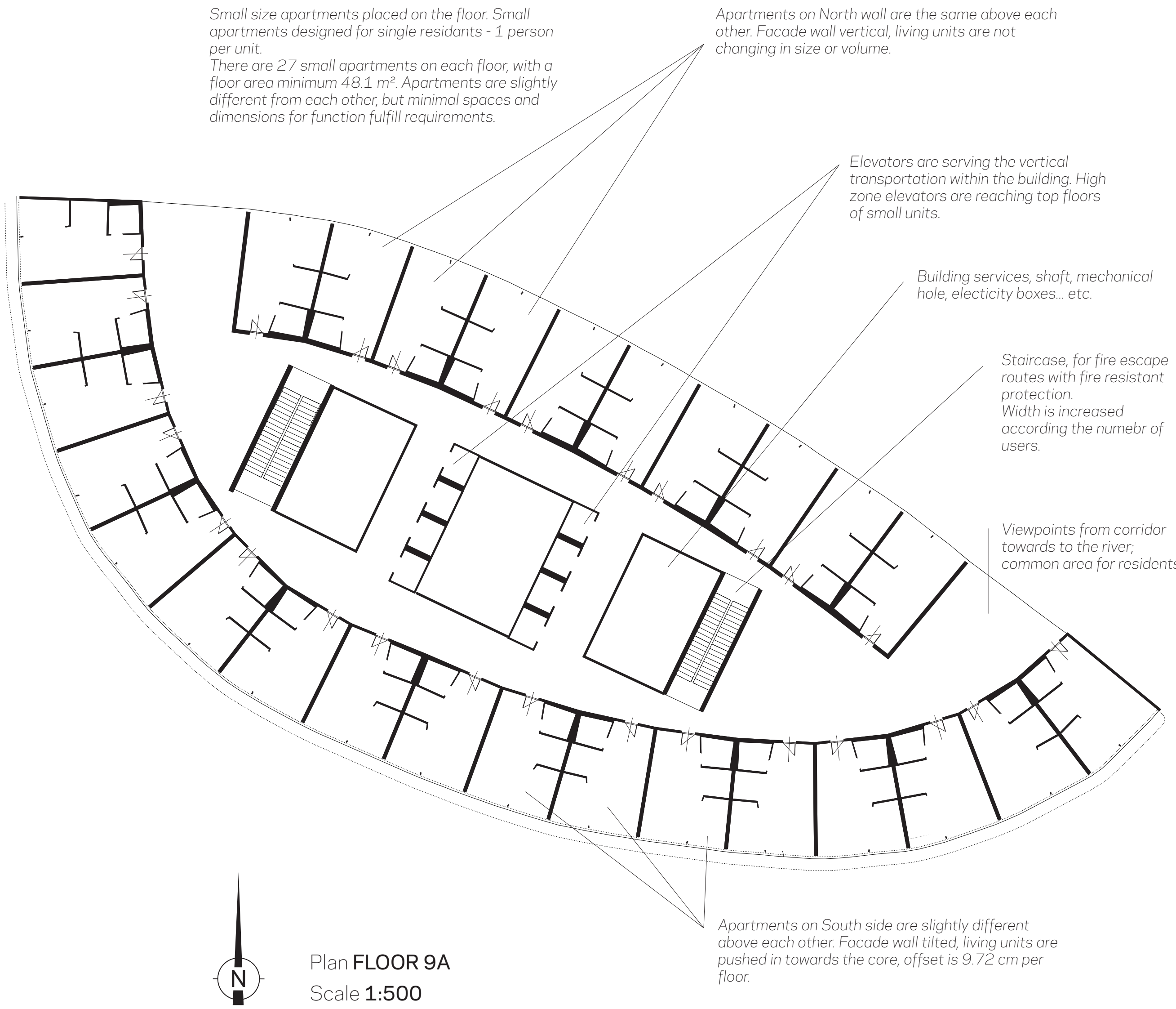
Window frames of 1.25 m by 1.5 m

Test 16:

Specific Space Heat Demand:	74.5 kWh/m²a
Specific Primary Energy Demand:	111 kWh/m²a
Frequency of Overheating:	16.0 %
Daily temperature swing due to solar load:	0.1 K

*For improvement on results, reference block has been used for tests. As a continuation of the tests on window sizes, two window has been used. Window frames has been changed according to layout and facade division.

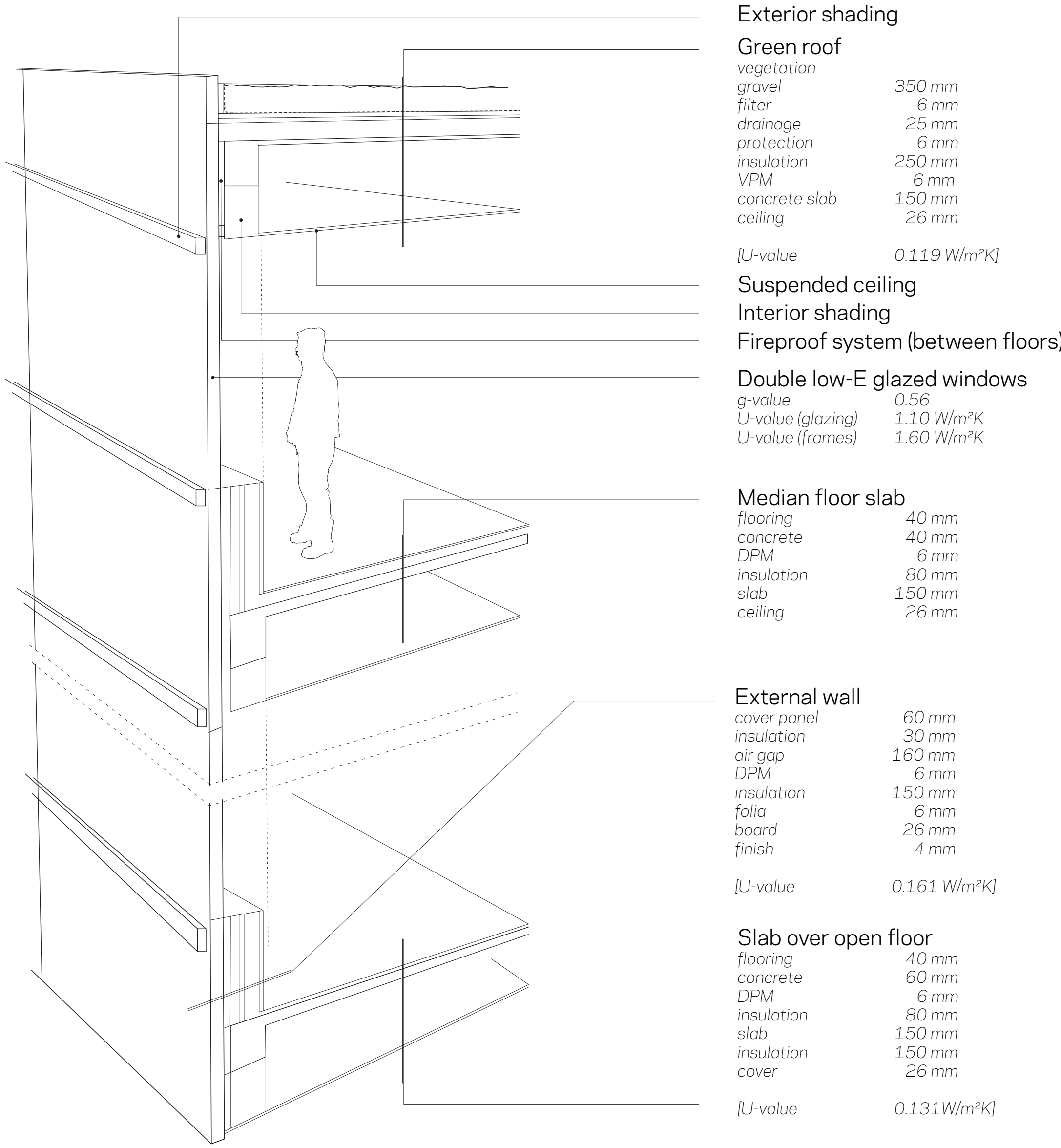
Synthesis on floor plan layout



Plan **FLOOR 9B**
Scale **1:500**


Large size apartments placed on the floor. Large apartments designed for families - 3-4 person per unit.
There are 17 larhe apartments on each floor, with a floor area minimum 98 m². Apartments are slightly different from each other, but minimal spaces and dimensions for function fulfill requirements.
Apartments on North wall are the same above each other. Facade wall vertical, living units are not changing in size or volume.
Elevators are serving the vertical transportation within the building. Low zone elevators are reaching lower floors of family-units.
Building services, shaft, mechanical hole, electicity boxes... etc. HIgh and middle zone elevators.
Staircase, for fire escape routes with fire resistant protection. Width is increased according the numebr of users.
Viewpoints from corridor towards to the river; common area for residents.
Apartments on South side are slightly different above each other. Facade wall tilted, living units are pushed in towards the core, offset is 7.72 cm per floor.
N
Plan **FLOOR 15C**
Scale **1:500**

Structure and materials



Schematic perspective of details

Load-bearing structure of the building is designed with a concrete core and concrete slab structure. Hollow core slabs lead forces to beams and core, which forward forces towards to the foundation.

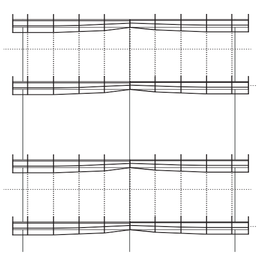
Horizontal load-bearing structure made of reinforced concrete elements, which allow more freely arranged interiors. Interior spaces are separated by lightweight walls.
External walls must have good transmittance attribution in order to lower heat demands. Layers are designed to achieve low U-value.
All details and connections are designed to avoid cold bridges or heat loss.

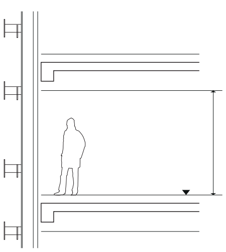
Due to the open floors within the structure, floor slabs requires extra insulation. Floor division under open floor considered as green floor, therefore it is calculated with low thermal transmittance, slabs above the open floors designed with thick insulation to achieve better values.

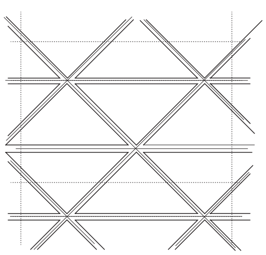
The facade is designed as double skin structure. Curtain walls are designed as a facade technology to clad large buildings. Curtain wall system does not carry loads of the building structure, just their own weight, and they transfer horizontal loads to the primary building structure.

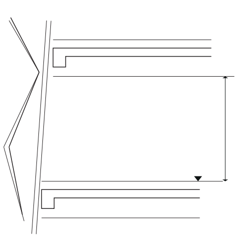
Elevations have a curtain wall as primary facade, with properly insulated connections and double glazed windows.
The second skin acts as a protective and supportive structure on both sides.
On the South side it consists triangular panels, as fixed shades and perforated for view, with PV cells for energy production.
On the North side a Green wall helps the microclimate while it provides seasonal summer shading.

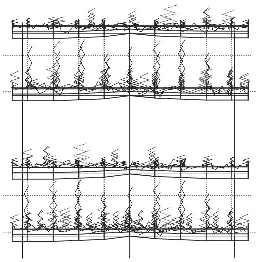
All openings are designed with double glazed low-energy windows, with U-value of 1.10 W/m2K for glazing and 1.60 W/m2K for the frames.

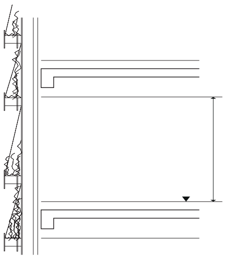

Green wall

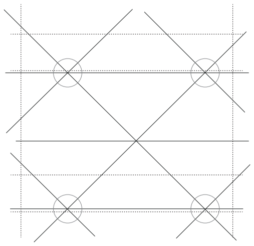

section

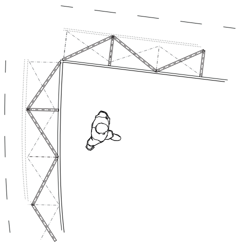

Shades


section


sumemr shading


section


Fixed panels


plan

Synthesis - Final PHPP results

After detailing the concept, final PHPP calculations were made for all blocks. Calculations include actual materials, proper layer thickness, shading and ventilation.

Calculation was made separately for each block to see final results on each part of the building. Test 17 for Block A, Test 18 for Block B and Test 19 for Block C shows final results.

Heat demand does not have to fulfil passive house requirements. Technical goal was set to achieve zero-energy building. It means building provides normal indoor comfort while it does not use energy. It means building will produce as much (renewable energy as it needs.

With different functions it is possible to balance energy needs and avoid extreme peaks. While residents need more energy during morning and late afternoons, while retail functions use the produced energy during daytime.

PHPP calculations resulted in average 30 kW/m²a specific heat demand. PV elements on the facade would produce maximum 200 kW/m²a.
Panels provide about 94% of energy needs for total floor areas.

Vertical axis wind turbines placed on top roof. However VAWT is not that effective that horizontal ones, it is quiet, efficient and economical; perfect for residential energy production. The rest 6% of the energy need will be provided by 8 turbines.

Final calculation for reference block

Test 17:

Specific Space Heat Demand:	32.3 kWh/m²a
Specific Primary Energy Demand:	79 kWh/m²a
Frequency of Overheating:	15.9 %
Daily temperature swing due to solar load:	0.1 K

*For more precize results, details of reference block have been used for tests. As a continuation of the tests before, U-value list has been updated according to layers of details, mechanical ventilation system and summer ventilation has been added.

Final results on block B

Test 18:

Specific Space Heat Demand:	29.9 kWh/m²a
Specific Primary Energy Demand:	75 kWh/m²a
Frequency of Overheating:	15.9 %
Daily temperature swing due to solar load:	0.2 K

Final results on block C

Test 19:

Specific Space Heat Demand:	28.5 kWh/m²a
Specific Primary Energy Demand:	75 kWh/m²a
Frequency of Overheating:	15.9 %
Daily temperature swing due to solar load:	0.2 K

Synthesis - Indoor comfort

The project site is situated next to the road close to the dense center of Pudong, it raises the question of disturbing noise levels. In a point of indoor acoustic comfort it is important to reduce noise levels from outside and also from the neighbouring apartments. If the proper insulation is used in the external and partition walls, it is easy to achieve 'silent' apartment. The insulation has high density (min 40 kg/m3) and fiber materials have very good attributes against sound.

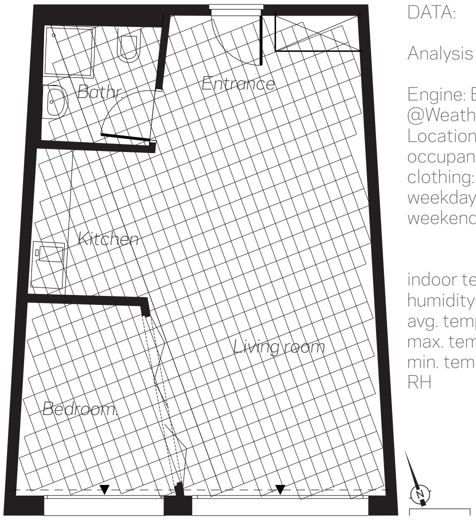
Assuming all the windows are double glazed low-energy windows and all external wall have dense insulation layers, noise from traffic do not penetrate the apartments. Green wall and green areas are also acting as buffer zones to reduce noise levels, and green extension covers, hence lower noise of bypass traffic. Noise levels are also lower in higher placement - first residential floor situated 70.3 m above ground.

To avoid impact sound all insulation layers are calculated well, since t is very difficult to improve that afterwards. During detailing all materials have been chosen to reduce energy needs, therefore they also considered acoustically comfortable.

ECOTECT is used to determine indoor climate in the reference apartment. Visual comfort has been tested before, and thermal comfort investigated to provide best settings possible.
However individual needs differ, indoor temperature has been set between 20-26°C indoor, and relative humidity between 5-23% for comfort. (See psychometric cart)
Air change is provided by mechanical system. Minimal air change rate is 0.5 1/h, U-values of building components used as in PHPP calculations.

The 3D model of apartment has been tested according to hourly temperatures in the coldest and hottest day of the year.

Mechanical ventilation has been used; due to the poor air quality of the area all inlet must be filtered. Solar radiance and user load affect on internal heat gain.

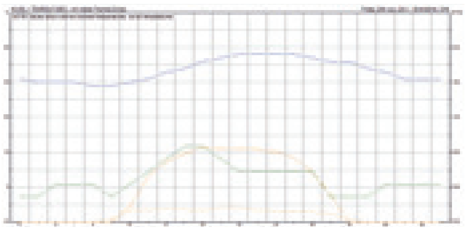


DATA:

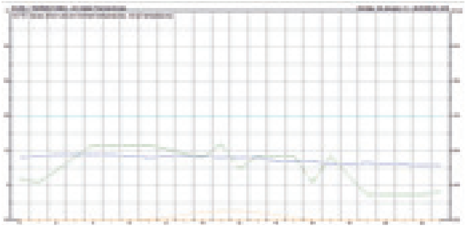
Analysis grid

Engine: ECOTECT
@Weather Tool
Location: SHANGHAI, CHN
occupants: 1
clothing: 0.6 clo
weekday times: 0-24 Hrs
weekend times: 0-24 Hrs

indoor temp: 20-26°C
humidity: 5-23%
avg. temperature
max. temperature
min. temperature
RH



Hourly temperatures on 20th July



Hourly temperatures on 1st January

Energy concept

Building complex' smart energy concept keeps costs relatively low over long-term use.
High-rise façade is made from panels and glazing, saving heating and cooling energy, cutting operating costs and reducing CO2 emission.

Thickness of layers is calculated for reducing heat demand, no thermal bridges, and mechanical ventilation runs with heat recovery system.

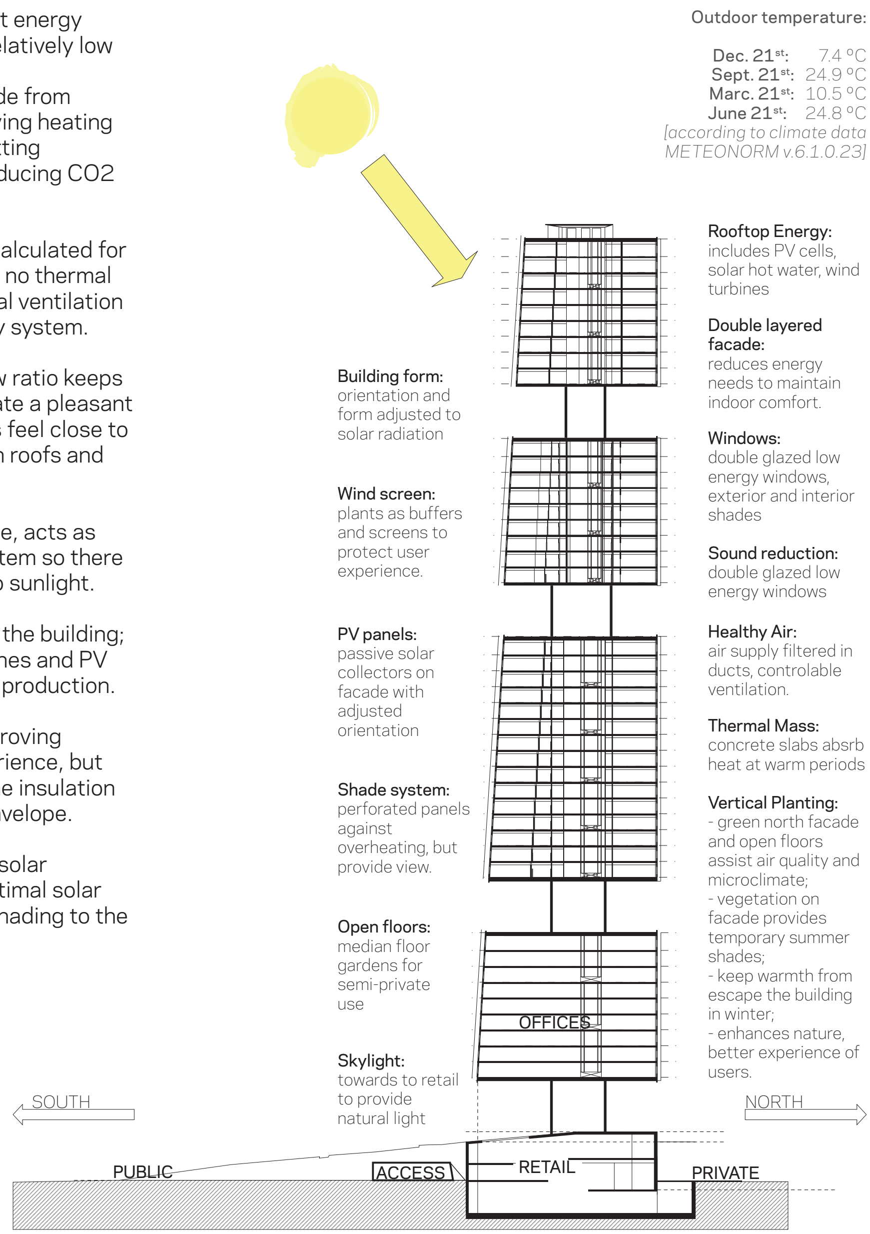
Moreover, floor-window ratio keeps interior well lit and create a pleasant atmosphere. Residents feel close to nature due to the green roofs and green facade.

This faces on North side, acts as temporary shading system so there is no direct exposure to sunlight.

Green power is used in the building; vertical axis wind turbines and PV panels help the energy production.

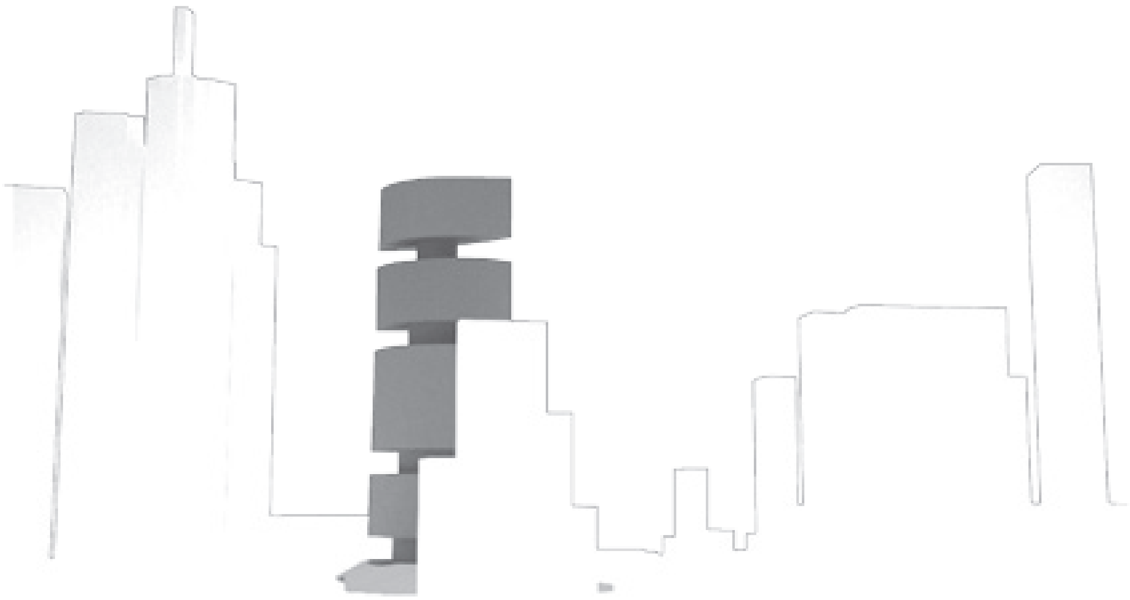
Green roof not just improving microclimate and experience, but it adds extra layer to the insulation and helps in thermal envelope.

Panels are adjusted to solar radiation to achieve optimal solar gain while it provides shading to the interiors.

