



**SUSTAINABLE
VALBY CULTURE CENTER**

Master thesis | MSc04 ARK Spring 2016 | Group ma4-ark8 | Anna Van

SUSTAINABLE VALBY CULTURE CENTER

Master thesis in Sustainable Architecture

Institute

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FOREWORD

This master thesis project is developed in the period between 1st February 2016 till 25th May 2016 and created by Anna Van, MSc04 spring 2016 Architecture and Design, Aalborg University. The theme is sustainability where a new culture center are developed with the use of advanced Integrated Design Process. The idea is to integrate engineering considerations in the design process, based on energy, indoor climate and social aspects. The project shows the stage of the developed knowledge, competencies and skills the student have achieved, throughout the whole education at Architecture and design at Aalborg University.

I would like to give a special thanks to the following people who contributed to the help and guidance, I have received during this project:

- Main supervisor Michael Lauring, Architect MAA PhD., Associate Professor, for the constructive guidance and encouragement, professional discussions and good cooperation throughout the whole project.
- Technical supervisor Peter Wilhelm Nielsen, Engineer Lic. techn., Professor, for constructive guidance on technical design solutions and good cooperation throughout the whole project.
- Finally, I would like to thank my family and friends for the encouragement and moral support through my master thesis.

ABSTRACT

A new Valby Culture Center and Valby library are developed in the historical industrial district, Valby in Copenhagen. It is the new cultural meeting place, that provides cultural activities to the new citizens, moving into the district in the near future. But it is also a place for people to meet and interact between different interest and cultural differences.

The culture center are visible in the district and forms a new innovative sustainable building with an attractive open square and opportunities for cultural events.

The project integrates aesthetic, functional and technical parameters into the design process to fulfill the goal of building class 2020. Both for the energy consumption and indoor climate and with additional renewable energy from solar cells on the roof, the building reach Zero Energy Building.

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INTRODUCTION

The project are based on personal interest on developing of my local area. Valby is a small district in Copenhagen, but are now under a huge development. Within few year, thousands of new residents, offices, commercial are developed in the district, therefore is there a need for a larger and modern culture center to fulfill the needs from the new citizens.

The existing culture house and library are out-dated and does not live up to the Valby culture strategy 2014-2018. They wish to have a strong cultural identity and profile in Copenhagen by creating a new Valby culture center that is more visible and open to the public with facilities as meeting rooms, workshops, workspaces, exhibition, café, library and Borgerservice. The new cultural center will be the new platform of cultural life, social activities located in the central of Valby and next to an open square, which is used as a gathering point for major cultural events. By linking the cultural facilities onto the square and makes it into the cultural center of Valby.

This creates at dynamic and attractive town where citizens across culture, age and social backgrounds meet and interact with each other to engage in the cultural life.

READING GUIDE

The report is divided into different chapter, where the first is the presentation of the results, shown both renderings and technical drawings.

The second chapter is about the site analysis and ends with and summarizing of the conclusions.

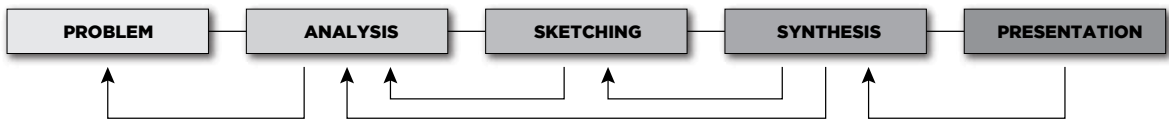
The third chapter is about the theme analysis of the culture center and other relevant themes. The chapter ends with and summarizing of the conclusions.

The fourth chapter is the program as a result of the both analyzes, with a design parameters and room program. It will function as the base for the next chapter in the design process, which is a mix of sketching and technical calculations.

The fifth chapter is the final considerations with an conclusion and a reflection.

References list, illustration list, table list and appendix is located at the end of this report as a supportive material. Harvard method is used for references, where surname and year is in the text and a more detailed reference is in the reference-, illustration- and table list.

METHODOLOGY



III. 01: The Integrated Design Process

The overall methods that are being used in this project is "The Integrated Design Process". This method is combining engineering and architectural skills to solve more complex problems, which often is seen in designing a sustainable building. The method is developed by the Mary-Ann Knudstrup as part of a Method Anthology book, "Pandoras Boks". [Knudstrup, M. 2005].

IDP deals with architecture, design, functional aspects, energy consumption, indoor environment, technology and construction. The method consist of five phases which all have to interact in an iterative process of designing. It is not a chronological process and consists of loops between the phases. It has an influence on the aesthetical as well as technical parameters and they relates to each other to achieve an integrated design in a early phase.

The illustration above shows a simple illustration of The Integrated Design Process, but the design phase is much more complicated [Knudstrup, M. 2005].

Both quantitative and qualitative methods is being used in the analysis phase that form the analysis for the site and theme:

Phenomenological registration

Is used to map the surroundings of a site and create an understanding of the organization of the overall context and structures. Photograph is taken at eye level where the focus is how the context is being experienced scenographic. It is a phenomenological registration, because it is a selective fragmentation of experiences that are created from roads, buildings, light, moods, colors and materials.

Mapping

The method used for tracking the contexts current typologies, functions, infrastructure, green areas to find the challenges and problems, but also qualities and potentials that exist in and around the site.

Case study

Case studies are used to understand how similar existing architectural Culture Center works. By understanding the plans and functions.

Quantitative analysis

Analyses that are measurable are quantitative. Quantitative analyzes can be done by surveys, which uses open or closed questions or on data collection. The quantitative analysis makes it easier to understand the target audience wider and compare the results of the investigations.

Quantitative analysis is used on the climate condition on the context, both on Sun diagram, Wind rose, Noise, Temperature etc.

Qualitative analysis

Analysis carried out by, for example, interviews that are not measurable, are qualitative. These provide enough results, but there can be much data processing associated with an interview, and it can be difficult to compare data, since the results can not be fed into a schedule.

Interviews are used for interviewing the leader of the culture center, to get information about the current situation of the culture center and what they wish to have in a new culture center.

Harvard Method

Harvard Method is used for references, where the surname and year is in the text [Surname, 20XX]. Further information is referred in a reference list at the end of the report.

VISION

The aim of this thesis project is to develop a sustainable Culture Center and library, as a innovative image of a modern sustainable multi functional Cultural Center. By setting the frames for learning, development, participation, performance, creativity, fun, contemplation and at the same time support a community as a informal gathering place for the citizens to interact with each other.

PRESENTATION

The following chapter are a presentation of the final results from the analysis and design process.

It contain a situation plan on how the building situates in the context, simple concept diagram that illustrates the develop of the final design. Renderings that illustrates a mood of the spaces, plans of each floor with a proposals of the interiors, section drawings through the building, to see how the building functions and the connection to the existing building and surroundings. Elevations of the facades are illustrated to understand facades and the building volume. A detail drawing are illustrated to understand the construction of the building collection.

Eventually a concept drawing of the sustainable strategy are illustrated to understand the overall strategy for the building.

Valby Culture Center and library is a cultural meeting point for the citizen of Valby district, but also for the people living in Copenhagen Municipality. The new culture center is located on the corner of a main junction and curves around the corner, to create a softer barrier towards the roads. This curved facade will lead people around the building and into the square. Inside the square you will find a circular square that creates a quiet environment, enclosed from the busy traffic.

The culture center is flexible for the users with a self-service access the building, whether you need to use of the culture facilities or at rent a book in the library.

This give the user an opportunity to use the facilities when ever they want. The diversity of different functions and spaces creates opportunities to be creative, in a dynamic environment, where people can meet and interact between different interest and cultural differences. It a place for people to unfold them self and be creative.

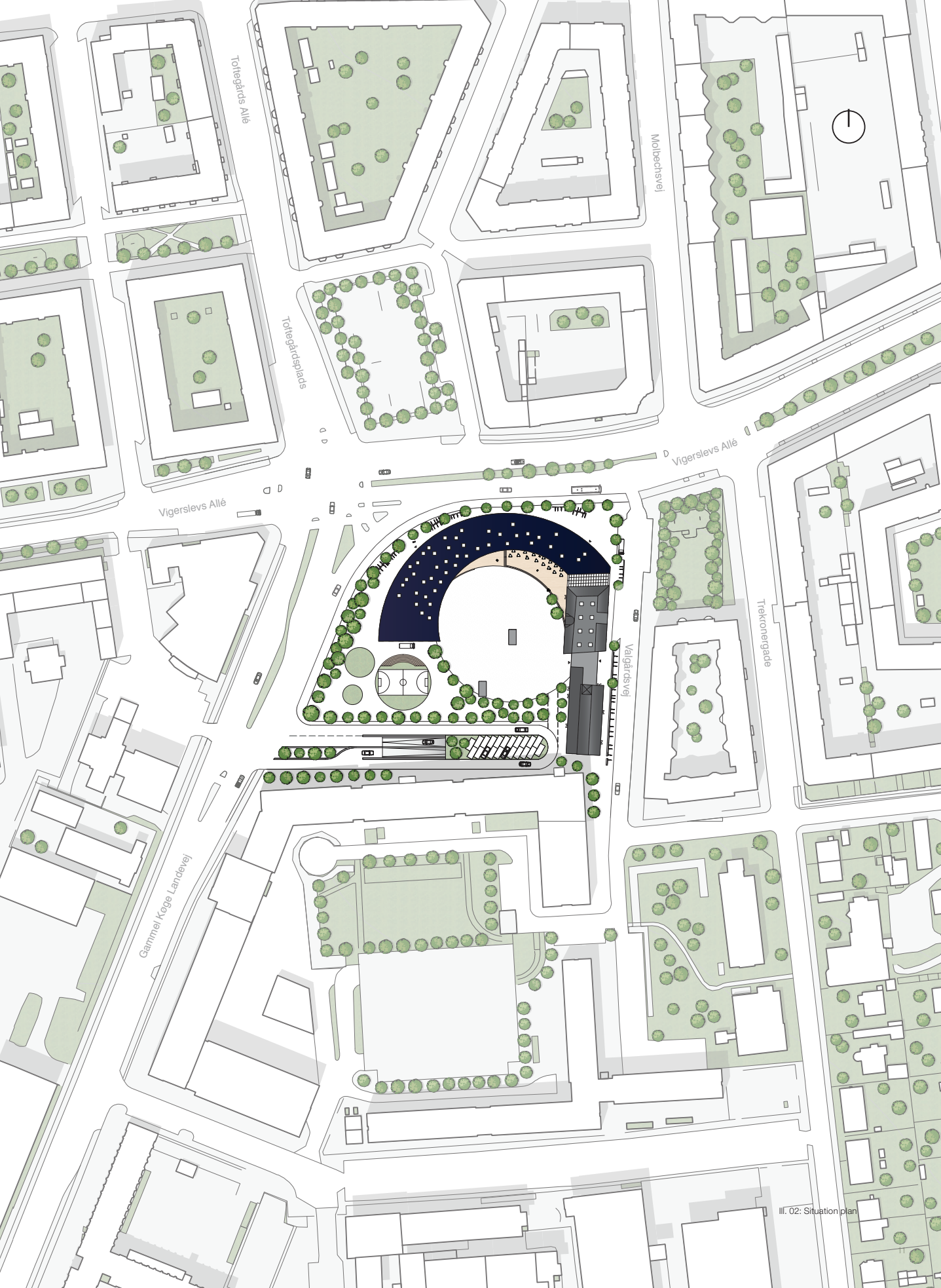
The final room program can be found on page 66.

SITUATION PLAN
1:2000

Site: 13.395 m²
Parking on site: 22

Valby Culture Center
excl. basement: 5.358 m²
Valby Library: 1.903 m²
Total incl. basement: 12.978 m²

Building ratio: 40%
B/N-factor 1,3



Tottegårds Alle

Molbechtsvej

Tottegårdsplads

Vigerslevs Allé

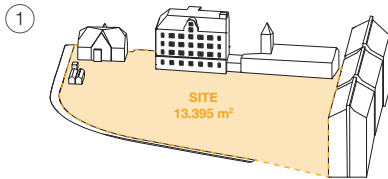
Vigerslevs Allé

Trekronergade

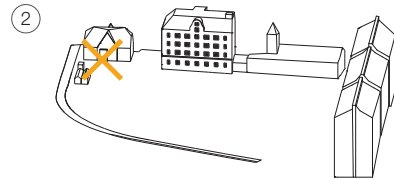
Valgata (52)

Gammel Koge Landevej

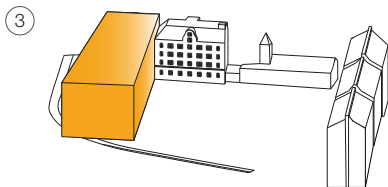
CONCEPT DIAGRAM



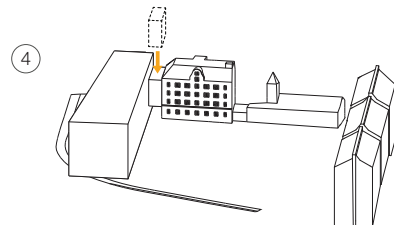
III. 03: The site (Toftegårds square south)



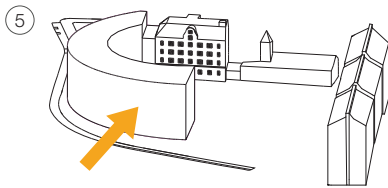
III. 04: Demolish existing building and sheds



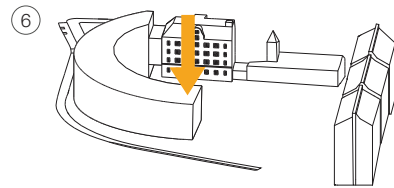
III. 05: Adding a rectangle to enclose the square from the traffic



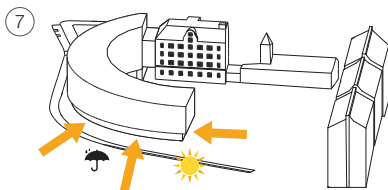
III. 06: Adding a glass atrium in order to separate the existing building with the new



III. 07: Push in the building to follow the road and enclose the square even more



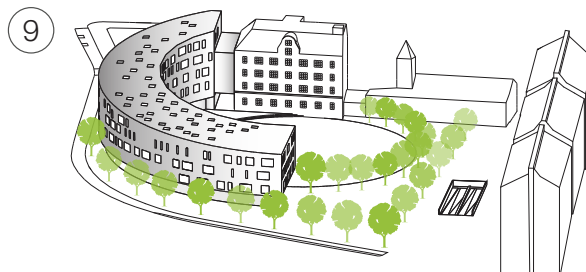
III. 08: Push down the roof to emphasize the human scale



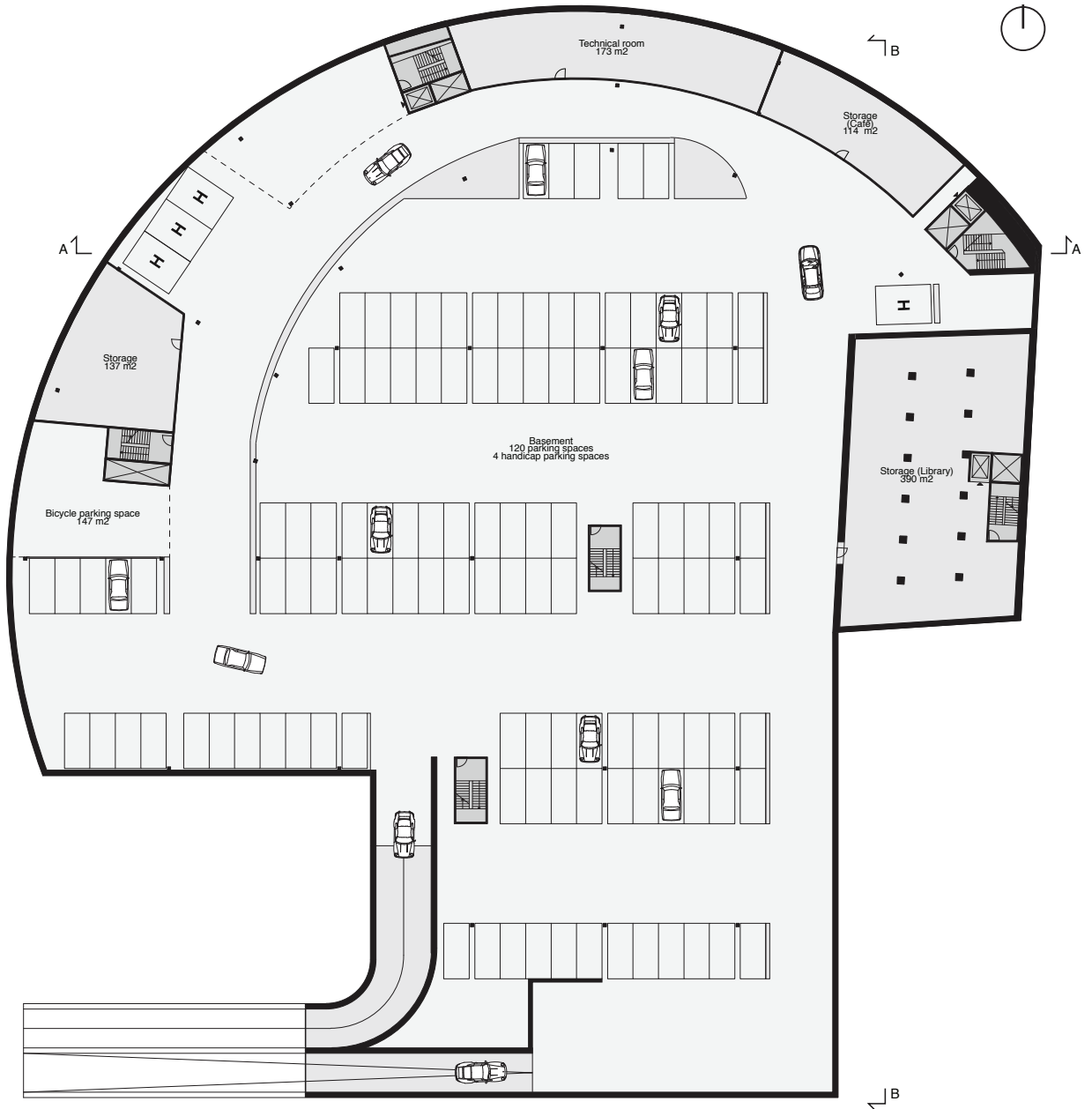
III. 09: Ground floor facade are pushed in 1,5 meter to create shelter from the rain and sun.



III. 10: Soft materials such as wooden terrace and trees around the building lessen the traffic noise.



III. 11: The curved building creates an enclosed square away from the traffic noise



-1 BASEMENT
1:600



III. 13: View from West into Toftegårds square south

The new Valby culture center represent a modern sustainable building where the main aspect are the social sustainability. The building is visible in the district, as a curved building with the character of the old industrial history.

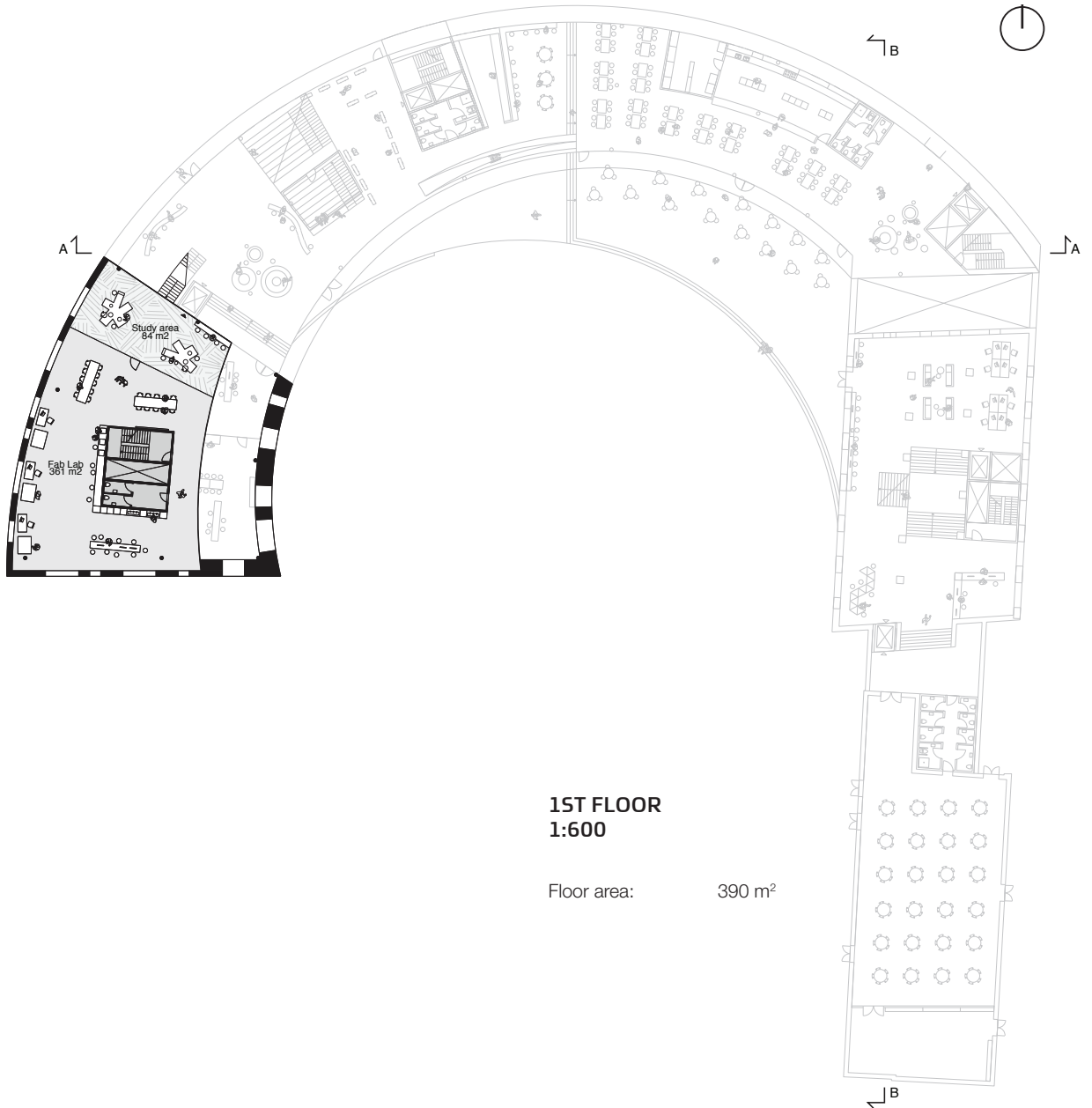
It contributes to a creative environment with the possibility to pursue your interests and function as a community, where people meet and interact between different ages, gender and cultural differences. The culture center has a transparent open facade on the ground floor, where public functions are located to attract people into the building. These function are the lobby, exhibition, study area, café and workshop area. The further up you get inside the building, the more private the functions are.

The culture center wraps around a circular square and are framed by the new culture center, the existing building and trees. It is an open square with opportunities for cultural events and activities, such as skating, flea market, concerts, performance, ice skating in winter, events, etc.

The square are enclosed from the busy traffic and the wind, but still visible through the ground floor. It functions as the central community of the cultural center and are connecting the existing building with the new.

