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# Paris 2050
Developing the city within its limits

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Graz, October 2017

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# KURZFASSUNG

Wie in vielen europäischen Metropolen wächst die Pariser Bevölkerung rasant, weshalb bis 2050 bereits 2.4 Millionen Einwohner mehr erwartet werden. Die damit verbundene großflächige und ungeplante Ausdehnung der Stadt bringt viele Probleme mit sich. Eines davon ist der intensive Gebrauch von Autos, welcher derzeit eine der Phasen mit den höchsten Werten der Schadstoffbelastung seit der industriellen Revolution zur Folge hat.

Dies fordert uns auf, das Potential der übrig gebliebenen Räume um und über der Infrastruktur zu überdenken, und die Stadt innerhalb ihrer Grenzen weiterzuentwickeln.

Das Projekt ist ein alternativer Lösungsvorschlag zur horizontalen Erweiterung der Stadt. Es fokussiert sich dabei darauf, auf einer dieser Restflächen ein belebtes Viertel zu schaffen, welches die inneren und äußeren Stadtbezirke verbindet.

# ABSTRACT

With its rapidly growing population, Paris is expected to have 2.4 million more inhabitants by 2050. The metropolis has been widely spreading in an unplanned way and urban sprawl has brought many problems such as an intensive use of cars, resulting in one of the most intense pollution peaks episode the city had to face since the industrial revolution. The centre of the city today is one of the most compact in Europe and therefore can hardly be densified.

It challenges us to reconsider leftover spaces near and above street infrastructures as a potential to develop the city within its limits.

This project offers an alternative solution to the horizontal expansion of the city, focusing on one of those residual spaces and explores the possibility to create a lively neighbourhood that reconnects inner and outer districts.

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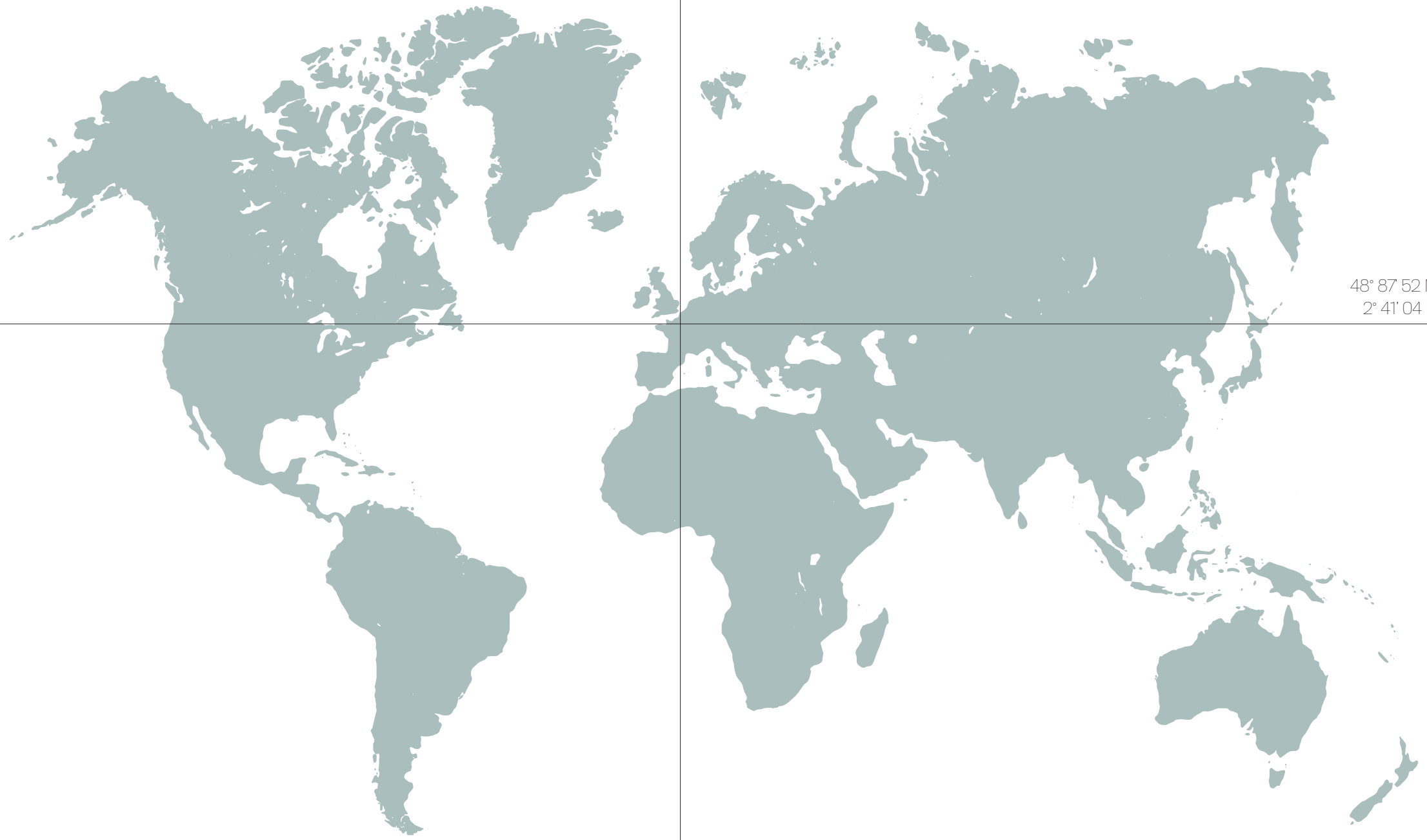
# 1. ABOUT PARIS

*Fig. 1  Location of Paris on world map >*



48° 87' 52 N
2° 41' 04 E

# Climate

Paris is located in a temperate oceanic climate zone which is characterized by a moderate temperature difference between summer and winter, rare negative temperatures, a monthly average temperature below 22°C and more than four months averaging above 10°C. The precipitation is almost constant over the whole year. [1]

1 (Köppen climate classification, 2017)

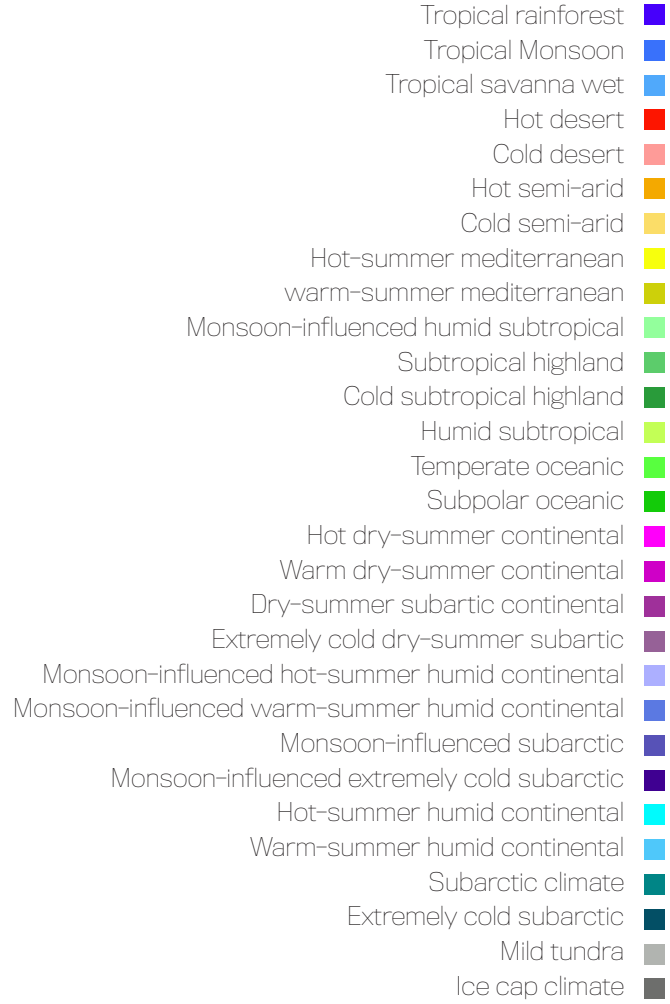
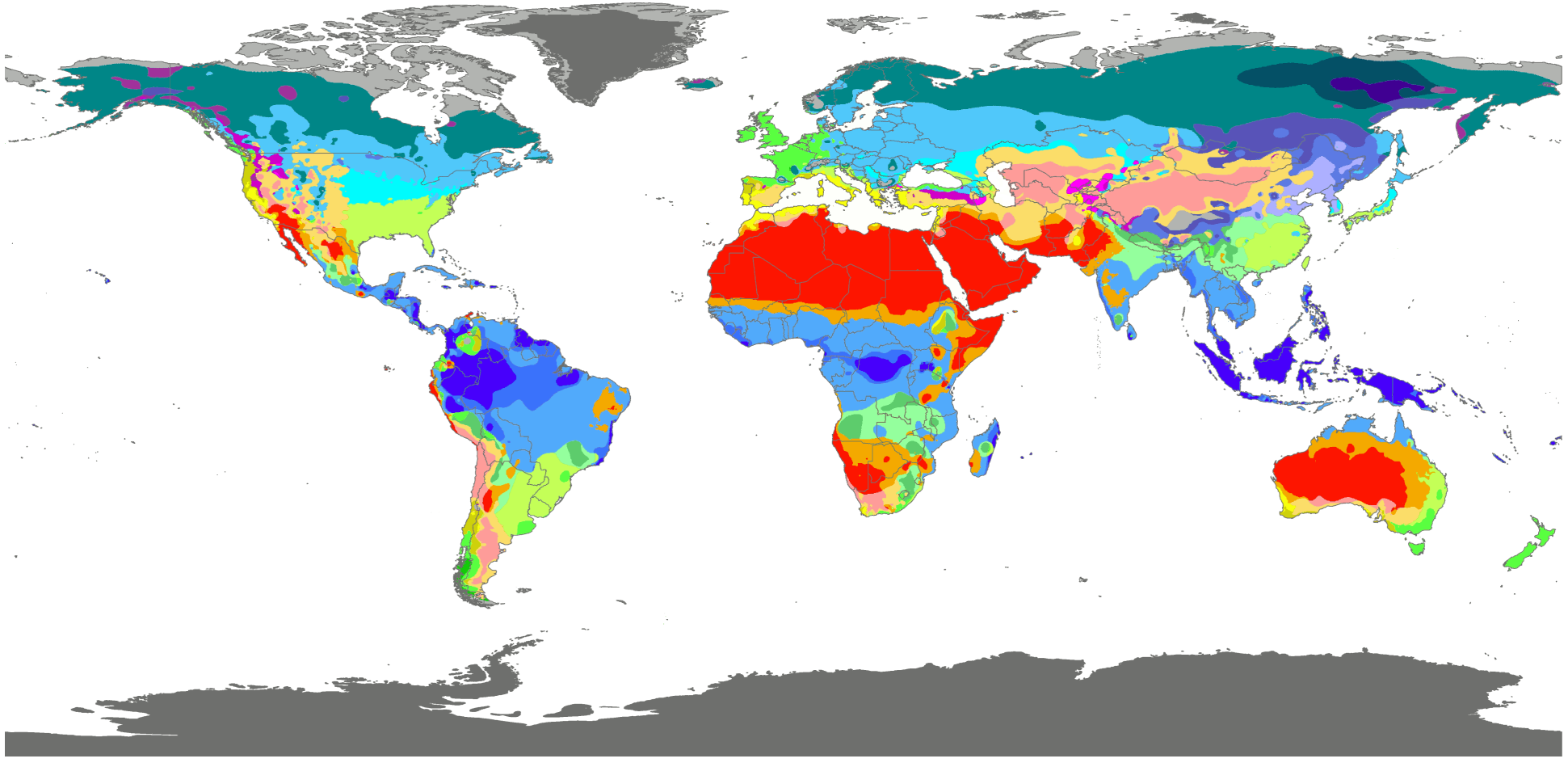



*Fig. 2 World map of Köppen-Geiger climate classification (Source: Ali Zifan, 2016) >*

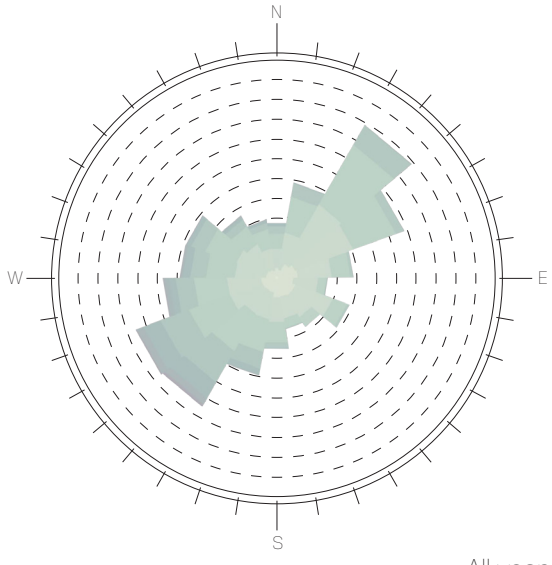


# Wind and temperatures

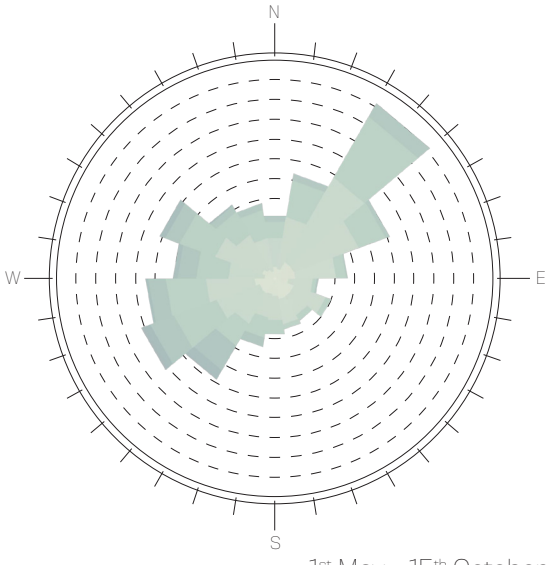
Average daily temperatures range from -5°C to 30°C over the whole year. The Universal Thermal Climate Index (UTCI) method[1] can be used to calculate felt temperatures. It is based on air temperature, relative humidity and wind speed. For Paris it shows two periods: from the 15th of October to the 1st of May, the temperatures are generally too cold for outdoor activities and from the 1st of May to the 15th of October, it is comfortable for the human body to do outdoor activities. Rare episodes of heat stress are happening during summer.

1 (UTCI, 2017)

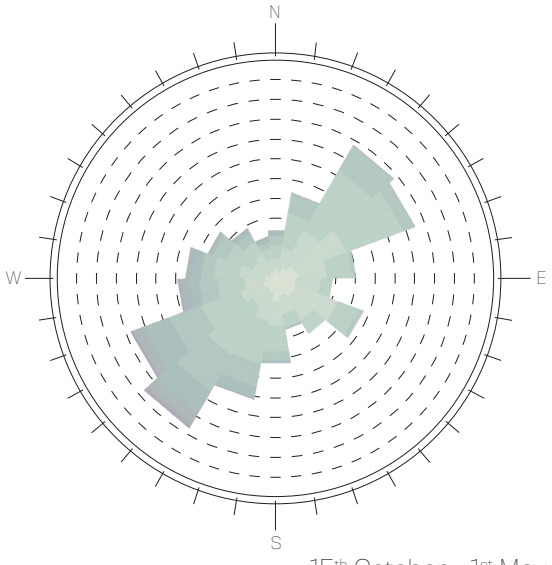
*Fig. 3 Wind speed and direction at 10m / all year >*
*Fig. 4 Wind speed and direction at 10m / from 1st May till 15th October >*
*Fig. 5 Wind speed and direction at 10m / from 15th of October till 1st of May >*
*Fig. 6 Temperatures / all year >*
*Fig. 7 Felt temperatures / all year >*




All year

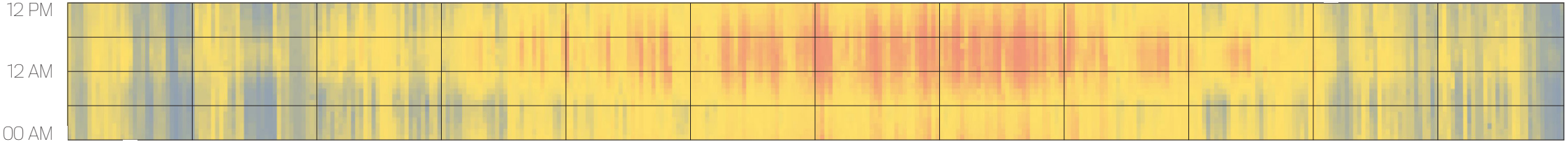



1st May – 15th October

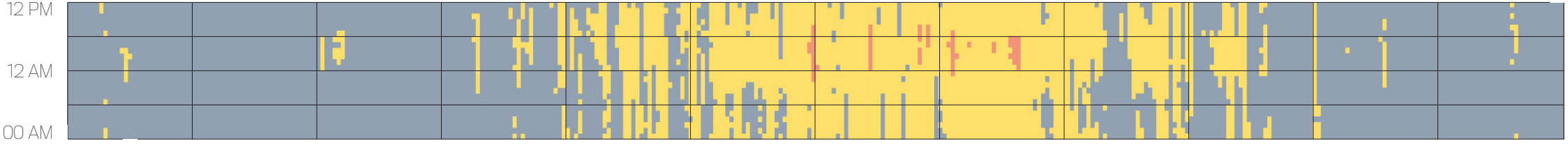



15th October – 1st May

≤ 2m/s 4m/s 6m/s 8m/s 10m/s 12m/s ≥ 14m/s




≤ -5°C 0°C 5°C 10°C 15°C 20°C 25°C ≥ 30°C




discomfort – cold stress – temp. < 9° UTCI comfort – temp. > 9° < 26° UTCI discomfort – heat stress – temp. > 26° UTCI

# Population growth

France is a very centralized country in comparison to other european countries such as Germany. The capital Paris concentrates most job and study opportunities as well as political power and therefore attracts all segments of the population.

The amount of inhabitants of this urban area has been continuously increasing at a fast pace for the last two centuries. The projections of population predict a growth of up to 20% by 2050[1]. The inner city population has slightly decreased since the 50's and is now almost stable. Main reasons are the low amount of new constructions and the decline of persons per household.

Vocabulary:

"An *aire urbaine* ([ ...] "urban area") is an INSEE (France's national statistics department) statistical concept describing a core of urban development and the extent of its commuter activity"[2]. The urban area of Paris spreads over 17 175 km$^2$ and contains 1 798 *communes*[3] (lowest level of administrative division). At least 40% of its population is working in the centre[4].

An urban unit "is a statistical area defined by INSEE [ ...] for the measurement of contiguously built-up areas." It forms a single unbroken spread of urban development with no distance between habitations greater than 200 meters. The urban unit of Paris is a group of 396 *communes* that spreads over 2 723 km$^2$.[5]

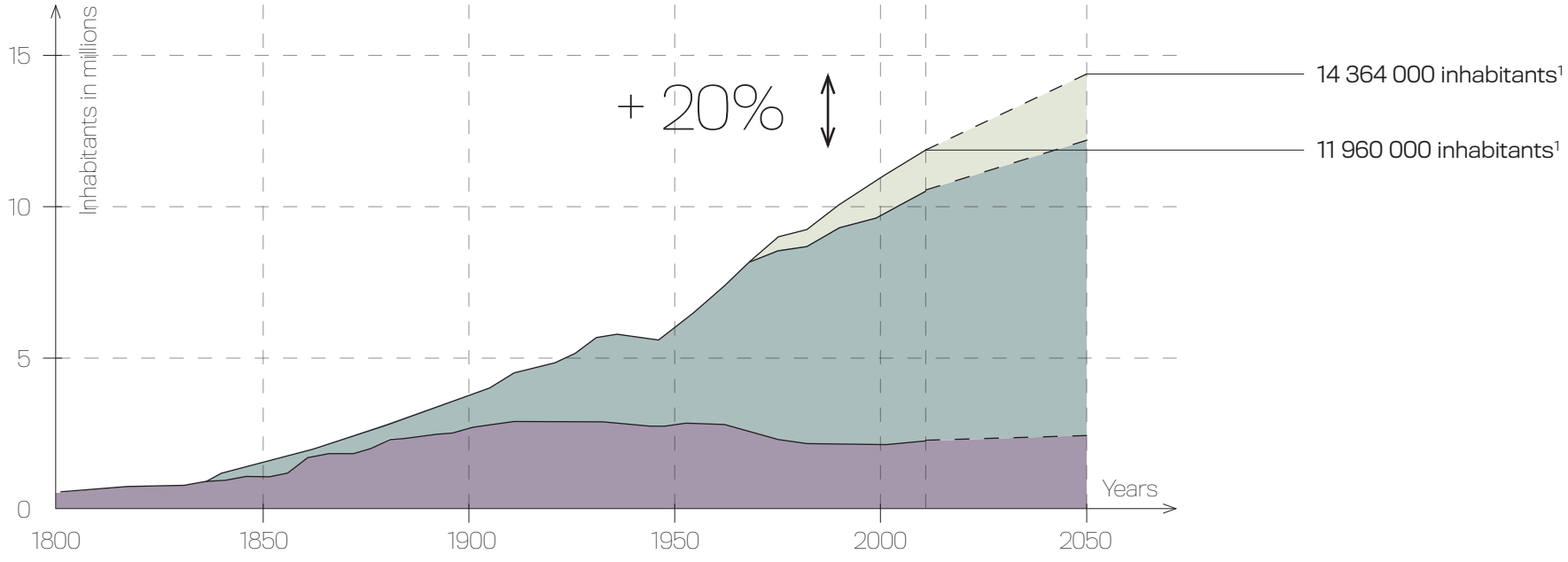
1 (INSEE, 2017)

2 (Urban area, 2017)
3 (*Aire urbaine de Paris*, 2017)
4 (INSEE, 2016)
5 (Urban unit, 2017)

How will the city face a population growth of 20% by 2050 without sacrificing its quality of life?