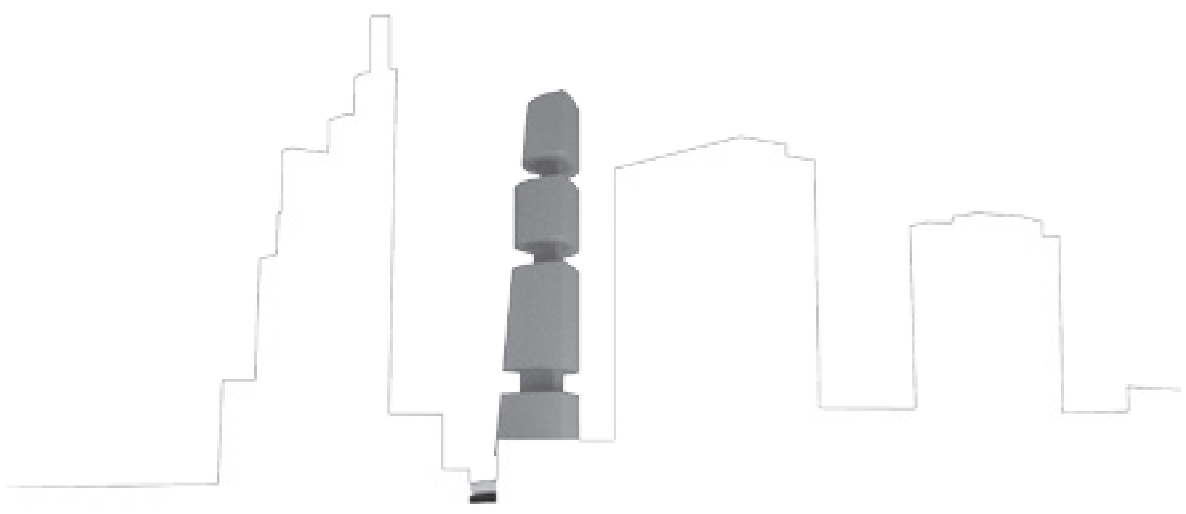


Section **CROSS SECTION (AA)**
Scale **1:2000**

Volume in context



Volume in context | view from Southeast



Volume in context | view from East

Part VI

Design Proposal **Presentation**

PRESENTATION OF THE RESULTS OF THE DESIGN PROCESS, VISUALIZING AND DETAILING

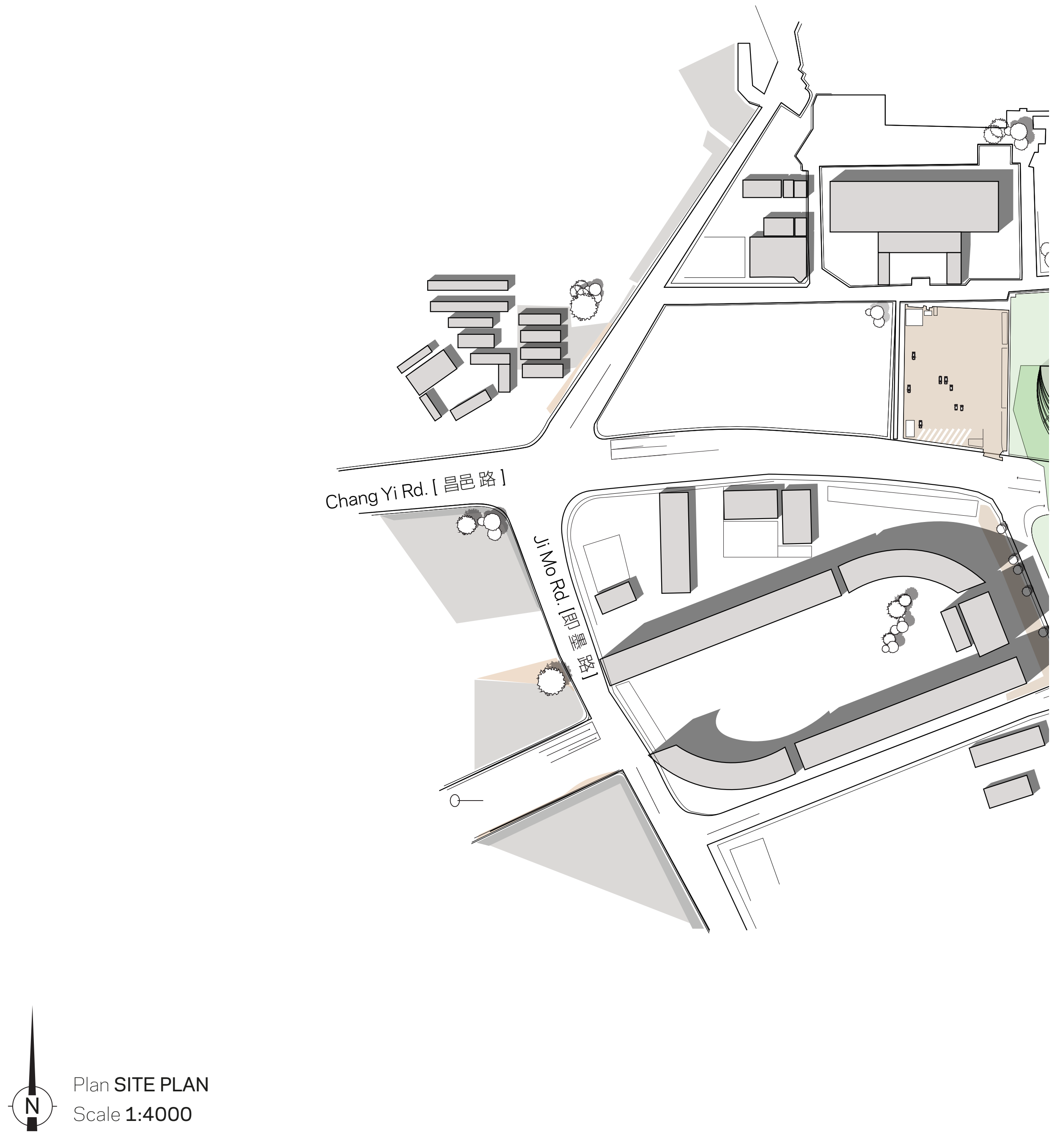
Plan drawings of the layout of the floors

Site plan and master plans of different scales

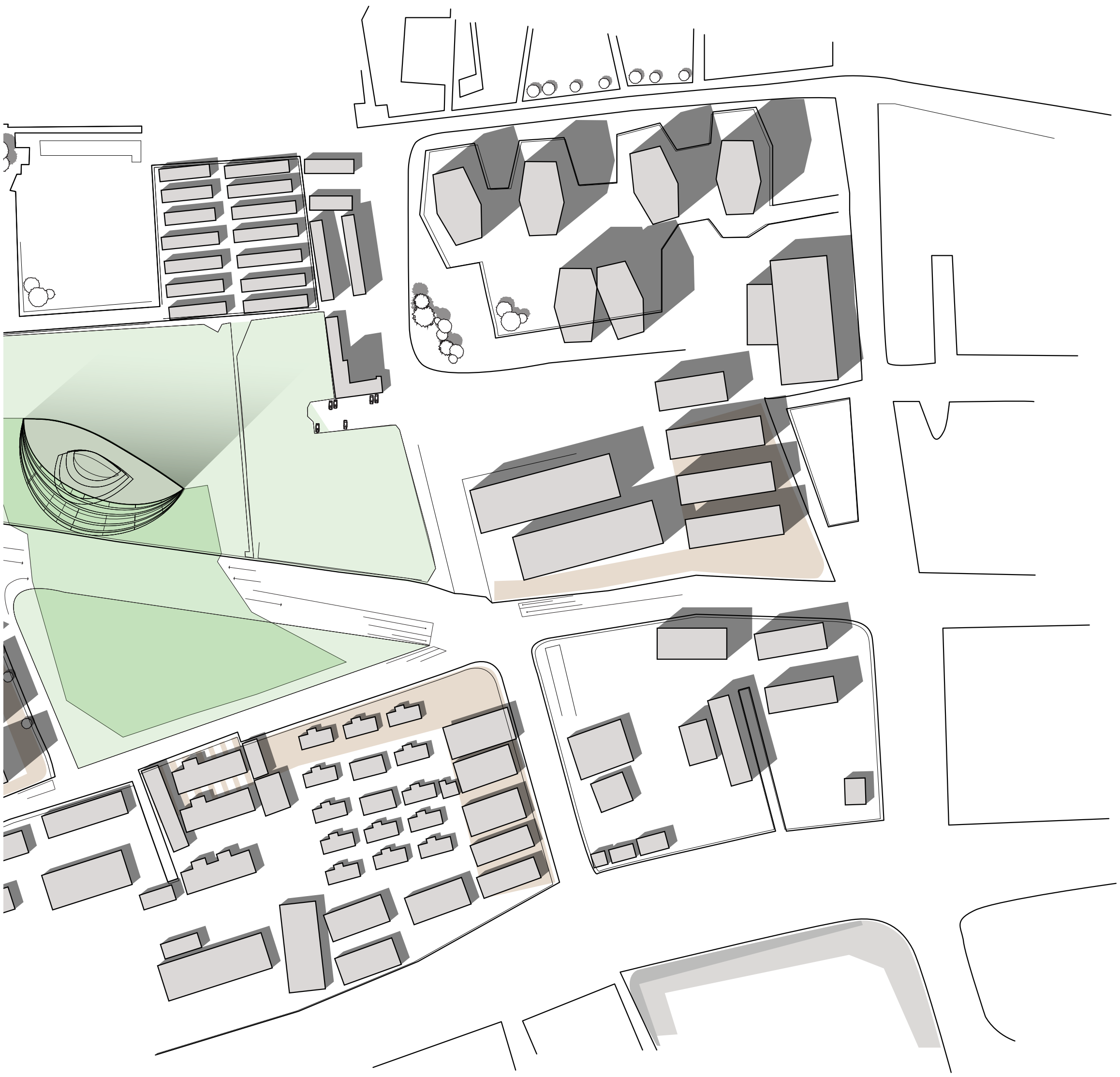
Sections and elevations, expression of the building

Visualization of the qualities of the design

Mater plan



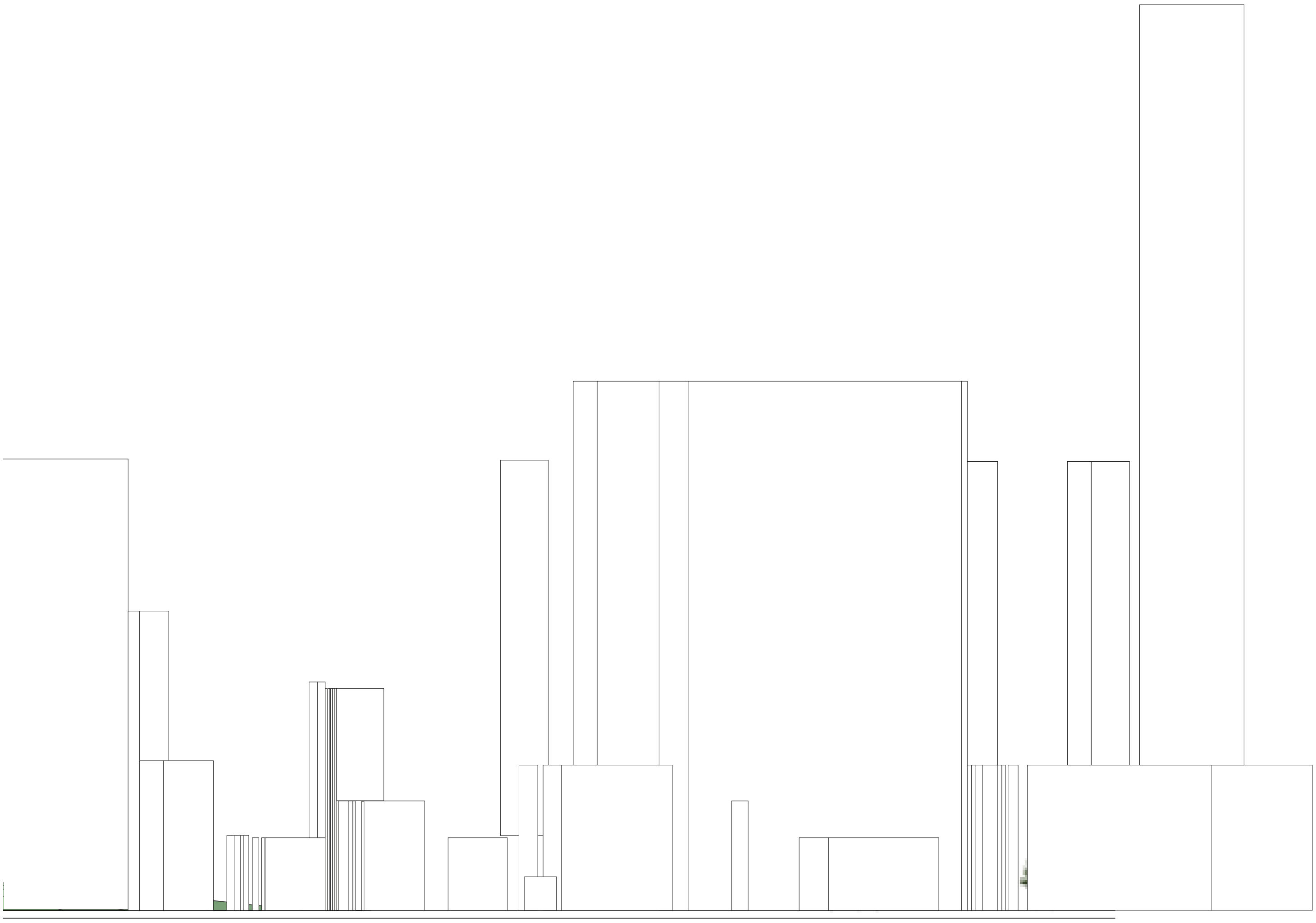
Plan SITE PLAN
Scale 1:4000



Section | Context

Section CONTEXT

Scale 1:2000



Site plan

Wall:
Garden is surrounded by an organic wall, providing protection and bounderies for the place.

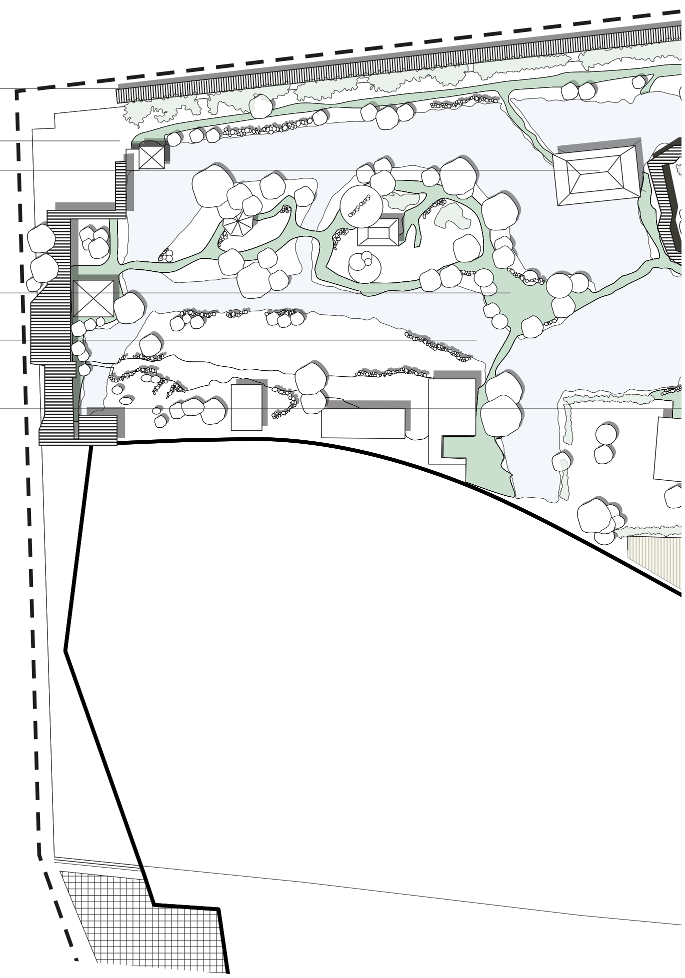
Gate:
As one of the traditional element Chinese gardens all have ornamental gates to lead in to the green area.

Pavilions and galeries:
Covered places for different activities; perfect points for sitting, reading, eating within the garden for users.

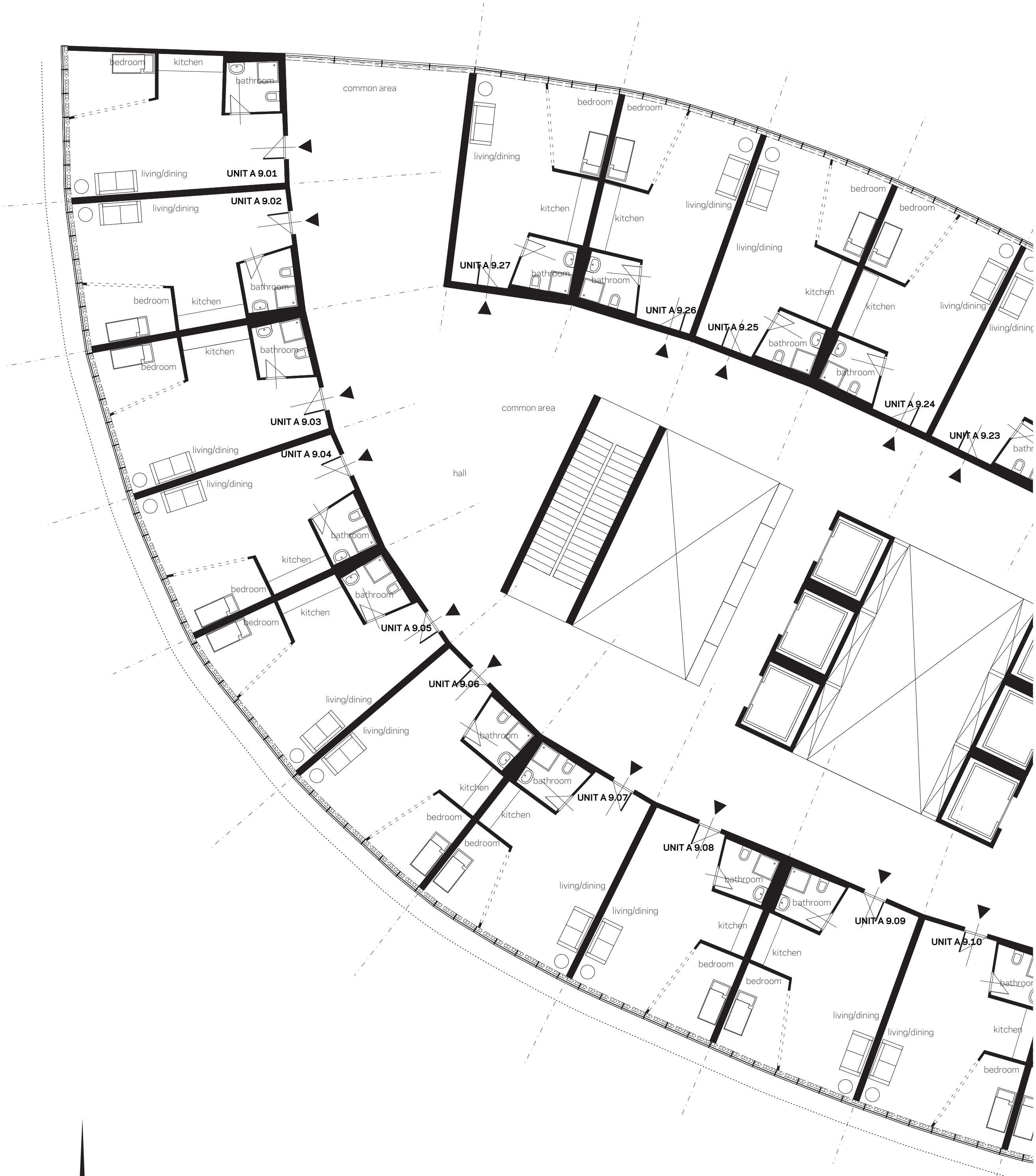
Pathways:
Pathways leading through the garden to the different sceneries while providing possibilities for relaxing walks.

Water and briges:
Artificial ponds and small fontains placed in the garden to create mroe relaxing and calming environemnt.

Landscape:
Rock gardens, and many colorful flowers decorating the garden, emphasizing the sense of place.

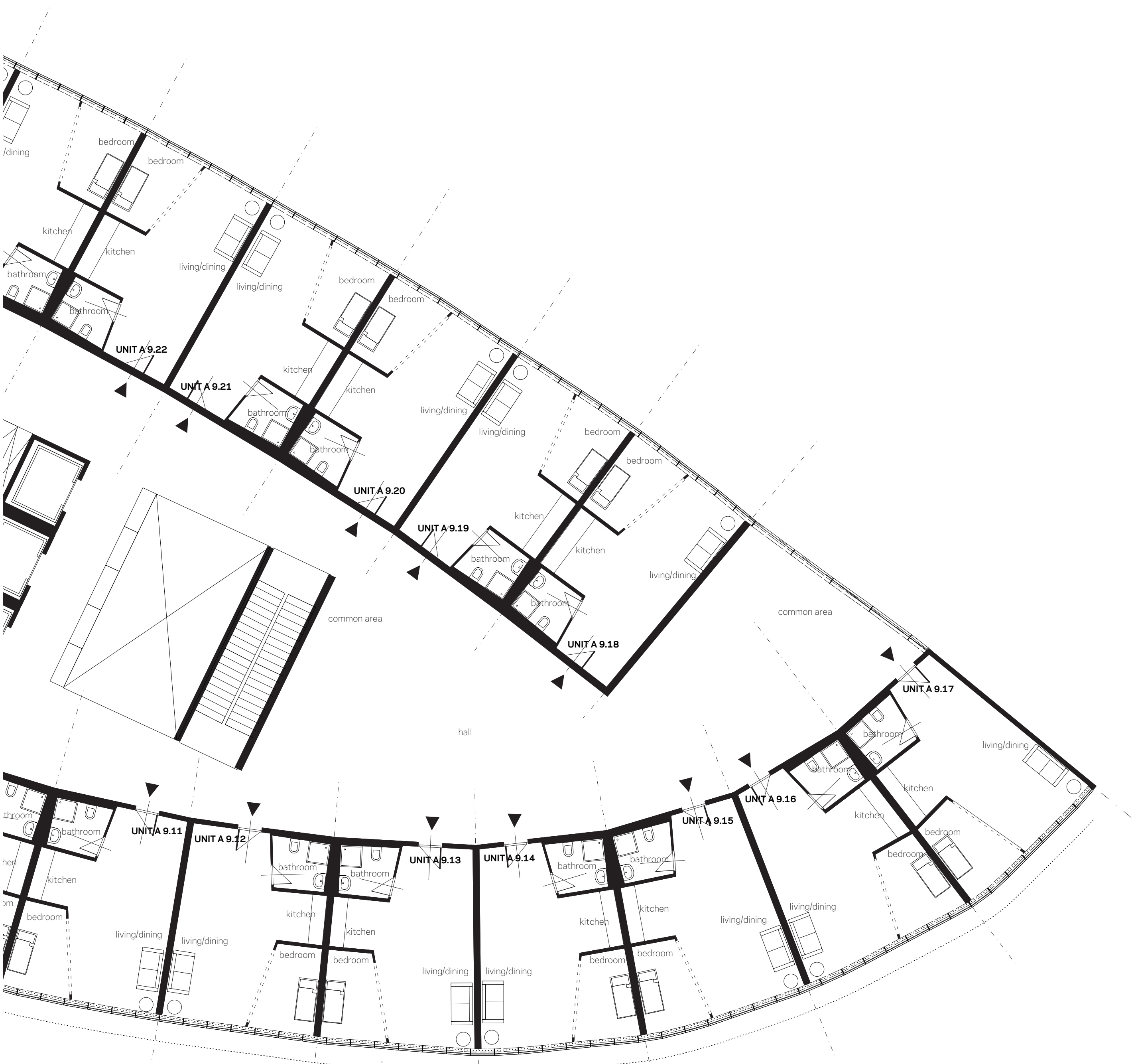


Plan **SITE PLAN**
Scale **1:1000**



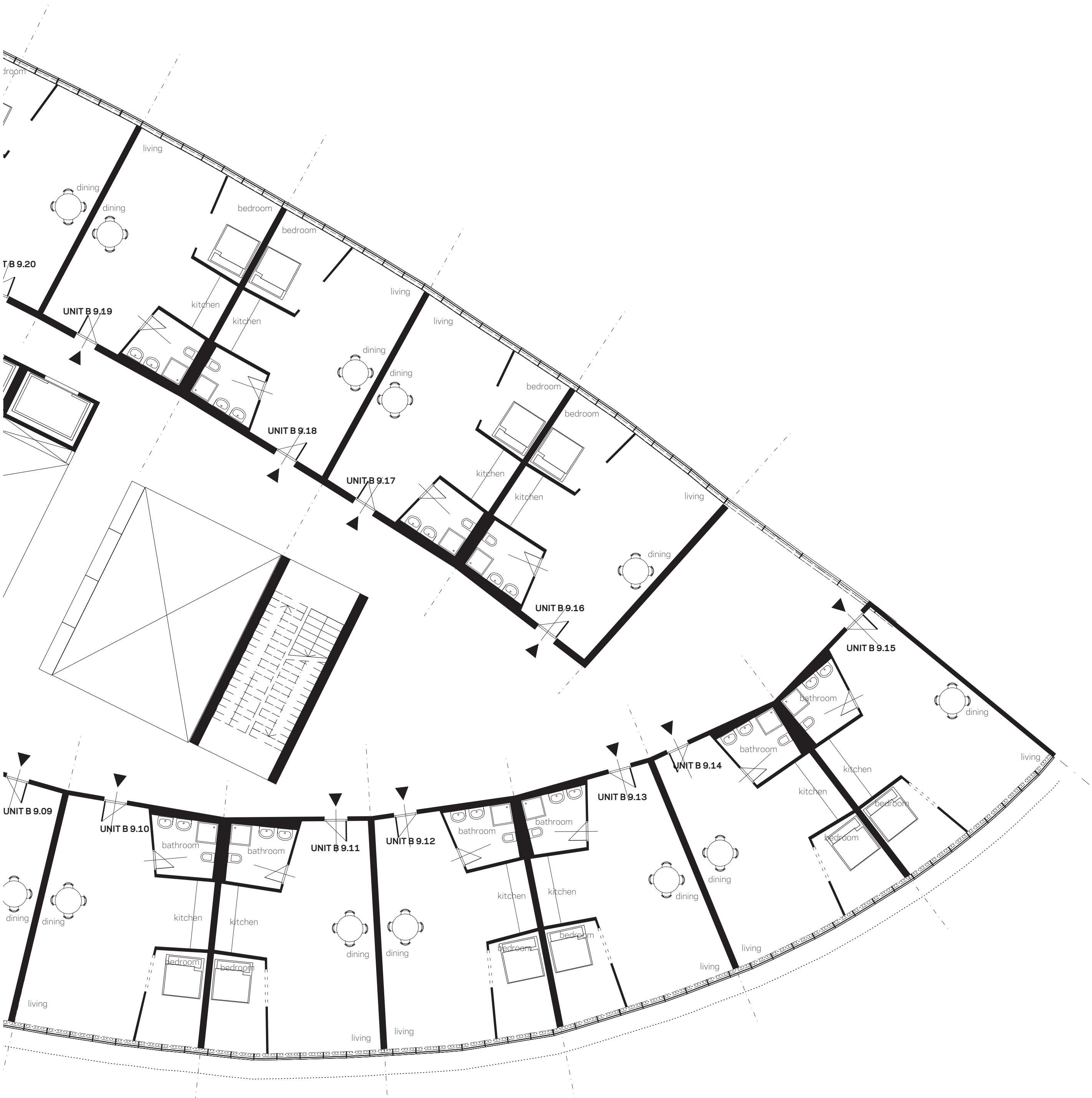
Plan **FLOOR PLAN (A9)**
Scale **1:250**

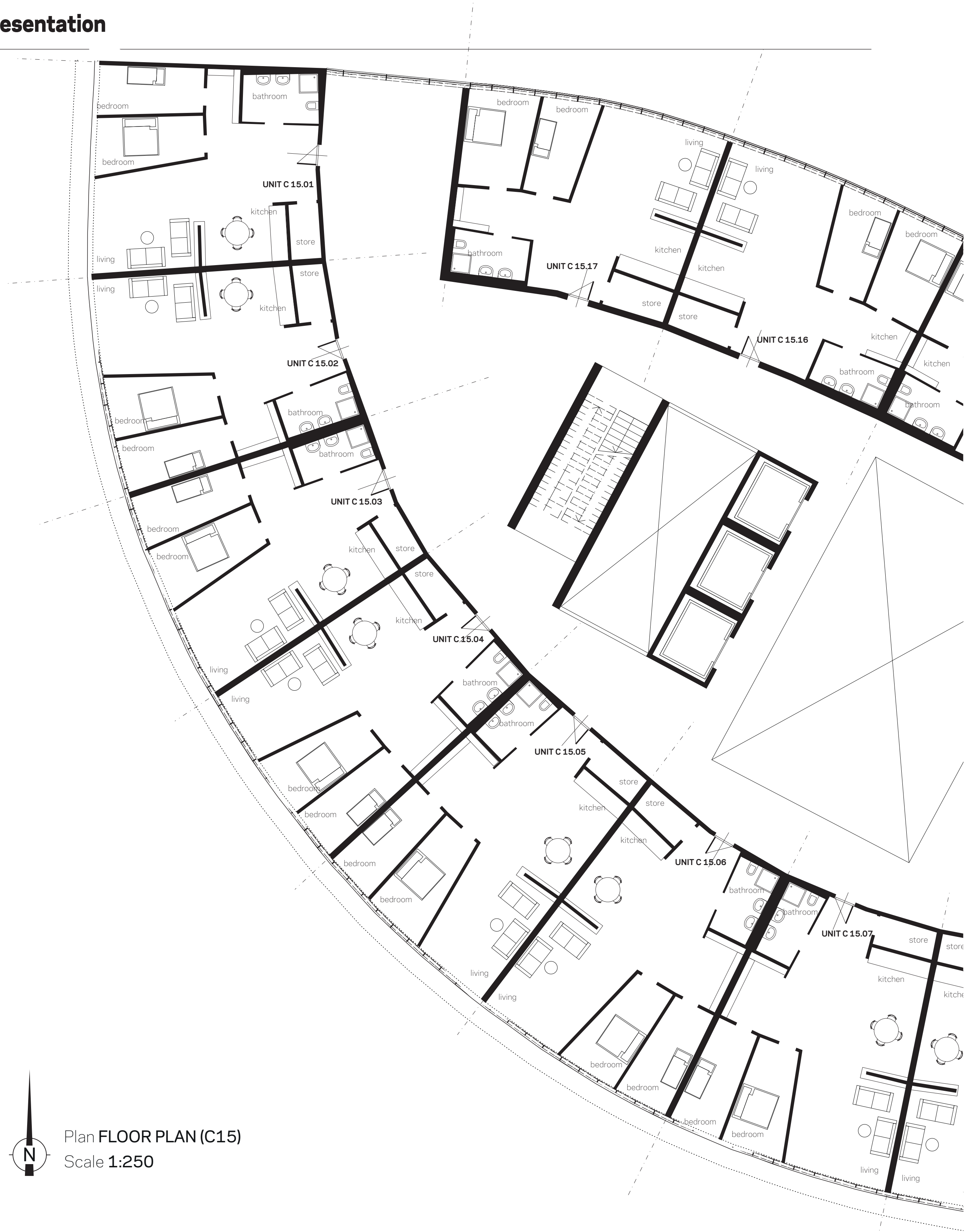
Floorplan | Top floors



Plan **FLOOR PLAN (B9)**
Scale **1:250**

Floorplan | Middle floors





Plan FLOOR PLAN (C15)
Scale 1:250

Floorplan | Low floors

Apartment layout

Room usage:

1: Entrance	4.42 m²
2: Kitchen	6.93 m²
3: Dining area	8.64 m²
4: Livingroom	14.42 m²
5: Bedroom	8.45 m²
6: Bathroom	5.23 m²
Total:	48.06 m²

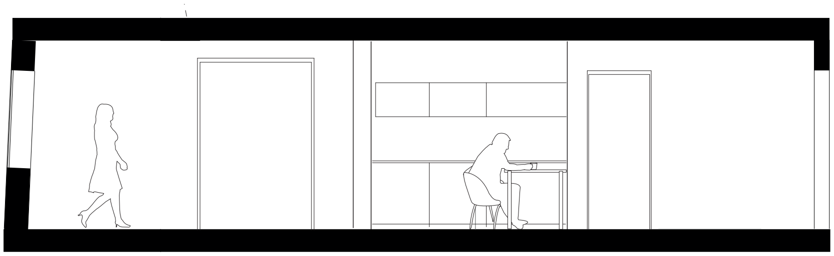
Floor plan Appartment layout (Unit A)
Scale 1:100

Section Appartment layout (Unit A)
Scale 1:100

Room usage:

1: Entrance	6.74 m²
2: Kitchen	9.81 m²
3: Dining area	15.12 m²
4: Livingroom	22.00 m²
5: Bedroom	10.56 m²
6: Bathroom	8.06 m²
Total:	72.29 m²

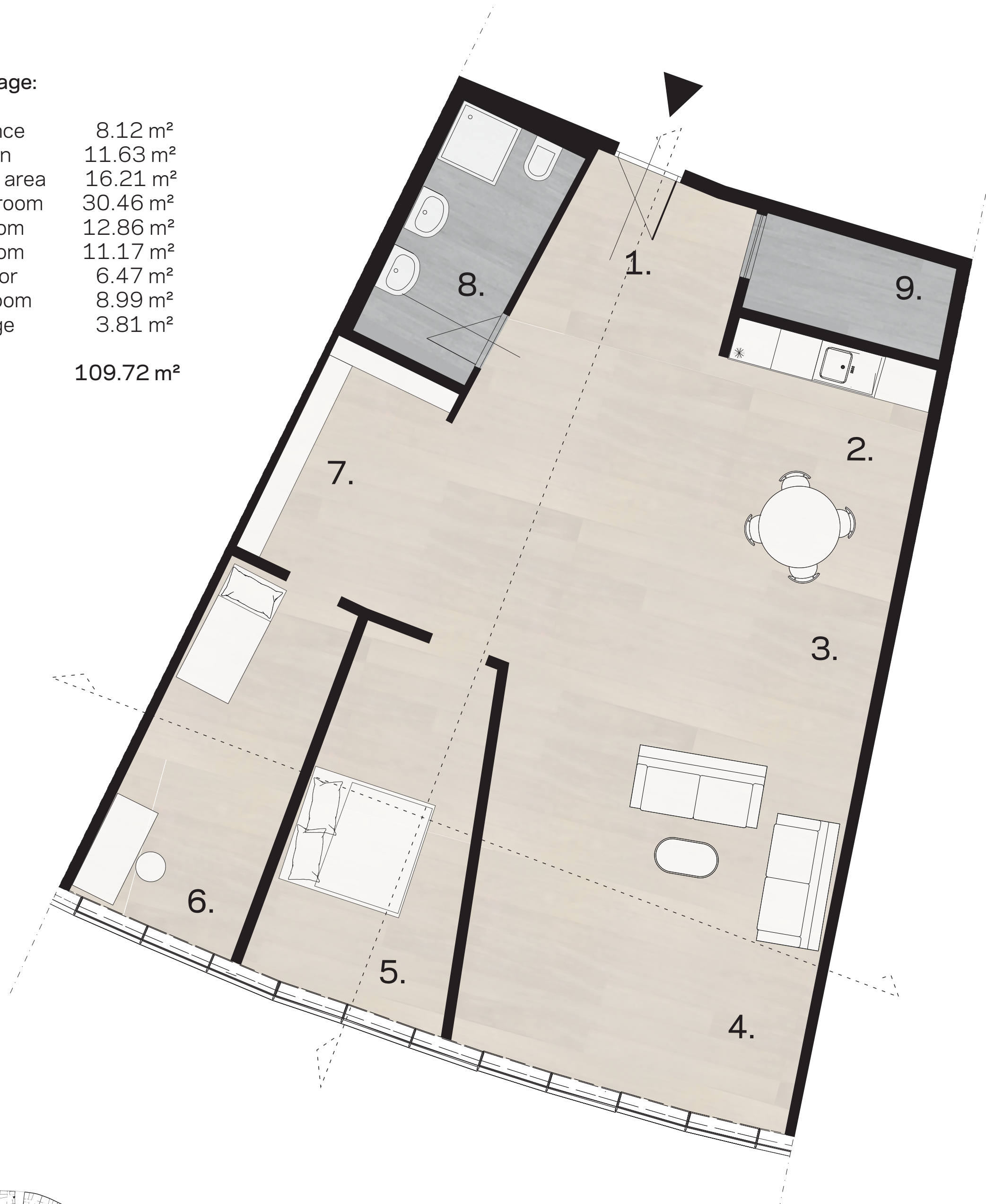
Floor plan Appartment layout (Unit B)
Scale 1:100

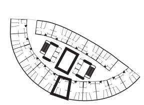


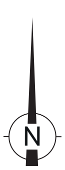
Section Appartment layout (Unit B)
Scale 1:100

Room usage:

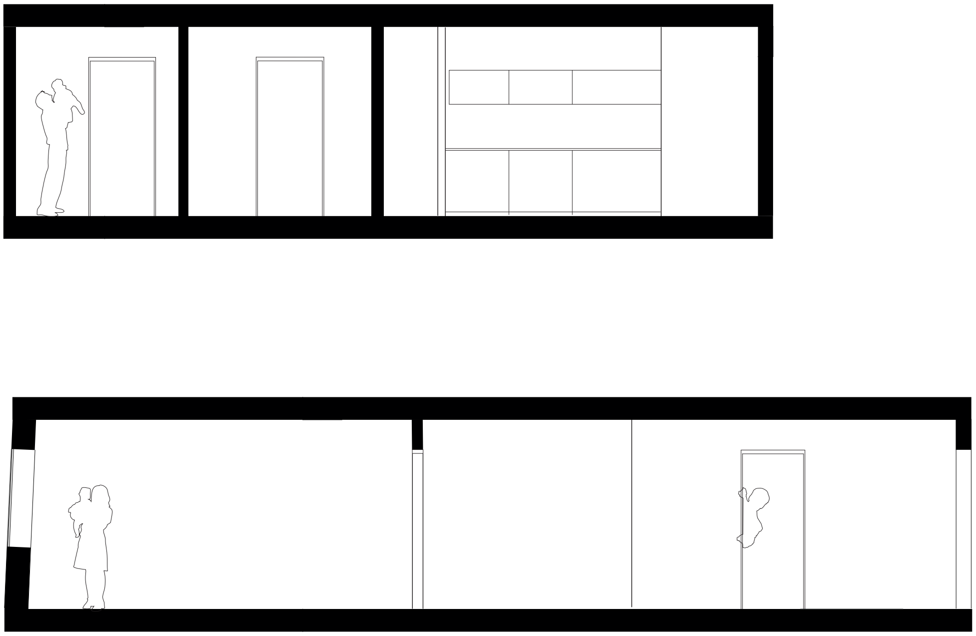
1: Entrance	8.12 m²
2: Kitchen	11.63 m²
3: Dining area	16.21 m²
4: Livingroom	30.46 m²
5: Bedroom	12.86 m²
6: Bedroom	11.17 m²
7. Corridor	6.47 m²
8. Bathroom	8.99 m²
9. Storage	3.81 m²
Total:	109.72 m²





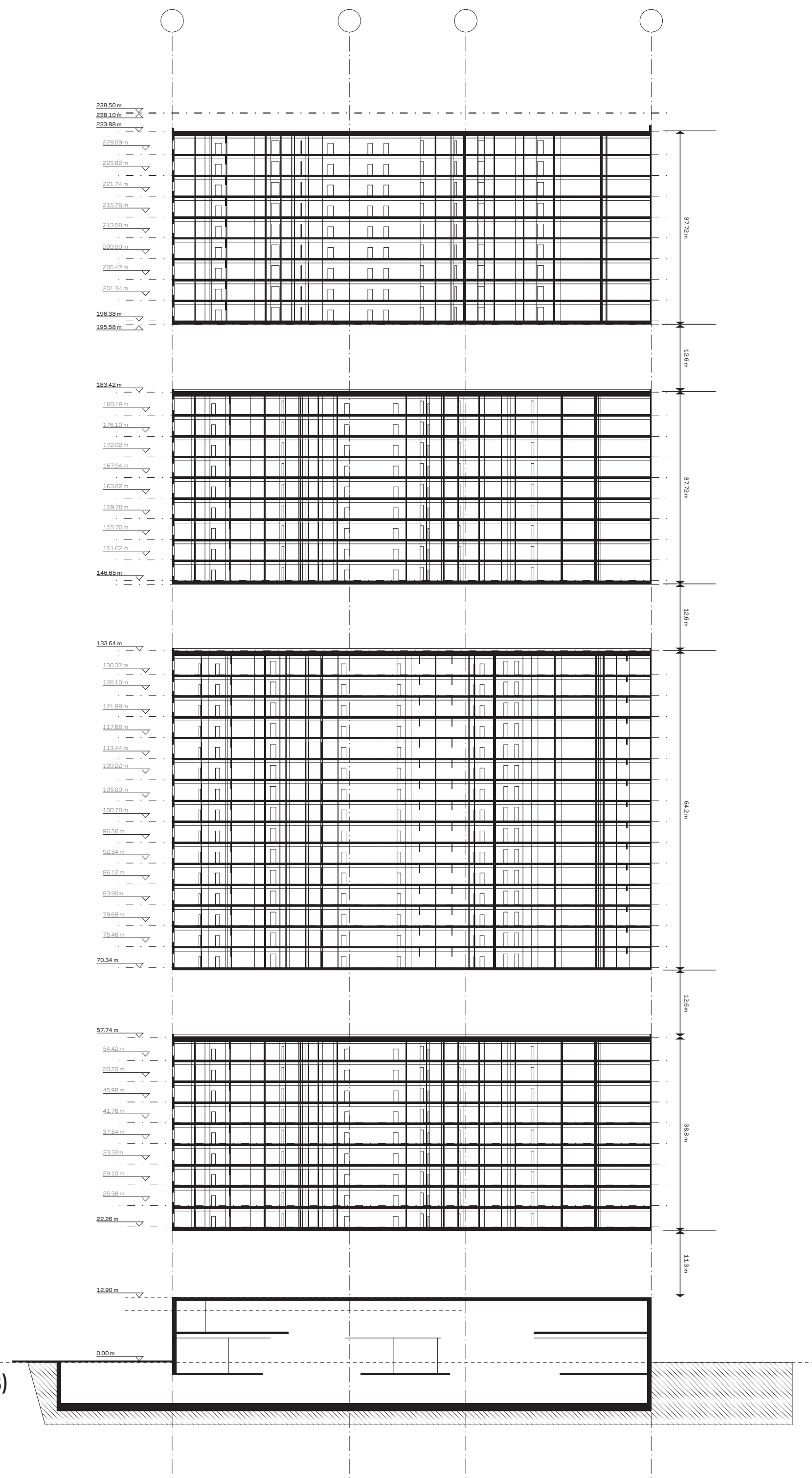


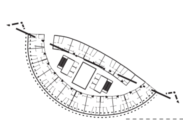
Floor plan **Appartment layout (Unit C)**
Scale **1:100**



Section Appartment layout (Unit C)
Scale 1:100

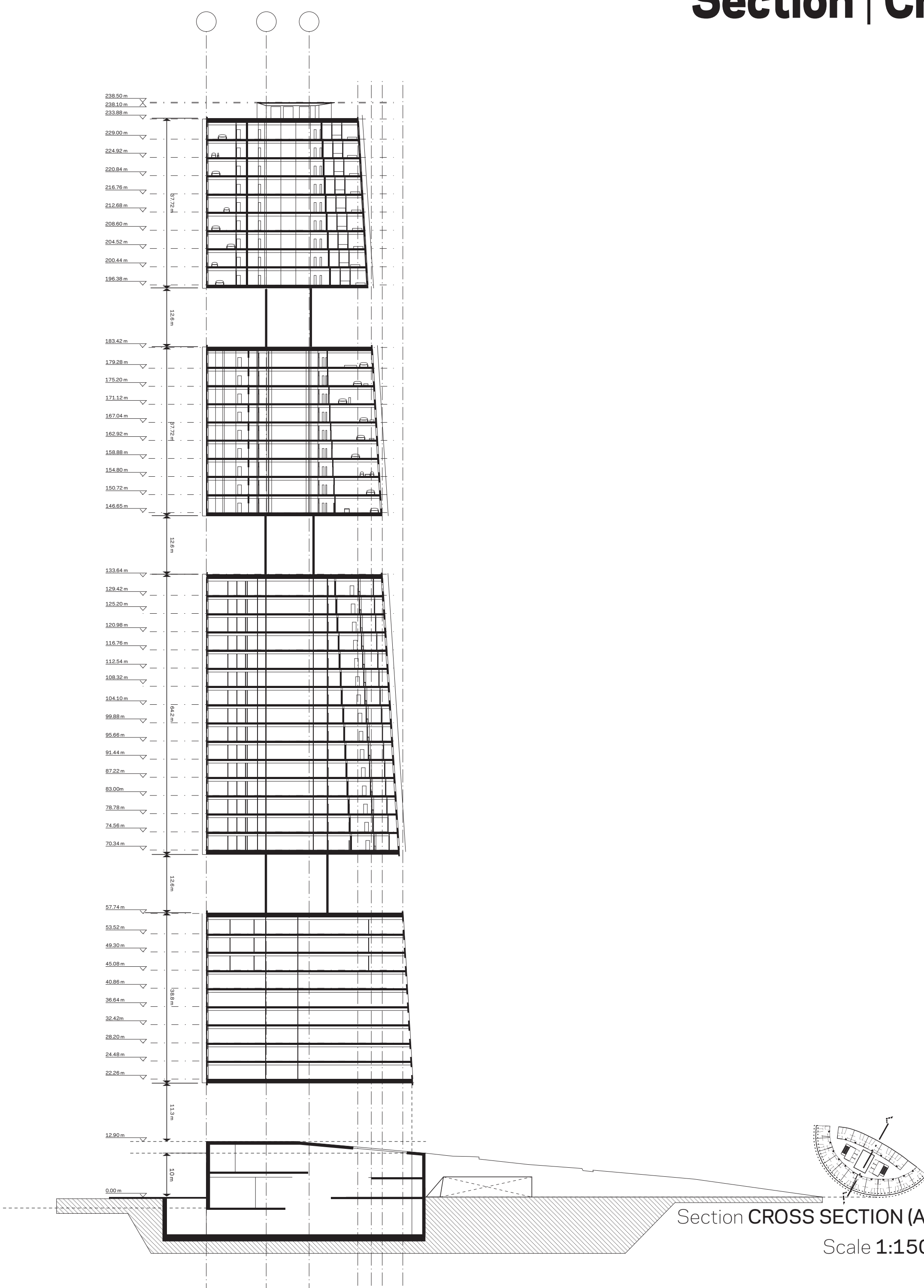
Section | Long section





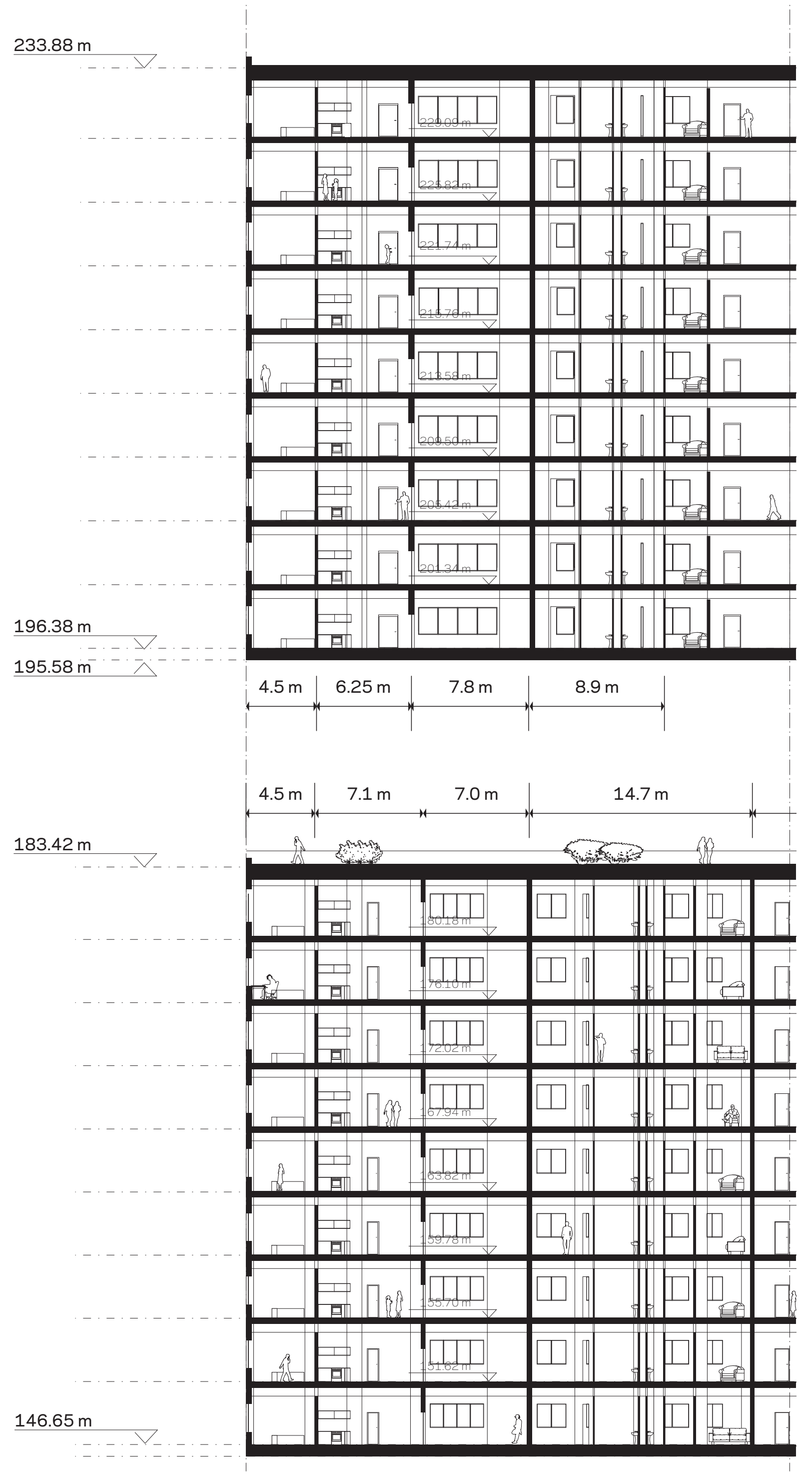
Section **LONG SECTION (BB)**
Scale **1:1500**