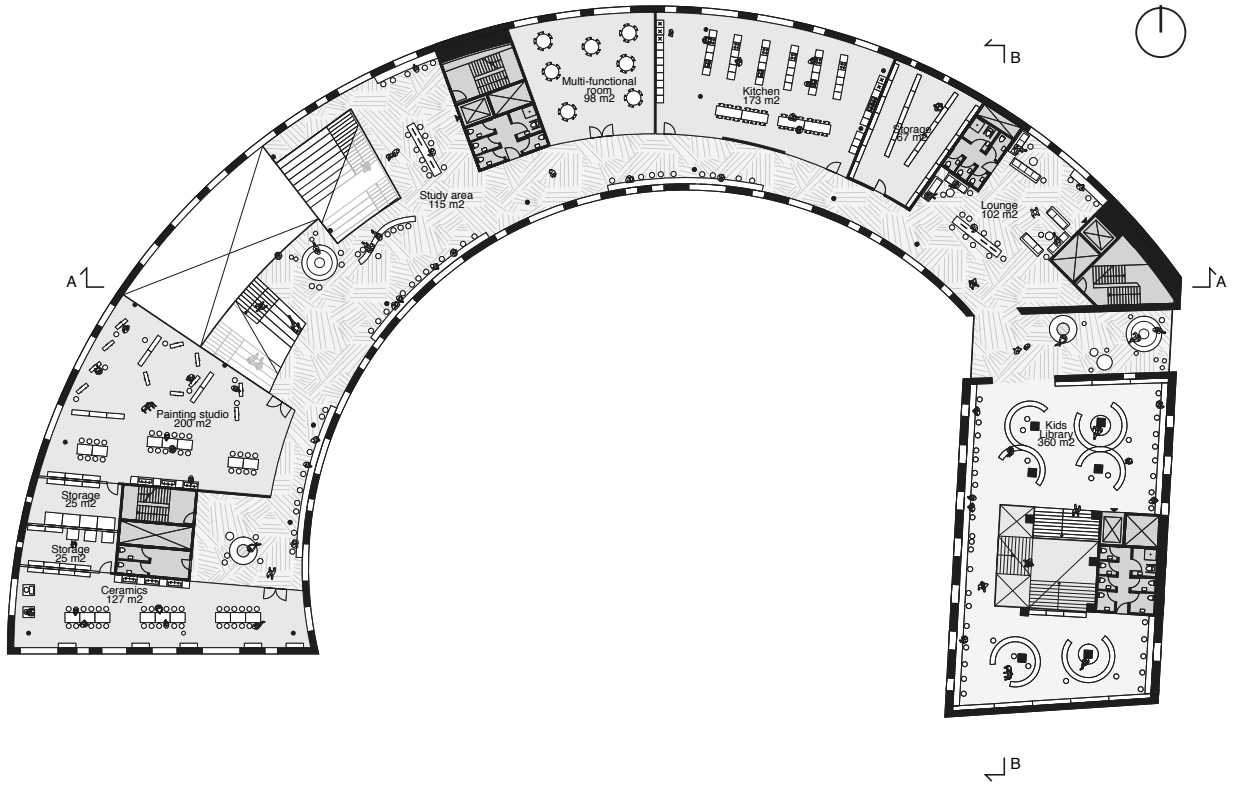


11.14: Ground floor plan



**1ST FLOOR
1:600**

Floor area: 390 m²



**2ND FLOOR
1:600**

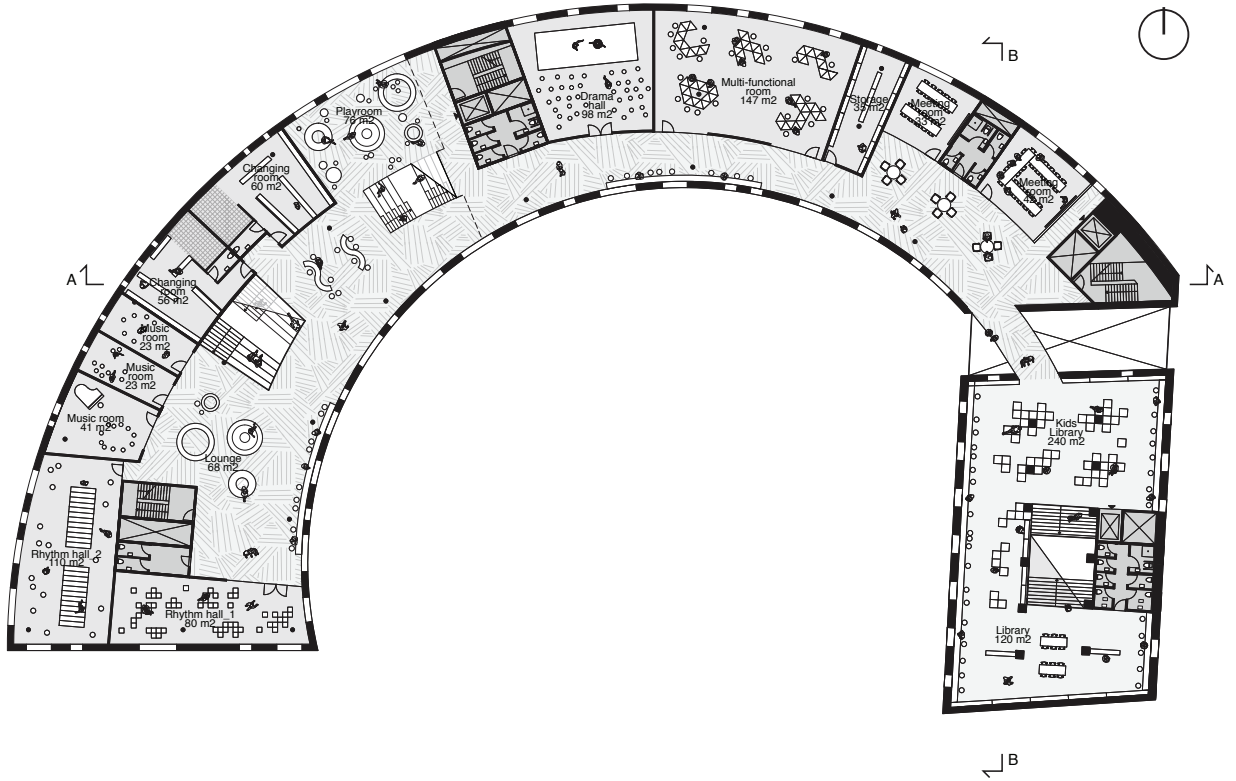
Floor area: 2.212m²



Ill. 17: View of Zone02 in the hallway on 3rd floor

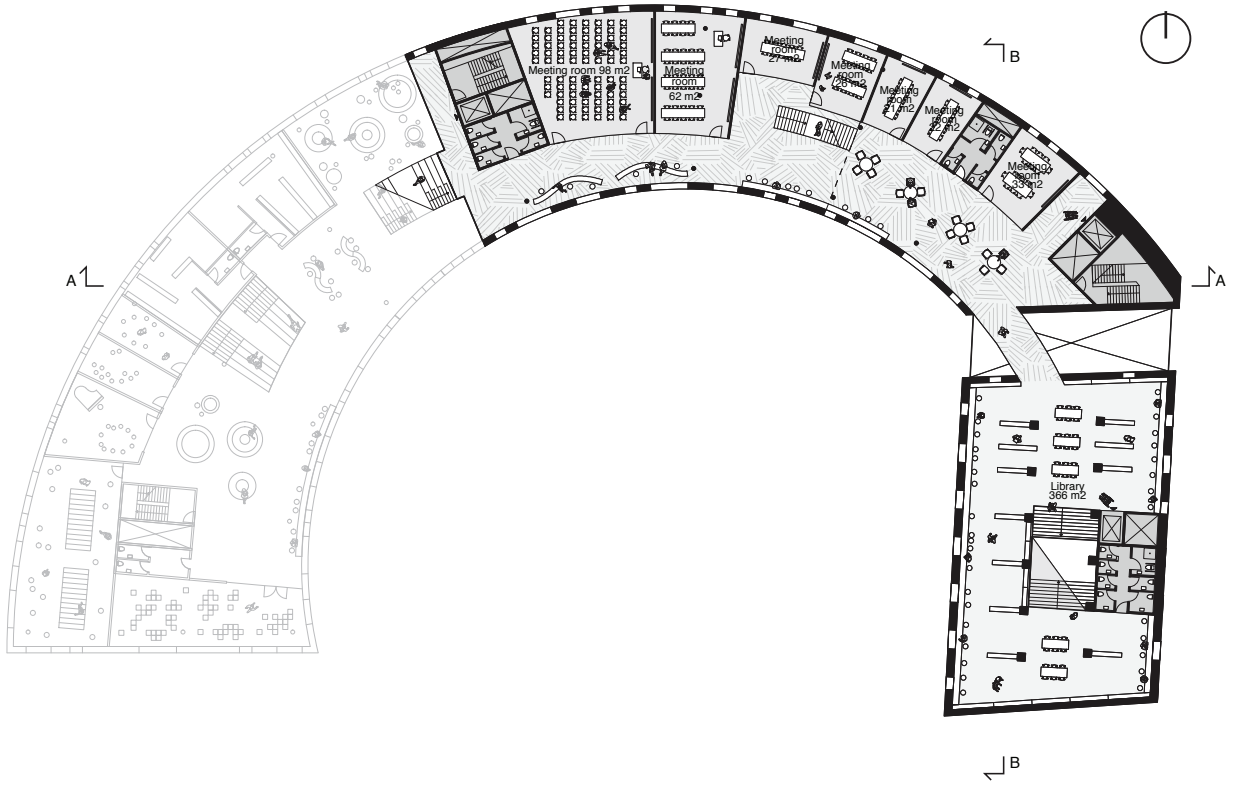
The new Valby culture center are a diverse multi functional and open building, where people come for learning, self development, performance, creativity, fun, contemplation and at the same time a community that gather the citizens informal surroundings.

The 3rd floor is a creative zone for children, with spaces for play and development. The floor is a double height space which creates a open feeling and great daylight from the facades and roof windows. The curved wall guides you through the building and are connected to the floor of Valby library in the existing building. The floor in the library are the kids library, which creates easy access between these facilities. All the stairs combining the floors are made of wood to indicate the connections.



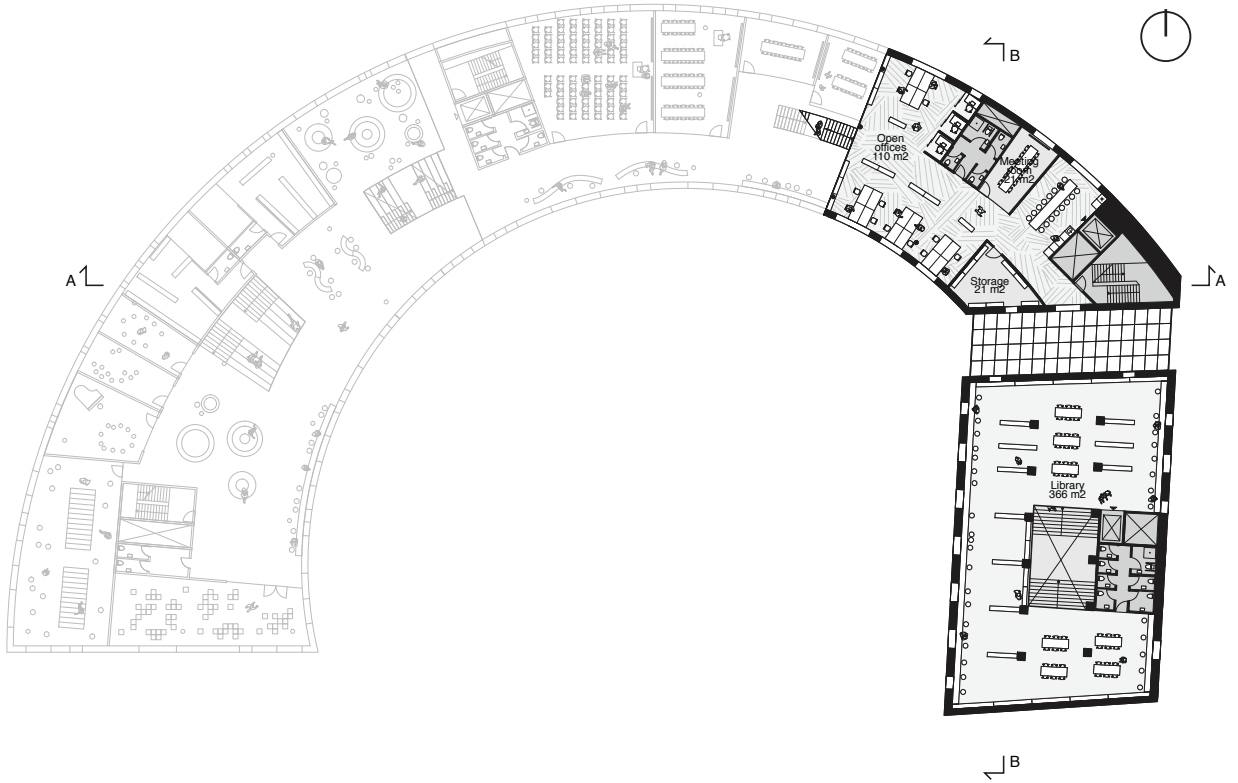
3RD FLOOR
1:600

Floor area: 2.112 m²



4TH FLOOR
1:600

Floor area: 1.199 m²



5TH FLOOR
1:600

Floor area: 703 m²



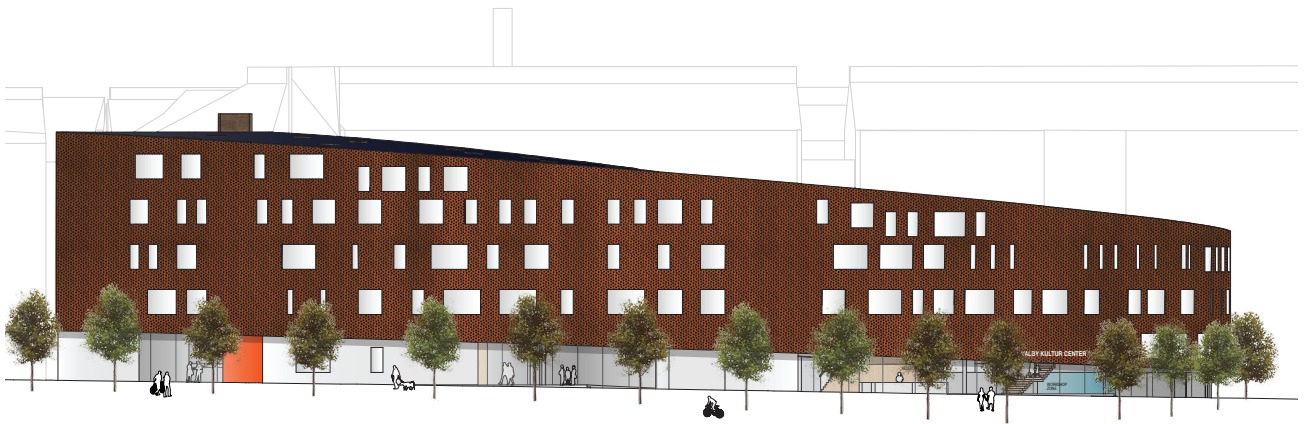
ELEVATION EAST
1:600



ELEVATION SOUTH
1:600



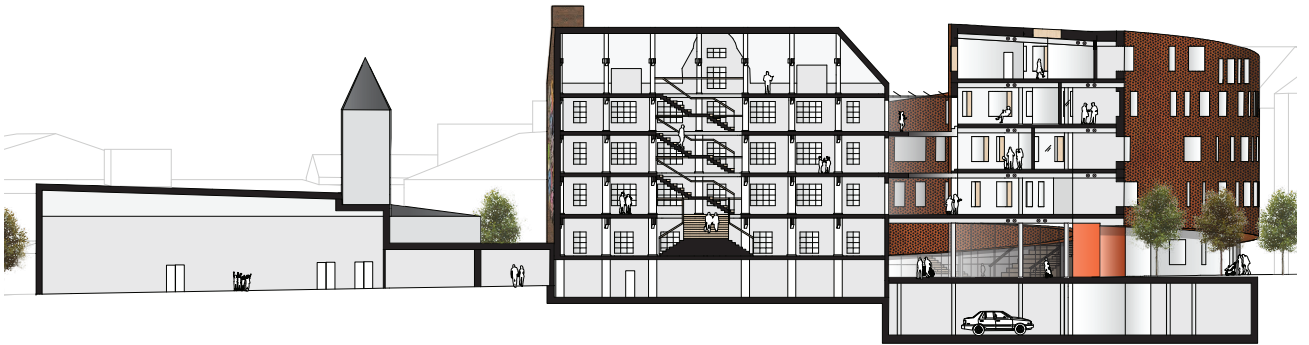
ELEVATION WEST
1:600



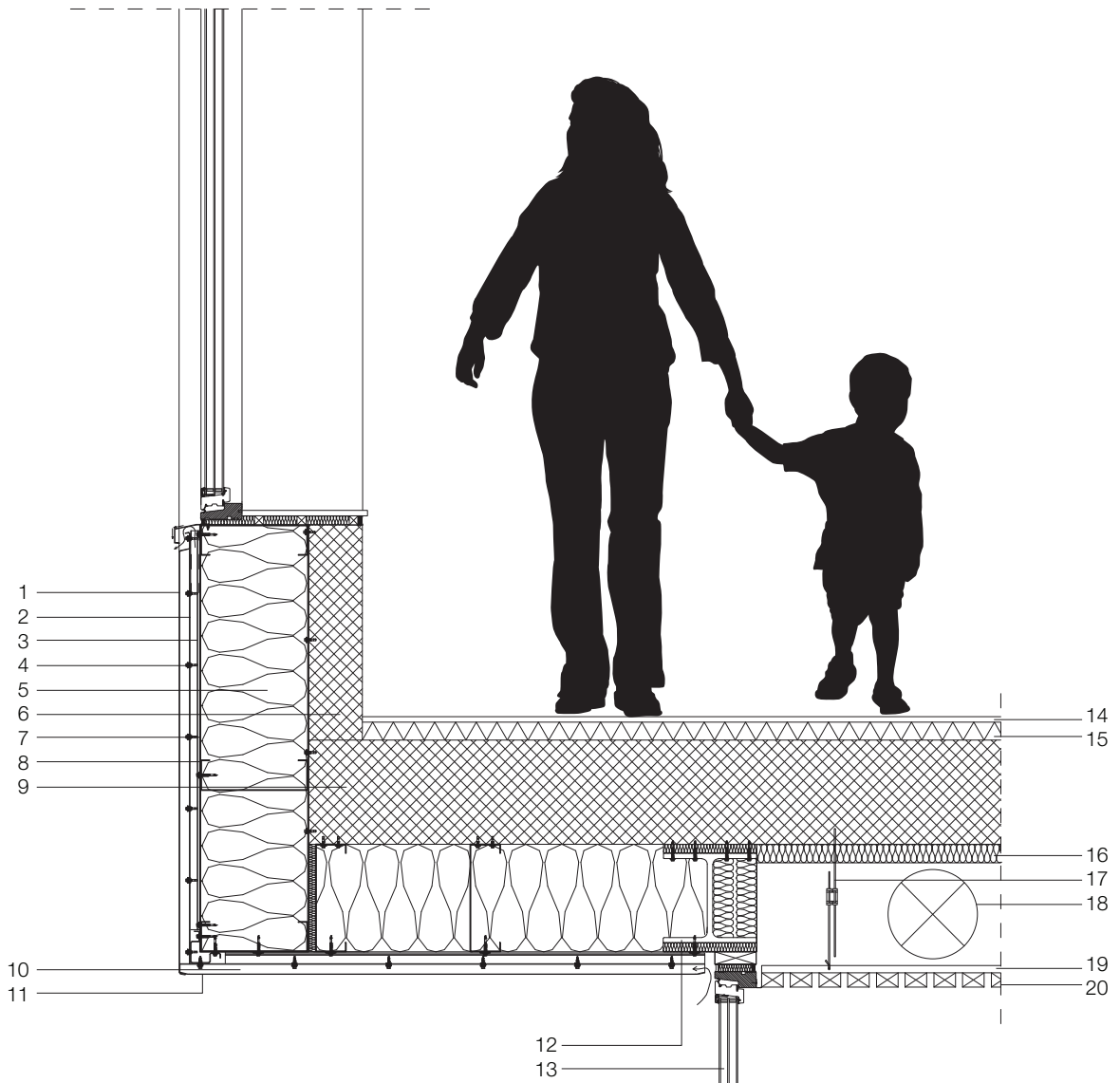
ELEVATION NORTH
1:600



SECTION A-A
1:600



SECTION B-B
1:600



**DETAIL OF NORTHERN FACADE
1ST FLOOR
1:20**

- 1) 1,5 mm Perforated corten metal
- 2) Support stud
- 3) Waterproof membrane
- 4) Screw
- 5) 300 mm Thermal insulation
- 6) 150 mm Light aggregat concret
- 7) 300/90 C-profile (vertical)
- 8) 300/90 C-profile (horizontal)
- 9) 300 mm Reinforced concrete
- 10) Air flow
- 11) 1,5 mm Perforated corten metal
- 12) HEB 300-profile
- 13) 3-layer glass VELFAC (Wood frame)
- 14) 15 mm Concret floor
- 15) 50 mm ROCKWOOL FlexiBatts
- 16) 50 mm ROCKOWOOL insulation
- 17) Adjustable hanger
- 18) Ø250 Ventilation channel
- 19) Wooden frame
- 20) 60x40 mm Wooden lamella

SUSTAINABLE STRATEGY

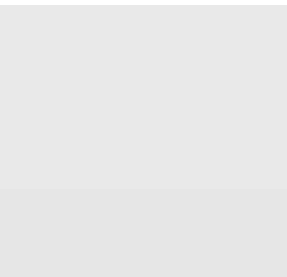
The sustainable strategy in Valby culture center are based on different strategies.

- The round building geometry reduce the energy consumption as the building surface are small relative to the volume.
- The orientation of the building are facing north and south which optimize the heat gain and thermal mass storage in the concrete floors and cores.
- Most functions are located on the northern facade to avoid excess temperature from the southern facade. Therefore the hallways are located on the southern facade and works as a buffer zone.
- Windows between 1-5 floor and the roof windows are used for natural ventilation. The windows on the south facade and the roof windows are mechanical regulated, when it gets too hot or when pollution levels are too high.
- Optimal building envelope and window type
- Manual interior solar shading
- Rain water collector and water recycling for domestic water
- Solar cells as renewable energy source

SITE ANALYSIS

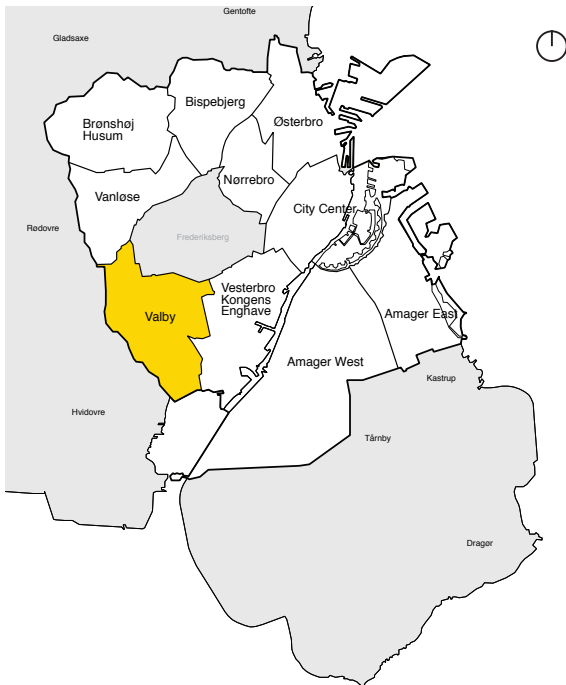
The following chapter contain analysis of the site, regarding the location of the site, the city, character, terrain, preservation, typology, vegetation, functions, infrastructures and weather conditions. It is a general informative study and description of the existing area and condition, by using a quantitative and qualitative methods. The chapter ends with a conclusion on the site analysis and the material will contribute to the design process.





III. 29: Tottøgårds square south and Valby Culture Center

THE SITE



Ill. 30: Valby in Copenhagen



Ill. 31: Valby district in Copenhagen, Denmark

The site is located in the district, Valby in Copenhagen, Denmark. It is located in the west part of Copenhagen and bordering the districts Hvidovre, Frederiksberg, Vesterbro/Kongens Enghave and Vanløse. Valby district is 9,23 km² and with a population of 51.727 (01.01.2015). [Københavns Statistik, 2015] Valby was originally a village with factories such as Carlsberg, FL Smidth, China factory, gasworks, cotton mills, sugar factory (Sukkertoppen). Valby was developed into an industrial district with an industrial identity. [Valby online, 2016]

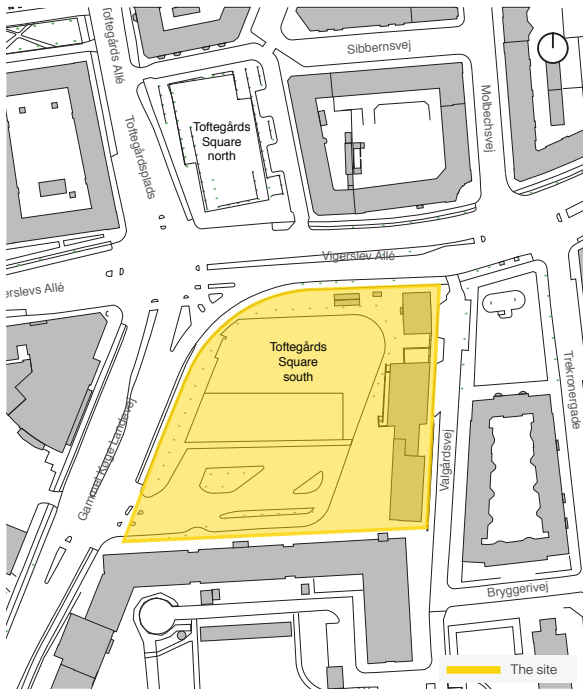
Today, modernization and sophistication developed these old industrial buildings to new and creative offices and commercials, but still preserved its architectural culture intact. Valby is a mix of suburbs and city center and offers peace and quiet to the residents who want to live close to city center. [Valby online, 2016] The district consists of nine train station and buses which makes it easy to get around in different parts of Valby and Copenhagen with only 10 minutes to the city center.

In few years Valby has become a popular and attractive district to live in with a strong cultural scene, with a Culture center, library, exhibitions, theater, thriving retail, creative companies and coveted institutions and schools. There is also lots of green

recreation areas such as parks, Valby Sports Park and hall that offer lot's of different sports facilities.

A part of Valby will be developed within the next couple of years, there will be new dwellings, student houses and up to at least 10% commercial, education and cultural facilities. [Madsen, K. 2015]

VALBY



Ill. 32: The site in Valby, Denmark

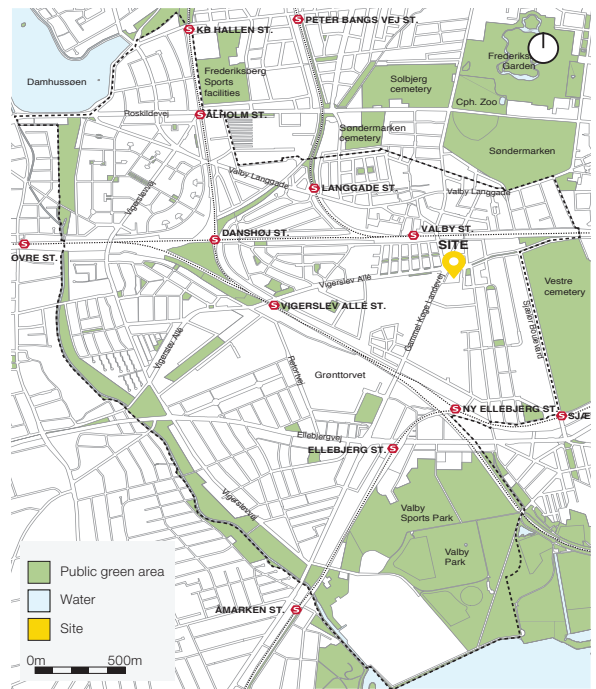
There are two Toftegårds square, one on the northern side of Vigerslevs Allé road and another south of that. Toftegårds square North is a smaller rectangular square that are surrounded by trees and bushes are enclosed from the main streets. It makes the square more intimate and manageable.

The exciting Valby Culture Center is located on the east side of Toftegårds square South. The square is a open asphalted square with trees around to enclose parts of the main roads.

The square is approx. 11.000 m² and are the second largest square to Copenhagen Rådhuspladsen in the city center of Copenhagen.

The site is almost square and it is being used for football field, Bicycle Play track, planting box, seatings, parking and stopping place for people who takes driver license. Once in a while there is being held event on the square, with flea market, musical events and ice rink during winter.

VEGETATION



Ill. 33: Vegetation in Valby and surroundings

The site is located near lots of green areas. The nearest park Søndermarken is not a part of Valby district and are located north of Valby and next to that is Frederiksberg garden.

East of the site is a big green area, which is the Vestre cemetery and citizen in the area are also using it as a park. South of the site a huge Valby sports park with lots of sports facilities and indoor swimming pool. Next to that a huge green area, Valby Park is located and border to Kalveboderne harbor.

A green belt are dividing the western border between Valby district and Hvidovre district, there is lots of football fields, playgrounds and running track.

If looking on the green areas, it seems like there is lots of opportunities for green recreational areas in the district. It might therefore be interesting, to look into how to use Toftegårds square south for other types of activities and how to integrate it as a part of the new Culture Center.

CHARACTER OF THE SITE



III. 34: Cultural advertising



III. 35: Containers next to the Culture Center

Toftegårds square South is the site where the current Valby Culture Center is located. The pictures here shows how the surroundings looks. Event posters are hung on the outside of the square on the football cage, to attract most attention towards the transient and cars.

The square is a big asphalted square and can therefore look quit empty. In some corners there are created seating areas but doesn't feel so comfortable to stay at, because of the exposure of the open space and traffic from surrounding main roads.

In some area there is containers they use as storage but many of the walls and elements are being painted with art such as graffiti and bright colors makes it look like a recreational cultural area.

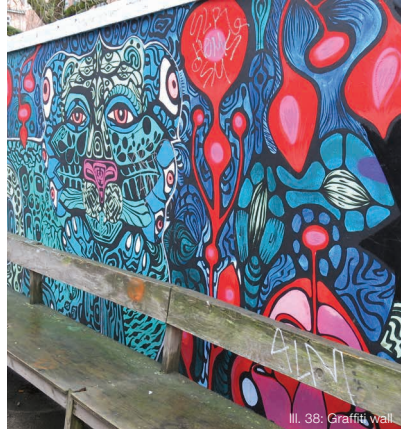
As an overall impression on the site, is that it looks like nobody really cares about it. People are not really using it or staying there, it looks dilapidated and there is even a pile of soil that has started to grow plants on.