Urban area
Urban unit
Paris inner city

*Fig. 8 Evolution of the population >*


Inhabitants in millions
15
10
5
0
1800
1850
1900
1950
2000
2050
Years
+ 20%
14 364 000 inhabitants[1]
11 960 000 inhabitants[1]

1 (INSEE, 2017)

# Urban sprawl

Over the last centuries, the city has extended far over its historical footprint, including neighbour cities and villages. Today it's forming a widely spread continuous urbanized area that covers 277 ha[1].

Paris remains the only centre of this metropolitan area and continues to drag economical, social and cultural forces toward its centre. Satellite cities are mostly residential except rare specialized zones such as *La défense* (business district) or Disneyland (tourist area).

1 (Atlas of Urban Expansion, 2016)


*Fig. 9 Map of Paris's urban expansion >*

# Consequences of urban sprawl

The horizontal spreading of the city has a negative impact on the environment and the urban quality of life.

Artificialization of arable fertile soils and wetlands due to urbanisation is a nearly irreversible degradation and should be considered when thinking about feeding future generations. The distance between the places of food production and the consumers is the key of tomorrow's agriculture. Forests and wetlands are crucial for the biosphere.

In Paris, most of the population use public transportation daily to go to work and only 13% use their vehicles. This number rises to 43% when looking at the whole metropolis[1]: the farther away from the city centre, the higher the number of vehicles per household. The roads are systematically congested in the morning and after work resulting in time-consuming traffic jams that negatively affect commuters lifes. The number of cars owned by inhabitants living in the centre has been slightly decreasing since 1990 but at the scale of the urban area it keeps increasing at a fast pace. There are about 770 000 parking spots available in Paris[2]. This equals an area of around 885 ha that could be used differently.

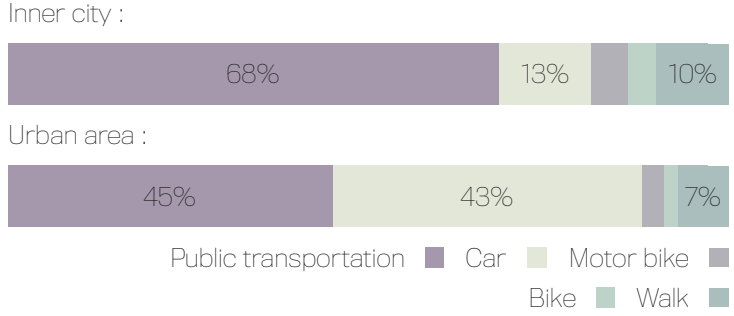



*Fig. 10 Distribution of means of transportation in 2010*

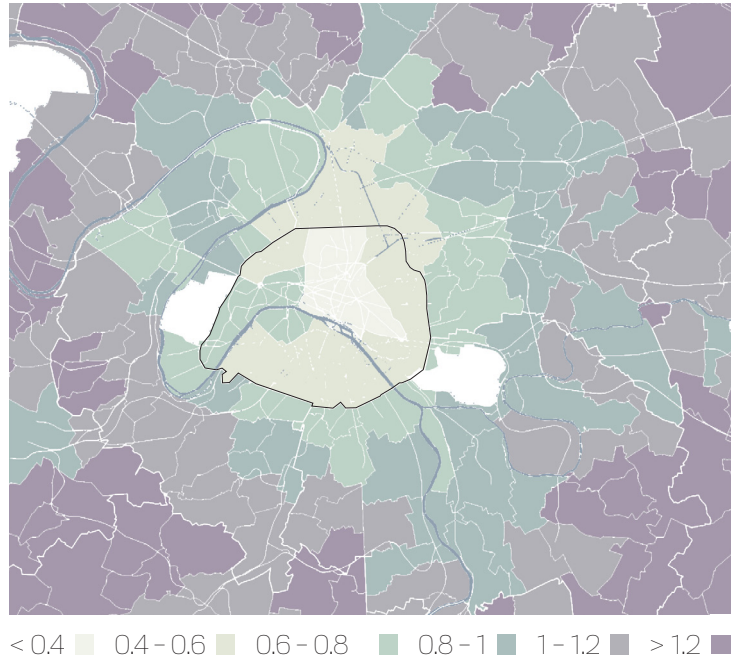



*Fig. 11 Average number of cars per household in 2006*

1 (INSEE, 2017)

2 (apur, 2010)

Main roads are responsible for most of the air and noise pollutions within the city. It strongly affects the health of lower class populations that are living in close proximity.

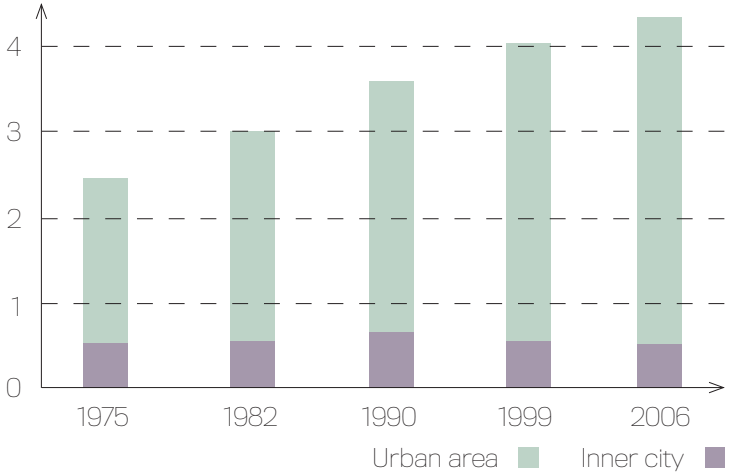



*Fig. 12 Evolution of the number of cars (in millions)*


*Fig. 13 Air pollution (NO2 in µg/m³)*

The economical cost of urban sprawl is difficult to estimate but is presumably very high, since street, water, sanitation and electricity networks must constantly be extended further for a lower density of users.

There are also social consequences: the urban sprawl tends to segregate population classes and functions. Inhabitants of monofunctional residential areas become dependent on their cars to access shops, social and cultural spaces.

The horizontal expansion of the city can not be the development strategy for the 21st century.

# Land use

Paris's urban fabric is the result of various consecutive densifications and large scale projects (e.g. Haussmann) that progressively shaped the dense urban landscape that we experience today.

The demand for housing and offices in the centre has already been high for a long time. Almost all parcels are already built. Very rare empty plots are made available due to the demolition of former industrial buildings, and those opportunities are becoming increasingly rare.

The river, canals and parks are wide unbuilt surfaces within the city, however they are absolutely necessary for the quality of urban life and should remain untouched.

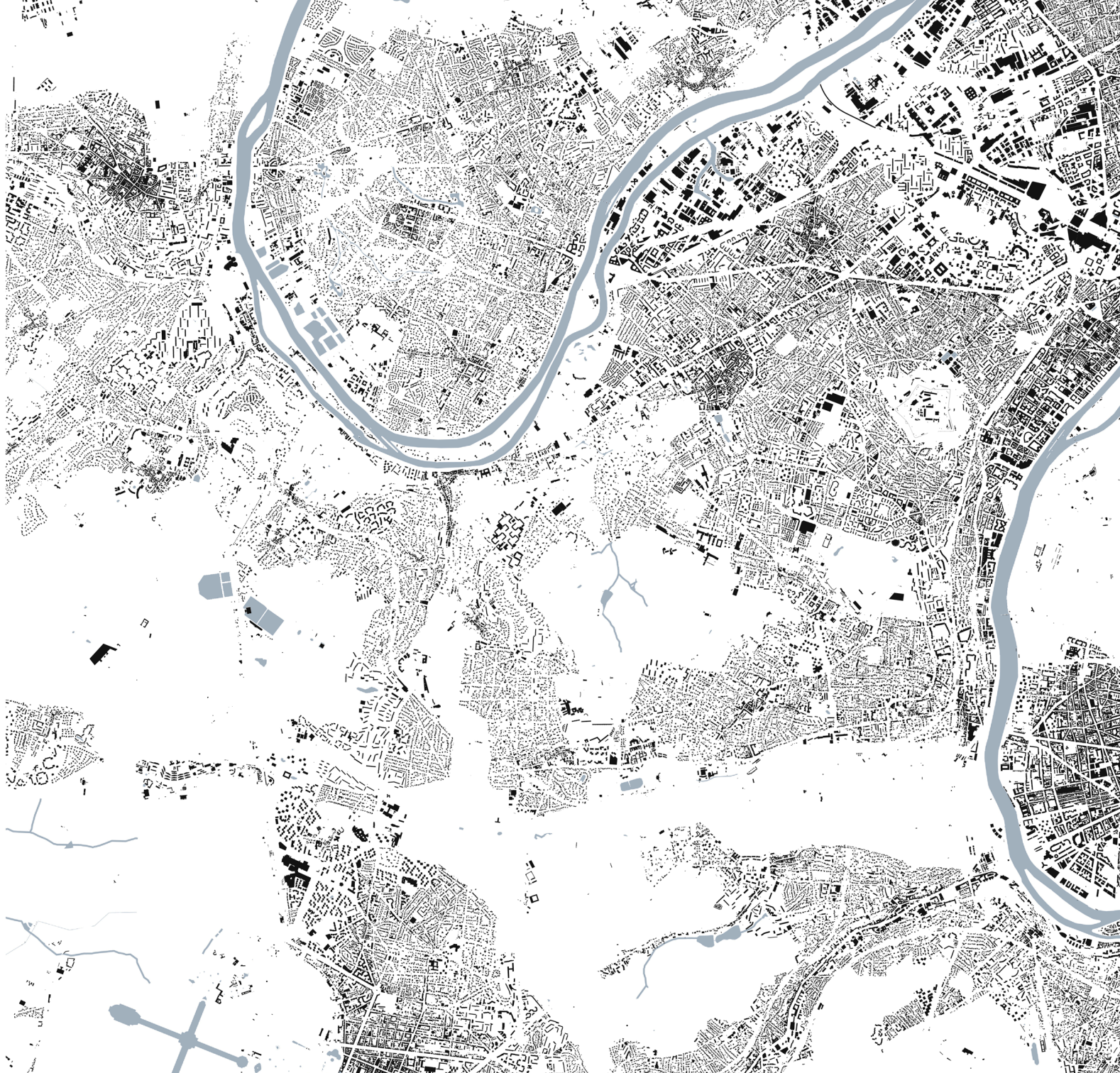



*Fig. 14 Figure-ground diagram >*

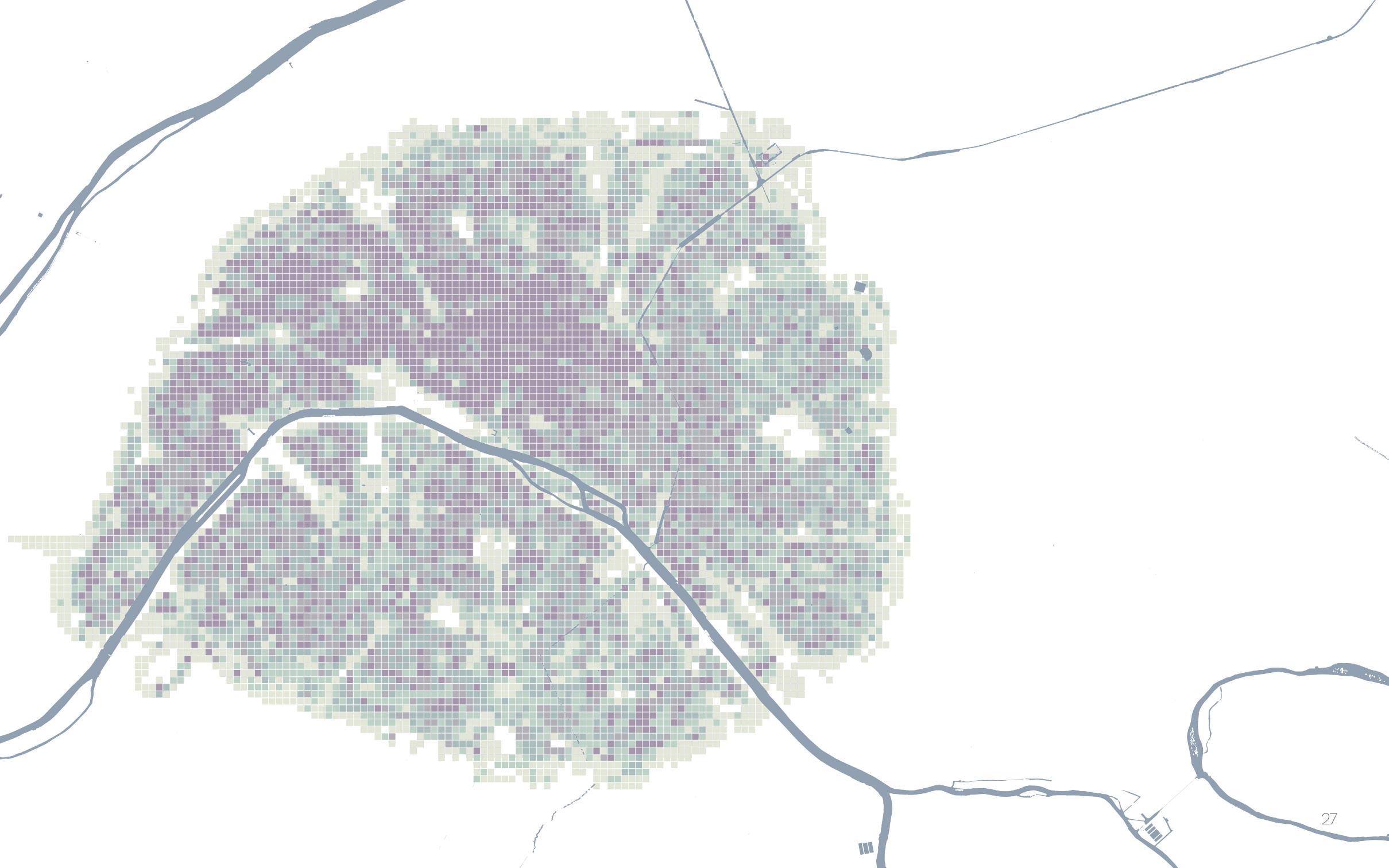
# Building density

The overall high building density can vary from one district to another. For comparison, a single-family house, a townhouse, and a suburbian apartment complex respectively have a floor area ratio of 0.3, 0.75 and 1.

In the parisian urban fabric, most of the time vertical densification is not feasible, since daylight must be preserved for existing buildings and the old structures can not carry new constructions.

Densification of existing urban blocks is in most cases impossible.


*Fig. 15 Map of building density (Source: intermezzo, 2011)* >

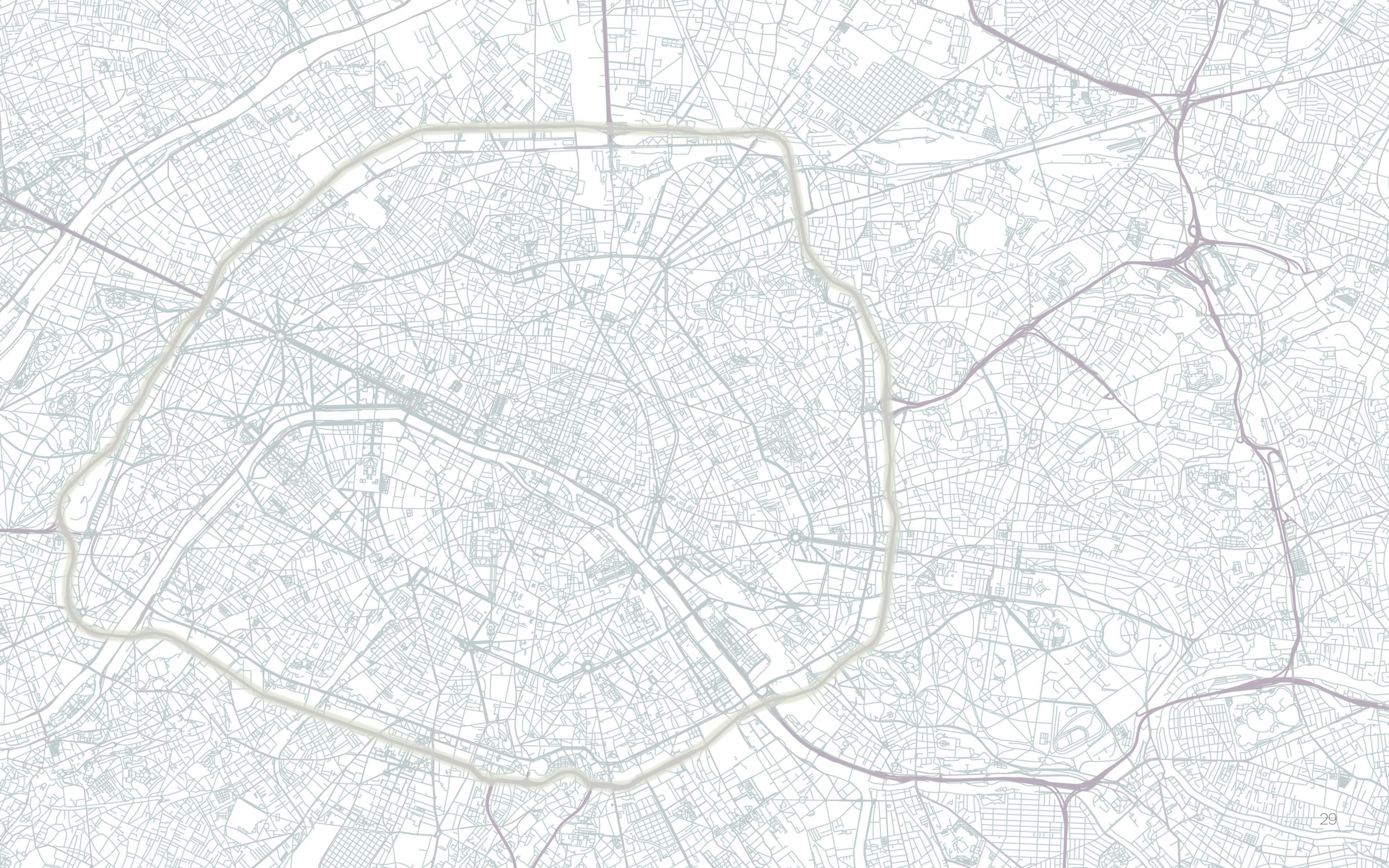


# Street network

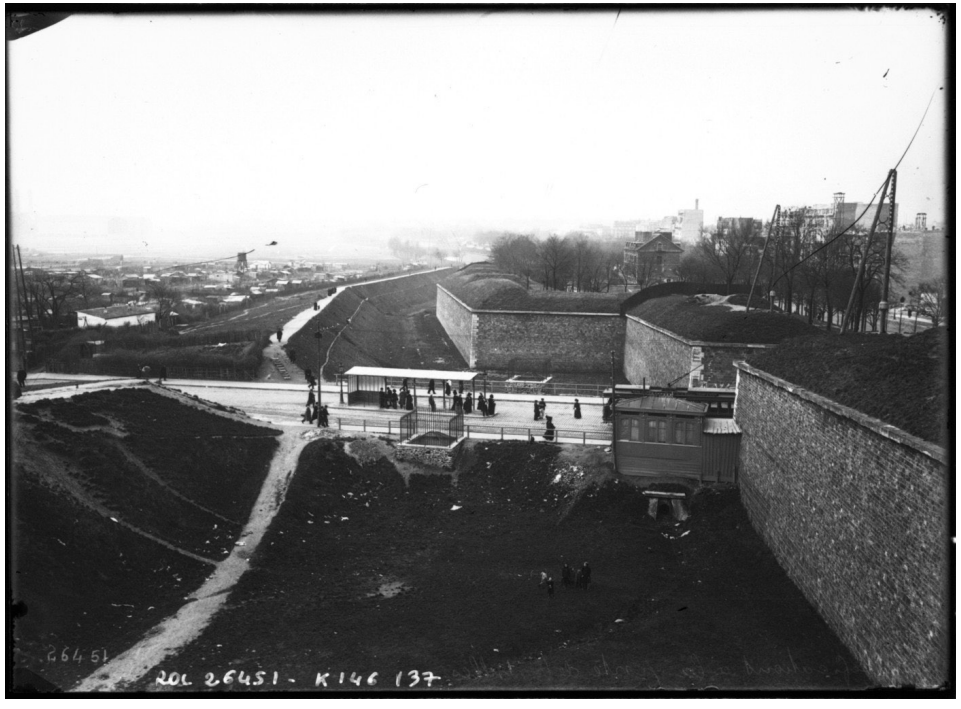
The *boulevard périphérique* is a 35km loop that covers an area of 140 ha, including its access roads. The average width is 40m with between 6 and 8 lanes depending on the sections. For half of the length, the ring road is above the surrounding ground, for 40% under ground level and for 10% at the same height.

The ring road covers an area of 140ha which could be used to develop the city within its limits.


*Fig. 16 Street network map (Source: OpenStreetMap, 2017)* > 28



# History of the *Boulevard Périphérique*



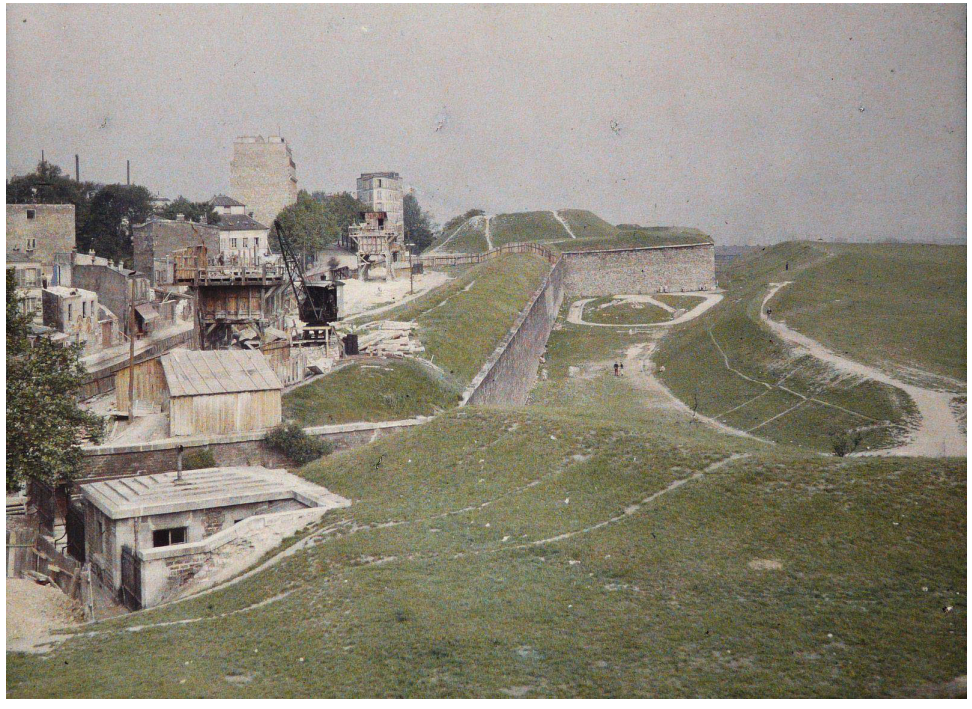


*Fig. 17 Porte de Versailles (Source: Agence Rol, 1913)* <
*Fig. 18 Porte du Pré Gervais (Source: Stéphane Passet, 1914)* ^

1919 — Beginning of the demolition of military fortifications.