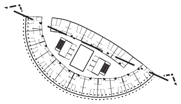
Section | Cross section



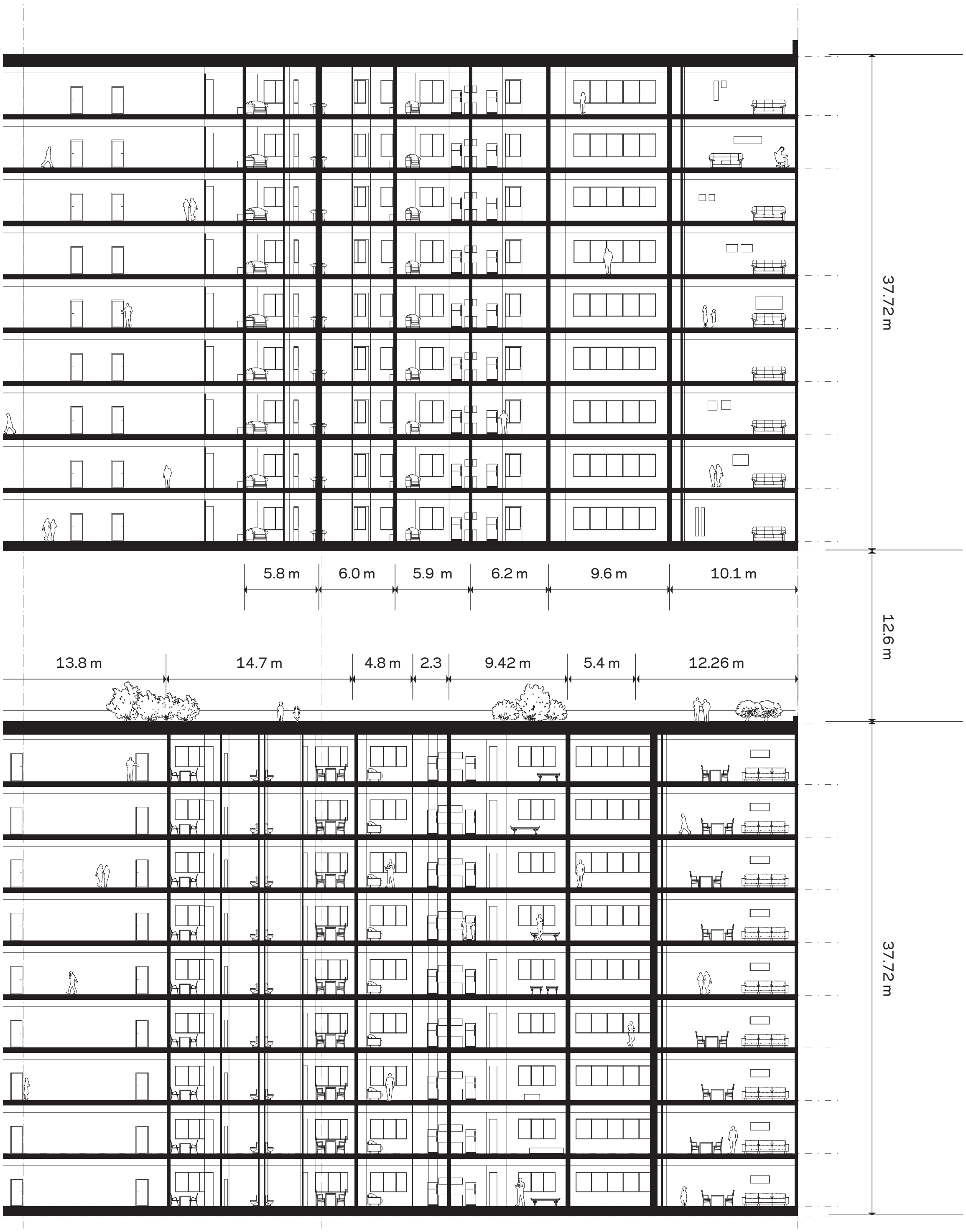
Section CROSS SECTION (AA)
Scale 1:1500

Section | Long section

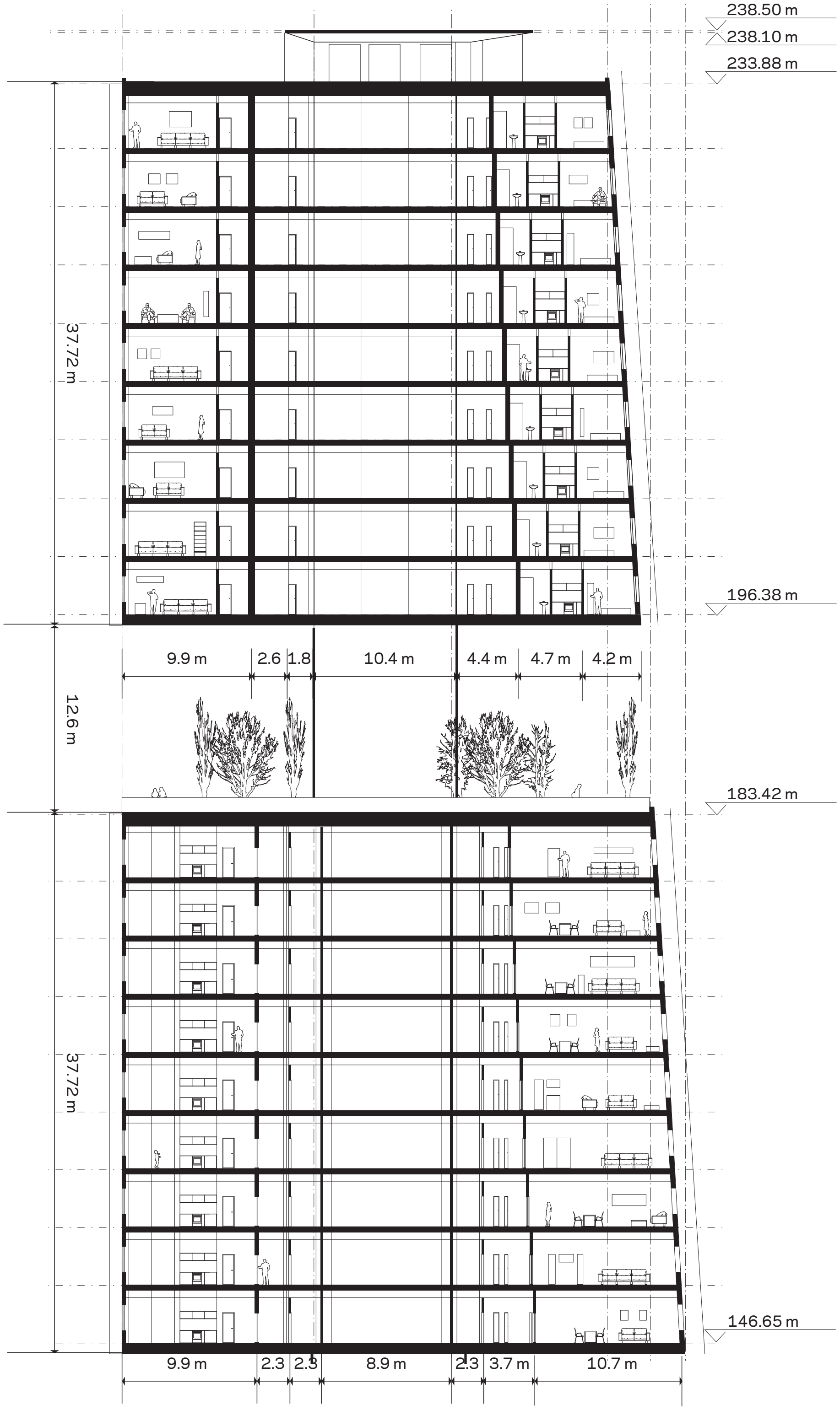


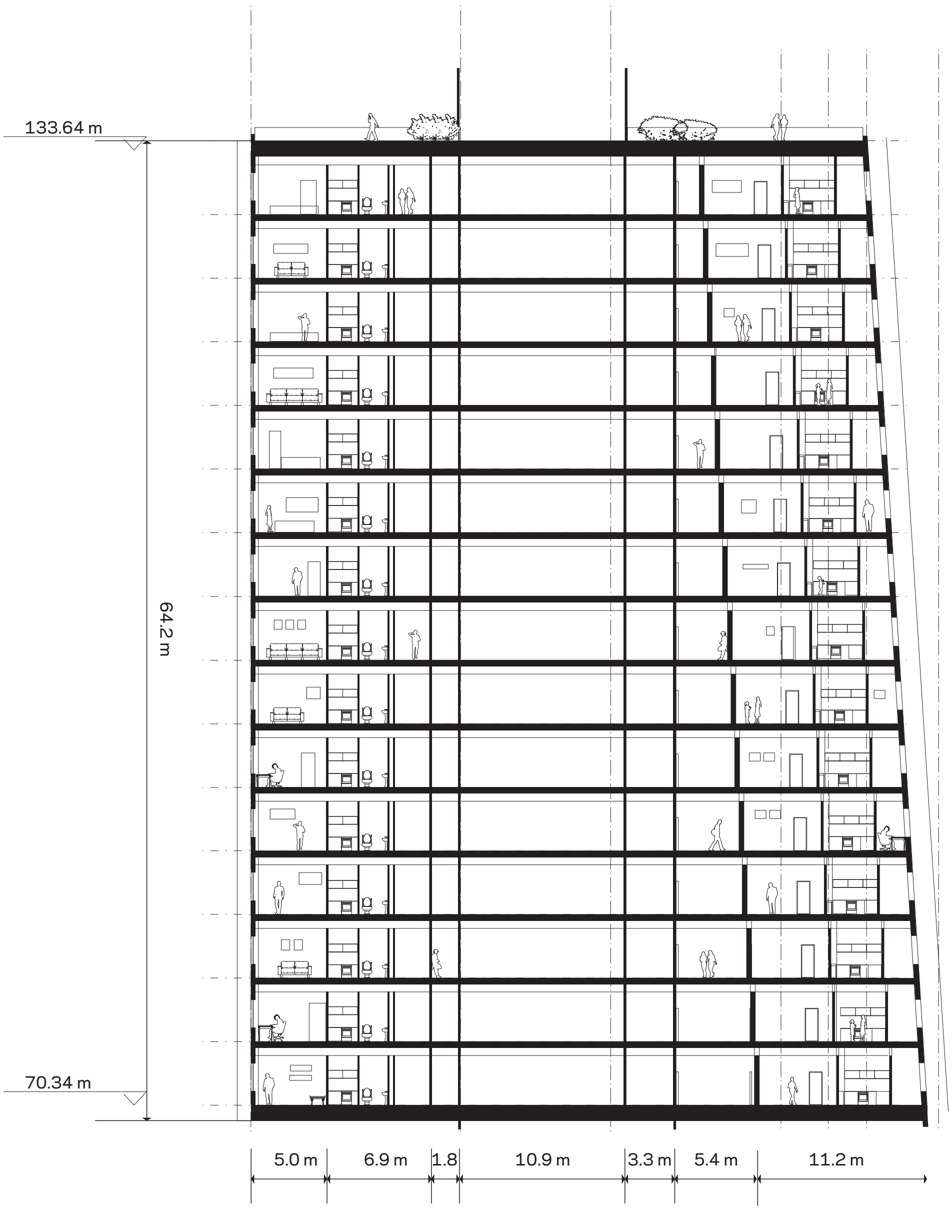


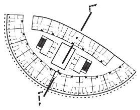
Section **LONG SECTION (UNIT A&B)**
Scale **1:500**


37.72 m
5.8 m
6.0 m
5.9 m
6.2 m
9.6 m
10.1 m
12.6 m
13.8 m
14.7 m
4.8 m
2.3
9.42 m
5.4 m
12.26 m
37.72 m

Sections


238.50 m
238.10 m
233.88 m
37.72 m
196.38 m
9.9 m
2.6
1.8
10.4 m
4.4 m
4.7 m
4.2 m
12.6 m
183.42 m
37.72 m
146.65 m
9.9 m
2.3
2.3
8.9 m
2.3
3.7 m
10.7 m



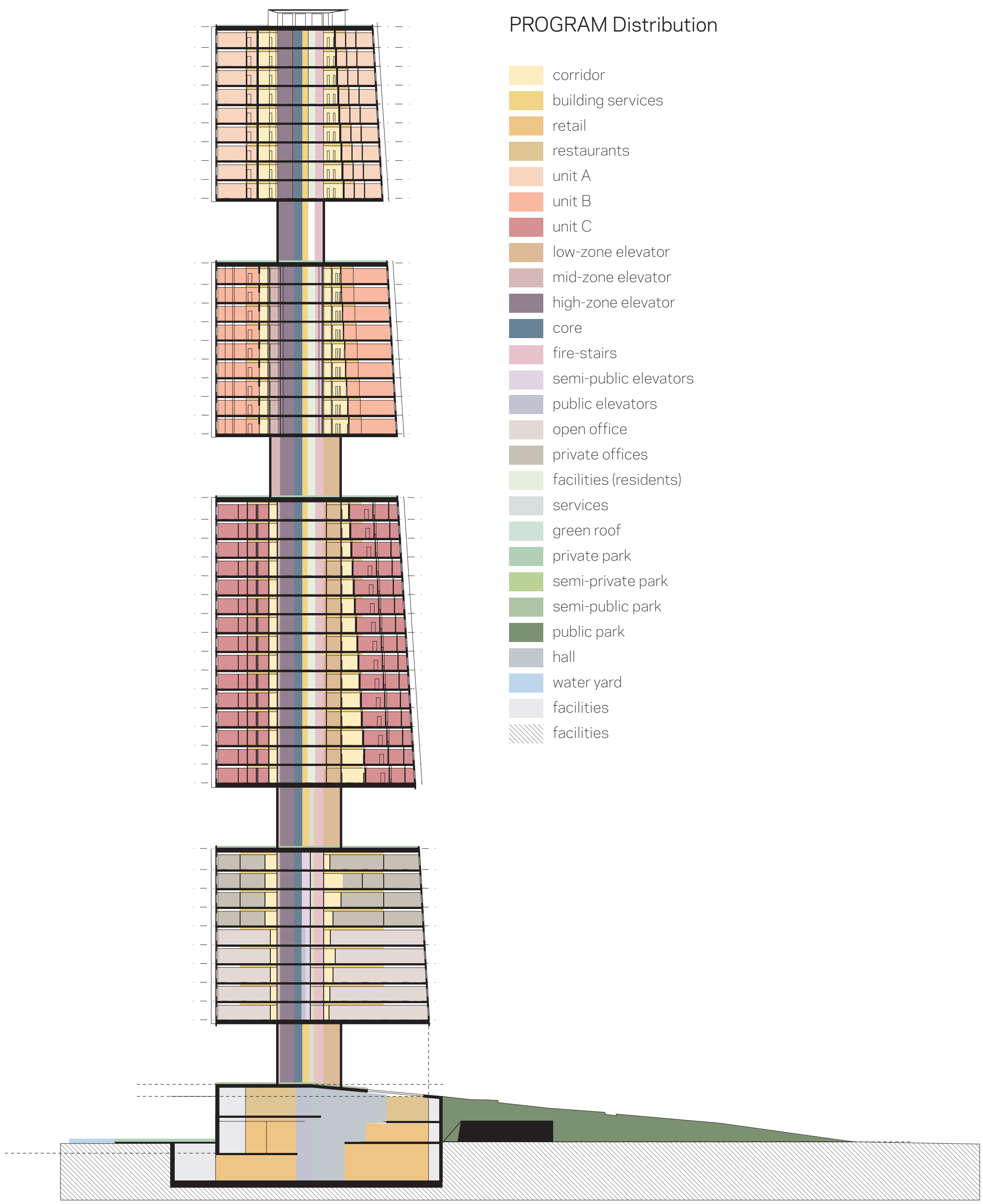


Section **CROSS SECTION (UNIT A,B &C)**

Scale **1:500**

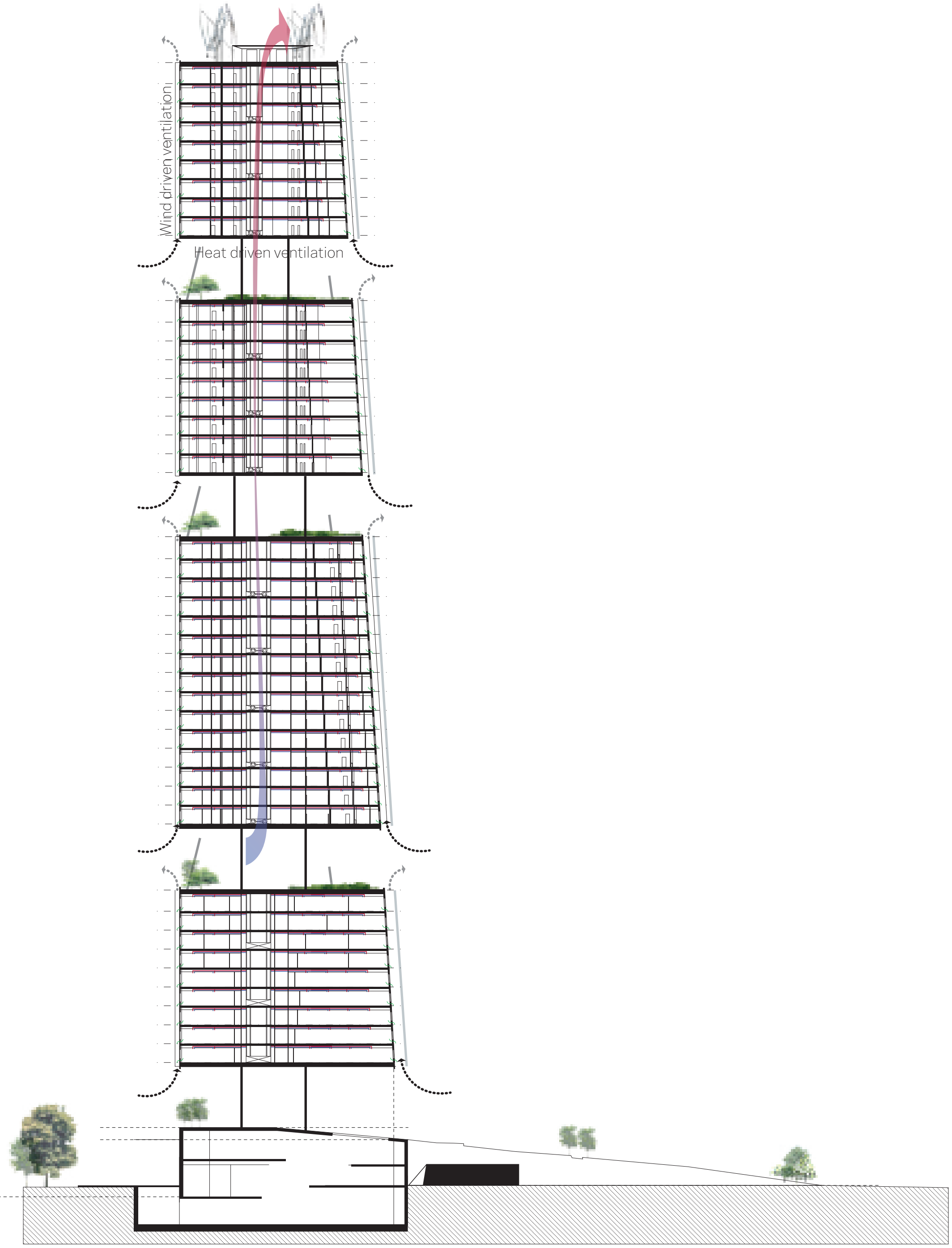
Aalborg Universitet | ad:mt - Department of Architecture, Design and Media Technology
Timea Török - 20081144 - ttorok08@student.aau.dk

Section | Program



PROGRAM Distribution

- corridor
- building services
- retail
- restaurants
- unit A
- unit B
- unit C
- low-zone elevator
- mid-zone elevator
- high-zone elevator
- core
- fire-stairs
- semi-public elevators
- public elevators
- open office
- private offices
- facilities (residents)
- services
- green roof
- private park
- semi-private park
- semi-public park
- public park
- hall
- water yard
- facilities
- facilities


Wind driven ventilation
Heat driven ventilation

Part VII

Design Proposal
Evaluation

EVAULATION OF THE RESULTS OF THE DESIGN PROCESS, POTENTIALS

Discussion on overall result, living circumstances

Evaluation of overall building performance

Evaluation of intelligent technology use

Discussion

As a reflection on the result of this project it is necessary to compare the aspects of the vision and the aims of the project.

After concluding from research that urban growth is inevitable, and even so crowded cities became more and more crowded, people still favour living in urban areas. Displacing colonies or promoting sub-urbs is not a working solution; therefore advantages of sub-urban living must be implemented into the design.

The problem formulation frames a significant dilemma if architecture would be able to contribute to a better urban living. Research and problem formulation drive decisions during the design process.

The focus group of users is urban residents who prefer to live in the dense areas. Dense areas providing all advantages of the city, while advantages of single-family house living are fading out. It become important to provide opportunities to the residents to feel close to the nature, to give semi-private and semi-public outdoor areas. These outdoor areas are able to accommodate outdoor activities and relaxing moments.
Green areas are one of the priorities when looking at the overall concept of the building complex.

The layout of the site and the placement of the volume divide a partly closed semi-private area and a huge public park. Building site becomes attractive for whole neighbourhood giving a place for peace and fun. The slope of the green extension enables various features, which improves the overall quality of the building.

While public park lays on the green extension, semi-private gardens are placed on northern part of the site and on the open floors.
Gardens on the open floors compensate the absence of balconies and vegetation on facade emphasizing natural characteristic of the concept.

Maximizing green vegetation on site makes users feel close to nature. Besides physical effects of vegetation, such as noise barrier, air filtering, natural shades, physical affects are also acting on residents.

Living in the overcrowded city, people never have time to stop or take a breath; living in tiny dwellings in huge condominiums does not promote human relations. With right functions, more common areas concept encourages residents to a more alive social interaction to create a sense of community.

In regard to environmental aspects, recycling and natural materials are used to some extend, natural light utilized in every apartment, and even implemented in retail floors in form of skylights.
Details are developed and other features are applied to create low energy consumption.
Energy needs can be supplied from low-cost, locally available, non-polluting, renewable sources. With allowed grid connection energy balance of the building is in the net zero-energy margin.

Building performance

Buildings and construction industry is counted for 40% of the energy consumption. At the same time, the potential to safe energy by appropriate design is relatively high. Modern buildings allow using advanced construction technologies and significantly improve energy performance. Adapting to the local settings and consider renewable sources is crucial for environmental design.

Concept is approaching net zero-energy concept. The amount of energy provided on-site from renewable sources covers the energy used by the building. Energy needs have been calculated along the process, and results are considered in design decisions. Design process took the most cost-effective steps towards to reduce energy needs; hence energy production will be sufficient to fulfil them. Building orientation and window areas are optimized to passive solar gain and secondary facades have been used to optimize shading.

Materials used on North and South facade creates a clear contrast in solutions. The two main elevation displays how natural and technical solutions can be used within one complex.
North facade is covered by vegetation while South side uses shading panels and PV components. Both solution improves airflow between the layers, insulation values and they shade against overheating. North side is an active contribution to urban air quality in terms of natural air filtering; South facade has a passive role in energy production.

User comfort

Good indoor climate was one of the most important aspects during the process. Designing with environmental conscious materials and lowering the energy needs of the building have already supplied some of the qualities for indoor comfort. Although energy consumption is often prioritized above all architectural values, it is important to match aesthetics and technicality during the integrated process.

Both outdoor areas and indoor spaces stand as example how life could be still close to nature while living in the cense city. Concept tends to keep some of the qualities of the sub-urban living in the middle of the dense city.
Apartment layouts maximizes usable spaces, areas of functions fulfil requirements, while they provide spacious sense inside. Given the shape of living units, interior spaces are opening up from entrance towards to the facade, ending in a framed panoramic view over surroundings.

Height of the building is working with the context; therefore users have great view from resident floors.

Viewer experience is provided through primary and secondary facade, while division of facade components are divided to allow undisturbed view.

Evaluating the indoor climate, qualities have been found adequate. However energy calculations results in a little high overheating percentage, daily temperature swing is almost zero.
Ventilation is provided with mechanical system; natural ventilation is avoided due to the highly polluted urban air quality, all inlets must be filtered.

Outdoor shading device preferred to be fixed from the very beginning of the process. Given the surface area of the structure, it is hard to operate such a huge face to please every individual inside. Each resident has his own preferences and unique need. Hence shading system adjusted to the local settings - individual need can be fulfilled with internal shades. Fixed structure also have more advantages is respect of life cycle costs and maintenance. Huge surface of panels and right orientation gives plenty of opportunity for PV implementation. Solar cells on facade provide major part of energy needs.

Reflection - Potentials of use

As a conclusion on research based process, the problem of the dense areas has been stated before. All cities, mega-cities have to deal with the high density, pollution and huge environmental effects.

Since the circumstances are the same in these cities, the contribution might be similar as well. Would it be a common solution for the common problem? To find the solution, common elements must be found in the given places.
There are crowded cities all around the world; all with their unique look and individual climate. The common element of the mega-cities is the high density. High density triggers high-rise architecture. High-rise building leads to huge surfaces.

Most of the high-rise structure does not have their identity due to their elevation, but from their form, height or overall volume.

Therefore these huge surfaces, in a way, become unexploited. With the right algorithm and reference curves, scripted surfaces can be generated according to the very local settings.
Hence, huge surface would become an active/passive contribution to the environment.

Development of passive solar technologies and PV elements enables all building to produce energy for their own needs. Each building has the opportunity to be upgraded and became a low(er)-energy building.

Solar cells and green walls are both existing, already tested and working solutions. Apart from the local adjustments it is possible to use both of the solutions under most of the circumstances.
Could you imagine the iconic buildings covered with their very own energy productive skin?

Part VIII

Attachment of **Appendix**

ATTACHED DATA AND STUDIES USED DURING THE PROCESS

Studies on human generated pollution and urban air quality

Studies on high-rise structure and their use

Studies on skyscrapers of Pudong area

Studies on Chinese culture and traditional values

Documentation of process of design development

CD: file of brief, midway presentation, riport, calculations and model

Appendix A

Studies on **Pollution**

SCIENTIFIC DATA ON POLLUTION IN URBAN ENVIRONMENT

Kind of pollutions of the urban context

Nature and causes of polluted urban air

How is it possible to contribute to a better urban air quality?

Acknowledgement

There are many kind of pollutions in urban areas effecting the population and health,

noise
visual
soil
air

Project deals mainly with air pollution, investigating urban air quality to find a location for the project.

Proposal must contribute to better urban air quality, as finding a way of building, which minimize its environmental impact, and provide better living quality.

The project tends to result in a strategy, which has the potential to implement in other project proposals.

Human generated pollution in urban context

Nowadays, there are nearly 3000 different atmospheric air pollutants have been identified and most of them organic.

Air pollution is really complex in its sources and components. Most of the air pollutants are coming from human activities, which concentrate in an urban context.
Air pollution has serious effect both on the environment and on humans. Ambient air pollution in the highly urbanized modern world is a great threat on the health of the large part of world's population. Studies show that air-borne emission from urban and industrial areas has a huge influence on climate change in various scales, from the microclimate until the global climate change.

This challenge is particularly difficult in dense urban areas, in the developing world and the rapidly growing mega-cities*.

Numerous thesis and numberless modelling tools investigate and describes the impacts of air pollution in different contexts.
Lawrence et al. (2007) used a global model to examine the characteristics of pollutants in mega-cities; results evidently demonstrate the tradeoffs between pollution pattern in the regions surrounding mega-cities versus rural regions or upper atmospheric layers.
Unfortunately, simulations always have uncertainties due to the changing properties, and dealing with difficulties to capturing the details, but indisputably urban areas are the most dangerous regions for human health.

In most urban areas the majority of the emission comes from fossil foil use, high traffic and increasing number of generators. The most harmful pollutants, such as nitrogen oxides (NO.) and particulate matter (PM) are raising the biggest concern in poor urban air quality. The concentration of human activities in a relatively small area puts enormous pressure on the microclimate and leads to numerous environmental problem.

Since 1950, the population doubled, the fraction of people living in cities increased by 4, and global number of car use has increased by a factor of 10. Nowadays, there are nearly 3000different atmospheric air pollutants has been identified and most of them organic. For example, combustion sources, especially vehicles emit about 500 different compounds. However the ambient concentration is determined with a smaller number of compounds, it determines the limitations for urban air quality management**.

Several concepts and indicators exist to measure and relate urban areas by their air quality.
Project research will consider components in respect to health and environmental impacts and try to set a rank of cities to find extreme scenarios, and to propose a site in need.

Sources of urban air pollution

Among 18 considered mega-cities, 5 have been classified as having "fair" air quality, and 13 as "poor" air quality. *[Gurjal et al.,2007]*

Air pollutants are coming from wide variety of sources.

The most important source of ambient pollution is generally the combustion of fossil fuels; there are three major sources are separated:
mobile sources, stationary sources and open burning sources.
Assessment report by Mage et al. (1996) indicates that motor traffic is the major source of air pollution in megacities.

The most classical pollutants are:
sulfur dioxide (SO2), nitrogen oxides (NOX), carbon monoxide (CO), volatile organic compounds (VOCs) and particular matter (PM).

Sulfur dioxide:
SO2 is a poisonous gas released by volcanoes and in various industrial processes. Since fossil fuels often contain sulfur compounds, their combustion generates sulfur dioxide. Sulfur dioxide is a major air pollutant and has significant impacts upon human health. In addition the concentration of sulfur dioxide in the atmosphere can influence the habitat suitability for any life forms. Sulfur dioxide emissions are catalysts to acid rain and atmospheric particulates.

Nitrogen oxides:
Nitrogen oxides are produced from the reaction of nitrogen and oxygen gases in the air during combustion, especially at high temperatures.
Nitrogen oxides are produced during natural and industrial procedure as well. But in areas of high motor vehicle traffic, such as in large cities, the amount of nitrogen oxides emitted into the atmosphere, as air pollution can be significant.
Nitrogen oxides are the main reactors for form smog and acid rain; they are also catalysts to the formation of tropospheric ozone.
There are several regulations and emission control technologies used for limitations worldwide.

Carbon monoxide:
Carbon monoxide is colourless, odourless, and tasteless, but highly toxic. The largest source of carbon monoxide is naturally produced by photochemical reactions in the troposphere that generate about 5 x 1012 kilograms per year; thus it is an important chemical element of nature, and indispensable for lifecycle.
But carbon monoxide poisoning is the most common type of fatal air poisoning in many countries.
Concentrations as low as 667 ppm may cause up to 50% of the body's hemoglobin to convert to carboxyhemoglobin; and a level of 50% carboxyhemoglobin may result in seizure, coma, and fatality.
Carbon monoxide is a temporary atmospheric pollutant in some urban areas, due to the combustion engines and various other fuels. It is a threat in urban scale and in closed indoor spaces as well.

Particulate matter:
Particulate matters are tiny subdivisions of solid matter suspended in a gas or liquid. Some particulates occur naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as the burning of fossil fuels in vehicles, power plants and various industrial processes generate significant amounts of particulates.
Particulate matters have great effect on human health and on global climate as well.
The large number of deaths and other health problems associated with particulate pollution was first demonstrated in the early 1970's. PM pollution is estimated to cause 22 000-52 000 deaths per year in the United States and 200 000 deaths per year in Europe [studies from 2000].
PM is a major problem in almost all Asia, exceeding 300 pmm/y/m3 in many cities.

Air quality in mega-cities

Air pollution in mega-cities is influenced by many factors such as topography, meteorology, industrial growth, transportation systems and expanding population.

As a fact, measures shows that emissions of the urban and industrial areas of the developing world change the chemical content of the lower troposphere in a numerous of fundamental ways. Increasing emission of mega-cities produce thousands of tons of primary pollutants, which in a reaction in the atmosphere generate secondary pollutants in local and regional levels. This chain-reaction can be extremely dangerous to health.

On one hand, nitrogen oxides, carbon oxides and organic compounds form ozone, necessary for life cycle; ground level ozone is highly dangerous to human health and the production of ozone as a powerful green house gas (GHG) contributes significantly to global warming.
Urban and industrial areas are also the main sources of other GHG such as CO2, CH4, N2O.

The term 'air pollution episode' is also a creation of the developed world. Originally it implies a short-term increase of ambient pollution in the air than normal. In a more extreme form, air pollution episode causes physical discomfort, disruption in daily life, spreading public fear, illness or even death. Therefore it belongs to the category of environmental disaster.
In many cases, episodes can be more than a short period in consequence of burning fuel of transport, industry or domestic use. At many occasions episodes are not simply just the effect on an increased emission, but it may be caused by weather conditions.

Certain areas or cities may be more disposed to air pollution episodes due to their particular topography or climate. Characteristics, such as air temperature, humidity and wind speed within the urban area, increase the hazard of the episodes.

The most serious air pollution episodes are called smog in the common language. The world is a combination of the words "smoke" and "fog".
It characterized by reduced visibility, eye irritation, plant damage; it increases mortality and illness, stress and discomfort.