III. 36: South sided gabled with solar cells



III. 37: Terrace at the café



III. 38: Graffiti wall



III. 39: Painted boxes



III. 40: Football cage



III. 41: Sitting and potting area



III. 42: Container and a dirt pile

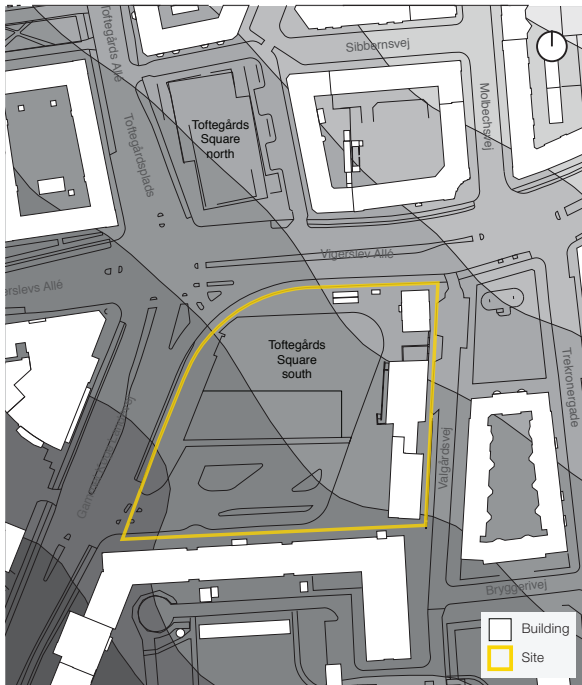


III. 43: Plant boxes



III. 44: Concrete blocks

TERRAIN



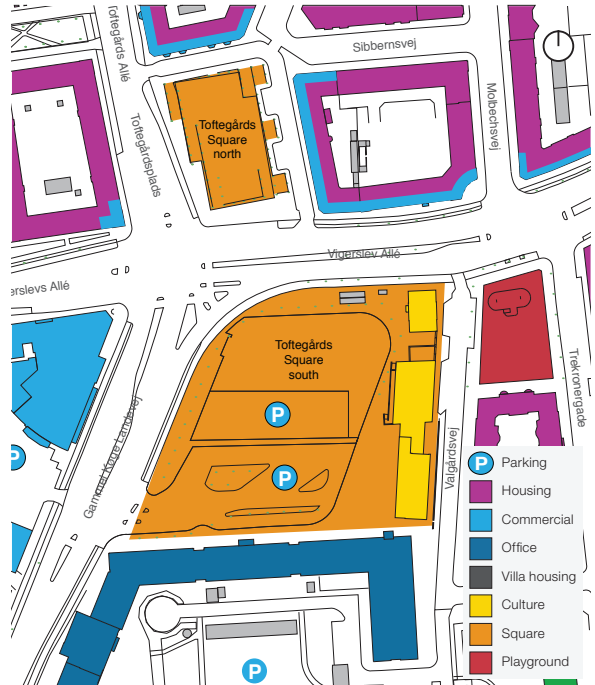
III. 45: Terrain at Toftegårds square south

Looking at the hypsometric map the terrain lines indicates for every one meter different. The darkest gray is the lowest area while the light gray is higher.

The diagram shows that the site is rather flat with a sloping of three meters on the square, from the north-east corner down to the south-west corner.

The diagonal length on the site is around 173 meter and with a slope of three meter, means that the angle of the slope is only one degree and won't have big influence on the design.

FUNCTION



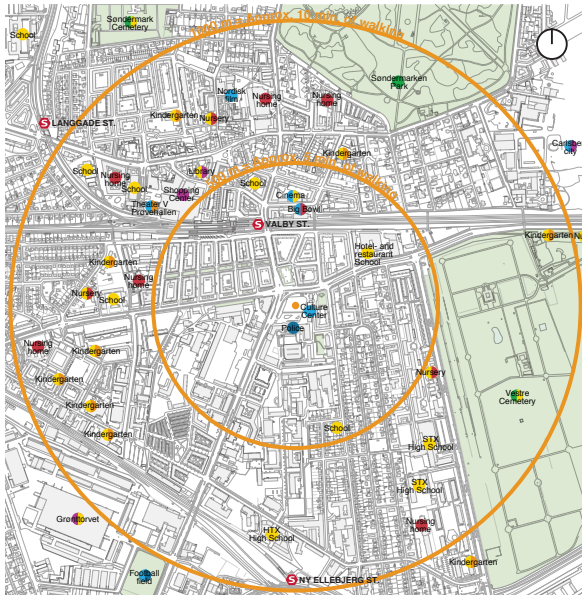
III. 46: Functions diagram, Valby

The site is the south part of the Toftegårds square, a square of approx. 11.000 m². The north part of the square is an open space with opportunity for recreation activities, sports and events. While the south part of the site is used for parking, next to a police station and offices.

The existing culture center is located on the east side of the square and on the west side commercial like a supermarket and a gas station.

The functions near the site consist of mainly housing/apartments and on the ground floor of these apartment there is a mix of commercial, cafés and restaurants.

DISTANCE CIRCLE



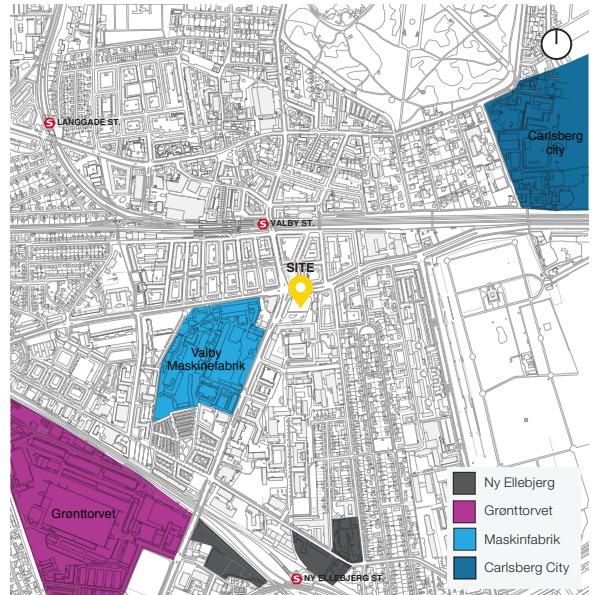
Ill. 47: Distance circle for 5 minutes or 10 minutes by walking

The culture center is located central and it is easy to reach within 5-10 minutes by walking from some main functions, activities and housing areas, this makes it a great location for a social meeting point in the district.

The diagram shows two distance circle. The smallest circle is an distance of 500 meter which is approximately 5 minutes walking. The biggest circle a distance of 1000 meter approximately 10 minutes walking.

Within a 5 minutes radius, Valby train station is located and can take you directly into Copenhagen Main train station in 10 minutes or take the regional train to the rest of Denmark. Next to the train station there is a shopping center and not far from that theater, cinema, schools are also within the 5 minutes. A 10 minutes walking distance from the site, you can find green parks and lots of kindergartens and nursery near housing areas.

FUTURE DEVELOPMENT



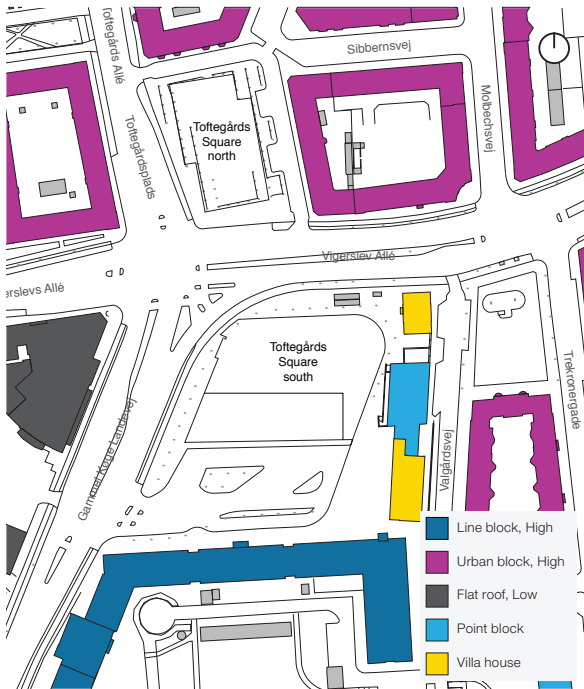
Ill. 48: Future development in Valby

Valby Maskinfabrik is located next to the site and are now under development. Within few years the area will consist of 1.000 new dwellings, offices and parking. [De Forenede Ejendomsselskaber A/S, 2016]

Grøntorvet is renamed New Valby because it is a new green district with 2.000 new apartments, townhouses and row houses. The area is around 160.000 m² and will bring the district 4.000 new residents, office, shops, cafés, children's institutions and a park. The area is a mix of public housing, rental, house owner, senior- and student housing. They are also planning to create five towers of 50-80 meter as a landmark to the area. [FB Gruppen A/S, 2016]

Carlsberg City is located just outside the border of Valby and within 10 minutes to the culture center. In few years the area will be developed into new housing, offices, commercials, cafés, schools, children's institutions and a new train station. [Carlsberg Byen, 2016]

TYOLOGY



Ill. 49: Typology on the site, Valby

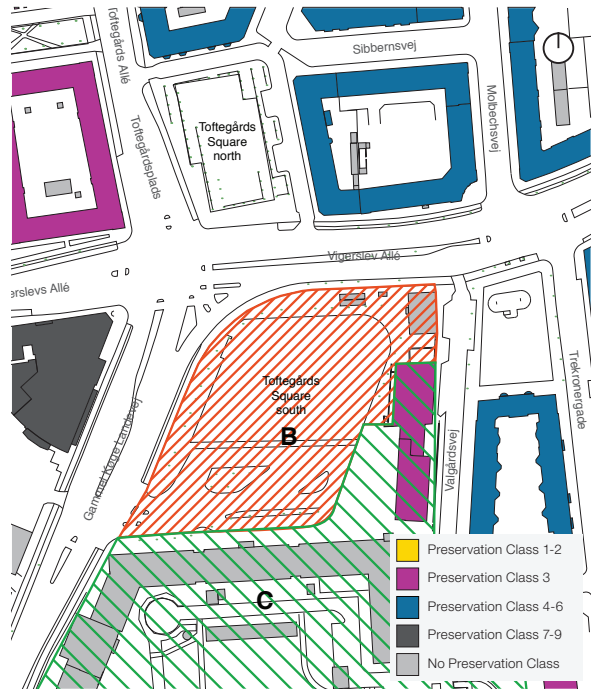
The typology for housing in the context is mainly blocks with pitched roof of 4-5 floors, where the ground floor is typical for commercial. The materials of the block are red bricks with red tile on the roof.

South of the site is a six floor line block, with a pitched brown metal roof. The building have a concrete base and red bricks.

On the west side of the site is yellow brick and plastered facades on flat roof typology.

The current culture center is a low pitched rectangular house and a old factory that looks like a church. The building have gray plastered facades. The point block is connected to it and is another part of the culture center. This building is a five floor red brick typology. And north of that, is another red brick house villa typology of two floors.

PRESERVATION AND LOCAL PLAN



Ill. 50: Preservation around the site Valby

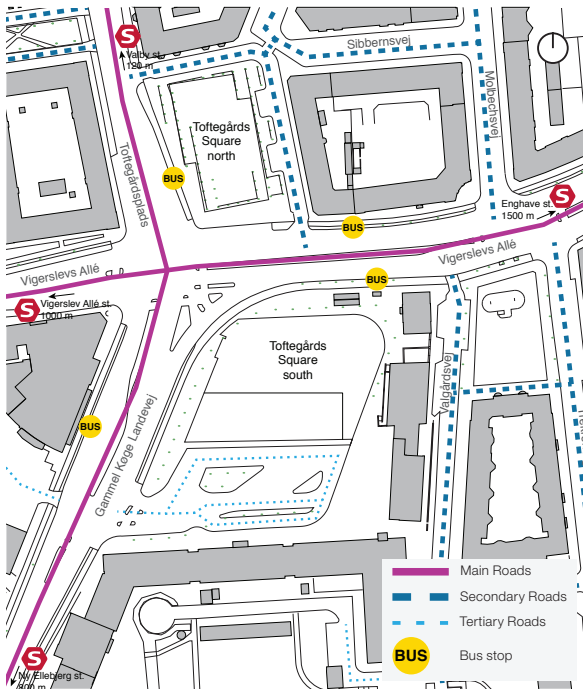
Preservation The existing culture center on the site have a preservation class 3, this mean that the build is a high class and the building's exterior can't change, because of their architecture, cultural history and workmanship for the context. [Kulturstyrelsen, 2016]

Local plan no. 17 - Toftegårds Plads, January 1981:

There can't be built any new buildings on plot B and there shall be an attractive appearance on the unbuilt area, with plantings, benches and windscreens. On plot C the plot ratio can't exceed 150 percent of the area and for each building and with a maximum height of six floors exclusive the basement. The appearance for new buildings must be consistent with the surrounding buildings and the areas character, with the materials, color and shape [Bygge- og Teknikforvaltningen 1981].

I will in this project disregard the local plan, as it is from 1981 and the place needs a renewal in today's 2016.

INFRASTRUCTURE



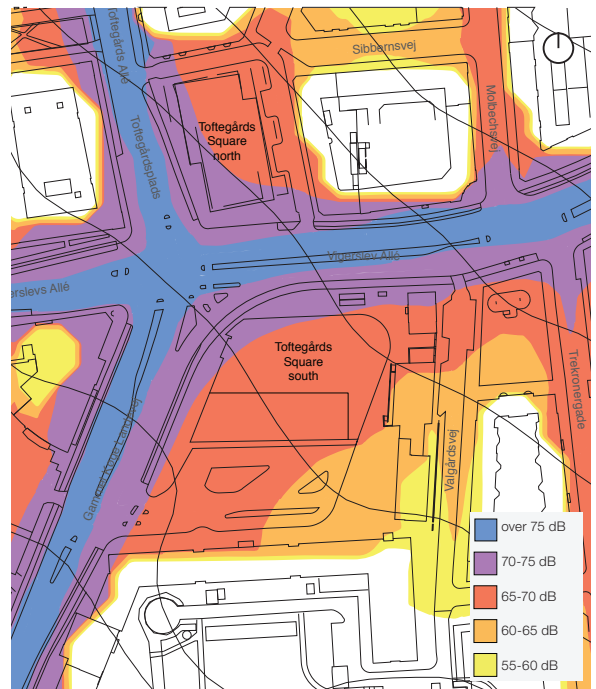
Ill. 51: Infrastructure diagram, Valby

The site is located on the corner of a main intersection between Vigerslevs Allé and Gammel Køge Landevej, Toftegårds Plads road. It is a main junction between roads leading towards a high way in south, Vesterbro district in east and rest of Valby in north and west. These roads also lead towards train stations near the site.

Next and near to the site there are four bus stop. A-buses that drives in the city areas, bus line 1A, 4A, 8A and the yellow-bus is between the city areas in the outer edge of the city, bus line 132 and 133.

Because of the central junction for the infrastructure in the district, the culture center is easy to reach, either by car or walking from a train station or by bus. Even though the culture center have a central location the culture is retracted from the road, which makes it not so visible to the passers.

NOISE



Ill. 52: Total Noise from roads, measured at 1,5 m height, Valby

The noise on the site is very dominating, because is located in the corner of a main intersection. This diagram is made from Miljøstyrelsen and has been measured at a height of 1,5 meter (2012) for day. [Miljøstyrelsen, 2016]

Miljøstyrelsen made a guidance values for maximum 58 dB and the diagram shows that the whole site is over the maximum value. Most part of the site is 65-70 dB and barely the south east corner of the site is under the 58 dB. [Miljøstyrelsen, 2016] This mean that the Culture Center is noise-plagued. The square consist of a asphalted surface and the materials of the surrounding buildings are very hard and reflects the noise, which is why the square isn't really used because it is uncomfortable to stay at.

To create a more attractive Culture Center and a comfortable square, the noise problem needs to be considered and incorporating into the design.

CLIMATE

When designing a sustainable building it is important to analyze the microclimate of the context, because it can have a influence on the final design with the shape, orientation, height, window size and location.

Temperature

Denmark have four seasons during a year, spring, summer, autumn and winter. The average temperature in Copenhagen during winter season is 5,5°C and during summer season 16,6°C. This shows that the average outdoor temperature is not high and therefore have to utilize most of the sun's heat to the outdoor space and sheltered from the wind.

Rainfall

The diagram showing the amount of rainfall in Copenhagen is measured between year 2000 to 2012 [World weather online, 2016]. The most amount of rainfall is during summer, July but most raining days is during December.

The future weather condition in Denmark means that there will be more rainfall during winter and less during summer, but more heavier rainfall or cloudburst. [Olesen, M. 2014] Therefore it is needed to develop an solution to avoid flooding in the future. A solution that can collect rainwater and reuse it to reduce the buildings water consumption and watering for plants.

Sun

Denmark is located on the northern part of the world, this mean that there is more hours of sun during a day in the summer season and less sun hours during winter season, therefore it is important to maximize the sunlight when designing a building.

The average bright sunshine hours is 1.662 in Denmark in year 2015 [Danmarks Meteorologiske Institut, 2016].

Looking at the Sun angle diagram it shows that, the sun is low on the sky in winter season and high in the summer season. This mean that solar shading might be needed and can be used as a passive strategy for cooling.

Furthermore the sun angle will have an important influence on the production of electricity from solar cells.

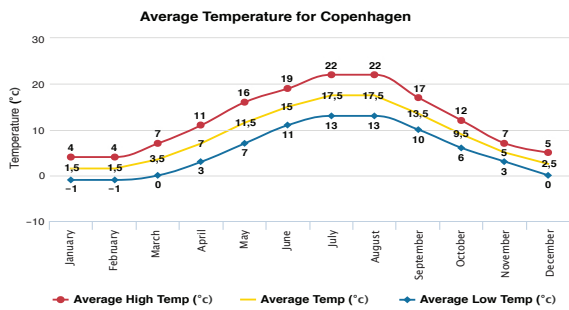
Wind

Wind speed is important to analysis in Denmark when developing an open square, because the wind speed and direction influence the temperature.

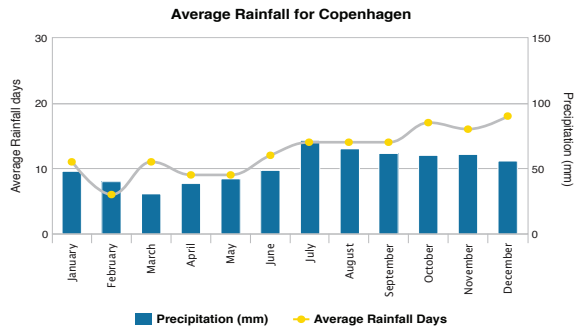
The wind rose shows that the average wind is coming from west, 15,3% of the measured period. Here is the medium wind speed 6 m/s [Cappelen, J. and Jørgensen, B.1999].

When looking at the wind direction on the site, the western part of the square is exposed to the main wind direction. Therefore developing a barrier that shields the wind can create a comfortable outdoor environment, but it can also shield the traffic noise.

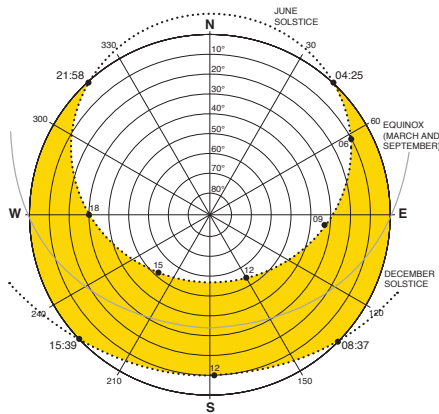
The wind speed and temperature is important for estimating the ventilation capacity, when creating natural ventilation. Therefore can the wind be further investigated as a design parameter.



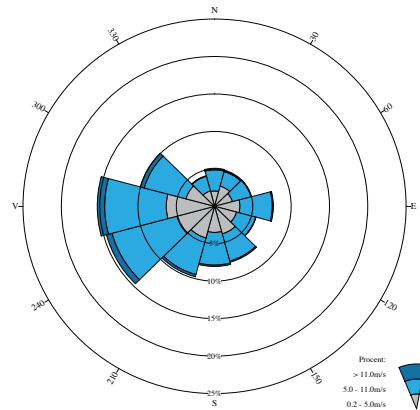
III. 53: Average temperature in Copenhagen



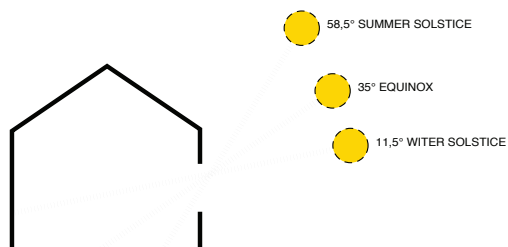
III. 54: Average rainfall in Copenhagen



III. 55: Sun path diagram of Copenhagen



III. 56: Average wind rose in Copenhagen



III. 57: Sun angle in Copenhagen

Wind table	N	30	60	E	120	150	S	210	240	V	300	33	Total
%	5.1	4.9	5.0	7.7	5.6	7.7	8.0	9.7	14.6	15.3	10.0	4.2	98.0
% 0.2-5.0 m/s	2.1	2.8	2.4	3.3	3.0	3.8	3.5	4.4	5.1	6.3	3.9	2.1	42.7
% 5.0-11.0 m/s	2.8	2.0	2.5	4.2	2.6	3.8	4.4	5.1	8.8	8.0	5.6	2.0	51.7
% ≥ 11.0 m/s	0.2	0.1	0.1	0.1	0.0	0.2	0.2	0.3	0.8	1.0	0.5	0.1	3.6
Medium speed	5.9	5.0	5.2	5.5	5.0	5.2	5.5	5.6	6.3	6.0	6.1	5.3	5.7
Maximum speed	18.0	16.5	13.9	17.0	12.9	15.0	16.5	14.9	21.6	19.6	18.0	14.4	21.6

Total observations = 29189
 Wind calm defined as speed <= 0.2 m/s
 Number of observations with wind calm/varying wind: 580 = 2.0%

Source: DMI

III. 58: Wind table of wind speed and directions in Copenhagen [Danish meteorological institute, 1999]

SHADOW

This shadow analysis was done in order to understand how the surrounding buildings are casting a shadow on the site.

Summer, winter and spring season is measured the shadow in the morning, afternoon and before sunset.

In December/winter season the sun is low and the sky therefore the most of the site is covered in shadows by the surrounding building and cast long shadows on the site.

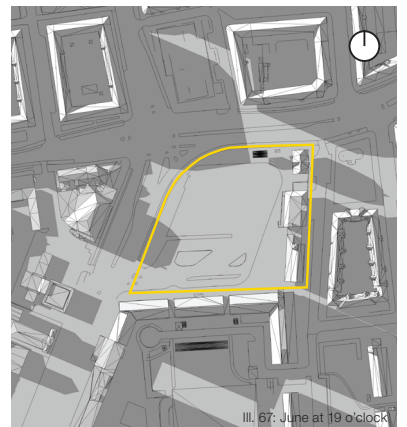
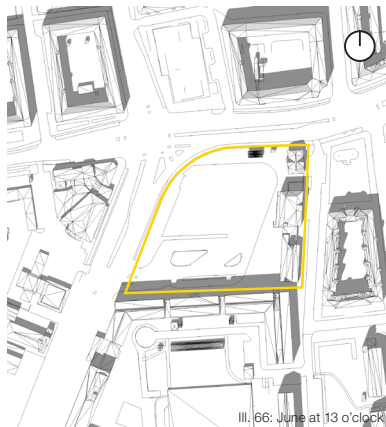
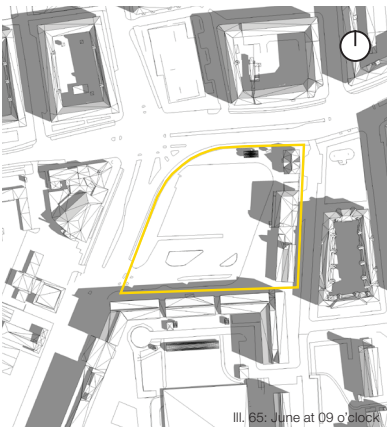
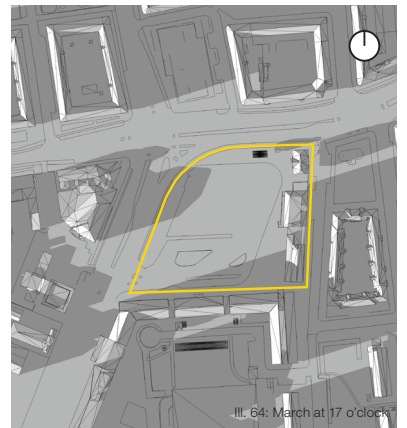
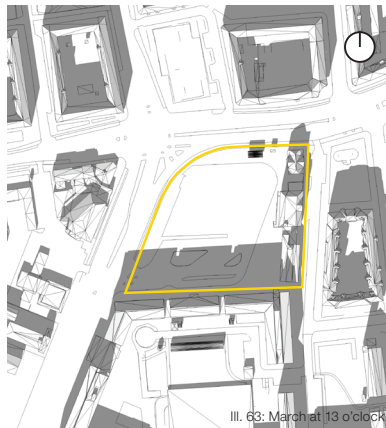
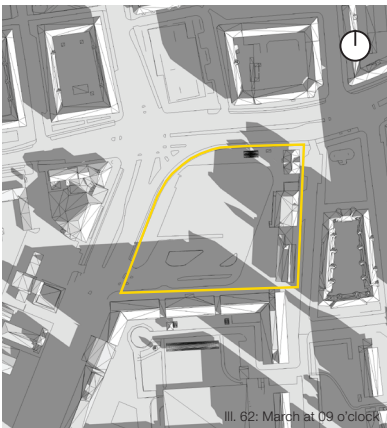
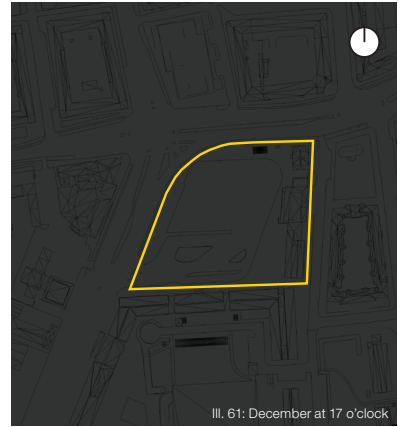
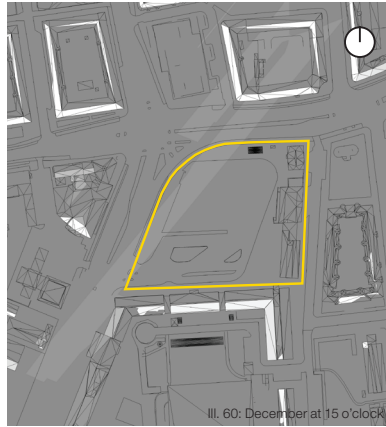
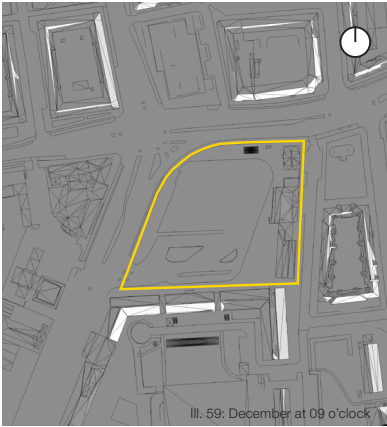
The temperature are lower and there are fewer sunlight hours during winter season, therefore it is needed to maximize the sunlight and to gain some solar heat. But the sun are also low on the sky and the direct sunlight can bother some of the building's functions, therefore may be needed solar shading for the south- and west facing facades.

In March/spring season the shadows are covering almost half of the site, therefore solar shading might be needed on the west facade. When considering an outdoor space, the northern part of the site will be the most optimal for sun exposure.

