

MASTER`S THESIS



ESCAPE

HOTEL IN THE CITY

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ESCAPE

HOTEL IN THE CITY

MASTER´S THESIS

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AFFIDAVIT

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THANK YOU

First of all, i want to say thank you to Univ.-Prof.B.Sc.(Hons). CEng MCIBSE Brian Cody for guiding and supporting me through creation of this thesis.

Secondly, big thanks to great assistant Mast.arh Aleksandar Tapavcevic who gave support just in time when it was mostly needed.

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INTRODUCTION

This master thesis will engage in topic how to build energy efficient hotel and in the same time provide beautiful city-boutique hotel with recognizable design full with greenery.

Interesting about this projects is that whole sight is currently under construction and only few of buildings from Master plan Smart city Graz are built or finished so it is making whole project more challenging.

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HOTEL

INTRODUCTION
HOTELS THROUGH HISTORY
HOTEL TYPOLOGIES
CITY-BOUTIQUE HOTELS

At a time when global world development was reaching great wideness in every sense, some things remained almost the same as from the time of ancient Greece. Furthermore engineering and architectural facilities are growing with each day and hand in hand with that fact are growing also architectural wonders. Great hotels have always been something that fulfilled travelers and successfully enabled jumping from one world to another. From the ancient time basically hotel function remained the same- lodging but everything other has changed. Hotels have gained lot of other functions, opportunities and categories. Nowadays there are lot of influencing factors that are making some hotel more successful and profitable than others: marketing, enterprise, location, planning and design and economics.¹ Moreover hotels have become a matter of prestige, so the owners in order to make it more attractive are hiring some of the most famous architects known as "starchitects" in order to attract more attention. As it was in history, race has still the same point, that every new hotel has something what previous didn't have had. Short historical overview will be shown in next chapter.



Figure 1. Marina Bay Sands-Safdie Architects

¹ Penner/ Lawrence/ Robson, 1995, 23-24.

HOTELS THROUGH HISTORY

500 BC

First resorts at mineral and hot springs in Greece, Mansions built along Roman roads

Middle ages

Manorial lords and monasteries sheltered traveler, Hospices built as hospital and shelters for travelers, some Inns developed in larger town (no meal), Rooming houses used as relay stations for rest stops, changing horses etc

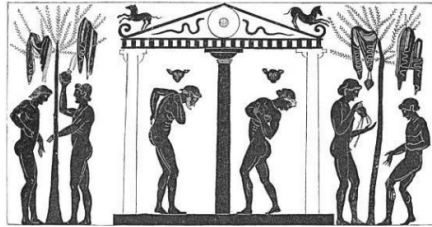


Figure 2. First resorts at mineral and hot springs in Greece



Figure 3. Marina Bay Sands-Safdie Architects



Figure 4. Tremont House, Boston



Figure 5. Fifth Avenue Hotel, New York



Figure 6. Postcard from Coney Islands, New York



Figure 9. The Ritz Condominium, New Jersey



Figure 8. Holiday Inn, Topeka, Kansas



Figure 7. The Ritz Hotel, London

2000s

Many chains developed boutique (or "lifestyle") hotel brands to compete with independent design-centric hotels, Hotel chains introduced the lobby "great room" concept, encouraging socialization among guests, tub/shower combination, Suites became more common, especially in resort destinations

2010s

Hotels introduced smart-phone applications for check-in/out and use as room key..

1980s

Airport hotels, conference centers, all-suite hotels, vacation villages, health spas, marina hotels, ski lodges, time-sharing and condo resorts developed rapidly

1970s

Airlines became active in hotel development through subsidiary chains, Luxury condominiums developed offering hotel services

1960s

23,000 hotels, 40,000 motels, and 170 chains operated in the USA, Resorts developed in Spanish Mediterranean, Portugal, Balearic Islands, Scandinavia, Greece, and Yugoslavia

1950s

Hotel boom #2 generated by expanded education and mass travel, Holiday Inns was first motel chain with large rooms, casino hotels, airlines began developing hotels

1940s

Flamingo in Las Vegas was first casino hotel,

1920s

Hotel boom #1 generated by economic prosperity, complex connecting five hotels,

1910s

Kahler Hotel in Rochester, Minnesota, was first medical hotel, first early mixed complexes, first scheduled airline

1100s

Travel become safe in Europe, Inns prospered with freedom, The Tree King opened in Basel earliest Inn still operating

1200s

Guest houses, courier mail stations opened in China and Mongolia, Cour ST. Georges Inn opened in Ghent

1300s

English country Inn developed, some Inns in London, Castle Inn found in Somerest, England

1400s

French law required hotel register, English law established regulations for Inns, The Krone Inn in Switzerland

1500s

European spas revived in Carlsbad, using Roman road system; teams changed, carriages checked, and travelers rested at posting houses

1600s

Hotel industry developed in Europe with well-placed and reliable cuisine

1700s

Industrial revolution stimulated hotels in England, Europe, and America; resorts developed Corre's Hotel and City Hotel in New York were first downtown hotels

1800s

Luxury "swagger hotels" established in major cities, Early resorts built along French and Italian Riviera, first atrium hotel

1820s

Tremont House in Boston was first luxury downtown hotel with indoor toilets, locks on guest room doors, and à la carte menu

1830s

First hotels with an elevator for baggage

1850s

Spa resorts reached height of popularity, Fifth Avenue Hotel in New York City was first with passenger elevators

1870s

Coney Island in New York was themed seaside resort with Queen Anne and Oriental-style hotels and amusement park with roller-coaster

1880s

Sagamore Hotel at Lake George in New York State was first with electricity in all rooms, Hotel with baths in all rooms, Hotel from concrete

1890s

Hotel Netherland in New York City was first with phones in all rooms

1900s

The Ritz founded in London, established main principles of modern multi-story hotel and circulation flow

HOTELS TYPOLOGIES

According to the global development and wide range of population needs, hotels have been classified by many parameters. Some of them are location, quality, size, appearance, function, circulation, some special characteristic according to the type.

In order to have some unique system of rating hotels, World Tourism Organization has made classification called "Minimum hotel standard". This classification is conducted through 78 requirements, through which every hotel gets assignment in form from one to five stars and it is adopted world wide. Part of this table is shown in "Table 1. WTO classification: "Minimum hotel standard"" on page 9 *Table 1* and some general characteristics are listed below:

1. Hotel with good basic facilities and furnishings
2. Hotel with higher standards (better accommodation, better facilities)
3. Hotels that are well appointed (en-suit bathrooms, meal facilities)
4. Hotels that have high standards of equipment (wide range of services)
5. Outstanding hotels with exceptional quality (highest international standards)¹

After concluding in which star category hotel belongs, it should be also listed what type hotel is. There are eleven types:

1. Urban hotel
2. Suburban hotel
3. Design hotel
4. Multi-branded hotel
5. Mixed-use hotel
6. Resort hotel
7. Casino hotel
8. Convention hotel
9. Conference center
10. Residential hotels, Condominiums and vacation ownership
11. Updating existing hotels²

² Penner/Lawrence/Robson, 2013, 27.

¹ Lawson, 1995, 18.



Figure 10. Marqués de Riscal Hotel, Spain (Architect Frank Gehry)



Figure 11. Renaissance Paris Arc de Triomphe Hotel, Paris, France

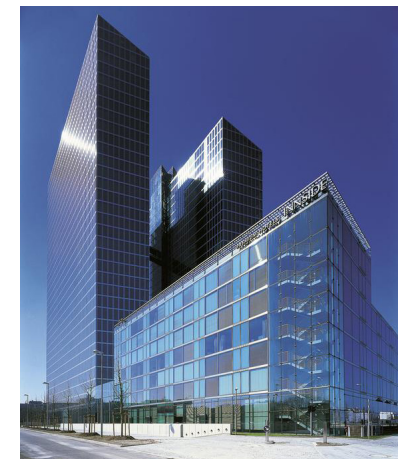


Figure 12. Innside Premium Hotel, Munich, Germany

HOTELS TYPOLOGIES

| PHYSICAL REQUIREMENTS | 1 STAR | 2 STAR | 3 STAR | 4 STAR | 5 STAR |
|-----------------------------------|--|---|---|--|--|
| SIZE | Minimum of 10 letting bedrooms | | | | |
| ENTRANCE | The hotel must have its own independent entrance | | Hotel restaurants must have their own external as well as internal entrance. Separate service entrance. | | |
| FURNITURE, FITTINGS AND EQUIPMENT | Moderate cost construction, simple, durable equipment and furniture of standard design | | Medium cost construction materials and fittings. Custom made furniture. | High cost construction and fittings. Custom made equipment and furniture | Top cost construction, fittings, equipment and furniture. Individualized decor |
| SIZE SINGLE | 8 | 8 | 10 | 12 | 13 |
| DOUBLE | 10 | 10 | 12 | 14 | 16 |
| TRIPLE SUITS | 12 | 12 | 14 | 16 | 19 |
| | | | Some suits available or connecting rooms to make temporary suites | Independent suites of various types and connecting rooms | |
| SINGLE BED MIN SIZE | 1900mm*800mm | | | 2000mm*800mm | |
| IN ROOM ENTERTAINMENT | | | TV available | Color TV | Color TV with video channel |
| BATHROOMS | Wash-basin with mirror, light, shelf, towels, soap and electric socket marked with voltage | +at least 25% of rooms with private bathrooms | All rooms have private bathrooms | | Spacious bathrooms Separate toilet |

| | | | | |
|---------------|---|---|---|---|
| PARKING | Free access by car. Some reserved parking spaces | Parking space reserved for average number of car-using guests | Exclusive parking or garage to accommodate all hotel guests and casual visitors. 24hr security | As four star plus basic care services available |
| GREEN AREA | | | some garden area or terrace with plants | terrace with plants, roof garden, patio, or adjoining gardens |
| ROOM CLEANING | Daily | | | Additional room cleaning on request up to 12:00pm |
| BREAKFAST | As above or by service to rooms | Provided in hotel or facilities in immediate proximity | Restaurant(s) provided within hotel with adequate seating capacity for breakfast and other meals. Breakfast served: 7.00 - 10.00am BS:7.00 - 11.00am | |
| ROOM SERVICE | Breakfast served in rooms where no breakfast area available | Limited room service may be offered | Breakfast service including newspaper 24 hour beverage and light meal service | 24 hour full meal and beverage service |

Table 1. WTO classification: "Minimum hotel standard"

URBAN HOTEL

Positioned in urban city surroundings this type needed to cope with lot of challenges in order to be successful urban hotel. Mostly it is orientate to some active business centers and shopping districts.

Urban type hotel has a few subtypes:

- *Business and leisure*
- *Waterfront*
- *Entertainment*
- *Super-luxury hotels¹*

SUBURBAN HOTEL

Main characteristic of this sub-typology is its location. Fleeing from city centers, in search for fresh air, peace, in late 19th century people started to inhabit suburban places. Suburban places started to be developed and social functions were added one by one.

Planning this hotels have had mitigating circumstances due to less restrictive sites, bigger plots, less restrictive zoning. Highs were customized to regional architecture, but emphasis was given to the visibility because the travelers from surrounding roads was very important.

As conclusion from previous line, parking was very important item, so this hotels had in average 50% more parking spaces than urban hotels. Rooms were planned approximately 30 m² and 39.5 m² for extended-stay concept. Facilities were pretty much similar to ones in downtown hotel in order to be competitive and desirable on the same level.

Suburban type hotel has a few subtypes:

- *Airport hotels*
- *Office-park hotels*
- *Country Inns and Bed and breakfast inns*
- *Special-purpose and hybrids*
 - *Mall Hotels*
 - *University Hotels*
 - *Medical Hotels*
 - *Small-town Hotels²*

¹ Penner/Lawrence/Robson, 2013, 43.

² Penner/Lawrence/Robson, 2013, 169.



Figure 13. W London, London, United Kingdom



Figure 14. Connexion Integrated Health Center, Medical Hotel, Singapore



Figure 15. Sheraton Milan Malpensa Airport hotel, Milan, Italy

DESIGN HOTEL

Hotels have always been guidelines when it come to design and lifestyle. Through process of making each one more spacial and recognizable in terms of interior and exterior design hotel category was made.

There are tree subtypes:

- *Boutique Hotel*
- *Lifestyle Hotel*
- *Design Hotel*¹

Difference between this tree is minor and main point is to provoke emotion in visitors and make unique experience.

Boutique hotels have got name that symbolized something "**small, fashionable and independent**"² what was also same general idea behind this all tree types.

Design hotels are very innovative with strong emphasis on unconventional design. Can be on scale from budget to luxury.

Lifestyle hotel has qualities as boutique and design hotel only adding special attention on entertaining atmosphere.

Some researches have shown that design hotels, even though building costs exceed standards, they still earn much more than non-design hotels. The logic is very simple, they are paying special attention to the atmosphere and ambiance, restaurants and bars, all in all owners are counting on certain guests that are following idea to see places and to be seen. Topic that is also connected to this kind of hotels is renovation of the already existing structures.

DESIGN GUIDELINES

- °Attention and atmosphere
- °Restaurants and bars
- °Lobbies as main gathering point

¹ Penner/Lawrence/Robson, 2013, 132.

² Penner/Lawrence/Robson, 2013, 137.



Figure 16. The Ritz, Paris, France



Figure 17. Example of room provided in Ritz Hotel in Paris

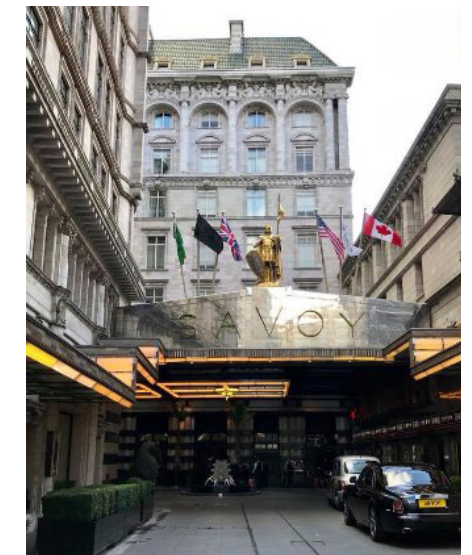


Figure 18. The Savoy, London, England

MULTI-BRANDED HOTELS

As the name says, this typology represents more brands on same plot. This compensation was made in order to reduce plot costs. At the beginning it was always two brands from the same company but later on it has expanded on multiple brands and companies.

At early phase of developing this typology, was clearly that this two brands must be separated in two buildings, but later on it was also usually merging it in the same building. This way of thinking has brought even more economic and operational benefits, such as bigger public space, but on the other hand there was a danger of losing identity. Companies have solved this with brand prototypes, such as usage of certain materials, shapes, colors.¹

MIXED-USE DEVELOPMENT

Mixed use hotels came as idea after saying how much benefits were made with Multi-branded hotels. This typology has went step further and merged not only more hotels, but many other functions. In one complex could be found as office, shopping malls, condominiums and so on. This wide spectrum of functions has caused that about this projects were spoken as "cities within cities"².