Air quality measurements in mega-cities

The rapid development and population growth caused serious air-quality problems. Measurements of pollutants in mega-cities are required to help characterize their nature and quantity. The challenge of improving existing techniques involves all fields of life. Current efforts should continue to help develop air quality and improve life conditions.

WHO and UNEP created an air pollution-monitoring network to study 20 mega-cities air trends. The reports show that each 20 mega-cities have at least one major air pollutant, which occurs, at levels above the guidelines. From the review of trends in air quality it is clearly implied that controls must be implemented without further delay.

Air quality improvement programs have been already made to reduce emission from fossil fuels. Limitations of vehicle use, transportation policies and improvement in engine solutions are indented to improve ambient air quality. These strategies appear to reduce smog precursors, but efforts must be made in other fields of technologies as well.

Assessment reports concluded at the beginning of the 21th century, that current megacities present a great challenge for air quality, regional atmospheric chemistry and global warming.
Economic growth, technological inventions, social dynamics and advanced industry offer possible opportunities even in highly populated urban areas to manage a growing population in a sustainable way. Well-planned, densely populated areas can reduce the need of land and provide sustainable infrastructure and services.

Appropriate ambient air quality management and accurate monitoring help in the fight against air pollution, but there is no single strategy for addressing the problems in the mega-cities.

Pollution and long-term effect on human health

Pollutants and their long-term health effect are shown in the table below, indicating their major source as well.

Pollutant	Sources	Organs Affected/Effects
Lead	Lead battery manufacture	Brain
		Impairment of learning and intelligence in school children
	Paint/Smelting industry	
	Ingestion of crayons containing lead pigment	Lead encephalopathy (damaged to brain tissue)
	Chewing of toys with paint	Mental retardation
	Leaded gasoline	Digestive system
		Persistent abdominal pain
		Kidney
		Bloody urine
		Bone
		Damage to the formation of hemoglobin; joint pains; anemia
		Death
Mercury	Gold extraction from mineral ores	Brain
	Electrical contacts and vapor lamps	Tremor, loss of memory, lack of . confidence, vague fears and depression
		Kidney
		Bloody urine
		Oral cavity
		Gingivitis (infection of the gums)
Arsenic	Pesticides containing arsenic	Skin
	Copper smelting	Chronic irritation of the skin
		Digestive system
		Persistent abdominal cramps, nausea
		Eyes
		Chronic irritation/permanent
Irritant Gases/ Asphyxiants	Fumes from smoke-belching cars; emissions from	Heart
Sulfur dioxide	industries; cigarette smoke	Aggravation of cardiovascular illnesses
Hydrogen	Coal gas industry	Brain
Sulfide (H2S)	Gold extraction from mineral ores	Loss of consciousness; impairment of mental function
Ammonia	Fertilizer industry	Aggravation of respiratory diseases (asthma, pneumonia)
Nitrogen dioxide		Cancer
Carbon dioxide		Eyes
Carbon monoxide		Reduction of vision
Hydrogen cyanide		Coma/death
Cigarette smoke	Cotton fibers	Lungs
	Coffee bean hull	Respiratory tract irritation (cough, sneezing) asthma, pneumonia

Pollutant	**Sources**	**Organs Affected/Effects**
	Rice hull Sugarcane bagasse Animal feathers	Cancer Death
Pesticide	Manufacturing, packaging industry Residues from food Pesticide from household use	Brain Nervous disorder (paralysis); loss of consciousness Behavioral disorder (mental disorder) Multi-organ Cancer Skin Chronic allergy Lungs/heart Chest tightness/pain, chronic respiratory tract irritation
Ultraviolet radiation	Destruction of the ozone layer Prolonged exposure to sunlight	Skin Cancer of the skin Eyes Eye impairment (e.g., cataract)
Cadmium	Anti-rust plating material As salts used as pigments and coloring agents for plastics, In nuclear reactors as absorbing material	Lungs Chronic pulmonary irritation Prostate Cancer Heart Hypertension (High-blood pressure) Bone Itai-itai disease (softening of the bone associated with pain) Kidney Chronic kidney damage
Barium	Geothermal industry As a component of pesticide As pigments of white paints.	Lungs Chronic irritation of the nose and throat Pneumonia-like symptoms Reproductive organs Impaired female and male reproductive functions.

Pollution in the mega-cities

Table shows ranking of mega-cities according their ambient air quality data gathered from different sources. Ranking helps to find an appropriate location fro the proposal.

	NAME	Population	Area [km2]	Density [/km2]	Annual growth
26	Osaka	16700000	222.47	12004.90	0.15
25	Moscow	16000000	1081.00	10651.55	0.20
24	New York	22000000	8683.20	27532.00	0.30
23	Tokyo	34300000	2187.66	6027.20	0.60
22	London	12500000	1572.10	4978.00	0.70
21	Rio de Janeiro	12600000	4557.30	4781.00	1.00
20	Buenos Aires	14900000	4758.00	14219.80	1.00
19	Paris	10500000	2723.00	20980.00	1.00
18	Los Angeles	18100000	502.69	7544.60	1.10
17	São Paulo	20900000	1522.99	7216.30	1.40
16	Mexico City	22900000	1485.00	5960.30	2.00
15	Jakarta	18900000	740.28	14464.08	2.00
14	Calcutta	16300000	1480.00	24252.00	2.00
13	Seoul	25100000	605.25	17288.80	2.20
12	Manila	20300000	638.55	43079.00	2.50
11	Tehran	13300000	1274.00	10327.60	2.60
10	Cairo	15400000	6640.00	17190.00	2.60
9	Beijing	16000000	16801.25	1167.30	2.70
8	Istanbul	13100000	5343.00	2481.00	2.80
7	Mumbai	23000000	603.00	20694.00	2.90
6	Lagos	12300000	999.60	7941.00	3.20
5	Guangzhou	25200000	3843.00	1708.00	4.00
4	Dhaka	14200000	360.00	23029.00	4.10
3	Shanghai	24800000	6340.50	3630.50	4.60
2	Delhi	23300000	1483.00	11297.00	4.60
1	Karachi	17000000	3527.00	5685.30	4.90

:h [%]	**Urban air quality** [µg/m3]				**buildings at least 100 m H**	**buildings at least 35 m H**
	SO2	**NO2**	**SPM**	**PM10** 'Particulate matter with diameter of 10 µm or less.'		
	22	64		27		1463
				33		3273
				21	794	5024
	21	66		23	556	2702
				14		1478
				64		2564
				38		
				38		
				25		
				38		
				57		1364
				43		
	38	32	388	148		
	64	66	103	64	282	2877
	30		192	47		
				96		2804
				121		
	96		378	121		
				59		2148
	29	32	254	132		1223
				122		
	57		248	125	295	
				134		
	79		250	81	430	
	26	49	481	198		
				193		

Appendix B

Studies on **Skyscrapers**

EXPLORING THE CHARACTERISTICS OF HIGH RISE POSSIBILITIES

How tall buildings work in structure and function?

Possibility of integrating information technology and intelligent building components

Aalborg Universitet | ad:mt - Department of Architecture, Design and Media Technology
Timea Török - 20081144 - ttorok08@student.aau.dk

Acknowledgement

There is no official definition of what considered as “skyscraper”.
The word “skyscraper” was first used to describe a building of steel construction of at least 10 storeys in the late 19th century (Home Insurance Building, Chicago, Illinois; 1885).

A relatively small building may be considered as a skyscraper if it protrudes well above its built environment and changes the overall skyline.
The Emporis Standards Committee defines a high-rise building as “a multi-storey structure between 35–100 metres tall, or a building of unknown height from 12–39 floors” and a skyscraper as “a multi-storey building whose architectural height is at least 100 metres.”
Generally, skyscraper is used as a term in a loose conversation with over 150 m high buildings.

The structural definition of the word “skyscraper” was redefined in the end of the 19th century. This definition is based on a steel construction as the core of the building, giving a stiff backbone to resist wind forces.

The term “supertall” has been recently called for buildings over 300 m height.

Housing types

Traditions and traditional living

China's tradition and culture has a very strong identity. Traditional housing buildings are still presents, especially in the Old Town. Many sections of the town have old housing parts, with narrow alleys and typical dense roof patterns.
Although most of these areas look dingy and neglected, traditional block are not equals to poverty. Residents of these houses belong to worker or middle class.

Modern developments

New, modern developments of some areas have a strong contrast to the old traditions. Skyscrapers built in the last decades made with high technological solutions in a form of the developed west. Massive steel structures are overtaking the city, destroying the identity of the old town.
New design sometime looses the connections to the tradition not continuing the trend of evolution.

Mixture of tradition and modernity

Some modern building tries to implement old tradition in their design. The most typical Chinese roof forms often come back on new buildings. Modern and old has to be mixed carefully and tastefully. Colours, materials and forms could link to the traditional Chinese design.
Old forms and colorful culture must inspire the design at least in details or in way of usage.









Functions

Given the problem of high density and constantly growing population the project is aimed to provide comfortable living possibilities in the urban area.
The proposed building would mainly function as residential house. Different tests will be carried out in sketching phase to test sizes, layouts of the apartment plans to give a spacious experience in an optimized functional floor area for the residents. Furthermore outdoor spaces will be considered both for private and public use.

Extra functions will be added in order to emphasize the potential of the mixed used.

The design will take the advantages of the low dense suburb living to combine with the opportunities of the high dense city life. The values like private space, quite nature and peaceful daily life would be considered as an important principle during designing well-equipped dwellings close to the public transportation, urban infrastructure and services.

The main characteristics of a developed city are showing a modern dense pattern in the city's web.

Most of the buildings are serving finance, business, institutes and tourism. The high-rise buildings are filled with offices, rentals, stands as hotels, but the goal of the project to design a high-rise for residential use.

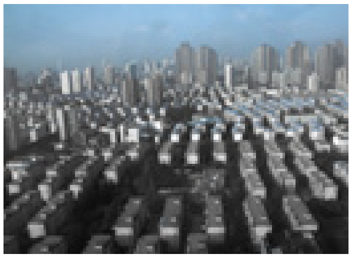
Low-dense housing:

Century Par, edge of Pudong

- open space for private use
- familiar neighbourhoods
- safety
- healthy
- ownership
- calm and peaceful environment
- close to nature
- distances

countryside, villages, farms
bigger parcels with housing (15-45%)

Medium-dense housing:



Apartments between the highrise of Pudong

- residential developments
- public services
- semi private spaces
- public services
- efficiency
- noise problems
- fire hazards
- social life

suburbs, smaller towns
bigger parcels with housing (45-65%)

High-dense housing:

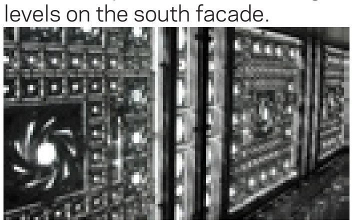
High-rise housing on the banks of Huangpu River

- urban infrastructure
- small private place
- public areas
- close services
- recreational areas
- compactness
- activities

city centers, dense urban centrums
high-rise buildings with small footprint (65-80%)

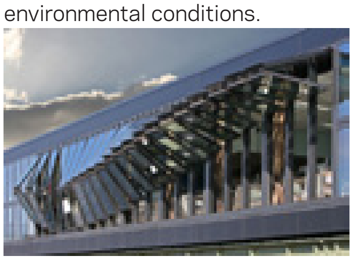
Building skins, intelligent solutions

Arab Institute by Jean Nouvel, completed in 1987 is one of the first buildings to apply responsive building skin with senses sensitive to environmental conditions. 25,000 photoelectric cells similar to a camera lens are controlled with a computer to moderate light levels on the south facade.

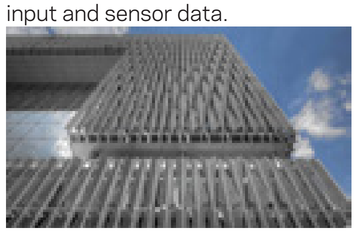


The facade system of folding shades is designed by Giselbrecht+Partners. for the showroom in Bad Gleichenberg, Austria. The 'dancing facade' has 112 metal tiles in line on the exterior and all of them are movable.

Open restaurant in Amsterdam by CIE architects has one of few newly constructed kinetic facades. The facade of the building is dynamically adaptable to the environmental conditions.

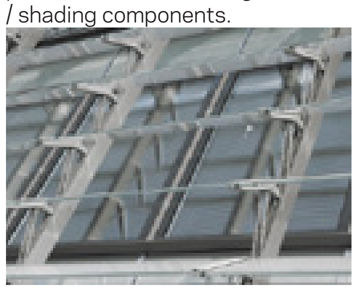


The recently built Q1 headquarters in Essen, Germany is shaded by 3,150 kinetic "feathers" that open and close based on user input and sensor data.



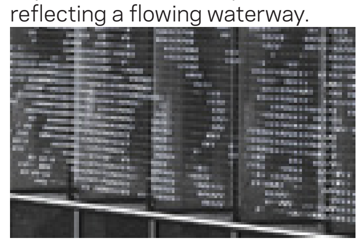
The dynamic glass by Soladigm, is used on the exterior of the facade to protects from the elements yet provides natural light and a connection to the outside. It can change its tint from clear to dark on demand and provide unprecedented control over the amount of light and heat that enters a building.

There are also many movable shading systems provides solutions for energy sufficient design. For example Colt, Holland based company offers a wide variety of automated glass and metal louver products as well as integrated PV / shading components.

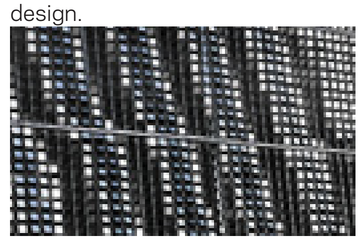


Solar motions are also offering different movable solutions with various finishes. Automatically operating shading systems are programmed to adjust to the movement of the sun optimize solar heat gain, to reduce energy usage and maximize daylight.

"Vertical canal' facade installed by Cepezed on their own office building in Utrecht. A 300 m2 metal grid contains a giant array of small plastic discs, which move with the wind and reflect the hues of the sky to create visual experience reflecting a flowing waterway.



Ned Kahn's facade system, Thecnorama is more like a media facade, but still effective solution for shading. The materials amplify natural forces, moving by the wind allowing the nature to form the design.



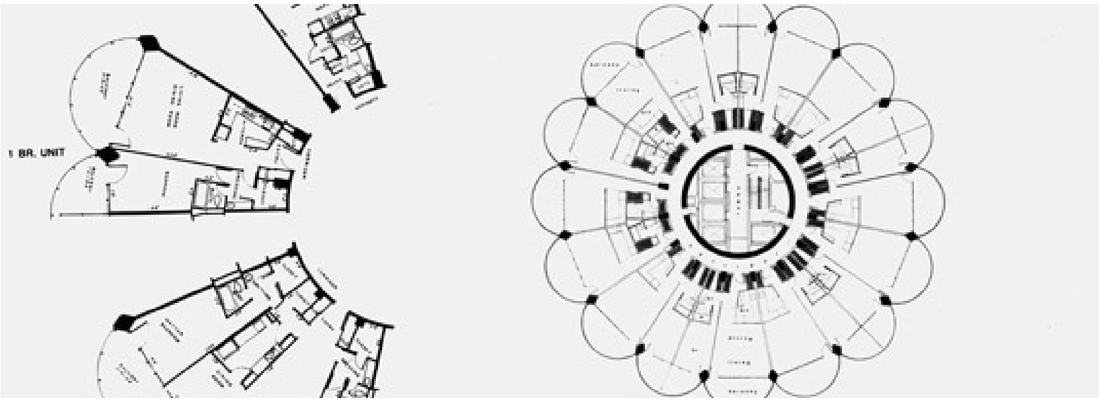
Case study 1 - Marina city

Marina City is a complex of two 60-story towers built in 1964 by Bertrand GoldBerg in Chichago, Illionis.

The complex consists of two high-rise corncob-shaped 65-story towers (including five-story elevator and physical plant penthouse), at 179 m. It also includes a saddle-shaped auditorium building, and a mid-rise hotel building, all contained on a raised platform adjacent to the river. Beneath the raised platform at river level is a small marina for pleasure craft, giving the structures their name.

Marine City is an example to follow in meaning of use, form and architectural expression.

The two towers contain identical floor plans. The bottom 19 floors form an exposed spiral parking ramp with 896 parking spaces per building. The 20th floor of each contains a laundry room with panoramic views of the Loop, while floors 21 through 60 contain apartments (450 per tower). A 360-degree open-air roof deck lies on the 61st and top story. The buildings are accessed from separate lobbies that share a common below-grade mezzanine level as well as ground-level plaza entrances beside the House of Blues. Originally rental apartments, the complex converted to condominiums in 1977.



Marina City apartments are unique in containing almost no interior right angles. On each residential floor, a circular hallway surrounds the elevator core, which is 10 m in diameter, with 16 pie-shaped wedges arrayed around the hallway. Apartments are composed of these triangular wedges.
Bathrooms and kitchens are located nearer to the point of each wedge, towards the inside of the building. Living areas occupy the outermost areas of each wedge. Each wedge terminates in a 16.3 m2 semi-circular balcony, separated from living areas by a floor-to-ceiling window wall. Because of this arrangement, every single living room and bedroom in Marina City has a balcony.

In addition, the residential towers are noted for the high speed of their elevators. It takes approximately 35 seconds to travel from the lower-level lobby to the 61st-floor roof decks.

The corncob appearance of the towers is said to have inspired a similar design for the Corinthian Tower in New York.

Case study 2 - Urban cactus

Urban Cactus is rising above the mostly box shaped Dutch architectural landscape and responding to the natural context with its organic shape and large outdoor terraces.

Urban Cactus is a residential building complex on the harbour in Vuurplaat, Rotterdam, proposed by UCX Architects. The design has its name due to its architectural shape and environmental friendly features. The design of the building uses the advantages of the location, and chooses to have a closer relation with natural landscape rather than the build urban structure.

The building has 98 residential dwellings, on 19 floors, using large outdoor terraces to determine the building form. Hence the building has a very natural and organic overall expression.
The changing pattern of the outdoor spaces creates a sense of double floor heights, while each dwelling gets more natural light.
Construction of building has started in 2006, but in the last few years, the number of similar designs multiplied. There are numberless buildings, which try to achieve suburban advantages within a high-rise structure.

Building stands as a great example of green implementation of the design to help residents to feel closer to nature even in a high-rise structure.
Outdoor spaces maximizing green areas and helping microclimate. User comfort is provided indoors and outdoors as well.

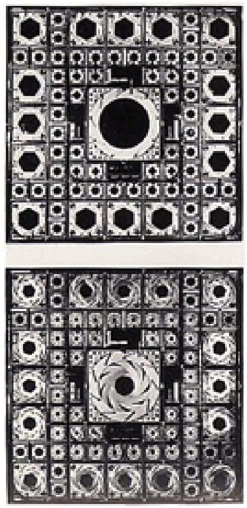
Case study 3 - L'Institute du Monde Arabe

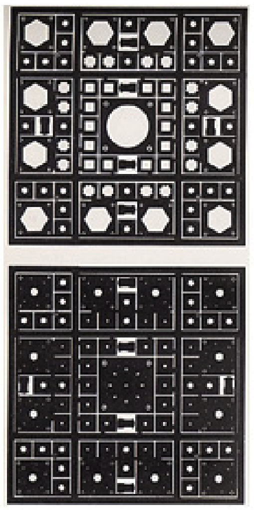
Arab institute is designed by Jean Nouvel, was established to unite 19 Arabic countries and France and to spread information about the Arab world and its cultural and spiritual values.

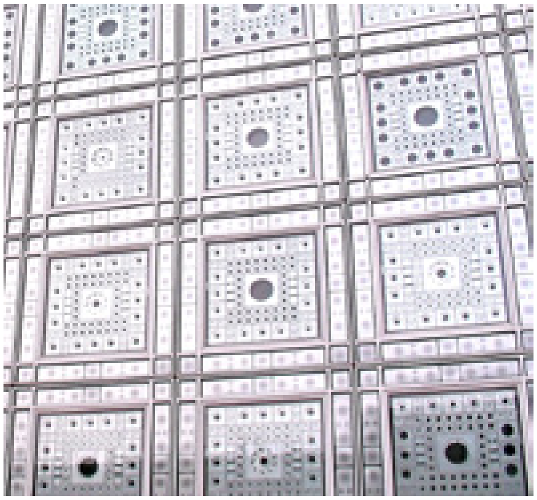
Besides its great goal in promoting Arabic values in France and in the whole World, the Institute of World Arab is an outstanding building in its design and architecture.
The building was constructed from 1981 to 1987 with a floor space of 16 894 m2, it is located at the historical quarter of Paris along the River Seine, where it immediately responds to context both in plan and elevation.
In plan it follows the curvature of the road, whose form is dictated by the river. The two main volumes enclose an inner courtyard with the north mass rising 9 stories and the southern portion rising up to 11 stories. Furthermore the outdoors spaces are paved to mimic the pattern of the façade and emphasize the design.

The interior spaces house numerous typologies including a restaurant, museum, library, offices, and auditorium. A multi storey glass atrium is wrapped with a steel staircase featuring exposed elevator lifts on the interior. The library and northern portion of the 4th floor feature increased floor to ceiling heights as well as incorporating numerous terraces and a mezzanine.

Building is studied due to its outer skin and architectural expression. Pattern and texture of facade creates a spectacular flavour. Playing with light and perception emphasizing the design, pattern and form creates a sense of traditional values while material and technology projects modernity.







Study on additional elements

Several additional elements can help to emphasize design of the building, while keeping original vision. Elements can be added to the whole building form or implemented into details.

Active features


badminton


excercise

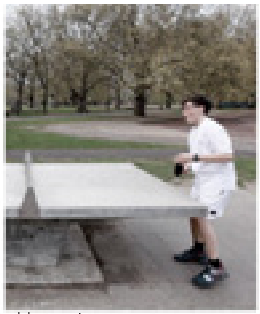
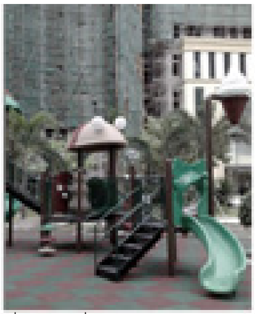
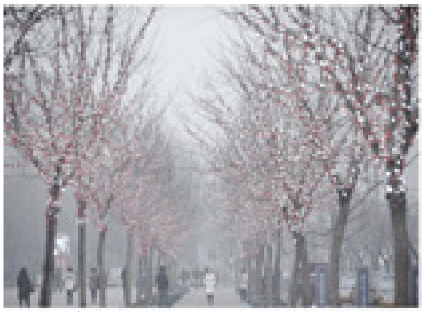


table tennis


playground

Passive features

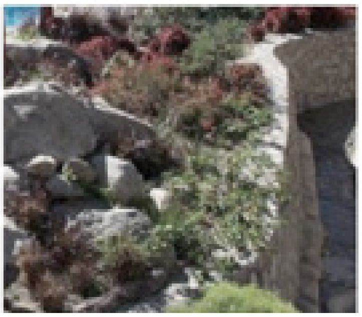

promenade


gallery


picnic

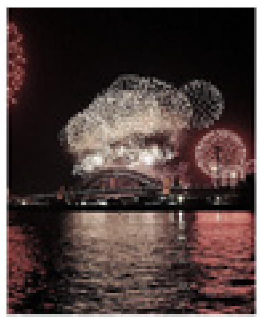
Creative features

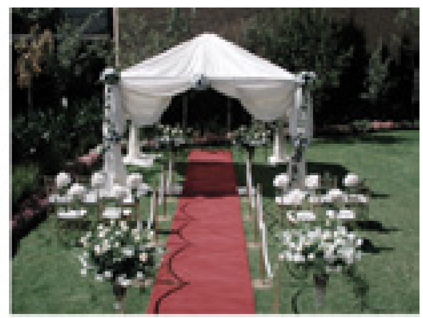

pavilion / exhibition


stone garden


fountains

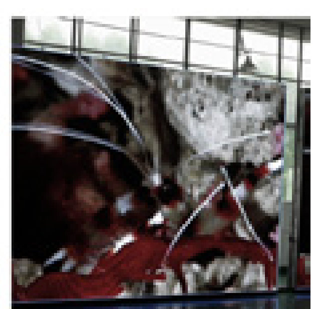
Temporary features






skyscrapers


density


media

Appendix C

Shanghai **Skyscrapers**

CATALOGUE OF TALL
(SUPERTALL) BUILDINGS IN
SHANGHAI

Aalborg Universitet | ad:mt - Department of Architecture, Design and Media Technology
Timea Török - 20081144 - ttorok08@student.aau.dk

Acknowledgement

The city of Shanghai, one of China's fastest growing cities terms of skyscraper construction.
Since 2008, Shanghai has more freestanding buildings above 400m than any other city in the world.

At December 2011, the City of Shanghai reporting 1,057 completed high-rise buildings; and 165 more over 300 m tall buildings either under construction, approved for construction, or proposed for construction.

Shanghai has earned the name "skyscraper city" within two decades, due to the economic reforms in 1991, the city is experiencing its second construction development phase, to gain a status as important global financial center.

1. Shanghai Tower

Shanghai Tower designed by Gensler, located next to Jin Mao Tower and the Shanghai World Financial Center in Pudong financial district.

At the time of its completition in 2014, with its 128 floors and the proposed 632 m height, it is going to be the tallest building in Shanghai, and the second tallest in the world.

The tower designed as nine cylindrical blocks placed upon each other, enclosed by the inner layer of the glass façade. Between the inner and the outer layer of twisted glass surface, nine indoor zones will provide public space for visitors.
Each of these nine areas will have its own atrium, featuring indoor gardens, cafes, restaurants and retail space and providing panorama views of the city.
The "sky gardens" will provide relaxing and meeting place for visitors; several facilities will serve the visitors needs, serving as places to eat and shop; event spaces will be provided at the base of the tower.

The mixed used building will be able to accommodate 16 00 people on a daily basis.

2. Shanghai World Financial Center

The Oriental Pearl Tower is a TV tower in Shanghai, China. Its location at the tip of Lujiazui in the Pudong district, by the side of Huangpu River, opposite of The Bund makes it a distinct landmark in the area.

It was designed by the Shanghai Modern Architectural Design Co. Ltd. Principal designers are Jiang Huan Chen, Lin Benlin and Zhang Xiulin. Construction began in 1990 and the tower was completed in 1994.

At 468 m high, it was the tallest structure in China between 1994 and 2007, than it was surpassed by the Shanghai World Financial Center. The Oriental Pearl Tower belongs to the World Federation of Great Towers.

The tower features 11 spheres, big and small.
The two largest spheres, along the length of the tower, have diameters of 50 m for the lower and 45 m for the upper.
Three columns link them, each 9 m in diameter. The highest sphere is 14 m in diameter.

Three enormous columns that start underground support the entire building.

An antenna, broadcasting TV and radio programs, extends the construction by another 118 m to a total height of 468 metres.

3. Oriental Pearl Tower

The Oriental Pearl Tower is a TV tower in Shanghai, China. Its location at the tip of Lujiazui in the Pudong district, by the side of Huangpu River, opposite of The Bund makes it a distinct landmark in the area.