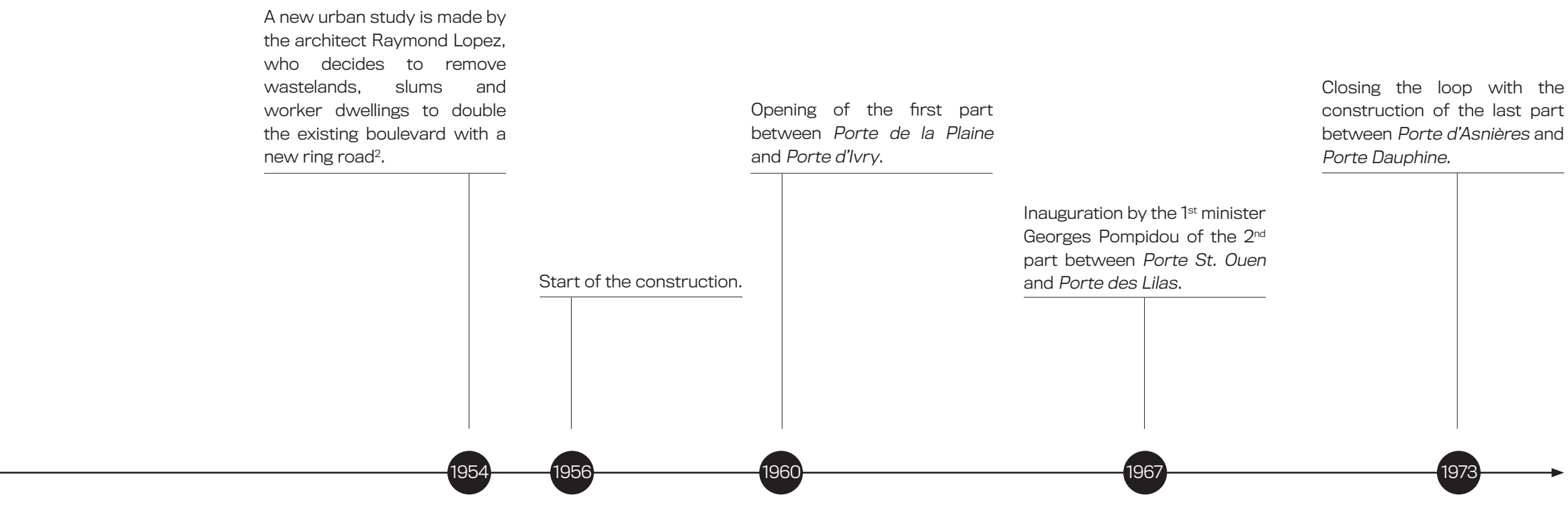
1924 — City council studies different options for the use of this area.

1925 — The idea of constructing a ring road is discussed for the first time.

1930 — Construction of social housing, sport facilities, parks and a first ring road called *boulevard militaire*.

1940 — The road is already congested despite its 20m width and its 8 tunnels.

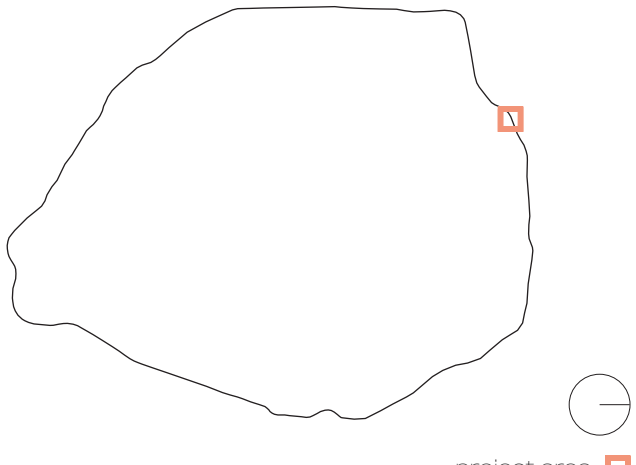
1943 — The name *boulevard périphérique* appears for the first time[1]. A new road surrounded by various public buildings is planned but never built.




1 (*Urbanisme*, 1943)
2 (*Revue générale des routes et des aérodromes*, 1955)

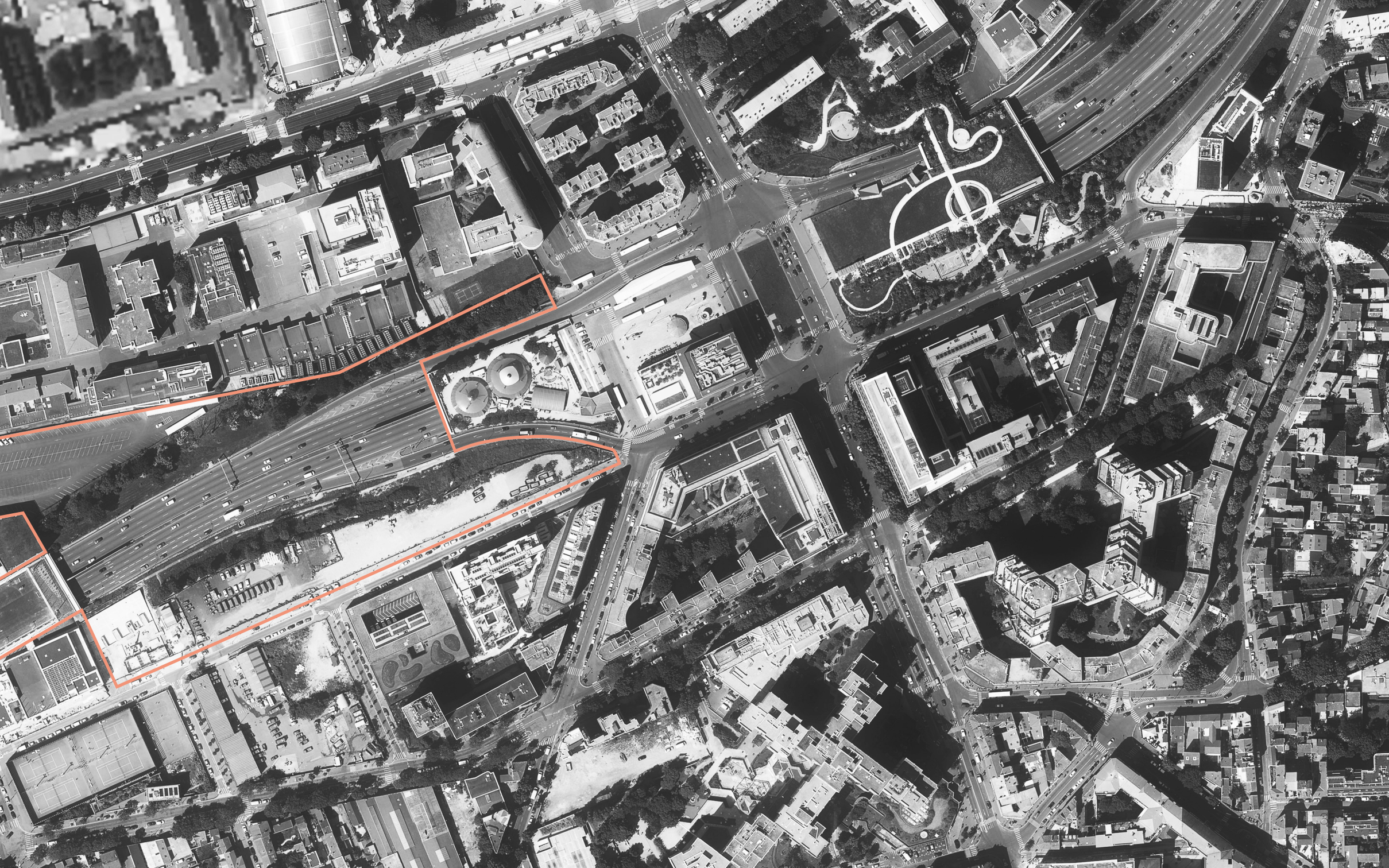
# Project site

The selected site for the project is a section of the ring road in the north-eastern part of Paris near *Porte des Lilas*. The 3.7ha area extends over the ring road and spaces on both sides. The ground on one side was occupied by warehouses that have already been demolished. The parking on the other side will be removed.



project area

*Fig. 19 Aerial view Porte des Lilas (Source: Google, 2017) >*



# Covering the ring road

The ring road is around 6m below the surrounding street level, making it easier to cover parts of it without creating a height difference.

Between 2003 and 2012, the area progressively evolved from a simple roundabout bridge to a wide concrete slab, covered with various programs like a park, circus tents, a cinema, as well as bus stops. Those modifications improved the connection between inner and outer districts, especially for bikes and pedestrians, and gave a more urban character to the space.

I propose to continue this process and completely cover the road in the project area. It brings air and noise pollution to an acceptable level that benefits the project as well as surrounding buildings.

It would have the effect to concentrate pollution at the ends of the tunnel and that is the reason why filtration systems should be installed along the way.

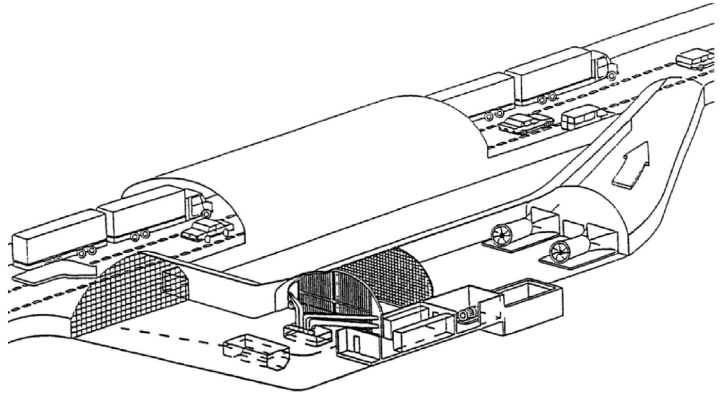
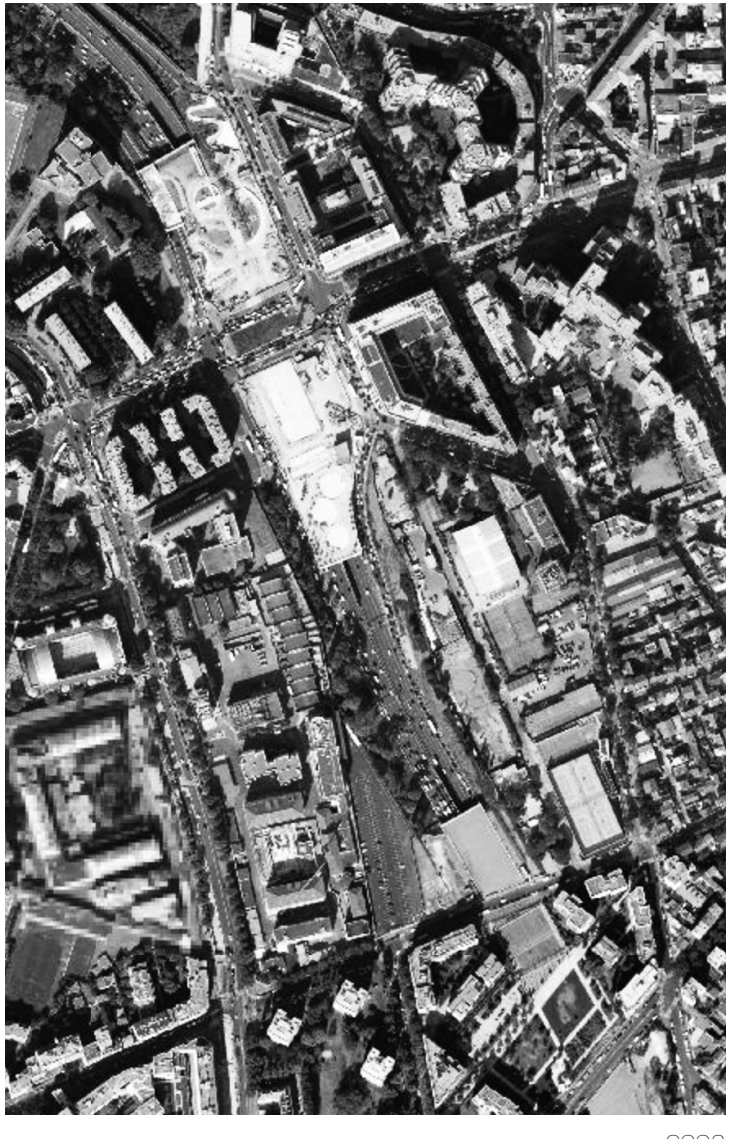
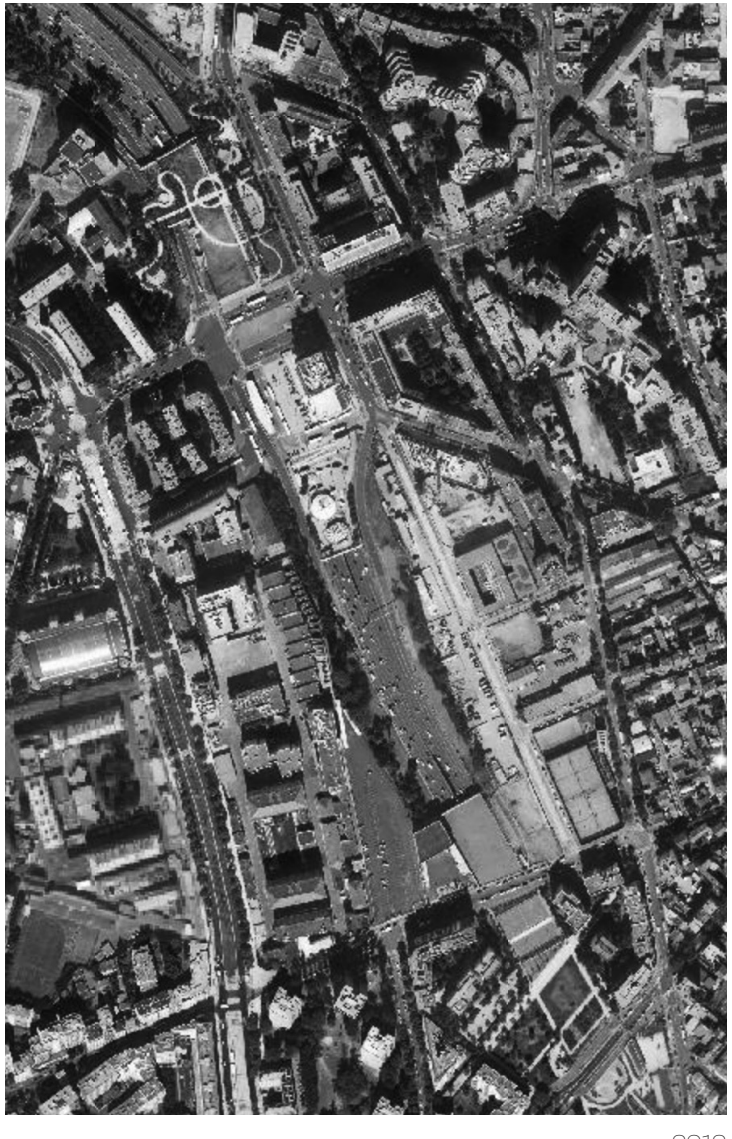


*Fig. 20 Noise pollution above regulation (68dB) (Source: Bruitparif, 2016)* ^
*Fig. 21 Bypass filtration system (Source: IREX, 2015)* ^
*Fig. 22 Aerial view (Source: IGN, 2003)* >
*Fig. 23 Aerial view (Source: Interatlas, 2008)* >
*Fig. 24 Aerial view (Source: Interatlas, 2012)* >

2003



2008



2012


CINEMA
étoile
LILAS
CRÉDIT AGRICOLE
IMMOBILIER


*Fig. 25* *Photo of the area* <
*Fig. 26* *Photo of the area* ∧

# 2. URBAN DESIGN PROCESS

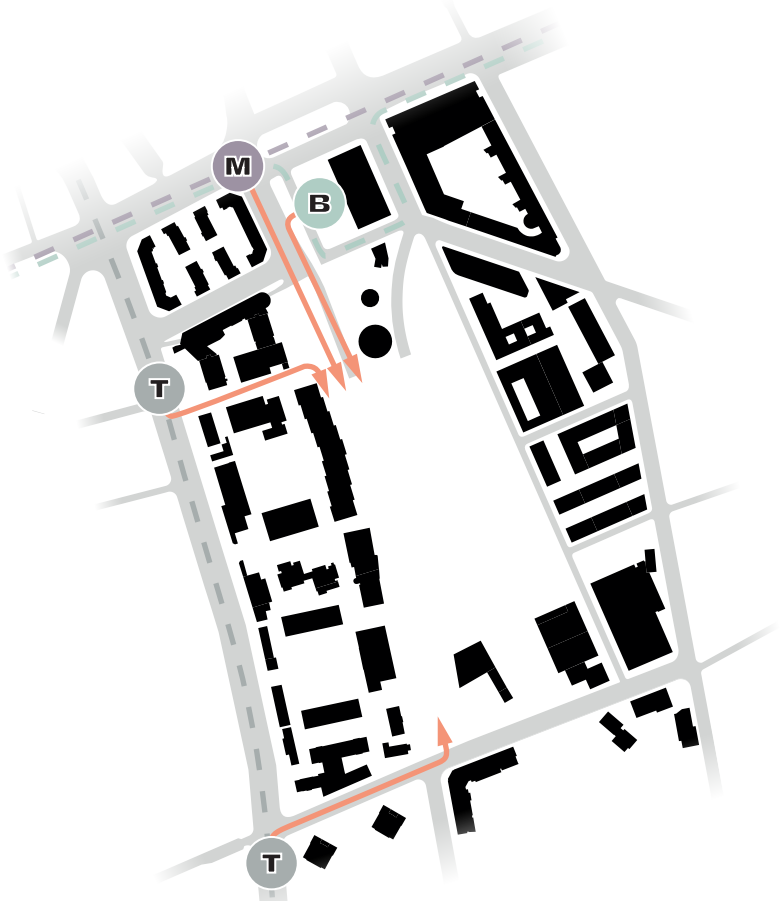



Fig. 27

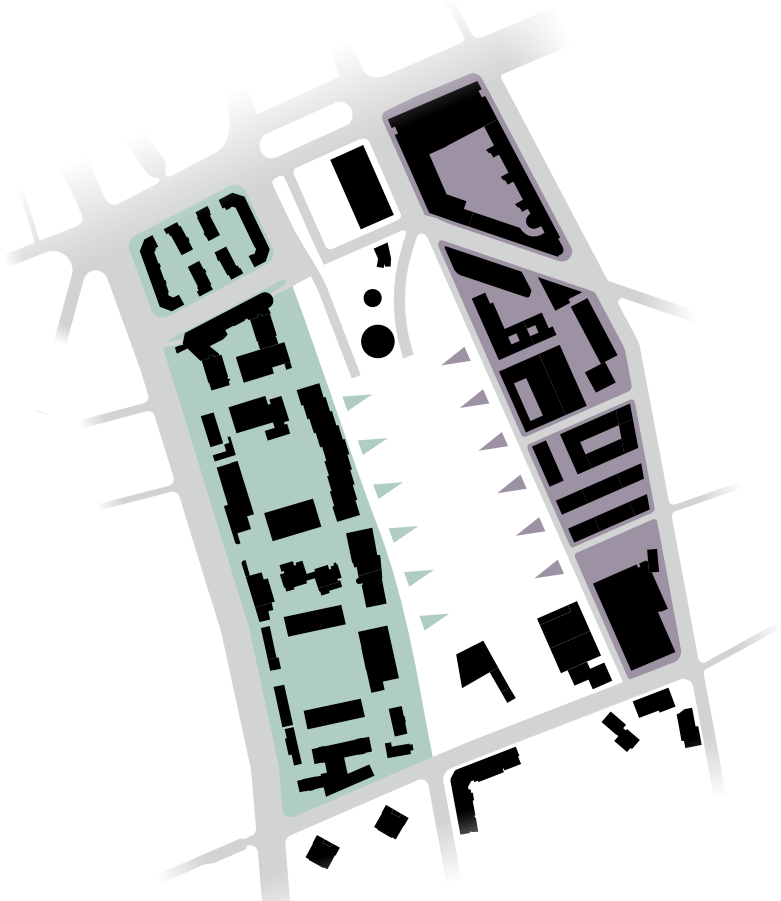


Fig. 28

# Public transportation

Metro, tram and busses are accessible from the site within five minutes walking distance.

# Connecting districts

The project reconnects inner and outer districts.

*Fig. 29*

# Accessing site

Existing streets are extended within the site allowing bikes and pedestrians to cross easily what was formerly a strong physical border.

*Fig. 30*

# Parking

The entire site is a car-free zone. Undergound parkings are located under existing buildings and accessible from outer edges.