On Figure 21 is shown one of the most spectacular examples of this typology. It is designed from Adler and Sullivan through combination of office block, 4 300 seat theatre and luxurious 400 room hotel.

Nowdays this hotels are mostly sown as sky scrapers in competition to out do every previous one. Some examples are :

- Burj Khalifa, Dubai, UAE
- India Tower, Mumbai, India
- Kingdom Tower, Jeddah, Saudi Arabia

1 Penner/Lawrence/Robson, 2013, 221.

2 Penner/Lawrence/Robson, 2013, 251.



Figure 19. Auditorium Building, Chicago, USA, Adler and Sullivan

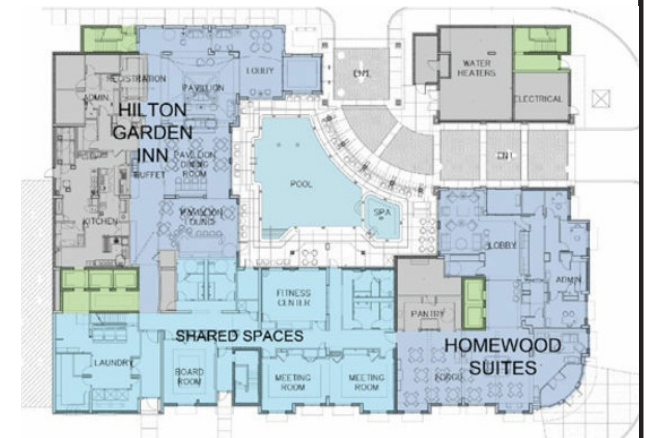


Figure 20. Hilton Garden and Homewood Suites, Florida, USA

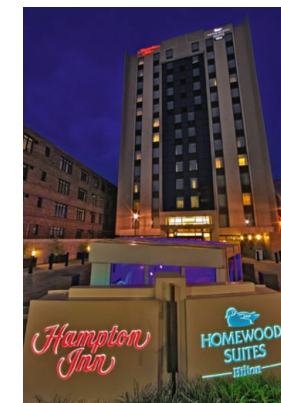


Figure 21. Homewood suites and Hampton Inn, Maryland

HOTEL TYPOLOGIES

RESORT HOTELS

Resorts were present in every day life since ancient Greece. They are assembled with most facilities of all other hotels. For this type of hotels location is most important and of course accompanying location, the topic. They are based also on cultural and vernacular architecture and market trends.

Resorts are moving toward whole family destination moreover nowadays they are mostly providing suits and self-contained villas.

There are few subtypes:

- Seaside resorts
- Island Resorts
- Desert Resorts
- Golf Resorts
- Spa Resorts
- Marina Hotels
- Ski and Mountain resorts
- Eco tourist resorts
- Wilderness Lodges and Wildlife Reserves¹

Main features that architects consider while planning:

- Great geographical location and attraction
- Longer length of stay
- Enhanced food and beverage sales
- Enhanced retail, logo, and themed merchandise sales
- General experience improved to extraordinary²



Figure 22. Hotel Therme Vals, Switzerland (Spa resort)



Figure 23. Four seasons, Bora Bora, Tahiti (Seaside resort)



Figure 24. Amangiri, Canyon Point, Utah, USA (Desert resort)

¹ Penner/Lawrence/Robson, 2013, 284.

² Penner/Lawrence/Robson, 2013, 286.

CASINO HOTELS

In the beginning of gaming era casino hotels were planned as something what was behind and main point was on casino itself. After 1989- advent of the Mirage whole this hotel package as rooms, restaurants, retail, bars were not seen as addition but on the contrary as equal part of revenue stream.¹ This typology is very strongly connected to the USA.

Special attention is payed to security measures, "money path", division of gambling machines, luxurious rooms and generally design. VIP suites are something that is also included into design. One is for sure, casino hotels will be definitely under pressure of guest taste and must always include up-to-date design and facilities in order to be successful.

CONVENTIONAL HOTELS

Hosting conventions, national and international meetings is main domain of conventional hotels. Very oft is seen that conventional hotels are combined with resort ones, where guests can bring families and spend free time after conventions. Speaking about location it would be wished for large site where the majority of functions can be spread over one floor. Almost all public spaces, such as corridors, lobbies, must be oversized in order to accommodate big number of guests.

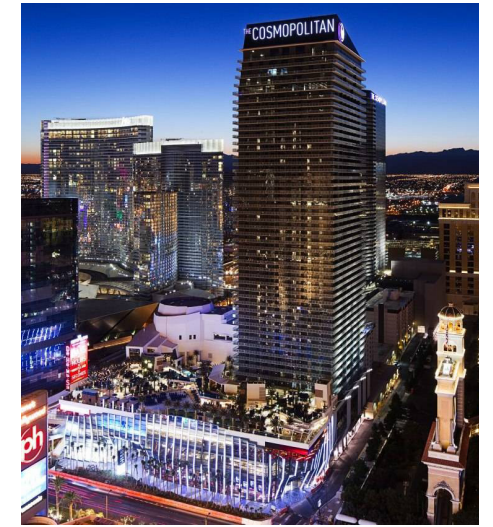


Figure 25. The Cosmopolitan, Las Vegas, Nevada

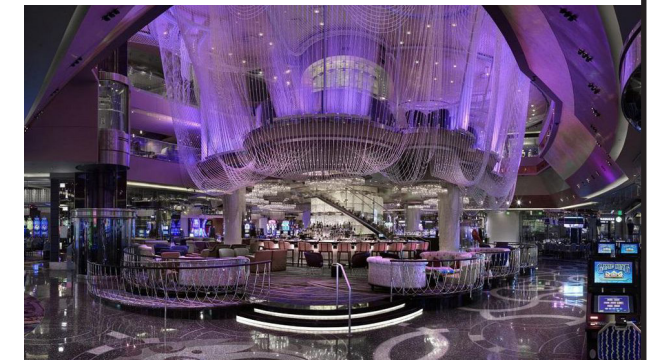


Figure 26. The Cosmopolitan, Las Vegas, Nevada -luxurious interior

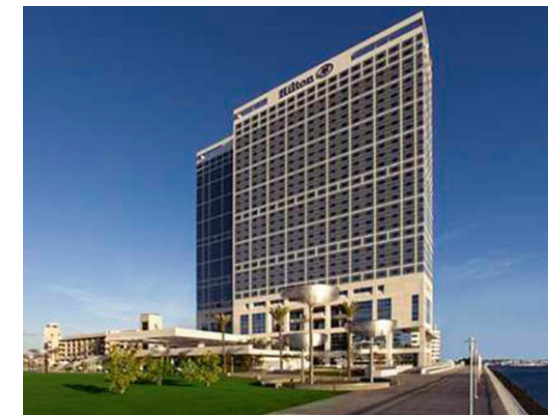


Figure 27. Hotel Hilton, USA

¹ Penner/Lawrence/Robson, 2013, 394.

CONFERENCE CENTERS

Speaking about conference hotel, firstly need to be cleared difference between it convention hotel. Only difference is in amount of upcoming guests. Conference hotel is planned for way smaller number of attendees, seen as more intimate venue. It is also designed to provide environment conducive to effective meetings (group of people not more than 50).¹ Events that should be possible in the conference centers are: training programs, management meetings, professional and technical meetings, regional and national sales meetings, incentive trips and another types of meeting.²

As in other hotels there are subtypes :

- executive
- resort
- corporate
- university
- not-for-profit.

RESIDENTIAL HOTELS, CONDOMINIUMS, AND VACATION OWNERSHIP

As the name already says, residential hotel are places where people, were staying in a way of living.

Hotels with condominiums

This mixed use means that condominiums are built within hotel as separate units who are sold to customer who can still use hotel service as room service or housekeeping. Planning this types of hotel is very demanding in a term of privacy between hotel guest and condominium owners.

Condominium hotels

This typology works inversely. Condominium owners rent their apartments to the hotel and its guest when they are not in the hotel.

Vocation ownership resorts

Made to relieve families costs by sharing vocation apartments by sharing it on certain time.



Figure 28. AT&T Executive Education and Conference Center, University of Texas, Austin

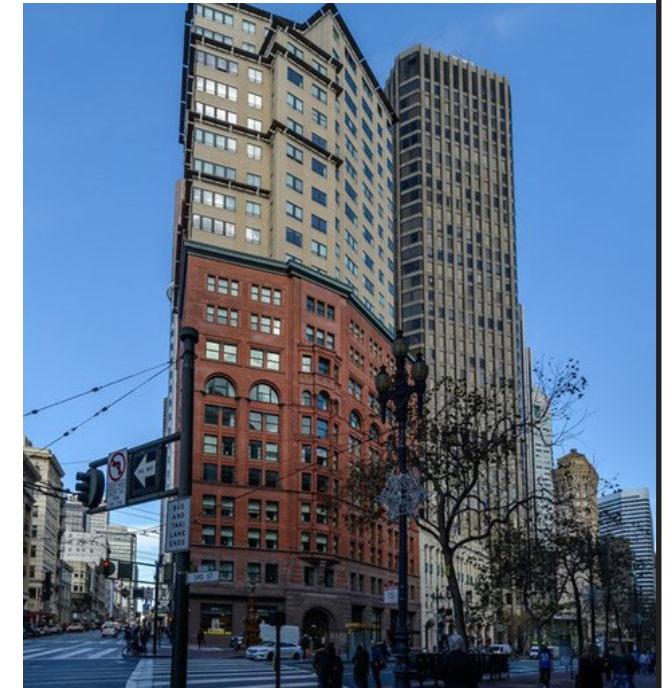


Figure 29. Ritz-Carlton Club and Residences, San Francisco, California

1 Penner, Lawrence, Robson, 2013, 475.

2 Penner, Lawrence, Robson, 2013, 481.

CASE STUDIES

OASIA HOTEL DOWNTOWN
HOTEL JAKARTA
STUDIO MALMÖ

OASIA HOTEL DOWNTOWN

Architects WOHA
Location Singapore
Year 2016

Architects have made skyscraper that has provided among it hospitality functions green percentage for 10 buildings around it. Process of connecting and uplifting public-spaces with tropical spaces full of greenery, fresh cross-ventilated air and nature light has brought this project to creating comfortable social spaces despite high density on this particular location instead of relying on surrounding.

As seen on *Figure 31* and *Figure 32* there is a few variety of openings and building itself. Sometimes as on *Figure 31* it is a pool with a greenery and a view and sometime as on *Figure 32* it is big green free space meant as extension for public space. Roof is made like sphere that exceeds itself, forming one more strata and on that way forming usage of this space on very high level.

Facade is made in variety of red colored aluminum mesh that is design as backdrop for creepers (*Figure 34*). This combination is making beautiful interaction of a mesh and green leaves



Figure 30. Building from man perspective

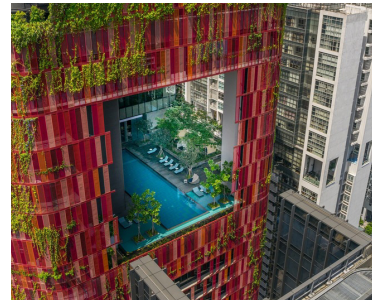


Figure 31. Building opening with a pool

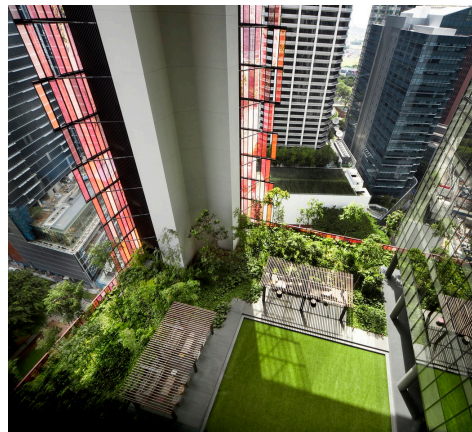


Figure 32. Opening with a green space

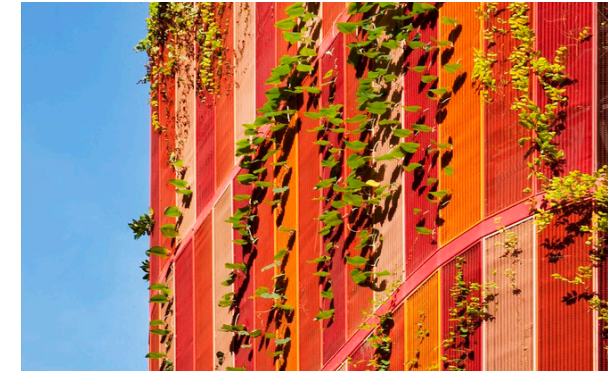


Figure 33. Facade zoom in

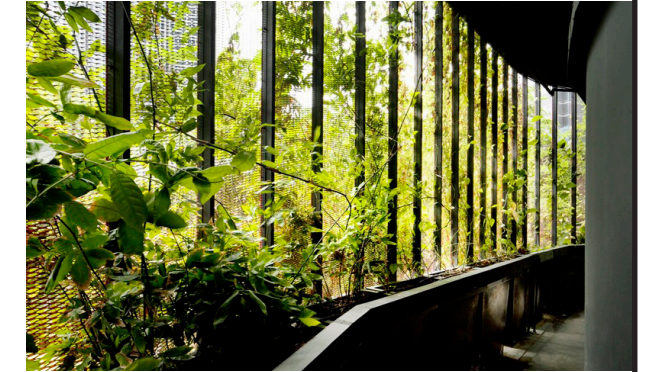


Figure 34. Outdoor corridor zoom in

and its flowers making perfect compound for a birds, insects and generally uplifting biodiversity in this area. This kind of facade forms has also another function and that is forming nice green corridors to the rooms which uplifts whole atmosphere of the green.

DESIGN GUIDELINES

Project is great example how building can be awoken with public spaces even though it wasn't its primary function. With a combination of green facade and green oases it was compensated lack of greenery on the site. At the same time making facade double functional, firstly as envelop and secondly as holder for greenery makes hotel very interesting as experience.