In June/summer season the sun is high on the sky therefore not much shadow are being casted on the site and optimal for an outdoor space during this season.

The temperature are higher and there are more sunlight hours during the summer season, therefore there might be needed solar shading to avoid getting overheated rooms.

The shadow analysis are showing that there is lots of sun exposure on the site, which mean that solar cell can be but onto the south and western facade and on the roof of the building.



CONCLUSION ON SITE ANALYSIS

The site analysis shows a need for a new Valby Culture Center, as the district is under a major developing with increased citizen, within few years. Therefore a need for a new and larger cultural gathering place is needed, to fulfill citizens needs.

An important note is the visibility and an openness, showing the citizens what the district can offer. To do so, I will in this project disregard the local plan because it is outdated and from 1981. The place needs a renewal in today's 2016.

The new Culture Center is located in the center in the district, next to a main junction with easy access to public transport. This location is perfect for a new Culture Center, close to housing area, schools, kindergartens and daycare institutions. Toftengårds square south is on the site and very affected by the traffic noise and therefore not really used, because it is not comfortable to stay at and nothing to do. Therefore it is important to consider how to use the space into the design, to make it more attractive to use.

When looking at the analysis the north part of the square will have lots of sunlight, but the south part of the square will be shadowed by the huge office building in south. Because of that, the shape, location and orientation of the new building must be considered carefully, to gain most daylight but still avoid overheating. At the same time using the roof and facades for placing solar cells is a great idea.

The orientation of windows can be orientated in a way that it can take advantage of the natural ventilation from the main wind direction from west.

The current Culture Center is worth preserving and should either be incorporated into the design or ignored. But it is a part of Valby cultural history and therefore, could be a good idea to transform.





THEME ANALYSIS

Theme analysis consist of studies, case study and discussion on the themes where subjects as, Valby Culture Center, Culture Center in general, Library, User group and Sustainability.
The analysis is an investigation and ends with a conclusion of the aspects that could inform the design process.



Ill. 69: Valby Culture Center

CULTURE CENTER

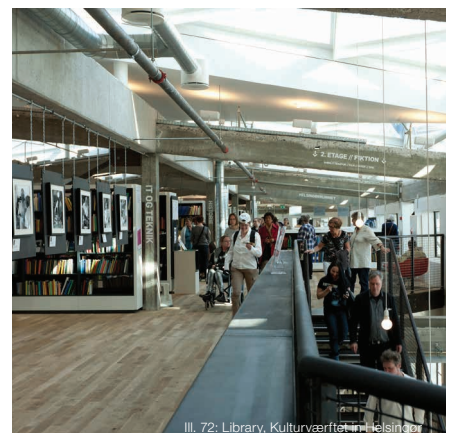
A typical culture center is also working as a community center and activity center, they are owned by the municipality and have functions like, meeting rooms, workshops, theater, cinema, exhibition, book café and music rooms.

Throughout the years the Culture center has become more like a social meeting place where synergy between functions and institutions are combined into a modern Culture center. [Den Store Danske, 2016]

There is potential for synergies in bringing together different cultural institutions into the Culture Center. Culture Centers that already have combined these functions are, Kulturværftet in Helsingør, KulturØen in Middelfart and Nordkraft in Aalborg. They have mixed and combined a library and multi functional hall, event functions, sports facilities tourist information and Borgerservice Kvik. [Køge Kommune, 2012]

By combining more institutions and functions into one building, it creates a more vibrant building, because different functions are used at different times during a day. And at the same time different users meet and interact between each other across interests by creating new, interdisciplinary experiences and functions.

Therefore combining the current Valby library and Borgerservice Kvik into the new Culture center, will bring together cultural functions. But also functions the library offers, such as IT-, homework- and language support and free legal assistance into a common cultural meeting place.



VALBY CULTURE CENTER



Ill. 73: West entrance

The current Valby Culture Center is used as a case for my project. And based on that I had a meeting and a tour of the Culture Center by the head of the Culture and Leisure, Lars Becher. During this tour Lars, described all the functions in the building, type of users and what kind of problems they have. I also talked with some of the users I met on the way, about what they thought was good, bad and what they would like in a new Culture house.

Valby Culture Center consist of two buildings that are connected with an entrance hall. The main entrance are being highlighted with a bright color on the facade and an arrow that indicates the entrance. The opening hours are very flexible and you can access the culture center between 08:00 - 22:00 with your Health Insurance Card and your library code. Nothing is locked and is freely available to all citizens, because the Culture center trust their uses. This creates a flexible opportunities for citizens and helps them to put their own stamp on things. You feel relaxed and a feeling of belonging which make you take better care of things.

The main building have six floors and a basement. In the basement, there is a medium size music rehearsal, CNC-machine, burning stove for ceramics and storage for the culture

center and the café. They have experienced problems with the acoustic from the music room, because the offices are located just above it and therefore only rent it out after office hours.

They have placed the CNC-machine and burning stove in the basement because the machines are too heavy and big and therefore can't be transported up to the 4th floor, where they have a workshop area. Dividing the machines from the functions makes it complicated to use for the users.

The ground floor is the entrance hall and are being used for an information board and folders on events in the building and the district, but are also being used for as a waiting room for the driving license school. There is also a café that are being used as a reception.

On the 1st floor, offices for the Valby Culture Center and Valby Local Council are situated in an open landscape. There is three private meeting rooms and a kitchen.

On the 2nd floor is a culture area for kids, they call it Zone2, with tree rooms, "The stage" for drama, dancing/movement room and a multi functional room with a kitchen. They had problems with the acoustic when the rooms are being used at the same time and lack of storage.

The 3th floor have four meeting rooms, a small music rehearsal room for rent and an office for Ældre Sagen union. The meeting rooms are also being used for lecture, choir practicing, hobby club meetings and teaching. When the rooms are occupied at the same time, they also experience problems with the acoustic from the other rooms.

The 4th floor is a workshop area, where they have a ceramics, Cph. Fablab (laser cutter and 3D printer) and a painting studio. This floor is very thigh and they have problems with lack of storage space, natural ventilation, because the windows were too old to open and sproblems with transporting of large and heavy materials, therefore placing these function on the ground floor would be more optimal.

The 5th floor is a large meeting room they use for bigger meetings, lectures, music events and private parties.

There are solar cells on the roof and placed in a way that you can't see them from ground and there is also some solar cells on the south-facing gable. These solar cells should cover the energy consumption of the workshop area.

The other building have a exhibition hall, where they get a graffiti artist to paint the walls every 2nd year. There is toilets and a theater hall they rent out for cultural- and private events. They actually don't use the theater for performances because they don't have professional equipment and it doesn't suited for a theater. Only 7 minutes from the culture center a professional theater, Theatre V in Prøvehallen is more suited for a theater performances and therefore more attractive to rent.



III. 74: Information board



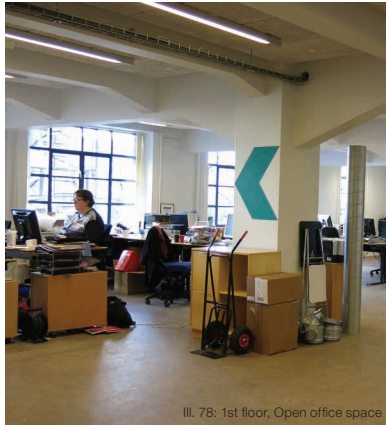
III. 75: Ceramics area



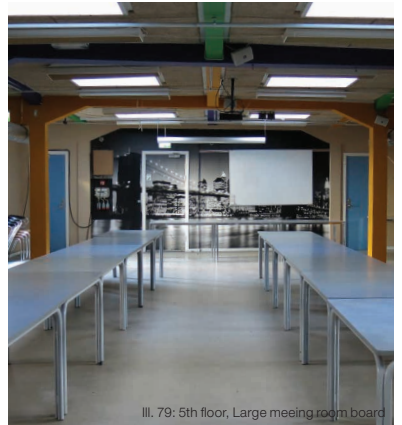
III. 76: Dancing/movement room



III. 77: 3rd floor, Meeting room



III. 78: 1st floor, Open office space



III. 79: 5th floor, Large meeting room board



III. 80: 80th floor, Painting studio



III. 81: 4th floor, Fablab



III. 82: Exhibition hall



III. 83: 2nd floor, Zone2, Multi functional room



III. 84: Ground floor, Café



III. 85: Theater hall

THE MODERN LIBRARY

Libraries have existed for many years and is a place where books, articles and information are stored. A place that people often portray as mystique and a quiet location, where people go to immerse themselves in knowledge, but also a place where people go to get information and searches for answers and wisdom.

The classic library used to be something that was exclusive and only for the privileged class, but throughout the history the library has evolved into a “information society” and break down the barriers of social differences, into a place where all social classes, genders and ages can go [Hammer B. 2014].

Modern technology and the Internet is a kind of a modern digital library, where information is accessible to anyone and anywhere. But why is there still a need for a physical library?

Modern libraries are often multifunctional libraries, where new functions are implemented into the library or combined with a cultural center. Functions that a culture center have like workshops, meeting rooms, café, computer rooms, exhibition, Borger Service, playroom and shops. These new functions also bring new types of users and the public library becomes more then just a place, where you can get information, but a social space with cultural activities. A place where people interact and surrounds themselves with other people.

A theory of these kind of places is also known as the “Third Place” by the urban sociologist Ray Oldenburg, from his book The Great Good Place.

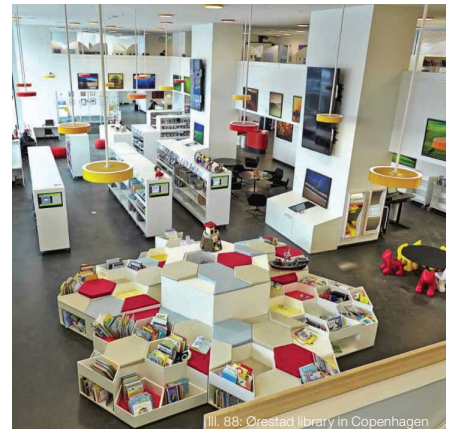
The Third Place is a place that isn't your home or work, but a public place where the public- and private sphere interact in a community. It has therefore an important influence to the society and the community. A unique space for learning, sharing and interacting, where you can get inspiration from other people [Hammer B. 2014].

Digitalized self-service provides the users a flexible opportunity to use the library after opening hours, with your health insurance card. This give the users a sense of ownership.

When implementing the library into the Culture center, it is important to create a social meeting point with an openness that invites the citizen into an unique building, where people feel relaxed and interact with each other.



Ill. 87: Search station at Albertslund Library

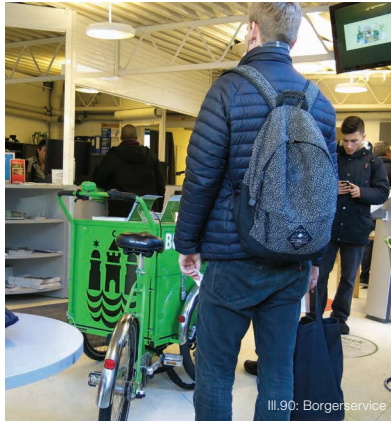


Ill. 88: Crestad library in Copenhagen

VALBY LIBRARY



III. 90: Library entrance



III. 90: Borgerservice



III. 91: Computer area



III. 92: Lending and reservation area



III. 93: Librarian office



III. 94: Valby library

Valby library was originally an pre primary school, called Rytterskole and in year 2002 they extended the building to provide more space for more activities in the library. [Post, M. 2014]

At the entrance of the library you will find Copenhagen Borgerservice Kvik, a place where can make a new passport, take a passphoto, make a driving licenses and get help with NemID and Digital Post. You feel like you meet a wall when you entrance this area, because it is crowded with people waiting, making it a barrier to access the library and also noisy because it is located in the central of the library.

It is a small library of almost 1.133 m², but have more then 150.000 people visiting per year. [Post, M. 2014]

The library is divided into different areas, a kids library, normal library, reading room, computer area, Borgerservice Kvik a

reserved books area and loan self-service. Between almost every bookshelf a single table and chair are located for people to read a book or study.

After being at the Valby library the atmosphere feels stressful and crowded, because of bad acoustic and daylight. This old building doesn't fit to a modern library. Therefore moving the library into the new Culture center, creates a new environment as a new meeting point for the citizens in Valby.

CASE STUDY - CULTURE CENTER AND LIBRARY

LIBRARY IN CPH NV. BY COBE ARCHITECTS AND TRANSFORM



III. 95 Culture Center and Library in CPH, NV



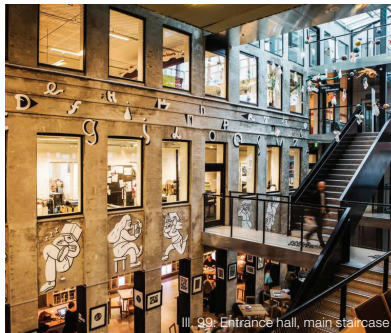
III. 96 Reading area



III. 97: Kids library



III. 98: CPH, NV library



III. 99: Entrance hall, main staircase



III. 100: CPH, NV library

Built in 2011

Location, Copenhagen North-west, Denmark

Existing 1.150 m², New build 2.000 m², Total area of 3.150 m²

Visitors 30.000 people per month

The library is an extension of an exciting Culture Center. Here is the old Culture Center combined with and new building, consist of four boxes that are twisted and stacked on top of each other. The building expression is in contrast with the old which has been renewed with artistic graphics on the facades, to the new golden colored expanded metal facade.

The library is divided into three areas, a kids library on the ground floor, a youth library on the 1st floor and an adult library on the 2nd floor.

On the ground floor you will find the entrance, a reception, Café and Borgerservice Kvik where you can get a passport, NemID and some types of driving license.

The 2nd floor is an offices area for the local committee and the employee of the Culture Center. But also a place where the citizen can come at get help and support on different projects and provide a range of counseling and guidance services, such as help with homework, computer workshops and legal assistance.

The 2nd and 3rd floor is a combined workshop area, with inspiration night and painting workshop.

There is a concert hall on the 3rd floor that are being used for events such as, concerts, lectures, kids theater and author evenings.

A main open staircase connects the functions and floors together and the spaces between is a multi-propose area for people to meet and interact with each other. [Københavns Biblioteker, (2016)]

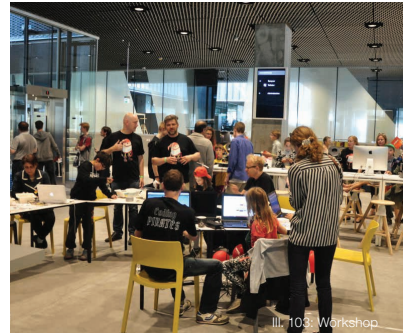
CASE STUDY - CULTURE CENTER AND LIBRARY DOKK 1 IN AARHUS BY SCHMIDT HAMMER LASSEN ARCHITECTS



Ill. 101: Dokk1 in Aarhus



Ill. 102: Recreation area



Ill. 103: Workshop



Ill. 104: Dokk1 library



Ill. 105: Lounge/reading area



Ill. 106: Recreation and reading area

Built in 2015

Location, Aarhus, Denmark

Area 28.000 m²

The average number of visitors 3.500 per day [Holm, S. 2015]

Dokk1 is located in the city center of Aarhus at the harbor front, as a huge compact building with parking spaces. Transparent facades link the interior with the surrounding environment. The open facades create an inviting feeling, that invites the citizen into the building. The materials of the building are mainly made of concrete, glass and light-coloured expanded metal.

Dokk1 is a modern hybrid library, which means it is a new meeting place that is open for the public with a learning environment that promotes democracy. The building provides various facilities for social activities, hobby clubs, associations and networking. A 'third space' between your home and work, where citizens can interact with each other.

It is a huge building and has two event halls, library, Borgerservice, study cells, meeting- and teaching rooms, media room, café, exhibition area, lots of multi-purpose spaces and also outdoor playgrounds as a part of the building.

The building has integrated sustainable solutions for the early design phase to reduce the energy consumption. And therefore lives up to the Danish class 2015 low energy requirements.

Effective solutions are implemented by using, seawater for cooling the building, a wide overhanging roof creates a shielding effect against direct sunlight, reduce energy consumption for cooling purposes.

LED lighting is used for inside and outside of the building and with a rooftop covered with 2.431,8 m² solar cells contributes to the reduction of energy needs for electricity.

The thermal loss area is being reduced with a compact building shape, which contributes to a smaller surface area [Kærup, Ida, 2015].

USER GROUP

The new Valby Culture Center and library is a place where everyone is welcome and people from all ages, gender, cultural- and interests differences, can meet and interact with each other. It is a building that offers many cultural experiences and activities and a place where you can express your creative interests, get inspired, exhibitions, meet, learning, performance, play but at the same time also a place, where you can find silence and immerse yourselves.

The user group is a large and diverse group. I will therefore describe the different types of users and the time they use the Culture Center in this project, and for that I got inspired from a report made by SIGNAL (2016).

EMPLOYEES

The Culture Center is also a normal 08-16 workplace, for those people that are managing the cultural center and cultural activities in the district. They are planning activities, events and managing the economy.

Valby Local Council are also situated in the building. They function as a link between Valby citizen and the City Council of Copenhagen municipality. Their job is to communicate with Valby citizens about their wishes and visions for the district, to the City hall in Copenhagen. And also have to communicate the municipal vision and decisions that are being taken, to the citizens of Valby. [Valby kulturudvalg, 2016a]

Employee at the Borgerservice helps you to get a passport, NemID and some types of driving license. The librarian is the one who have the personal contact with the citizens', when they need help to find books, information or materials. They have a work hour between 13-18 o'clock.

VOLUNTEERS

They help voluntarily the citizens with IT problems, like how to use a computer, how to use the Internet, your NemID, e-Boks, tablet and smart phone. They are also offering help with homework and language support, together with free legal assistance. These deals are offered a few hours once a week.

INSTITUTIONS

Childcare institutions, day carers and mothers groups are frequent users of a Culture Center. They use it to as a playground for kids to play, meet and learning. They often use the Culture Center between 08-13 o'clock.

FAMILIES WITH YOUNG KIDS

Families that want to give their children recreational activities and opportunities for them to meet other kids at, gymnastics, rhythm, drama, dance or music classes. They often use the cultural center after the parents' normal working hours (16-20), because some must be accompanied by an adult. But they are

using it diligently on weekends and when there have special cultural events.

YOUNG PEOPLE

Young people that go there to rent a book or after school to use some of the workshops, activities and classes the Culture Center offers. Or just go there to hang out and meet with friends or hobby clubs and associations. They will use the Culture Center between 14-24 o'clock.

STUDENTS

It can be any student from all grade that use the Culture Center, from renting a book, study in a quiet student room or meeting with their student groups. They will use the Culture Center at any hours of the day.

ADULT/THE NORMAL CITIZEN

Anyone that uses the library for rescearch, reading, workshops, exhibition, lectures, cultural activities or going to the café. But also the ones that need help at the Borgerservice. They will use the Culture Center at any hours of the day.

ELDERLY OR RETIRED PEOPLE

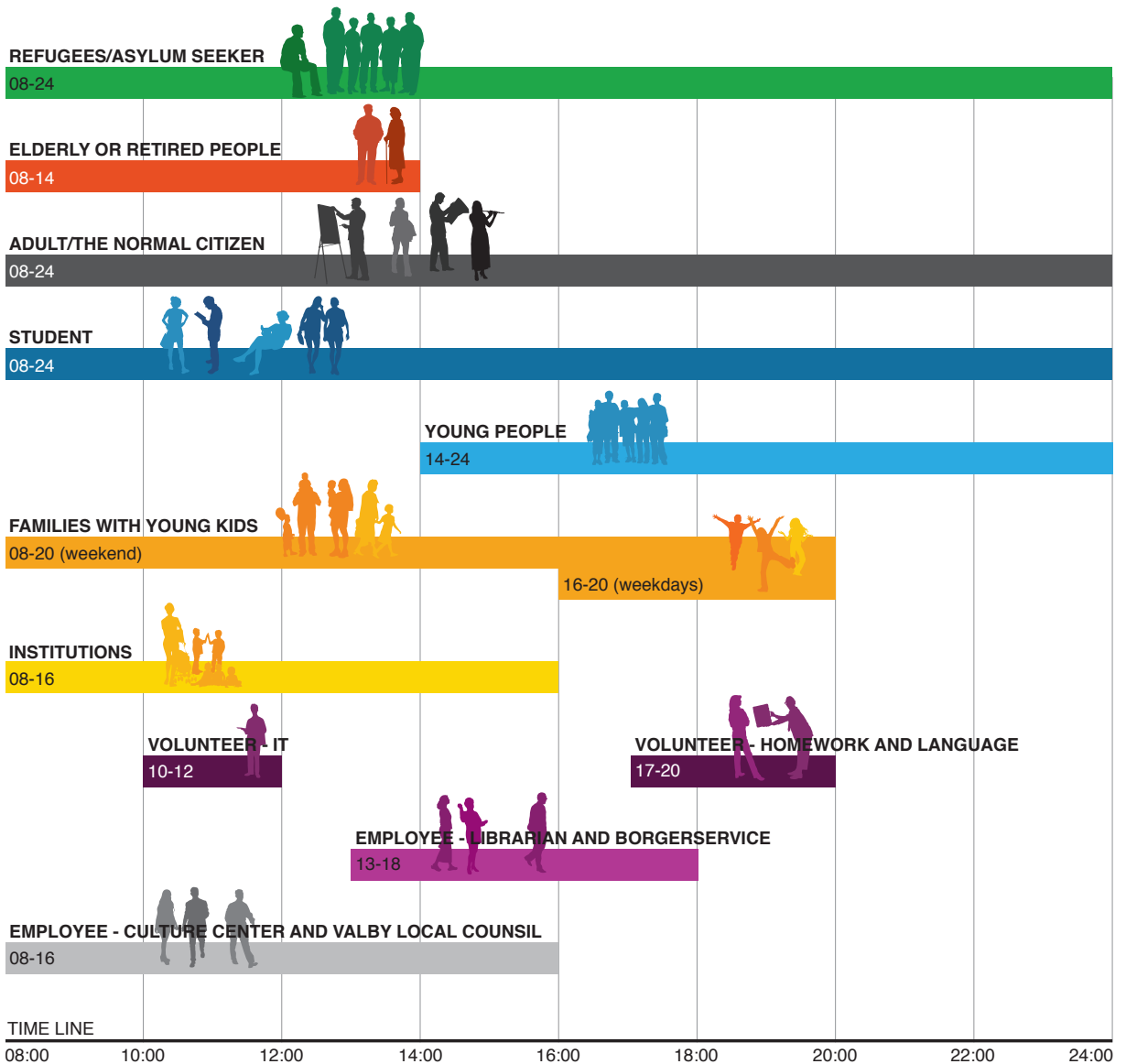
Elderly or retired people need daily activities and the Culture Center offers many different activities, such as ceramics, painting studio, sewing workshop, meeting rooms, reading area, library or just a place to stay, meet for a coffee and interact with other people. They will normally use the Culture Center in the morning and early afternoon, between 08-14.

REFUGEEES/ASYLUM SEEKER

Copenhagen will receive it is first refugees in Valby. They will be housed in an abandoned office building for temporary housing, just a few meters from Toftegårds square south and the new Valby Cultural Center. The first people will already move in the 1st April 2016 and house 224 refugees during year 2016. [Valby kulturudvalg, 2016b] The Cultural Center gives good opportunities for refugees to interact and get in touch with the district and the citizens, through workshops, activities, events and library. This will simultaneously promote the integration of refugees. They will use the Culture Center at any hours of the day.

CIRCADIAN RHYTHM

This diagram shows the dynamic and how the activities will be, in the new Valby Cultural Center, throughout a day.



SUSTAINABILITY

The Danish climate policy is based on the fact that Denmark should help limit global warming and live up to its international obligations. Therefore has the government in Denmark a goal of being independent of fossil fuels by 2050, to ensure a long-term supply by having a lower energy consumption, use renewable energy and with a strong cooperation with European in the energy field. And in 2020, Denmark final energy consumption must consist of at least a share of 30% of renewable energy. This goal is a part of the EU climate and energy package of December 2008. [Energistyrelsen, 2016]

There is an increased awareness about our responsibility toward the environment, where the term sustainability is used in many contexts. From sustainable products and buildings but also sustainable processes and therefore also a broad term that can be defined in many ways.

It requires lots of resources when constructing a new building and the building will throughout its whole living life, also affect the environment it is in, but also when the building is in use. From producing materials, to build the building, the operation of the building and when renovating or demolishing the building in the future, requires lots of energy. It is therefore important that sustainability is integrated into the design from start. [Birgisdottir, H. 2010]

Architectural firms have many different definitions about what sustainability is and often says they have a sustainable approach to architecture, but in real, it is just something they use as a business strategy.

So what is sustainability? Is it when you have a low energy consumption, thinking environmentally friendly, the building's life cycle or is it when the building achieves a DGNB, LEED or BREEAM certificate?

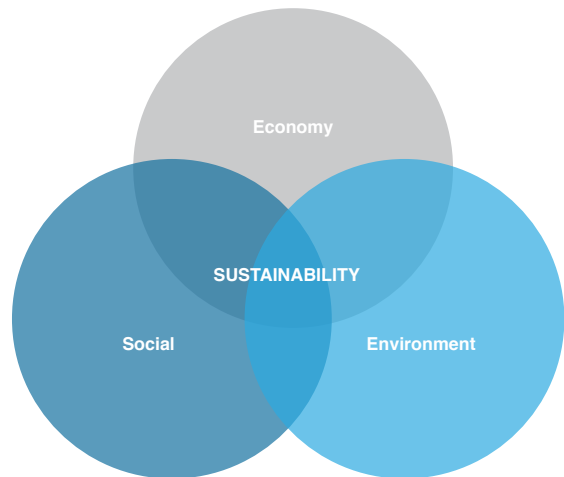
Sustainability in the perspective of the building industry is about a holistic way of thinking, where the environment, social and economy aspect is incorporated into the design. It is about thinking longterm and the quality in all parts of the building, but it is also how the building is a part of the city and the community. The building as a whole must be sustainable and contribute to solving some of the environmental and social challenges that we face. [Energistyrelsen, 2015]

I will in this section writing about my definition of sustainability and how I will use it in this project.

ENVIRONMENTAL ASPECT

The building's environmental impact is extremely important when designing a sustainable building, because it has to live up to the government's future plans.

When designing a new building the production of building



Ill. 108: Sustainability

materials, disposal of materials or demolishing of the building, affects the environment locally, regionally and also globally. [Energistyrelsen, 2015]

The energy consumption is one of the major factors and needs to be reduced as much as possible. Both in the production of the materials, but also for the building operation throughout the building life cycle. A Life Cycle Analysis (LCA) is a tool that can provide a better understanding of a building's potential environmental impacts. [Energistyrelsen, 2015]

In this project I will not look deep into the Life cycle analysis but focus on the building's energy consumption by fulfilling the Danish Building Class 2020. Where the total demand for energy supply for heating, ventilation, cooling, domestic hot water and lighting per m² heated floor area, doesn't exceed 25 kWh. year. [Bygningsreglementet.dk, 2015b]

To reduce the energy consumption for the building operation, energy efficient appliances, light and also the overall design of the building can reduce it. Integrating renewable technology will ensure a sustainable renewable resource.

When choosing materials ensuring a healthy local environment and indoor environment is needed, by reducing the use of hazardous substances, associated with the construction of the materials. But also considering whether the materials require a lot of energy to produce is sustainable, if it is durable and requires minimal maintenance. Over a material which produces less energy but are viable and often require maintenance.

