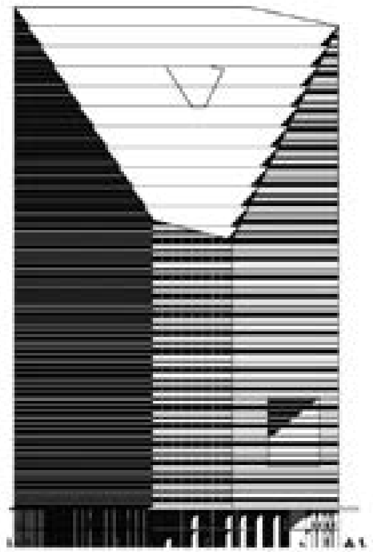
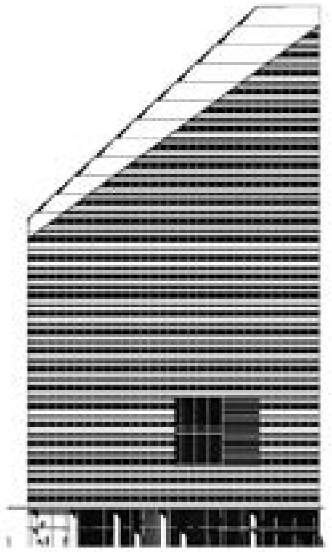
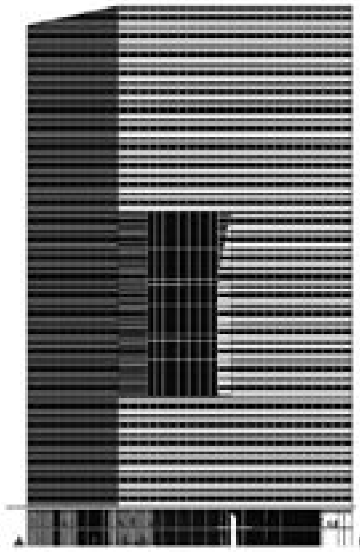
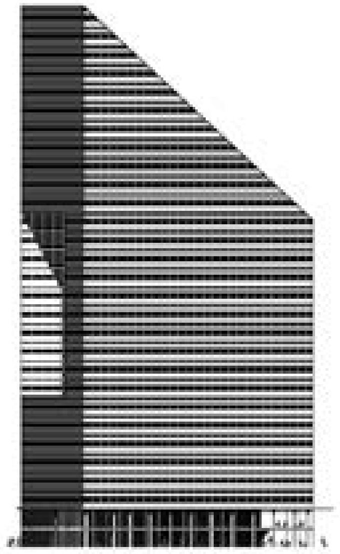





O S L O S O L A R

CONTENT

DIGITAL ATTACHMENTS:
- Passive house calculation, Simien (pdf)
- BREEAM NOR pre-assessment estimator (excel)
- Material Calculator (excel)
- Solar Power calculation (pdf)

INNOVATION

OsloSolar has an energy concept which fullfills the Urban+ Futurebuilt criteria of net positive energy of +2 kWh/m2. The exremely low demand and the high power production is based on innovative, simple and reliable solutions.

The integrated energy design and system design thinking with architects, researchers, specialists and engineers is the main innovation for OsloSolar.

The building shape, active and passive technical systems have been designed to achieve BREEAM Outstanding, and to:
- Maximize the power production from solar power,
- Reduce the energy demand to 30 % below passive house,
- Maximize the harvesting, filtering and usage of rainwater and snow, and
- Increase biodiversity on the property

As a team, we have chosen to make the layout of this booklet show how the different parts have contributed. There is not one overall lay out on graphs etc, we try to show the process and it's multifaceted input on it's way to become a complete proposal.

A TRUE PLACE MAKER
When we think of the building, we want it to represent the many, not only a few. We want it to be experienced as including and understood, not excluding and alien. We see it in line with Norwegian culture. It represents efficiency, hard work and technical, innovative sustainability.

We think the way the building works with the city is important for the image of the building. The building softens the impact the two high-risers have had on the skyline, making them look better, and it brings new urbanity with bicycles, openness and life to Vaterland. We believe the building can be appreciated by the public.

We also think that the concept of the building is about innovation that works. The solutions, both architecturally and technically, can provide efficient, flexible and comfortable work conditions. Although the focus has been on "good" rather than "fancy", the architecture does not lack the element of the spectacular. The many corner offices, "mountain top" restaurants, the urban grotto, bicycle logistics, the passage with the airy lobby; these are all elements that can be developed to beauty and fascination. Nevertheless: it's the connection with the city and the public appreciation of the building that we believe will make it stand out.

CODE Architecture

Institutt for energiteknikk

ECO-EFFICIENCY

Plus House Concept - visualization of the technical system

SOLAR PANELS

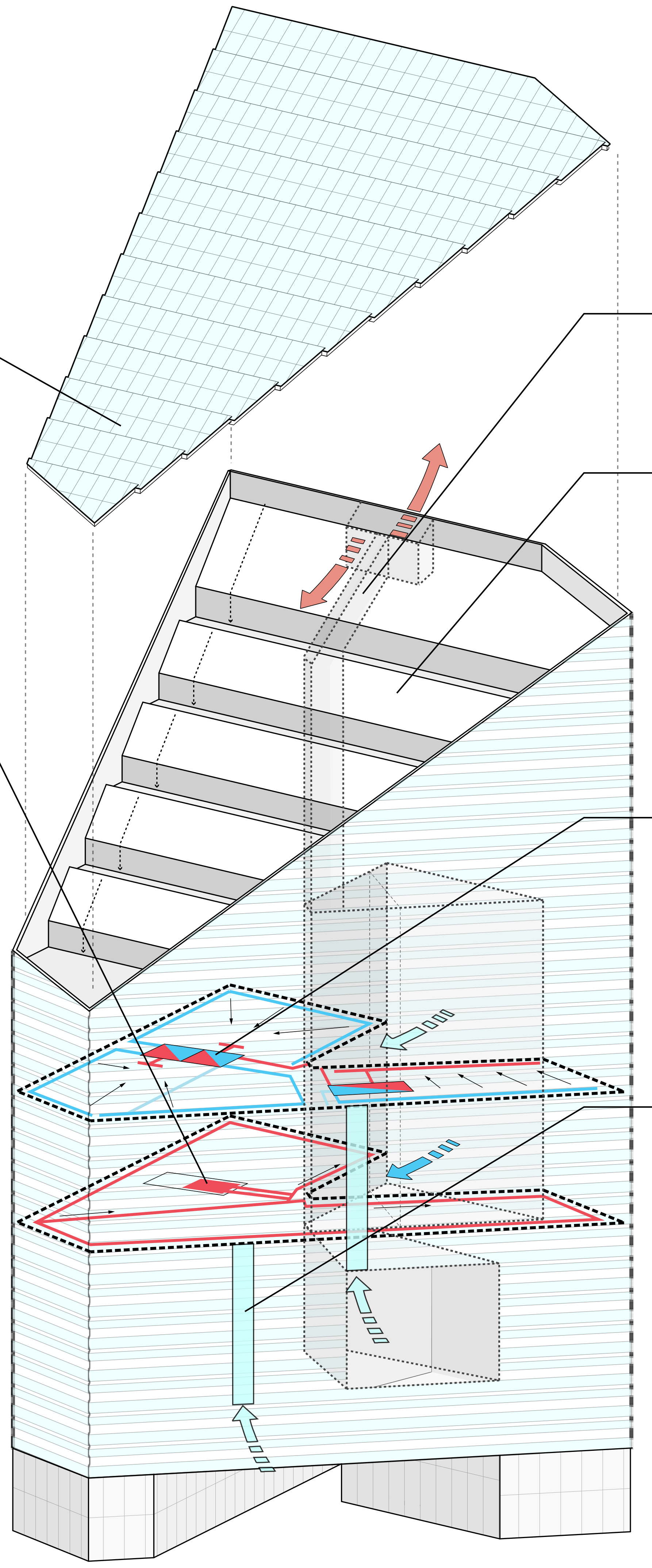
Nearly 8300 m² of building integrated solar panels is placed on the roof tilted 40 degrees towards the south and on the facades facing east, west and south.
The panels are estimated to produce 1 420 000 kWh per year.

HEATING AND COOLING

The heating season is very short due to the highly insulated building construction. Heating is only needed during the night and some days in the morning. Passive solar heating is used as much as possible during winter months in addition to district heating.

Room heating will be done mainly by ventilation heating. There is no need for radiators and under floor heating on all of the floors, only towards the outer rims of the building.
The heating and cooling system work with the sun. Excess heat which need to be cooled when the sun is on the east side, will be displaced to the west side until noon. The system is reversed in the afternoon. Thus, for optimal distribution, the piping goes through the centre of the building with heating distribution functioning counter clockwise.

During the warm season the atrium to the north is ventilated and used for free cooling during night. Air intake is changed to the cold north side of the building.



AIR OUTLET

Used air is sucked out through the atrium and shaft with the help of the dominant wind.

SNOW AND WATER COLLECTOR

1500m³ collection capacity for snow, ice and rainwater on the roof completely removes the risk of such falling down. The PV panels on the roof are tilted at a slightly steeper angle than the roof to ensure that snow and ice is sliding under the panel below and into the snow depot.

The ambition is to utilize all of the collected water for watering of plants, cooling and climatizing of the building and for flushing the toilets.

VENTILATION

Decentralized ventilation system with three air handling units (AHU) per floor permits three independent tenants.

The AHU filter and and conditions the air. More than 90% of the heat air is recovered. The 20 storey atrium and shaft works as a ventilation chimney and reduces the use of fans.

SOLAR WALL

Each AHU is connected to a solar wall facing southeast for air intake during the cold season and to an air intake og the cold north side during the warm season. The solar wall preheat the air 2-6 degrees.

The atrium towards east will also function as a solar collector preheating the ventilation air entering to the lower floors.

ECO-EFFICIENCY

Passive House Evaluation

Showing only the summary, the full Simien report is attached digitally.

SIMIEN
Evaluering passivhus

Simuleringsnavn: Passivhusevaluering Oslosolar
Tid/dato simulering: 14:12 7/6-2015
Programversjon: 5.502
Simuleringsansvarlig: GEMO
Firma: Rambøll Norge AS
Inndatafil: \\s...\OsloSolar.SubSones.MNK.REV.J.smi
Prosjekt: Oslo Solar
Sone: Alle soner

Resultater av evalueringen

Evaluering mot NS 3701	Beskrivelse
Varmetapsramme	Bygningen tilfredstiller kravet for varmetapstall
Energiytelse	Bygningen tilfredsstiller krav til energiytelse
Minstekrav	Bygningen tilfredsstiller minstekrav til enkeltkomponenter
Luftmengder ventilasjon	Luftmengdene tilfredsstiller minstekrav gitt i NS3701 (tabell A.2)
Samlet evaluering	Bygningen tilfredstiller alle krav til passivhus

Varmetapsbudsjett

Beskrivelse	Verdi
Varmetapstall yttervegger	0,01
Varmetapstall tak	0,01
Varmetapstall gulv på grunn/mot det fri	0,01
Varmetapstall glass/vinduer/dører	0,10
Varmetapstall kuldebroer	0,01
Varmetapstall infiltrasjon	0,03
Totalt varmetapstall	0,15
Krav varmetapstall	0,40

Energiytelse

Beskrivelse	Verdi	Krav
Netto oppvarmingsbehov	6,2 kWh/m²	20,1 kWh/m²
Netto kjølebehov	6,6 kWh/m²	9,4 kWh/m²
Andel av varmebehovet som dekkes av annet enn direkte el. og fossile brensler	100,0 %	60,0 %
Gjennomsnittlig effektbehov belysning	4,0 W/m²	4,0 W/m²

SIMIEN; Evaluering passivhus Side 1 av 5

OSLOSOLAR
ENERGY CONCEPT
DESIGN AND ENGINEERING

Job	**Futurebuilt+ // Oslosolar**
Date	**June 07, 2015**
To	**Code: Arkitektur**
From	**Magnus Killingland**
Copy to	**Rambøll Project Team**

Date June 07, 2015

T
F

1. Key Data

44.400 m^2 heated area, 53.400 m^2 gross area. 25 floors, 115 meters in height. Building footprint ~2000 m^2.

OSLOSOLAR: +5,8 $kWh_{el}/m^2/year$

Production:	1.420.000 $kWh_{el}/year$	-	32,0 $kWh_{el}/m^2/year$
Demand*:	1.164.450 kWh/year	-	26,2 $kWh/m^2/year$
Panels:	5090 building integrated panels, 8300 m^2		

* weighted delivered without technical equipment according to Futurebuilt specifications

2. Energy and Environmental Concept

OsloSolar has an energy concept which fullfills the Urban+ Futurebuilt criteria of net positive energy of +2 kWh/m^2. The exremely low demand and the high power production is based on innovative, simple and reliable solutions.

The integrated energy design and system design thinking with architects, researchers, specialists and engineers is the main innovation for OsloSolar.

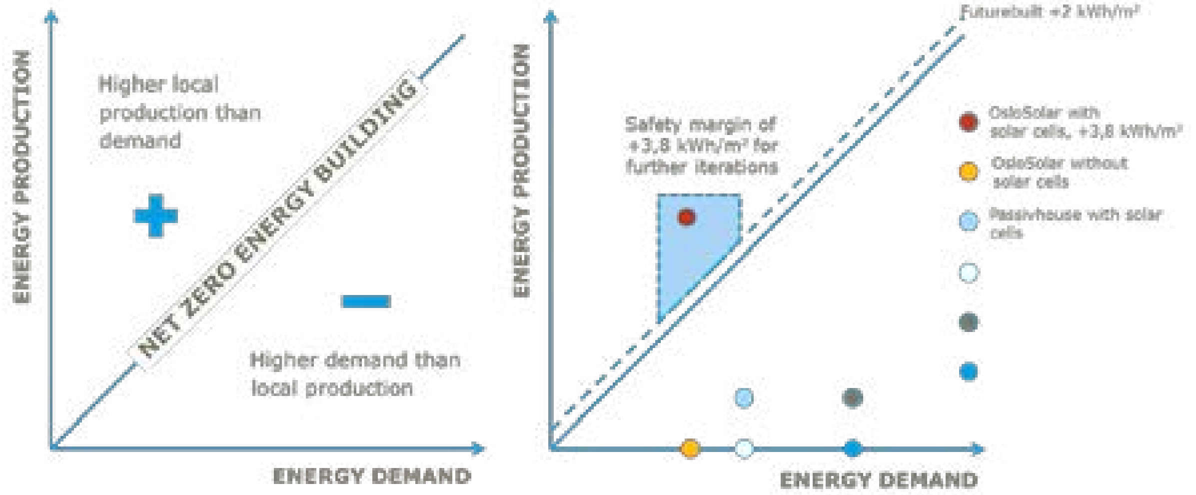
The building shape, active and passive technical systems have been designed to achieve BREEAM Outstanding, and to:
- Maximize the power production from solar power,
- Reduce the energy demand to 30 % below passive house,
- Maximize the harvesting, filtering and usage of rainwater and snow, and
- Increase biodiversity on the property

The net positive energy target has resultet in various trade-offs to reach the goal. Architects and engineers have iterated numerous times to overcome various trade-offs concerning light, energy demand and supply, as well as environmental issues. For instance the "solar trilemma", where daylight, passive heating and solar power compete for the same rays of light. The energy production and demand "dilemma", has also been iterated several times where we established a lowest reasonable demand level, and the highest reasonable production level. ***Oslosolar has + 3,8 kWh/m^2, in addition to the +2 kWh/m^2, which means +5,8 kWh/m^2 in total. With this net positive energy "safety margin" there will be no doubt that the Futurebuilt energy requirements will be met.*** Safety has been the number one priority, which has led to compromises such as lower power production on the roof and facade to avoid snow and ice from falling down.