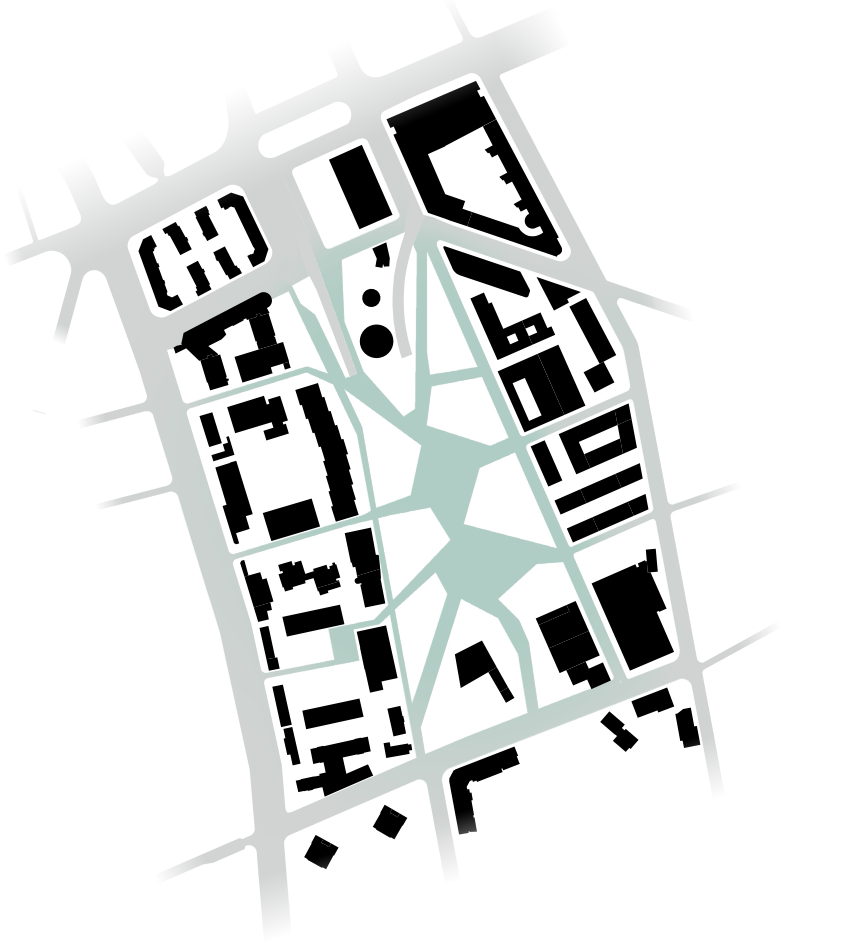


*Fig. 31*

# Public space

The urban space is designed for pedestrians rather than cars and therefore can have a wide variety of shapes that creates interesting urban situations.

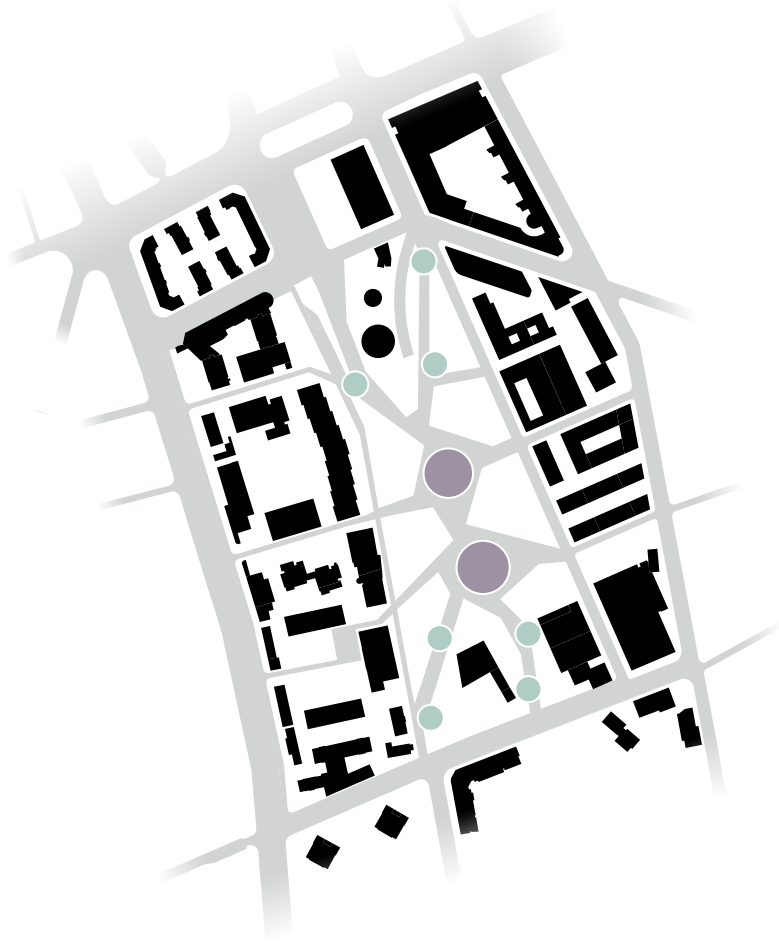


*Fig. 32*

# Series of squares

Smaller and larger squares punctuate the urban sequence.

*Fig. 33*

# Program

Shops are located along the busier paths, offices spread over the ground and first floor and the upper floors are dedicated to housing. Two public buildings are placed in the lively centre of the public space.

*Fig. 34*

# Accessible rooftops

An extra layer of public spaces takes place on the roofs that are connected to each other and gives a different perspective on the built environment.

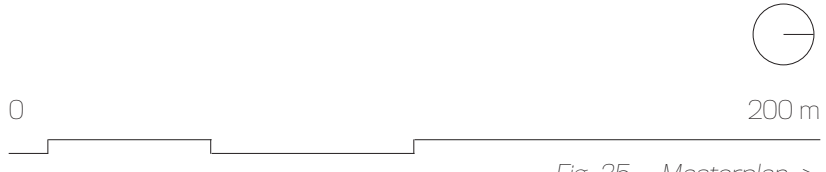
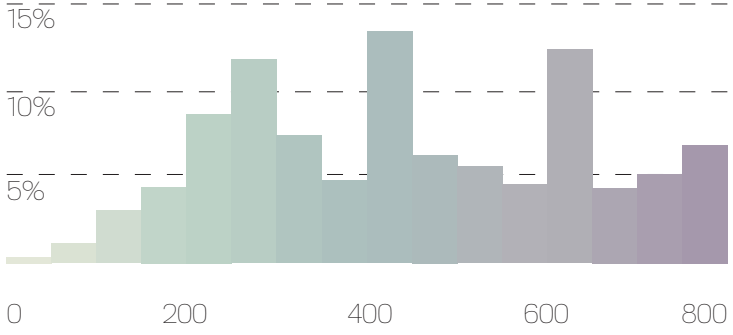



*Fig. 35 Masterplan >*

# Radiation simulation

Within urban regulations, heights and positions of the upper volumes have been optimized to maximise daylight on the facades while achieving a relatively high density (floor area ratio: 2.6).



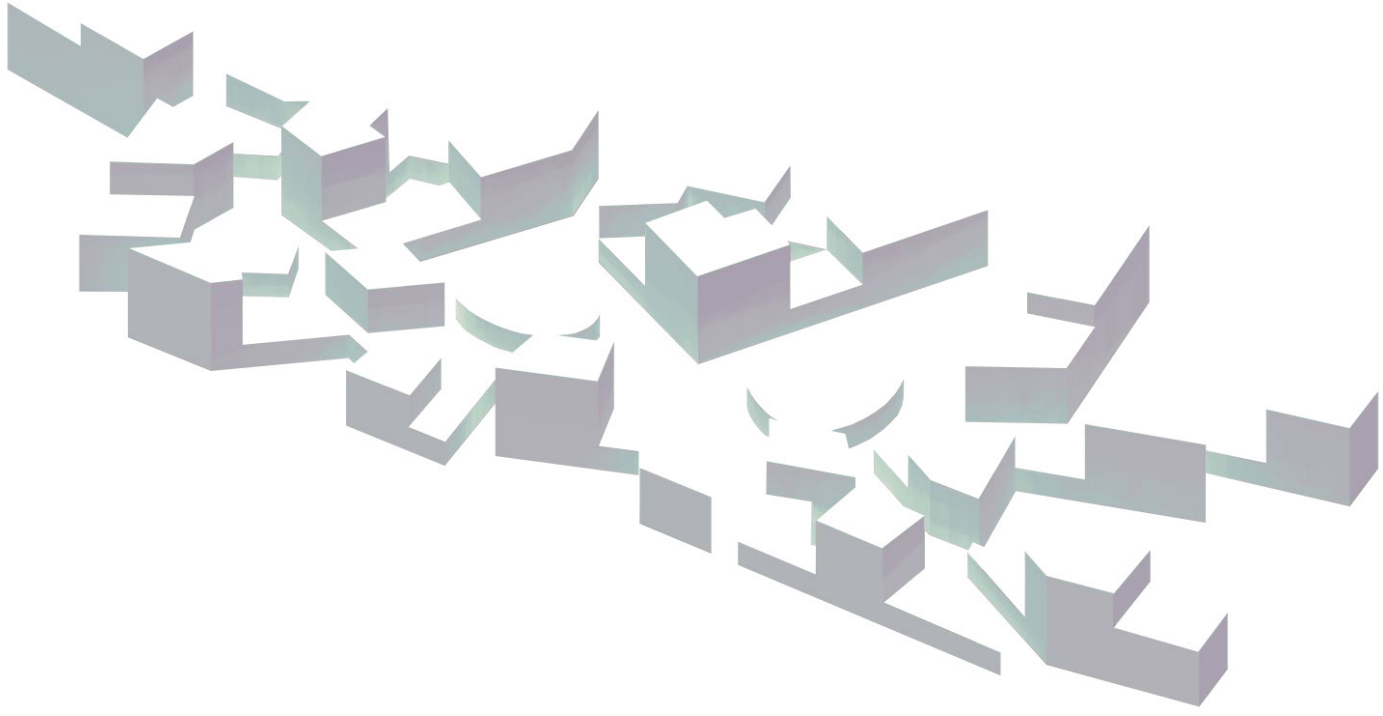
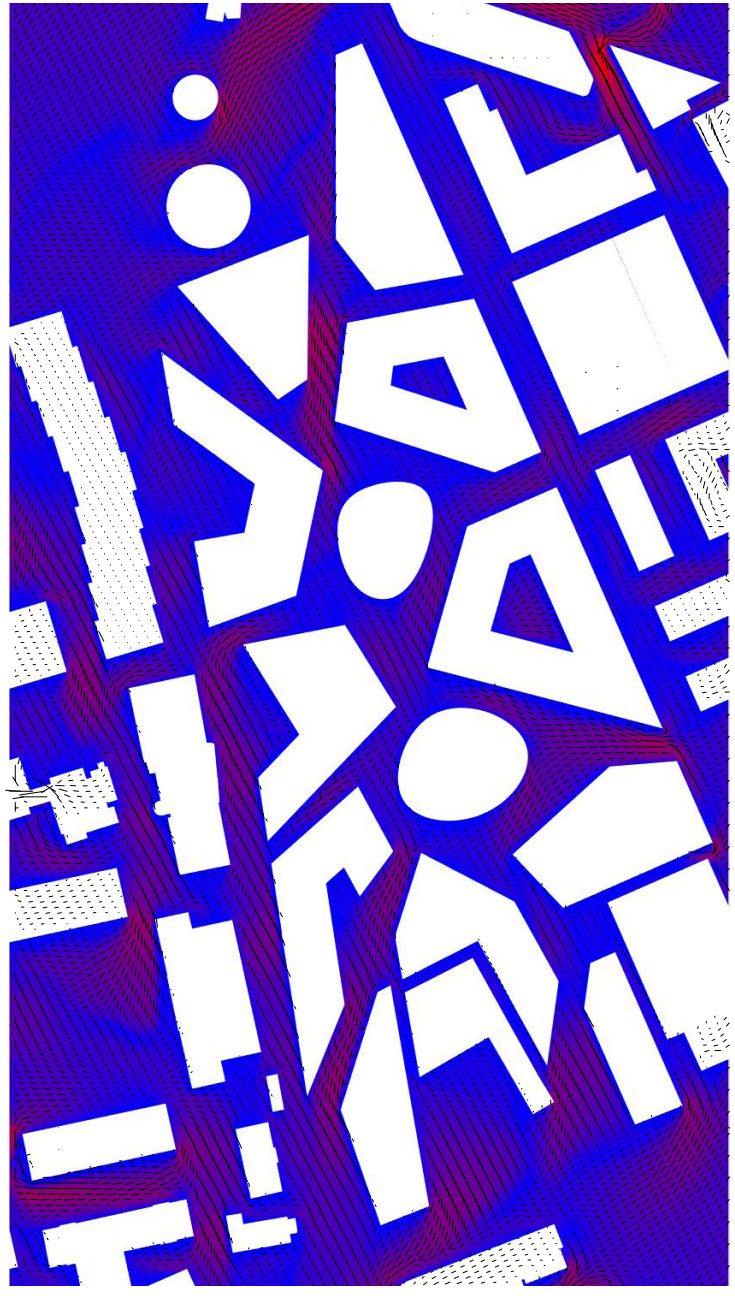



*Fig. 36 Radiation simulation on facades (kWh/m²) (graph)* ∧
*Fig. 37 Radiation simulation on facades (kWh/m²) (model)* >

# Wind simulation

A good ventilation between the buildings, especially during the summer period, is crucial to ensure cross ventilation through the apartments. The difference between the high air pressure on the windward facade of the building and the low air pressure on the leeward side make the passive ventilation of the building possible.



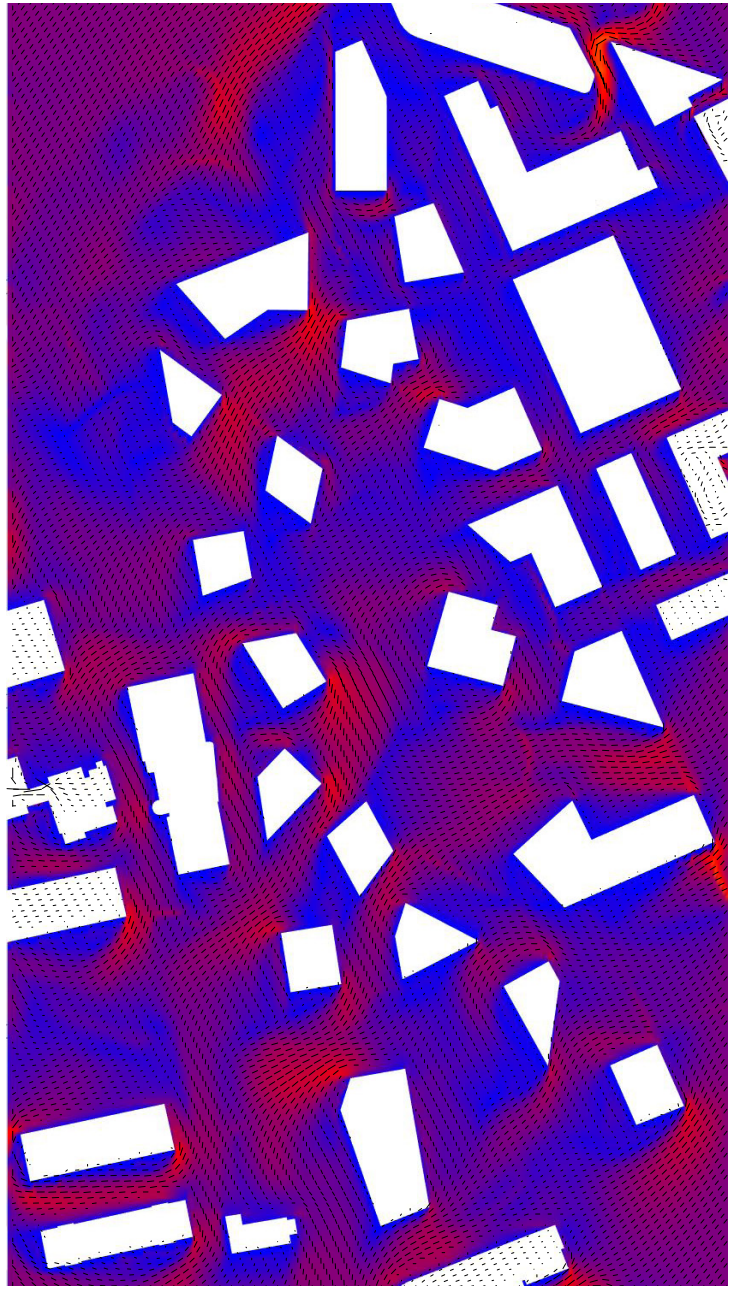


*Fig. 38*
*Wind simulation (north east wind source, 6m/s, height 2m) >*
*Fig. 39*
*Wind simulation (north east wind source, 6m/s, height10m) >*

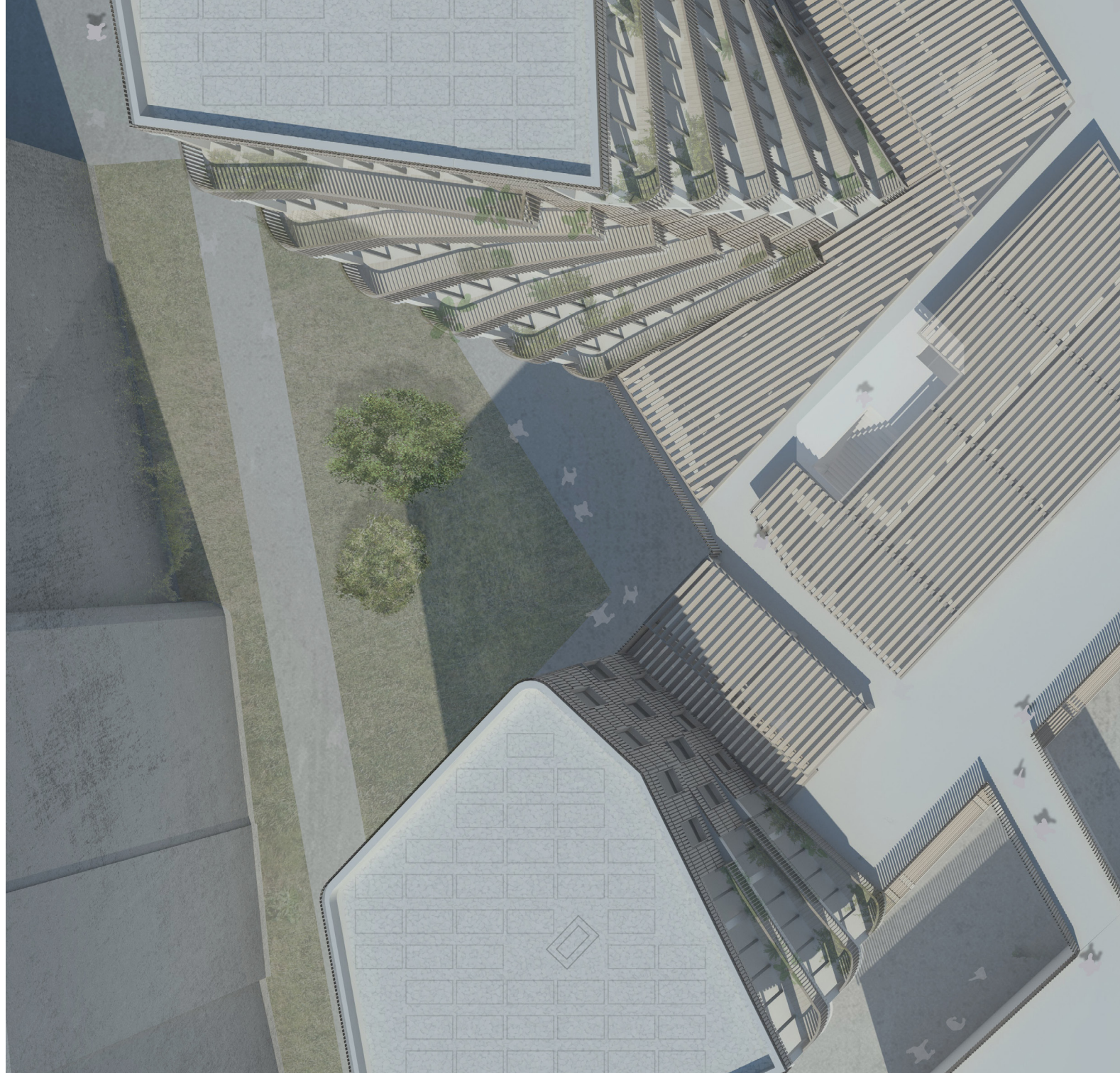
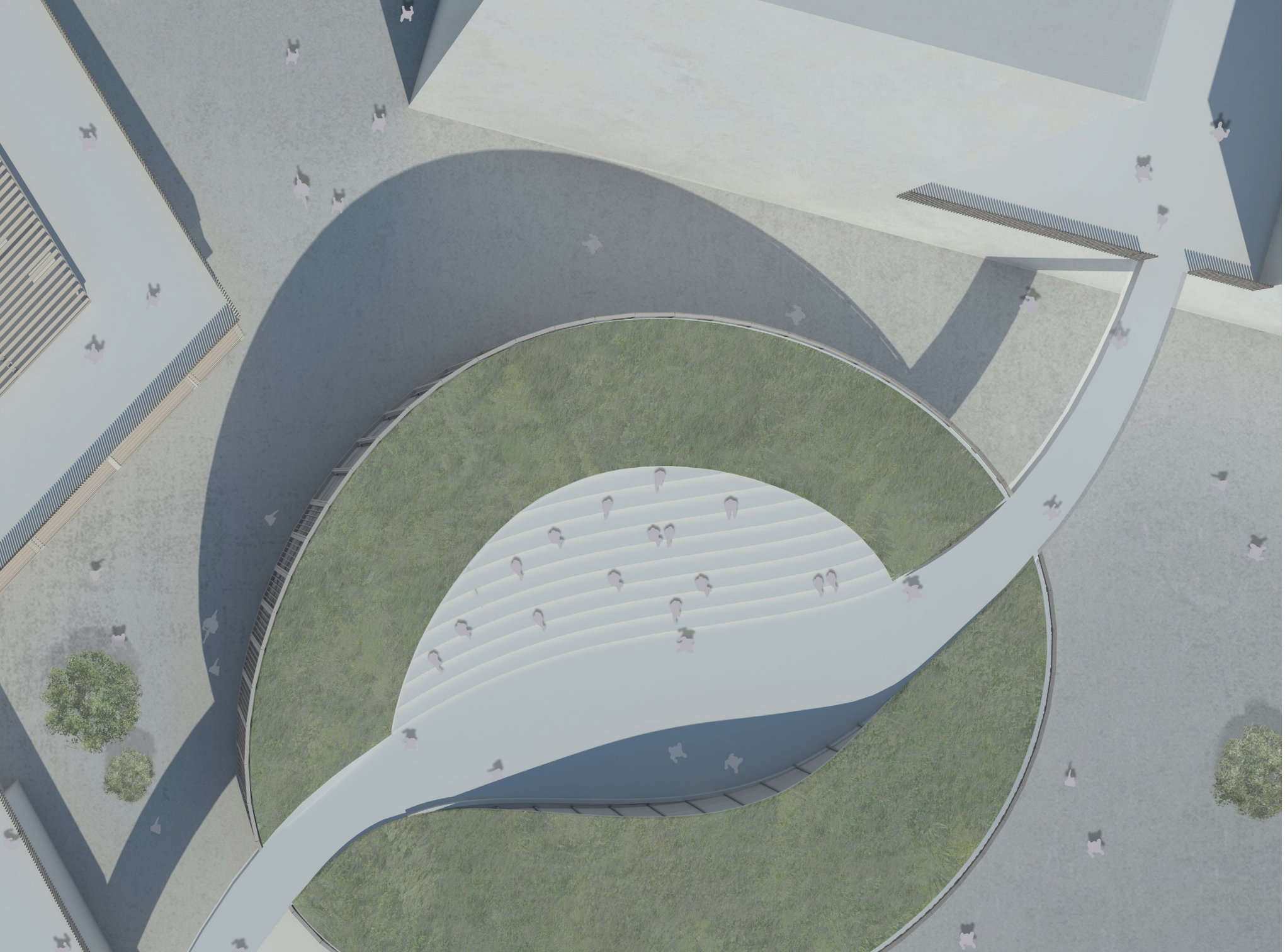