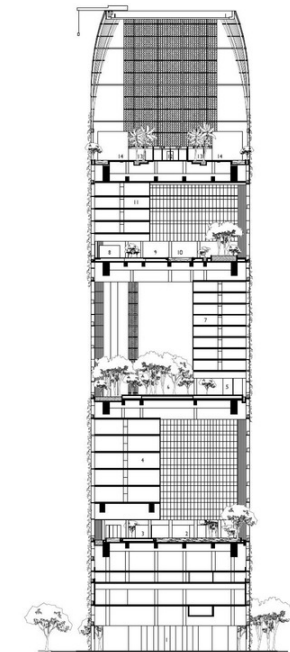


Figure 35. Section

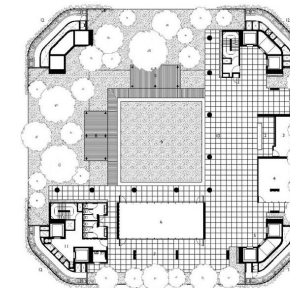


Figure 36. Plan 12th floor

HOTEL JAKARTA

Architects SeArch

Location Amsterdam, Netherlands

Year 2018

Hotel Jakarta is made on island Java in Netherlands. This site has very important historical aspect because it symbolizes Amsterdam maritime with Asia and because of this background it was preferably that hotel has unique design, special attention to the sustainability and induction of public spaces and its interaction with a surrounding.

In terms of energy design this project is very successfully solved. East and south facade are formed with BIPV system (building integrated photovoltaics). On the other side there are also integrated PV panels in Loggias. Moreover the rooftop above atrium is also made of BIPV cells system that is providing in the same time energy and shadings.

Last but not least, subtropical garden in atrium serves also as temperature regulator.

Architects have provided diagram that shows how sustainable design is designed and how it is working. Regarding to the subtropical garden it is clear that rainwater is used to ir-

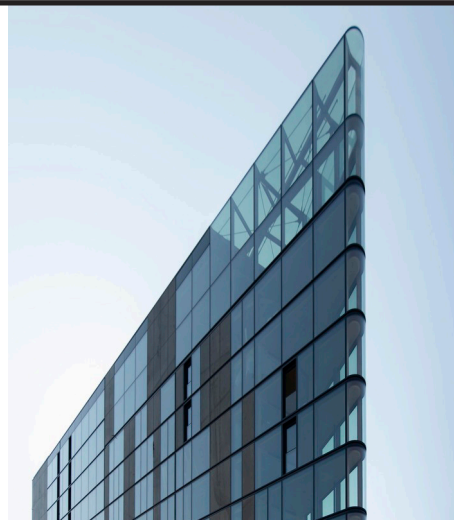


Figure 37. Hotel Jakarta- side view

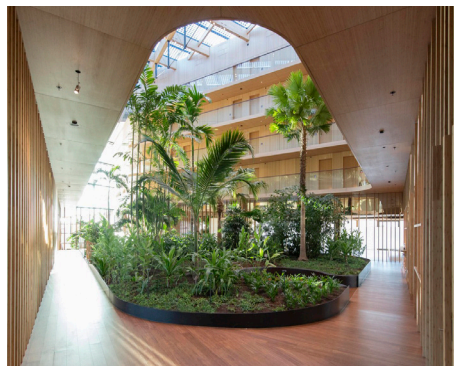


Figure 38. Inside greenery



Figure 39. Atrium and greenery

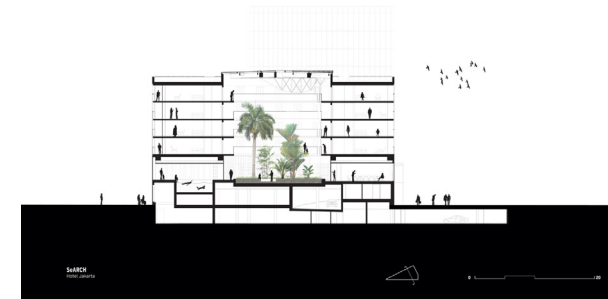


Figure 40. Cross section

rigate garden and in the same time plants presence in the summer is making whole temperature cooler and in the same time in winter warmer. Within process of evaporation warm air is uplifting and leaving cooler air in the lower parts.

DESIGN GUIDELINES

Positioning of the vegetation in the building contributes better micro climatic situation and reveals one of the successful methods of sustainability. Integrating BIPV cells or PV panels shows how important is to think about this system already in conceptual phase in order to make compact system that can do more than just reduces energy needed for maintaining the building (as for example shading).

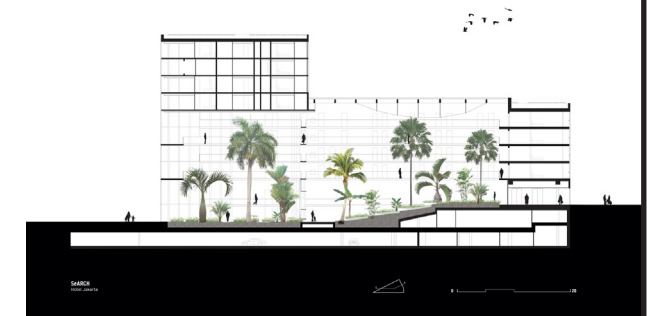


Figure 41. Longitudinal section

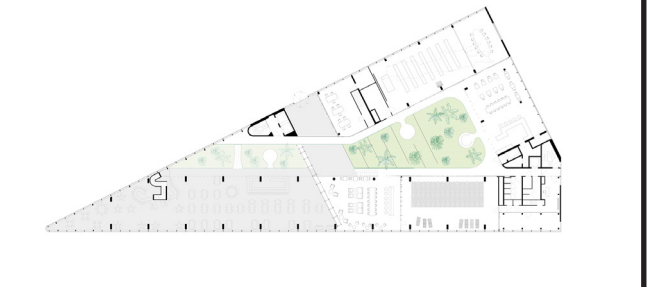


Figure 42. Plan 1st floor

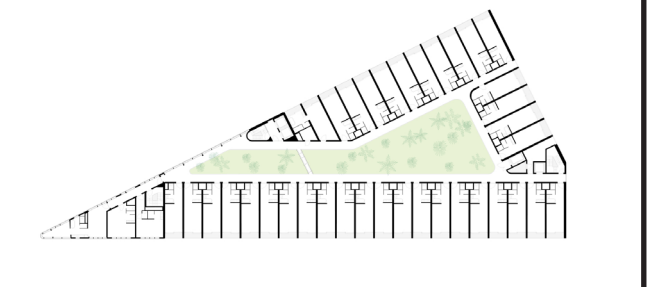


Figure 43. Plan 4th floor

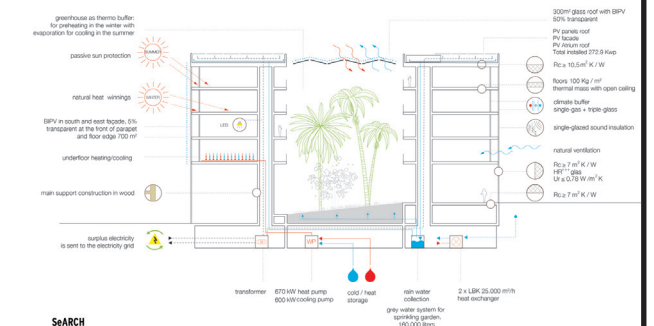


Figure 44. Cross section with energy concept

STUDIO MALMÖ

Architects SHL Architects
Location Malmö, Sweden
Year 2016

Studio Malmö is building with mixed used. It contains functions as hotel, restaurant, sky bar, cocktail bar, conference, retail. Its location is on the Malmö harbor so it is becoming very important landmark who is unifying whole site.

As *Figure 47* shows, facade has very strong impression. It is made from dark brick with same rhythmic windows that are emphasized with white concrete jambs.

Part that connects all functions and in that way becomes heart of building is in public atrium. It is accessible from both site sides, shore side and street side.



Figure 45. Front view



Figure 46. Inside greenery



Figure 47. Facade zoom in

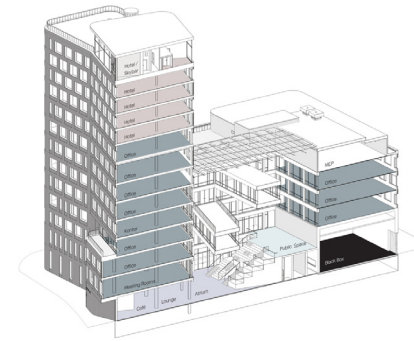


Figure 48. Section with functions

Big and wide staircases are forming sitting places with a feeling of semiprivate space because of the height difference. This design makes space more attractive and in the same time uplifts usage of it.

DESIGN GUIDELINES

Having public space centrally positioned is forming stronger connection in whole building. In the same time it makes this point as gathering and remarkable point that is significant. Furthermore it is designed in high levels which brings in the same time dynamics of the space and feeling bit more privacy as being all on the same level.

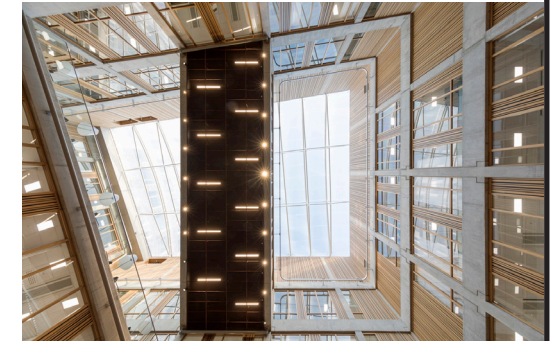


Figure 49. Glass rooftop above atrium

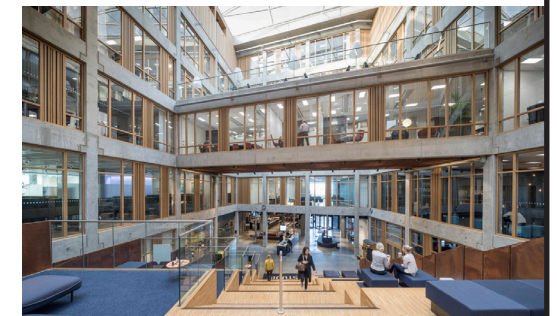


Figure 50. Atrium-public space



Figure 51. Atrium-public space

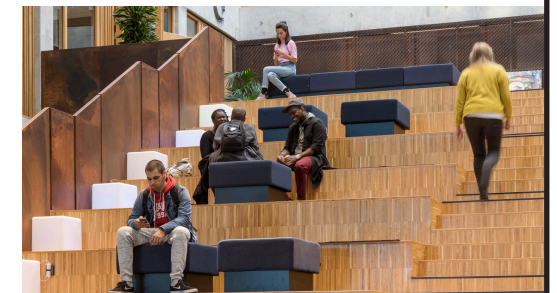


Figure 52. Atrium - zoom in

CLIMATE ANALYSIS

MACRO CLIMATE
GRAZ, AUSTRIA

MACRO CLIMATE

In order to design an energy efficient building, climate conditions should be taken as an important factors of the whole process. Climate and environmental conditions are guidelines for good strategy and successful energy design for building.

World climate classification system (Figure 54) made by Wladimir Köppen and Rudolf Geiger shows climate divided into 5 main climate groups based on temperature patterns and seasonal precipitations. Groups and subgroups meaning is explained in table below. First letter represents climate zone, second one is for precipitation and the third one represents temperature.

| 1st | 2nd | 3rd |
|-----------------|--------------------------|----------------|
| A - Tropical | f- rain forest | |
| | m- monsoon | |
| | w- savanna, dry winter | |
| | s- savanna dry summer | |
| B - Arid | w- desert | |
| | s- steppe | h- hot |
| | | k- cold |
| C - Temperate | w- dry winter | |
| | f- no dry season | |
| | s- dry summer | |
| | | a- hot summer |
| | | b- warm summer |
| D - Continental | w- dry winter | |
| | f- no dry season | |
| | s- dry summer | |
| | | a- hot summer |
| | | b- warm summer |
| | | c- cold summer |
| E - Polar | T- tundra | |
| | F- eternal frost ice cap | |

Table 2. Description of Köppen Geiger Climate symbols

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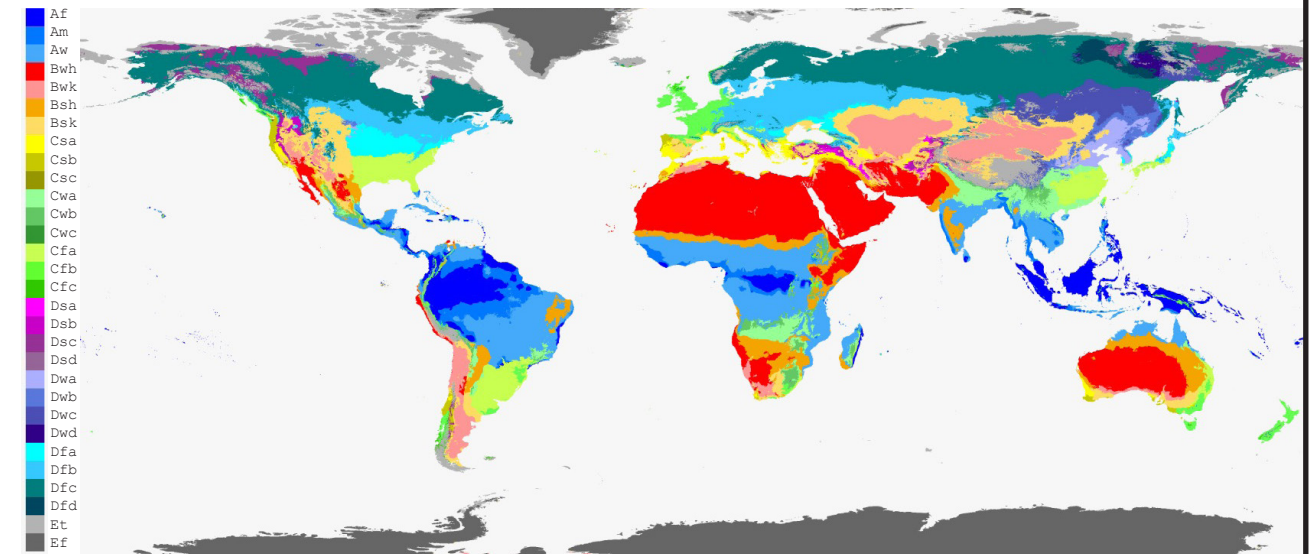


Figure 53. Köppen- Geiger Climate classification map

As seen on the bigger map of Europe, Europe has 4 main climate types in the following order D-cold (44.4%), B-arid (36.3%), C- temperate (17.0%) and E- polar (2.3%).

Austria is mostly under sign Dfb, which means continental climate with no dry season and warm summer.

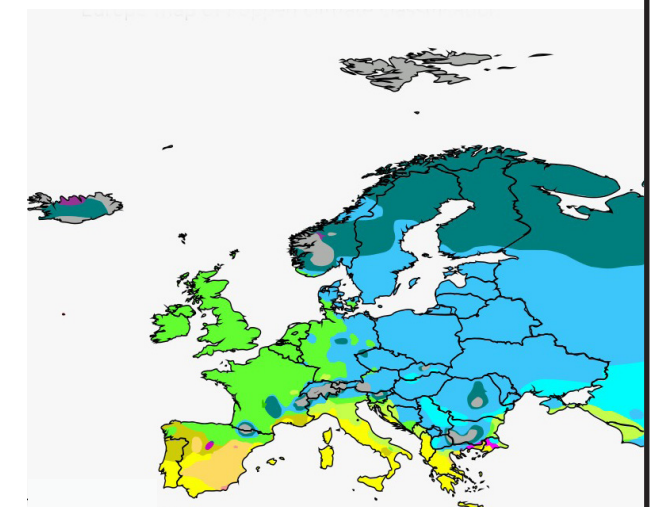


Figure 54. Köppen Geiger Climate classification map: Europa

Based on climate references provided by Köppen-Geiger classification map, ECOFYS consultancy has made design guidelines for different climate zones in order to move towards building the nearly zero energy buildings - NZEB.