2.1 Iterations

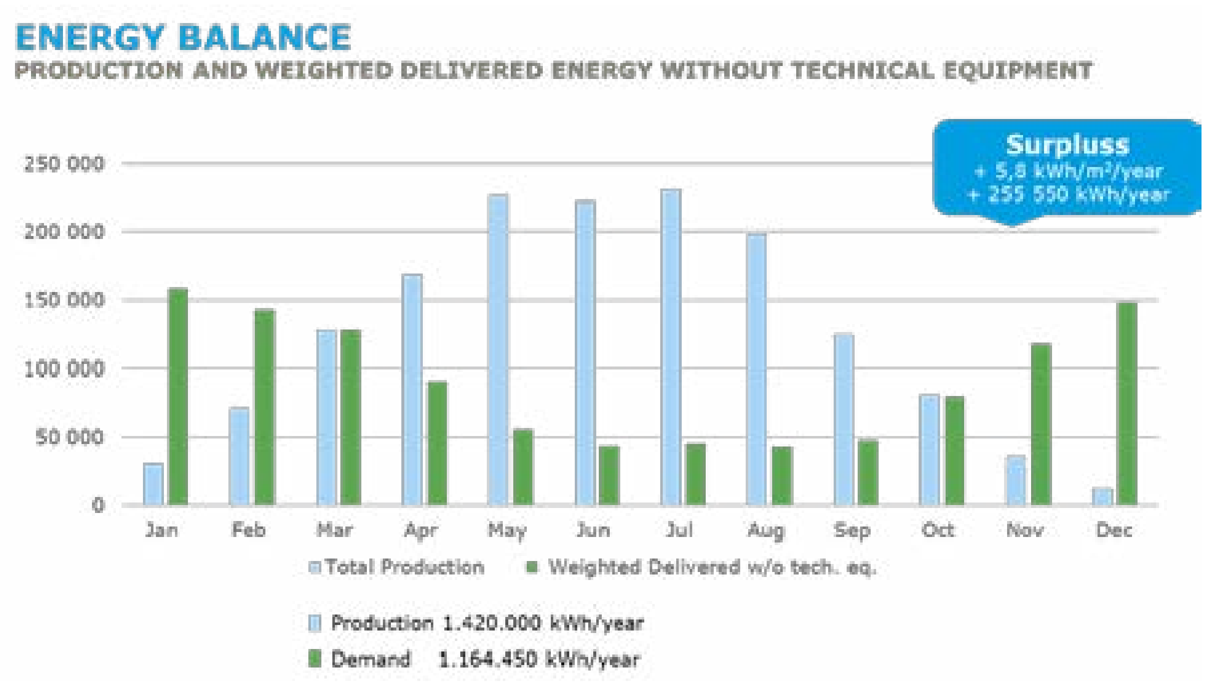
When the building shape was established, it was to maximize the solar collecting area towards the south, east and west, with a roof optimally inclined at 40 degrees to harvest as much solar power all year. An initial solar power production simulation was performed. These results was the basis for how energy efficient the building had to be. The expert team then calculated demand to somewhat lower than passive house standard and over fulfilling the daylight requirements. This resulted in not enough power production which led to increasing the wall area as much as possible without compromising daylight requirements. After several iterations and simulations with thicker walls, smaller windows to increase the area of solar power, reduce unwanted cooling loads and heating loads we achieved a net positive energy building.

The iteration process is shown in the figure below as the blue area. The area represents the limits for the Futurebuilt requirements and energy target possible with available technology towards 2020. OsloSolar position is optimized by daylight requirements, cooling and heating loads through windows and power. OsloSolar now has a safety margin of +8 kWh/m^2 for further iterations, and to ensure the +2 goal is reached since recent reports show lower than expected performance for SunPower panels, high chance of dust and soiling, and increased losses due to snow. The safety margin is also to ensure the possiblity for increasing the window area at some or all parts of the solar collecting façade, and lower areas which get a lot of shadow from Plaza and Postgirobygget.



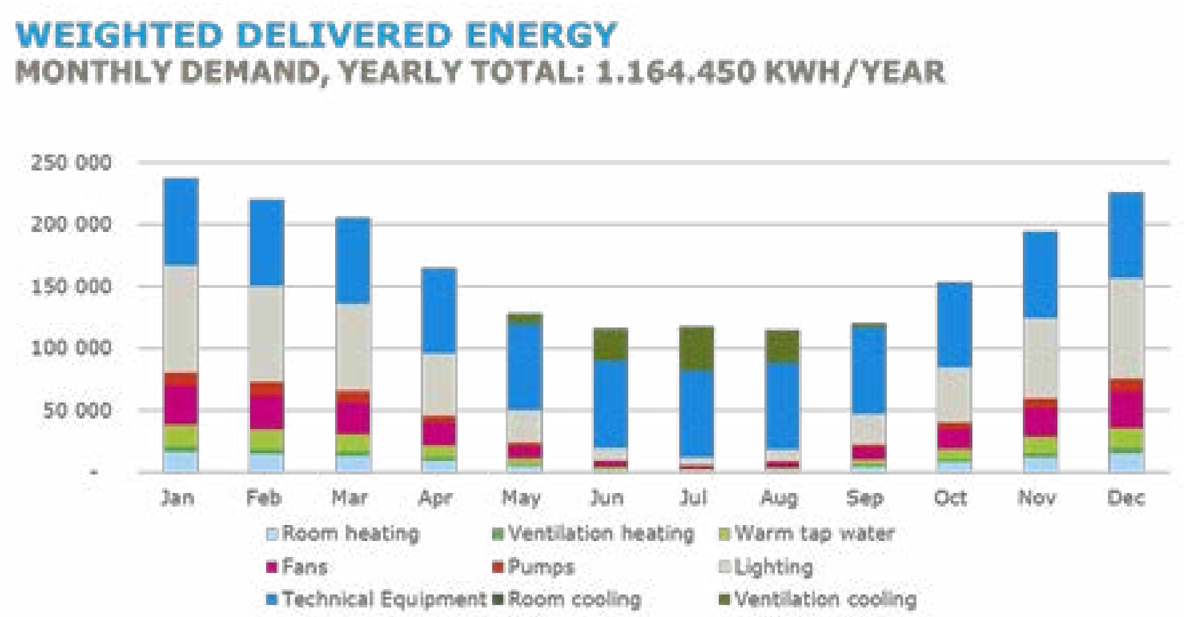
2.2 Energybalance

The energy balance, per month is shown below.



2.3 Energy Demand

The total energy net demand of OsloSolar, 55 kWh/m^2 per year is almost 30 % less than a Passivhouse Office Building according to NS3701:2013 minimum and typical passivehouse values and requirements. The demand has been calculated with SIMIEN, the accredited software for simulating and fullfilling the Norwegian building regulations, see attachments for detailed results.



To reduce the demand as much as possible, Oslosolar has a highly insulated facade with wall U-values of 0.06 W/m^2K and windows with 0.6 W/m^2K, minimal thermal bridges (0.01 normalized), an extremely air tight construction (0,35 air leakage at 50Pa), highly efficient balanced ventilation with more than 90 % recovery of heat during the winter and free cooling at night. The team also has investigated solutions to use harvested rain and snow for cooling and climatization purposes through watering of indoor plants (see later chapters cooling from rainwater and biodiversity).

Energy Demand	OsloSolar	Passivehouse NS3701	OSLOSOLAR Net demand assumptions
Room heating	4,8	**10**	Passive House+ Insulation: Walls and roof: 0,06 W/m^2K, low air leakage through façade (N50 = 0,35, and minimal through ventilation), Windows 0,6 W/m^2K, 0.01 normalized, thermal bridges. District heating and under floor heating at edges of building
Ventilation heating	1,4	**10**	>90 % Heat recovery, Solar walls preheat the air at east façade (2-6 degrees)
Warm tap water	5,0	5,0	District heating, well insulated piping for hot water loop
Fans	4,5	4,5	Balanced Ventilation, as much updraft as possible with "ventilation chimney"
Pumps	1,5	1,5	Highly efficient pumps
Lighting	12,5	**12,5**	Demand controlled, "constant light level" automation with maximizing the use of natural lighting
Technical Equipment	*18,8*	18,8	*Efficient, but not part of +2 kWh/m^2 criteria*
Room cooling	0,0	**9,4**	
Ventilation cooling	6,6	6,6	"Free cooling" as much as possible at night through atrium to the north. Cold water and Ice Energy storage Heat pump (with recovery of heat), dynamic solar screens (prevent cooling loads, but utilize passive heating)
Total	**55,1**	78,3	**30 % lower net demand than typical Office Passivehouse Building in Norway**

Net Energy Demand [$kWh/m^2/year$] for 44.400 m^2 heated area (oppvarmet BRA)

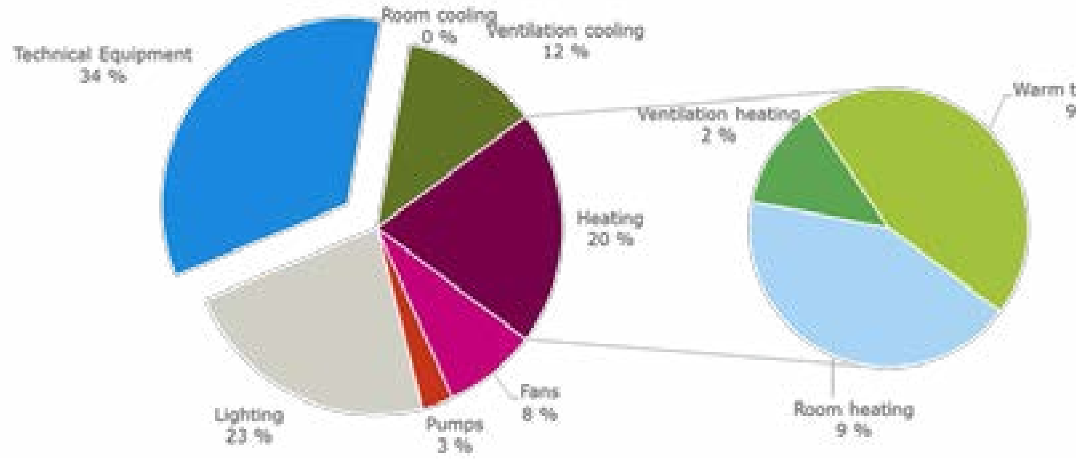
The facade has been model by our building physicists and verified the low U-values and normalized thermal bridges.

Table 1 – Calculations of energy demand, based on SIMIEN model and passivhous evaluation

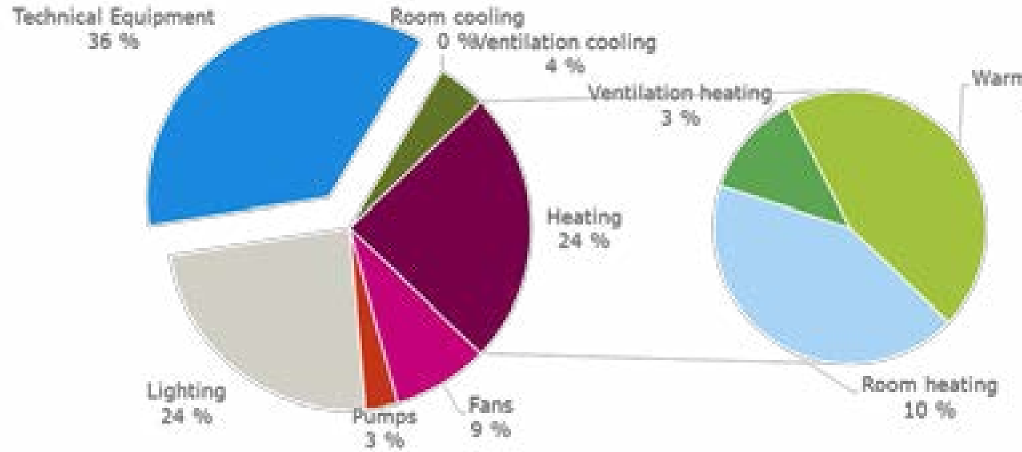
ENERGY DEMAND CALCULATIONS
NS3701:2013 AND FUTUREBUILT REQUIREMENTS

Calculations	Net Energy Demand, NS3701:2013			Delivered Energy		Weighted Delivered Energy		
Oslosolar	kWh/m²/year	kWh/year	System efficiency	District Heating	Electricity	Renewable ratio	District Heating	Electricity
Room heating	4,8	213 120	88 %	241 204	0	43 %	103 718	0
Ventilation heating	1,4	62 160	88 %	70 351	0	43 %	30 251	0
Warm tap water	5,0	222 000	88 %	251 254	0	43 %	108 039	0
Fans	4,5	199 800	100 %	0	199 800	100 %	0	199 800
Pumps	1,5	66 600	100 %	0	66 600	100 %	0	66 600
Lighting	12,5	555 000	100 %	0	555 000	100 %	0	555 000
Technical Equipment	*18,8*	*834 720*	*100 %*	*0*	*834 720*	*100 %*	*0*	*834 720*
Room cooling	0,0	0	290 %	0	0	100 %	0	0
Ventilation cooling	6,6	293 040	290 %	0	101 048	100 %	0	101 048
Total	55,1	2 446 440		562 809	1 757 168		242 008	1 757 168
	kWh/m²/year	kWh/year	%	kWh/year	kWh/year	%	kWh/year	kWh/year
Total Net Energy Demand	2 446 440	kWh/year	Totalt Delivered Energy	2 319 977	kWh/year	Totalt Weighted Delivered Energy	1 999 176	kWh/year
	55,1	kWh/m²/year		52,3	kWh/m²/year		45,0	kWh/m²/year