*Fig. 40 Top perspective >*

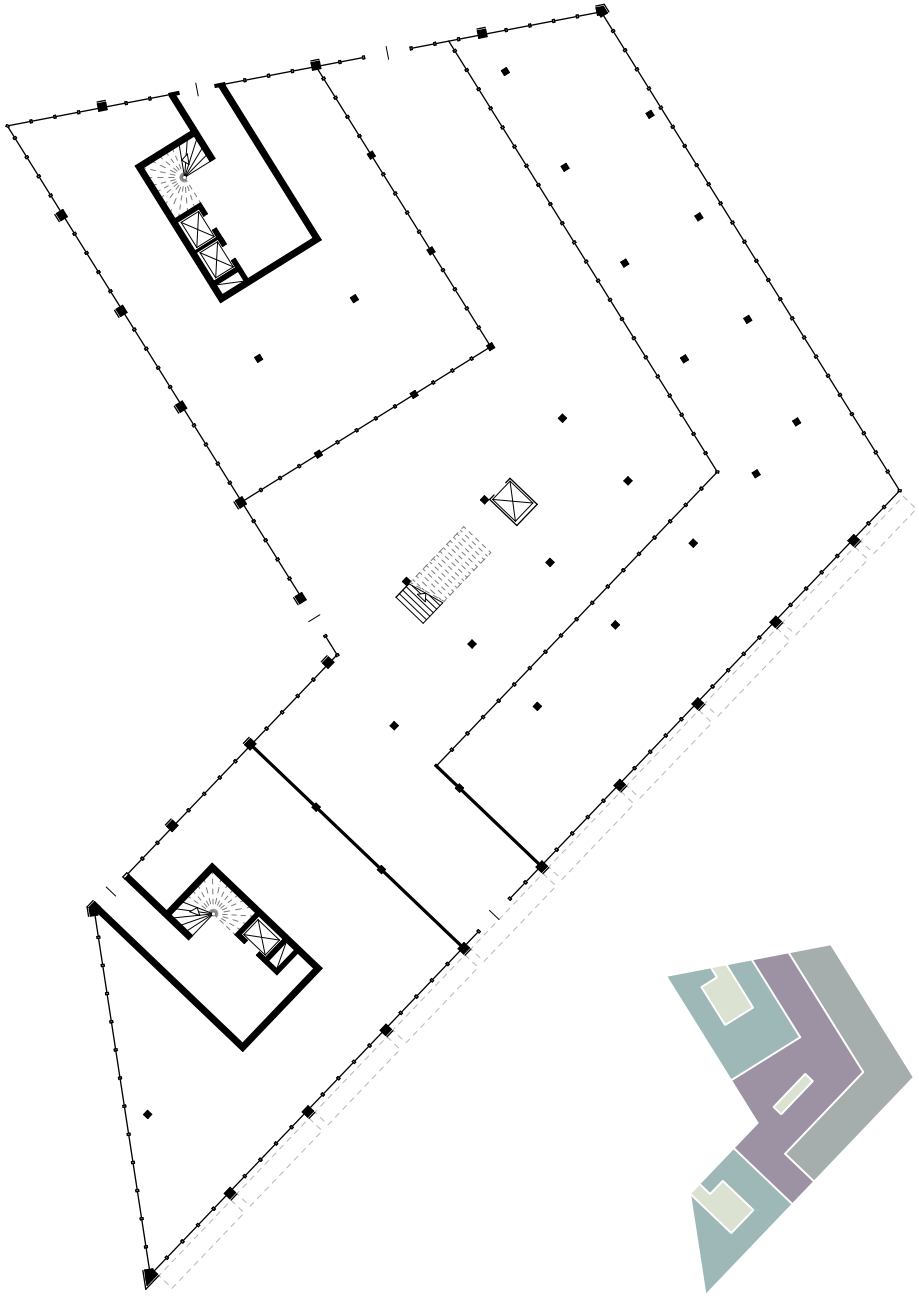


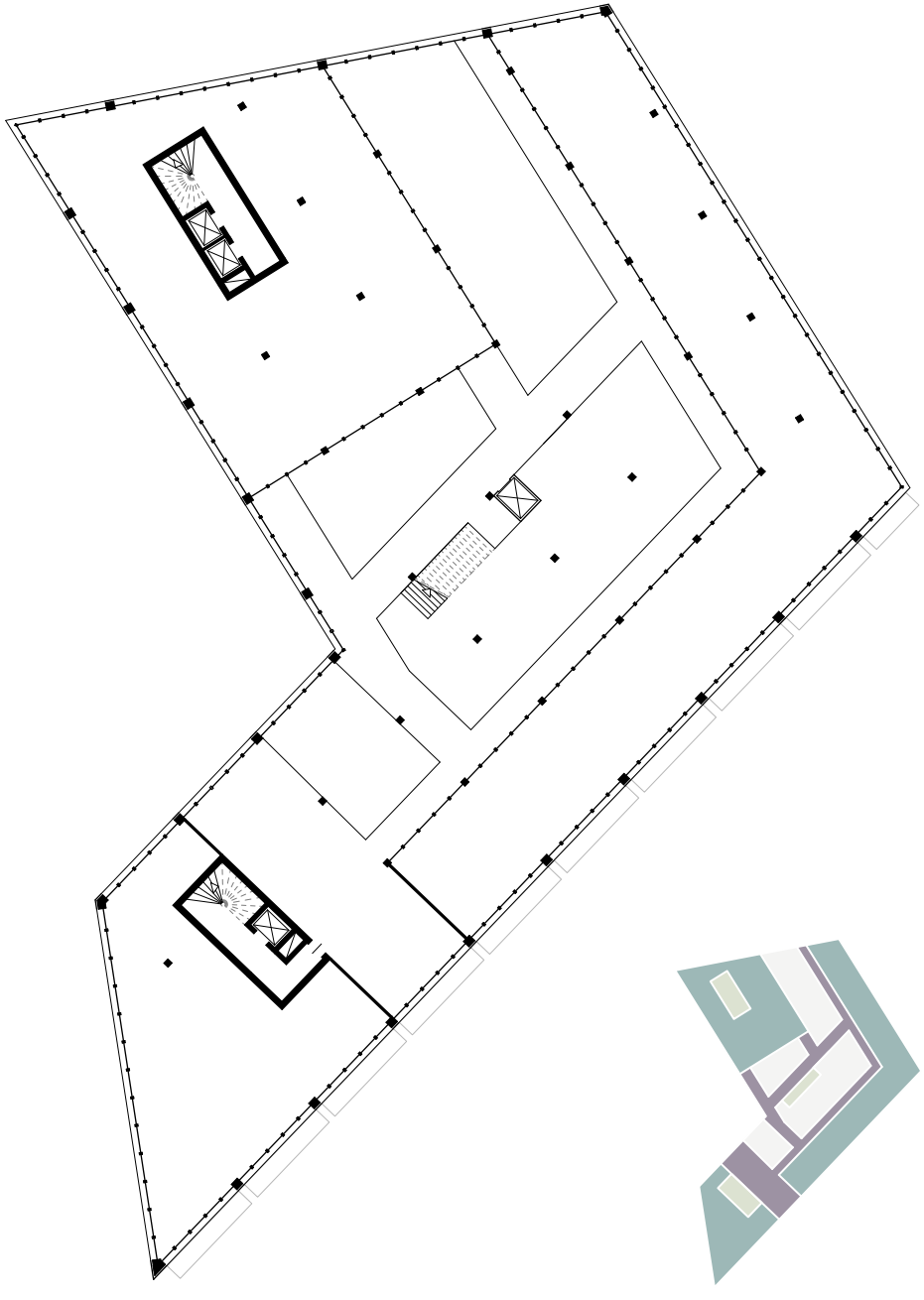
# 3. MIXED-USE TYPOLOGY

Program
Meeting Space
Shops
Offices
Apartments
Circulation

0 20 m

*Fig. 41 Ground floor >*
*Fig. 42 1st floor >*



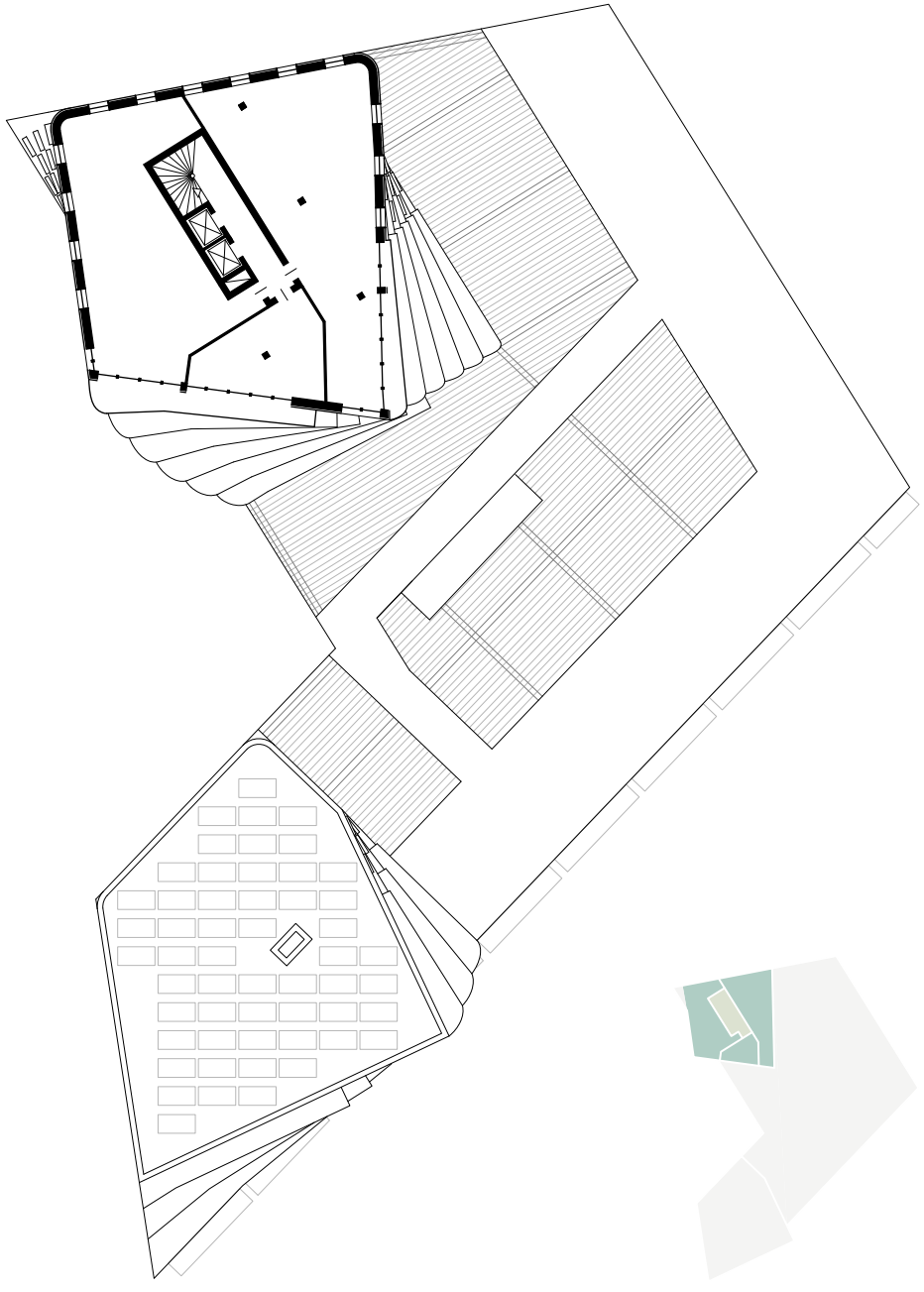


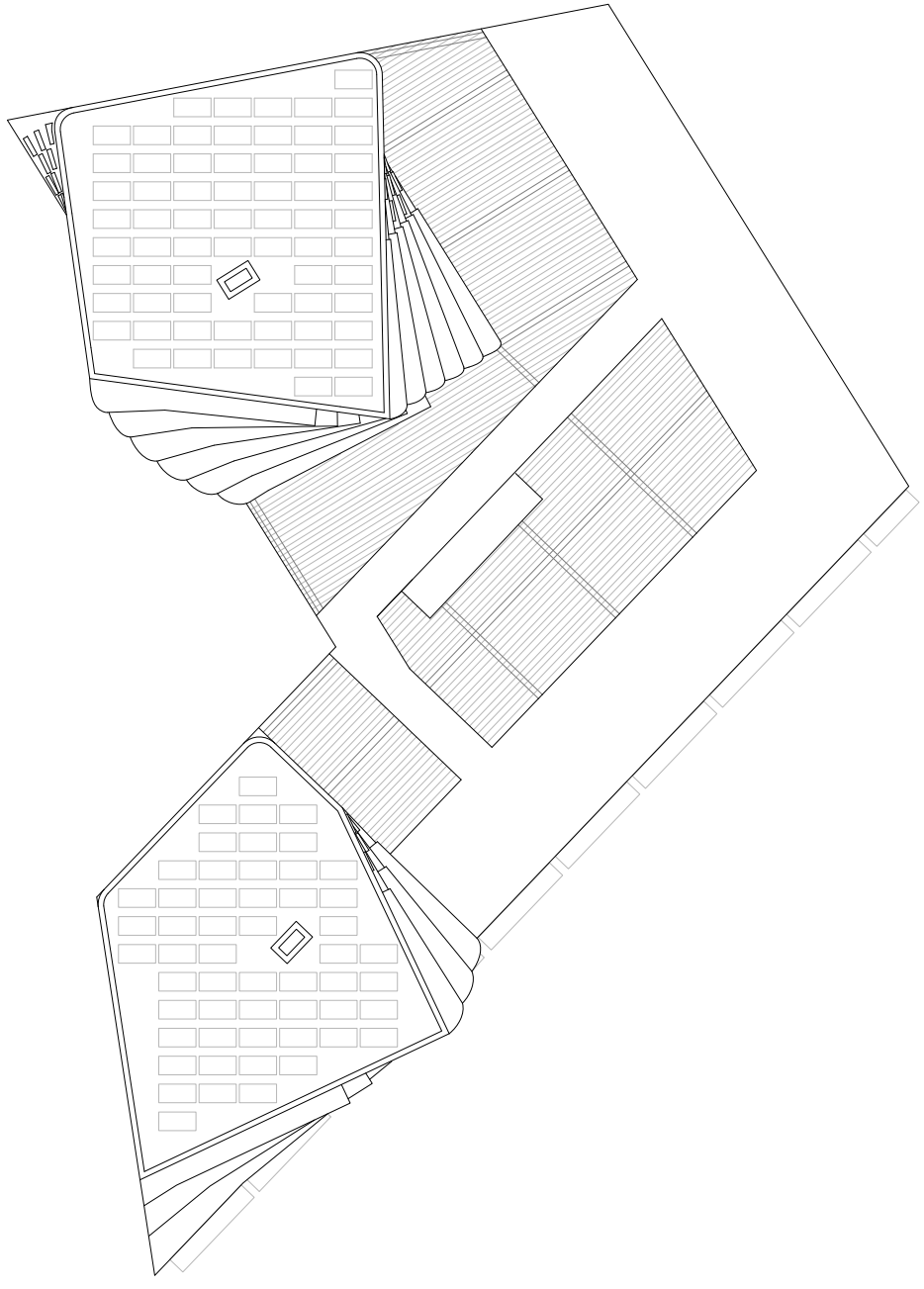


Program
Meeting Space
Shops
Offices
Apartments
Circulation

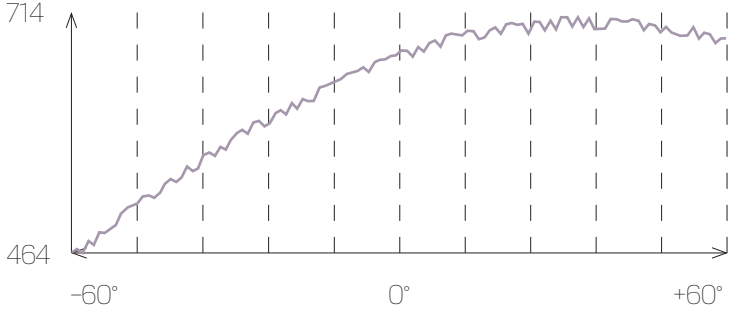
0 20 m

*Fig. 43 2nd floor >*
*Fig. 44 7th floor >*
*Fig. 45 Top view >*





# Orientation study




Top floor orientation : offers better daylight results for the apartments

Ground floor orientation : fits best for the urban composition and the structural grid of the office space

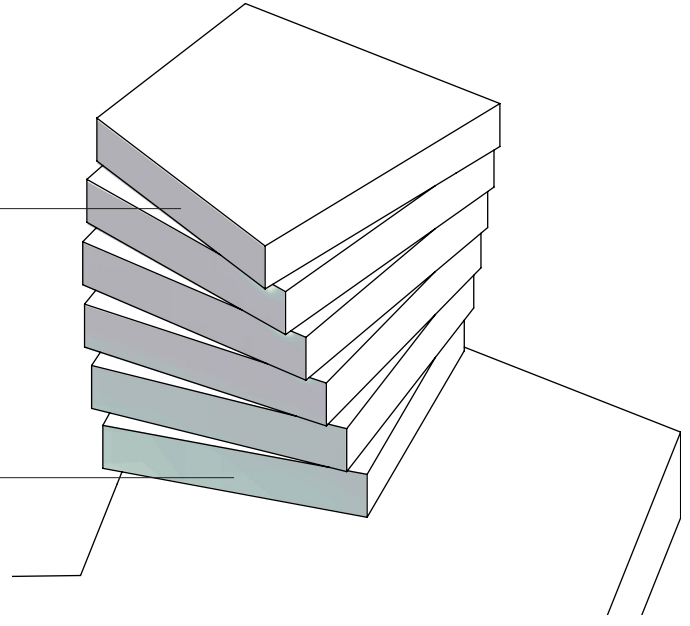
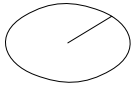


*Fig. 46 Impact of the rotation (annual radiation on the apartment floor in MWh/m²) >*
*Fig. 47 Floor orientation >*
*Fig. 48 Views from balconies >*



The rotation of the floors creates balconies.