European countries were divided in 5 climate zones based on global radiation, heatings degree-days, cooling degree-days and cooling potential by night ventilation. They were classified into the table below with provided information about needed strategies.

Austria is classified under Zone 3 as temperate continental climate/humid continental climate without dry season and with warm summer.

| Köppen-Geiger climate classification | ECOFYS | NZEB typology |
|--------------------------------------|---|--|
| Csa- Hot and dry climate | Zone 1&2 - Temperate with dry, hot summer. (Mediterranean climate) | Well-insulated building envelope with limited fenestration area; glazing with very low SHGC and shading from direct sunlight in summer; reflective or cool colors exterior envelope surfaces essential (colors with low heat absorption to reduce the solar load during the summer period) ; solar powered AC equipment can provide day-time cooling; thermal mass and lower night-time temperatures provide comfortable indoor conditions after sunset (nocturnal ventilation). |
| Dfb- Warm and humid climate | Zone 3 - Temperate continental climate/humid continental climate without dry season and with warm summer; | Moderately insulated building envelope with limited fenestration area having low SHGC and effective shading devices; green (vegetated) roofs and/or reflective exterior envelope surfaces are beneficial; since the removal of latent heat (water vapor) matches the energy required for sensible cooling, investing in sophisticated ventilation is essential to provide healthy and comfortable indoor air conditions without wasting energy. |
| Cfb - Temperate climate | Zone 4 - Temperate without dry season and warm summer | Well-insulated building envelope with energy efficient fenestration (very low to low U-value, moderate to high SHGC- depends on glazing area); operable shading systems required to prevent summer over-heating; thermal mass and balanced ventilation with heat recovery is beneficial. Nocturnal ventilation. |
| Dfc- Cold climate | Zone 5 - Cold, without dry season and with cold summer. | Compact building design with very well- insulated building envelope components; total fenestration area should be limited with very low U-value and high SHGC (solar heat gain coefficient); thermal mass and balanced ventilation with heat recovery is essential. |

Table 3. Building strategies in different climates

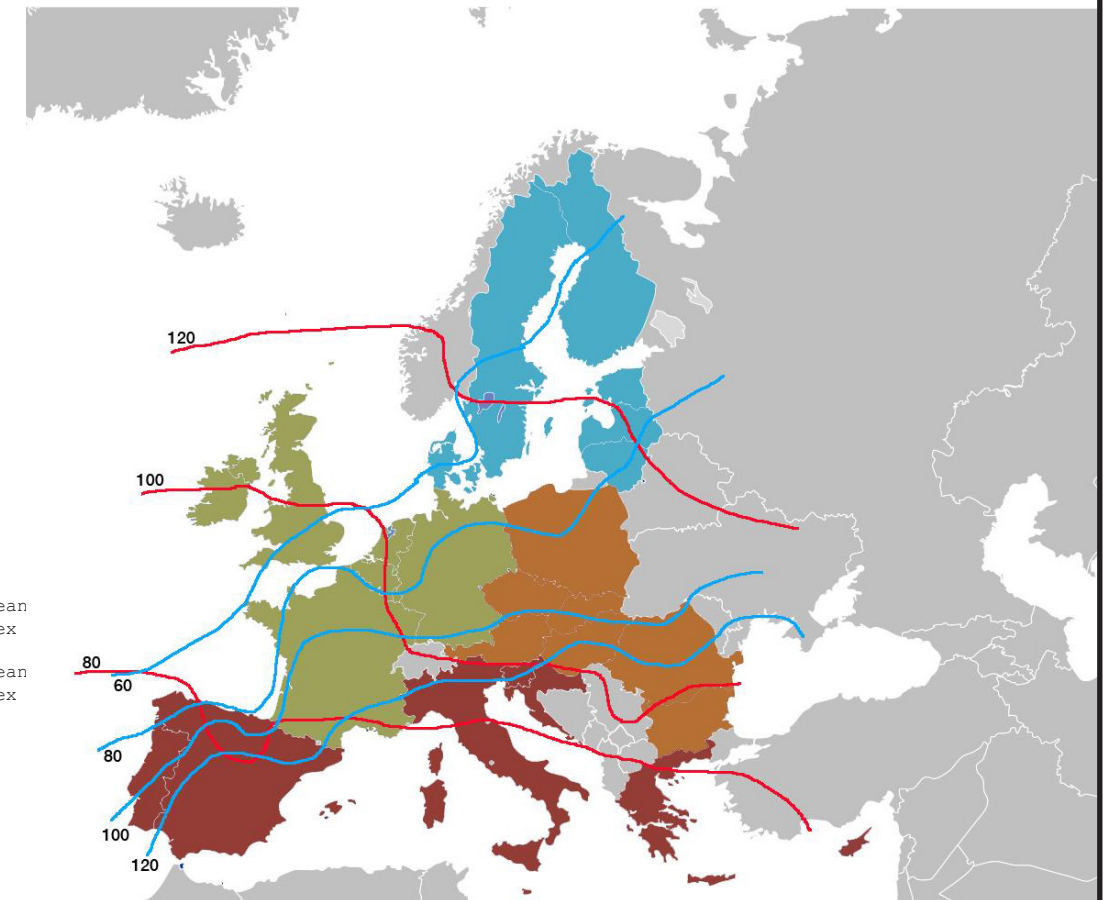


Figure 55. NZEB climate zones combined with EHI and ECI index

SUN, LIGHT AND SOLAR ENERGY

Graz is located on 362m above sea level. Generally summers are warm and in the winter is cold and dry. City is significant for rainfall, which is 858 mm per year.

Figure 57 shows temperature range during the whole year. Warm season is 3.6 months long, precisely from 22.05. to 10.09., with a average temperature above 21°C. Cold season lasts for 3.2 months, precisely form 19.11. to 26.02., with average low temperature -5°C.¹

Figure 58 shows daylight and twilight duration in Graz during the year. Latest sunset is at 8:57 PM on 25.06. and earliest is at 4:08 PM on 10.12. Latest sunrise is at 7:44 AM on 02.01. and earliest is at 5:02 AM on 16.06.¹

After seeing that Graz has good corresponding on topic sun Figure 59 goes further more and shows totally daily incident shortwave solar energy. It was made considering seasonal variations in the length of the day, Sun absorption by the clouds and atmospheric constituents and elevation of the sun above the horizon.

As final result of the study, it shows that daily solar energy faces extreme seasonal variation through year.¹

Most effective period of the year is from 27.04 to 17.08., lasting 3.7 months, with average power of energy per square meter above 5.5 kWh. Highlight of this period happens on 7 July with power of 6.6 kWh.

In dark period of the year average daily incident shortwave energy is listed as 2.3 kWh with the lowest value of 1.2 kWh on 15.12.¹

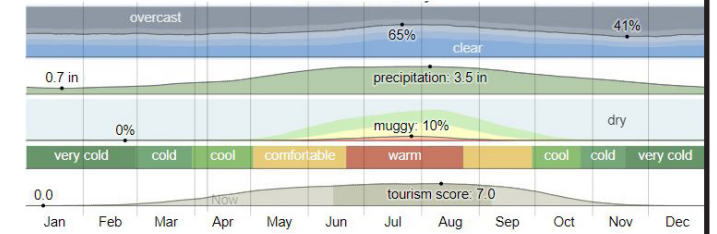


Figure 56. Climate Summary in Graz

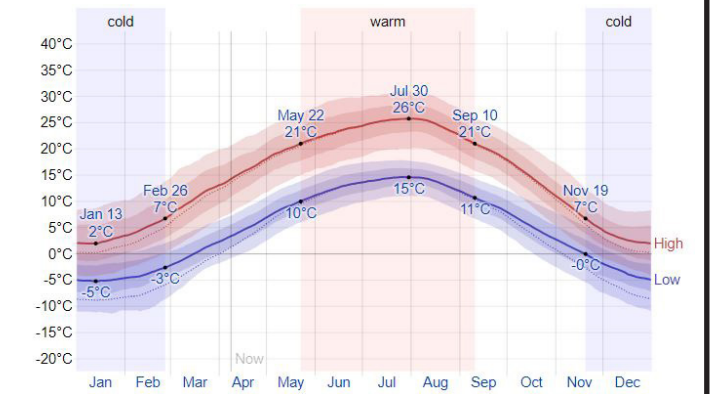


Figure 57. Average high and low temperature

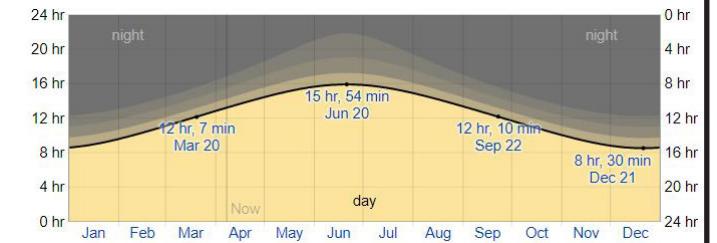


Figure 58. Hours of daylight and twilight

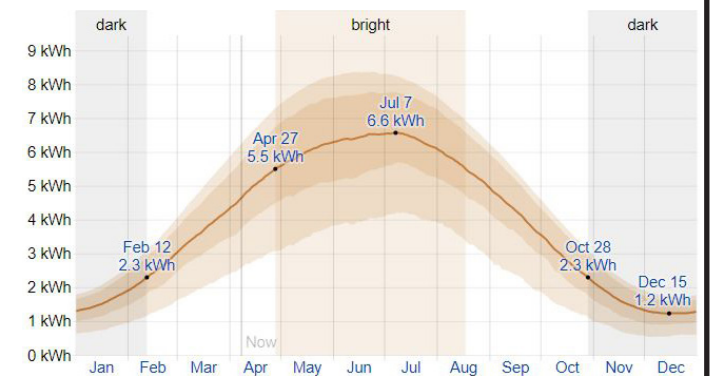


Figure 59. Average daily incident shortwave solar energy

PRECIPITATION

Wet seasons in Graz lasts 5.1 months, more precisely from 24.04 to the 28.09. with a chance of 25% to precipitation.

Dry seasons is 6.9 months long, from 28.09 to 24.04. with a small chance for rainfall (11%).¹

Precipitation differs tree condition, rain falling alone, snow alone or combination of this two.

RAINFALL

Figure 61 shows that greatest amount of rainfalls during 31 day, with highest point on 05.08. with total accumulation of 3.5 inches (8.89 cm). On the day 18.01. accumulation is the smallest, with amount of 0.5 inches (1.27 cm).¹

SNOWFALL

Snow period lasts 4.3 months. precisely form 07.11. to 16.03. with snowfall of at least 0.1 inches (0,25cm). Most significant period of snow fall is during 31 day, with highest point on 27.12 with accumulation of 0.3 inches(0.76 cm).

On the other hand, slowness period lasts for 07.07 months, precisely form 16.03 to 07.11.. On the 28.07. is least snow with 0.0 inches(0 cm).¹

¹ Weather Spark, August 2020.

HUMIDITY

Graz phase seasonal variation in term of humidity.

The period when the muggy lasts for 2.6 months and is from 10.06 to 30.08. where muggy or oppressive phase is about 3%.

Highest mugginess is experienced 26.07. with 10%. Lowest point of mugginess in on the 23.02. with 0%.¹



Figure 60. Daily chance of precipitation

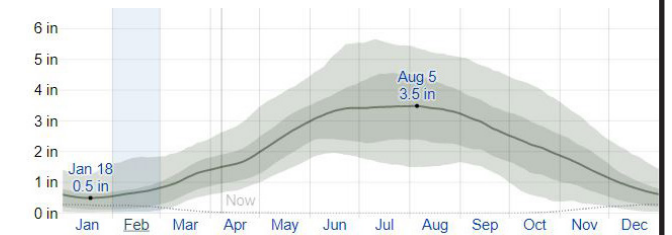


Figure 61. Average monthly rainfall



Figure 62. Average monthly snowfall

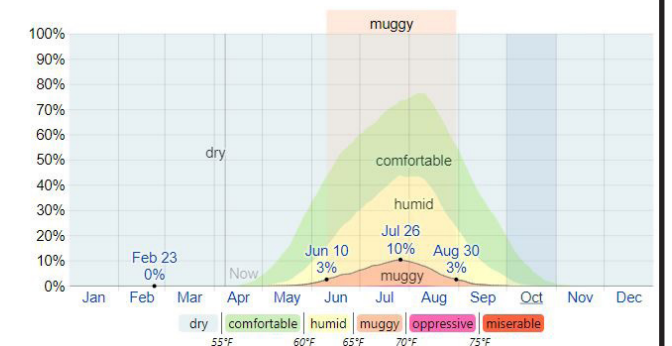


Figure 63. Humidity comfort levels

WIND

In Graz wind is marked as mild seasonal variation in the annual terms.

Active wind part of the year lasts for 4.3 months and lasts from 23.01 to 31.05. with average speed more than 5.4 miles per hour. As windiest day of the year is marked 02.04. with average hourly speed of 6.3 miles per hour.

On the opposite, as shown on *Figure 64* calmer part of year is marked 7.7 months long, exactly from 31.05 to 23.01. As calmest day in the year is marked 09.08 with average hourly speed of 4.6 miles per hour.¹

DESIGN GUIDELINES

According to the previous showed diagrams, it is obvious that solar energy in this climate part can be used as one successful method of producing energy. In climate that Graz has, with strong winters like we have saw in previous charts accumulated sun energy can reduce heating loads, on the other side in warm summer it effect can be reduced with shading mechanisms in order to make pleasant temperature inside of the objects. Facades and rooftops can be used as main strategic points for gaining sun power. On the other hand good rainfall season can be used for successful irrigation of the plants and green islands inside of the building. Furthermore having green atrium or islands in the building can stimulate cooling general atmosphere with water evaporation and uplifting warm air to the top while leaving cool one in the bottom of the space.

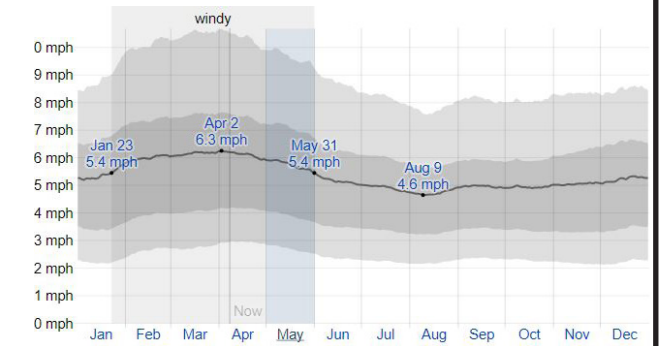


Figure 64. Average wind speed

¹ Weather Spark, August 2020.