NET ENERGY DEMAND
TOTAL 2.446.440 KWH // 55,1 KWH/M²
WITHOUT TECHNICAL EQUIPMENT 1.611.720 KWH // 36,3 KWH/M²

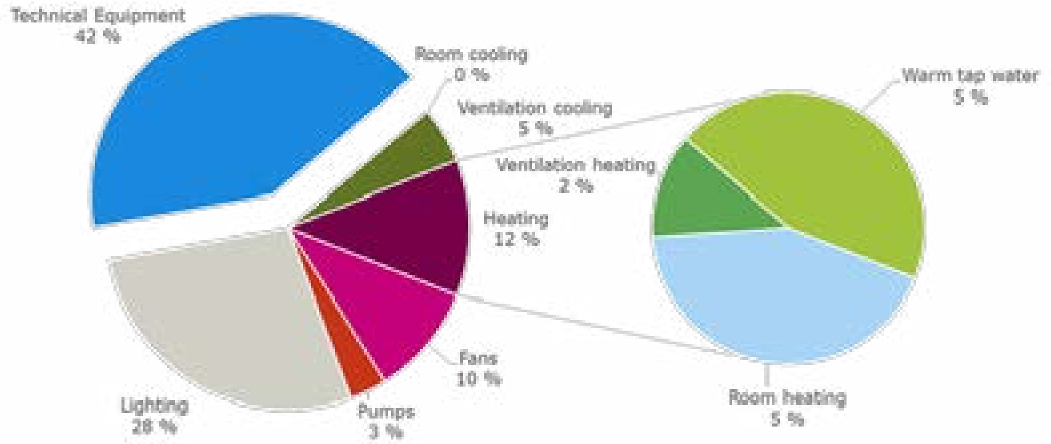


DELIVERED ENERGY
TOTAL 2.319.970 KWH // 52,3 KWH/M²
WITHOUT TECHNICAL EQUIPMENT 1.485.250 KWH // 33,5 KWH/M2



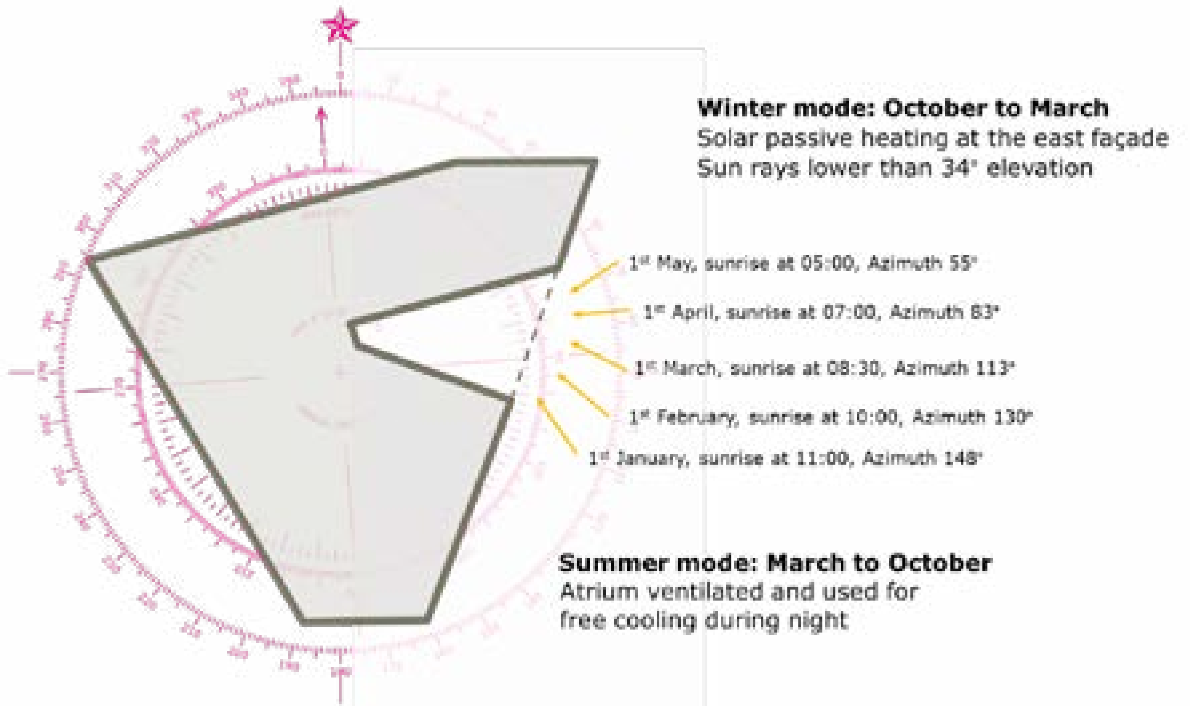
WEIGHTED DELIVERED ENERGY
TOTAL 1.999.100 KWH // 45,0 KWH/M²
WITHOUT TECHNICAL EQUIPMENT 1.164.450 KWH // 26,2 KWH/M²

This +2 kWh/m², has to be covered with local production



2.3.1 Heating

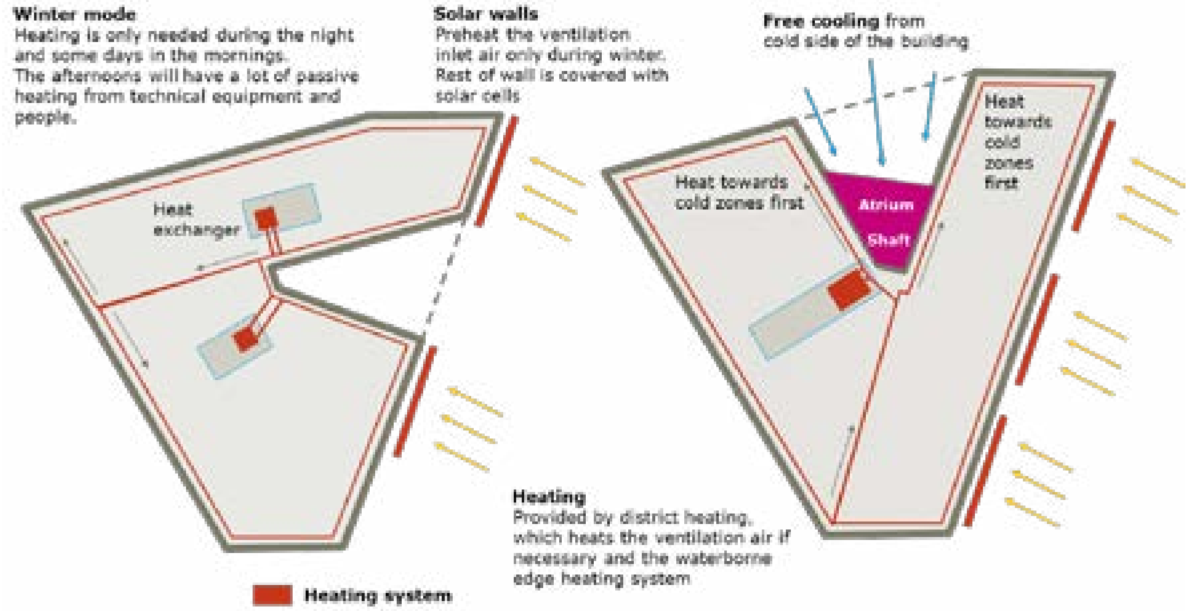
The room heating strategy is to use passive solar heating as much as possible during winter months from the end of October to midle of March. The heating season is very short due to the higly insulated building construction.



Ventilation heating and room heating is done by low temperature waterborne distribution. The ventilation system will have 90-92 % ventilation heat recovery with the state of the art heat recovery systems. According to our system design, and NS3031:2014 recommendations, the system efficiencies for district heating is 98 % for production, 98 % for distribution and 92 % for room heating, which means a total factor of 88 %.

The room heating will be done mainly by ventilation heating, and we have estimated that there is no need for radiators and under floor heating on all of the floors, only towards the outer rims of the building. The the lower floors with more shadows and less passive solar heating will need more heating.

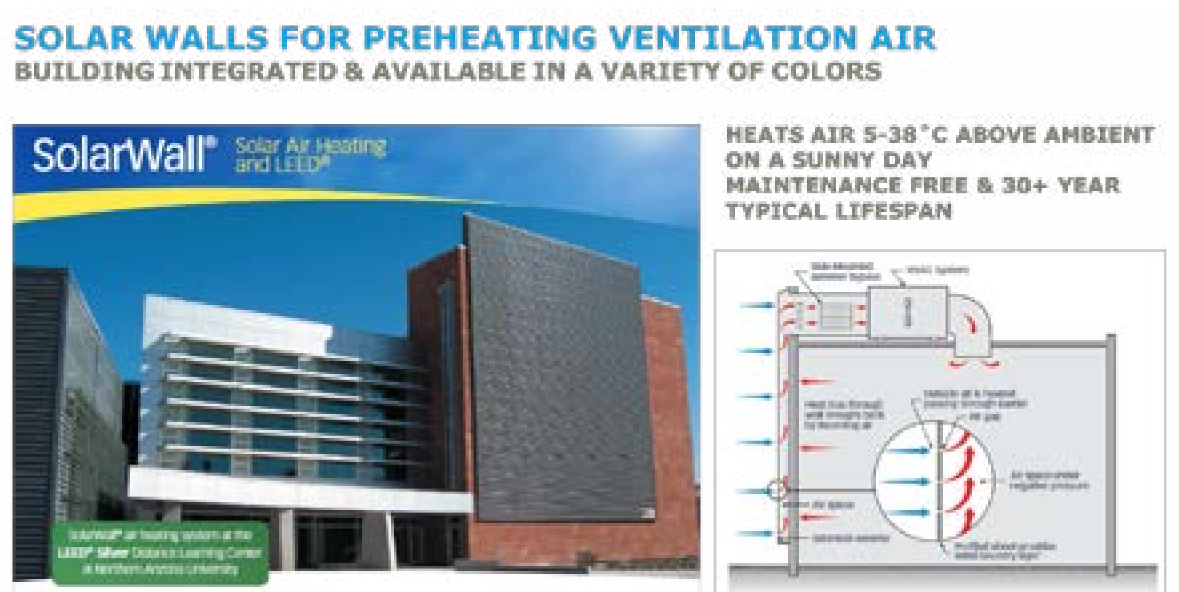
We propose to utilize the heating and cooling system to work with the sun.
During winter mode the whole building needs heating, but the west more during the morning. Excess heat which may need to be cooled on the east side can then be displaced to the west side until noon, and then after noon vice cersa. We propose to have a counter clock wise heating distribution with piping through the center of the building for optimal distribution and heating at warm and cold side during the day.



When calculating the net positive of energy balance of +2 kWh/m² or more, the energy demand for technical equipment is not counted in the Futurebuilt methodology for buildings higher than four floors. However, office buildings have a lot of passive heating sources from various technical equipment, which will be more than enough to cover the heating demand most of the year. The building will have a cooling challenge due to these internal loads, especially during June, July and August. Computer servers will also be an important heat source, and can provide heating large parts of the year with heat recovery, which means reduced district heating.

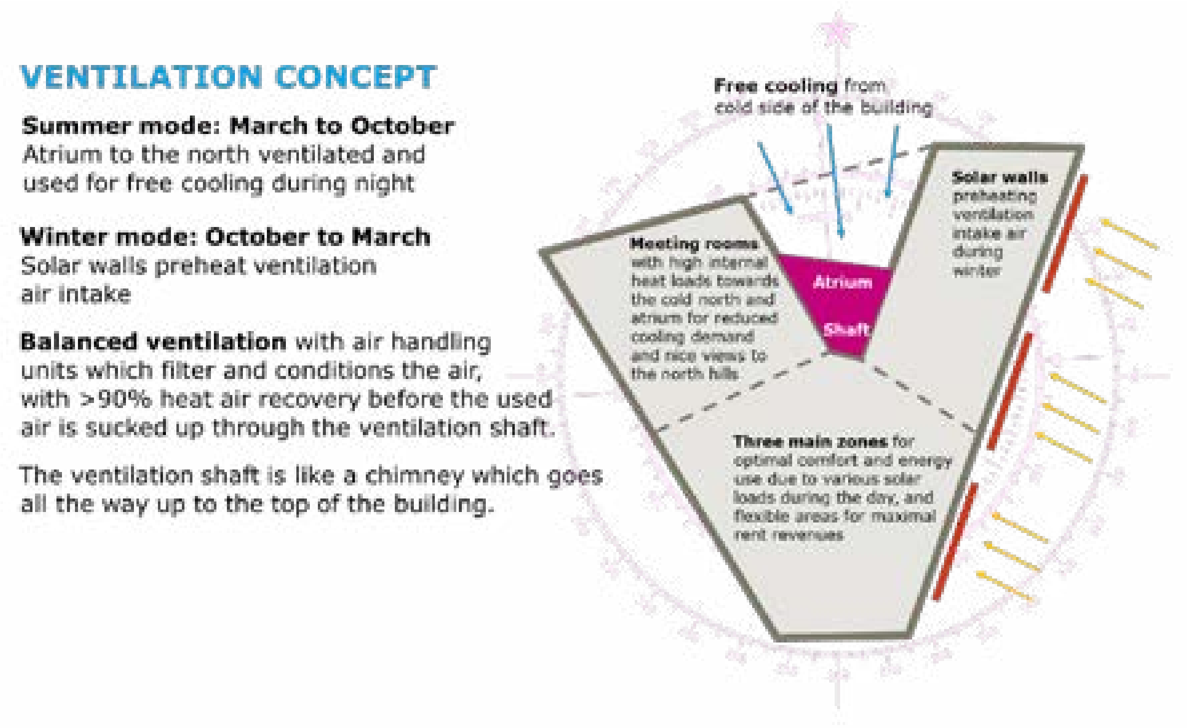
Warm tap water will be heated by electricity where it is needed on each floor to reduce the heat loss and costs for hot tap water pumping and circulating tubes rising in the building. Solar power will provide electricity for tap water all or most of the year.
To reduce the need for heating ventilation air, we propose to use solar walls, harvesting the morning sun on the east façade for preheating during winter. Renowned for its high efficiency and low capital costs, the solar wall technology uses the sun's energy and the heat loss from the façade to pre-heat ventilation air. It substantially reduces heating energy and expenses in a building integrated system which requires no maintenance and has a 30+ year lifespan. The solar walls can preheat the air temperature several degrees, for instance 2-6 degrees during cold winter days. The solar walls will preheat the inlet air when necessary, and be bypassed during summer mode.