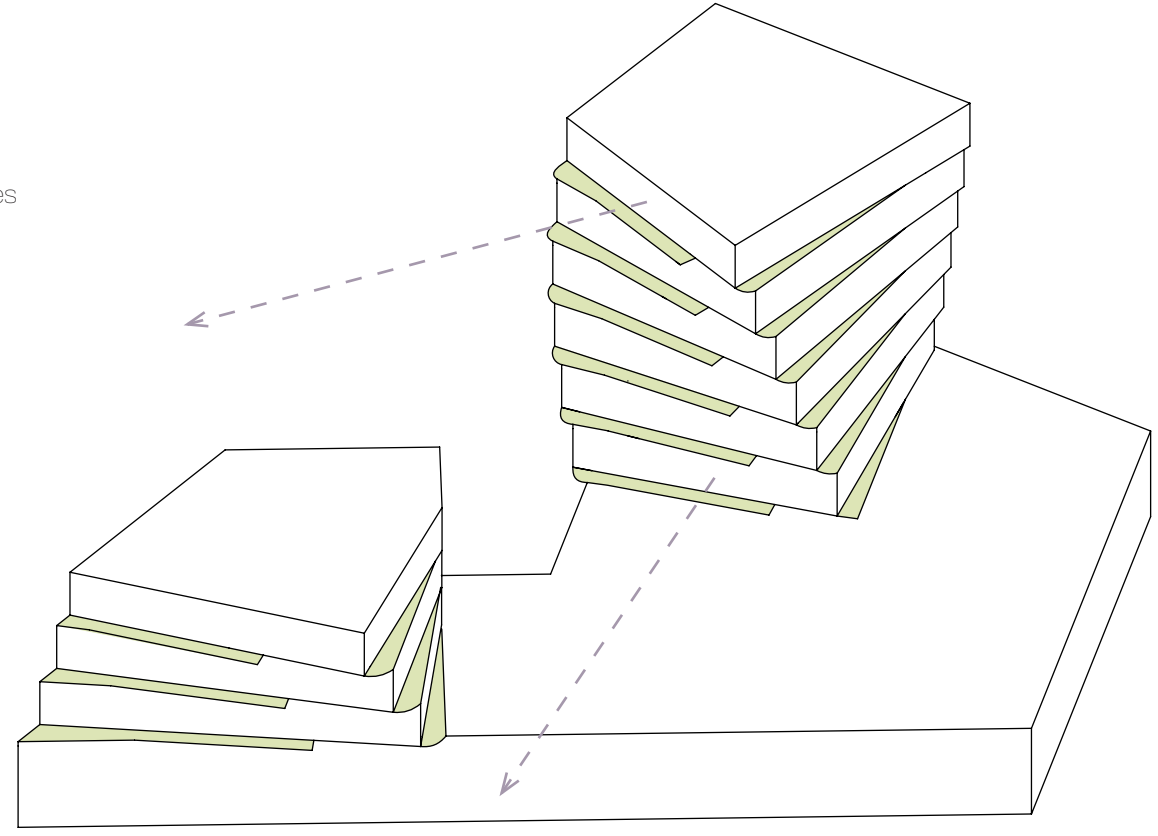



*Fig. 49* *South elevation* <
*Fig. 50* *East elevation* ∧

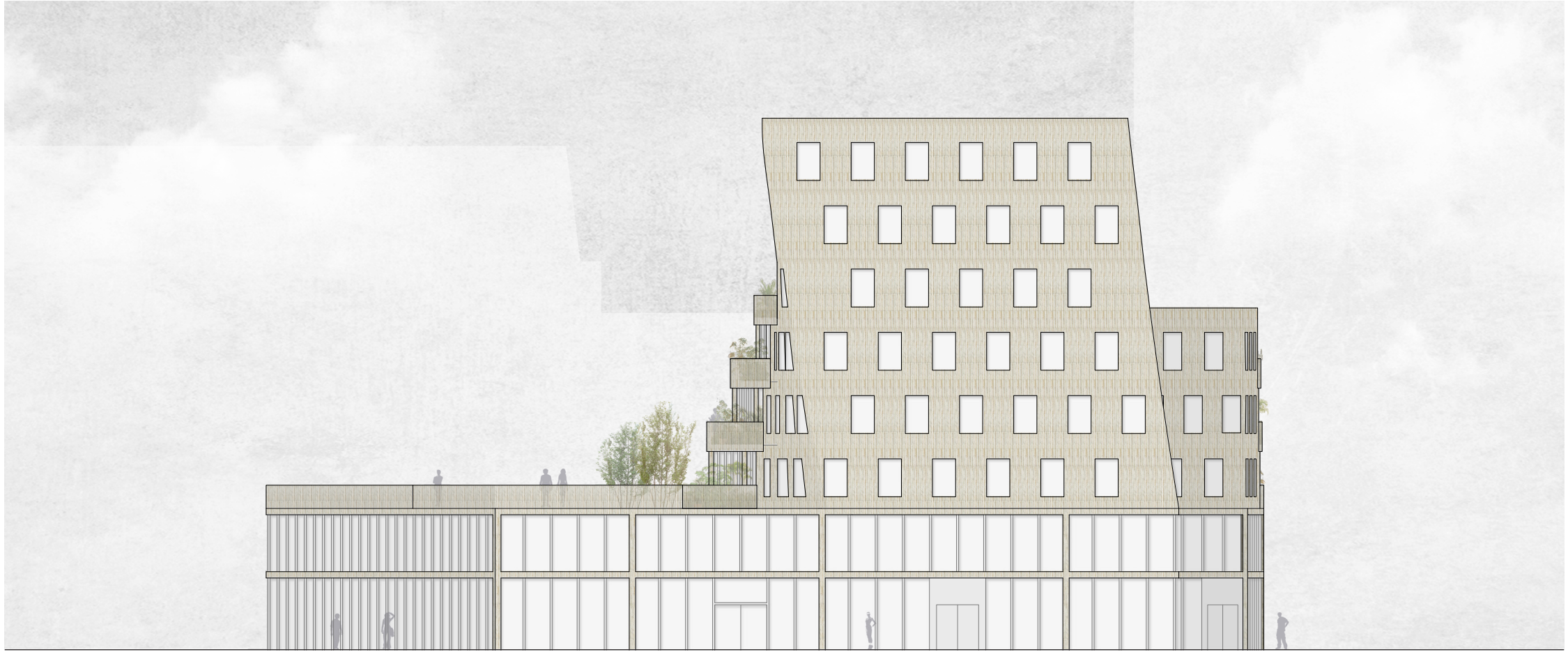



*Fig. 51* *North elevation* <
*Fig. 52* *West elevation* ∧

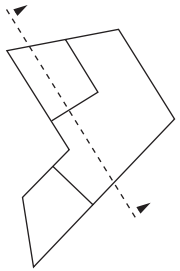
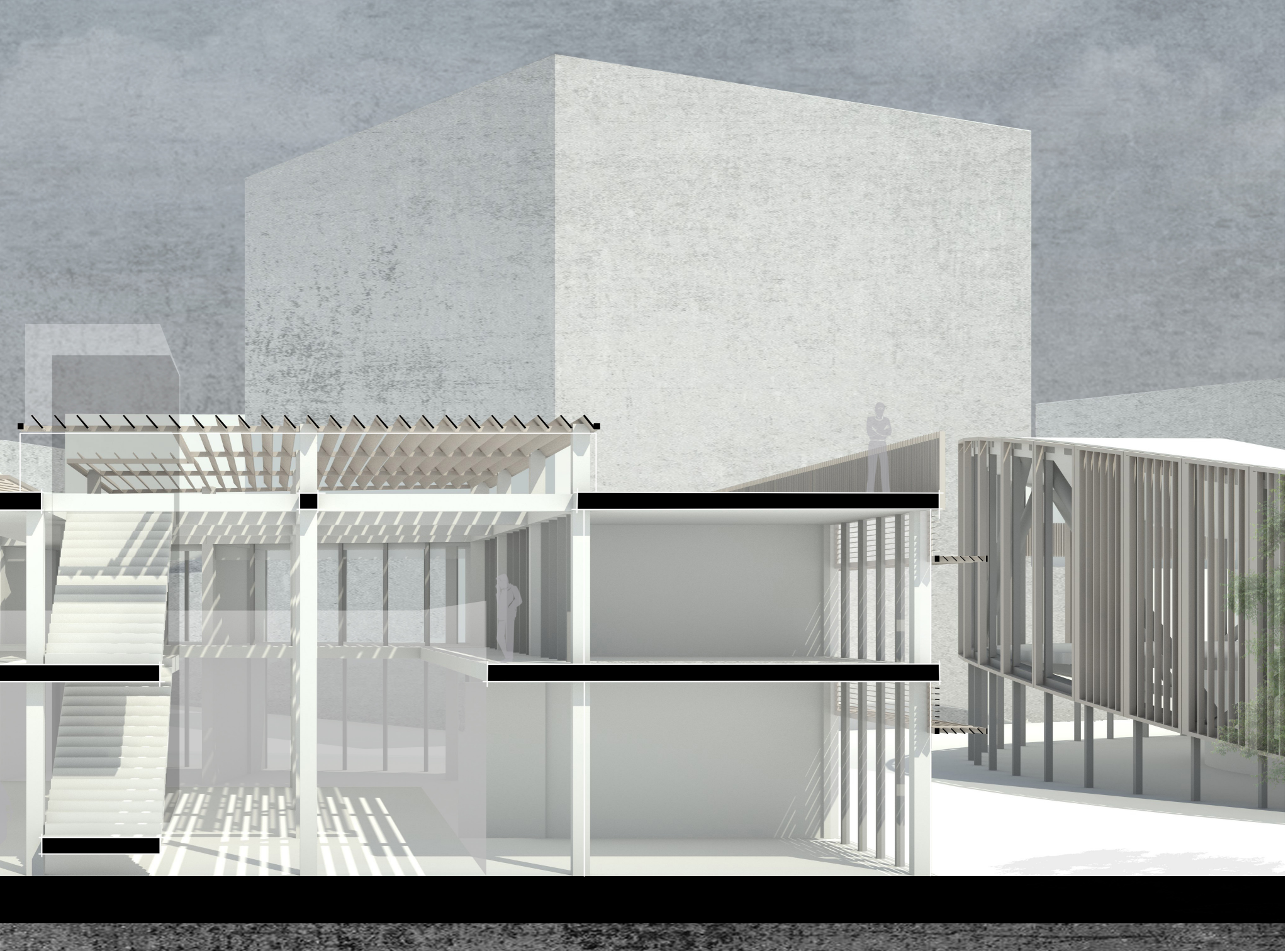


*Fig. 53 Section perspective atrium >*



# Energy section

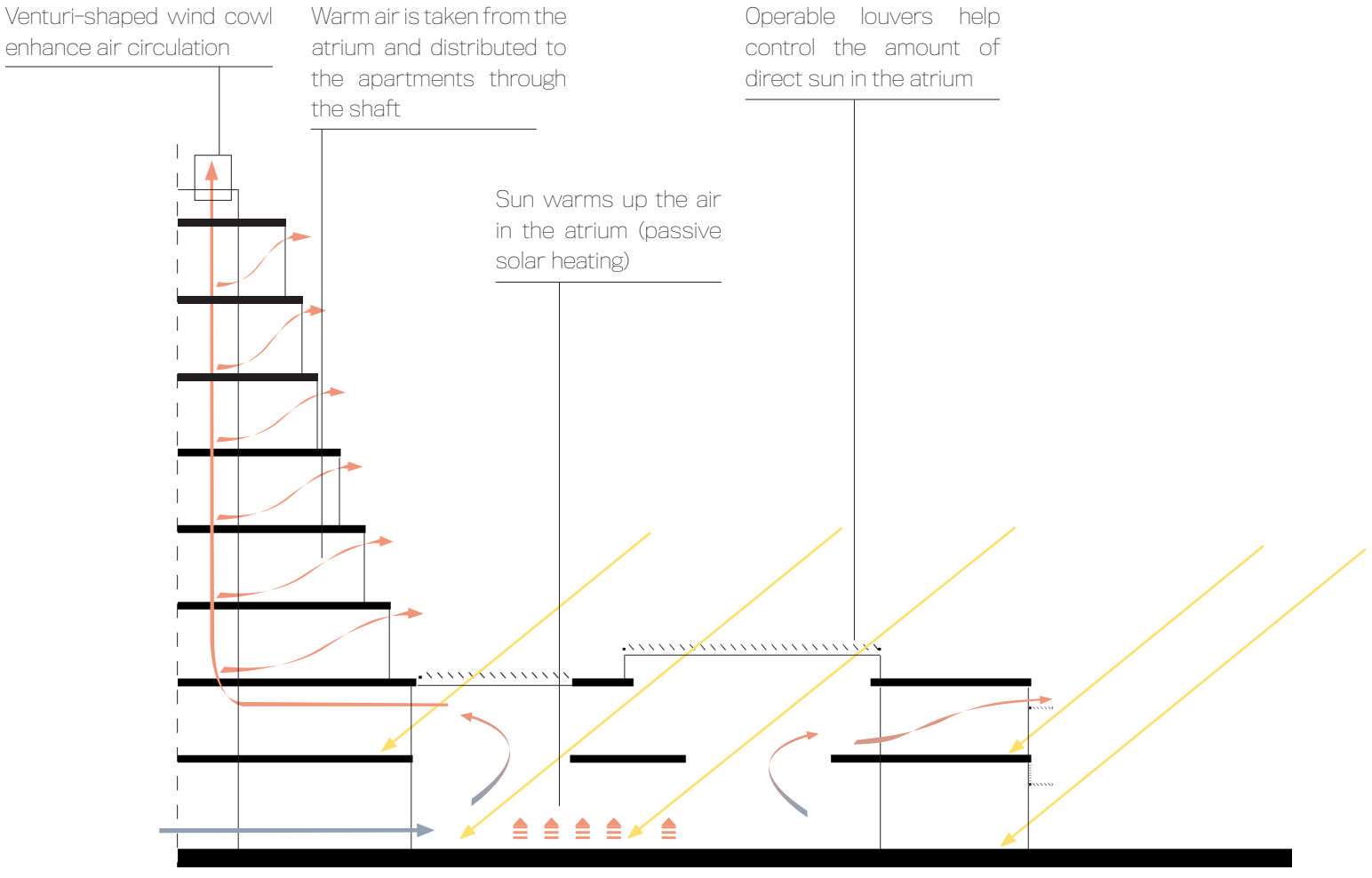
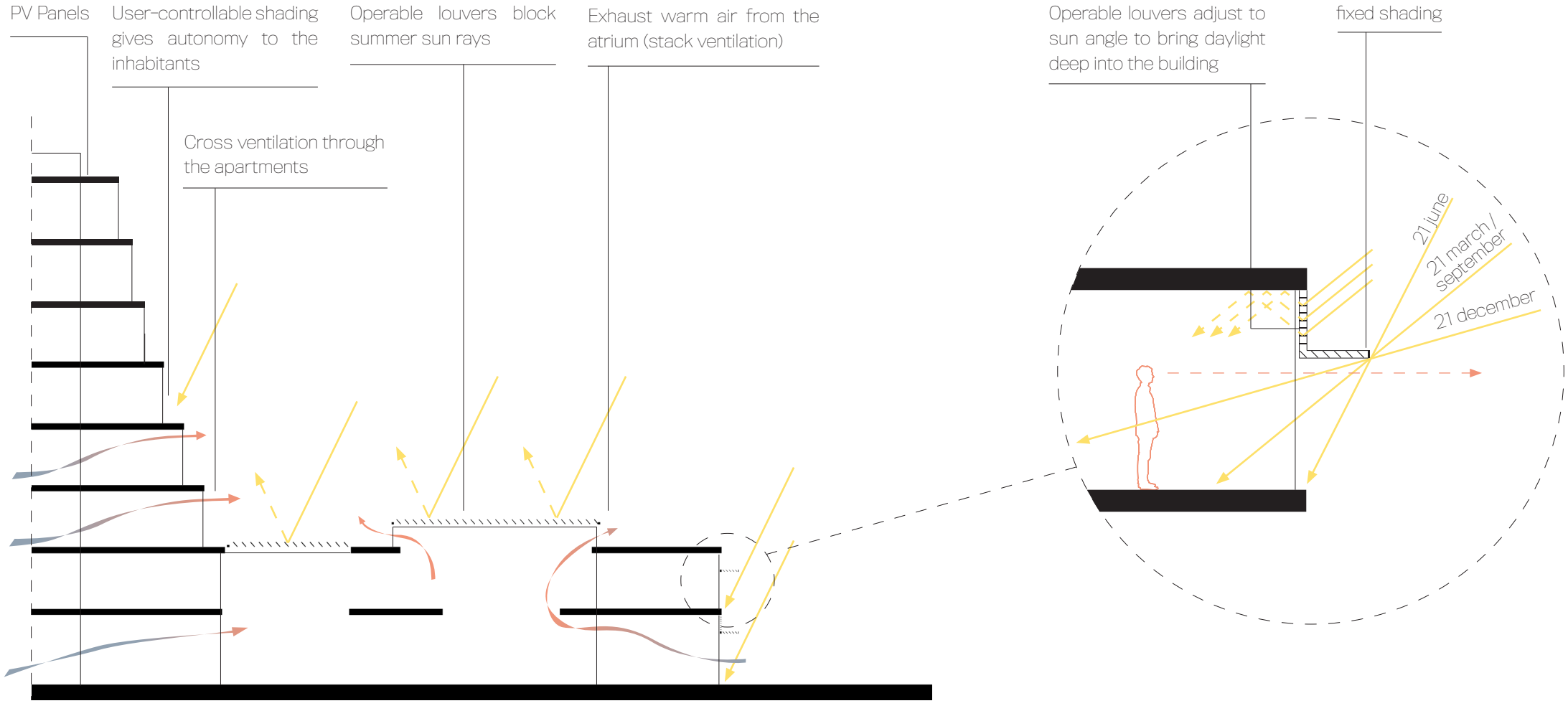



*Fig. 54 Energy section winter >*
*Fig. 55 Energy section summer >*
*Fig. 56 Shading office south facade >*


PV Panels
User-controllable shading gives autonomy to the inhabitants
Operable louvers block summer sun rays
Exhaust warm air from the atrium (stack ventilation)
Cross ventilation through the apartments
Operable louvers adjust to sun angle to bring daylight deep into the building
fixed shading
21 june
21 march / september
21 december

# 4. A MEETING PLACE FOR THE DISTRICT

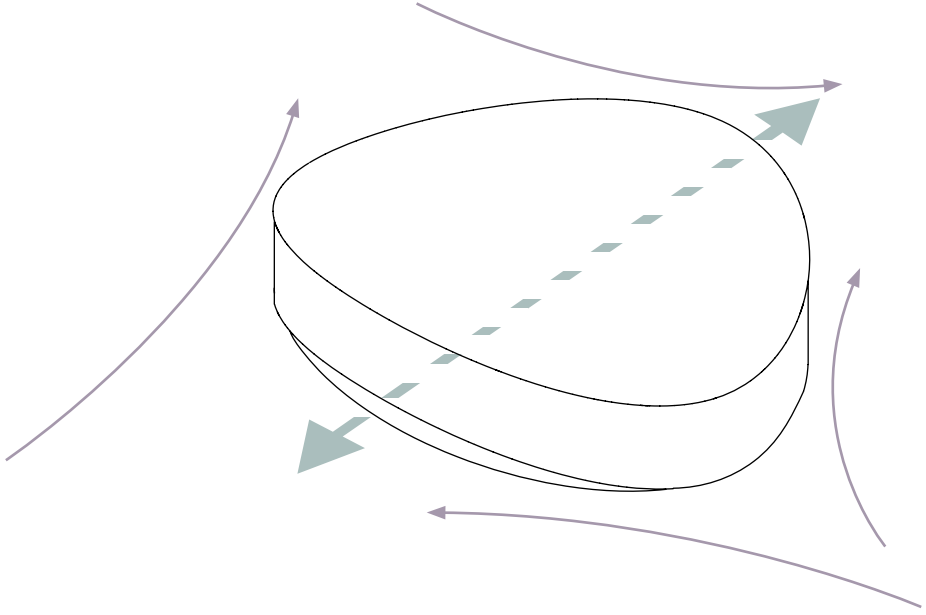


*Fig. 57*

# Relation to the urban space

The curvy form of the building enhances the flow of pedestrians. Due to the glass facade of the ground floor there is a visual connection between inside and outside.

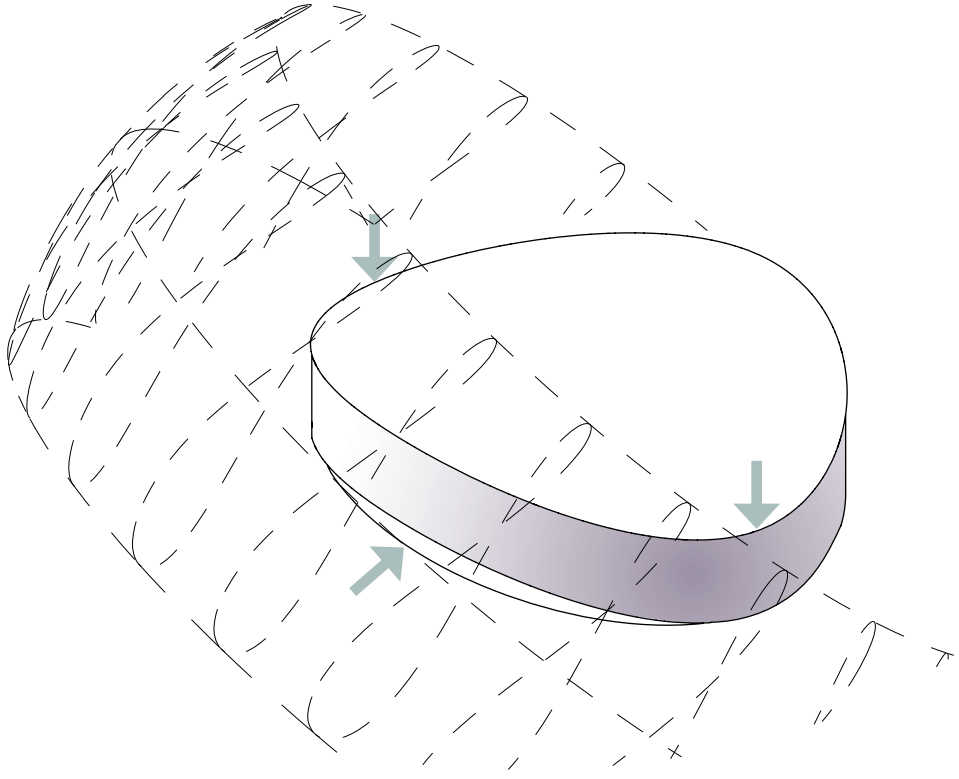


*Fig. 58*

# Sun path

To prevent the building from overheating, the lower southern glass facade is set back to be in the shadow during summer. On the east and west, where the sun is low, the upper facade is pulled down to shade the building.

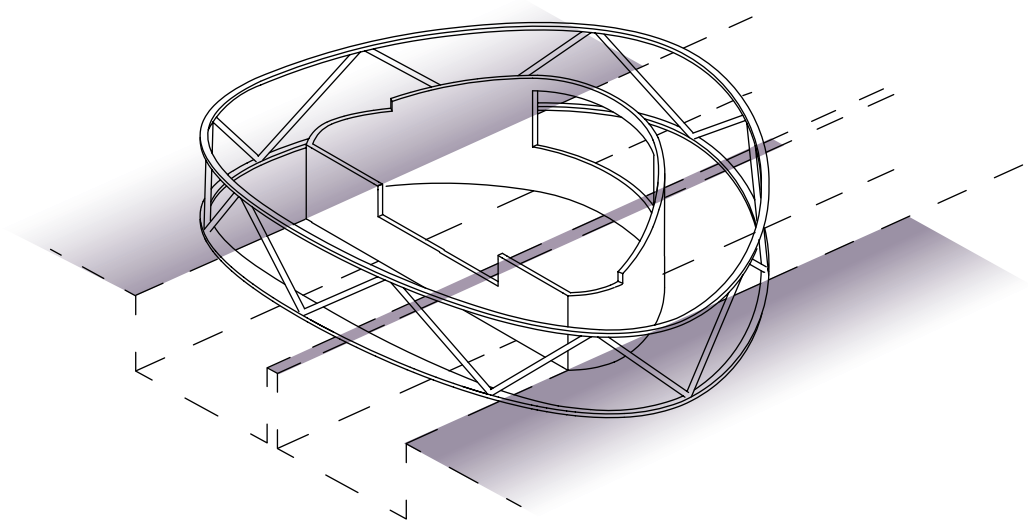


*Fig. 59*

# Structure

The truss structure spans between the walls of the ring road and leans on it on both sides.