It was designed by the Shanghai Modern Architectural Design Co. Ltd. Principal designers are Jiang Huan Chen, Lin Benlin and Zhang Xiulin. Construction began in 1990 and the tower was completed in 1994.

At 468 m high, it was the tallest structure in China between 1994–2007, when it was surpassed by the Shanghai World Financial Center. The Oriental Pearl Tower belongs to the World Federation of Great Towers.

The tower features 11 spheres, big and small. The two largest spheres, along the length of the tower, have diameters of 50 m for the lower and 45 m for the upper.
They are linked by three columns, each 9 m in diameter. The highest sphere is 14 m in diameter.

The entire building is supported by three enormous columns that start underground.

An antenna, broadcasting TV and radio programs, extends the construction by another 118 m to a total height of 468 metres.

4. Jin Mao Tower

The Jin Mao Tower is an 88-story landmark supertall skyscraper in the Lujiazui area of the Pudong district of Shanghai, China.

It contains offices and the Shanghai Grand Hyatt hotel. Until 2007 it was the tallest building in the China, and the fifth tallest in the world by roof height and the seventh tallest by pinnacle height.

Along with the Oriental Pearl Tower, it is a centerpiece of the Pudong skyline. Its height was surpassed on September 14, 2007 by the Shanghai World Financial Center which is next to the building.

It was designed by the Chicago office of Skidmore, Owings & Merrill. Its postmodern form, whose complexity rises as it ascends, draws on traditional Chinese architecture such as the tiered pagoda, gently stepping back to create a rhythmic pattern as it rises.

The building's proportions revolve around the number 8, associated with prosperity in Chinese culture. The 88 floors (93 if the spire floors are counted) are divided into 16 segments, each of which is 1/8 shorter than the 16-storey base. The tower is built around an octagon-shaped concrete shear wall core surrounded by 8 exterior composite supercolumns and 8 exterior steel columns. Three sets of 8 two-story high outrigger trusses connect the columns to the core at six of the floors to provide additional support.

5. Shimao International Plaza

Shimao International Plaza is a 333.3 m tall skyscraper of 60 stories in Shanghai's Huangpu District.

It was completed in 2005 under the design of Ingenhoven, Overdiek und Partner, East China Architecture and Design Institute.

Shimao International Plaza has two spires on its top, which make its total construction height to 333.3 metres. Most of the building (the upper 48 floors) houses the five-star, ultra-luxurious Le Royal Méridien Shanghai hotel with 770 rooms. The building also includes a 9 floors of shopping mall and 3 floors of exclusive clubs.

Shanghai Shimao Group bought the original developer of the tower, Wan Xiang Group, in 2001 and the name of the building was changed.

6. Shanghai Wheelock Square

Shanghai Wheelock Square is a skyscraper located in Puxi, Shanghai, China. It is the 52nd-tallest building in the world.

The Wheelock Square building has 58 floors, and just over 100 000 m^2 of prime office space. It is located across the street from the Jing'an Temple Metro station, providing convenient transportation on Lines 2 and 7.

The building is 274 m height and the height of the spirere aches 298 meters.

7. Plaza 66

Plaza 66 is a commercial and office complex in Shanghai, consisting of a shopping mall and two skyscrapers.

The shopping mall has 5 levels with a total area of over 50,000 square metres. Tower One is 288 metres high and was completed in 2001, while Tower 2 is 228 metres high and was completed in 2006.

Tower One is currently the 5th tallest skyscraper in Shanghai and the third tallest building in the Puxi area.
It is located at 1266 Nanjing Road West and has 66 floors.

The project was developed by Hang Lung Properties of Hong Kong, led by Ronnie Chan. The buildings were designed by Kohn Pedersen Fox (KPF) architects from New York. The lead designer for KPF was James von Klemperer and the manager in charge of the project was Paul Katz.

The building got third most votes in the 2001 Emporis Skyscraper Award selection.

8. Tomorrow Square

Tomorrow Square is the fifth tallest building in Shanghai, China. It is located in the Puxi district, close to People's Square.

It is about 285 m tall and has 55 floors.
This multi-purpose building contains a 342-room Marriott hotel, and 255 executive apartment units.

It was completed on 1 October 2003. Starting from a square base, the all-concrete Tomorrow Square tower transforms itself into a diagonal square as it rises to a peak.

Engineers of the exterior vertical support system were faced with a unique challenge as a result of this unusual shape. They chose flat slabs for the hotel floors and beam and slab construction for the office floors. A combination of sheer walls and frame action stabilizes the slender tower laterally against wind and earthquake forces. The foundations are 80-metre-long bored piles supporting a column mat.

9. Hong Kong New World Tower

The Hong Kong New World Tower is a 61-floor skyscraper, completed in 2002, located near Huaihai Park in the Luwan District of Shanghai.

It is 278 meters high and was built by Bregman and Hamann Architects. It overlooks the People's Square across the Yan'an Elevated Road.

10. Bocom Financial Towers

The Bocom Financial Towers are two conjoined skyscrapers which reach 265 metres in height.

They are located in the Pudong District of Shanghai, China and are split into the North and South Towers. Both towers were designed by ABB Architekten. The North tower is the 64th tallest existing building in the world when measured up to the highest architectural point.

An atrium connects the two towers together and reaches a height of 163.4 metres. A swimming pool offering views over all of Shanghai is located on the 48th floor of the North Tower.

Appendix D

Studies on **Chinese Traditions**

EXPLORING THE CHARACTERISTICS OF CHINESE TRADITIONS

Implement traditional Chinese forms and materials into a modern design

The garden as a social site of activities

Study and use of Chinese interior design and oriental homes

Aalborg Universitet | ad:mt - Department of Architecture, Design and Media Technology
Timea Török - 20081144 - ttorok08@student.aau.dk

Acknowledgement

Many other cultures admire or copy historical elements of the Chinese culture, while China itself seems to lose its original values. Technological development rabidly took over the area and modern settings dominate the site.
The sudden development of the new millennium did not regard traditional values. Improvements took place in the dense centres so quickly it did not have the time to implement original Chinese elements into the modern features.

While centres of the cities went through major changes, the perimeter seemed to remain. The gap between centres and poor quarters got bigger and bigger while they are locating just form a corner from each other.

Although many places in Shanghai still have the original charm, and protected from modern changes. Most of these places are visited by tourists and act more as an attraction than as a lifestyle. Many districts also have their strong original identity, low houses, ornamental rooftops, tents and markets; but by looking at the distance, steel skyscrapers broke the horizon.

Many design try to apply traditional elements; modern material in traditional shape or traditional elements in a modern form. Study has been made to investigate the traditional elements of the classical Chinese garden to use features at the landscaping of the site. Elements and vegetations collected into a catalogue to be used in the design process.

Traditional Chinese garden

Just as any other element of the Chinese culture, Chinese gardens also have strong characteristics and identity.

The Chinese garden, also known as a Chinese classical garden, recreates natural landscapes in miniature. The style has evolved for more than three thousand years, and includes both the vast gardens of the Chinese emperors and smaller gardens built by scholars, poets, and former government officials.

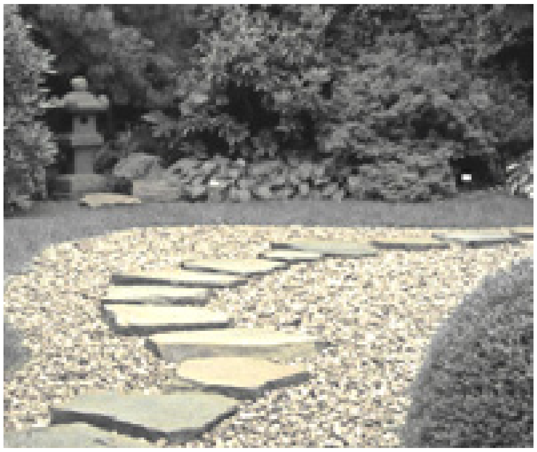
The classical Chinese garden is closed by a wall and it usually has one or more ponds, a rock garden, colorful trees and flowers, and an assortment of halls and pavilions within the garden, connected by winding paths and zig-zag galleries.

By moving from structure to structure, visitors can view a series of carefully composed scenes, unrolling like a scroll of landscape paintings.

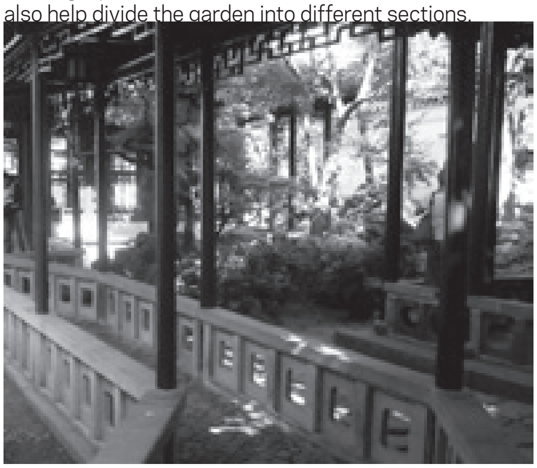
Walls:
A Chinese garden court is always surrounded by walls, usually painted white, which served as a pure backdrop for the flowers and trees.

Landscape:
Chinese garden represents a landscape with artifical mountains, where plants, trees, and rocks, all carefully composed into small perfect scenes.

Path:
Widing and narrowing pathways are leading between the sceneries of the garden. These paths used to have hidden massages and symbolic meanings.



Gallery:
Galleries are narrow covered corridors which conGalleries are narrow covered corridors, which connect the buildings, protect the visitors from the rain and sun, and also help divide the garden into different sections.



Bridge:
Bridges built from rough timber or stone-slab raised pathways , arch over the ponds, providing different parts of the gardens from different points of view.

Pavilion:
Small pavilions and artificial winding streams became extremely popular in both imperial and private gardens. Pavilions served as observation points of the garden features.

Water:
A pond of water is usually located in the center of the garden. Many structures, large and small, are arranged around the pond.

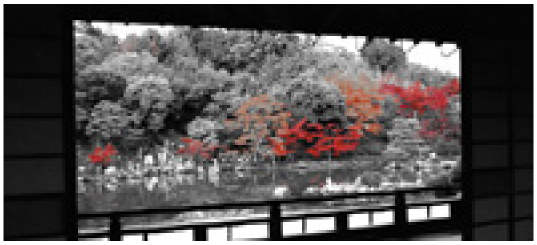
Flower:
Colorful flowers decorating the garden all over, as a contrast of the straight lines of the architecture. Each flower and tree has its symbolic meaning.

Rocks:
The artificial mountain or rock garden, as a mountain peak is a symbol of virtue, stability and endurance in the philosophy became a central element.

Window and door:
These important architectural features of the garden are usually round or oval, hexagonal or octagonal, or in the shape of a vase or a piece of fruit; sometimes they have highly ornamental ceramic frames.

Tree:
Courtyard usually planted with many different types of trees, which remained evergeen, or whose blossoms announced the arrival of spring. Miniature trees as bonsai, are also typical.

"Borrowed scenery":
According to Ji Cheng's 16th century book "The Craft of Gardens," "borrowed scenery" was the most important element of a garden. This could mean using scenes outside the garden, such as a view of distant mountains or the trees in the neighbouring garden, to create the illusion that garden was much bigger than it was.



"Time and seasons"

"The immaculate ribbon of a stream, animals, birds, fish, or other natural elements, or something less tangible, such as a moonbeam, a reflection in a lake, morning mist, or the red sky of a sunset." *[Ji Cheng]*

The season and the time of day were also important elements. Garden designers took into account the scenes of the garden that would look best in winter, summer, spring and autumn, and those best viewed at night, in the morning or afternoon. Ji Cheng wrote: "In the heart of the tumult of the city, you should choose visions that are serene and refined: from a raised clearing, you look to the distant horizon, surrounded by mountains like a screen; in an open pavilion, a gentle and light breeze invades the room; from the front door, the running water of spring flows toward the marsh."

Oriental landscaping

Gardens, as pleasant retreats with easily access, were favourite locations for social gatherings of many type of users. It is a perfect meeting place; one could entertain distinguished guests, throw elaborate or intimate parties, or relax in private with family members.

The gardens used to be fancy accessories of the more elegant homes. The garden served as an extension of the house proper in summer, and often the architecture built within the garden portion of the family compound included habitable living quarters.

These rooms could prove to be more comfortable during the hot summer months, being ideally positioned to take advantage of breezes off the central pond and surrounded by plantings of aromatic flowers and herbs.

These ancient gardens are usually in the property of a family, which might include up to a dozen people. Implementing the traditional garden idea as a design principle into the landscaping of the site, is oppose the challenge to widen the user groups and provide relaxing, yet simulating indoor environment for the residents of the building complex.

Chinese interior

One of the most impressive features of courtyard homes is the flexibility of the courtyard space, but interior spaces have such as strong identity and charm as any other traditional elements.

Courtyards could be used as a place for carrying out household tasks, or as a place to relax but the interior of the house has also very important rule in Chinese family life.

The most important space in a Chinese home was reserved for the family's ancestors; traditionally Chinese families devoted a space to the ancestors of the family. In ordinary homes this usually consisted of a small corner in the main room of the house. In richer families, an entire hall may have been made into the ancestral shrine.

Chinese sleeping areas are often separated with curtains. Most items of furniture, such as tables and chairs, are also common to Western usage but often have different designs that respond to specific customs or practical considerations.

Dining area is usually not defined, and just screens were used to divide space in Chinese homes. Kitchens are also different from Western kitchens. Chinese kitchens are more compact than Western counterparts. In the Chinese kitchen, the focus of activity generally centres on the stove, which dominates the kitchen space. In the space above the stove, there was often a nook for the kitchen god, who was said to protect the home.

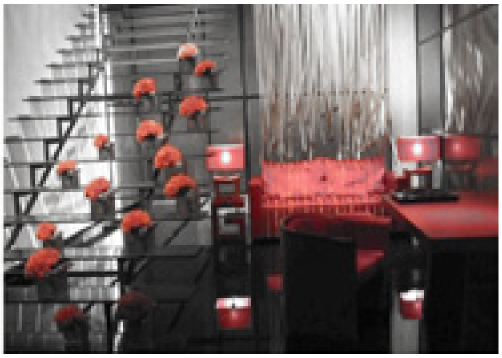
The modern Chinese interior kept many characteristics of the traditional way of living. The clean forms, ornamental lines, freedom of room layout are still noticeable in the 21st century's oriental home.

Most of the design mixing the tradition and the modern, the old habits and the new technologies, the practical traditions and the comfort of development.

Many elements remain from the ancient homes, but material, shape, size or function might be changed. Modern interpretation of traditional elements usually lost their purpose, and most of them functioning just as decoration or souvenir of old times.
Although the strong identity of Chinese interiors are still stand out and modern use of tradition is still recognizable in most of the design, modernity and luxury takes over the space.

Interiors, specially in the urban areas, takes many element inside from the garden, gates, windows and walls all follow the design of the outdoor spaces, but the organic flow of the garden would transform into a cubical more organized layout indoors.

Lighting and decoration are very important within the living spaces.



Traditional values in the modern China

“A trail through the mountains, if used, becomes a path in a short time, but, if unused, becomes blocked by grass in an equally short time.”
[Mencius (372 – 289 BCE), a Chinese philosopher]

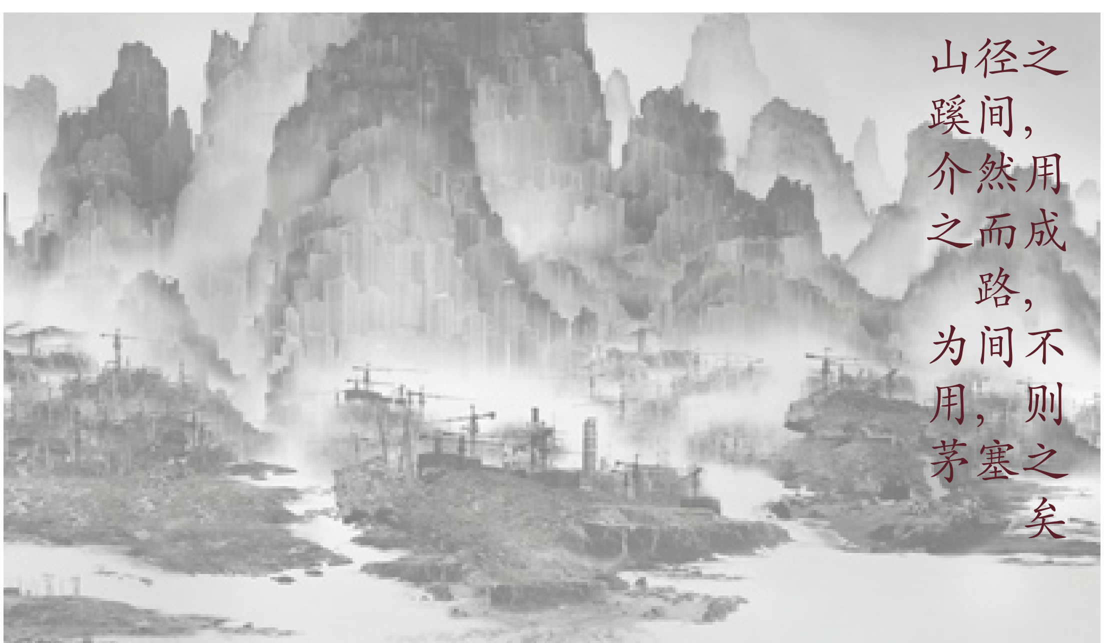
Although many times in history, China has set an example for development and improvement it has kept its main identity throughout the centuries.

But with the post-modern era, a transition took place in all fields of life, arts, philosophy and living style. Music, painting, architecture are all changing with the modern age. However Chinese values are still considered as traditional in the modern world, the most basic way of thinking has already changed.

A project is set in a location like the heart of Shanghai, must consider elements of the context. Steel skyscrapers dominate the immediate surroundings of the project. On the other hand, close to the location, poor districts displaying the ruins of the classical forms. Given the location, the concept creates a bridge, from out of the high-rise financial center to a human friendly low-rise environment.

It is very important to keep traditional values nowadays; hence the project will use traditional elements at the human scale in the design. While the urban scale of the project follows the modern technical development of the global financial center, at the human scale, details maintain traditional values.

Classical elements have many advantages in forming the interior spaces. Both for the interior design and outdoor spaces Chinese design has many principles to follow during the design process.



Plant catalogue

Appendix E

Process of **Design development**

DOCUMENTING THE DESIGN PROCESS AND THE DEVELOPMENT OF THE DESIGN

Digital sketching and free hand brainstorming

Initial rendering of models and forms

Additional analysis and tests on daylight conditions

Acknowledgement

Some of the additional material of design process is attached in Appendix E.
Images show more analysis and testing of different investigations.

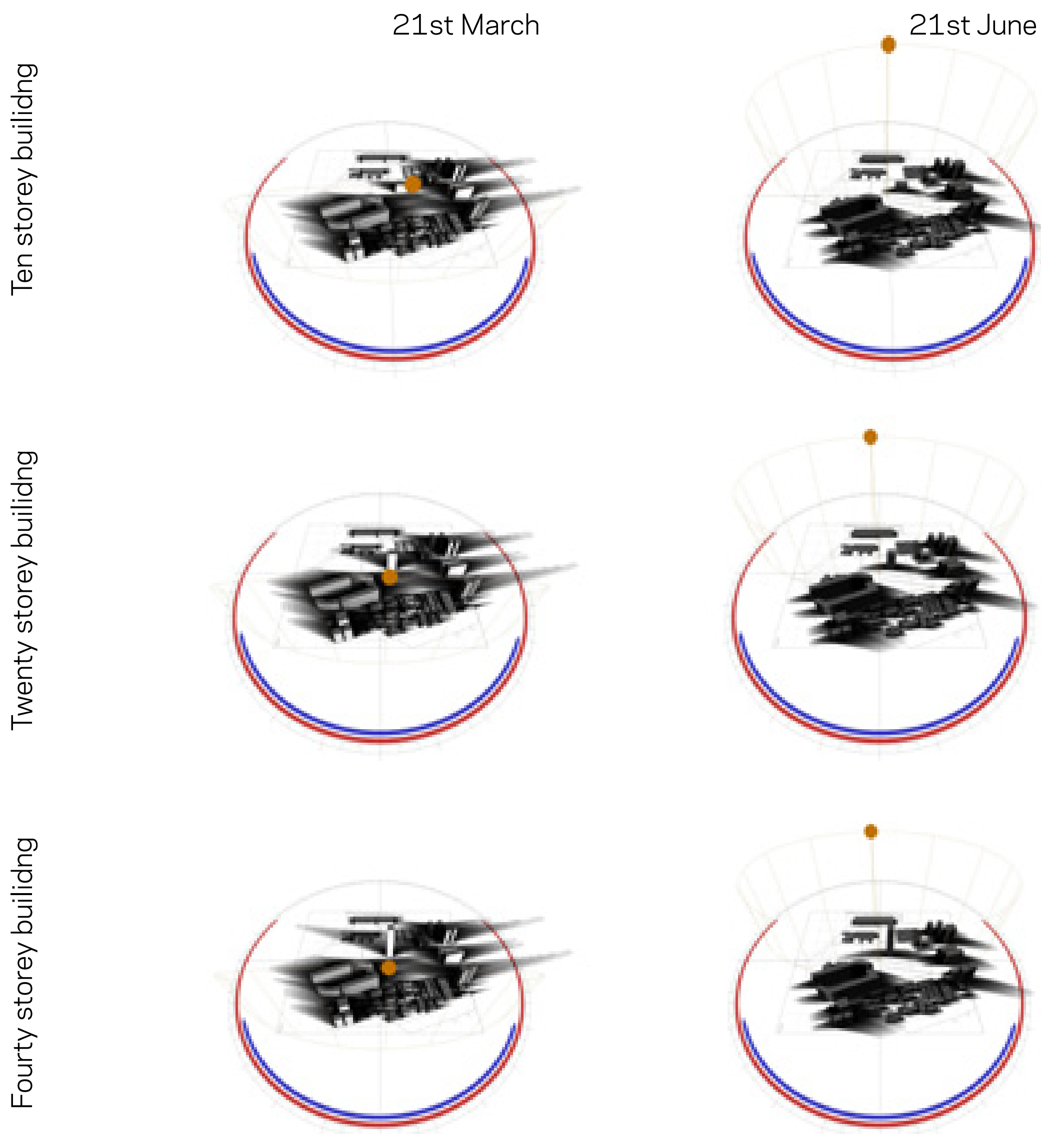
Shadow study showing shadow range on site, for different heights of the volume with seasonal changes. Results used for design development and landscaping.

Geometry test show daylight levels in the different size of apartments with maximized glazing area. Results have been used at the beginning of the design process, for layout arrangements; while it has been tested in PHPP calculations simultaneously.

More analysis has been made with Velux Visualizer, to display light distribution in the apartments with different conditions.

Shadow study on site

Seasonal shadow range shown as a table for ten, twenty and forty storey building on site on the 21st of March, June, September and December, also showing daily sun path.