The atrium towards the east will also function as a solar collector preheating the ventilation air entering to the lower floors. Atrium double façades with solar walls on the indoor facades will preheat the ventilation air, but also the atrium, even further than the solar walls on the high rise walls.

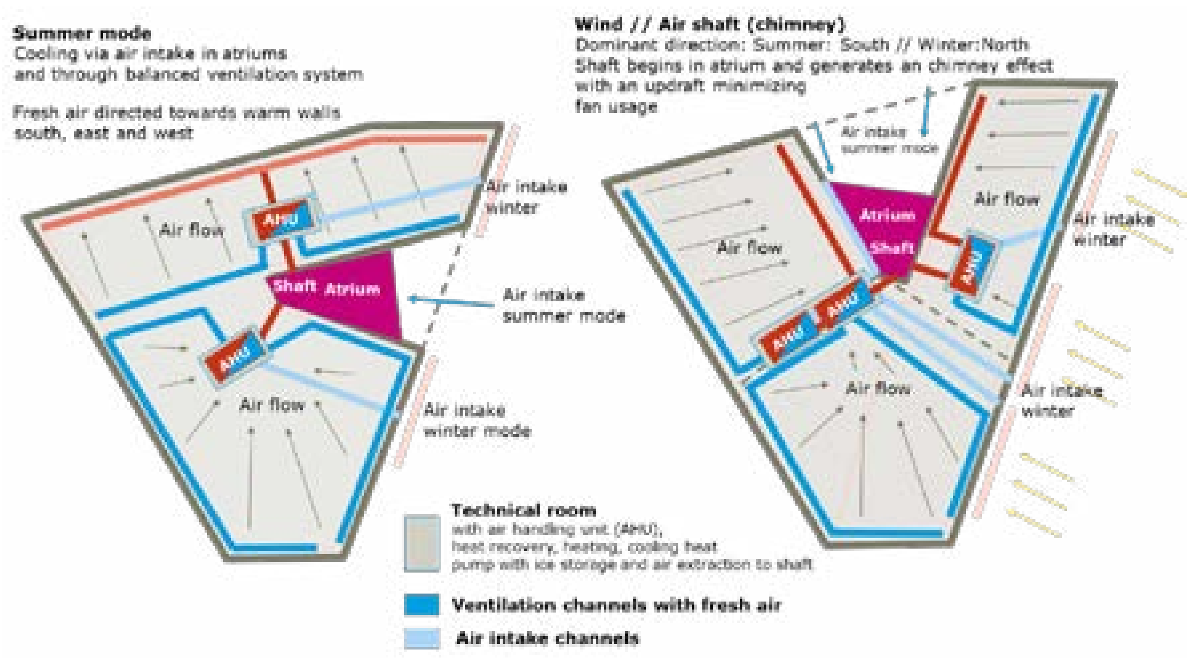


2.3.2 Ventilation

The building will utilize as much passive technologies as possible for ventilation, both to reduce fan energy, heating and cooling. The ventilation will have have a balanced ventilation system with fans, similar to a conventional system, but with larger dimensions for the heat recovery and pipes. However, the building will have an internal ventilation shaft, functioning as a chimney with a substaintial updraft which will reduce the fan energy consumption considerably.



The building will have a summer and winter mode where the summer mode will utilize as much free cooling through the atriums as possible. Oslosolar will have a warm and cold side all year, but will also have a warm east side from sun rise until an hour after noon, the south will be warm from a few hours before dawn, while the west from 11 until dawn. The cold side, on the north face, has a large atrium which will work as a "radiator" and dispensing excess heat to the surroundings or precooling inlet ventilation air during summer mode. The north atrium will be actively used during summer nights to free cool the building before the next day.



Air intake will have to be sufficiently high enough to avoid car fumes.

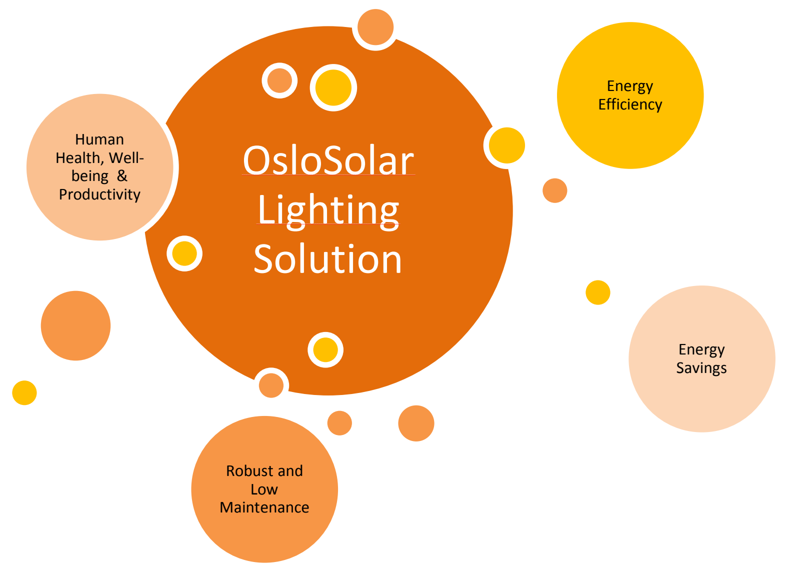
2.3.3 Technical systems

The building will have different heating and cooling needs during the day, both following the east to west axis, but also from south to north and from lower to higher floors. The floors will therefore be divided in three zones. Meeting rooms will have the highest cooling needs and will be placed close to the air handling units and towards the atrium towards the north, which is the colder part of the building with less solar gains. This part also has large windows and excellent views towards Nordmarka and the surrounding mountains.
Pump energy will be reduced with variable load (frequency controlled) pumps. The piping systems for cooling will also be divided into 6-7 systems not higher than 3-4 floors for efficient pumping, but also adaptive and dynamic systems with a short response time.

2.3.4 OsloSolar Lighting Solution

Optimizing daylight and electrical lighting in OsloSolar is an important part of the energy strategy and well-being and productivity of the users. The dynamic and efficient lighting solution have been designed for maximizing four main goals:

The goal for OsloSolar is using electrical lighting only when daylight is too low.



2.3.4.1 Human Health, Well-being and Productivity

Lighting designers design light for people who spend their workday inside a building. People's health, productivity and performance at work are the most important factors for employees and employers, which are in direct relation with lighting condition of a work space.
To achieve the optimal light system the luminaires must provide:

- ✓ Quality of the light, (e.g.
  - Selecting the right light source for the type of work which will be carried out in each space, for example considering diffuse light for work space while keeping the contrast to the required level)
- ✓ Luminaire performance, (e.g.
  - Selecting low glare luminaires for work places,
  - Using luminaires which don't reflect in the computer screens,)
- ✓ Using lighting control system,
  - To adjust the light level to required level at all times we have introduces lighting control system. Selected areas can be fitted with luminaires with tuneable white light source which can change from cool white to warm white with an astronomical timeclock. This is the best way of simulating natural daylight which human body requires for balancing their circadian system.

Another point is using high frequency ballasts which reduce the visible flickering in some type of luminaires.

2.3.4.2 Energy Efficiency

To achieve a very energy efficient lighting solution we have considered:

- ✓ Only using energy efficient luminaires, which means all luminaires have to have a high ratio between their delivered lumen and their energy consumption, for example using high efficiency dimmable LED luminaires where possible,

- ✓ Having electric light only where it is needed, for instance using shielded luminaires with controlled beam to direct the light

2.3.4.3 Energy Savings

Using a lighting control system to control the light in a building is the best way of saving energy. This system can be part of building management system. For OsloSolar we have considered different types of integrated sensors which are designed to suit different areas. For example, small areas with less occupancy (WC cubicles) would have presence sensors. Light will be ON when someone enters the room and will be OFF when they leave the space. Delay time can be adjusted as per client's requirements. Bigger areas would have a user interface such as push button controller or a touch panel. It is recommended to have presence sensor in all areas to turn the light off after some time without anyone present. Open plan office areas will be divided into different zones. Each zone will be equipped with presence sensors. Light will be ON in a zone where people are present, in the adjacent zone with no presence light level will be dimmed down and the furthest zone where people are not present, light will be adjusted down to 10% of its light output.

2.3.4.4 *A Robust and Low Maintenance Solution*

Selecting low maintenance luminaires is the first step to have a low maintenance lighting scheme. There are two main factors for achieving this:

- ✓ Selecting a light source that have a very long life such as LED.
- ✓ Using approved ballasts and power supplies by luminaire manufacturers.

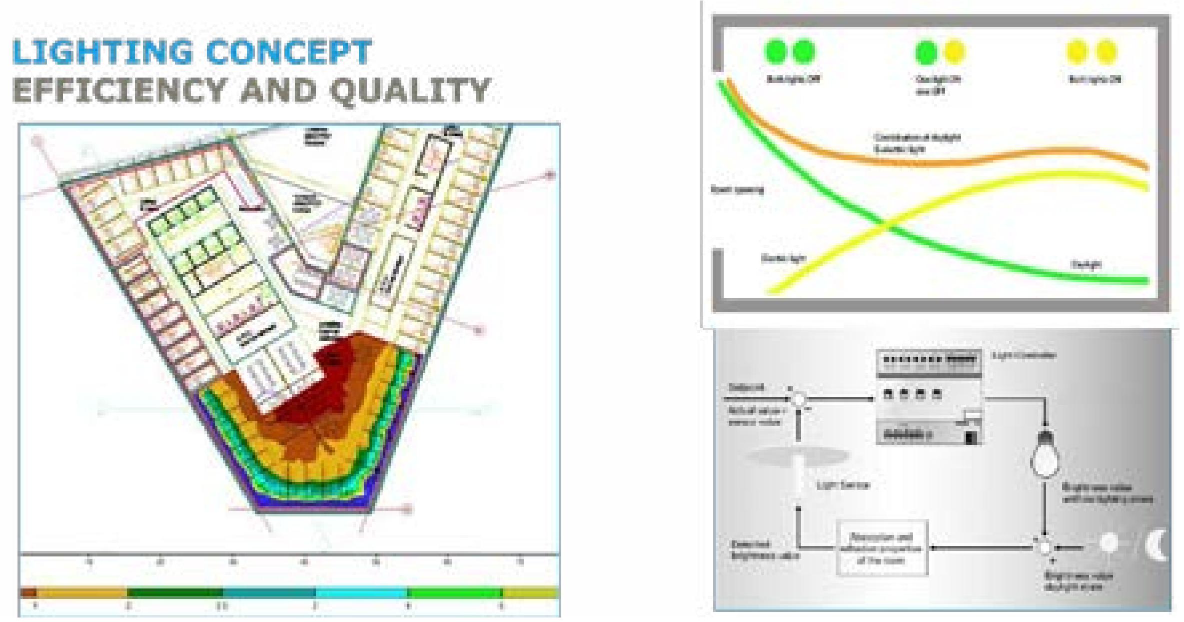
Less LED luminaire failures will mean low replacement rates, and manhours for changing light sources. Another way to reduce the maintenance cost is using a computer based DALI system. With this system technicians can control all the luminaires in the building individually and instantly find luminaires with problems.

2.3.4.5 Daylighting

Daylight is very important for our health and well-being. As mentioned earlier the type and amount of light that reach our eyes affects our biological system and helps our internal clock to work well. Daylight enhances our mood and productivity.

To benefit most from the daylight, OsloSolar should use a lighting control system and constant light control. All the luminaires within the system will be fitted with DALI ballasts. Areas with access to daylight will be fitted with constant light sensors. This means that the total amount of light is constant and the electric light dims up or down automatically with the changing daylight. With this method OsloSolar will be able to be very energy efficient without compromising light requirements.

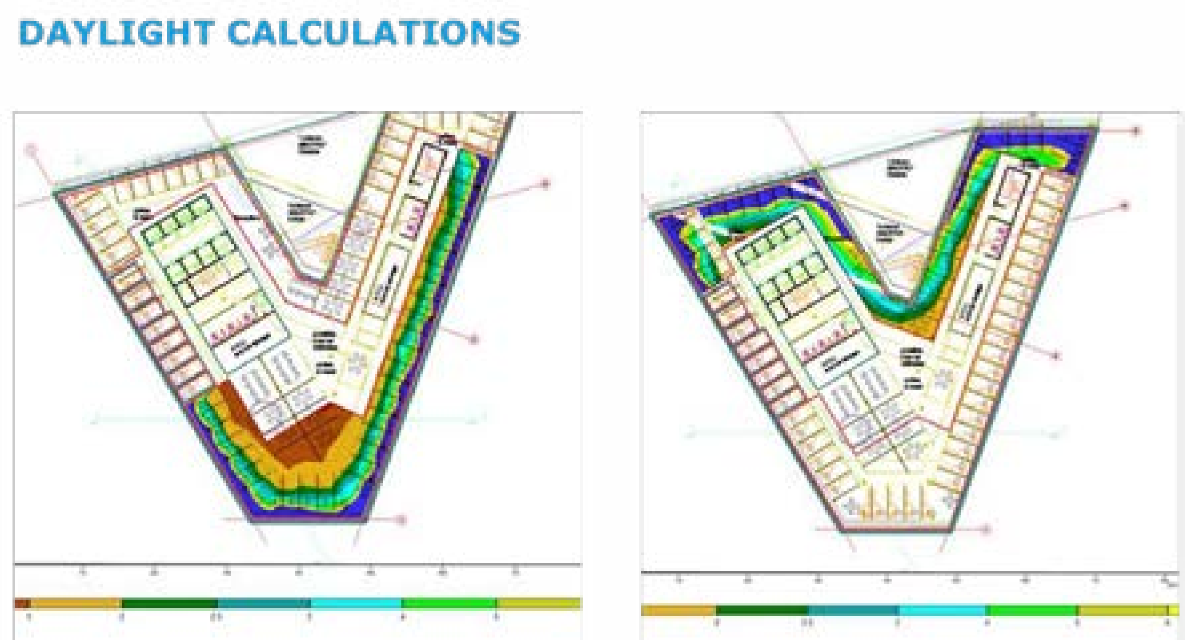
The figure below shows how day light can be integrated within a lighting control system, and the daylight and electric light control



2.3.4.6 Daylight Factor

To prove that we have achieved sufficient daylight inside the building we use Daylight Factor. Daylight Factor is a ratio that represents the amount of illumination available indoors relative to the illumination present outdoors at the same time under overcast skies. To get the highest credit as per BREEAM NOR there are two requirements which have to be met for the 80% of the office areas:

- ✓ Achieving average daylight factor 3.1 % for a multi-story office building (for an office building in Oslo),
- ✓ Achieving point daylight factor 1.26



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Following a series of daylight calculation, working on the ratio of glass and solid surfaces on the building facade, we could achieve the required Daylight factor in the building.To achieve the above we have considered surface reflectances as per below:

- ✓ Walls : 50%
- ✓ Floor: 20%
- ✓ Ceiling 80%

Glazing transmission is different in different parts of the façade. The North façade, with lower solar heat gains, and the internal atrium glazed walls will have a high transmission, about 80%. The West, East and South façade glass transmission will be 62%. With these parameters our calculations show that the targets are met, as shown in the figure below.