LOCATION ANALYSES

POSITION OVERVIEW
SMART CITY GRAZ
BUILDING TYPOLOGY
GREEN AND PUBLIC SPACE
TRANSPORT

POSITION OVERVIEW

Project is located in city part called Smart City Graz, that is newly and rapidly developing. This development involves lot new business opportunities, companies, living quarters. It is located near widely visible landmark called Science Tower and Central Station so it has advantage of fast access of passengers or hotel visitors. Moreover it is situated near famous Helmut List Hall where lot of cultural, business and other occasions are held, such as avant-garde performances, pop concerts, exhibitions and cabaret events.

City development is always going through widening or some other changes and only if every part of the city is seen as valuable and developed with good strategy it will be successful and it will benefit as whole city.

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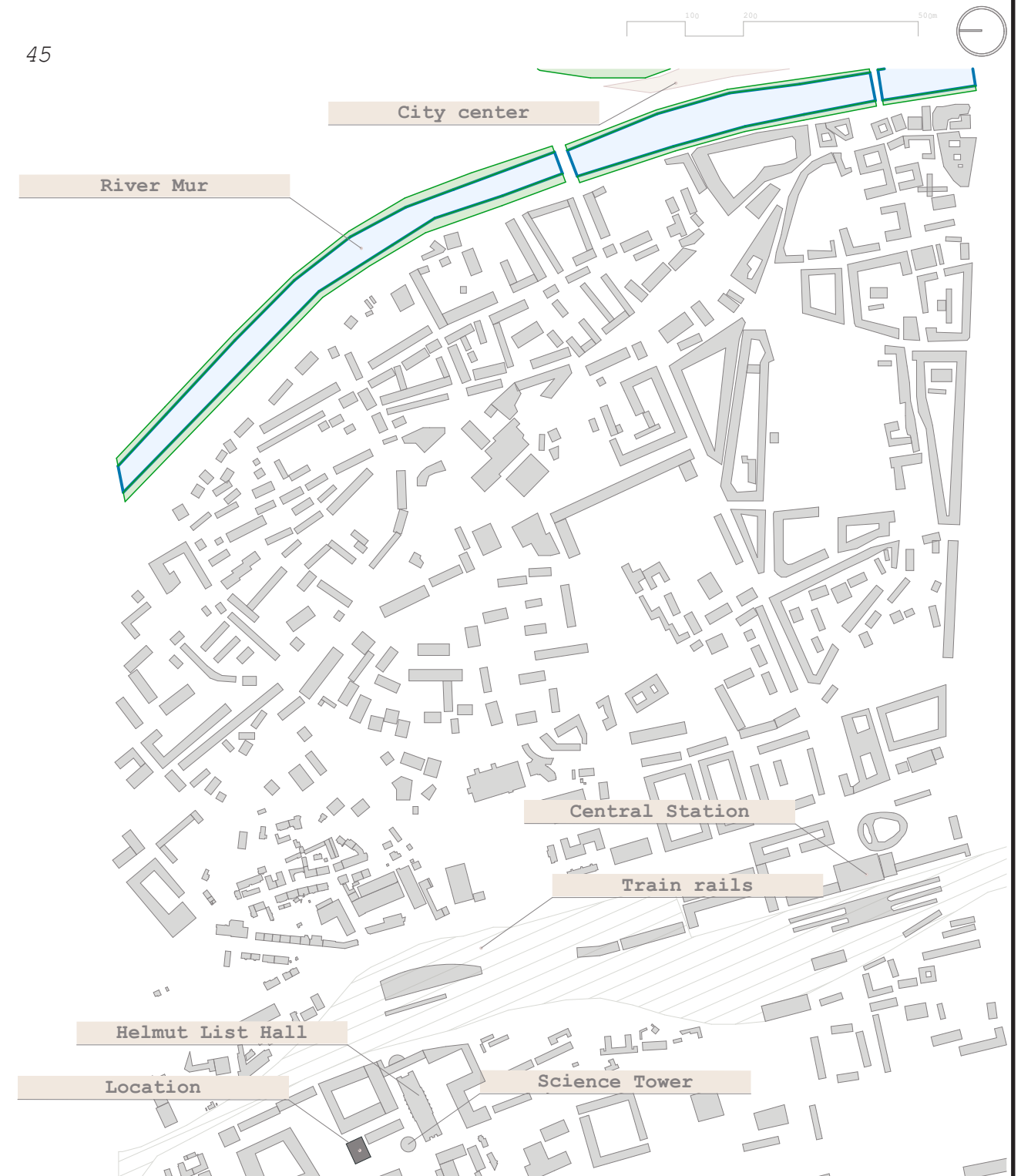






Figure 65. Analysis° Overview of connection with city center and important sight marks

LEGEND

-  Smart City Graz area
-  Construction site north
-  Construction site middle
-  Construction site south

Hotel is integrated in master plan called Smart City Graz which should describe energy-efficient project with a low emission and very high quality of life. In whole master plan are included activities such as living, working, groceries supply and free-time. Whole project is attracted with beautiful public squares and parks in-between the buildings.

On the smaller scale, Hotel is located in part called Smart City middle with three more planned buildings. Total area used for Smart City Graz middle is 8,2 hectares.¹

¹ smartcitygraz.at



Figure 66. Analysis° Overview of division in whole project Smart City Graz

BUILDING TYPOLOGY

LEGEND

- Public function
- Residential function
- Mixture between public and residential function

Directly near Hotel, in the area of the Smart City Graz middle are situated two office buildings arranged for whole companies and U-formed residential building with groceries shop, coffee, restaurant and pastry places.

Helmut List Hall is well known as gathering point for many conferences and other cultural occasions, so it fulfills need of hotel on this particular position.

Across the street is located Student dormitory, which contributes hotel position in occasion where parents would like to visit it children.

Among Smart City buildings, surrounding is mostly private residential houses with small shops or bigger storehouses with retail.

DESIGN GUIDELINES

Due to expansion of this area and bigger specter of new typologies, site needs are growing also. Hotel typologies with particular size of city hotel is suitable for current needs without compromising concept of Smart City Graz master plan.



Figure 67. Analysis° Building typologies

GREEN AND PUBLIC SPACE

LEGEND

- Green space
- Public open space

As seen on analyses, according to master plan, every building has its own green space except Hotel. It is surrounded with public space from three sides and only in back of building across the street has green part, that don't actually count as hotels green part.

DESIGN GUIDELINES

Through design of building, create hotels own green part and compensate lack of it in master plan.



Figure 68. Analysis° Green and public spaces

LEGEND

- Tram
- Tram station
- Residential function
- Street (cars, buses)

Every hotel needs good connection with city center so having tram station directly under building is great advantage. On the other hand also car accessibility is very good.

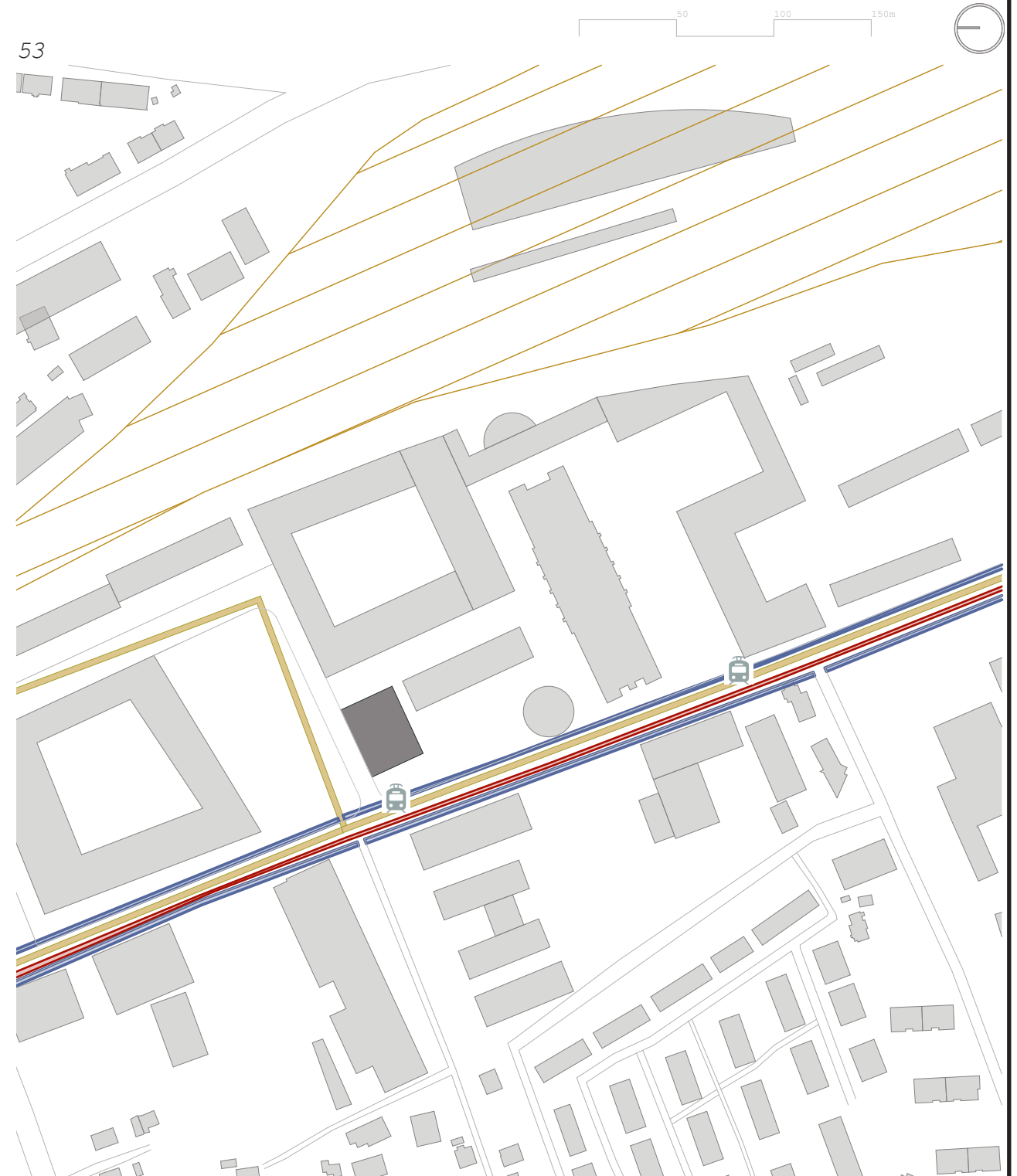
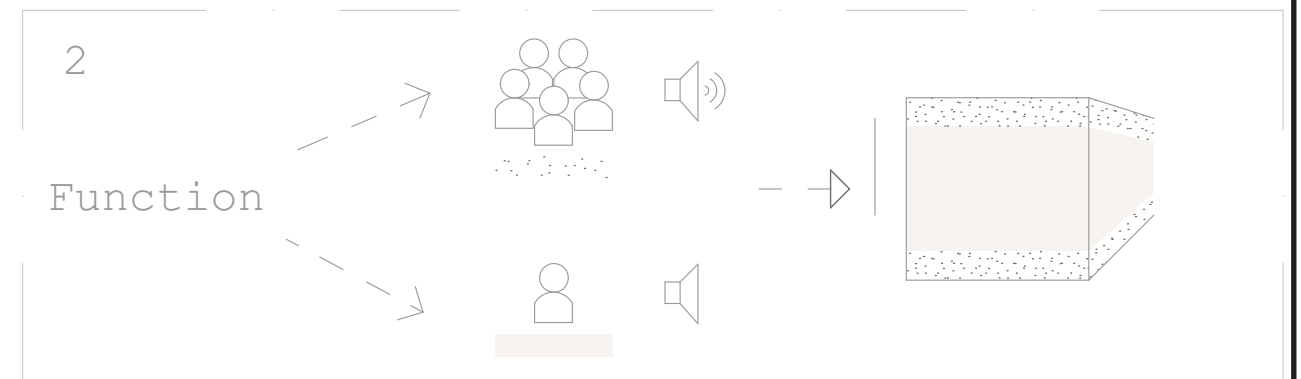
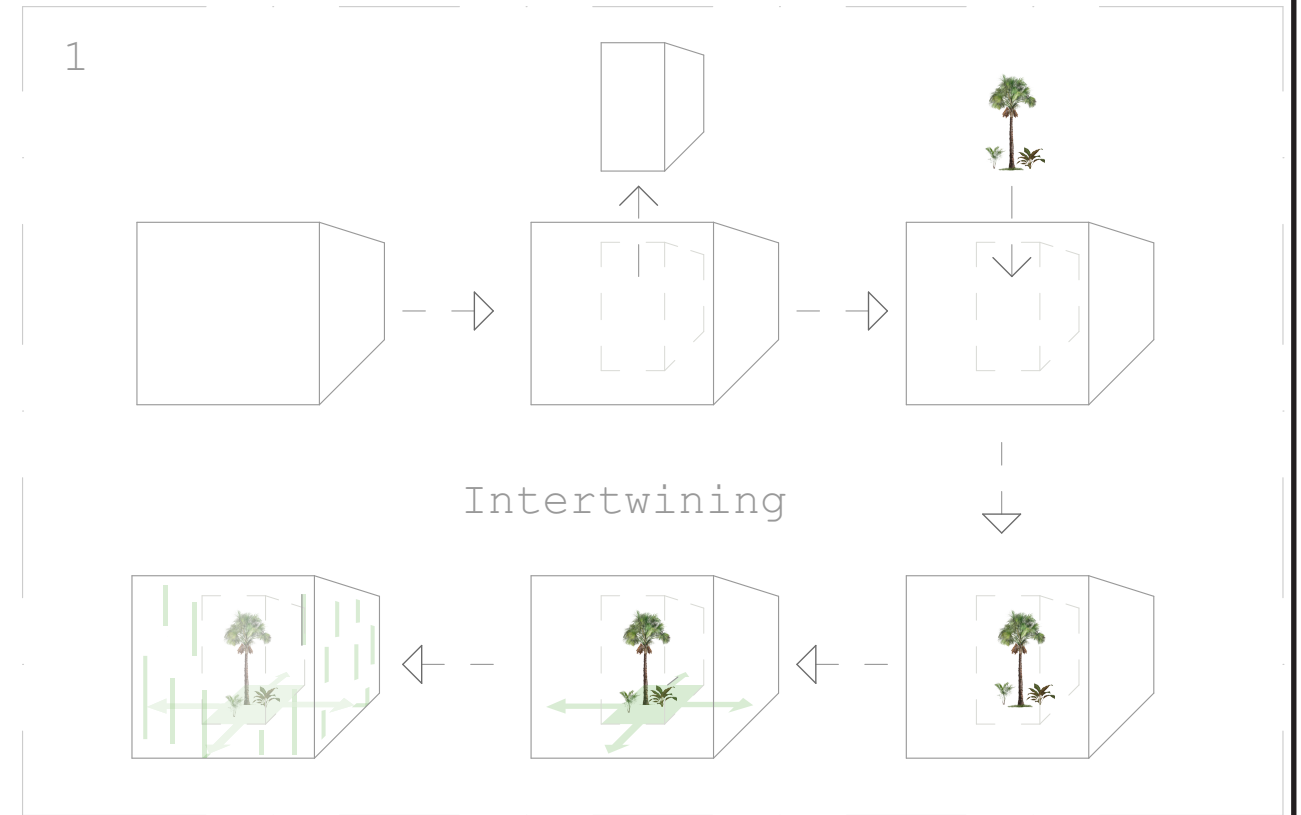