SOCIAL ASPECT

The Social aspect is about creating a safe and good environment for everyone and to people to interact between each other. But also about the human health and the well-being in the buildings, around buildings in the urban- and social context. It focus on the indoor climate, working environment, architecture, functionality, availability, accessibility and adaptation to the local environment, as well as health and safety. [Energistyrelsen, 2015]

An important part of the social aspect concerning the well being and a physical comfort of the building daily users. The comfort is about the indoor climate and factors such as temperature, air quality, acoustics, noise and daylight conditions. All these parameters are measurable and regulated by law and described in various standards. While the conditions regarding the architectural context and protection of the local environment, typically is covered by planning legislation. [Energistyrelsen, 2015]

To measure these parameters in this project, I will use the program, Building Simulation (BSim) in my sketching and synthesis phase for analysing the building, as a design tool.

ECONOMIC ASPECT

It is about create a balance between the costs and the achieved quality of the building by focus on the economy for the construction and operation phases. To do so using a total economy for the construction or renovation, operation and maintenance as a tool for decision making from the earliest stages. So that the long-term economic consequences of the building is invested in higher quality, also reduces the cost for maintenance and operation.

Designing a flexible building ensures the flexibility to use the building for other purposes and needs in the future. [Energistyrelsen, 2015]

I will not look into the economic aspect in this project.

CONCLUSION ON THE THEME ANALYSIS

The theme analysis shows the need, for moving the current Valby library into the new Valby Culture Center. The current library doesn't live up to the users expectation or the modern technology, of a self-service library and good study spaces. By combining these functions together creates a larger user group and opportunities for people to meet between different age, gender and cultural differences. A place for learning, development, participation, performance, creativity, fun and also contemplation. The Culture Center will therefor constantly be in use, throughout the day and therefore creates an dynamic and flexible place for people to come.

This flexibility also lay in the trust the Culture Center gives the citizens with self-service access the building, workshop area, meeting rooms and other facilities, outside the personal opening hours, by using their health insurance card.

Designing a sustainable Culture Center creates good environment both outside and inside the building, with comfortable indoor climate, good daylight, acoustic, materials and energy friendly appliances and light. It will make people want to stay and therefore also promote interaction between people. But as a sustainable building it should also give the knowledge and awareness to the citizens about their consumption, to learn how to take responsibility for the climate changes.







PROGRAM

This following chapter contain the program and is an overall view of the vision and goal for the project. Here is the design parameters defined and are developed from the site- and theme analysis, for the next phase of concept development.

DESIGN PARAMETER

The design parameter is setting the frames and guidance for the further concept development in the next phase of sketching and synthesis. These parameter is developed through the results from the site- and theme analysis and is divided into three category, Function, Aesthetic, and Technique.

The function relates to the many functions the Culture Center and library offers, how they are organized and related to each other to create a community in the building.

Aesthetic is relates to the architectural shape, material and the atmosphere. A place where people want to stay and immerse themselves.

Technique relates to the thesis theme, sustainability. The aim is to reach a sustainable building by fulfilling the Danish Building Class 2020 and creating a good indoor environment.

FUNCTION

- **Flexibility by:**
 - creating multi-functional rooms
 - clear plan organization by color code different cultural institutions
 - structural principle that are flexible for the building's interior space and for future changes
- **Space for community and individuality by:**
 - creating a common square between functions to promote informal meetings between interests
 - contemplative paces for individual concentration
- **Open and accessible to all types of user by:**
 - self-service access, handicap- and family friendly

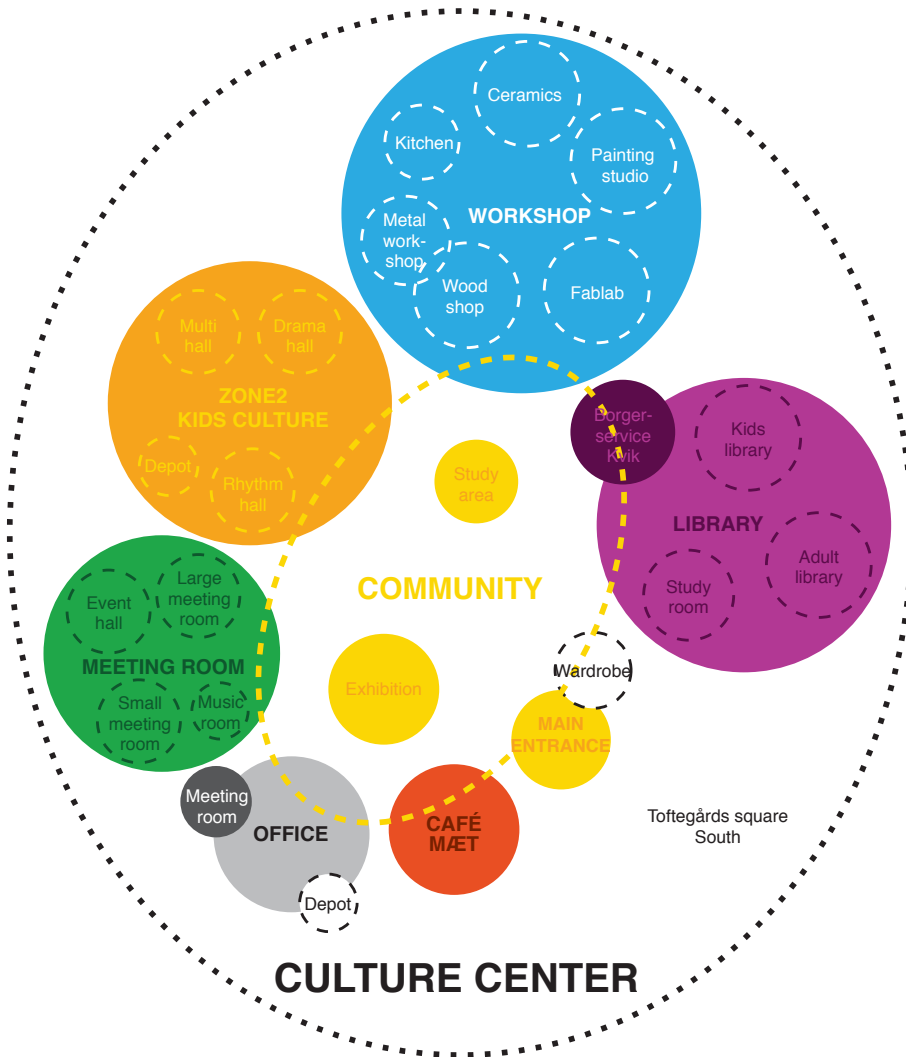
AESTHETIC

- **Visibility in the city by:**
 - locating the new building near the road
 - the entrance should be obvious to the citizens
 - visual contact between inside and outside by transparency on the ground floor
- **The building shape:**
 - should create a link between the new and existing building
 - should relate to the outdoor environment
- **Materials:**
 - should fit to the surrounding buildings

TECHNIQUE

- **Low energy consumption by:**
 - integrating passive solutions and utilize natural ventilation and solar gain
 - compact building shape
 - optimal orientation of the building
- **Comfortable indoor climate by:**
 - temperature and ventilation must adapt the activity in the rooms
 - good daylight condition
 - acoustic solution that adapted to the individual rooms
 - minimizing noise in open spaces by using soft materials and plants.
- **Minimize traffic noise on outdoor area by:**
 - building a noise barrier or by shaping the building in a effective way
 - using soft materials and plants

FUNCTION DIAGRAM



Ill. 111: Function diagram

This simple diagram shows overall how the functions in the New Valby Culture centers should be organized and how they relate to each other.

The main importance is to create a common space that is the heart of the building and function as the community, where people meet and interact between different ages, gender and cultural differences.

ROOM PROGRAM

The total square meter in the new Valby Culture Center excl. basement are 5.358 m² and Valby library in the existing building are 1.903 m². So the total usable area are 12.978 m².

Location [Floor]	Category	Room	Area [m ²]	Air flow rate (Mechanical)	Air flow rate (Natural)	Daylight factor [%]	
Basement 5717 m ²	Parking	Bicycle	174	-	-	-	
		Car	4729	-	-	-	
	Other	Storage	641	-	-	-	
		Technical room	173	-	-	-	
Ground floor 2090 m ²	Cafe	Café Mæt	200	0,35 l/sm ²	1,7 l/sm ²	2	
		Kitchen	54	20 l/s	1,7 l/sm ²	2	
		Storage	23	0,35 l/sm ²	1,7 l/sm ²	2	
	Common space	Lobby	244	0,35 l/sm ²	1,7 l/sm ²	2	
		Reception	18	0,35 l/sm ²	1,7 l/sm ²	2	
		Storage	24	0,35 l/sm ²	1,7 l/sm ²	2	
		Wardrobe	27	0,35 l/sm ²	1,7 l/sm ²	2	
		Study area	46	0,35 l/sm ²	1,7 l/sm ²	2	
		Exhibition	67	0,35 l/sm ²	1,7 l/sm ²	2	
		Entre	45	0,35 l/sm ²	1,7 l/sm ²	2	
		Entrance B	91	0,35 l/sm ²	1,7 l/sm ²	2	
	Workshop	Metal workshop	90	0,35 l/sm ²	1,7 l/sm ²	2	
		Goods delivery	27	0,35 l/sm ²	1,7 l/sm ²	2	
		Storage	34	0,35 l/sm ²	1,7 l/sm ²	2	
		Office	44	0,35 l/sm ²	1,7 l/sm ²	2	
		Wood shop	197	0,35 l/sm ²	1,7 l/sm ²	2	
	Meeting room	Event hall	300	0,35 l/sm ²	1,7 l/sm ²	2	
		Storage and backstage	81	0,35 l/sm ²	1,7 l/sm ²	2	
	Valby library	Study area	40	0,35 l/sm ²	1,7 l/sm ²	2	
		Café lounge	45	0,35 l/sm ²	1,7 l/sm ²	2	
		Computer area	50	0,35 l/sm ²	1,7 l/sm ²	2	
		Borgerservice kvik	110	0,35 l/sm ²	1,7 l/sm ²	2	
		Floor	152	0,35 l/sm ²	1,7 l/sm ²	2	
Other	Toilet	81	10 l/s	-	-		
1st floor 458 m ²	Common space	Study area	84	0,35 l/sm ²	1,7 l/sm ²	2	
	Workshop	Fab lab	361	0,35 l/sm ²	1,7 l/sm ²	2	
	Other	Toilet	13	10 l/s	-	-	
2nd floor 1365 m ²	Workshop	Painting studio	200	0,35 l/sm ²	1,7 l/sm ²	2	
		Storage	92	0,35 l/sm ²	1,7 l/sm ²	2	
		Ceramic ovens and storage	25	0,35 l/sm ²	1,7 l/sm ²	2	
		Ceramics	127	0,35 l/sm ²	1,7 l/sm ²	2	
		Multi-functional room	98	0,35 l/sm ²	1,7 l/sm ²	2	
	Common space	Kitchen	173	20 l/s	-	2	
		Lounge	115	0,35 l/sm ²	1,7 l/sm ²	2	
		Lounge/study area	102	0,35 l/sm ²	1,7 l/sm ²	2	
		Valby library	Kids Library	360	0,35 l/sm ²	1,7 l/sm ²	2
			Toilet	24	10 l/s	-	-
Other	Toilet	49	10 l/s	-	-		

Location [Floor]	Category	Room	Area [m ²]	Air flow rate (Mechanical)	Air flow rate (Natural)	Daylight factor [%]
3rd floor 1.326 m ²	Zone 2	Drama hall	98	0,35 l/sm ²	1,7 l/sm ²	2
		Rhythm hall	190	0,35 l/sm ²	1,7 l/sm ²	2
		Multi hall	147	0,35 l/sm ²	1,7 l/sm ²	2
		Small music room	46	0,35 l/sm ²	1,7 l/sm ²	2
		Large music room	41	0,35 l/sm ²	1,7 l/sm ²	2
		Changing room	116	0,35 l/sm ²	1,7 l/sm ²	2
		Storage	36	0,35 l/sm ²	1,7 l/sm ²	2
	Valby Library	Kids Library	240	0,35 l/sm ²	1,7 l/sm ²	2
		Adult Library	120	0,35 l/sm ²	1,7 l/sm ²	2
		Toilet	24	10 l/s	-	-
	Other	Toilet	49	10 l/s	-	-
	Common space	Lounge	68	0,35 l/sm ²	1,7 l/sm ²	2
		Playroom	76	0,35 l/sm ²	1,7 l/sm ²	2
	Meeting room	Large meeting room	42	0,35 l/sm ²	1,7 l/sm ²	2
Medium meeting room		33	0,35 l/sm ²	1,7 l/sm ²	2	
4th floor 1.465 m ²	Meeting room	Event hall	500	0,35 l/sm ²	1,7 l/sm ²	2
		Technique and backstage	250	0,35 l/sm ²	1,7 l/sm ²	2
		Large meeting room	160	0,35 l/sm ²	1,7 l/sm ²	2
		Medium meeting room	86	0,35 l/sm ²	1,7 l/sm ²	2
		Small meeting room	43	0,35 l/sm ²	1,7 l/sm ²	2
	Valby Library	Adult Library	366	0,35 l/sm ²	1,7 l/sm ²	2
		Toilet	24	10 l/s	-	-
	Other	Toilet	36	10 l/s	-	-
5th floor 557 m ²	Office	Open office	110	0,35 l/sm ²	1,7 l/sm ²	2
		Meeting room	21	0,35 l/sm ²	1,7 l/sm ²	2
		Quiet room	9	0,35 l/sm ²	1,7 l/sm ²	2
		Kitchen	32	20 l/s	1,7 l/sm ²	2
		Storage	21	0,35 l/sm ²	1,7 l/sm ²	2
	Other	Toilet	16	10 l/s	-	-
	Valby Library	Adult Library and Study area	324	0,35 l/sm ²	1,7 l/sm ²	2
		Toilet	24	10 l/s	-	-

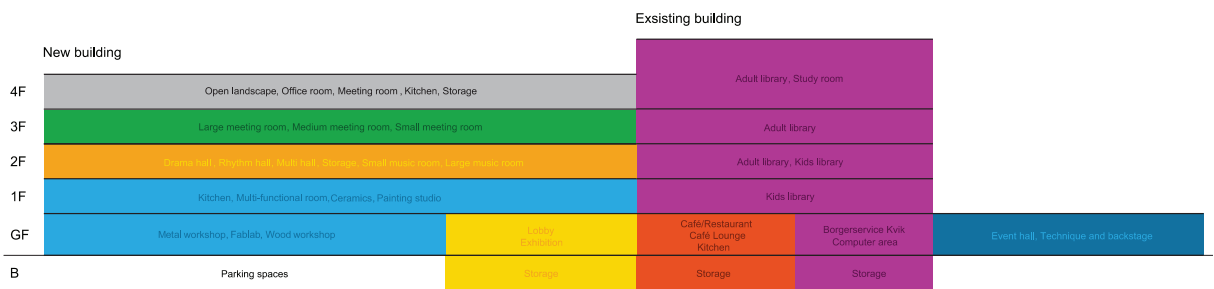
Total inkl. basement	12.978 m²
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Table 01: Room program

Site: 13.395 m²
Valby library: 1.903 m²

Culture center
excl. basement: 5.358 m² (net)
Building ratio: 40 %
Building gross: 6.921 m² (gross)
b/n-faktor: 1,3

PRINCIPLE SECTION



III. 112: Principle section

This section diagram shows an idea on how the principle is and where it would be preferred to place the different functions, in the new- and existing building.

The new Culture Center is organized so that the more public functions are located on the ground floor and more private functions are located on the top floors.

All functions that need easy access for transporting of large materials and machines are located on the ground floor. Functions as the entrance, lobby and the Café are also located on the ground floor. These functions are the first impression the citizens get, when they enter the new Culture Center and the Café will have the possibility of using the outdoor space.

Offices and meeting rooms are located on the upper floors, because they are more semi-private functions and doesn't necessarily have to be visible.

Valby library will be relocated into the existing building on all floors. The existing 5th floor in the building are removed to create a double high space with exposed beam and columns. In that case the 4th floor will be more spacious.

The event hall is located in the same low existing building. Parking spaces for the users is located in the basement of the new building and will have direct access into the new Culture Center.





DESIGN PROCESS

This following chapter contain the sketching and synthesis phase through out the design process. It is not presented chronological in this chapter, because this it is a iterative process. This phase is where aesthetic- and technical parameter are integreated into the design process.



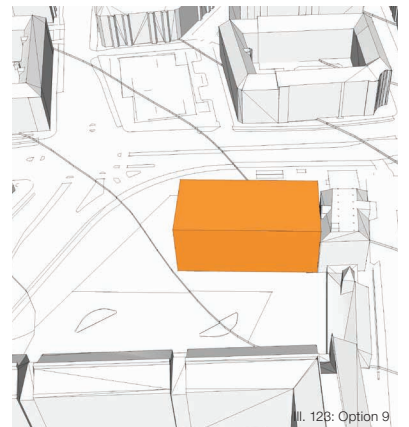
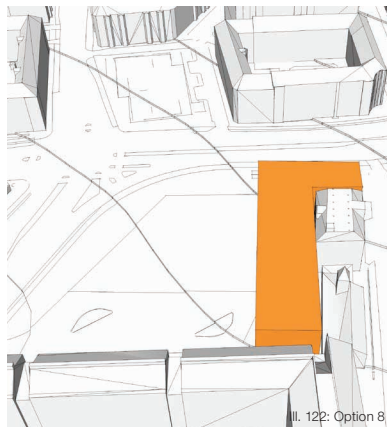
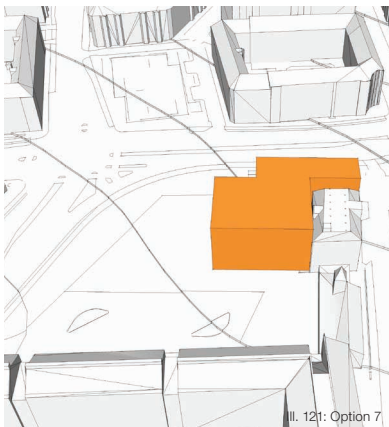
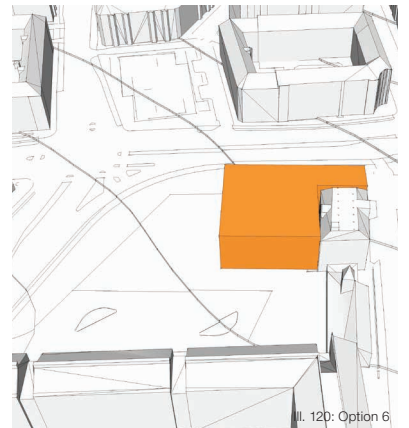
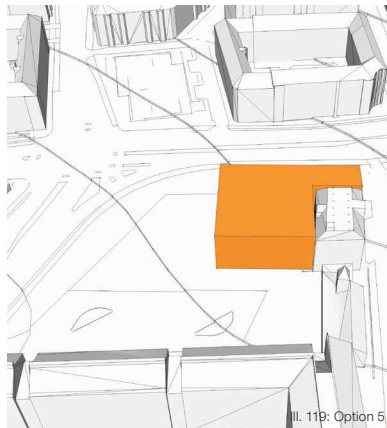
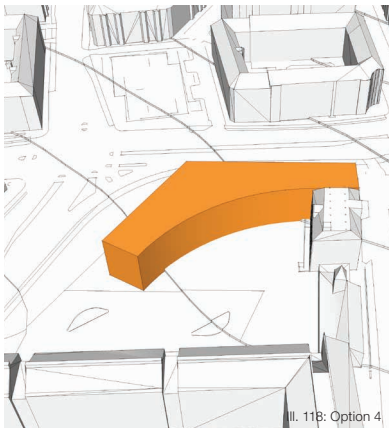
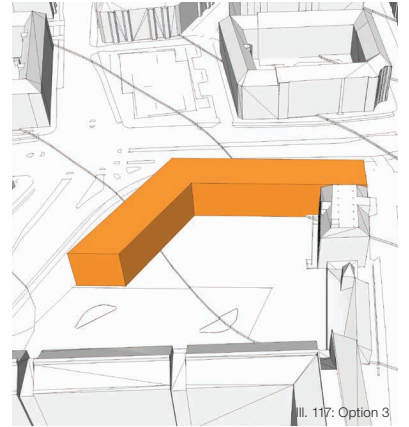
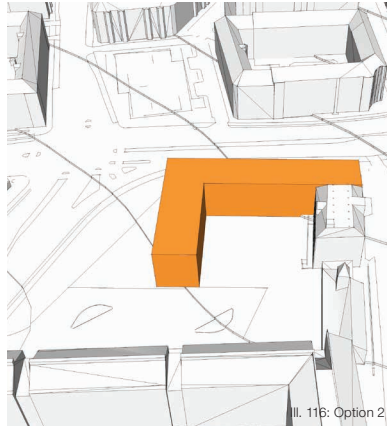
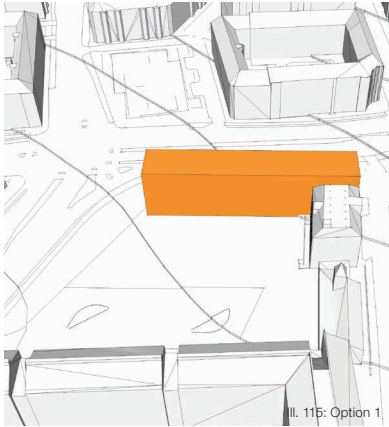
III. 114: Painting studio

VOLUME STUDIES

This volume study are the first phase of exploring and experimenting with different shapes. It is made regarding the design parameters and how the different volumes relates to the surrounding buildings, the experience for people in the urban context, orientation regarding daylight and noise. But also how the volume defines the square and how the local climate affects the volume.

The volume study shows different approaches of developing of the typology. Some of the volumes are shielding from the road while others creates an enclosed square. They do all have in common that, they have a connection to the existing building.

Volume option 3 and 4 has several parameters that meet the design parameters more then others. They creates an enclosed square that shields the traffic noise and defines a square together with the existing buildings. These volumes will be further investigated and developed on the next page.



VOLUME DEVELOPMENT

This volume development shows how volume option 3 and 4 from the volume studies, are being further developed and some of the volumes are a combination of both options. They all creates an enclosed square but with different curves towards the square and on the street side.

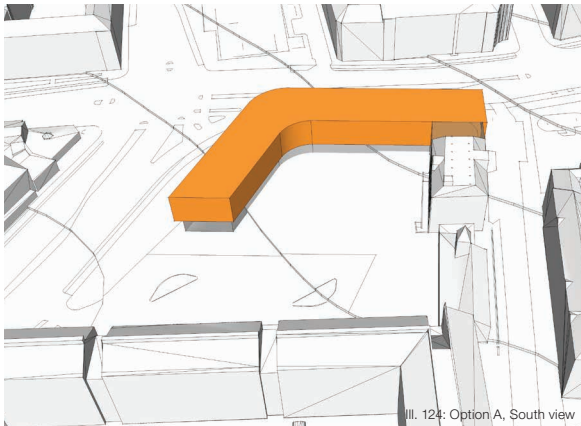
Option A has a more squared square and reminiscent of a typical building block, while option B relates more to the typology on the street side, but has a half circle on the square side. This divides and defines the two different spaces towards the urban context.

Option C and D is very similar with a curved facade towards the street side, this curved shape will lead people around the

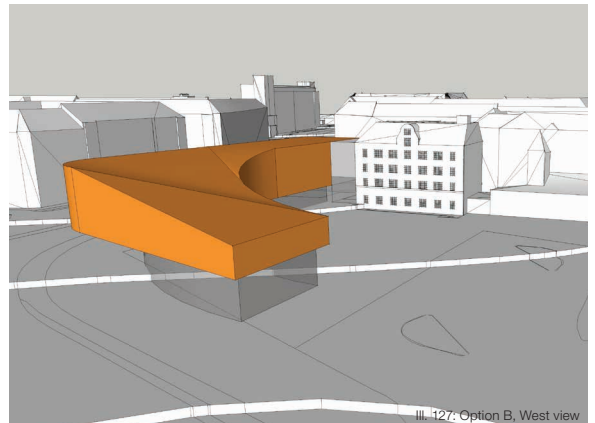
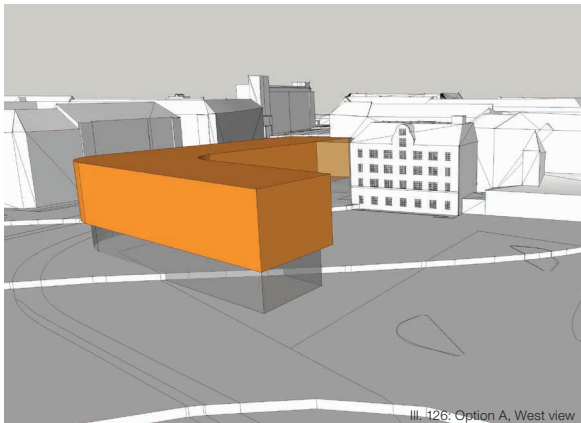
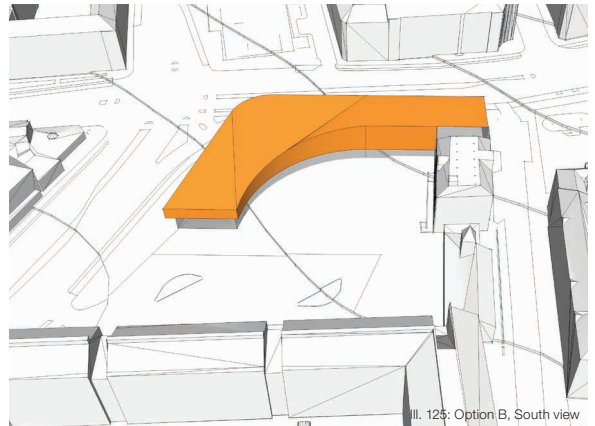
building and into the square. The facade in option C on the square side, are the same half circle as in option B. This curve are created from the flow of the road. While in option D the curve towards the square creates a circular space in front of the existing culture house. This respects the old building by incorporating the building as part of the square and as a part of the new culture center.

Option D are being further investigated, where technical parameter and detailing of the volume, are being developed in the design process.