OsloSolar is selfsufficient within lighting, either directly from daylight or electric lighting indirectly from the façade solar power modules.

2.3.5 Cooling

Dynamic room cooling systems are minimized due to the narrow windows and sun screens which do not let in unneccessary heat during summer. Daylight is preserved with a window or aerogel strip as high as possible on each floor without adding cooling loads.

Ventilation cooling is done with free cooling as much as possible during night at summer, most of the spring and fall, even in part of winter with low sun when a forecast of a sunny day for the next day triggers the building energy management system to store cool air in the building (above 18 degrees).

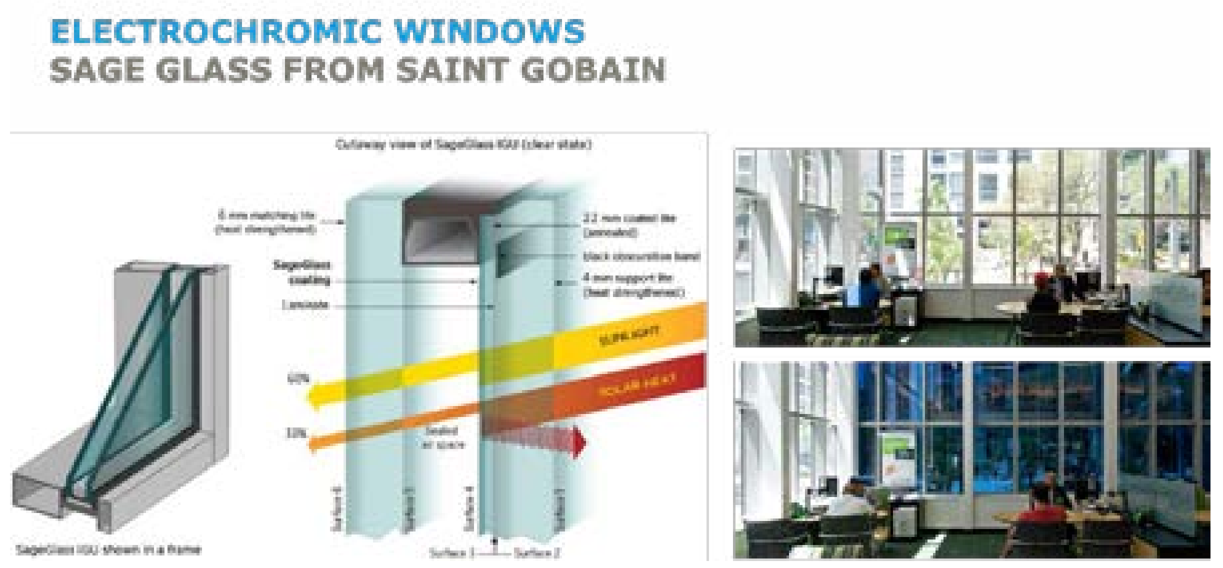
Cooling heat pumps, with CO_2 as refrigerant are commercial and used for instance in cars and super markets. These exchange heat from the surrounding cool air to a water borne system towards the north façade, with water and ice storage, and will provide the necessary cooling for the meeting rooms primarily, but also the offices. CO_2 has been chosen as a refrigerant since this CO_2 will not have any impact on climate change if it is leaked. It has already been subtracted from the atmosphere. The air conditioning unit is a highly efficient heat pump with condensing towards the water based system, and will then have a yearly average cooling factor of 2,9 (somewhat better than what NS3031:2007 states in recommended values table B.3).

The active cooling systems will use less energy than normal due to innovative, simple and reliable solutions. The passive solutions is roof and wall elements made with phase change materials, placed at the suspended ceiling and at the walls. The PCM panels will prevent rooms from overheating (above 25 degrees), if the heating load is not too high and the PCM cannot absorb any more heat. The PCM will reduce the energy consumption for cooling.

2.3.6 The light "trilemma" // Trade-off optimization

The design team has iterated several times to get the right amount of daylight, solar cell power production and windows without too much heat loss, or cooling need in summer.

To avoid glare and large cooling loads it will be necessary with efficent sunshading For the sunshading we propose to use one of the three following solutions on all or parts of the building depending on the needs and aceptable costs.



1) **Outside dynamic venetian blinds (with motors)**
   a) Advantages
      i) Dynamic and can prevent more than 90 % of unwanted heat to enter
      ii) Can let all wanted passive solar heat enter the building
   b) Challenges
      i) Costs and advanced control system
      ii) ii) Operation and maintenance
2) **Electrochromic Windows,**
   from Sageglas owned by Saint Gobain, which can dynamically change the light transmission from 0,62 to 0,09
   a) Advantages
      i) No moving outside parts, can be used in the upper floors and windy areas
      ii) Full control of light transmission
      iii) Control of for instance 2-3 horizontal bands on window, sunshading just were you need it
   b) Challenges
      i) Use electricity for changing light transmission
         (1) Increase of up to 2-3 % of electrical demand in Northern hemisphere
         (2) OsloSolar produces 3,8 kWh/m² excess power, more than the +2 kWh/m² required, which means 255.550 kWh/year. This is 12 % of the total and can cover the extra 2-3 % energy required for the electrochromic windows
3) **Permanent sunscreen,**
   optimized for utilization of passive heating from October to March, and blocking out most of the heat during summer, and not letting in more than can be cooled through free cooling at night
   a) Advantages
      i) Low investment and close to zero operations cost

RAMBOLL ENERGY

   b) Challenges
      i) Let in more heat during summer mode than with the dynamic alternatives
      ii) Do not let in all potential passive solar heat during winter mode than the dynamic alternatives

The permanent sunscreen has been optimized for a sun angle of 30 degrees, as shown on the figure at the right.

2.3.7 Cooling from rain water and evotranspiration from plants

The water harvested could teoretically cover all the cooling demands for the building by evotranspiration. The calculations below shows that there is needed 11.245 m² of plant walls to consume all the rain water and provide all this cooling. This is not realistic, so we propose to have a reasonable amount of plants which will clean the air, use some of the harvested water and provide an aesthetic indoor environment. See chapter Biodiversity for proposed plants and amounts.

Humidifying Power of Vegetation	$Q_L = (I_{THd} - 16) \times 0.49 \times S$	**= 28**	**W/m²**
Moisture Added to Air by Vegetation	$D_g = (Q_L / h_{fg}) \times 3600$	**= 0,0406**	**kg/m² h**

Q_L	= Latent Heat, W/m²	27,6
I_{THd}	= Total Horizontal. Design Solar Irradiance, W/m²	110
h_{fg}	= Latent Heat of Vaporisation ~ 2.45MJ/kg	2,45
D_g	= Moisture transpired to air per hour, kg/m²h	0,041
S	= Transmission Loss Factor for Glazing	0,60

Light hours	4 380	Hours
Water gathered	2 000 000	liters
Area to cover all the water gathered	11 245	m² with plants
Teoretical cooling potential	1 361 111	kWh
Humidity added	2 000 000	liters

1 liter ~1 kg

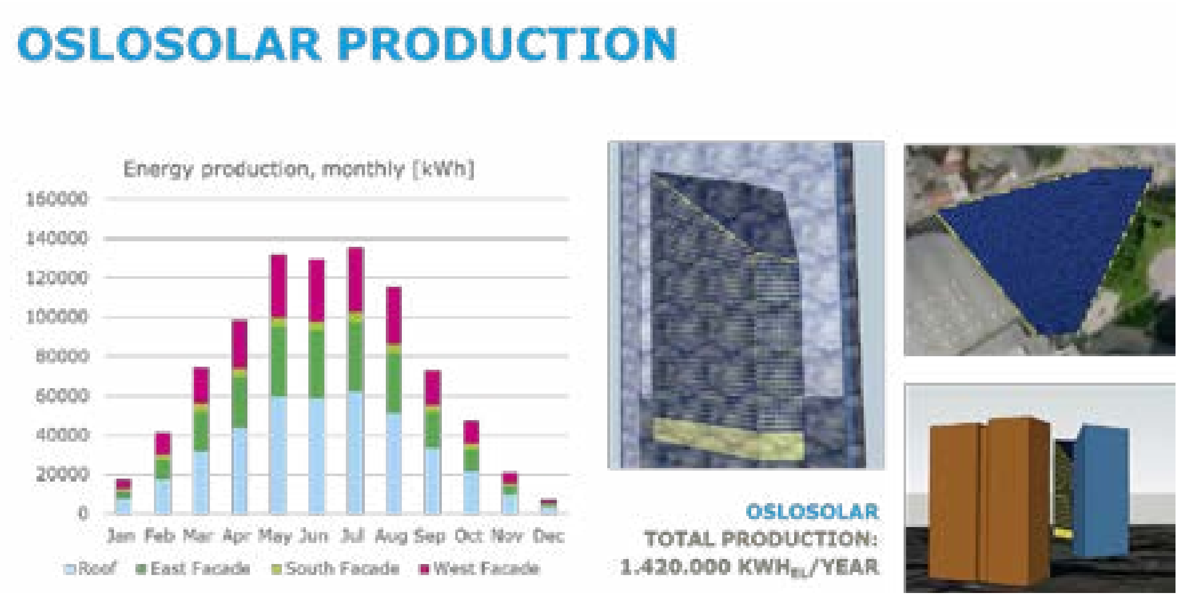
2.4 Energy Production from Solar Power

A yearly net positive energy building of +5,8 kWh/m² is achieved with solar power. The power production is done by more than 5090 building integrated solar panels, covering in total almost 9000 m² of the façade towards the east, west, south and the roof. The solar modules together with district heating will cover the annual energy demand.

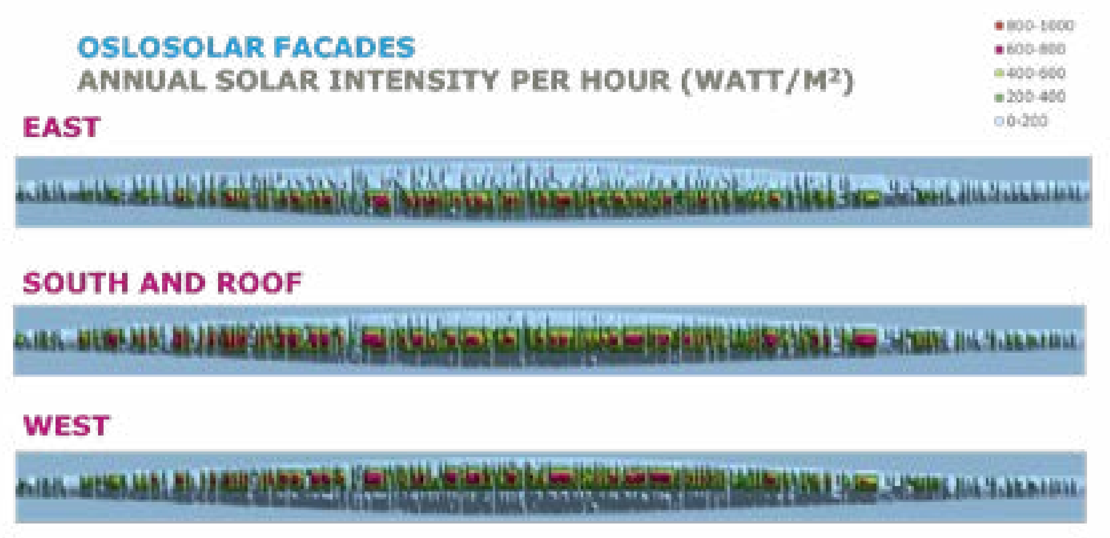
System overview

Area of panels	8300	m^2	**Area per module**	1,63	m^2
Amount of modules	5090	panels	**Watt per module**	345	Watt per panel
Energy production	1 420 000	kWh per year	**Watt per area**	212	watt/m^2 solar panel
Installed peak capacity	1 756	kWp (DC)	**Energy**	171	kWh/m^2 solar panel

The solar module power production has been performed with the software Skelion, a plugin in Sketchup which uses weather and solar data from the National Renewable Energy Laboratory and the PVGIS initiative from the European Joint Research Center in the EU. The simulation results are attached. The system can be further detailed and engineered in PVSyst in the next phase.

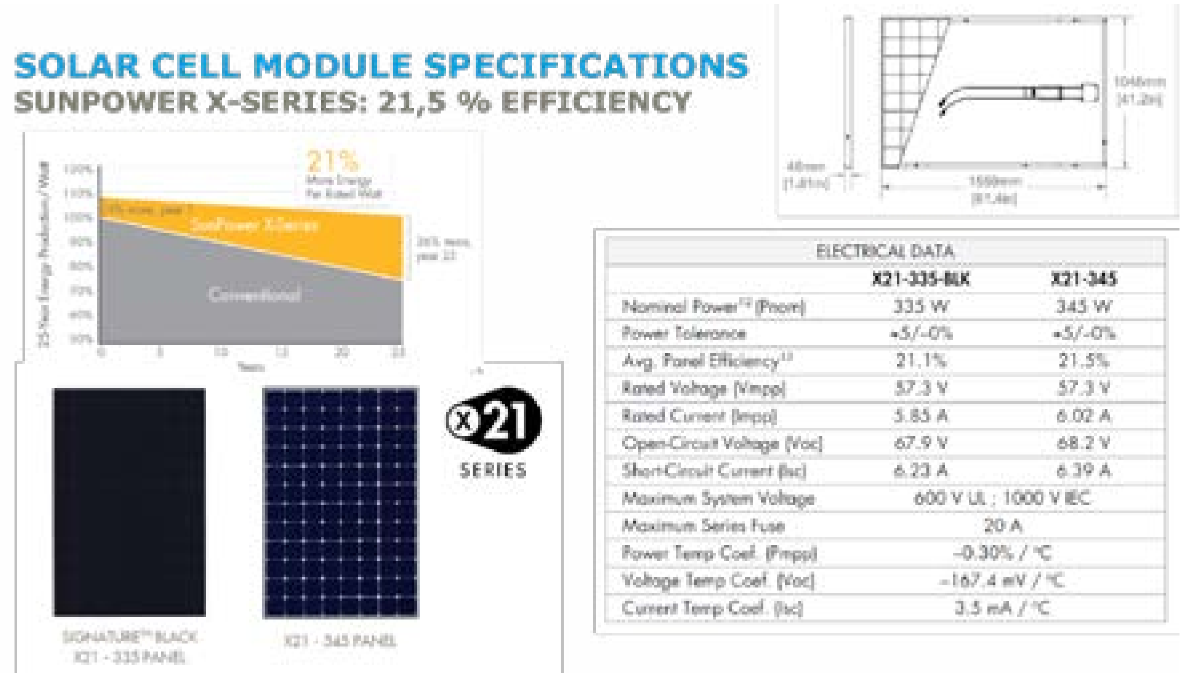


2.4.1 Practical challenges from positive energy balance
However, Oslosolar will sell electricity to the grid during the summer months to avoid expensive energy storage, and will also trade electricity back and forth on a daily basis during the spring and fall. It is worth mentioning that new regulations which will be valid from 2016 may prevent net positive energy buildings with more than 100 kW delivered to the grid. The grid operator Hafslund Nett, must be consulted early on for Oslosolar to investigate if it is possible to deliver more than 17 times the maximum allowed! There may also be a cost associated with upgrading the grid for receiving substantial solar power. If the local grid cannot handle the large power surges, large batteries must be installed to provide power to grid steadily and back to the building. It could also be possible with power to gas (P2G) and produce hydrogen to provide for a filling station nearby and reduce the emissions in Oslo.