Figure 69. Analysis° Traffic overview

PROJECT ESCAPE



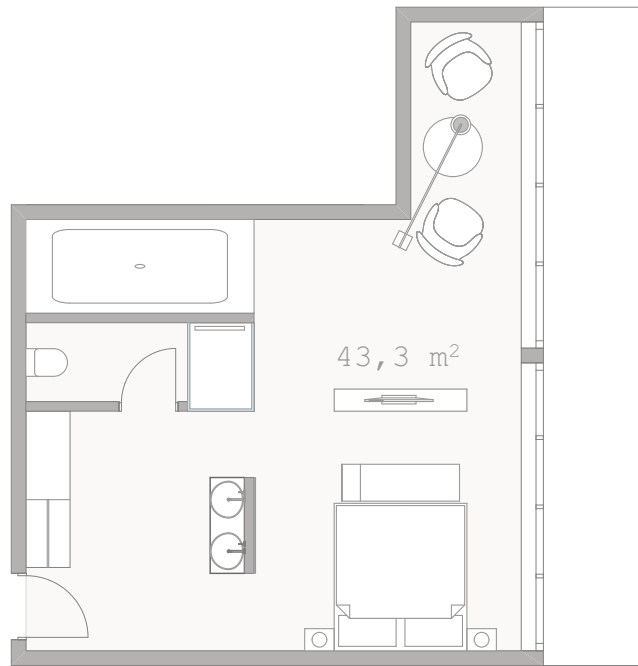


Figure 70. Suite plan

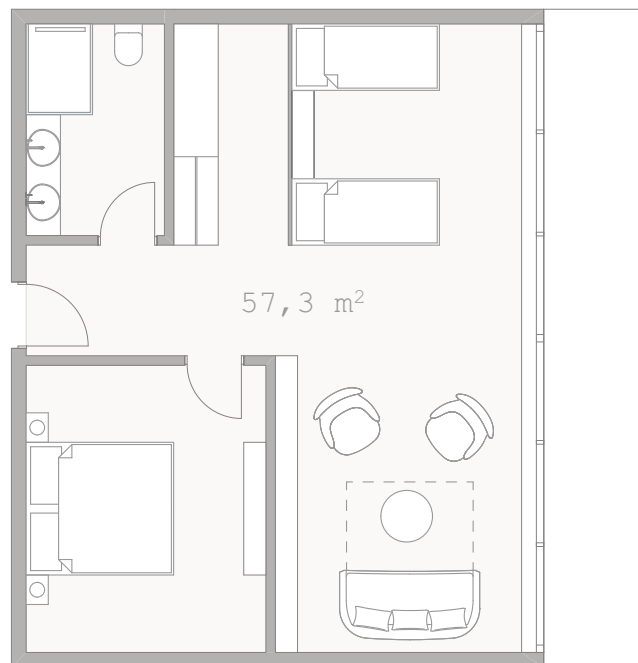


Figure 71. Family room

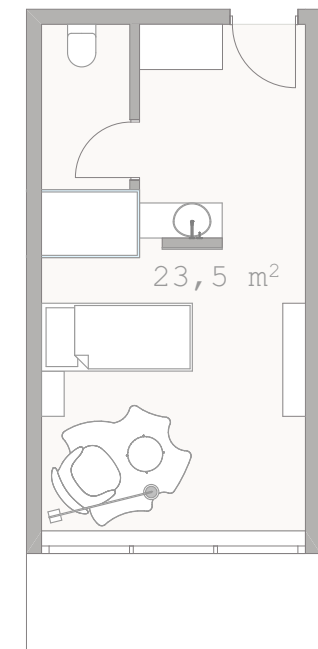
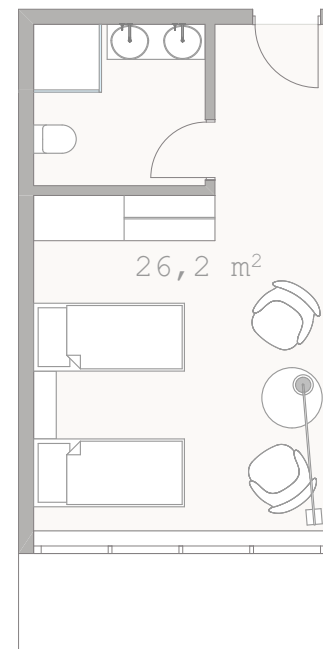
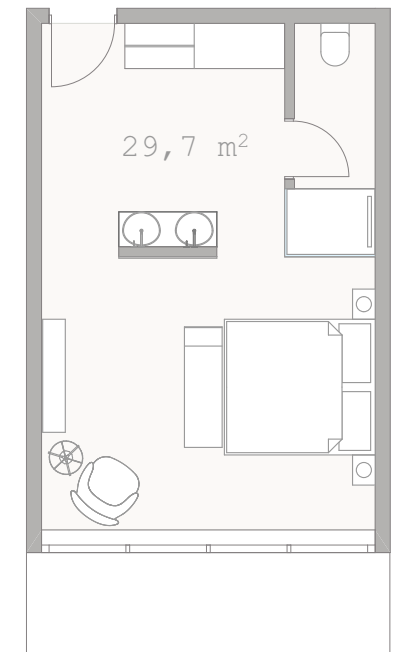
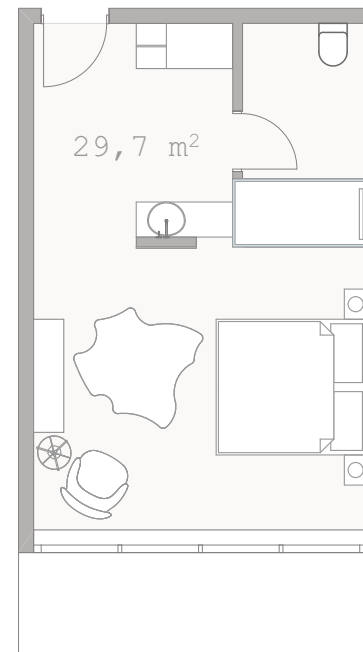


Figure 72. Double and single room

SITUATION

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Figure 73. Situation° S:1000