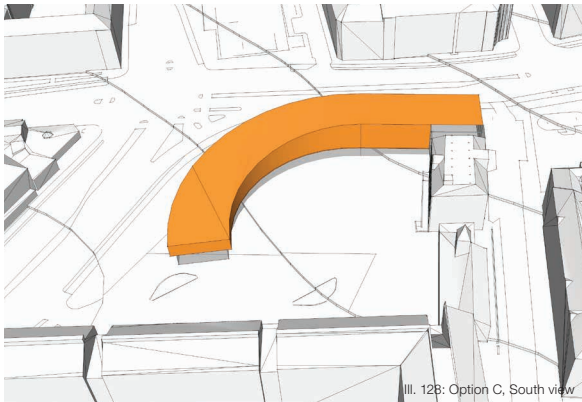
Option A



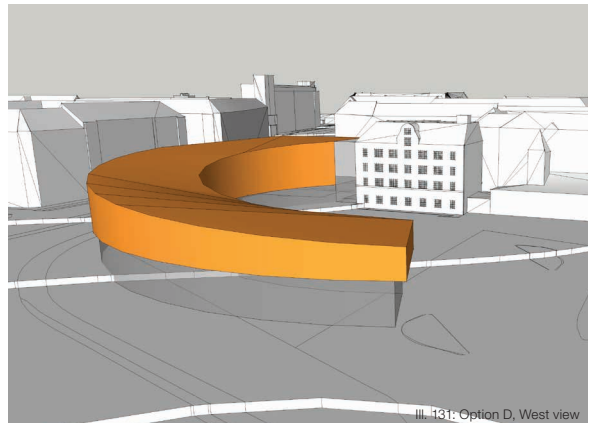
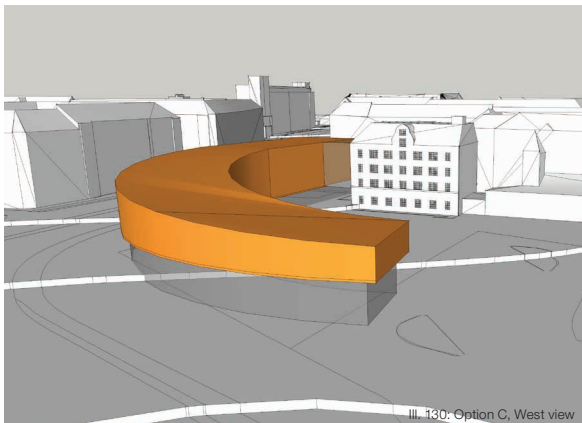
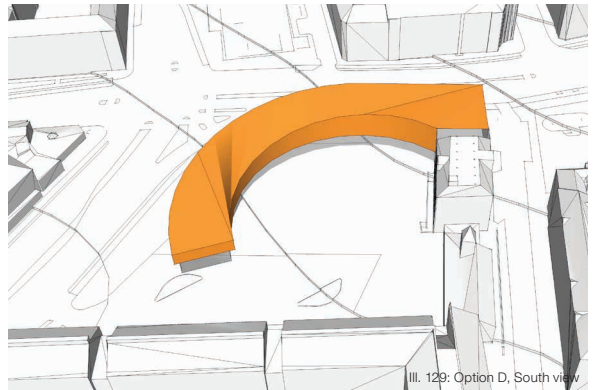
Option B



Option C



Option D



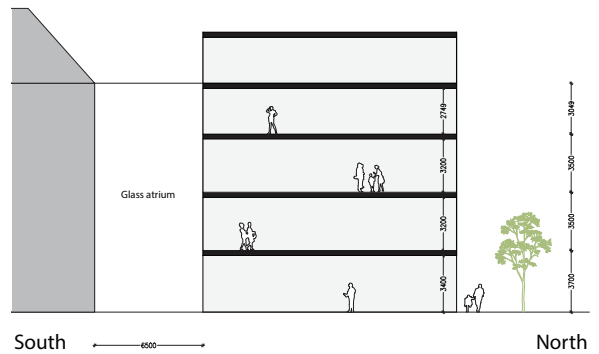
SECTION DEVELOPMENT

This section study are made to understand how the new building relates to the existing building, but also how the ground floor relates to the terrain and the human scale.

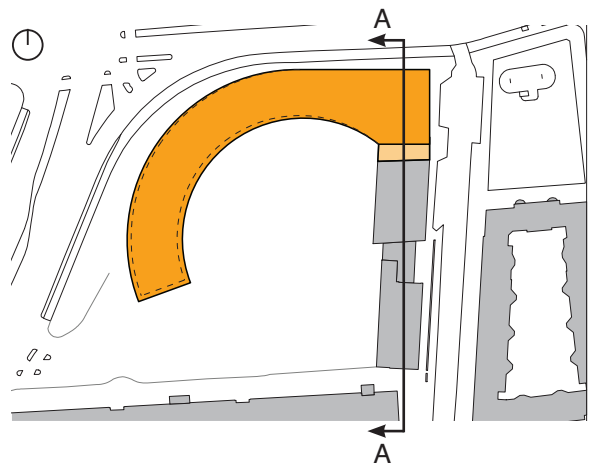
The following diagrams are showing a section of how different ground floor facades are pushed ind from the facade. This creates a overhang that draw people into the building. The northern facade is in some of the diagrams not pushed in, because there is less daylight from the facade and is therefore mainly studied on the southern facade.

The section studies shows that the option with the continuous facade all the way down, are not related to the human scale and urban context. It creates a barrier towards the street level. While the facades that are pushed in on the street level, are inviting people towards the building and creates shelter and also works as solar shading.

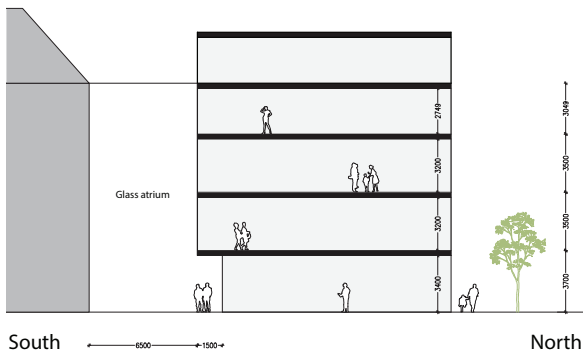
The facade that are pushed in with 1,5 meter on both side are enough to create shelter and a satisfied daylight condition of 2%. The overhang of 1,5 meter and 2 meter are investigated in a daylight simulation program. See the results on page 82-83.



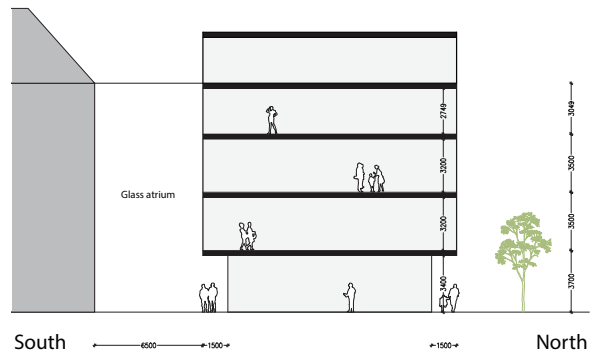
III. 132: Facade all the way down



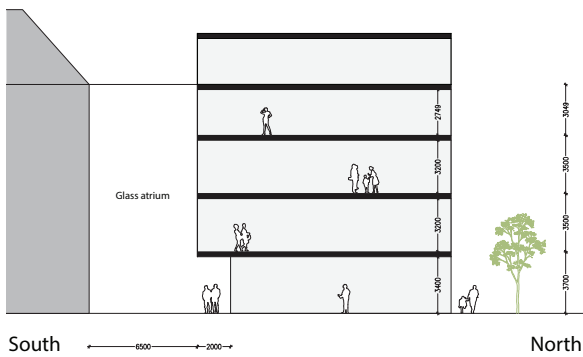
III. 133: Simple plan shows the section line



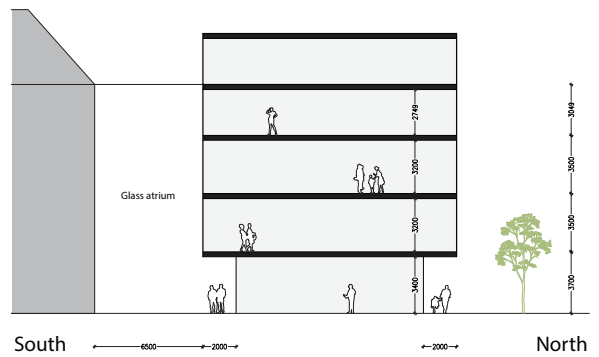
III. 134: Facade pushed in 1,5 m on the southern side



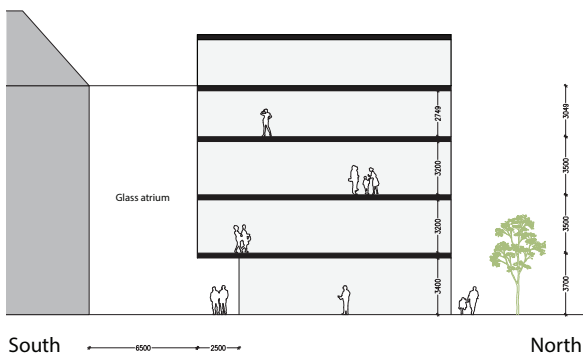
III. 135: Facade pushed in 1,5 m on both side



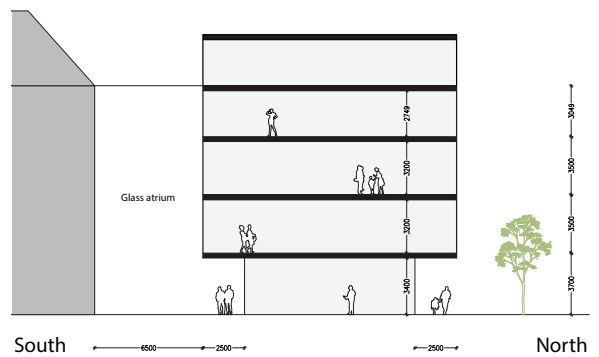
III. 136: Facade pushed in 2 m on the southern side



III. 137: Facade pushed in 2 m on both side



III. 138: Facade pushed in 2,5 m on the southern side



III. 139: Facade pushed in 2,5 m on both side

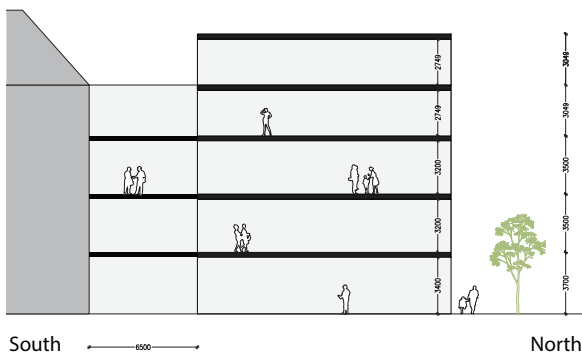
CONNECTION DEVELOPMENT

This connection study are made to investigate how the new building connects to the existing building and how it relates to the ground floor, the terrain and the human scale.

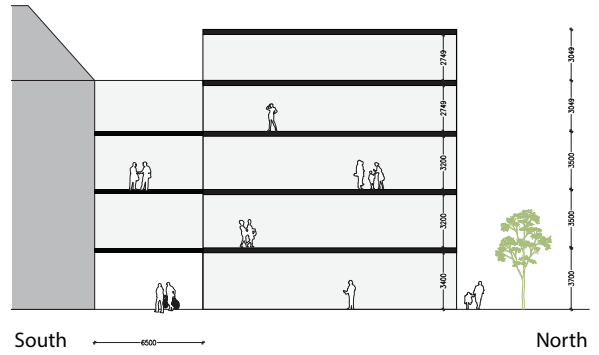
The new building will not be connected directly to the existing building. A glass atrium will connect the two different buildings, but at the same time creates a neutral clutch zone between them. This respect the existing old building, as the building are a preservation class 3, which mean that the exterior can't be changed. The atrium not only connects the two buildings on the exterior but does it also in on the floors. This creates a connection between Valby library and Valby culture center as one institution.

As a ventilation strategy, the roof in the atrium opens automatically to natural ventilate the culture center and library.

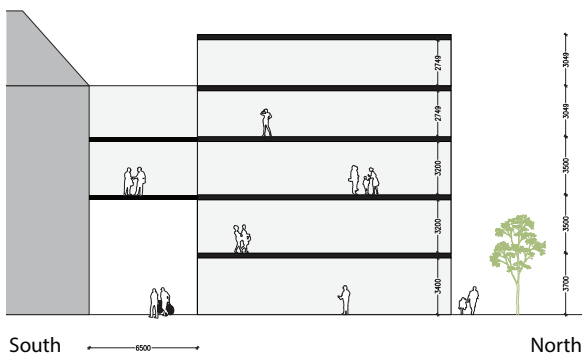
The openness and entrance of the square will be created by having a connection under atrium. This will draw people into the square from the north-west side of the site, but also function as a transit route across the square.



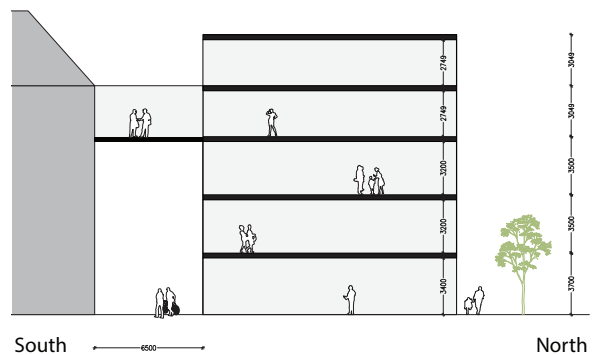
III. 140: Connection to the existing building on 1-3 floor



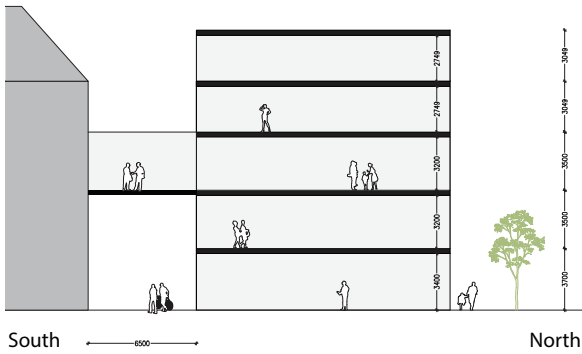
III. 141: Connection to square on GF and a connection to the existing building on 1-3 floor



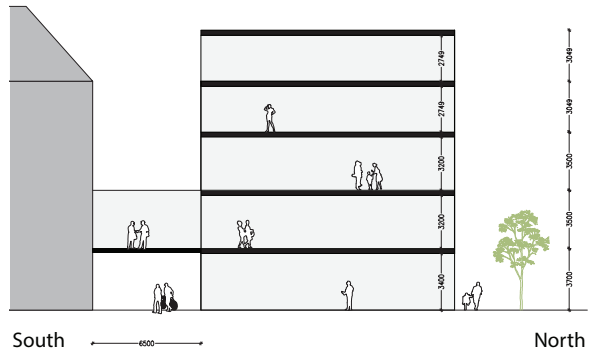
III. 142: Connection to square on GF and a connection to the existing building on 2nd and 3rd floor



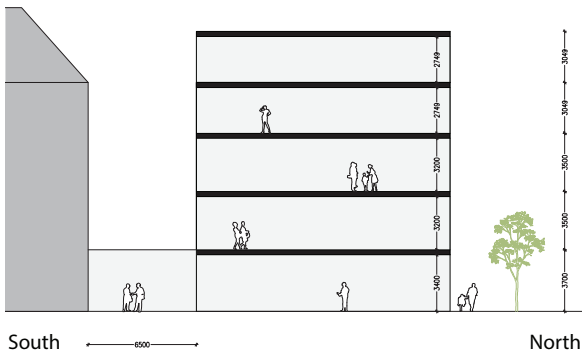
III. 143: Connection to square on GF and a connection to the existing building on 3rd floor



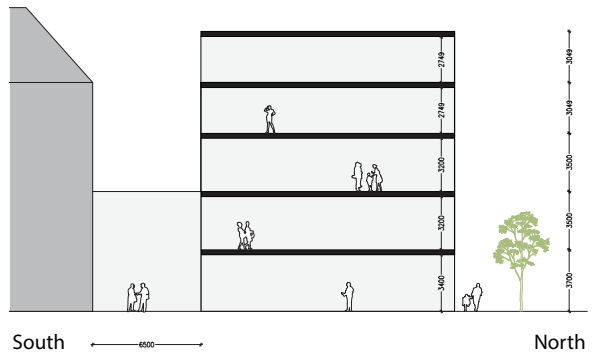
III. 94: Connection to square on GF and a connection to the existing building on 2nd floor



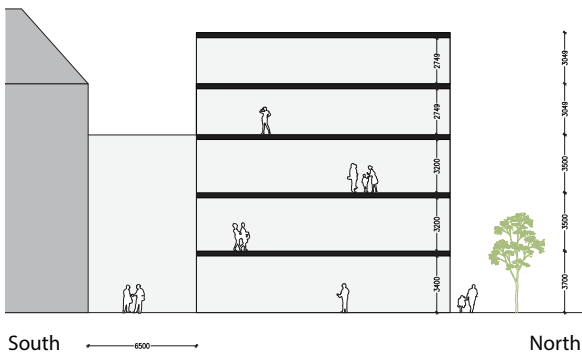
III. 94: Connection to square on GF and a connection to the existing building on 1st floor



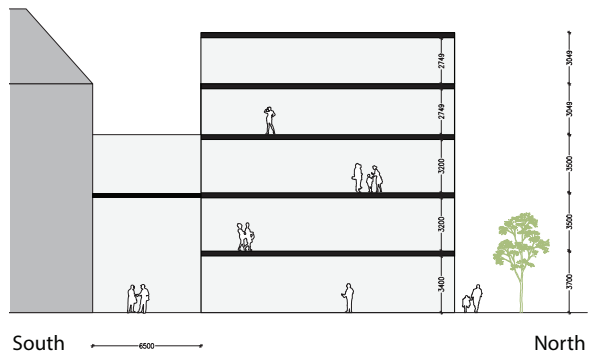
III. 144: Connection to square on and the existing building on GF



III. 145: Connection to square on GF with an double height atrium



III. 146: Connection to square on GF with an triple height atrium



III. 147: Connection to square on GF with an double height atrium and a connection to the existing building on 2nd floor.

MATERIAL FACADE DEVELOPMENT

This study are made to investigate different material on the facade and how it relates to the existing- and surrounding building. The existing building and surrounding building are mainly red brick facades and since Valby district use to be an industrial district, the industrial vibe can still be seen in the facades of some of the preserved buildings in the area.

Therefore using industrial materials could be used such as metal facade, concrete or brick.

Another thought could be that the new building should stand out from the surrounding buildings, as a contrast instead of blending in. This is to create awareness and visibility towards the citizens and at the same time indicate that this is the cultural meeting point in the district.

The materials that are could be used that relates to the industrial environment could be concrete or corten steel. For materials that will make the building stand out, materials such as glass panels or wood could be used.

The glass facade has a high u-value and will especially effect the building energy consumption, when creating the same effect of translucent as in the reference picture, on the next page.

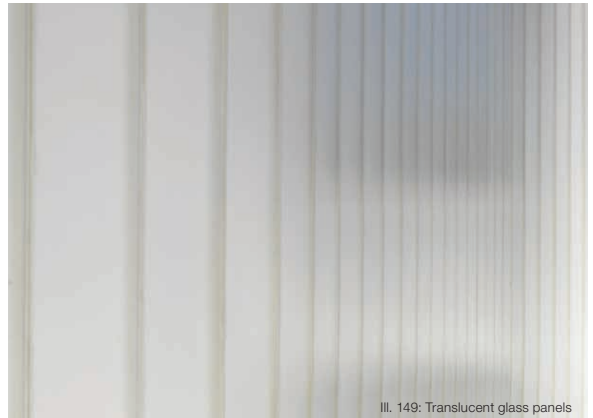
The wooden facade will naturally patina over time and turn gray and may look worn in contrast to the surrounding.

The building are situated on the corner of a busy main junction and hard materials such as concrete will reflect the noise into the square and create an uncomfortably place to stay.

Therefore a softer material would be ideal to use. Corten steel corten steel on the facade relates to the industrial history of the district, but it is not a soft material. By perforate the corten steel with circular holes, it could absorbe some of the noise. Perforate the facade in a pattern could express the creative environment.



III. 148: Concrete



III. 149: Translucent glass panels



III. 150: Perforated corten steel



III. 151: Wooden lamella

REFERENCE OF MATERIALS



DAYLIGHT ANALYSIS

Daylight analysis are made to analyze the daylight factor on some of the floors in the new culture center. This analysis primarily investigate two different floors, on the building depth of the space and the area and placement of the windows.

This is due to the Danish building regulations 2015, that recommend the daylight factor to be minimum 2% on working spaces. [Bygningsreglementet.dk, 2015c] The aim is to fulfill an average of minimum 2% daylight factor on working spaces.

The daylight analysis are simulated in the software VELUX Daylight Visualizer. The analysis are simulated with a overcast sky condition, this mean that it simulates on the most critical overcast mean on a year. The software do not take direct sunlight into account and use the diffuse lighting to check how the daylight spread into the building. All the simulation are measured 0,8 meter from the floor which corresponds to a table height.

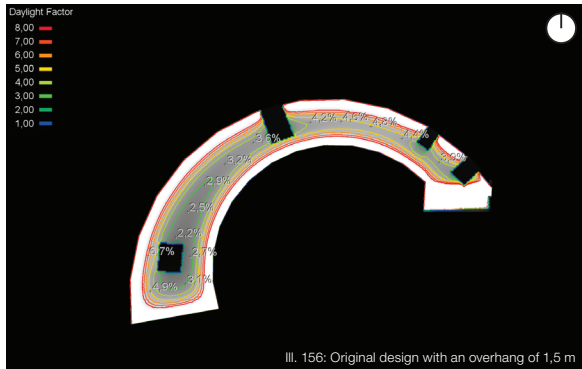
The ground floor are analyzed because its on the ground. The surrounding buildings can have an effect on the daylight and because of the overhang. The analysis on the next page are being done with an overhang of 1,5 meter and 2 meter. This is due to see which of the overhang that will be ideal for the building. The result shows that some places in the 2 meter overhang, do not reach 2% daylight where else 1,5 meter does. Therefore 1,5 meter overhang are being used for the new culture center.

The floor with open offices are analyzed, because the employee has the longest working hours and therefore need minimum 2% daylight on their working space. The analysis of the office shows the daylight condition in the open office, fulfills the recommended daylight factor both in the original design and redesign. The original design has less daylight factor because there is no roof window. The daylight factor in the redesign are higher because it has roof windows.

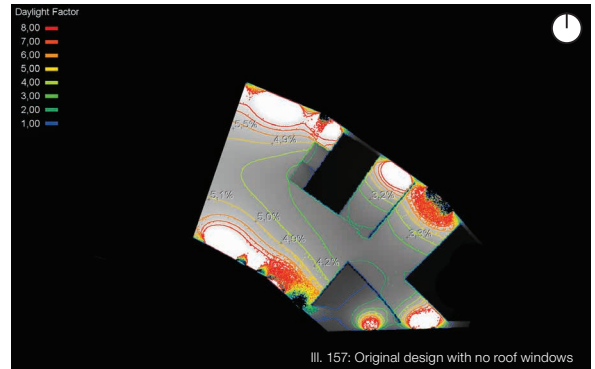
	Original Design	Redesign
Building floor area [m ²]	6238	6519
Building surface area [m ²]	3738,4	4439,4
Window area [m ²]	1732,2	1458,3
Window area [%]	46	33
Window height on GF [m]	5	3,8 - 2,4

Table 02: Information about original design and redesign

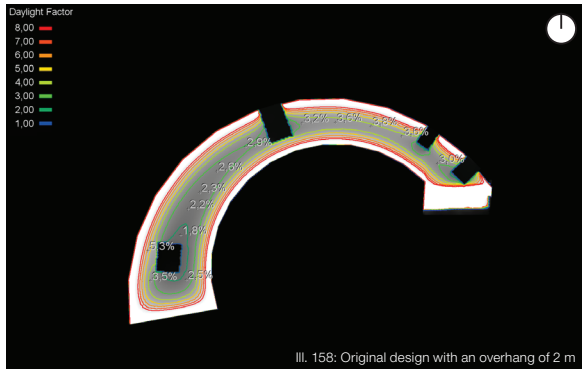
GROUND FLOOR WITH 1,5 METER OVERHANG
Original design



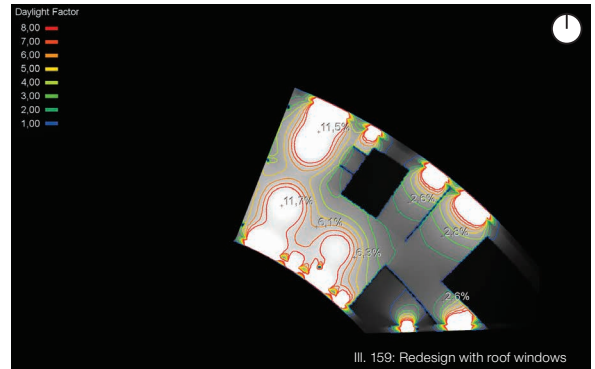
4TH FLOOR IN OPEN OFFICE AREA
Original design



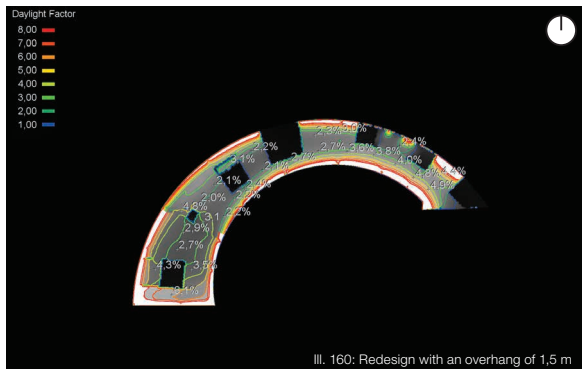
GROUND FLOOR WITH 2 METER OVERHANG
Original design



5TH FLOOR IN OPEN OFFICE AREA
Redesign



GROUND FLOOR WITH 1,5 METER OVERHANG
Redesign



BE15 ANALYSIS

Be15 analysis are made to estimate the energy consumption used in the building per year. This are due to the Danish building regulation by achieving the requirement of 25 kWh/m² per year for 2020, on non-residential buildings. [Bygningsreglementet. dk, 2016] The analysis are made by using the software Be15 as a tool throughout the design process to ensure the design solution fulfill the requirement of building class BR2020. The software are a calculating on monthly average basis and the total energy consumption for a building on a year. The software does also estimating the energy consumption for heating, cooling, mechanical ventilation, lighting and domestic hot water etc.

One of the main parameters that influence the energy consumption are the U-value and area of the building envelopes but also the U-value and area of windows. The U-value for the building envelopes are shown in table 03 and for the windows are shown in table 04. The building are curved which mean that the building surface area are smaller then a square building. The envelope should be well insulated as well as the airtight to prevent unnecessary heat loss and line loss. The heat gain from the sun, people and equipment tend to create excess temperature. Therefore the size and orientation of windows are an important factor for using natural ventilation.

Another parameter that influence the energy consumption are the ventilation strategy and to avoid excess temperature. Therefore different strategies are investigated with the original design and for the redesign. First the building design are investigated by using only natural ventilation during day time, the results shows that there will be excess temperature. Natural ventilation are therefore being used during day- and night time, and shows a huge different on the energy consumption. To further minimize the energy consumption and reach the building class 2020, the building has been redesign and heat recovery are used on the mechanical ventilation.

The results from the original design with heat recovery are described on page 85 and for redesign with heat recovery are described on page 86. The Be15 results for only natural ventilation during day time and natural ventilation during day- and night time, can be found in appendix 2 on page 113. The results of all the Be15 analysis are shown in table 05. For further information, the Be15 program files can be found on the attached USB.