2.4.2 Photovoltaic system
The Oslosolar solar photovoltaic system is estimated to produce more than 1.420.000 kWh/year, which means an excess of approximately 5,8 kWh per m^2 heated floor area (BRA) when compared to the Futurebuilt weighted delivered energy without technical equipment.

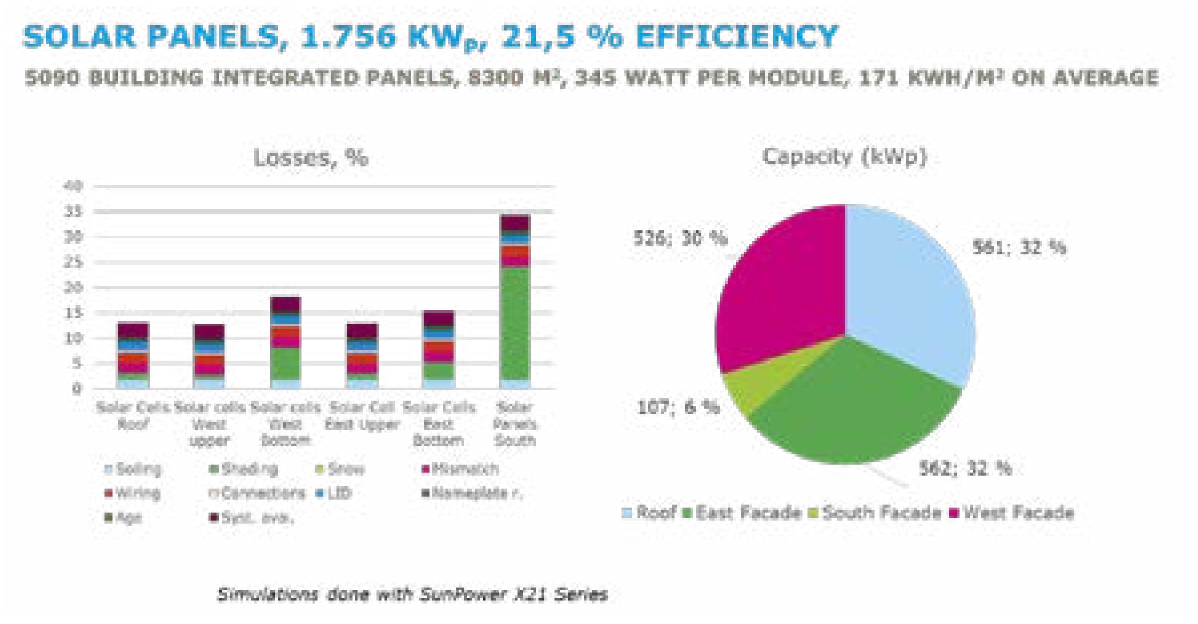
This means close to 255.550 kWh/year in surpluss electricity. The system will have 5090 modules of Sunpower X 345W panels, approx 1,6 m^2 each, which means more than 1,7 MWp of power, and more than 94.000 tons of panels!



ELECTRICAL DATA		
	X21-335-BLK	X21-345
Nominal Power[12] (Pnom)	335 W	345 W
Power Tolerance	+5/-0%	+5/-0%
Avg. Panel Efficiency[13]	21.1%	21.5%
Rated Voltage (Vmpp)	57.3 V	57.3 V
Rated Current (Impp)	5.85 A	6.02 A
Open-Circuit Voltage (Voc)	67.9 V	68.2 V
Short-Circuit Current (Isc)	6.23 A	6.39 A
Maximum System Voltage	600 V UL ; 1000 V IEC	
Maximum Series Fuse	20 A	
Power Temp Coef. (Pmpp)	–0.30% / °C	
Voltage Temp Coef. (Voc)	–167.4 mV / °C	
Current Temp Coef. (Isc)	3.5 mA / °C	

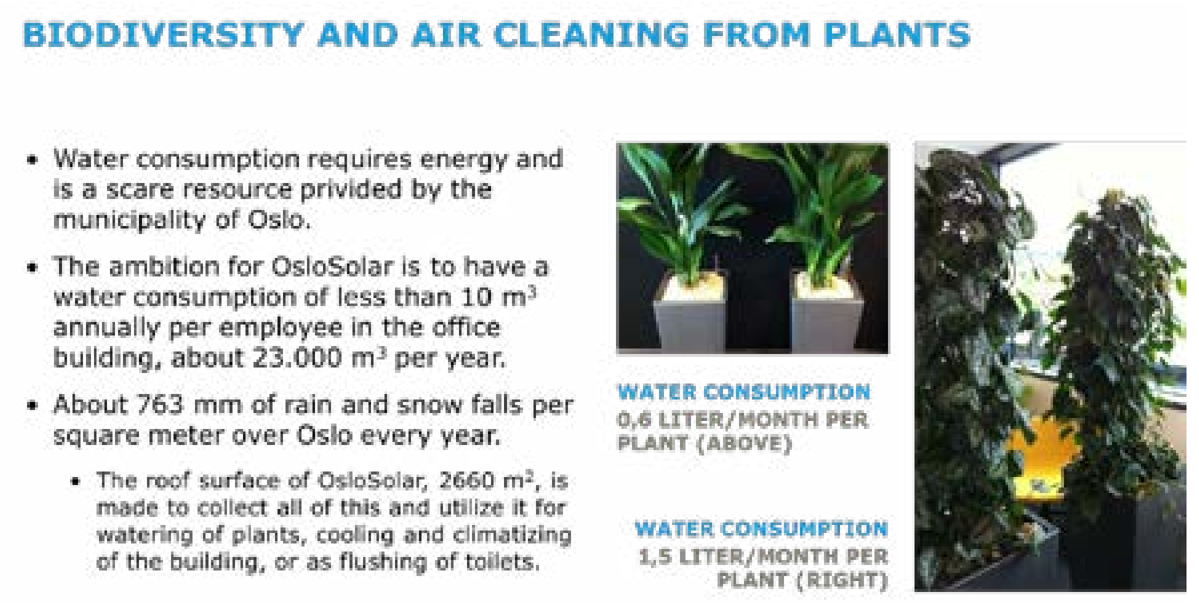
The team has decided to designate sufficent space for the solar panels to produce more than the requirements. This is to be certain that the building will be net energy positive since losses from soiling from the polluted Oslo air and snow can be higher than expected. In the future the climate change will mean higher temperatures or more cloud cover, which may mean more volatile energy production and demand.

2.4.3 Solar system specifications and losses
The table below shows the solar module parameters.



For maximum power produced in relation to construction costs Oslosolar will have building integrated solar panels on roof and façades towards the south, east and west. To achieve even higher production of solar power 2 or 3-axis tracking modulees could have been used, but this would mean a complex system never tried on a large office building roof before. Oslosolar is in the shadow of Plaza and Postgirobygget, which means that if it had been free standing it could produce up to 20 % more at the south façade.

2.5 Biodiversity
Our biodiversity strategy is to increase the biodiversity on the property and use this biodiversity for ecosystem services such as improved indoor climate, reduced cooling energy and watering of the plants from rain harvesting. Ecosystem services are the direct and indirect contributions of ecosystems to human well-being and support directly or indirectly our survival and quality of life.



More than 99.9% of the water used by an irrigated crop or turf is drawn through the roots and transpires through the leaves. Only a small amount (0.1%) of the water taken up by plants is actually used to produce plant tissue. The rain and snow harvesting system gathers approximately 2.000.000 liters per year which can be used for air conditioning (cooling and humidification) and water plants which can remove air pollutants.

Filtration of rain water can be done by a system like Hydrosystem 3000 from Helnor, which can filtrate rainwater from a roof of 3000 m^2. The filtration system is tested and installed a various places the past 10 years. **It can remove heavy metals, hydrocarbons, road and combustion particles as well as oils, and can then provide cleaner water than when the water was entering the building.** The water amounts harvested has been the input for the amount of plants to avoid sewage costs.

ENERGY

2.5.1 Top 10 Plant Air Cleaners

Based on an assessment of 50 houseplants by four criteria: 1) removal of chemical vapors, 2) ease of growth and maintenance, 3) resistance to insect infestation, and 4) transpiration rates. Environmental Health Perspectives studies suggest plants are most effective in removing volatile organic compounds (VOCs) in energyefficient, nonventilated buildings; in highly ventilated buildings, the rapid exchange of inside and outside air makes the benefits of plants mostly limited to their psychologic and aesthetic values. However, Oslosolar will have very low air exchange volumes after work hours and during night, if no one are working, and the plants will then have an effect.

However, the plants listed below have shown to be most efficient in improving indoor air

1. Areca palm (Chrysalidocarpus lutescens)
2. Lady palm (Rhapis excelsa)
3. Bamboo palm (Chamaedorea erumpens)
4. Rubber plant (Ficus elastica)
5. Dracaena (Dracaena decremensis 'Janet Craig')
6. English ivy (Hedera helix)
7. Dwarf date palm (Phoenix roebelenii)
8. Ficus (Ficus macleilandii 'Alii')
9. Boston fern (Nephrolepis exaltata 'Bostoniensis')
10. Peace lily (Spathiphyllum wallisii)

2.6 Water Consumption with Harvesting rain water and snow

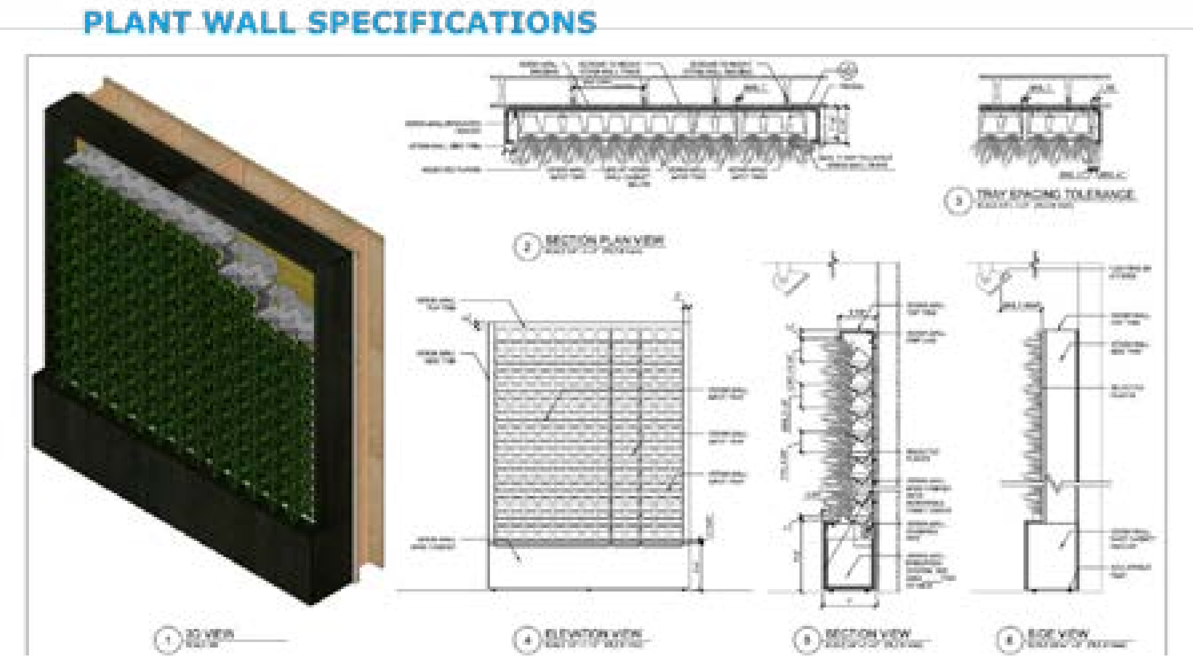
Water consumption requires energy and is a scare resource privided by the municipality of Oslo. The cost is 12,46 NOK/liter for water and 18,7 NOK/liter of sewage, in Oslo. The ambition for OsloSolar is to have a water consumption of less than 10 m^3 annually per employee in the office building, about 23.000 m^3 per year.

About 763 mm of rain and snow falls per square meter over Oslo every year. The roof surface of OsloSolar, 2660 m^2, is made to collect all of this and utilize it for watering of plants, cooling and climatizing of the building, or as flushing of toilets. The total water harvesting potential is calculated to be about 2.000 m^3, or about 9 % of the annual consumption. If this amount of rain is harvested it means 25.000 NOK/year in reduced water procurement costs. If all the water is used in the building for plant irrigation, additional 63.000 NOK/year of costs are avoided. The benefits are reduced costs for water procurement and energy for cooling, while the sewer system of Oslo will have a reduced flooding.

The realistic usage of harvested rainwater for plants is calculated to be approximately 60.000 liters per year. The rest of the rain water can be used for washing facades, pavements and for toilets and bicycle cleaning. The 60000 liters of water has a teoretical cooling potential of 40.800 kWh from evotranspiration, about 15 % of the total cooling demand for the building (netto energibehov, before cooling machines).

Plant	Annual liter per plant	Plants	Water consumption, liters
Large plants	36	250	9 000
Large plants, sunny area	72	250	18 000
Medium plants	6	250	1 500
Plant wall, 3 of 200 m^2	7200	3	21 600
Plants outside atrium	36	300	10 800
Total			**60 900**

These plants will have beneficial and profitable indoor climate qualities with evaporation reducing dry and static air, reduced cooling demand and reduced water procurement and sewer taxes.