SITUATION

63

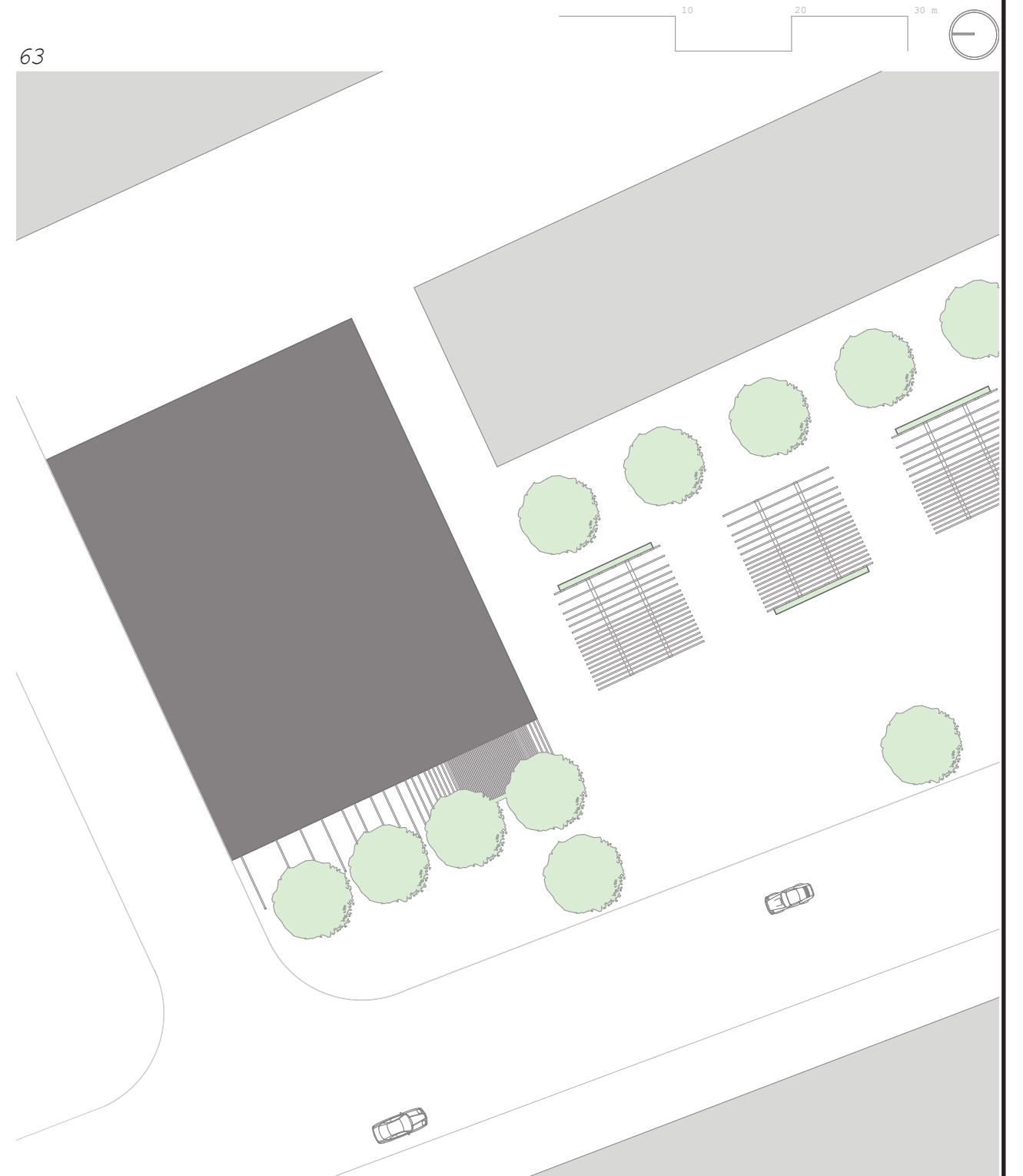


Figure 74. Situation° S:500

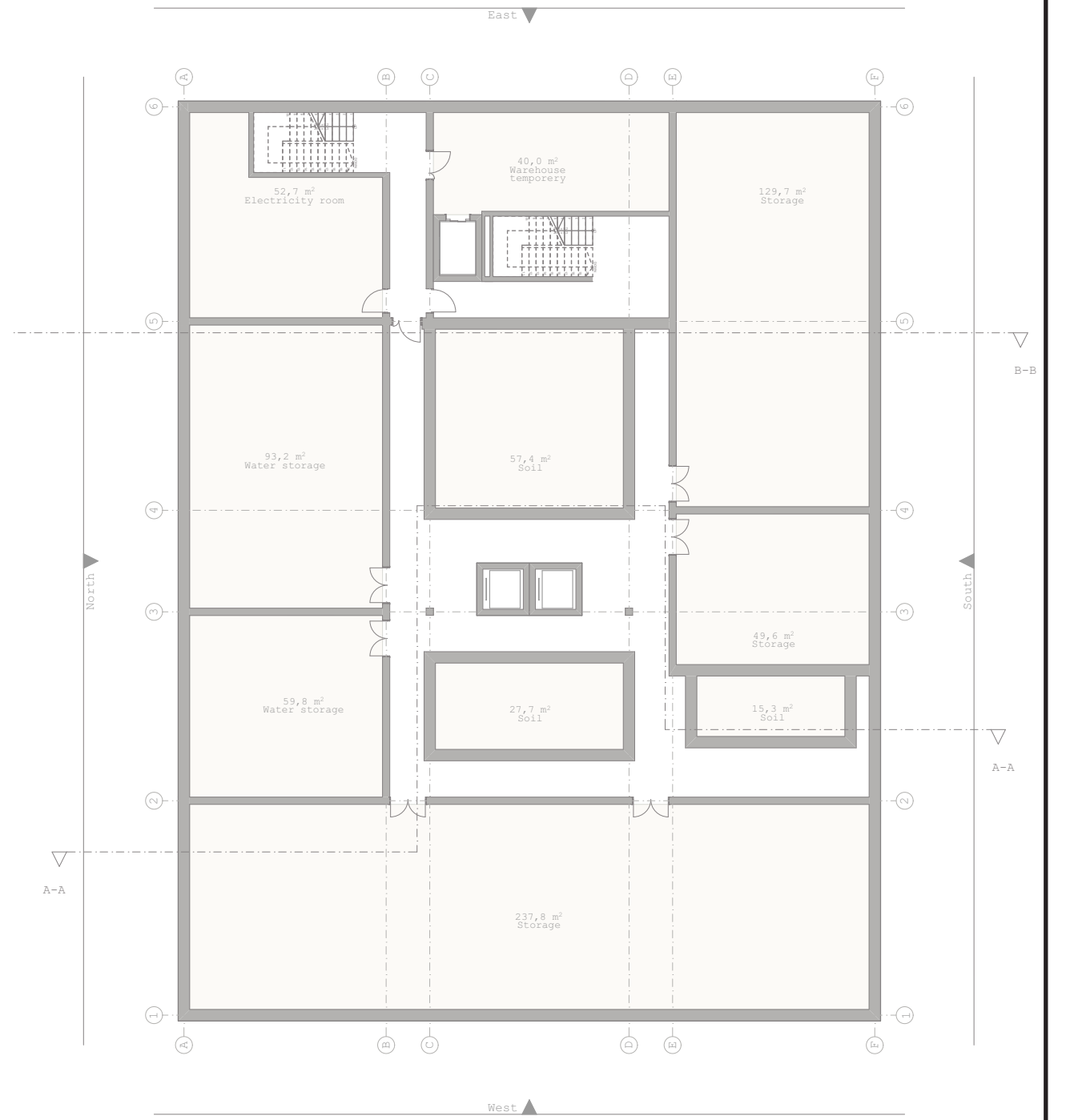


Figure 75. Basement

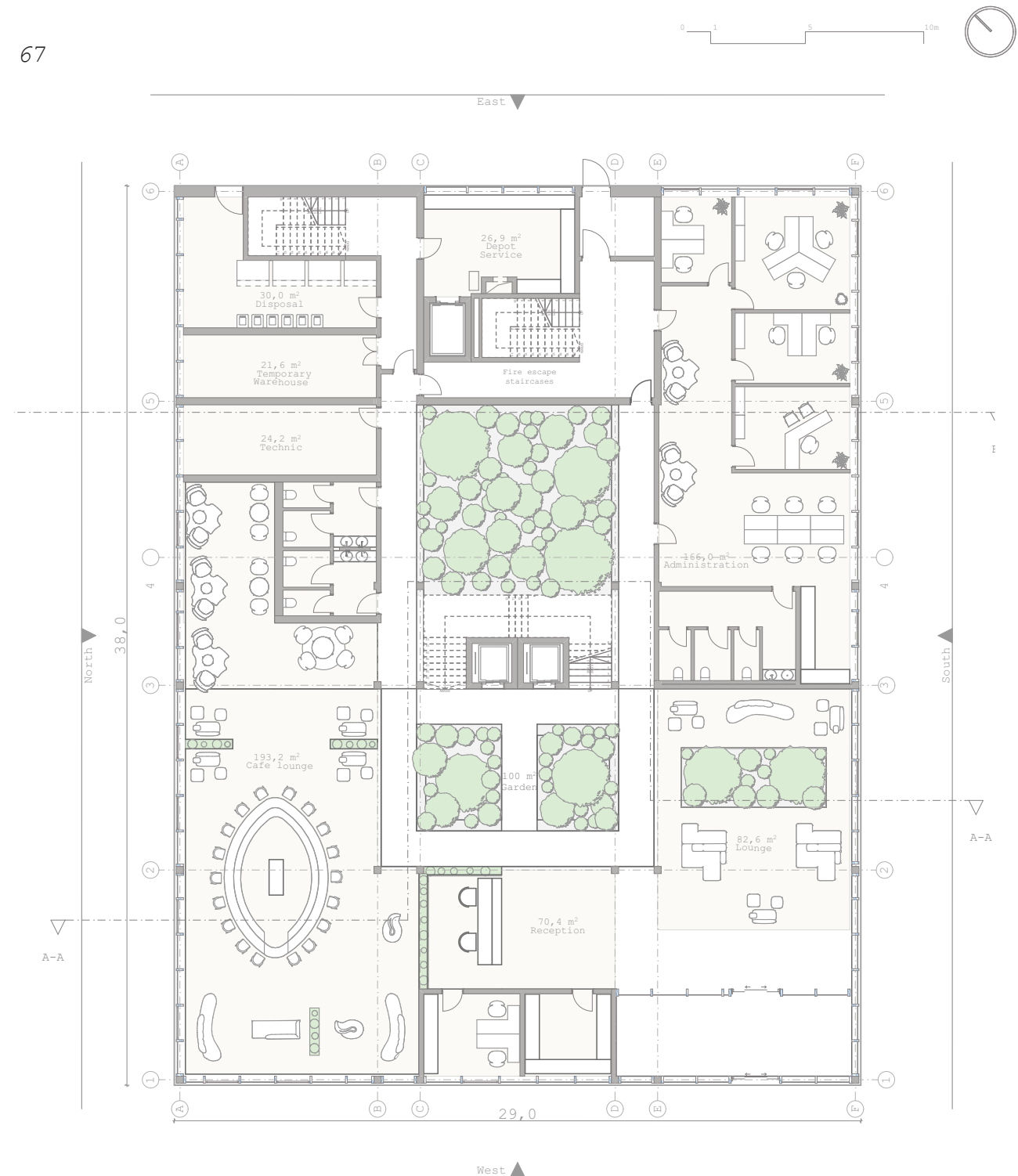


Figure 76. Groundfloor° Public zone



Figure 77. 1st floor- Hotel rooms° Private zone



Figure 78. 2nd floor- Hotel rooms° Private zone



Figure 79. 3th floor- Hotel rooms° Private zone



Figure 80. 4th floor- Hotel rooms ° Private zone



Figure 81. 5th floor- Hotel rooms° Private zone

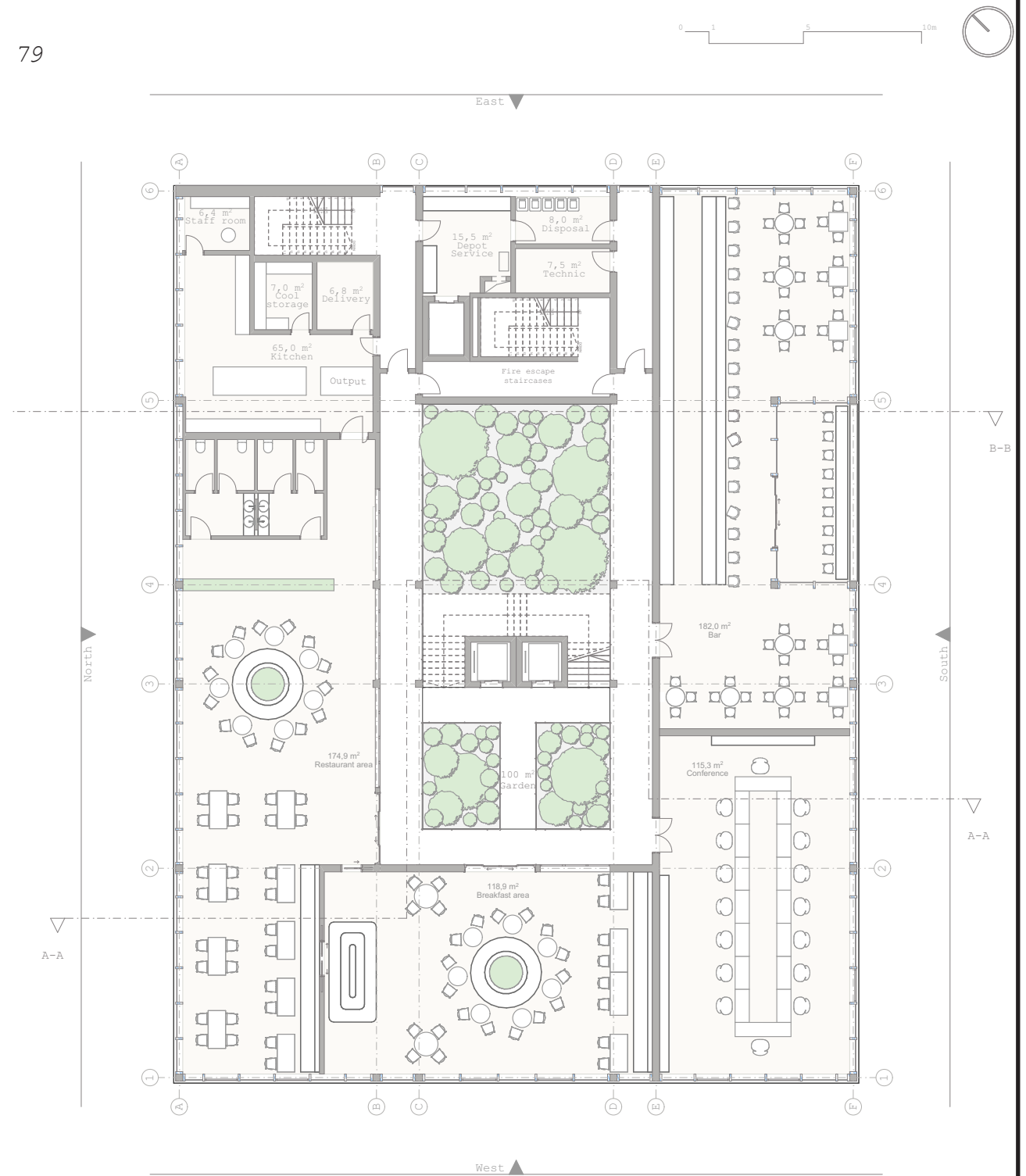


Figure 82. 6th floor- Public area

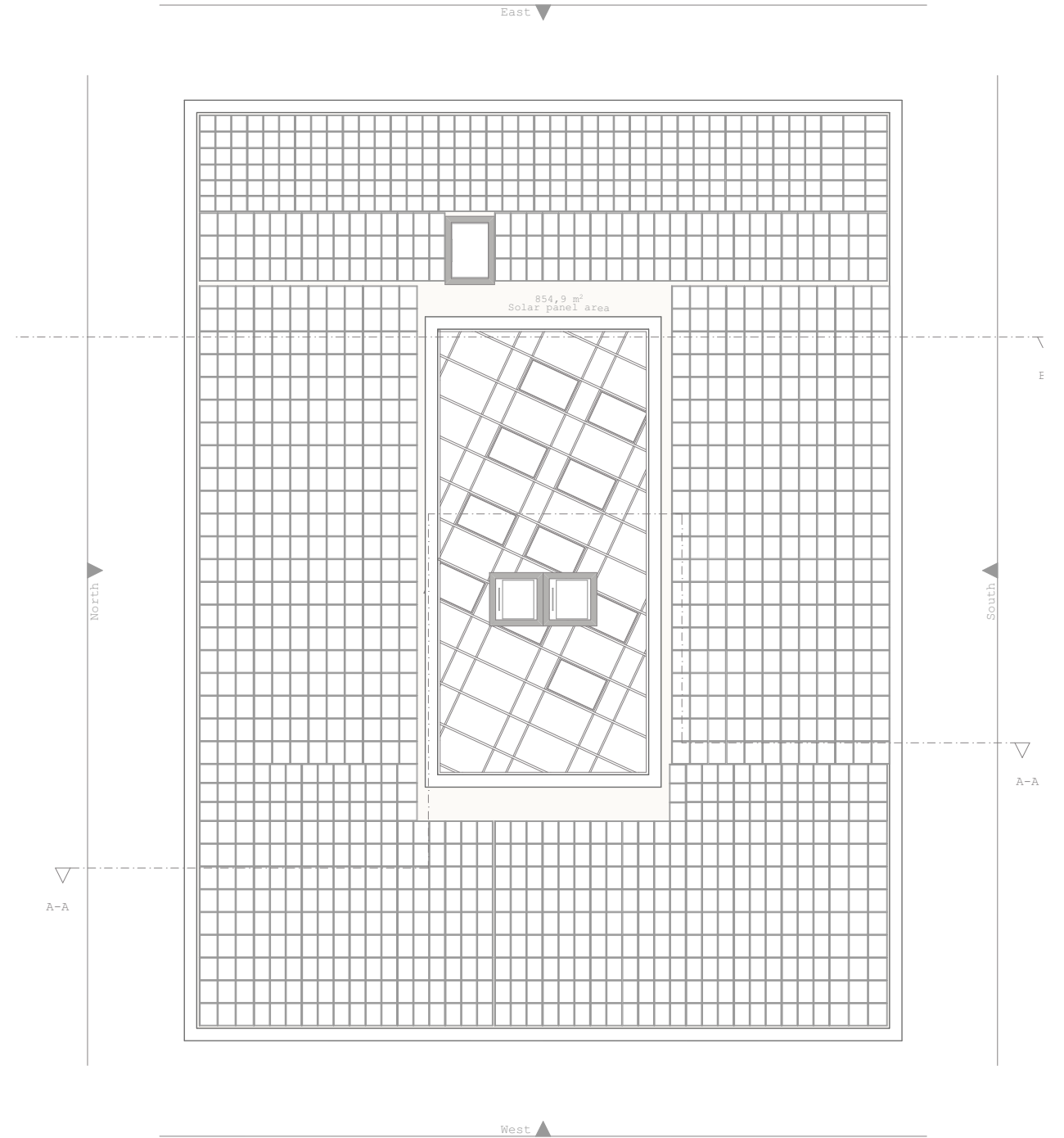


Figure 83. 7th floor - Roof



Figure 84. Section A-A



Figure 85. Facade° South



Figure 86. *Facade ° West*



Figure 87. Facade° North

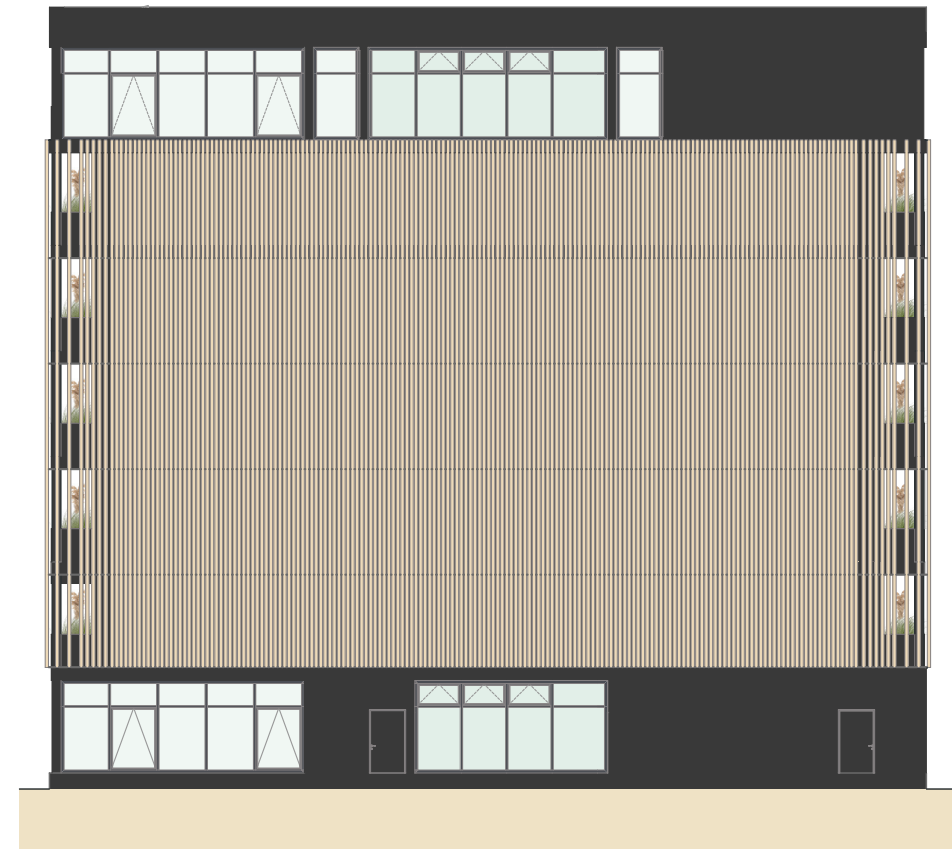


Figure 88. *Facade° East*

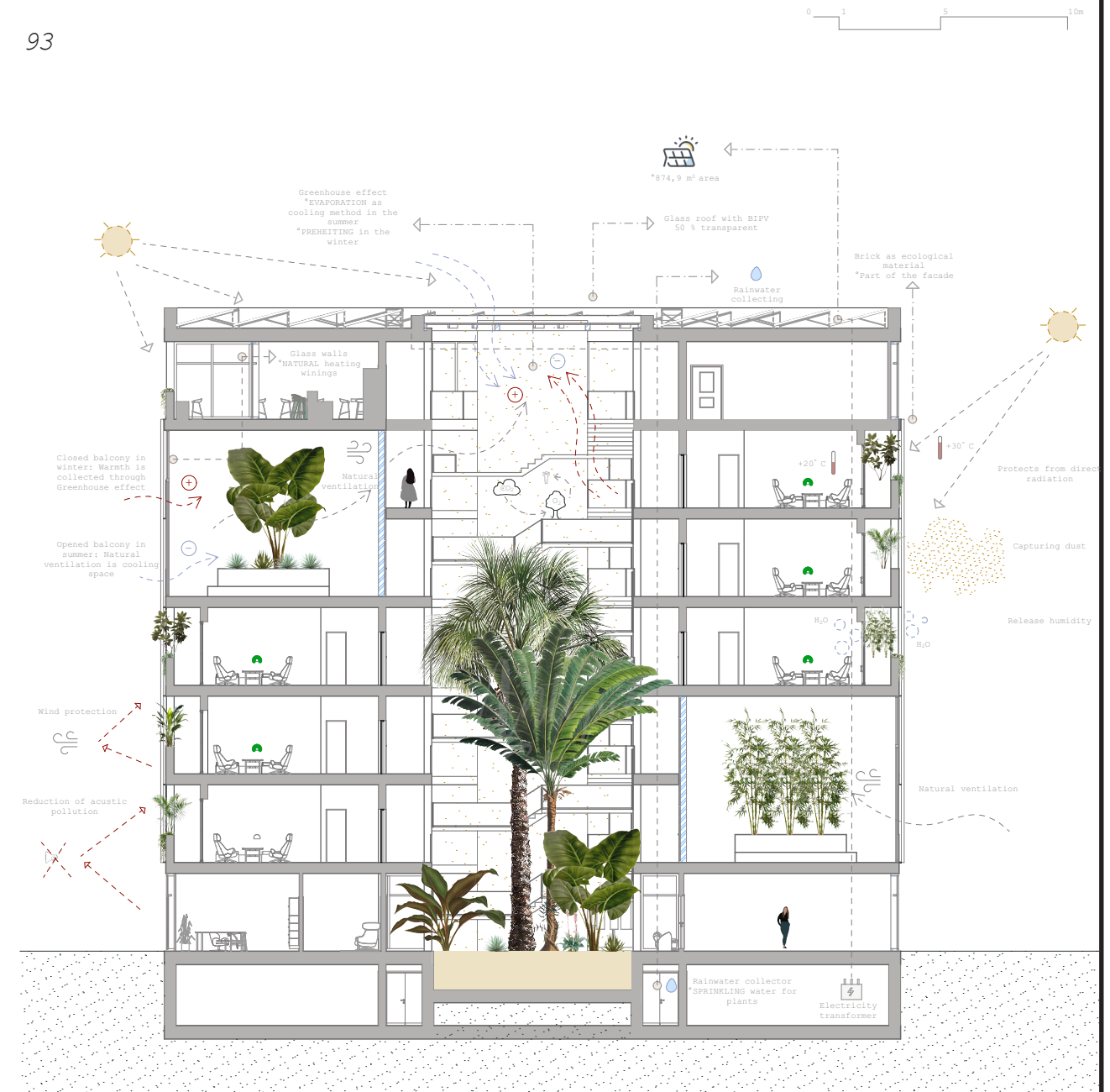


Figure 89. Section B-B° the concept of sustainable development

PV SITES CALCULATION

YEARLY IRRADIANCE

Yearly irradiance calculation computes the cumulated irradiance received on the object during the year.

In order to get most of the sun energy it very important that position of the possible sun collector has good strategic point.

As *Figure 96* shows roof is seen as very important point regarding sun energy. With a value of 250 Wh/m^2 it is on high scale of irradiance. Furthermore it confirms that flat roof fulfilled with Building-integrated photovoltaics is good strategy for gaining energy.

SHADING

Shading calculation computes the average exposure to shadows on the object during the year. Scale is from 0% to 100% where 100% means object never receive the shadow and 0 % means that element is in the shadow all over the year.

As the *Figure 98* and *Figure 99* shows mostly shadowed parts of building are the win-



Figure 90. Yearly irradiance south-east part of the building



Figure 91. Yearly irradiance north-west part of the building



Figure 92. Shading percentage of the south-east part of the building

dows openings because they are retracted. Two-storied terrace openings are noticeably lower on this scale because of their direct exposure to the sun. Using strategy of Greenhouse effect it gives to the project advantage of heating in the winter (the sliding windows stay closed) and with a help of ventilation (sliding windows are opened) pleasant cooler atmosphere.

DIRECT RECEPTION RATIO

Direct reception ratio shows average exposure to the sun on the object during the year. Difference with a Shading calculation is that direct reception ratio takes also self shading into account. Scale is form 0% to 100 %, where 100% means the element is always exposed to the sun and 0 % shows that element is never exposed to the sun.