Construction	Material	Thickness [mm]
External wall	Light aggregat concrete	150
	Insulation	300
	Steel Cor-Ten	1,5
U-Value [W/m ² K]		0,1

Roof	Chipboard	25
	Air	20
	Insulation	300
	Vapor barrier	0,4
	Insulation	40
	Plasterboard	39
U-Value [W/m ² K]		0,098

Ground floor	Reinforced concrete	300
	Flexi batts	350
U-Value [W/m ² K]		0,096

Table 03: U-value of the building envelopes

Window	Glass layer	U-Value [W/m ² K]	g _g	F _f	LT _g
VELFAC Ribo wood	3	0,8	0,5	0,74	0,72

Table 04: U-value of windows

RESULTS FROM BE15 ANALYSIS

		Natural ventilation day	Natural ventilation day and night	Heat recovery	Solar cells
BR 2020 [kWh/m ² year]	Requirement	25	25	25	25
	Original design	36,8	25,1	23,7	-1,3
	Redesign	32,3	24	20,1	-3,5

Table 05: Results from Be15 analysis

ORIGINAL DESIGN With heat recovery

	Original Design
Building floor area [m ²]	6238
Building surface area [m ²]	3738,4
Window area [m ²]	1732,2
Window area [%]	46
Window height on GF [m]	5

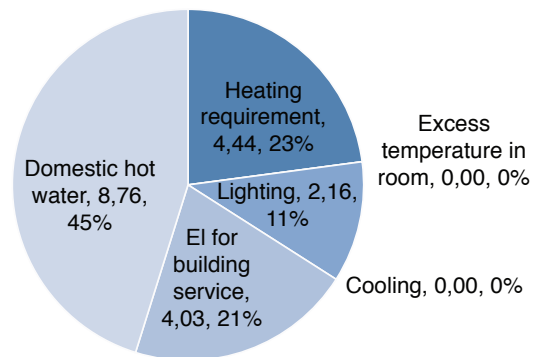
Table 06: Information about original design

In the original design the total energy consumption for a year with natural ventilation during day- and night time with heat recovery reach 23,7 kWh/m² per year. To further reach zero energy, the building need to use 1450 m² solar cells on the roof as a renewable energy solution.

The yearly distribution of building energy consumption are shown in illustration 161. And the distribution of energy consumption on a monthly basis throughout a year are shown in illustration 162.

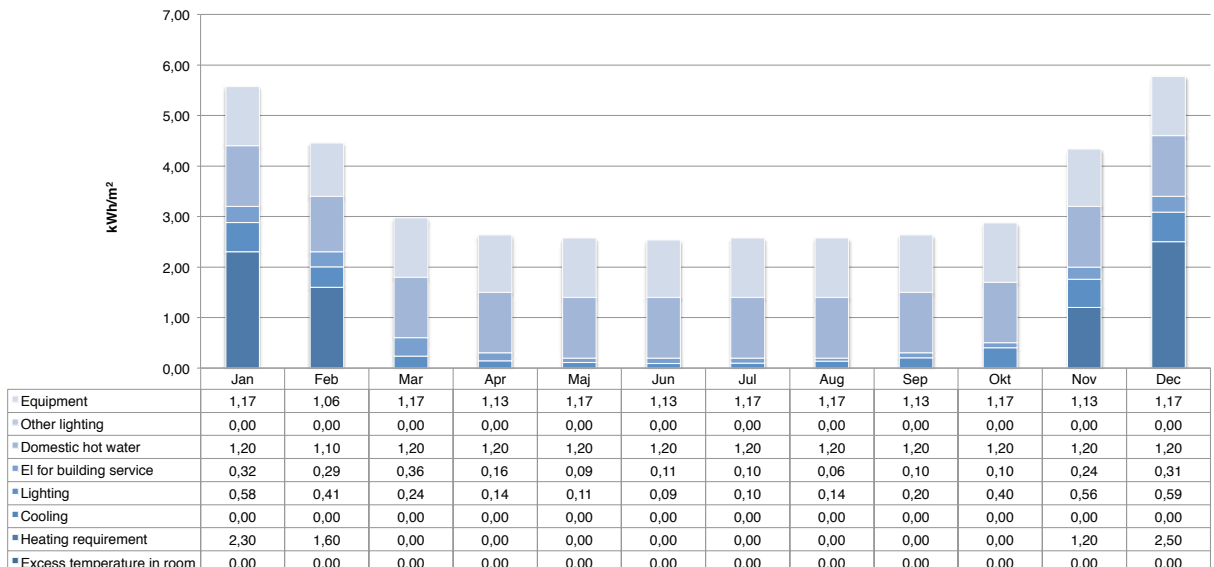
The results shows a higher energy consumption during winter because of the need for heating. The energy for mechanical ventilation are lower during summer time, because there is natural ventilation.

BR 2020



Ill. 161: Pie chart of the energy consumption

ENERGY CONSUMPTION



Ill. 162: Bar chart of the monthly energy consumption throughout a year

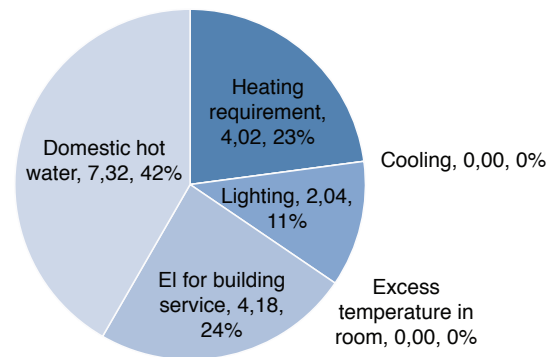
REDESIGN DESIGN With heat recovery

	Redesign
Building floor area [m ²]	6519
Building surface area [m ²]	4439,4
Window area [m ²]	1458,3
Window area [%]	33
Window height on GF [m]	3,8 - 2,4

Table 07: Information about redesign

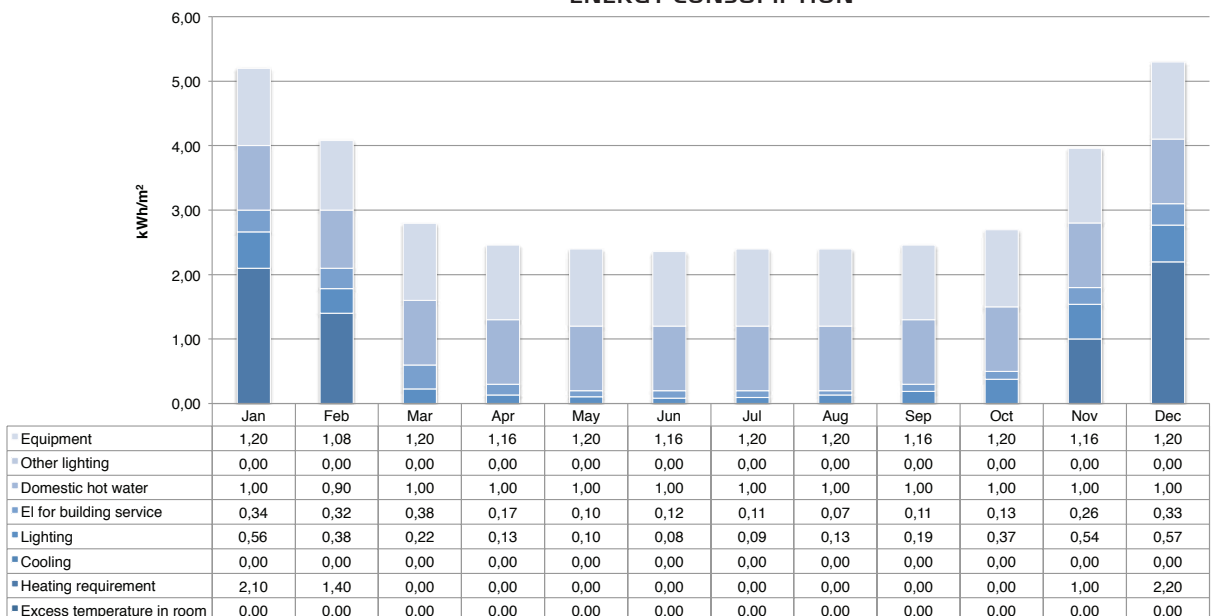
In redesign the window area are reduced from the original design, to optimize the total energy consumption for a year. The results from redesign with natural ventilation during day- and night time with heat recovery reach 20,1 kWh/m² per year. The yearly distribution of building energy consumption are shown in illustration 163. And the distribution of energy consumption on a monthly basis throughout a year are shown in illustration 164. The results shows a higher energy consumption during winter because of the need for heating. The energy for mechanical ventilation are lower during summer time, because there is natural ventilation. The results also shows that there is no excess temperature in room.

BR 2020



Ill. 163: Pie chart of the energy consumption

ENERGY CONSUMPTION



Ill. 164: Bar chart of the monthly energy consumption throughout a year

REDESIGN DESIGN

With heat recovery and solar cells

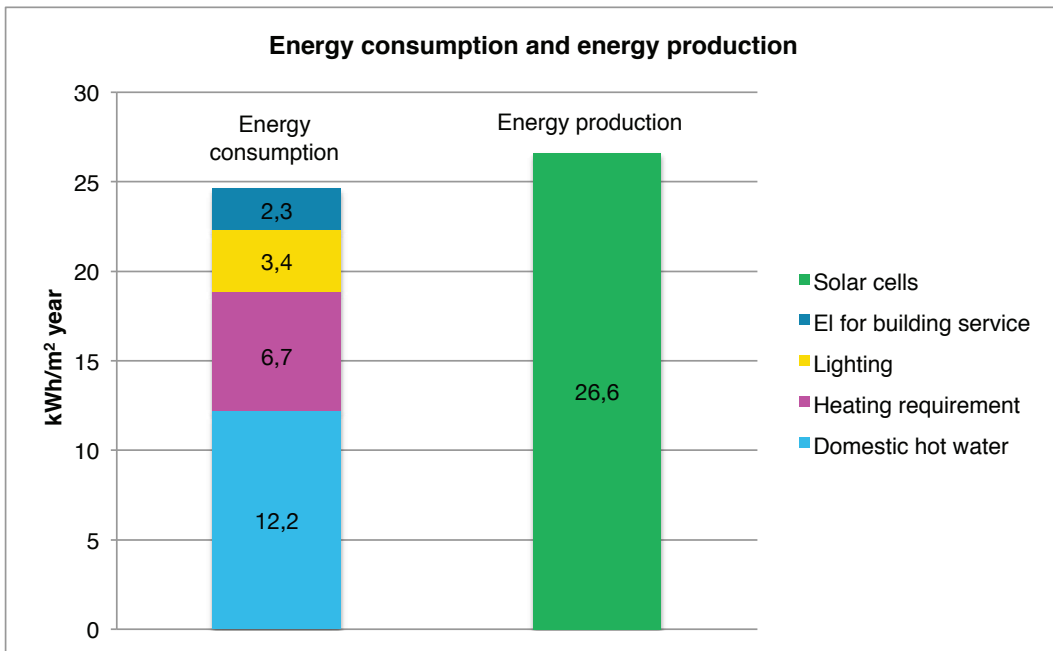
To further reach zero energy, the building need to use 1450 m² solar cells on the roof as a renewable energy solution.

The solar cells used on the building are monocrystalline because this type has the best efficiency and give the most uniform black look. For an optimal production the solar cells should face south with an angle of 43 degrees. In this case the roof are slopping in different angles and are therefore placed flat on the roof, with a minimum angle of 10 degrees and on other part of the roof the solar cells have a bigger angle. The solar cells creates enough energy to balance the building energy consumption.

[Solar Danmark, 2016]

The total energy consumption are therefore -3,5 kWh/m² per year, which mean that the solar cells produce more energy then the building energy consumption. The excess energy can either be stored and used on days where the solar cells produce less energy or sold back to the public supply grid.

Illustration 165 shows the shows the distribution of energy consumption and the energy production from the solar cells.



Ill. 165: Distribution of the energy consumption and production from solar cells

BSIM ANALYSIS

BSim analysis are made to simulate how the condition of the indoor environment and to ensure thermal comfort. The software BSim simulates on a hourly basis accounting to measured weather conditions from Design Reference Year (DRY) measured by Danish Meteorological Institute (DMI). According to the Danish building regulation the requirement for the excess temperature in building class 2020, are defined by the client for the number of hours per year, on how much the indoor temperature of 26°C and 27°C must not be exceeded. In this case, I use the number of hours in a residences building to define my maximum hours of excess temperature. The requirement of the temperature must not exceed more the 26°C for more than 100 hours per year and not exceed 27°C more than 25 hours per year. [Bygningsreglementet.dk, 2015a]

The operative temperature should fulfill thermal comfort class II from Dansk standard EN15251:2007 in summer and winter season. The table 08 shows the comfort class II.

Operative temperature	Category	Temperature range for heating, Clothing ~ 1,0 clo	Temperature range for cooling, Clothing ~ 0,5 clo
Single offices, open office, conference rooms, auditorium, cafeteria, restaurants, class rooms	II	20,0 – 24,0	23,0 - 26,0

Table 08: Temperature ranges for hourly calculation of cooling and heating energy [Dansk standard EN15251:2007, 2007]

To fulfill the thermal comfort of class II the ventilation rates for the building emissions on a very low polluting building should be 0,35 l/s, m². [Dansk standard EN15251:2007]

Ensuring a good indoor climate in building class 2020 the Danish building regulation, require the CO₂ concentration in the air to be less than 900 ppm for long periods. [Bygningsreglementet.dk, 2015d]

For further information, the BSim program files can be found on the attached USB.

BSim are used to analyze the condition of two rooms that are estimated to have, the most critical indoor environment.

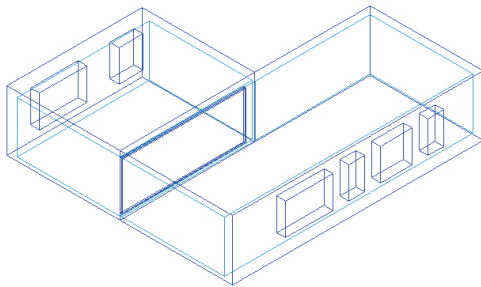
The first room are located on the top floor with an open office plan. This room are estimated to have a critical indoor environment because it is exposed to the sun on all the facades and it is the room where people are staying in the longest hours throughout a day. It is an office with a working hour between 8-16 with space for 15 people and appliances such as computer. The simulation are made on the original design and on redesign of the building. The result are illustrated on page 89. It shows that the CO₂ concentration and the mean operative temperature and excess temperature fulfill the requirement of BR2020 on both designs.

The CO₂ concentration in illustration 168 and 169 shows that there are less pollution during summer due to the natural ventilation.

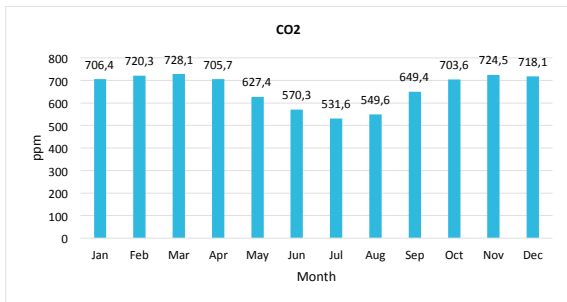
The mean operative temperature shows a higher temperature during summer which are expected. The significant difference are the excess temperature in redesign. The results are shown in illustration 173. There are more hours of 26°C and 27°C then in the original design, this are due to the smaller floor area in redesign.

OPEN OFFICE AREA ON 4TH FLOOR

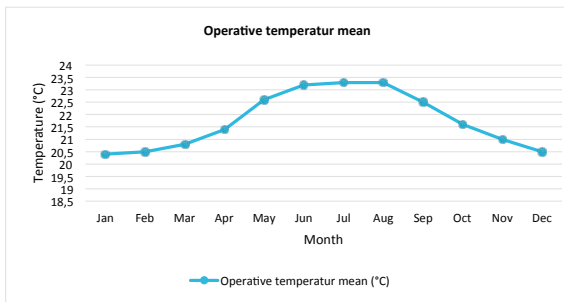
Original design



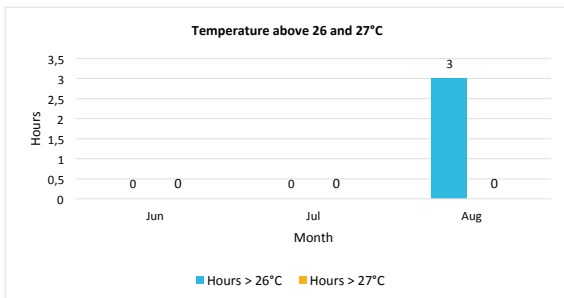
Ill. 166: BSim model of open office area



Ill. 168: Co2 level throughout a year



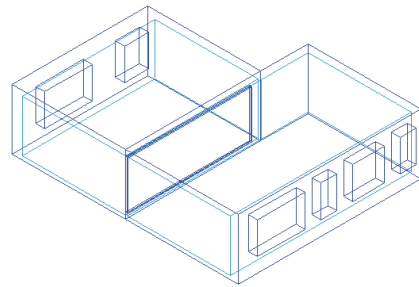
Ill. 170: The operative temperature throughout a year



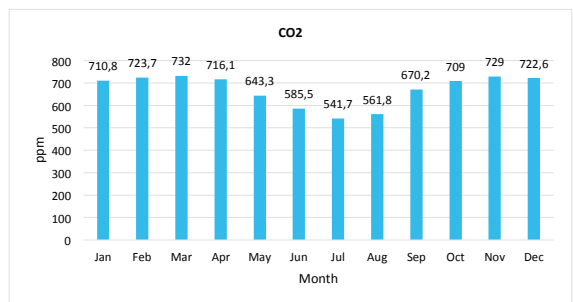
Ill. 172: Temperature above 26°C and 27°C during summer season

OPEN OFFICE AREA ON 5TH FLOOR

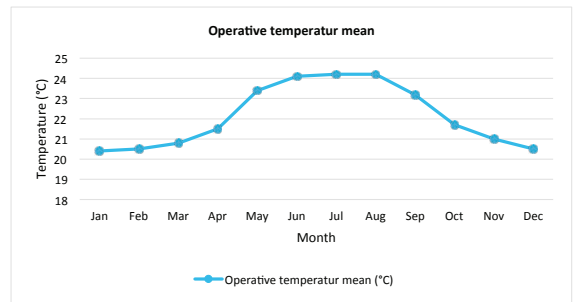
Redesign design



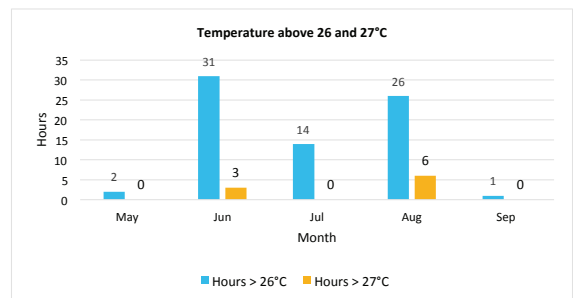
Ill. 167: BSim model of open office area



Ill. 169: Co2 level throughout a year



Ill. 171: The operative temperature throughout a year



Ill. 173: Temperature above 26°C and 27°C during summer season

Another critical room are the rhythm room that are facing south on 3rd floor and have a high activity level. This room in the original design rhythm room are 120 m² and used by 25 people with an high activity level, few hours per day.

The results from the simulation are made on the original design are illustrated in illustration 175, that the CO₂ concentration are very high during winter, because there are no natural ventilation in that period. The results does therefore not fulfill the BR2020 requirement of under 900 ppm for long periods.

The mean operative temperature illustrated in illustration 176, and shows that it fulfill the recommended class II.

The hour of excess temperature shown in illustration 177, does not fulfill the requirement of BR2020. Therefore a redesign are made due to the results from Be10 calculation but also from the BSim simulation.

In redesign 1 the rhythm room are smaller but still orientated in the same direction. The room are 80 m² and used by 16 people with an high activity level, few hours per day.

The results from the simulation shows in illustration 180, that the CO₂ concentration are even higher now, this are due to the room are smaller and large window area.

The mean operative temperature illustrated in illustration 181, are not fulfilling the recommended class II during summer, due to the smaller room and large window area.

There are lots of hour above excess temperature shown in illustration 182. This is a huge problem and does not fulfill the requirement of BR2020. Therefore another redesign 2 are simulated for that room.

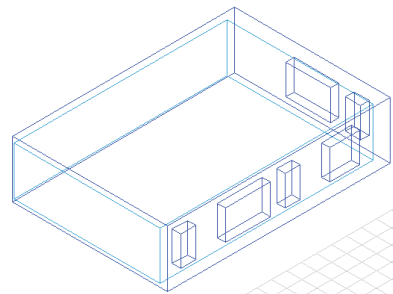
In redesign 2 the rhythm room are still the same size, orientation, number of people and same activity level, but the window area are reduced and the mechanical ventilation are increased.

The results from the simulation are now showing in illustration 183, that the CO₂ concentration fulfill the BR2020 requirement. The mean operative temperature illustrated in illustration 184, shows now that it fulfill the recommended class II.

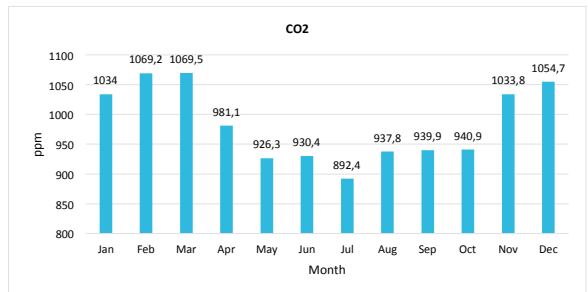
The hour of excess temperature shown in illustration 185, does also fulfill the requirement of BR2020.

RHYTHM ROOM ON 3RD FLOOR

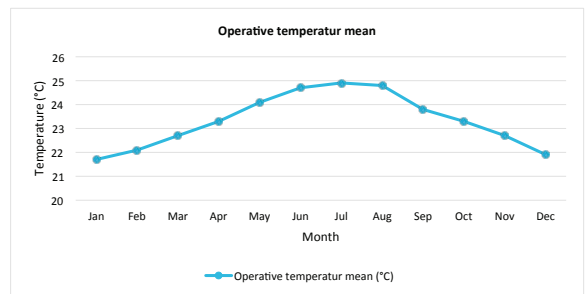
Original design



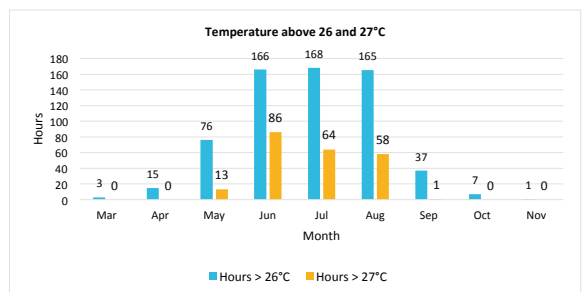
Ill. 174: BSim model of rhythm room



Ill. 175: Co2 level throughout a year

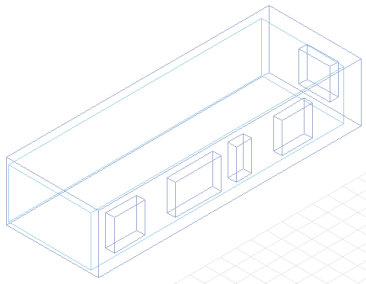


Ill. 176: The operative temperature throughout a year

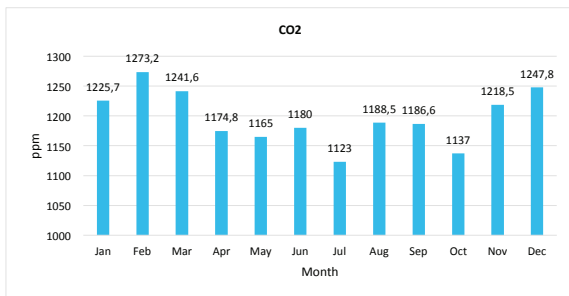


Ill. 177: Temperature above 26°C and 27°C during summer season

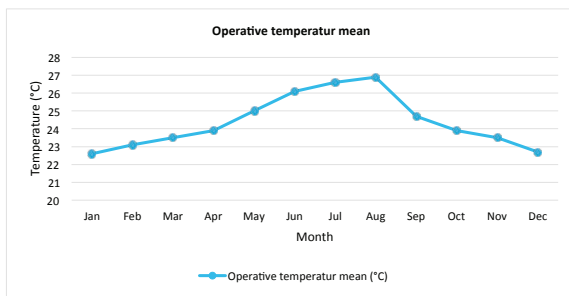
RHYTHM ROOM ON 3RD FLOOR Redesign design 1



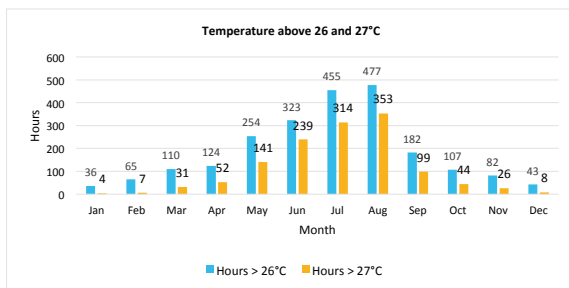
Ill. 178: BSim model of rhythm room



Ill. 180: Co2 level throughout a year

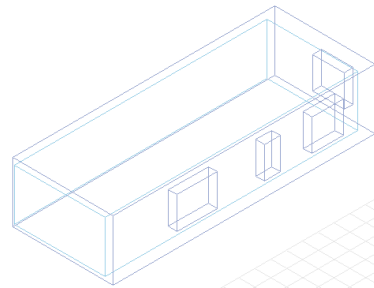


Ill. 182: The operative temperature throughout a year

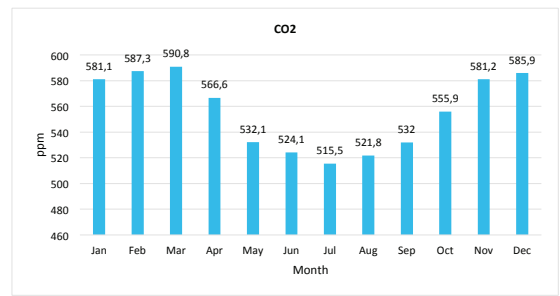


Ill. 184: Temperature above 26°C and 27°C during summer season

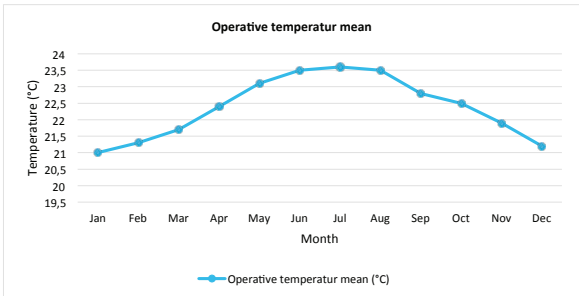
RHYTHM ROOM ON 3RD FLOOR Redesign design 2



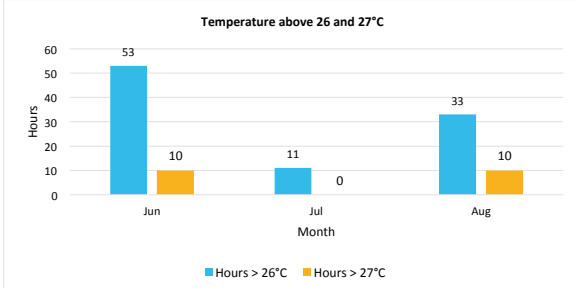
Ill. 179: BSim model of rhythm room



Ill. 181: Co2 level throughout a year



Ill. 183: The operative temperature throughout a year



Ill. 185: Temperature above 26°C and 27°C during summer season

NATURAL VENTILATION

One of the sustainable strategy are, using natural ventilation in the building. This are due to avoid excess temperature and poor indoor air quality, but also to reduce the need for mechanical ventilation.