3. Final remarks

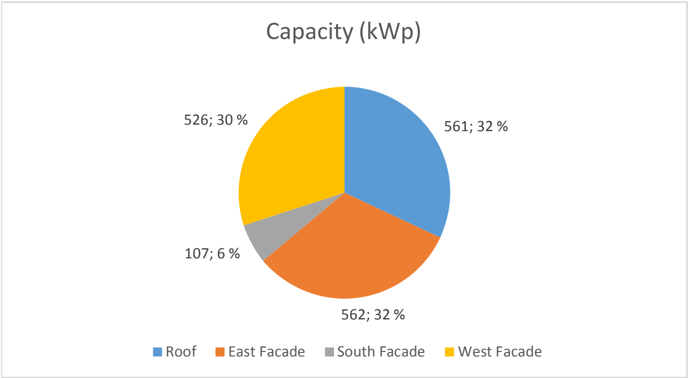
OsloSolar fullfills the Futurebuilt+ requirements with robust, well proven and innovative solutions. The building will be a sustainable lighttower for all future urban development!

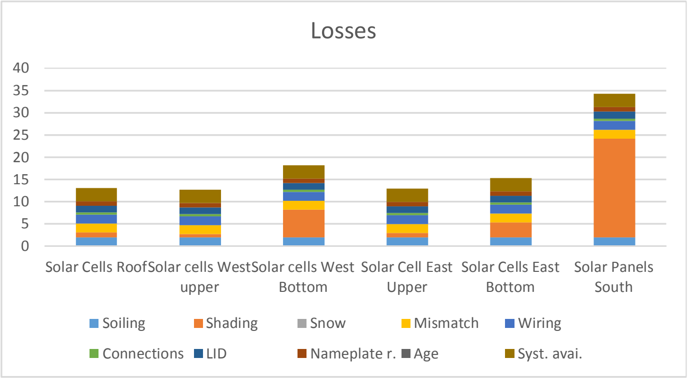
OSLOSOLAR

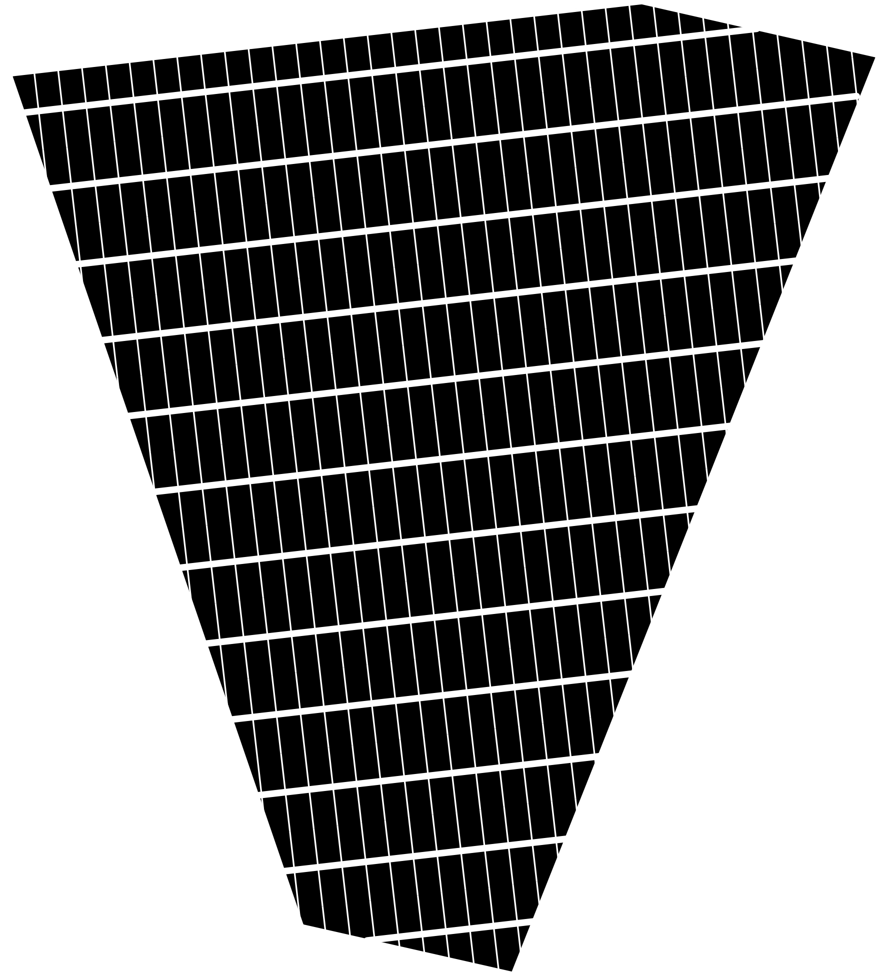
ECO-EFFICIENCY
Solar Power

Area of PV-panels on the facade with a total of 8302 m².

Tables show calculations on solar power for the PV modules SunPower 345.
The full calculation is attached digitally.

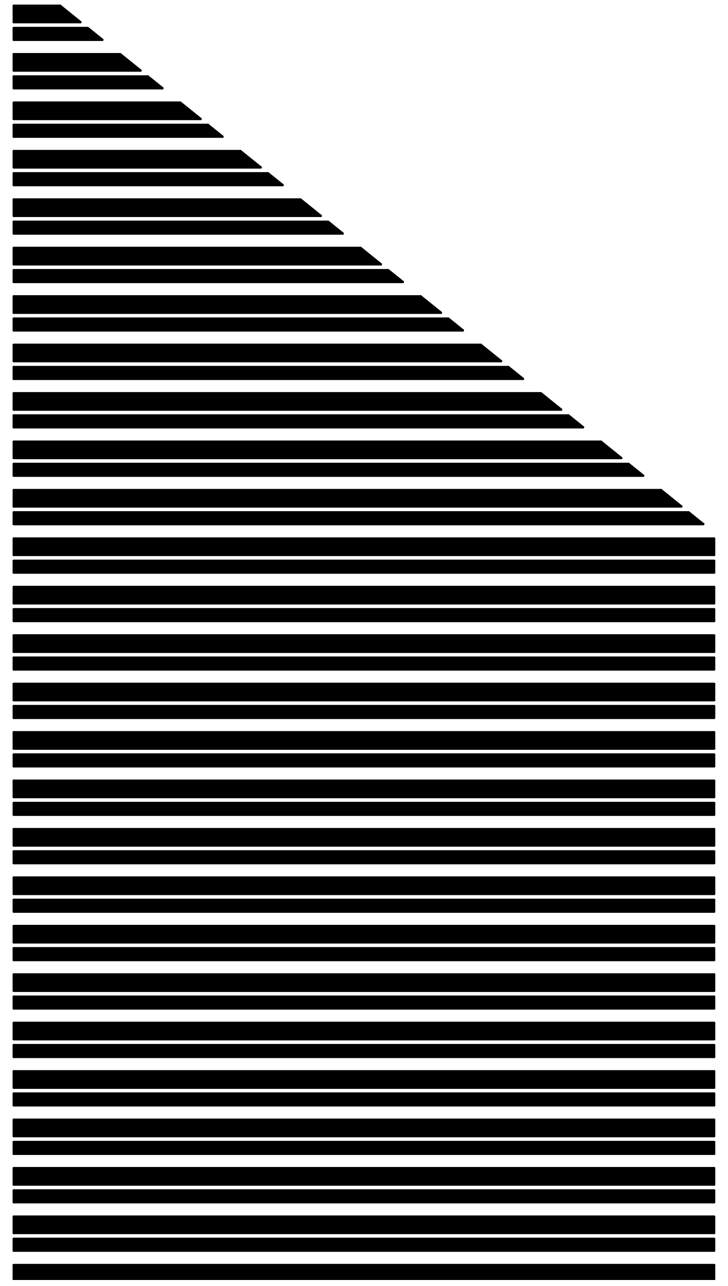




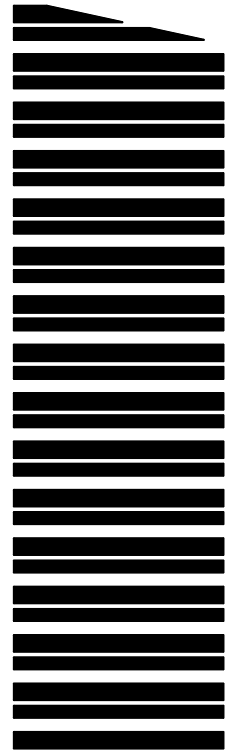


ROOF 2599 m²

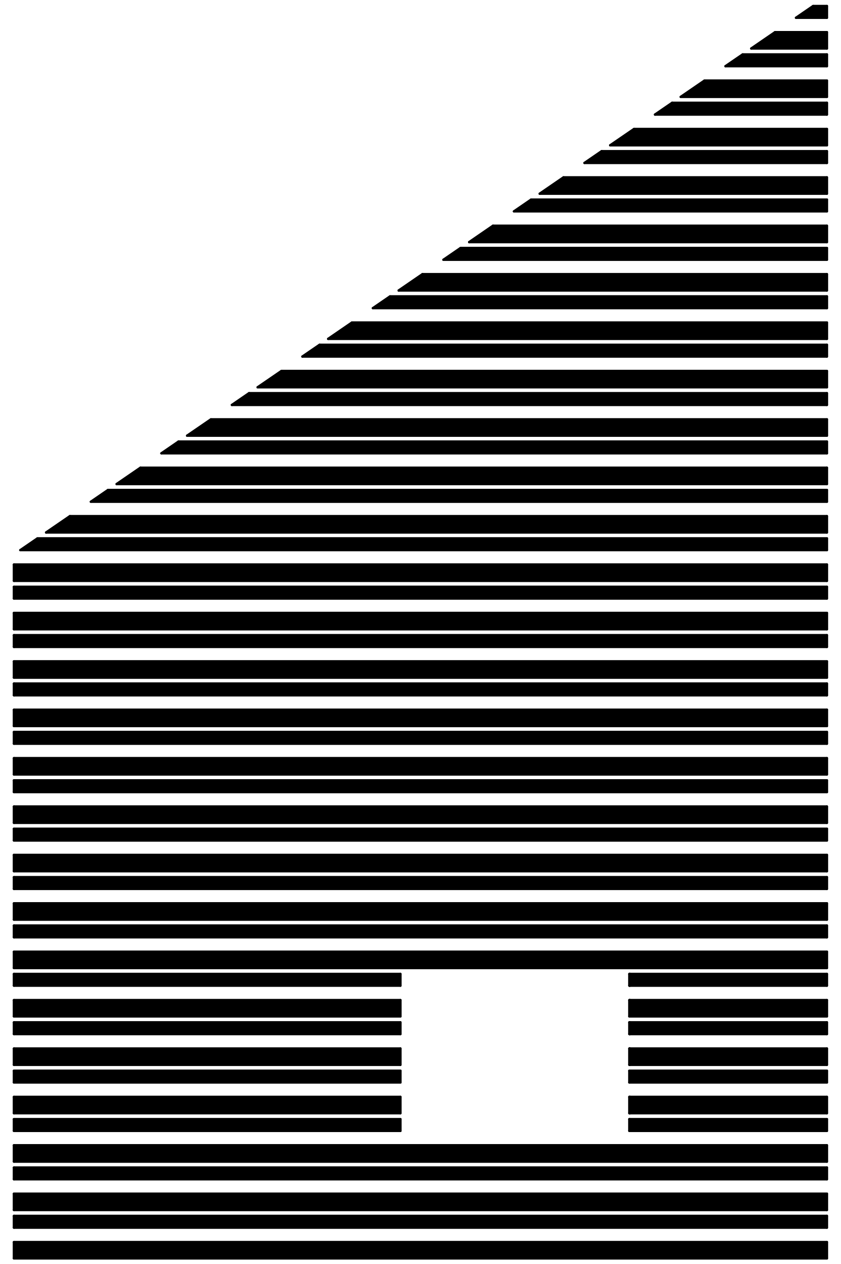
ECO-EFFICIENCY
Solar Power



SOUTHWEST 2647 m²



SOUTH 525 m²



SOUTHEAST 2531 m²

OSLOSOLAR

illustration from Lilletorget

ECO-EFFICIENCY

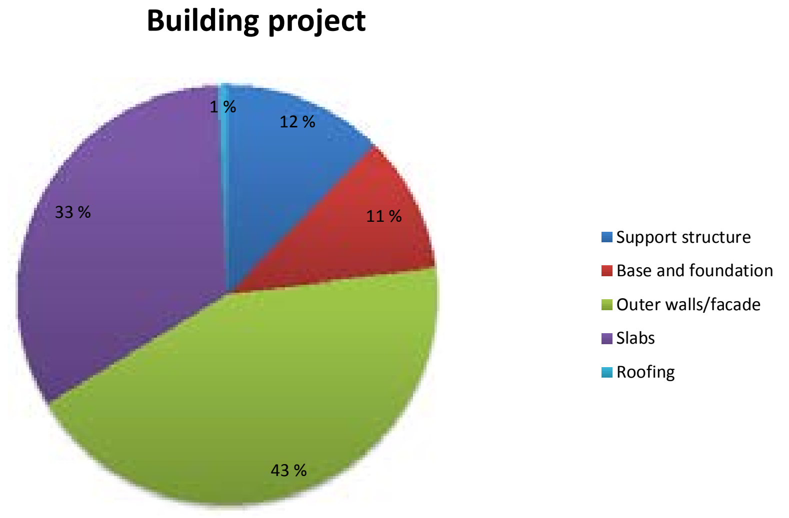
Material Calculator and C2C

Several alternative solutions have been assessed to determine the solutions that will ensure the smallest CO2-emissions overall. From the composition of slabs and structural framework to the insulationmaterials.

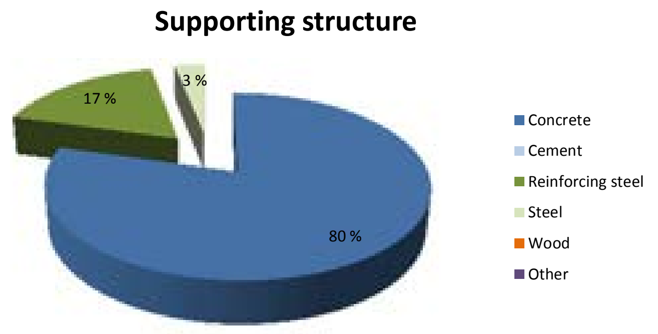
In some cases, the project have decided to choose materials that have a greater CO2-emission per m^3, like the vacuum insulation in the outer walls. The technical properties of this material however, reduces materialuse and thickness of the wall, resulting in an effective way to reduce CO2-emissions.