As seen on the *Figure 100* and *Figure 101* windows are again into shaded zone and this time also two-storied terrace openings. Furthermore calculation of self shading gives advantage to this spaces in the summer and preventing overheating.



Figure 93. Shading percentage of the north-west part of the building



Figure 94. Direct reception ratio of south-east part of the building



Figure 95. Direct reception ratio of north-west part of the building

RESULTS

Figure 102 shows amount and ratio between direct, diffuse and indirect irradiance on Building integrated photovoltaics panels through year. Most represented irradiance is diffuse one but still in a big amount after it comes direct irradiance, which is most productive on BIPV system.

Figure 103 explains that in this case there are almost no noticeable losses in a term of shadow, what also contributes to the bigger and more successful usage of photovoltaic system.

Figure 104 represents amount of electricity production through one year. Obviously most successful production is in the summer months, especially in July and smallest production is in winter months, especially in December.

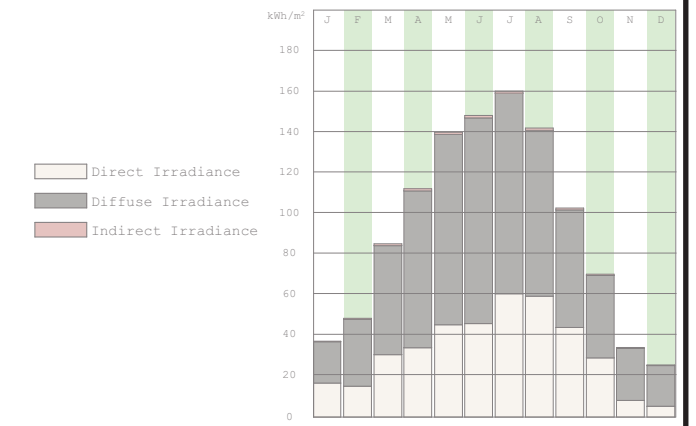


Figure 96. Irradiance through months

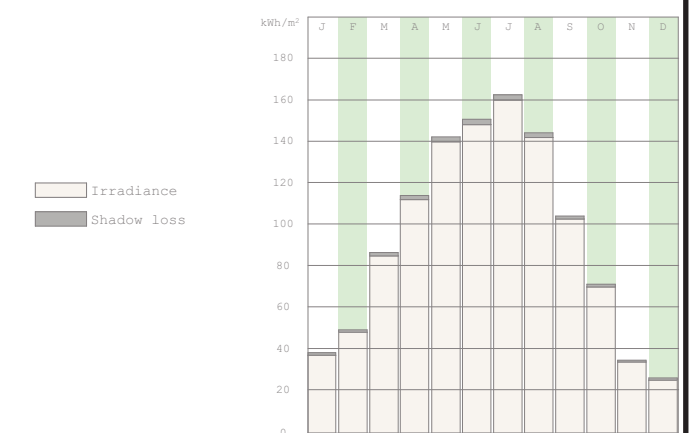


Figure 97. Irradiance loss by shadow

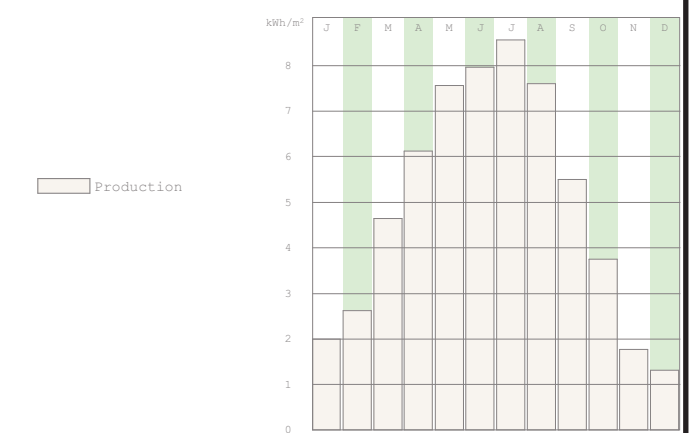


Figure 98. Electrical production

RESULTS

Figure 105 shows ratio in production and possible losses due to shadow. As seen on diagram, amount of losses in production is almost imperceptible and there is no big losses.

Figure 106 explains what amount of heat losses are present. Furthermore numbers are strongest in the summer part of the year and smallest in the winter.

Figure 107 represents difference between temperature on the photovoltaic panels and in the air.

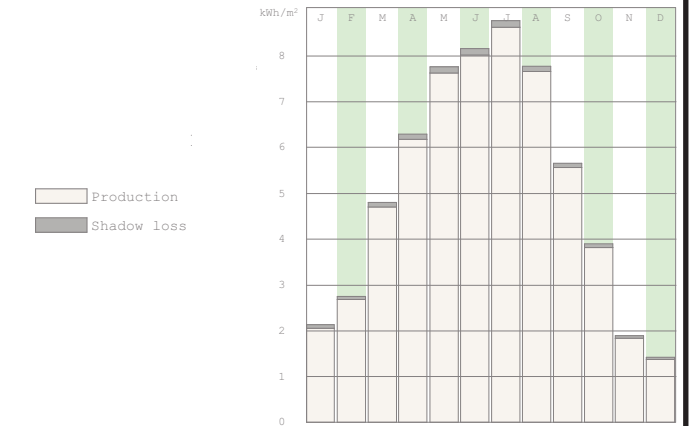


Figure 99. Electrical production loss by shadow

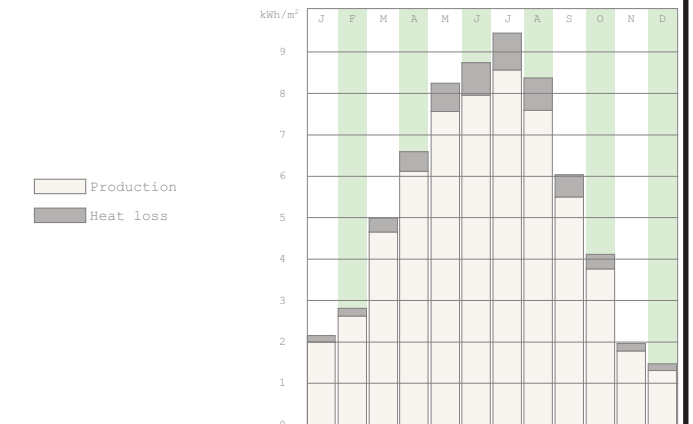


Figure 100. Electrical production loss by temperature

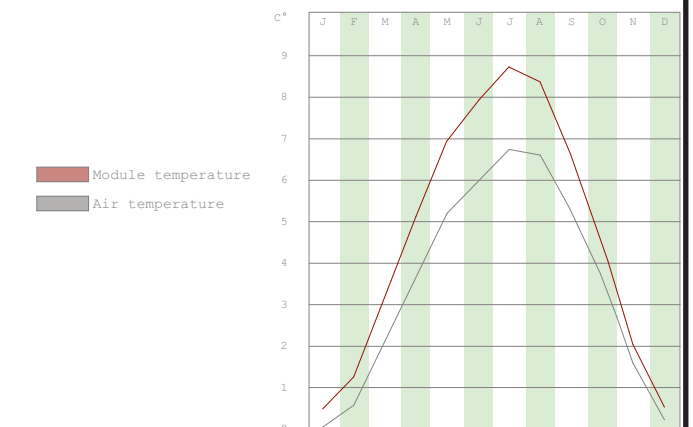


Figure 101. Module temperature

RESULTS

Figure 108 shows ratio between Self consumption and Feed-in strategy. Feed-In is a policy mechanism designed to accelerate investment in renewable energy technologies.

Figure 109 point on self consumption compared to Network consumption and Feed-in investments.

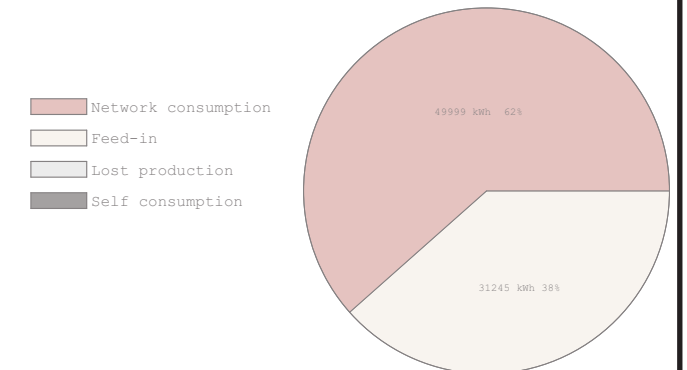


Figure 102. Pie diagram ratio Self consumption and Feed-In

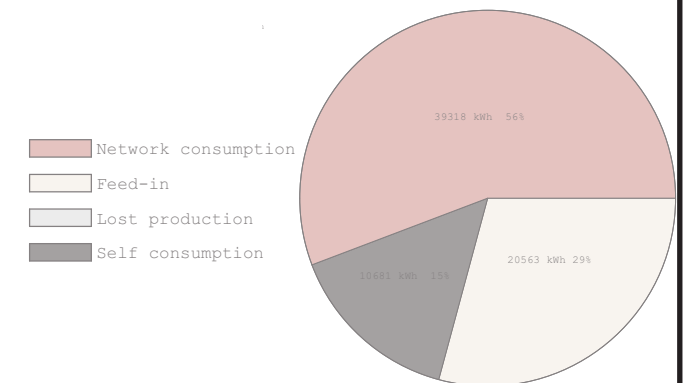


Figure 103. Pie diagram ratio Self consumption, Feed-In and Network Consumption



Figure 104. 3D Rendering



Figure 105. 3D Rendering



Figure 106. 3D Rendering



Figure 107. 3D Rendering Inside Atrium



Figure 108. 3D Rendering Lobby

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LIST OF TABLES

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