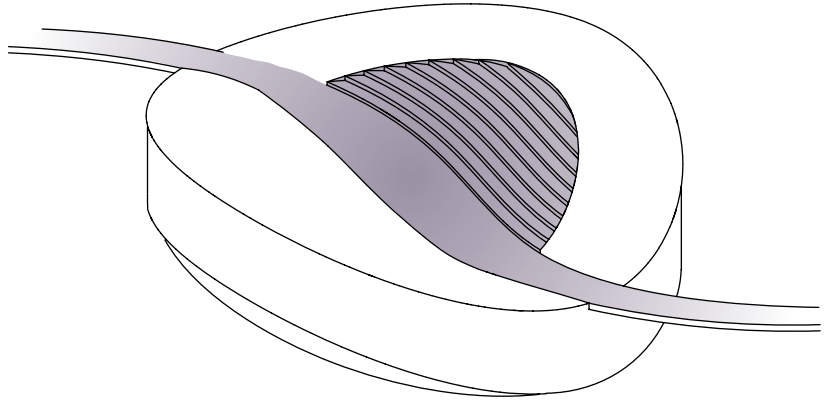
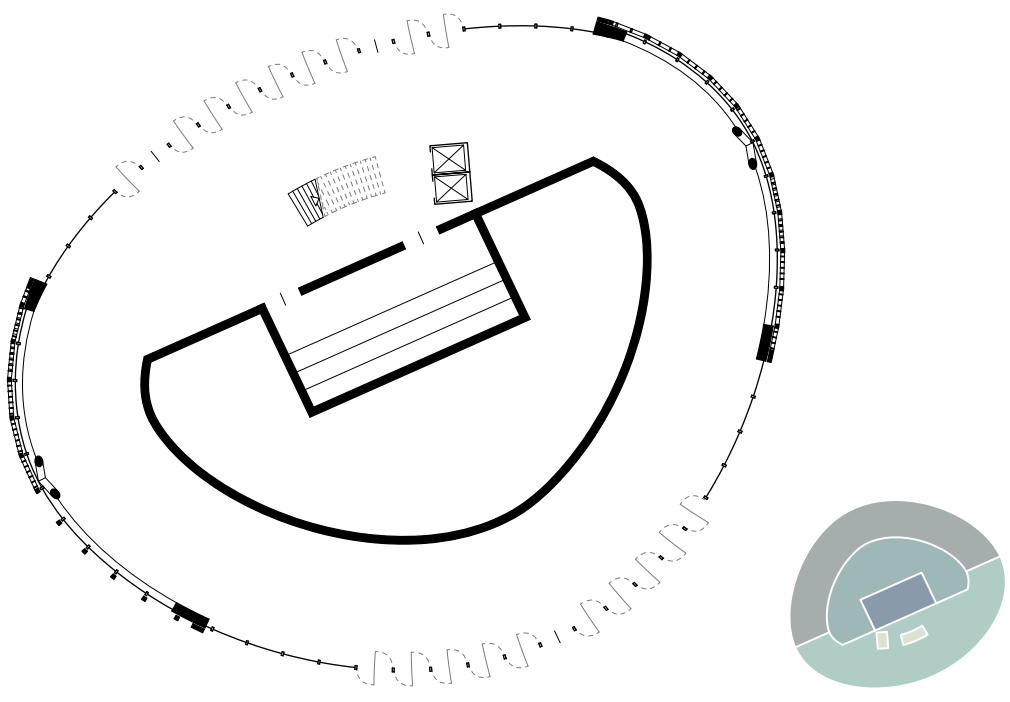


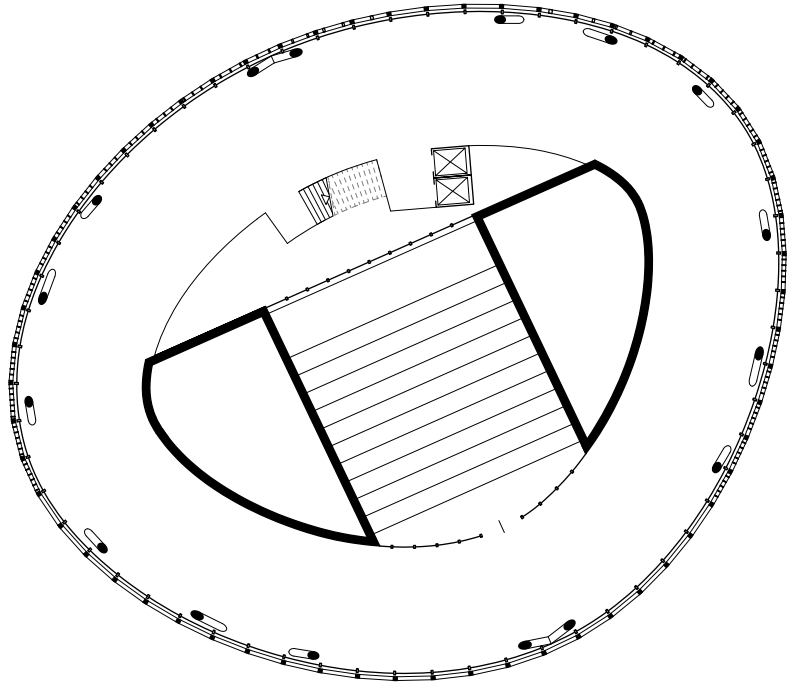
*Fig. 60*

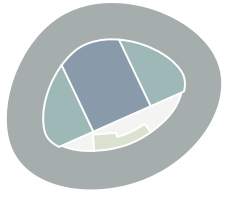
# Public rooftop

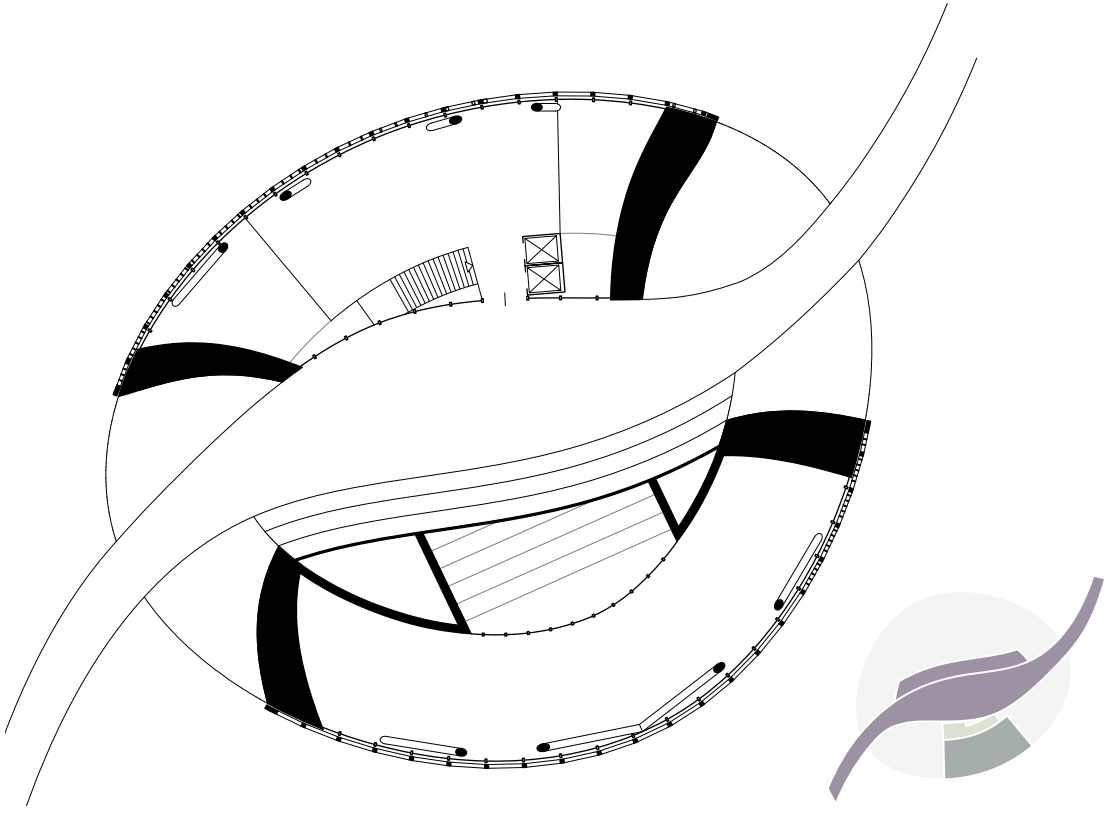
The roof is used as an outdoor public auditorium, which is accessible from the building and connected with the surrounding rooftops.

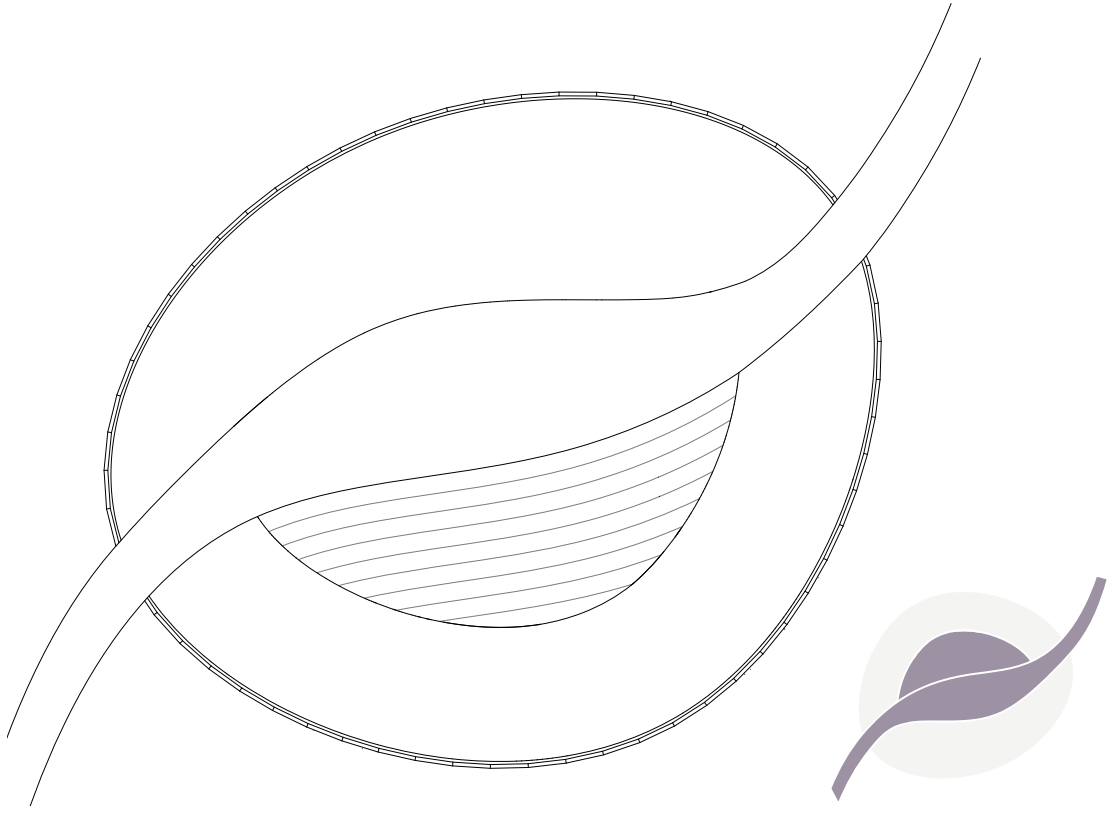












Program
- Meeting Space
- Library/ Media Center
- Facilities / Storage
- Cafe
- Circulation
- Auditorium

0 — 20 m

*Fig. 61 Ground floor <*
*Fig. 62 1st floor <*
*Fig. 63 2nd floor ∧*
*Fig. 64 Top view ∧*

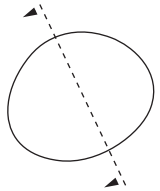
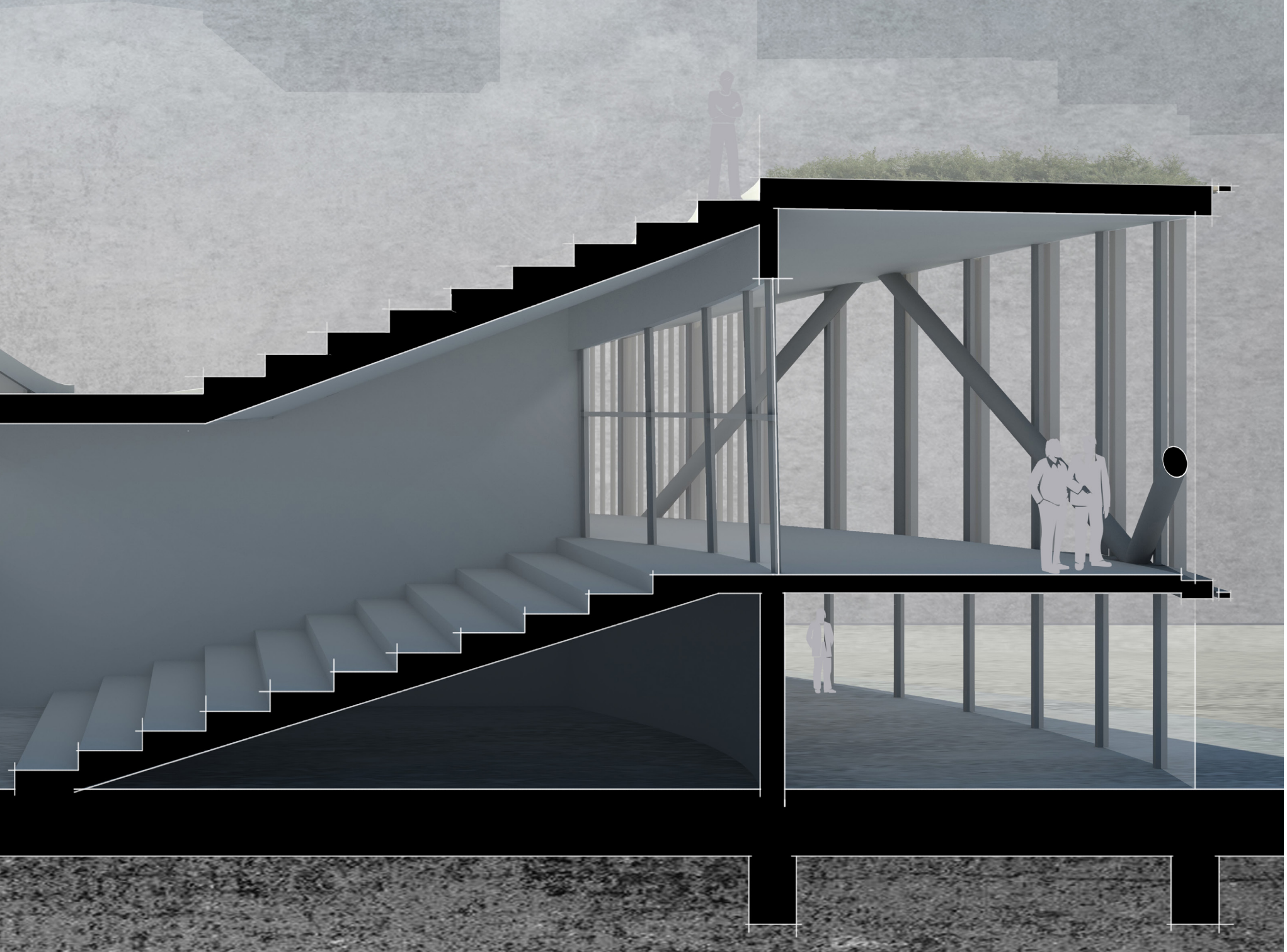


*Fig. 65 Section perspective >*



# Energy Section

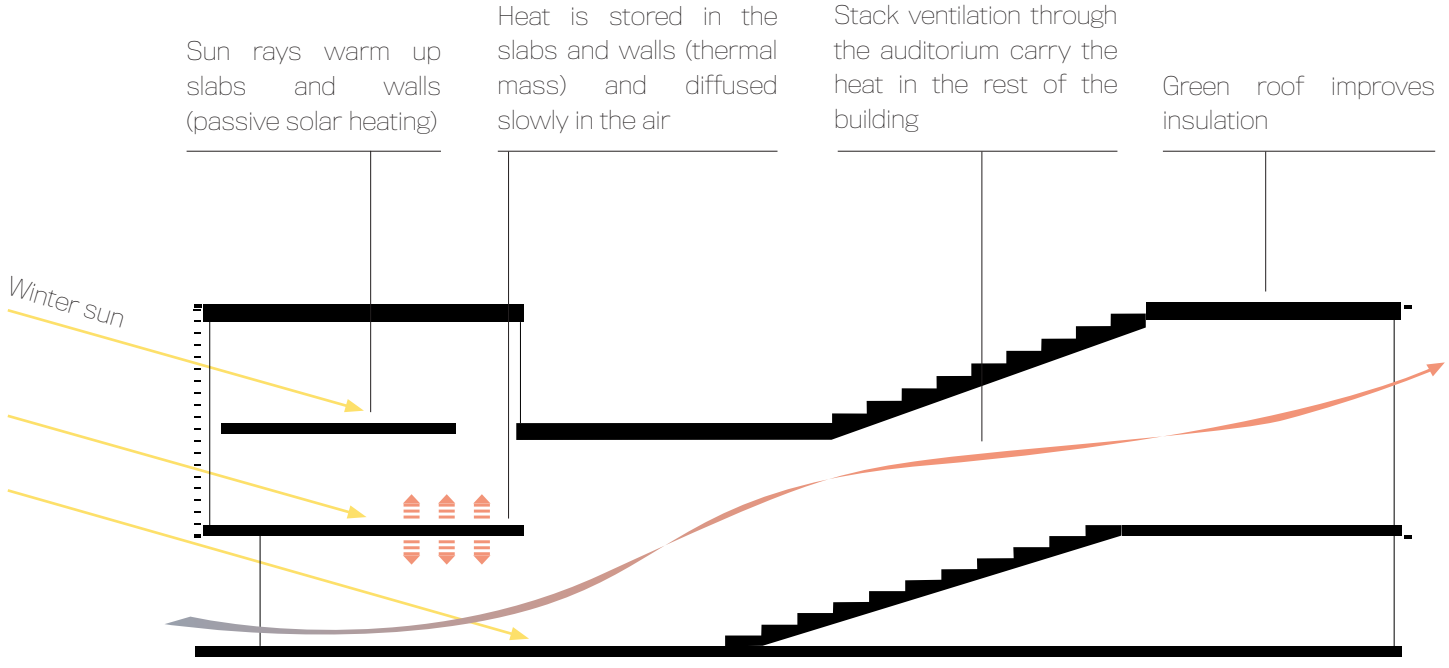
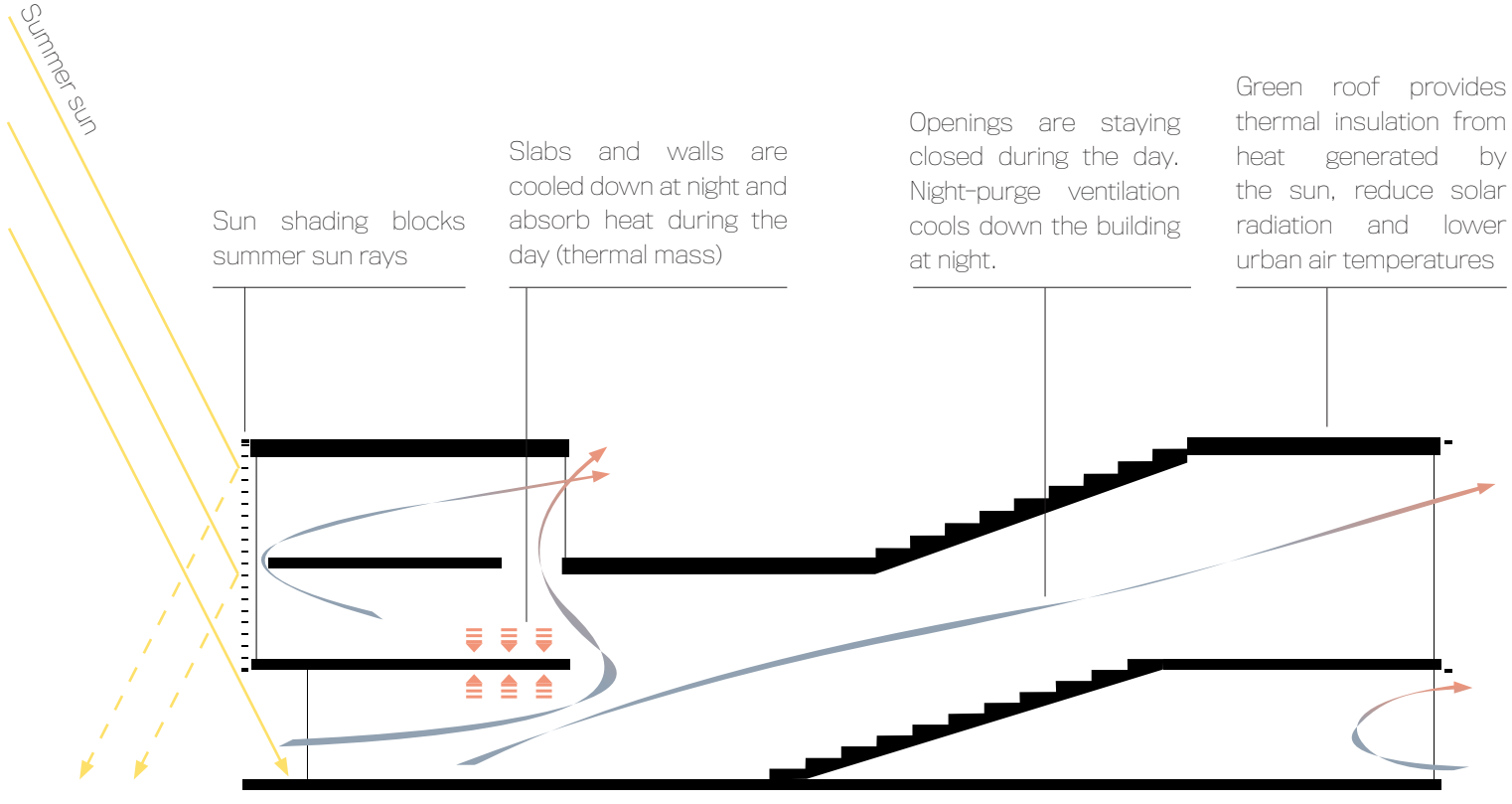