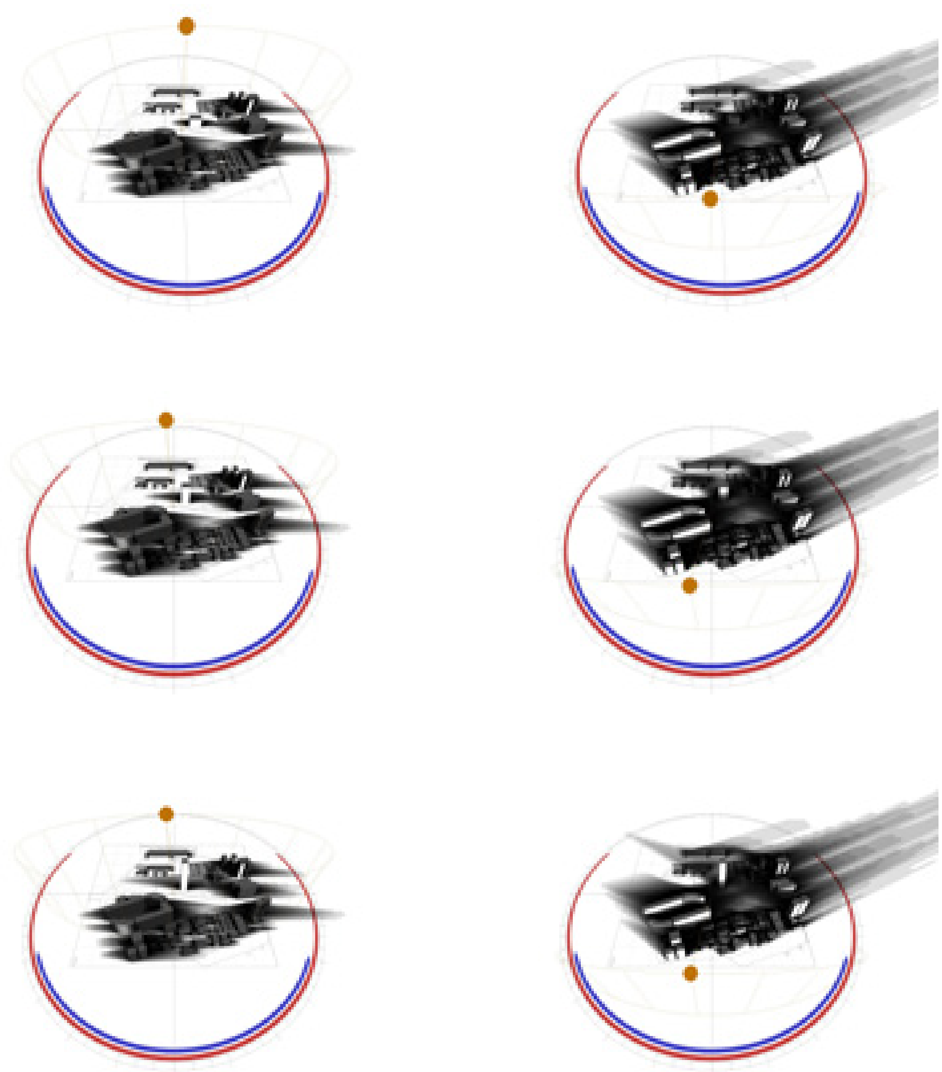


21st September | 21st December

Ten storey builidng

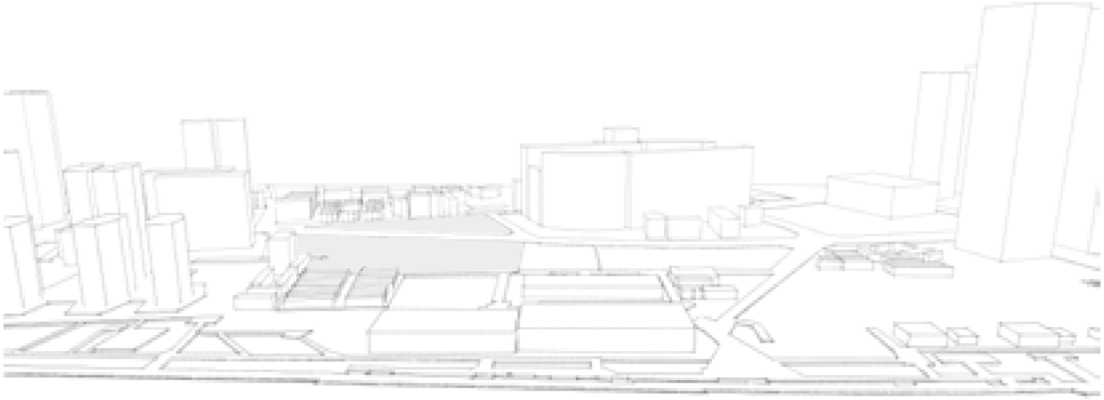
Twenty storey builidng

Fourty storey builidng

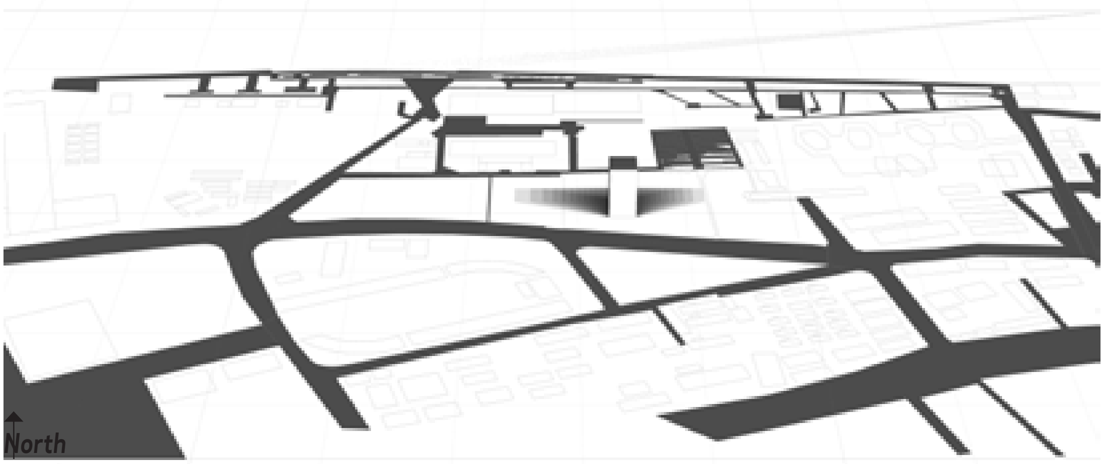


Shadow study of building

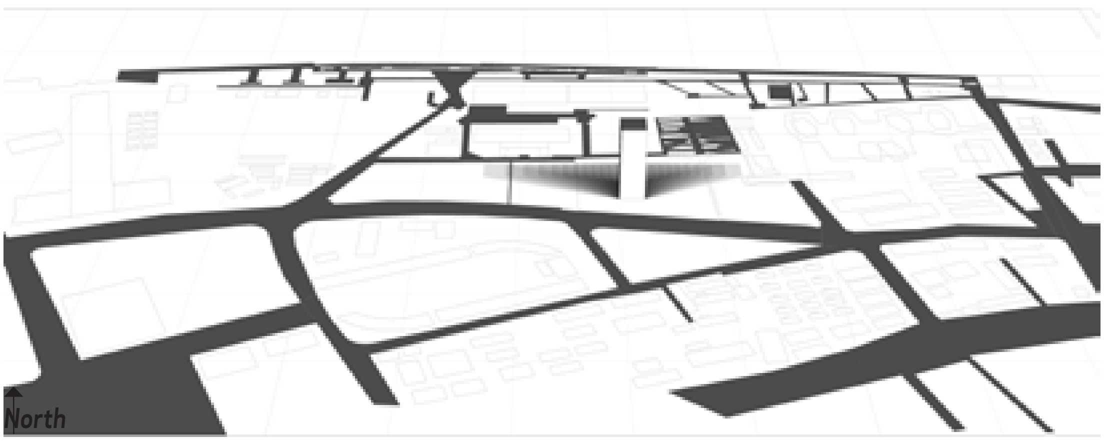
Shadow range shown on illustrations for ten, twenty and forty storey building on and around the site on the 21st of September to evaluate cast shadow on context.



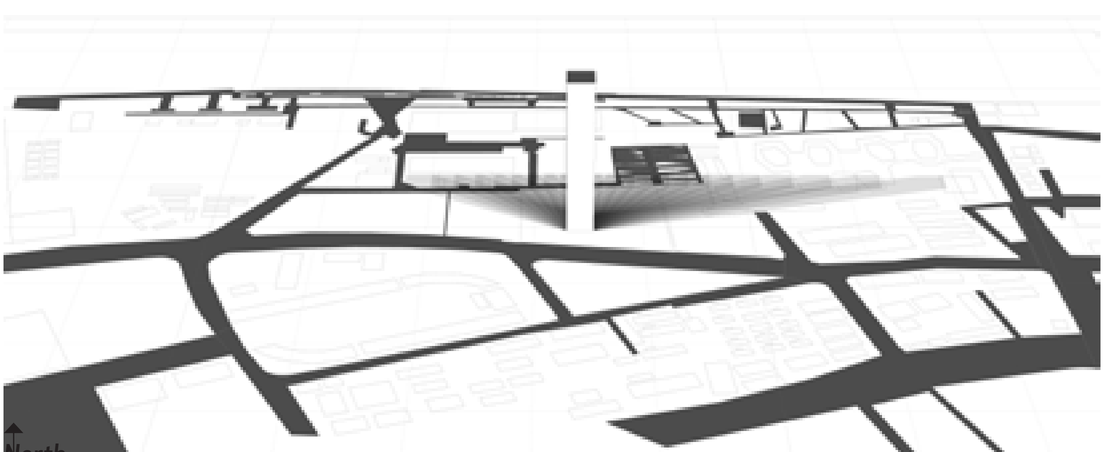
Heights of context around the site - looking from above the river towards South



Daily shadow range of ten storey high on 21st September - without context

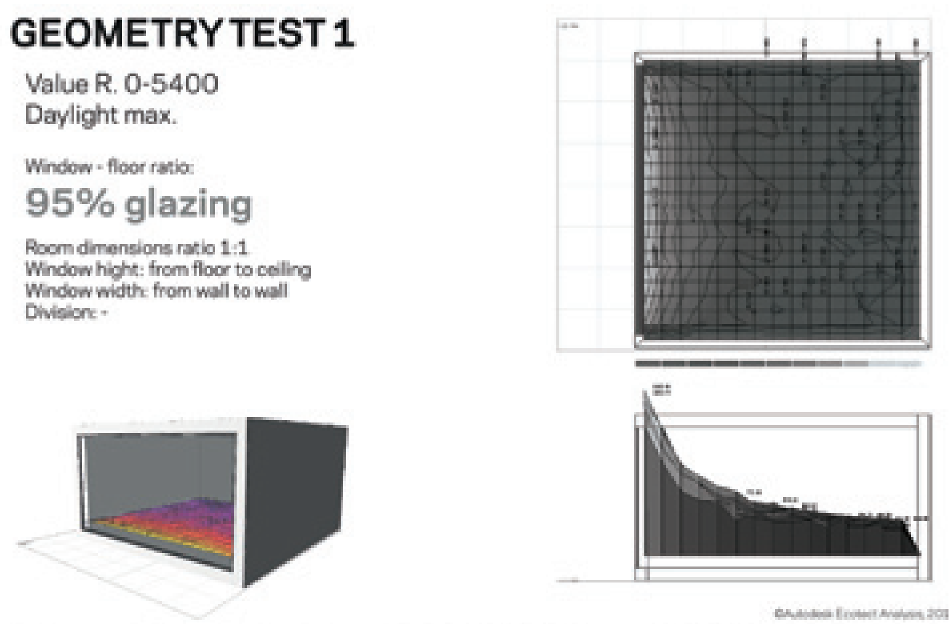


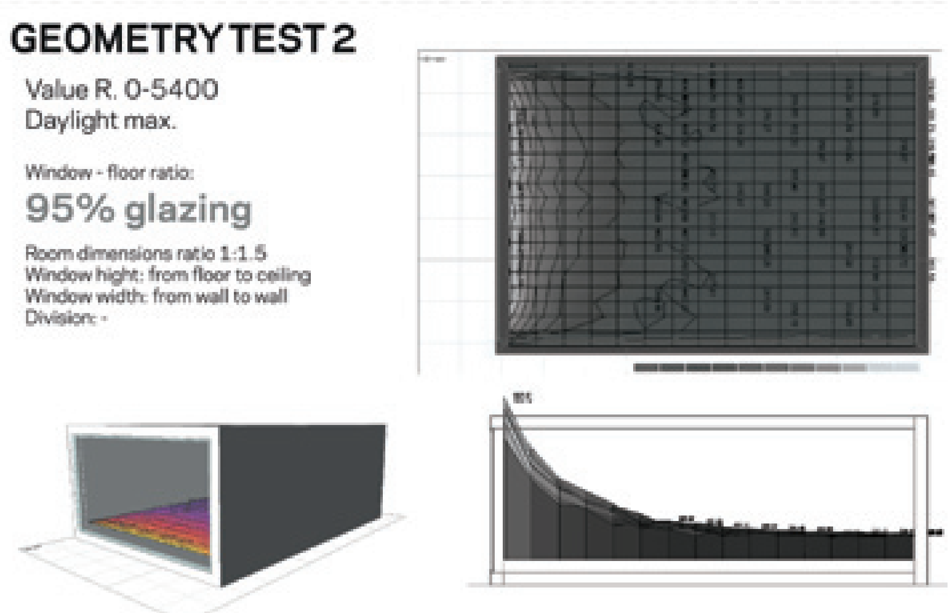
Daily shadow range of twenty storey high on 21st September - without context



Daily shadow range of fourty storey high on 21st September - without context

Room geometry for natural light





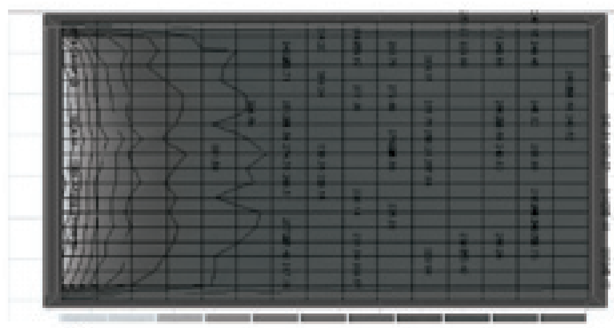
GEOMETRY TEST 3

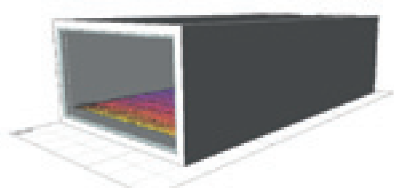
Value R. 0-5400
Daylight max.

Window - floor ratio:

96% glazing

Room dimensions ratio 1:2
Window hight: from floor to ceiling
Window width: from wall to wall
Division: -





©Autodesk Ecotect Analysis, 2010

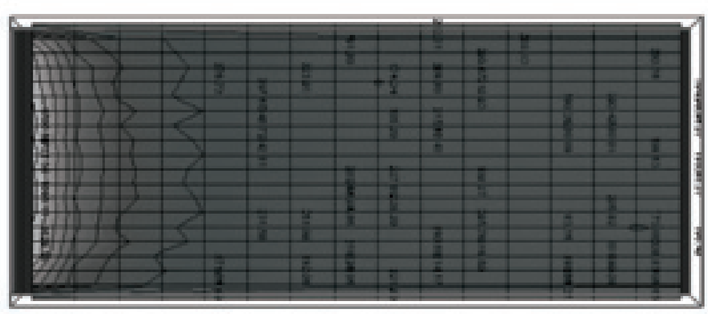
GEOMETRY TEST 4

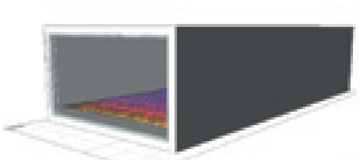
Value R. 0-5400
Daylight max.

Window - floor ratio:

97% glazing

Room dimensions ratio 1:2.5
Window hight: from floor to ceiling
Window width: from wall to wall
Division: -

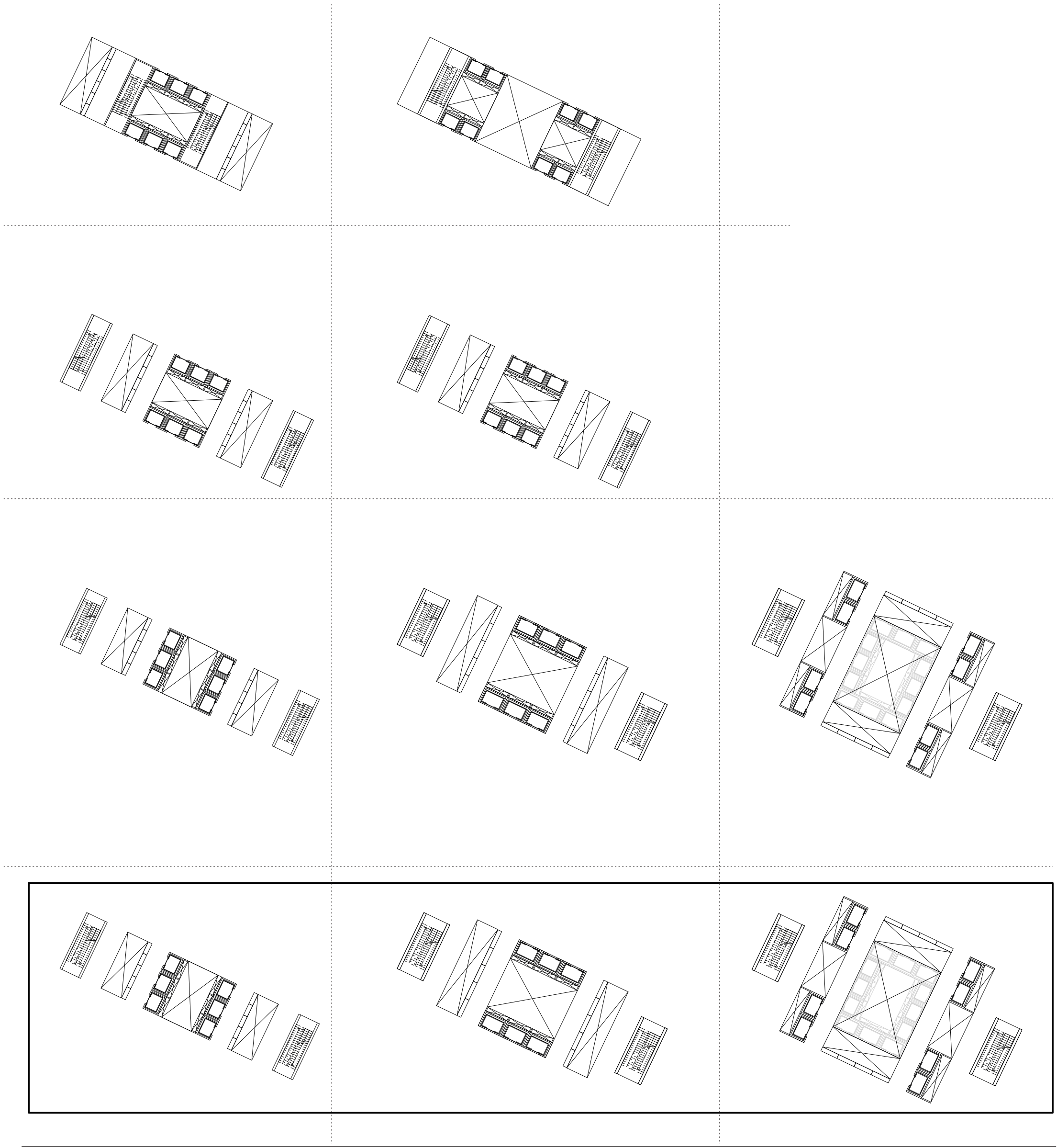




©Autodesk Ecotect Analysis, 2010

Sketching on building core

The core of the building has an important role both in construction and transportation of the building. Core provides place for placing elevators and staircases, building services, storage, laundry, extra facilities.



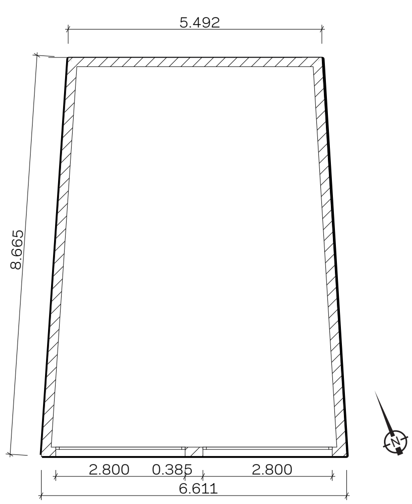
Daylight study in apartments

VELUX Daylight Visualizer has been used to visualize luminance levels inside the different living units in order to arrange favourable apartment layout.

Daylight study was also made of the apartments with VELUX Daylight Visualizer v2.6.0.
Apartments are investigated after sketching on floor plan layouts with initial sizes and openings in order to find the best settings for interior layouts.

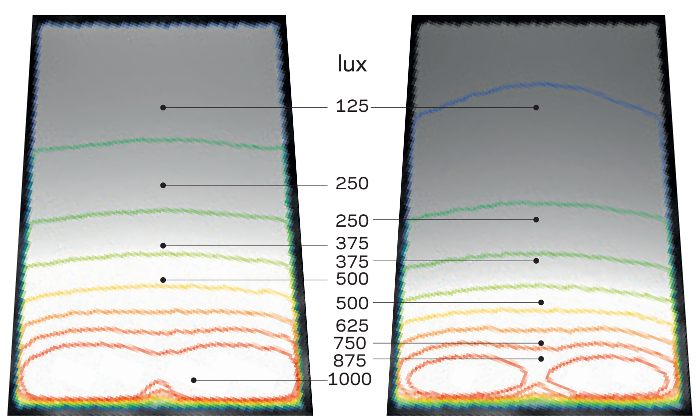
All tests were made with the date set to 21st June as the highest sun solstice.

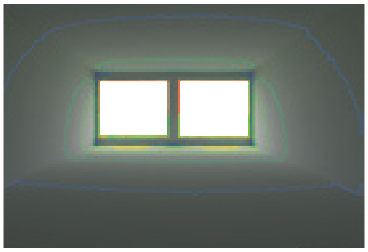
Test of the smallest unit was made to visualize illuminance levels inside. Levels displayed between 1-1000 lux with sunny and overcast sky on the plan views and with intermediate sky conditions on the section.
Perspective shows illuminance levels with intermediate sky conditions at openings.

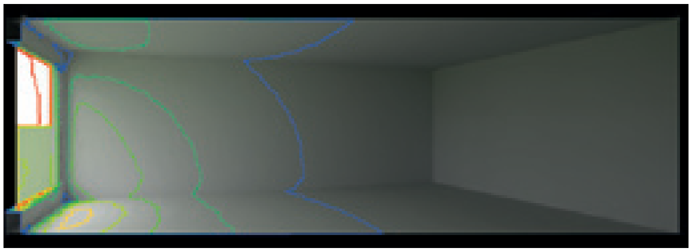


Illuminance levels
sunny sky (1)
1-1000 lux

Illuminance levels
overcast (12)
1-1000 lux



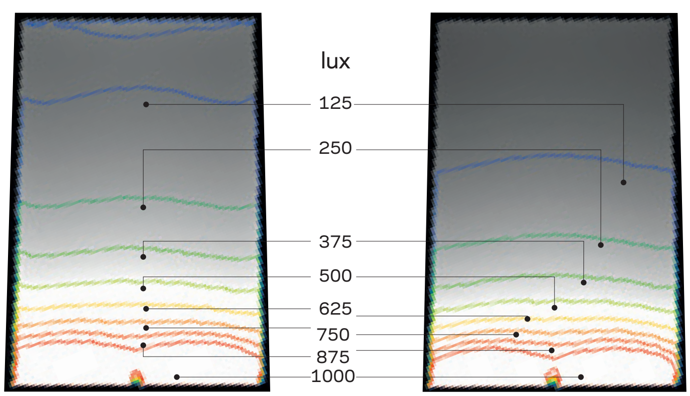


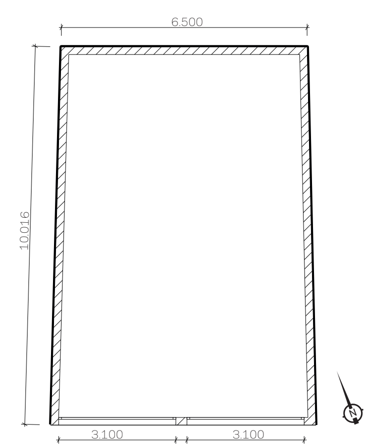


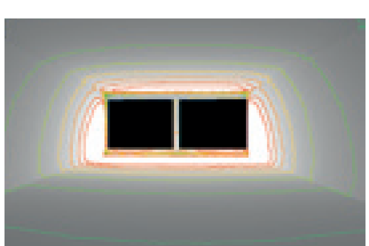
Test of medium unit was made to visualize illuminance levels inside. Levels displayed between 1-1000 lux with sunny and overcast sky on the plan views and with intermediate sky conditions on the section. Perspective shows illuminance levels with intermediate sky conditions at openings.

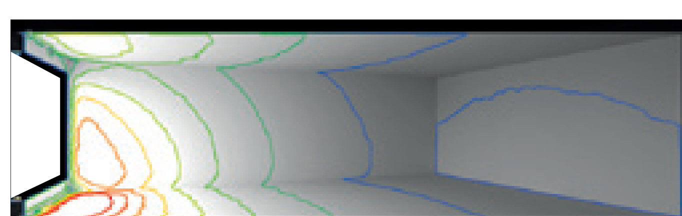
Illuminance levels
sunny sky (1)
1-1000 lux

Illuminance levels
overcast (12)
1-1000 lux

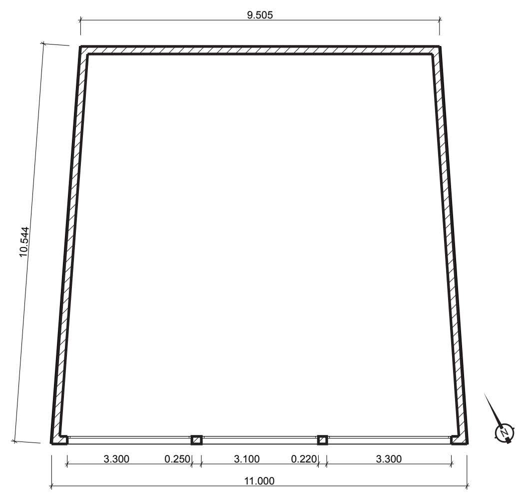






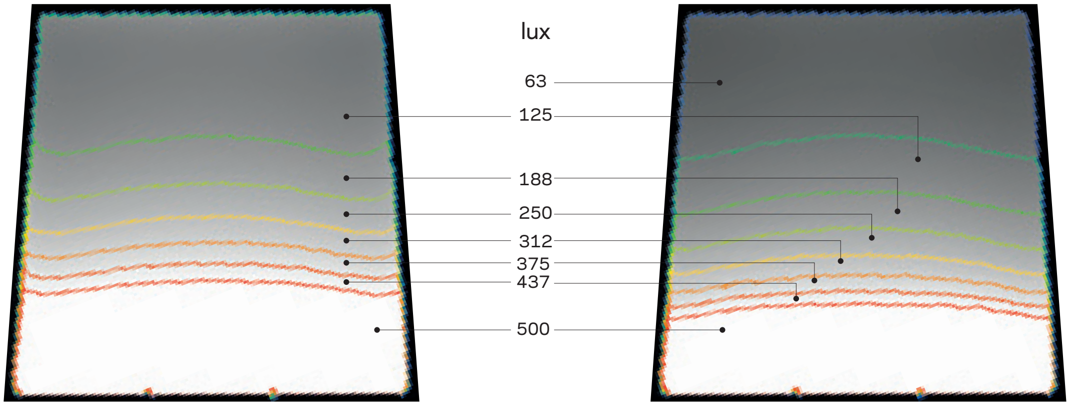


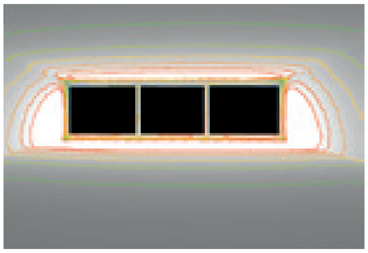
Test of the largest unit was made to visualize illuminance levels inside. Levels displayed between 1-500 lux with sunny and overcast sky on the plan views and with intermediate sky conditions on the section. Perspective shows illuminance levels with intermediate sky conditions at openings.