The strategy are investigated in Be15 analysis on page 84-87, where the design use natural ventilation during daytime and another where natural ventilation are used during day and night time. The results shows that using natural ventilation during day and night time, are efficient to cool down the building and reduce the use of energy.

The strategy for the natural ventilation are that, the 1/4 of the window area are intended to open inwards. The windows facing the square, the southern facade and the roof windows regulates automatically, depending on the indoor climate. When the room temperature reach 23°C and pollution reach 900 ppm the windows opens to ventilate.

The building are designed in a way that, on some floors there are double height spaces, which creates a stack effect for the hot air to gets ventilated through, the roof windows. This occurred due to the pressure difference.

The windows facing the road can be open manually, for the user to control their own indoor environment. Most function are located on the facade toward the road and are therefore manually controlled, due to the noise and pollution from the traffic.

The natural ventilation are calculated on the whole building, to determine the effective window area per floor. The calculation are based on values in table XX. [Jensen, 2005]

Total airflow over openings:

$$q_v = C_d \cdot A \cdot \sqrt{\frac{2 \cdot |\Delta p_T + \Delta p_v|}{\rho}} \cdot \frac{\Delta p_T + \Delta p_v}{|\Delta p_T + \Delta p_v|}$$

where:

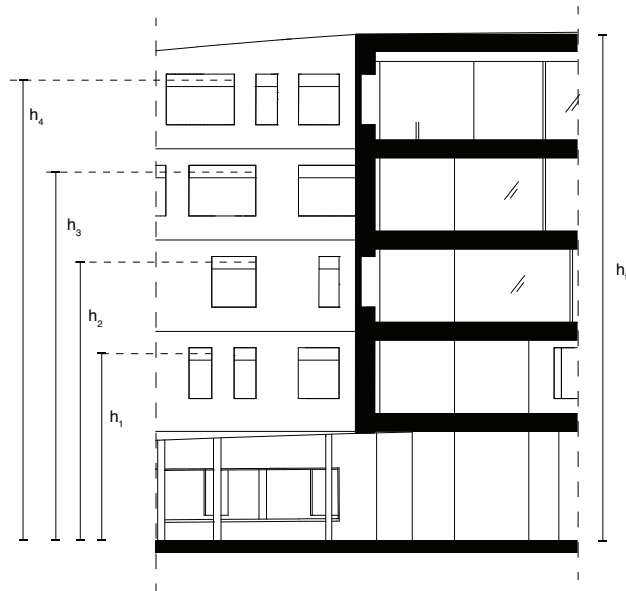
q_v	Total airflow
C_d	Discharge coefficient
A	Affective window area
Δp_T	Indoor pressure difference
Δp_v	Air pressure difference
ρ	Air density

Legend	
ρ_{air} [kg/m ³]	1,29
g [m/s ²]	9,81
T_{out} [K]	294
T_i [K]	298
$T_{u,night}$ [K]	284
ΔT_{night} [K]	14
ΔT [K]	4
v_{ref} [m/s]	0,14
v_{meteor} [m/s]	0,25
k [-]	0,21
α [-]	0,33
C_p [-]	0,06
C_{psug} [-]	-0,49

Table 09: Legend for calculating natural ventilation. [Jensen, 2005]

Required volume air flow	
$q_{n,summer}$ [l/sm ²]	1,70
$q_{n,night}$ [l/sm ²]	1,50

Table 10: Legend for calculating natural ventilation



III. 186: Principal section diagram

Natural ventilation, Summer						
H ₀ [m]	15,27	Δp _T [Pa]	Δp _v [Pa]	q _v [m ³ /sm ²]	q _{n,summer} [m ³ /s]	Effective area [m ²]
H ₁ [m]	6,50	1,49	0	1,04	6,06	5,81
H ₂ [m]	10,10	0,88	0	0,80	3,14	3,92
H ₃ [m]	13,80	0,25	0	0,43	1,36	3,18
H ₄ [m]	17,40	-0,36	0	0,51	0,53	1,03
H _{roof} [m]	20,15	-0,83	-0,01	0,78	11,08	14,19

Table 11: Result on natural ventilation, summer

Natural ventilation, Night						
H ₀ [m]	15,27	Δp _T [Pa]	Δp _v [Pa]	q _v [m ³ /sm ²]	q _{n,summer} [m ³ /s]	Effective area [m ²]
H ₁ [m]	6,50	5,21	0	1,95	5,34	2,74
H ₂ [m]	10,10	3,07	0	1,50	2,77	1,85
H ₃ [m]	13,80	0,87	0	0,80	1,20	1,50
H ₄ [m]	17,40	-1,27	0	0,96	0,47	0,49
H _{roof} [m]	20,14	-2,90	-0,01	1,46	9,78	6,72

Table 12: Result on natural ventilation, night

MECHANICAL VENTILATION SYSTEM

The mechanical ventilation system are a hybrid solution where mechanical ventilation alternates between natural ventilation during summer and where the mechanical ventilation ventilates with heat recovering during winter. In this case the indoor climate can therefore be optimized and minimizing the total energy consumption.

The mechanical ventilation channel are dimensioned in order to keep sufficient space for the channels in the suspended ceiling. Furthermore to avoid discomfort with drag and also high noise from the channels near the diffuser, the velocity should be between 2-3 m/s and near the fan up to 5-7 m/s.

The calculation are based on the 2nd floor and the location of the channels, which are shown in appendix 3, on page 114. Since the main channels are larger then the distribution channels, it is therefore suitable to locate the channels in the hallways. Table 13 shows that the larges diameter of the pipes are 0,25 meter. Therefore a suspended ceiling of 0,4 meter enough to accommodate it.

The results shows the velocity fulfill the recommended and the highest velocity near the diffuser are 2,23 m/s and near the fan are 5,09 m/s.

The equation for calculating the velocity in the channels:

$$v = \frac{q}{D_i^2 \cdot \frac{1}{4} \cdot \pi}$$

where:

q	Volume air flow [m ³ /h]
D _i	Pipe diameter [m]
v	Velocity [m/s]

Section	Pipe diameter	Pipe length	Volume air flow	Air velocity
	[m]	Deltal [m]	q [m³/h]	v [m/s]
228 - out			48,30	
227 - 228	0,1	4,79	48,30	1,71
				1,71
222 - 227	0,15	6,83	170,10	2,67
				2,67
221 - 222	0,15	4,13	223,02	3,51
				3,51
220 - 221	0,15	6,4	275,94	4,34
				4,34
219 - 220	0,2	5,65	328,86	2,91
				2,91
213 - 219	0,2	6,98	381,78	3,38
				3,38
205 - 213	0,25	6,85	686,70	3,89
				3,89
206 -205	0,25	7,21	899,64	5,09
				5,09
218 - out			63	
216 - 218	0,1	3,2	63	2,23
				2,23
215 - 216	0,1	4,59	126	4,46
				4,46
213 - 215	0,15	10,9	252	3,96
				3,96
201 - out			53,34	
202 - 201	0,1	7,6	53,34	1,89
				1,89
203 -202	0,1	7,28	106,68	3,77
				3,77
204 - 203	0,1	3,59	160,02	5,66
				5,66
205 - 204	0,15	5,87	160,02	2,52
				2,52
208 - out			16,38	
207 - 208	0,1	1,34	16,38	0,58
				0,58
224 - out			48,3	
223 - 225	0,1	6,274	48,3	1,71
				1,71
226 - out			25,2	
225 - 226	0,1	6,274	25,2	0,89
				0,89
212 - out			31,5	
209 - 212	0,1	3,65	31,5	1,11
				1,11

Table 13: Dimensioning of the Mechanical ventilation system



FINAL CONSIDERATIONS

This following chapter contain the final conclusion and reflection of the project. It is not presented chronological in this chapter, because this it is a iterative process. This phase is where aesthetic- and technical parameter are integrated into the design process.



III. 187: Roof window

CONCLUSION

Valby Culture Center was developed through an integrated design process where architectural and technical aspects were used in an iterative process.

The buildings are an extension from the existing culture house. The old Valby library is moved into the existing building and transformed into a larger and modern library. Moving the library into the existing building gathers the cultural functions into one place. This creates a cultural meeting point where people with different interests can meet, learn, develop, perform, be creative, have fun and a place for contemplation. The community gathering the citizens to interact with each other.

The existing building and new culture center are separated with a glass atrium, but connected with a curved bridge on each floor. The atrium is offset from the facade to indicate the transition between the two buildings, but also respects the old historical building.

The new culture center is visible in the cityscape, to create more awareness for cultural offers in the district. Valby Culture Center and Valby library are flexible for the users with easy access to the buildings during the day with self-service access by using a health insurance card.

The culture center is not only the cultural meeting point, it also contributes to the development in the district. Thousands of new residents, offices, commercial, children's institutions and parks are within the near future under development in the district. The building will therefore compensate for the need of cultural facilities, when the new citizens are moving into the district.

The curved facade is leading people around the building and into the circular square. Inside the square that is facing south, creates an attractive place to stay, away from the busy traffic. The square is enclosed by the curved building, trees and is framing the existing building. The open square creates various opportunities for cultural events and activities, such as skating, flea market, concerts, performance, ice skating in winter, events, etc. A wooden terrace connects the ground floor in the culture center to the square and functions as the café outdoor area. The sloping roof slopes from the west corner near the existing building towards the west side, to meet the lower typologies and the human scale.

Developing a sustainable Culture Center was a complex and challenging, but the final design did reach the goal of Building class 2020. With additional renewable energy resource from solar cells the building is now a Zero Energy Building. Solar cells are visible on the curved roof to make people aware of it is a sustainable building and the need for renewable energy resource. Screens inside the building will inform the users the energy consumption and production.

The final culture center meets the vision of being an innovative modern Valby Culture Center.

REFLECTION

Throughout the design process I revealed how high my ambition level are for this project. Taking in a problem I found in my local community and create my own brief, made it difficult to determined the final program. Even though I did do some research, visit the existing culture center and library as well as interviewing the leader of the culture center. Was it challenging to define the sizes and extra function needed in the new culture center. This are the results of the final design, with large hallways and many places for study areas and lounge are created, to fill out the spaces. After having organized the functions and furnishing I realized that it was to late in the design process to redesign, calculate and make new simulations.

The vision was to create a cultural meeting point, which the final design did solved. After reflecting on it, the building could have been solved in more effective way, to strengthen the community and the effect of people to meet and interact between each other. The building is huge and long, which makes it challenge for people to meet at a common place and between activities. With large hallways and many informal spaces around the building makes people spread around the building. The category of the functions are also organized in a way that it is easy to find, but are assembled either in one part of the building or on a floor, makes people only meet between the functions people walk through. A building volume that are more compact may have solved these problems, because there is less distance between the functions. The building shape does fit into the surrounding context and creates an attractive square, but are in conflict with the vision of a cultural meeting point. If there was more time I would have investigated the building shaper and plan organization more.

The slopping roof was developed to be used for placement of the solar cells but could have be investigated more, in order to create a more effective slopping angle for the placement of the solar cells as a integrated design solution.

Many of the design solutions have I thought passive strategies into, from the very beginning. It was something I unconsciously did when I developed the building. I first realized it then the technical aspect such as energy calculation and indoor climate simulation was made. There was not much to change and I did know which parameter that had a significant impact on results. At the end of this process, you wonder if these technical solution and results enough to make the culture center a sustainable building, even though the building fulfills the BR 2020? With many approach to what makes a building a sustainable design, I believe that the combination of social, environment as well as economic aspect makes a building sustainable. When integrating all these aspects would it then detract the architectural quality or only improve it?

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Table 14: Results from Be15 analysis

- Her kan du lege... 



APPENDIX

This following chapter contain further details on the analysis, as a supportive material to the project.

APPENDIX 1

KRAFTWERKET



There is a separate building next to the Valby Culture Center and it is a Youth Culture Center, named KraftWerket. It is owned by the Copenhagen Municipality as a project workshop and 'embassy' for young people in Copenhagen.

KraftWerket help and advise young project visionaries to start projects, artists and performers to develop ideas and realize their projects and create events. The Culture Center offers facilities for project work, consultancy for project managers, exhibitions, theater, recording in the studio, concerts and a civic kitchen by the volunteers, where they sell vegan food for a very cheap price.

The house is not a part of the Valby Culture Center because it works as a separate organization and is user-controlled which means that it is run by those who are active in the house and volunteers. They are also deciding what kind of activities and functions there should be in the house. In that way the Youth Culture Center are more flexible and the user can have an influence on the Youth Culture Center. [Kraftwerket, 2016] Where else the Valby Culture Center is run by the Culture Center leader who provide facilities for the citizens.

According to the analysis from the Preservation diagram, the building is not worth preserving. Therefore it could be an idea to demolish the building and bring together all cultural facilities under one roof.

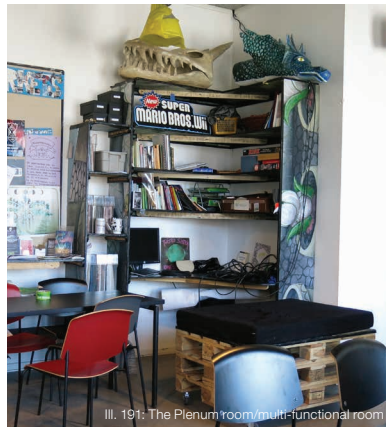
The employees do not wish to combine the Youth Culture Center and Valby Culture Center, because they are not the same institution and the organization is differently, therefore users can be confused, if the two culture centers are combined under one roof.

I will therefore not include the Youth Culture Center into this project, but demolishing the existing Youth Culture Center will create a better connection, between the new Valby Culture Center, the existing Valby Culture Center and Toftegårds Square. An alternative new location for the Youth Culture Center, KraftWerket could be located just next to the current location, on the right side of the site.

APPENDIX 1



III. 190: Sign in front of the building



III. 191: The Plenum room / multi-functional room



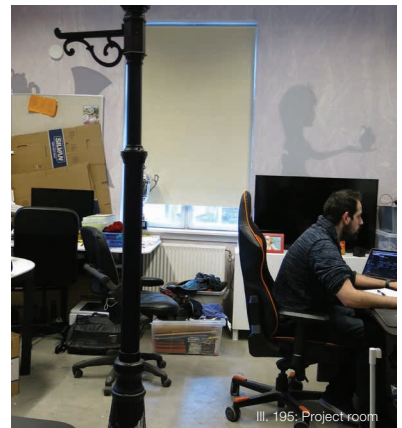
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III. 198: Recreational seating area in front of the building

APPENDIX 2

BE15 ANALYSIS

The results are from Be15 analysis of the original design and redesign are illustrated here and on page 112-113.

These design are analyzed with different approach such as natural ventilation during daytime, natural ventilation during daytime and night, heat recovering and with solar cells.

The results on the original design and redesign with natural ventilation during day time, shows that there is excess temperature in room, which is not acceptable. To avoid that natural ventilation are used both during day- and night time.

The results from heat recovery and solar cells on original design and redesign are shown in the report in chapter Be15 analysis on page 84-87.

RESULTS FROM BE15 ANALYSIS

RESULTS FROM BE15 ANALYSIS		Natural ventilation day	Natural ventilation day and night	Heat recovery	Solar cells
BR 2020 [kWh/m ² year]	Requirement	25	25	25	25
	Original design	36,8	25,1	23,7	-1,3
	Redesign	32,3	24	20,1	-3,5

Table 14: Results from Be15 analysis

APPENDIX 2

ORIGINAL DESIGN

Natural ventilation day

Nøgletal, kWh/m ² år			
Renoveringsklasse 2			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
135,5	0,0	135,5	
Samlet energibehov		51,2	
Renoveringsklasse 1			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
71,6	0,0	71,6	
Samlet energibehov		51,2	
Energigramme BR 2015			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
41,2	0,0	41,2	
Samlet energibehov		45,7	
Energigramme Byggeri 2020			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
25,0	0,0	25,0	
Samlet energibehov		36,8	
Bidrag til energibehovet		Netto behov	
Varme	27,6	Rumopvarmning	13,0
El til bygningsdrift	4,7	Varmt brugsvand	14,6
Overtemp. i rum	11,7	Køling	0,0
Udvalgte elbehov		Varmetab fra installationer	
Belysning	3,6	Rumopvarmning	0,0
Opvarmning af rum	0,0	Varmt brugsvand	9,4
Opvarmning af vbv	0,0	Ydelse fra særlige kilder	
Varmepumpe	0,0	Solvarme	0,0
Ventilatorer	1,2	Varmepumpe	0,0
Pumper	0,0	Solceller	0,0
Køling	0,0	Vindmøller	0,0
Totalt elforbrug	18,5		

Ill. 199: Original design, natural ventilation day

ORIGINAL DESIGN

Natural ventilation day and night

Nøgletal, kWh/m ² år			
Renoveringsklasse 2			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
135,5	0,0	135,5	
Samlet energibehov		39,4	
Renoveringsklasse 1			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
71,6	0,0	71,6	
Samlet energibehov		39,4	
Energigramme BR 2015			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
41,2	0,0	41,2	
Samlet energibehov		33,9	
Energigramme Byggeri 2020			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
25,0	0,0	25,0	
Samlet energibehov		25,1	
Bidrag til energibehovet		Netto behov	
Varme	27,6	Rumopvarmning	13,0
El til bygningsdrift	4,7	Varmt brugsvand	14,6
Overtemp. i rum	0,0	Køling	0,0
Udvalgte elbehov		Varmetab fra installationer	
Belysning	3,6	Rumopvarmning	0,0
Opvarmning af rum	0,0	Varmt brugsvand	9,4
Opvarmning af vbv	0,0	Ydelse fra særlige kilder	
Varmepumpe	0,0	Solvarme	0,0
Ventilatorer	1,2	Varmepumpe	0,0
Pumper	0,0	Solceller	0,0
Køling	0,0	Vindmøller	0,0
Totalt elforbrug	18,5		

Ill. 200: Original design, natural ventilation day and night

REDESIGN

Natural ventilation day

Nøgletal, kWh/m ² år			
Renoveringsklasse 2			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
135,5	0,0	135,5	
Samlet energibehov		46,0	
Renoveringsklasse 1			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
71,6	0,0	71,6	
Samlet energibehov		46,0	
Energigramme BR 2015			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
41,2	0,0	41,2	
Samlet energibehov		40,8	
Energigramme Byggeri 2020			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
25,0	0,0	25,0	
Samlet energibehov		32,3	
Bidrag til energibehovet		Netto behov	
Varme	26,3	Rumopvarmning	12,2
El til bygningsdrift	4,6	Varmt brugsvand	14,0
Overtemp. i rum	8,3	Køling	0,0
Udvalgte elbehov		Varmetab fra installationer	
Belysning	3,4	Rumopvarmning	0,0
Opvarmning af rum	0,0	Varmt brugsvand	8,8
Opvarmning af vbv	0,0	Ydelse fra særlige kilder	
Varmepumpe	0,0	Solvarme	0,0
Ventilatorer	1,2	Varmepumpe	0,0
Pumper	0,0	Solceller	0,0
Køling	0,0	Vindmøller	0,0
Totalt elforbrug	18,6		

Ill. 201: Redesign, natural ventilation day

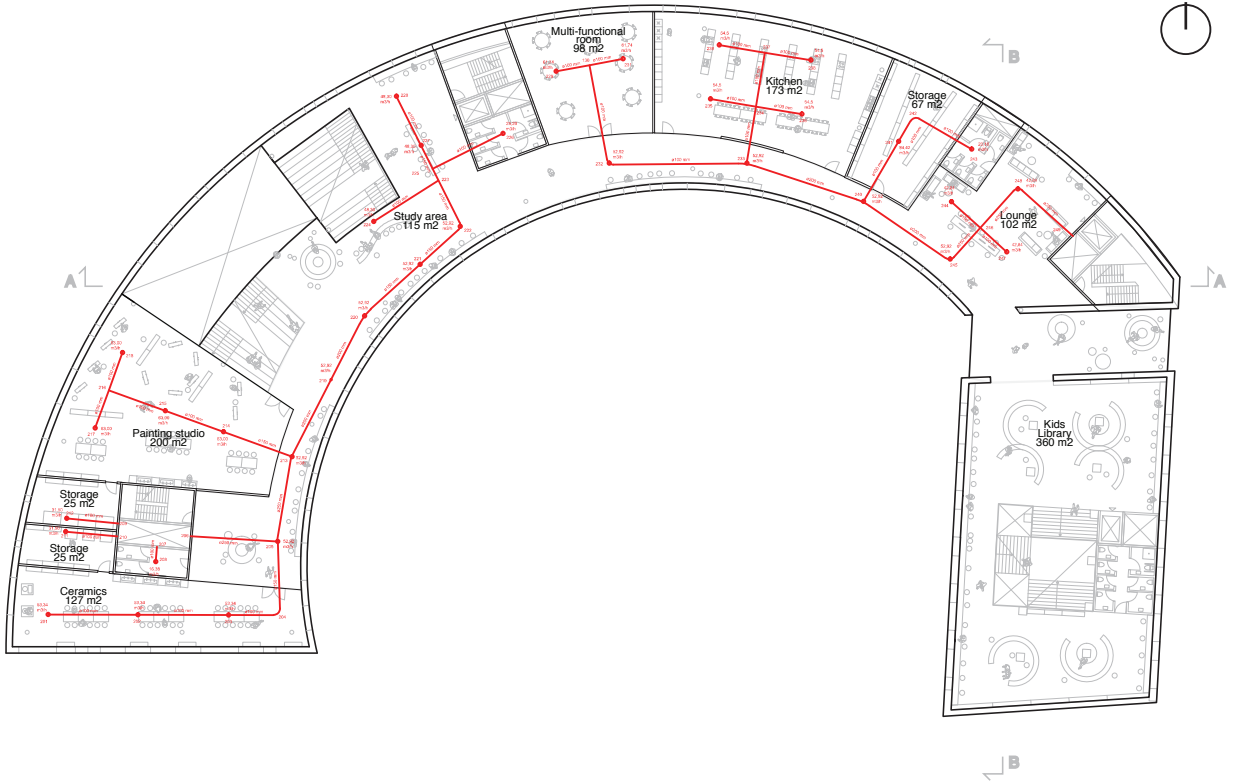
REDESIGN

Natural ventilation day and night

Nøgletal, kWh/m ² år			
Renoveringsklasse 2			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
135,5	0,0	135,5	
Samlet energibehov		37,7	
Renoveringsklasse 1			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
71,6	0,0	71,6	
Samlet energibehov		37,7	
Energigramme BR 2015			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
41,2	0,0	41,2	
Samlet energibehov		32,4	
Energigramme Byggeri 2020			
Uden tillæg	Tillæg for særlige betingelser	Samlet energigramme	
25,0	0,0	25,0	
Samlet energibehov		24,0	
Bidrag til energibehovet		Netto behov	
Varme	26,3	Rumopvarmning	12,2
El til bygningsdrift	4,6	Varmt brugsvand	14,0
Overtemp. i rum	0,0	Køling	0,0
Udvalgte elbehov		Varmetab fra installationer	
Belysning	3,4	Rumopvarmning	0,0
Opvarmning af rum	0,0	Varmt brugsvand	8,8
Opvarmning af vbv	0,0	Ydelse fra særlige kilder	
Varmepumpe	0,0	Solvarme	0,0
Ventilatorer	1,2	Varmepumpe	0,0
Pumper	0,0	Solceller	0,0
Køling	0,0	Vindmøller	0,0
Totalt elforbrug	18,6		

Ill. 202: Redesign, natural ventilation day and night

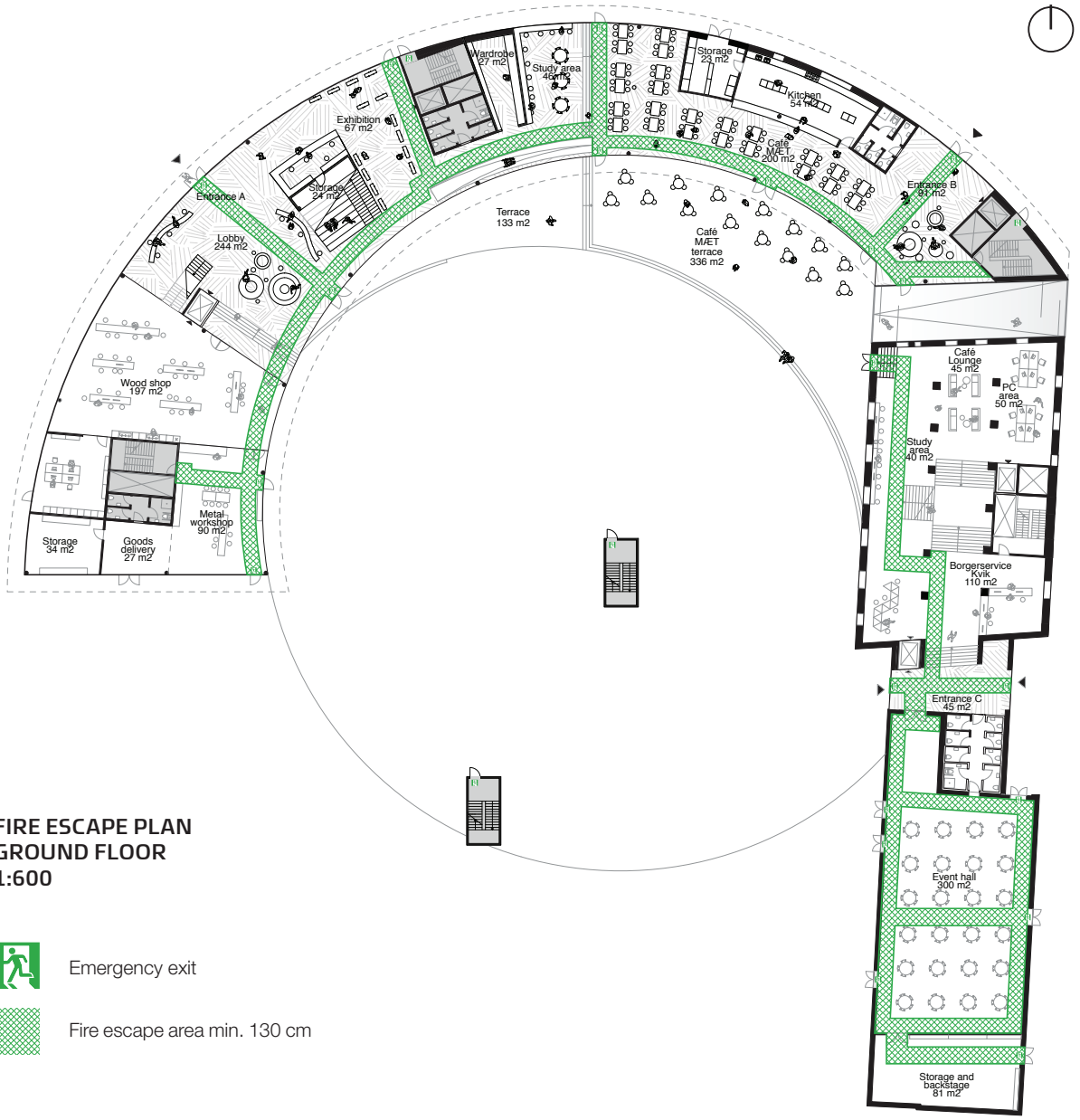
APPENDIX 3





MECHANICAL VENTILATION 2ND FLOOR 1:600

- Ventilation pipe
- Diffuser

APPENDIX 4



**FIRE ESCAPE PLAN
GROUND FLOOR
1:600**

-  Emergency exit
-  Fire escape area min. 130 cm