*Fig. 66 Energy section winter*
*Fig. 67 Energy section summer*

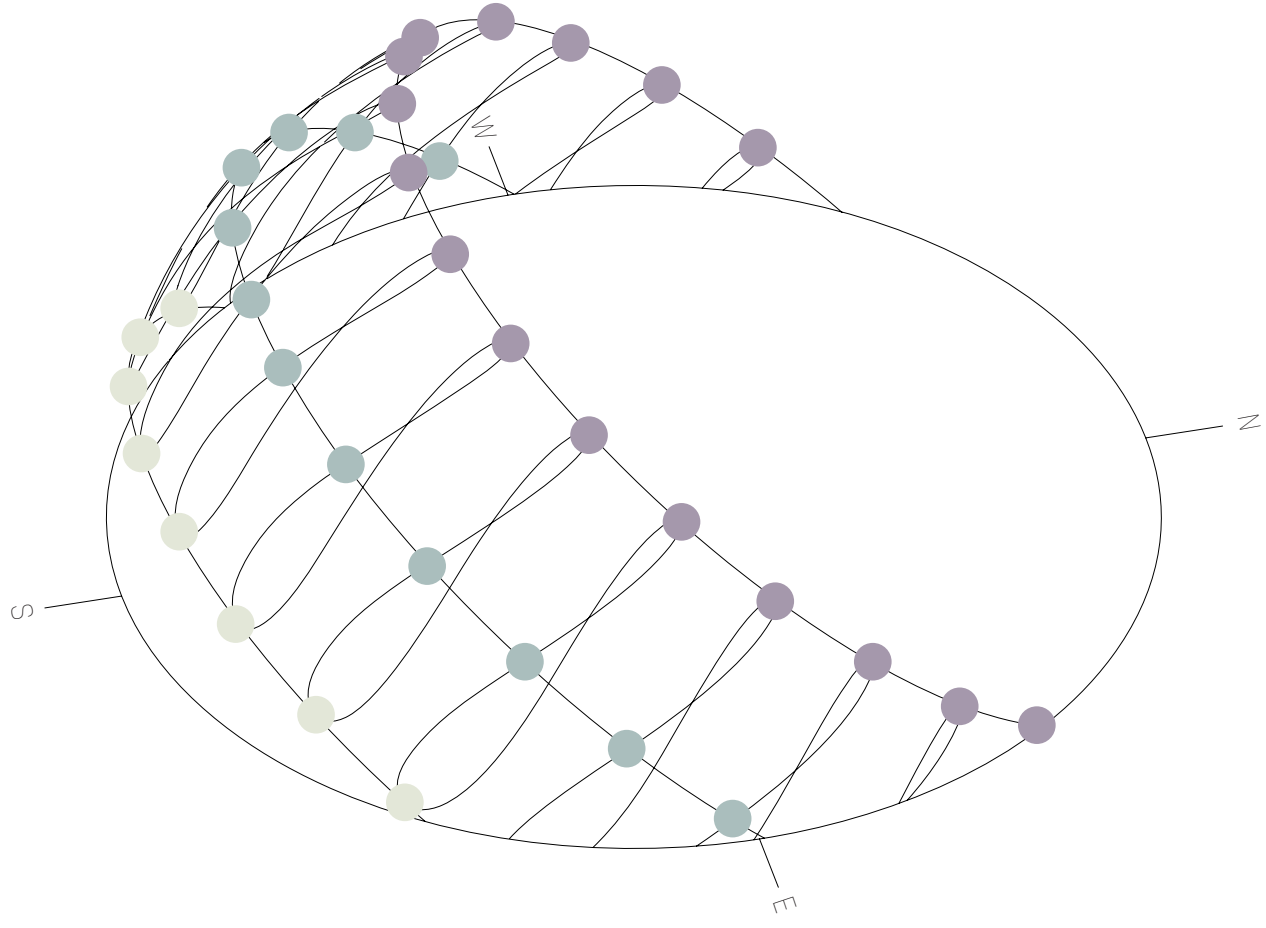

Summer sun
Sun shading blocks summer sun rays
Slabs and walls are cooled down at night and absorb heat during the day (thermal mass)
Openings are staying closed during the day. Night-purge ventilation cools down the building at night.
Green roof provides thermal insulation from heat generated by the sun, reduce solar radiation and lower urban air temperatures

# Sun shading

The purpose of the sun shading is to let the winter sun in the building while blocking sun rays in summer.

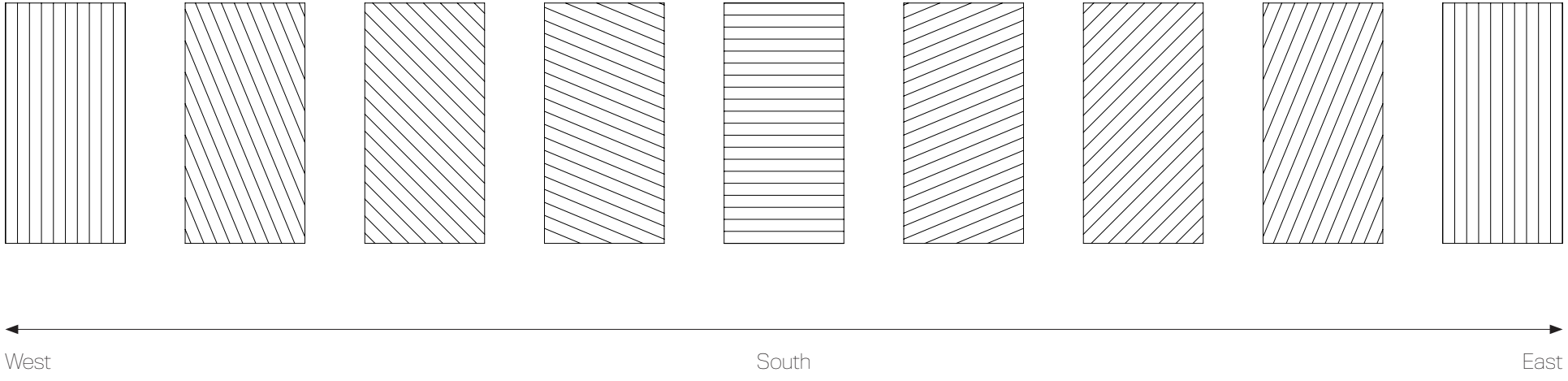
Blinds are typically placed horizontally on the south facade and vertically on the east and west facades. On this round building, the optimal orientation has been calculated for every panel.

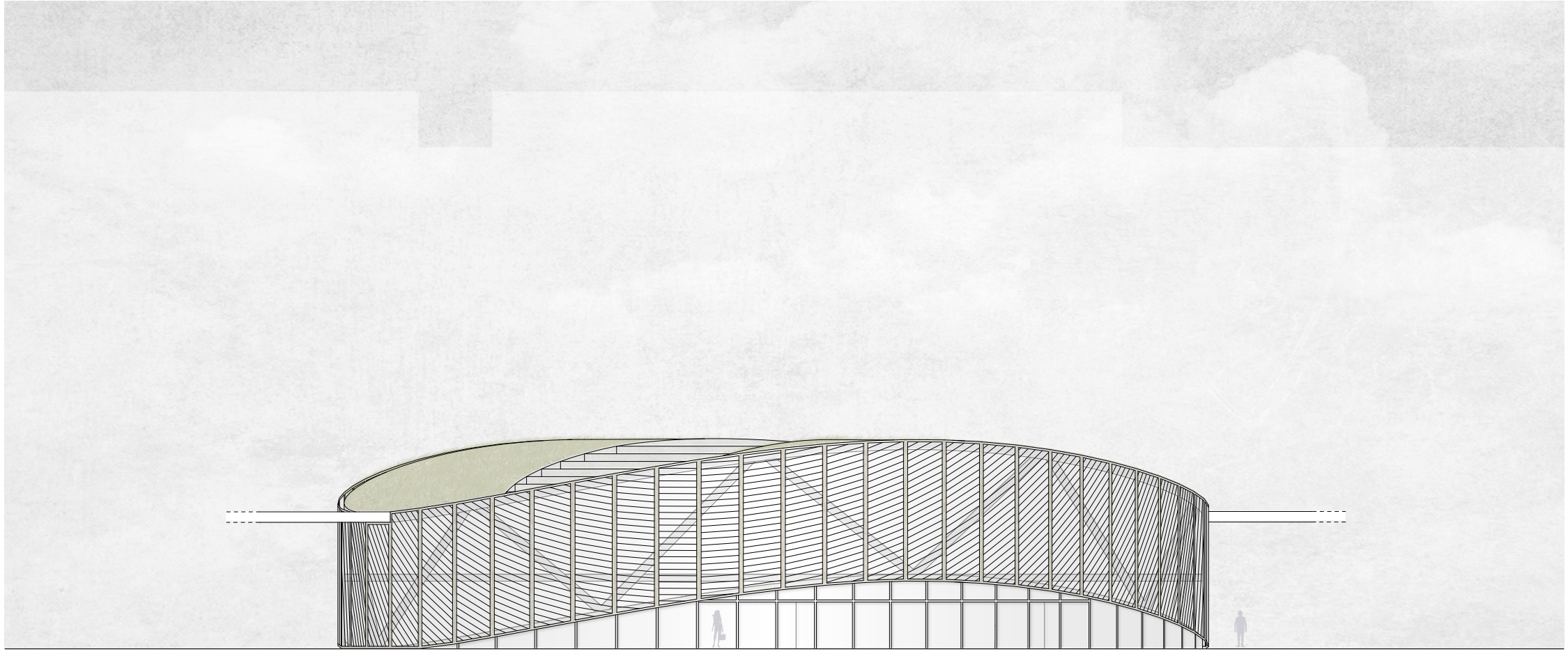
The shading system becomes the pattern of the facade.




Sun path 21st June
Sun path 21st September
Sun path 21st December

*Fig. 68 Sun path Paris >*
*Fig. 69 Shading system pattern >*


West
South
East



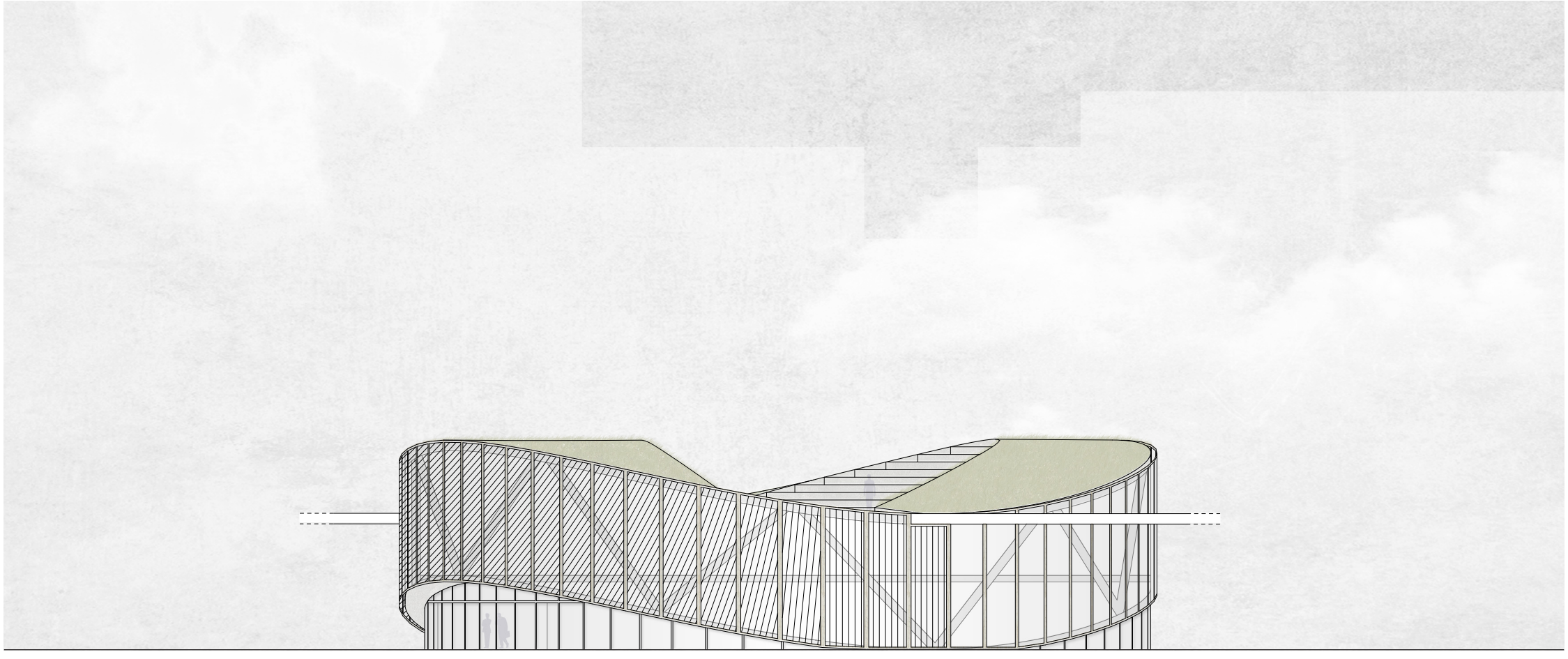
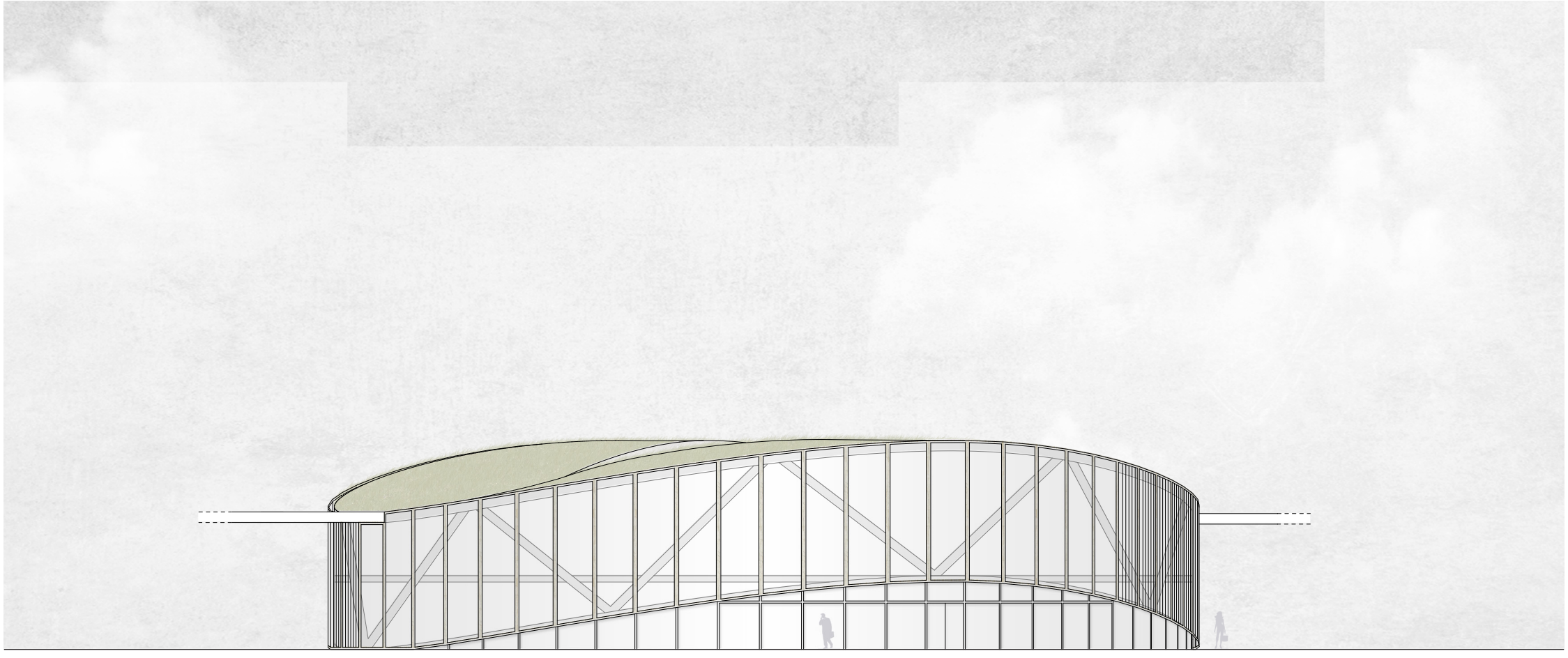



*Fig. 70* South elevation <
*Fig. 71* East elevation ∧



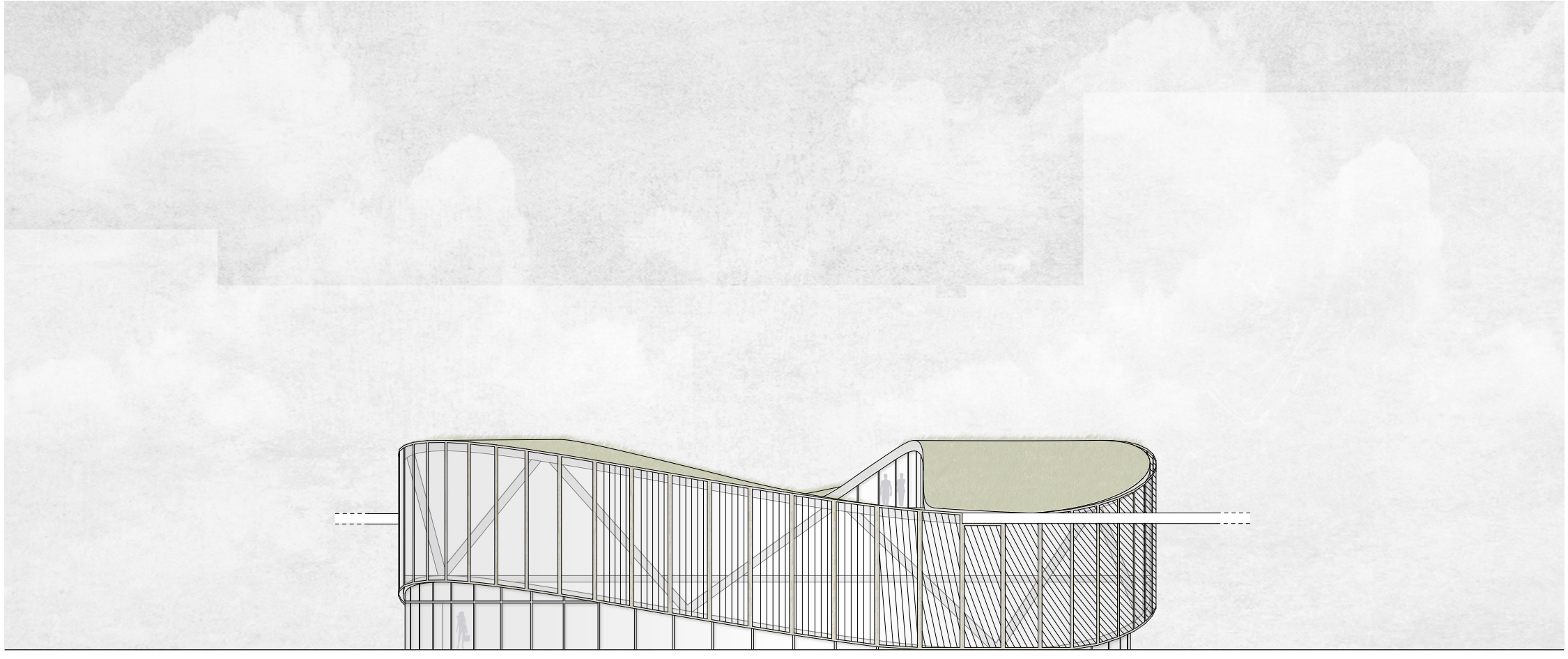



*Fig. 72* *North elevation* <
*Fig. 73* *West elevation* ∧

*Fig. 74 Perspective of the public rooftop >*

# CONCLUSION

The space above and nearby the ring road is a great opportunity to densify the city within its limits while improving the air quality and reconnecting inner and outer districts.

This type of development can only be a part of the solution to reduce air and noise pollutions in urban areas. It must be combined with other actions such as promoting and developing public transport, reducing speed limitations, using low-noise surfaces (30% of the ring road is already covered) or transition to electric cars.

Urban and architectural solutions have to be chosen locally for every part according to various factors: the ring roads relative position to the surroundings (underground, above ground), the type of program in the crossed areas (e.g. residential, business, landscape), the availability of ground on both sides to connect to the districts, the ability for public transport to increase its capacity, the financial costs, etc.

Such urban development can not be achieved without political will. In the last years, the topic of covering the ring road became more political with two visions confronting each other. A part of the political leaders wish to start the covering of the ring road in the near future and want to focus on improving the quality of life for the 100 000 inhabitants that are directly affected by the pollution today. The green party thinks this solution will prevent from thinking about a car free future for the city and suggest to rather transform it into an urban boulevard. A commission will be created later this year to further discuss the topic.

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*Fig. 39 Hugo Bernard-Lecharpentier. Wind simulation (north east wind source, 6m/s, height10m)*

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*Fig. 42 Hugo Bernard-Lecharpentier. 1st floor*

*Fig. 43 Hugo Bernard-Lecharpentier. 2nd floor*

*Fig. 44 Hugo Bernard-Lecharpentier. 7th floor*

*Fig. 45 Hugo Bernard-Lecharpentier. Top view*

*Fig. 73 Hugo Bernard-Lecharpentier. West elevation*

*Fig. 74 Hugo Bernard-Lecharpentier. Perspective of the public rooftop*

# THANK YOU

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