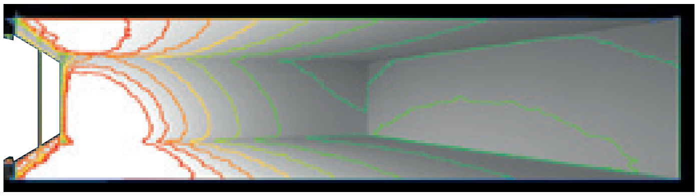


Illuminance levels
sunny sky (1)
1-500 lux

Illuminance levels
overcast (12)
1-500 lux







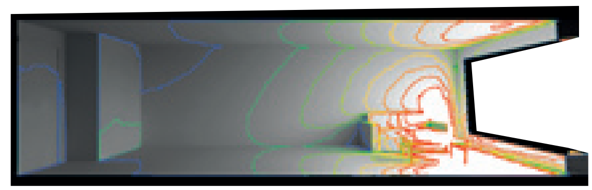
Daylight levels in small apartment

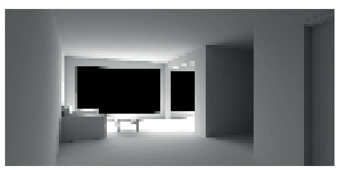
Small Apartment - Layout A

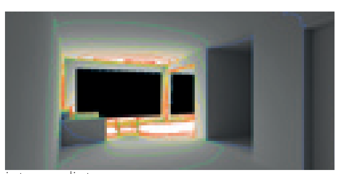
21th MARCH
[12:00]

Window height: 1.75 m
Window width: 2.0 m + 3.0 m

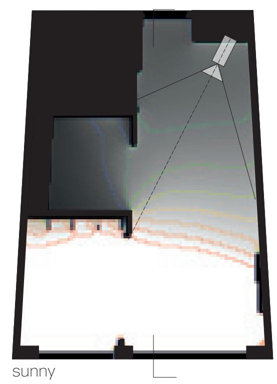
Daylight levels
Value range: 0 - 500 lux



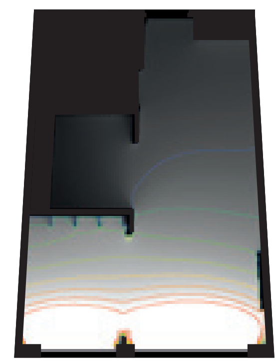




intermediate



sunny



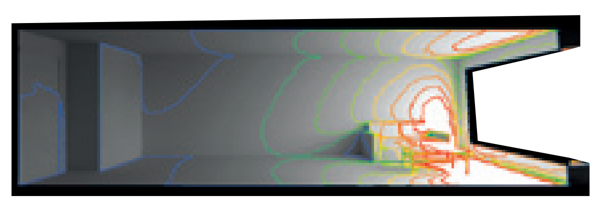
overcast

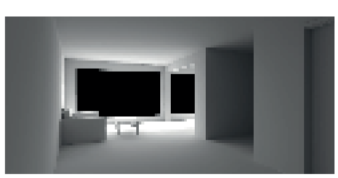
Small Apartment - Layout A

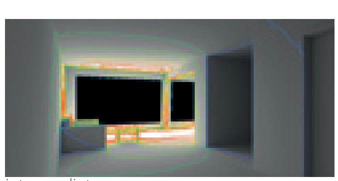
21th JUNE
[12:00]

Window height: 1.75 m
Window width: 2.0 m + 3.0 m

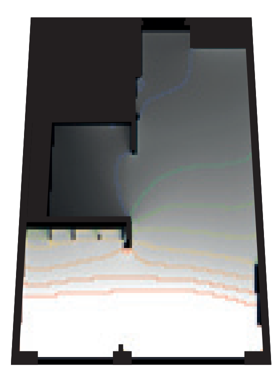
Daylight levels
Value range: 0 - 500 lux



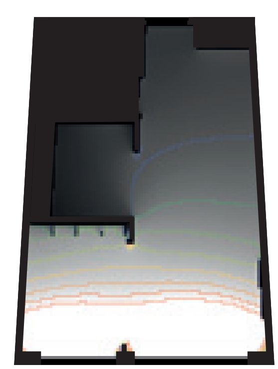




intermediate



sunny



overcast

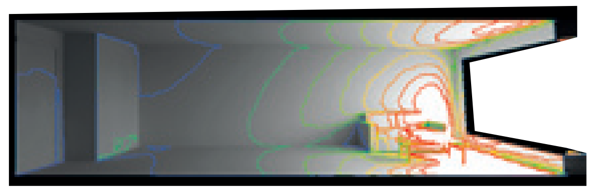
Small Apartment - Layout A

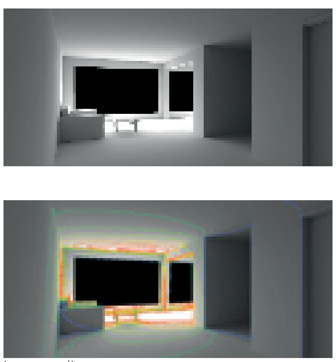
21th SEPTEMBER

[12:00]

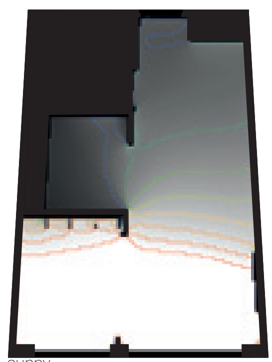
Window height: 1.75 m
Window width: 2.0 m + 3.0 m

Daylight levels
Value range: 0 - 500 lux

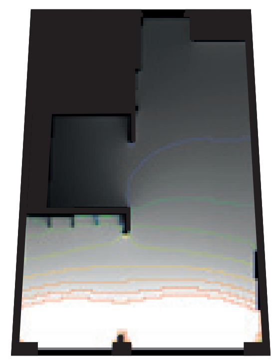




intermediate



sunny



overcast

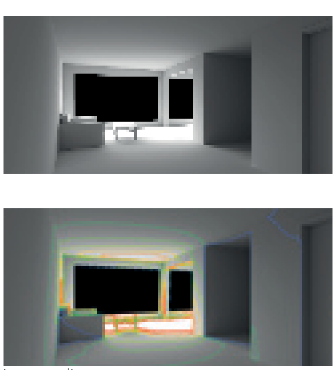
Small Apartment - Layout A

21th DECEMBER

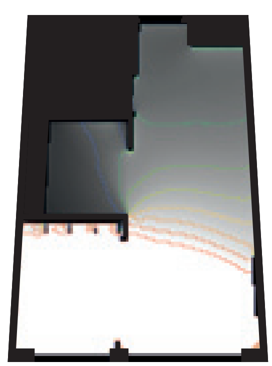
[12:00]

Window height: 1.75 m
Window width: 2.0 m + 3.0 m

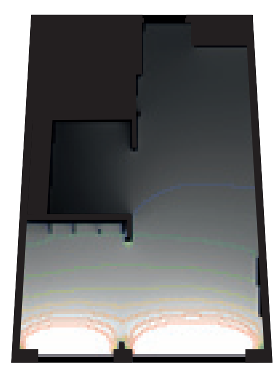
Daylight levels
Value range: 0 - 500 lux



intermediate



sunny



overcast

© VELUX Daylight Visualizer 2

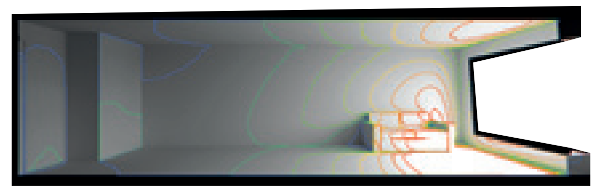
Daylight levels in small apartment

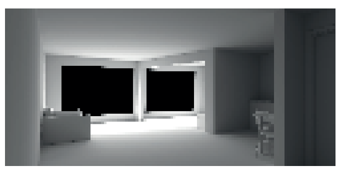
Small Apartment - Layout B

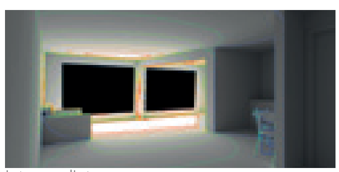
21th MARCH
[12:00]

Window height: 1.75 m
Window width: 2.5 m + 2.5 m

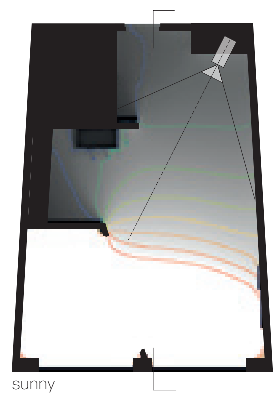
Daylight levels
Value range: 0 - 500 lux



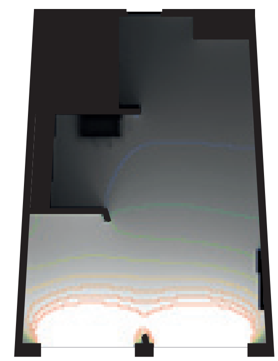




intermediate



sunny



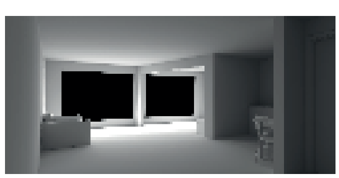
overcast

Small Apartment - Layout B

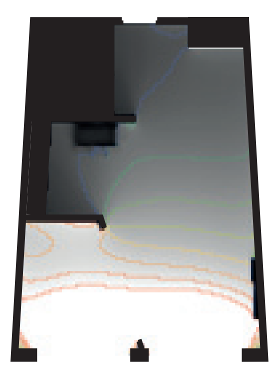
21th JUNE
[12:00]

Window height: 1.75 m
Window width: 2.5 m + 2.5 m

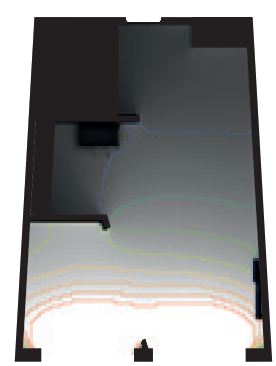
Daylight levels
Value range: 0 - 500 lux



intermediate



sunny



overcast

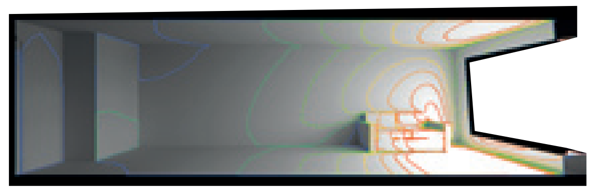
Small Apartment - Layout B

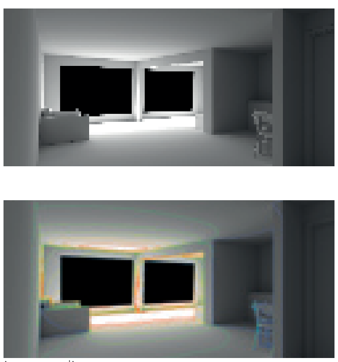
21th SEPTEMBER

[12:00]

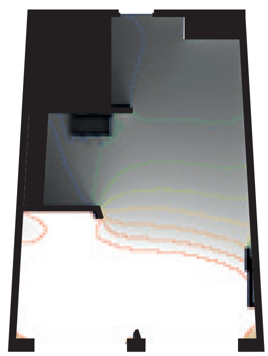
Window height: 1.75 m
Window width: 2.5 m + 2.5 m

Daylight levels
Value range: 0 - 500 lux

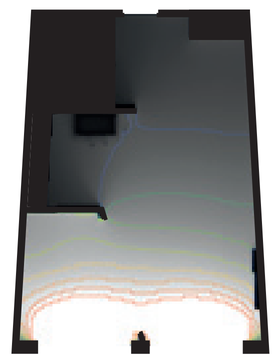




intermediate



sunny



overcast

Small Apartment - Layout B

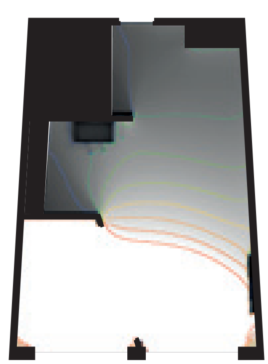
21th DECEMBER

[12:00]

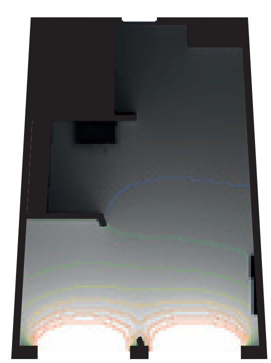
Window height: 1.75 m
Window width: 2.5 m + 2.5 m

Daylight levels
Value range: 0 - 500 lux

intermediate



sunny



overcast

© VELUX Daylight Visualizer 2

Part IX

List of
Sources and references

LIST OF LITERATURE AND USED MATERIALS DURING THE WORK

References of books and documents of the used literature

List of links for online resources

List of links for used pictures and illustratons

Literature

http://www.wikipedia.org/
http://www.eoearth.org/
http://www.nzdl.org/g
http://www.unep.org/
http://www.who.int/
http://www.data.eordbank.org/
http://www.esa.un.org/

Neufert, Ernst and Peter: Architects' Data, Blackwell, 2007
Richard Hyde, Steve Watson, Wendy Cheshire and Mark Thomson: The environmental brief; Taylor & Francis
Peter F. Smith: Architecture in a Climate of Change;Architectural Press
Peter F. Smith: Sustainability at the Cutting Edge; Architectural Press
Jenny Goldie, Bob Douglas and Bryan Furnass: In search of sustainability; CSIRO, 2005
Georgia Butina Watson and Ian Bentley: Identity by Design; Elsevier Ltd., 2007
Derek Phillips: Daylighting; Elsevier Ltd., 2004
Derek Thomas: Architecture and the Urban Environment; Elsevier Ltd., 2002
C. Gallo, M. Sala, A.A.M. Sayigh: Architecture - Comfort and Energy; Elsevier Ltd., 1988
Sustainable Building Design Book; The 2005 World Sustainable Building Conference in Tokyo, Student Session 23-29 September 2005, Tokyo, Japan
Belinda Yuen, Anthony G. O. Yeh : High-Rise Building Living in Asian Cities; Springer, 2011

Links and resources

http://www.wikipedia.org
http://www.flickr.com
http://skyscraperpage.com

Introduction and Research

http://www.travelersdigest.com/shanghai_smog.JPG
http://thumbs.dreamstime.com/thumblarge_417/1247239407kyRb2i.jpg
http://web.idrc.ca/uploads/user-S/11476980283traffic.jpg
http://thetreeblog.info/wp-content/uploads/2011/04/1303254937-15.jpg
http://freeimagescollection.com/images/nature/air-pollution-by-burning-urban-waste-f2.jpg
http://i.telegraph.co.uk/multimedia/archive/01007/england-population_1007441c.jpg
http://www.treehugger.com/times-square-night-080804.jpg

Method

http://vbn.aau.dk/files/1624830/The_Integrated_Design_Process_IDP___A_more_holistic_approach_to_sustainable_architecture
http://www.waterfrontoronto.ca/dbdocs/4561b14aaf4b0.pdf

Population

http://www.census.gov/main/www/popclock.html
http://sedac.ciesin.columbia.edu/theme/marine-and-coastal/maps/gallery/set/gpw-v3-population-density/4
http://www.ethiopianreview.com/2009/world-population-prospect-un-report-2008-revised-2009.pdf
http://www.unfpa.org/6billion/populationissues/migration.htm
http://www.ideaconnection.com/solutions/594-Disruptive-migration-of-rural-population-to-cities.html
http://www.citypopulation.de/world/Agglomerations.html
http://www.worstpolluted.org/files/FileUpload/files/2010/WWPP-2010-Report-Web.pdf
http://www.easts.info/on-line/journal_06/3105.pdf
http://www.un.org/esa/population/publications/longrange2/WorldPop2300final.pdf
http://www.epa.gov/airnow/ozone-c.pdf

Pollution

http://www. http://www.nzdl.org/gsdlmod?e=d-00000-00---off-0envl--00-0----0-10-0---0---0direct-10---4-------0-0l--11-en-50---20-about---00-0-1-00-0-0-11-1-0utfZz-8-00&cl=CL1.1&d=HASH0192c760fbf07f7d6fa34cb8.6&gt=1
http://www.eoearth.org/article/Air_quality_in_megacities
http://www.guardian.co.uk/global/interactive/2008/dec/09/climatechange-carbonemissions
http://www.grindtv.com/surf/blog/17567/which%20countries%20pollute%20the%20most/
http://www.unep.org/publications/ebooks/kick-the-habit/Default.aspx?bid=ID0EUUBG

Sustainable approach

http://www.calrecycle.ca.gov/greenbuilding/basics.htm
http://www.geni.org/globalenergy/library/renewable-energy-resources/solar.shtml
http://www.architecture.com/SustainabilityHub/Designstrategies/Introduction/1-0-5-Inbriefahistoryofsustainablearchitecture.aspx
http://www.ecologicalhousing.com/
http://irisholidays.com/blog/wp-content/uploads/2010/08/DSC00761.jpg

http://genuineecotourismmexico.wikispaces.com/The+Variety+of+Ecosystems+and+Rich+Biodiversity+of+Veracruz,+Mexico
http://megamoon.files.wordpress.com/2011/03/058-new-eco-house.jpg
http://cop15post.com/wp-content/uploads/2009/12/eco-house.jpg
http://decorating.visitacasas.com/wp-content/uploads/2010/01/Ecological-housing2.jpg
http://upload.wikimedia.org/wikipedia/commons/f/f2/Eden_Project_geodesic_domes_panorama.jpg

Environmental effects

http://www.natural-building.co.uk/environmental_impact.html
http://coldfusionnow.wordpress.com/2011/05/18/i-want-to-believe/
http://www.hydrogenambassadors.com/background/worldwide-energy-use-by-energy-type.php
http://3.bp.blogspot.com/_jajlw611hi4/SFCFFRyzbJI/AAAAAAAAACQ/md69sFK1Bz0/s320/untitled1.jpg
http://www.greendiary.com/entry/10-solar-powered-green-architecture-designs/
http://english.dac.dk/visArtikel.uk.asp?artikelID=5538
http://quarknet.de/fotos/berlin/reichstag-berlin.jpg

Human effects

http://www.sisailmayhdistys.fi/portal/sisailmastoseminaarit/healthy_buildings_2000/workshops/workshop_28
http://blog.heliopower.com/wp-content/uploads/2009/08/energyuse.jpg
http://www.geni.org/globalenergy/library/renewable-energy-resources/geothermal.shtml
http://www.rwsarchitect.com/rwsmagazinearticles/passivesolarprincipals.htm
http://www.arch.mcgill.ca/prof/sijpkes/arch304/winter2001/sharve6/passive_solar/index.html
http://collections.infocollections.org/ukedu/en/d/Jsk02ce/2.3.html
http://www.hse.gov.uk/temperature/thermal/explained.htm

Shanghai Analyze

http://www.chinatouristmaps.com/travel/shanghai/roads-streets-districts/entertainment-block.html
http://skyscraperpage.com/cities/?cityID=6
http://www.autumnleaves.com.cn/housing/h-over-area.html
http://www.chs.ubc.ca/china/shanghai.pdf
http://en.windfinder.com/windstats/windstatistic_pudong_shanghai_airport.htm#
http://www.shanghai.climatetemp.info/
http://en.wikipedia.org/wiki/Renewable_energy_in_the_People's_Republic_of_China
http://www.gaisma.com/en/location/shanghai.html
http://hsu.me/2011/01/real-time-hourly-air-quality-data-in-china-now-available/
http://www.envir.gov.cn/Eng/Airep/index.asp
http://www.sino-impression.com

Highrise

http://accessscience.com/content/Buildings/099000
http://theconstructor.org/structural-engg/high-rise-structures/5/
http://www.inti.gov.ar/cirsoc/pdf/accion_viento/200704.pdf
http://www.hurricaneengineering.lsu.edu%2FCourseMat%2F03Lect19TallBld.ppt&ei=SM1CT-vIlsf44QT_5vCkCA&usg=AFQjCNFTplE9vg-vW8SmQm8_WMhEOd248A&sig2=ZXvxmIQTavQts1gw9wZXXw

Sketching

http://cdn.architecturelab.net/wp-content/uploads/2011/05/Evolo_2011_Competition_Main_rendering.jpg
http://inhabitat.com/wp-content/blogs.dir/1/files/2011/03/eVolo-2011-Winner-LO2P-11-537x393.jpg
http://ecocity.files.wordpress.com/2008/03/4-green-skyscraper-1.jpg
http://www.bustler.net/images/news/evolo-2011-mention22.jpg
http://www.snobtop.com/wp-content/uploads/2011/08/vertical-safari-zoo-ferris-wheel.jpg
http://www.evolo.us/wp-content/uploads/2011/05/solar-park-south-1.jpg
http://lisastown.com/inspirationwall/wp-content/uploads/2009/06/overall_skyscraper.jpg

http://www.chineseartpaintings.com/images/products1/RPDcj001b.jpg
http://2.bp.blogspot.com/-QuhLbT3NaRQ/Tt9t_EDx1iI/AAAAAAAAA7A/edsWzhVWs5g/s1600/leaf.jpg

http://lh4.ggpht.com/_Cg02E5r8Wzo/Sn7xGb-kshI/AAAAAAAAA78/Ya-t-Wpv43A/
http://mw2.google.com/mw-panoramio/photos/medium/2090835.jpg
http://theethicsoflandscape.files.wordpress.com/2011/11/highline.jpg
http://agmetalminer.com/wp/wp-content/uploads/2009/07/image-1_high-line.jpg
http://interiorzine.com/wp-content/uploads/2012/02/park-urban-environment.jpg
http://interiorzine.com/wp-content/uploads/2012/02/park-green-oasis.jpg
http://interiorzine.com/wp-content/uploads/2012/02/landscape-architecture.jpg

http://www.ngdc.noaa.gov/geomagmodels/struts/calcDeclination
http://sustainabilityworkshop.autodesk.com/fundamentals/building-orientation
http://www.irccbuildingregulations.org/pdf/4-04.pdf
http://www.eurocode1.com/en/index.html
http://nceub.greenlux.org/uploads/66Nicol.pdf
http://www.planningportal.gov.uk/uploads/br/BR_App_Doc_B_v2.pdf

http://quintinlake.photoshelter.com/image/I0000cPdgMxSYSKE
http://www.world-housing.net/uploads/102902_fig_19-roofing_small.jpg
http://ad009cdnb.archdaily.net/wp-content/uploads/2011/02/1296581398-kettingstraat-scherm-13.jpg
http://mobilarena.hu/dl/upc/2009-12/19042_dsc00064.jpg
http://upload.wikimedia.org/wikipedia/commons/
http://mirror-us-ga1.gallery.hd.org/_exhibits/textures/perforated-zinc-sheet-AJHD.jpg
http://www.bestbees.com/wp-content/uploads/2010/08/Green-wall.jpg
http://www.petalsnbuds.ca/wp-content/flgallery/images/2wmm9poo.jpg

http://chinahousing.mit.edu/english/resources/BuildingCode.html
http://www.arch.hku.hk/research/BEER/jgj26-95/JGJ26-95.html
http://www.grasshopper3d.com
http://www.yourhome.gov.au

http://meteonorm.com/

Appendix B

http://www.alliesandmorrison.com/media/homepage/images/401-charlesstreetcarpark-sheffield-facadedetail-day_.jpg
http://www.shanghai-xpat.com/photo/Early/files/94_typical_little_street.jpg
http://www.sino-impression.com/Upimages/200925161833.jpg:
http://www.karriere-im-ausland.de/bilder/_agenturen/332_1303968765.jpg
http://a5.sphotos.ak.fbcdn.net/hphotos-ak-snc6/224635_180273932021143_130685850313285_440449_2647887_n.jpg
http://larrygolfstheworld.com/files/2010/04/ShanghaiSkyline.jpg
http://www.chinaodysseytours.com/shanghai-tour/photo/shanghai-expo.jpg
http://images.travelpod.com/users/crowdywendy/2.1191951668.museum-shanghai.jpg
http://lh6.ggpht.com/_i9kNsv7OS24/SSwXVq_rlMI/AAAAAAAAA24/kd7oI9iWGIQ/TallestSkyscrapers-10.jpg
http://www.bestinterioridea.com/wp-content/uploads/2011/10/modern-hotel-in-Shanghai.jpg
http://therepublicofless.files.wordpress.com/2010/04/nouvel-arabworldinst-screen-close.jpg
http://www.topboxdesign.com/wp-content/uploads/2010/07/Kiefer-Technic-Showroom-by-Ernst-Giselbrecht+Partner-zt-gmbh-588x391.jpg
http://yazdanistudioresearch.files.wordpress.com/2011/02/open-cie-16.jpg
http://yazdanistudioresearch.files.wordpress.com/2011/02/q1_essen_jswd-architects.jpg
http://tctechcrunch.files.wordpress.com/2010/07/picture-41.png?w=640
http://www.shadinglouvres.com/solar-shading-systems/shadoglass-glass-louvers/shadoglass-main.jpg
http://cdn.archdaily.net/wp-content/uploads/2010/08/1280765247-getty2.jpg
http://www.psfk.com/wp-content/uploads/2009/06/05-vertical-canal-500x437.jpg
http://2.bp.blogspot.com/_PnCPTb2jz6w/TJfDiPlgNaI/AAAAAAAAAEY/7e0XKPxy_Ik/s400/ned_khan.jpg
http://static.panoramio.com/photos/original/47143213.jpg
http://static.panoramio.com/photos/original/5503150.jpg
http://v7.cache4.c.bigcache.googleapis.com/static.panoramio.com/photos/original/58723212.jpg?redirect_counter=2
http://www.architizer.com/blog/wp-content/uploads/2010/06/Marina-city-plan.jpg
http://www.cityprofile.com/forum/attachments/illinois/26101-chicago-marinac.jpg
http://www.archidose.org/Blog/HD30c.jpg
http://www.altdotenergy.com/wp-content/uploads/2008/10/urban_cactus.jpg
http://thebuilderblog.files.wordpress.com/2008/03/urban-cactus-header.jpg
http://dreamofacity.files.wordpress.com/2011/11/institut-du-monde-arabe.jpg
http://img468.imageshack.us/img468/5738/arabe9ba.jpg
http://ad009cdnb.archdaily.net/wp-content/uploads/2011/08/1313783555-2821962571-322a7acbcc-olaura-manning-750x1000.jpg

Appendix C

http://2.bp.blogspot.com/_ir6h9Q90O7g/TOP0mSPysCI/AAAAAAAAAac/34Z-XKY_bLI/s1600/Lunch+atop+a+Skyscraper%252C+1932.jpg
http://farm3.staticflickr.com/2581/3847826560_f53d8d66c5_o.jpg
http://www.liftok.com/bbs/attachment/14_29_0473b45d4c63d04.jpg
http://1.bp.blogspot.com/_SY_ZtuPN86Q/TS9SVzvzcYI/AAAAAAAAAEg/INvwvCLK5FQ/s1600/Shanghai+World+Financial+Center+04.jpg
http://upload.wikimedia.org/wikipedia/commons/c/c6/Oriental_Pearl_Tower.JPG
http://upload.wikimedia.org/wikipedia/commons/4/4b/Jin_Mao_Building-2005.JPG
http://i4.photobucket.com/albums/y136/cityw/Architecture/DSC_0475x1200.jpg
http://farm8.staticflickr.com/7158/6541589561_c363233fef_o.jpg
http://farm2.staticflickr.com/1224/571062632_91a9283c75_o.jpg
http://www.flickr.com/photos/wander-on/5771254786/sizes/z/in/photostream/
http://farm4.staticflickr.com/3535/3256728631_aa60dd4f7e_o.jpg

Appendix D

http://www.seeraa.com/image/lyshangzhou.jpg
http://fc04.deviantart.net/fs70/f/2011/149/c/5/chinese_garden_by_sebartz-d3hk3tm.jpg
http://farm4.staticflickr.com/3270/2543424465_7b0ded3314_b.jpg
http://cache-images.writersnetwork.com/sites/default/files/imagecache/destination_site_medium/fotolia/Fotolia_4930161_Subscription_L_3.jpg
http://randleslikecandles.files.wordpress.com/2012/01/img_3134.jpg
http://2.bp.blogspot.com/-UK8qoDGTNzg/TZKd83zLDrI/AAAAAAAAABY/oG14oYjxtkc/s1600/landscape-design-zen-garden-Kyushu-Japan.jpg
http://4.bp.blogspot.com/_IrIhzZ4N5dk/S_6j8-tE38I/AAAAAAAAAXg/jxTy-kMjROk/s1600/Souzhou+garden+path.jpg
http://northwestphotos.files.wordpress.com/2011/09/100_5361.jpg
http://www.schnormeiergardens.org/Waterfalls_Garden/Red_Chinese_Bridge_Schnormeier_Gardens_Ronald_Bolender_0038.JPG
http://us.123rf.com/400wm/400/400/pekour/pekour1103/pekour110300014/9091446-row-of-bonsai-trees.jpg
http://berkeleygardencoach.files.wordpress.com/2010/12/pgr-fucbol.jpg
http://people.virginia.edu/~jlr5m/ChinaAlbum/IMG_0073_shanghai3.jpg
http://verityla.files.wordpress.com/2010/10/chinese-garden.jpg
http://zen.rinnou.net/exhibition/images/ex_01/tenryu04.jpg
http://www.monrovia.com/plant-catalog/search.php?start_page=15&garden_style=3