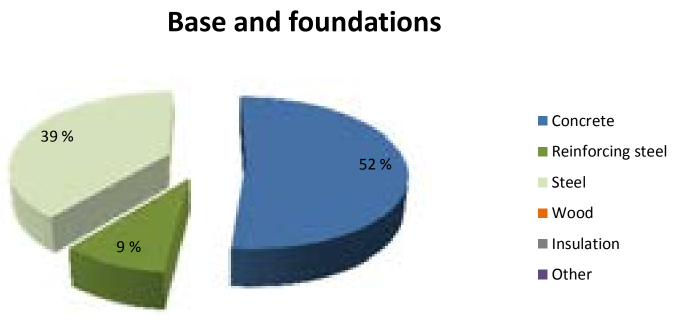
In regards to the C2C scheme, the team have focused on two main solutions in regards to materials. One is the facade cladding, where aluminium has been chosen for its reusable, recyclable properties in line with the C2C scheme. Using only pure materials and no composite, the process of reusing it at life end will be considerably easier and cost efficient.
The other solution is to utelize the alternative 2.nd basement floor for storaging office furniture for later reuse during shifting attendants of the building.

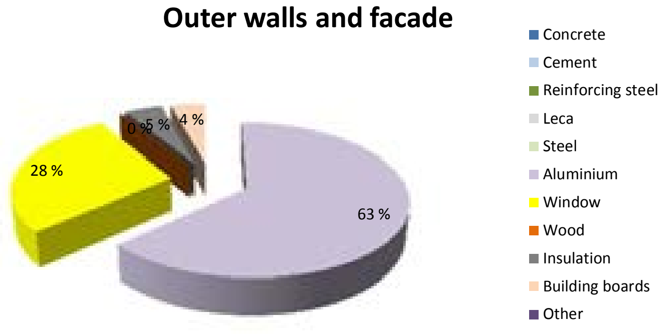
The material calculator is based on 25% cell offices and 75% office landscape between 2nd and 22nd floor.

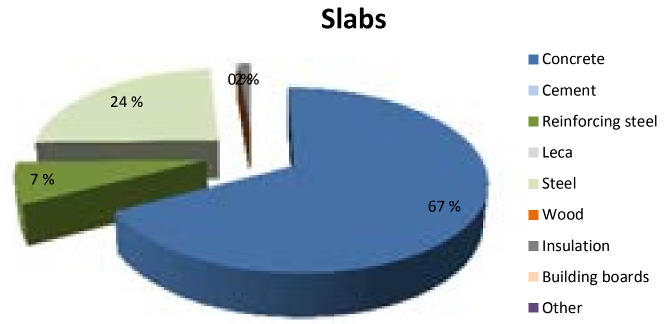


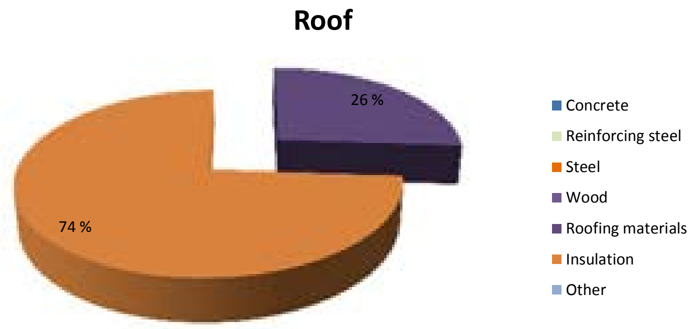
Impact distribution	
Support structure	1353 tonne CO2 eq
Base and foundations	1160 tonne CO2 eq
Outer walls/facade	4754 tonne CO2 eq
Slabs	3615 tonne CO2 eq
Roofing	76 tonne CO2 eq











Results from the material calculator.
The calculation is attached the proposal as an excel-file on the memory stick.

Project	**Oslo Solar**
Costomer	**EntraEiendom**
Doc. nr.	**01**
Date	**2015/06/11**
Produced by	**Ramboll Norway /Sunniva Baarnes**

How Oslo Solar will achieve BREEAM-NOR points for each of the chapters

This document describes, in short terms, how the project will achieve BREEAM-NOR Outstanding; the schemes highest level. It requires early planning and close collaboration between disciplines, contractor and developer. The location and energy efficient design of the building provides ample opportunity to achieve this high certification and with it an urban and environmentally friendly building with innovative characteristics.

BREEAM-NOR Outstanding requires that the project achieves 85% -points. The pre estimated analysis has a margin of 8.8% points. In an early phase, it is necessary with a margin to have any leeway as preconditions may change. The pre estimated analysis is at this stage programmed to 93.8% -points

Management (Man) -12%

Technical commissioning is assumed implemented in later phases, but must be planned well in advance. Contractor and client should be able to fulfill all the requirements of the contractor's guidelines for environmental and social responsibility and impact on the construction site with appurtenant checklists. Early planning will also enable innovation points by complying with whole checklist. A user guide will also be prepared according to the specifications. Active use of ProductXchange could simplify this process. LCC should be performed on parts of the building that will not cause problems for the selection later on. This requires some strategic choices. There will be performed a site analysis. Stakeholders and SLT shall be consulted in the process and measures in this regard should be followed up. A licensed AP has prepared a pre estimated analyses and the same AP or another licensed AP will guide the project and update the pre estimated analyses to achieve BREEAM-NOR classification Outstanding by 85% + margin.

Health and Wellbeing (Hea) - 13%

The energy scheme requires a low energy consumption from the indoor lighting. This, in turn, requires effective use of daylight. The credit can only be achieved by selecting section 3 a and b (daylight factor point) as the rooms geometrical design can be complex. Innovation credit is not obtainable. The building has good conditions for outwards views. External blinds are used for glare control and will be drawn up under the facade and controlled automatically. High-frequency lighting is designed as a standard. Placement of technical rooms will be in areas with insufficient daylight. Details will be designed in the next stages. There will be constant light regulation and effective lighting systems. Natural ventilation is incompatible with the buildings energy scheme. Meeting rooms are considered to need predictable air quantities. Retail facilities are more unpredictable. There will be user controlled mechanical ventilation in the building. The user will have the possibility to override night set back. Air intake will be 10 meters

U:\1506 Tekniske systemer og industri\Felles-for-divisjon\Energi og miljø i bygg\Miljø i bygg\Utkast tilbud uten mappe\Urban +\N-not -01 Oslo Solar BREEAM-NOR Pre Estimated analysis description.docx

ECO-EFFICIENCY
BREEAM-NOR

from any pollutant. Materials emission requirements must be described in a detailed level to avoid materials with excessive emissions to indoor air. The building is designed as a plushouse and takes advantage of the shadow from Oslo Plaza to maintain thermal comfort. User control of the thermostat is compatible with the chosen energy scheme as long as the controller has a limit to how many degrees that can be adjusted. Humidification will take place with purified water from rain and snowmelt. All of the collected water will be used in the building for watering plants, or cleaning bikes and the façade and as gray water for toilet flushing.

Energy (Ene) - 19%

The concept will provide over 100% reduction in delivered energy compared to the energy label C. There will most likely be installed BMS (Building Management System) in the building. High energy loads and tenancy areas will be monitored. If distribution of the rented area is not determined in time, the building should be monitored in zones. Requirements for outdoor lighting are set as the design standard. District heating from Hafslund shall be entirely renewable by 2020. As little district heating as possible will be used as the passive solar heating (solar walls), solar panels and an energy effect building envelope should ensure a plushouse consept for the year as a whole. This also makes it possible to obtain innovation points. Elevators should be installed with the most energy efficient solutions. To use the power from regenerative elevators there must be established an infrastructure for this.

Transport (Tra) - 10%

The building is centrally located with just 220 meters to Brugata stopover which departures more often than every 30 minutes, between 8 am to 5 pm, to a larger junction. (Oslo S is over 500 meters away). The building is situated 350 meters away from Oslo City which contains a grocery store, ATM, medical offices and pharmacies, 180 meters to Grønland post office and 19 meters to the nearest hairdresser. All of this combined results in full score for the relevant credits. 400 bicycle parking spaces with an easy accessible entrance is planned along with showers, changing rooms with lockers and drying area for wet clothes in relation to how many people are to use the building. Opportunities for expansion of bicycle parking and wardrobes may be situated in the optional floor U2. The only parking spaces imbedded in the building are for bikes, HC vehicles and electric cars. Besides this; no ordinary parking spaces will be facilitated in this project.

Water (Wat) - 4%

Toilets are intended with dual flush control and a maximum flush volume of 4 liters. Unisex toilets should be considered so that the options with waterless urinals are not applicable since they generally provide the largest savings. Monitors are to be installed on the main water supply cable going in to the building and to each rental unit in the retail section. There will also be installed a leak detection system from mains and into the building. Solenoid valves will shut off the water supply to the sanitary equipment when needed.

Materials (Mat) - 11%

Material reduction and the use of materials with low carbon footprint will be important measures to reach a 50% reduction of CO_2 emissions from the use of materials (3 credits) which also contributes to FutureBuilts targets (50% overall reduction). It will be possible to achieve 2 credits for material performance and one credit for obtaining EPDs (Environmental Product Declarations). Furthermore a credit can be achieved for carrying out a LCA (Life Cycle Assessment). It is not applicable to use recycling of facades, structural framework or use recycled aggregate in this project. To comply with requirements for responsible procurement, requests for the certificates should be implemented in the descriptions and will be incorporated in procurement practices of contractors and subcontractors. The project will take measurements to protect areas of the construction that are exposed to damage, wear, degradation or moisture damage. However the project has not envisaged any particularly exposed areas.

Waste (Wst) - 6%

The project is designed with a 90m2 area for 6 different fractions of recyclable waste as well as residual waste. The ramp down to Oslo Spektrum will be extended to be used for this project so that the necessary vehicles have access to pick up waste. Food waste will be stored in a cold room or in refrigerated containers pending transportation to a composting facility.

Land and Ecology (LE) - 4%

The area is very likely contaminated and must be disposed of accordingly. Ground investigations must be carried out with a report and action plan to be followed. Ecological value will be increased by using local plants in open areas in the building at the east and north-facing atrium with sand, stone and moss for filtering water and snowmelt. A qualified ecologist is to assess the ecological value of the area and draw up a management plan to be followed. The rest of the additional criteria are the responsibility of the contractor, but must be described in the contract.

Pollution (Pol) - 6%

CO_2 heat pumps are to be used in this project, in which the CO_2 is extracted from the atmosphere. Any leak would therefore not add pollution to the atmosphere. CO_2 heat pumps contain high pressure, much higher than for example systems utilizing HFC, that the entire system is designed not to have uncontrolled releases. System / installation requirements shall be in accordance with the stated standards in the compliance notes. Almost all energy to the building comes from the building integrated solar plant. Any peak load beyond this will come from district heating. District heating will be based on 100% renewable energy sources by 2020. This provides the opportunity for innovation points. Flood risk is not analyzed at this stage, but an analysis can generate possible credits. All water that runs of cars etc. in the basement is to be pumped out to an oil separator class 1. It is necessary to install an oil separator because delivery trucks and HC cars parking or maneuvering may spill some oil. All other Rainwater and snowmelt is entirely used in the building and other surfaces covered by sedum. It should not be a problem to limit light pollution at night with automatic time and brightness control. Since the building is located in a city center with a lot of noise, the building will not likely add more noise to the surrounding areas. However noise impact assessment must be prepared and measurements must be taken before initial groundworks.

Innovation credits - 8%

Described under each chapter.

ECO-EFFICIENCY

BREEAM-NOR - pre-assessment estimator - result

BREEAM NOR RESULTATER

Resultater fra analysen

Miljøområdene		Tilgjengelig poeng	Poeng fra Pre-analyse Poeng	Poeng fra Pre-analyse %	Scenario 1 Poeng	Scenario 1 %	Scenario 2 Poeng	Scenario 2 %	Vekting (%)	Oppnådd Preanalyse	Scenario 1	Scenario 2
Man	Ledelse	17	17	100 %	0	0 %	0	0 %	12	12 %	0 %	0 %
Hea	Helse og innemiljø	19	17	89 %	0	0 %	0	0 %	15	13 %	0 %	0 %
Ene	Energi	23	23	100 %	0	0 %	0	0 %	19	19 %	0 %	0 %
Tra	Transport	9	9	100 %	0	0 %	0	0 %	10	10 %	0 %	0 %
Wat	Vann	8	6	75 %	0	0 %	0	0 %	5	4 %	0 %	0 %
Mat	Materialer	12	10	83 %	0	0 %	0	0 %	13,5	11 %	0 %	0 %
Wst	Avfall	7	6	86 %	0	0 %	0	0 %	7,5	6 %	0 %	0 %
LE	Arealbruk og økologi	10	4	40 %	0	0 %	0	0 %	10	4 %	0 %	0 %
Pol	Forurensning	12	9	75 %	0	0 %	0	0 %	8	6 %	0 %	0 %
Inn	Innovasjon	10	8	80 %	0	0 %	0	0 %	10	8 %	0 %	0 %
Sum		**127**	**109**		**0**		**0**			**93,8 %**	**0,0 %**	**0,0 %**
BREEAM-klassifisering									*Uten hensyn til minstekrav, basert på sum*	*Outstanding**	*Fail*	*Fail*
									Med hensyn til minstekrav	**Outstanding***	**Fail**	**Fail**

Minstekrav oppnåd fra Preanalyse

BREEAM-NOR Minste antall poeng		Pass	Good	Very Good	Excellent	Outstanding
Man 1	Teknisk driftsstart	2	2	2	2	2
Mat 1	Materialspesifikasjon (unngå miljøgifter)	x	x	x	x	x
Hea 4	Høyfrekvent lys	1	1	1	1	1
Man 4	Brukerveileder		1	1	1	1
Hea 8	Ventilasjonsløsning for å sikre innendørs luftkvalitet			2	2	2
Hea 9	Forurensning i innemiljø			2	2	2
Hea 20	Fuktsikring			2	2	2
Ene 2	Delmåling av betydelig energibruk			1	1	1
Ene 1	Energieffektivisering				13	13
Ene 23	Bygningskonstruksjonens energiytelse				2	2
Man 3	Byggeplassen				4	4
Ene 5	Energiforsyning med lavt klimagassutslipp				3	3
Wst 3	Lagring av gjenvinnbart avfall				1	1

Minstekrav oppnåd fra Scenario 1

BREEAM-NOR Minste antall poeng		Pass	Good	Very Good	Excellent	Outstanding
Man 1	Teknisk driftsstart	0	0	0	0	0
Mat 1	Materialspesifikasjon (unngå miljøgifter)	x	x	x	x	x
Hea 4	Høyfrekvent lys	0	0	0	0	0
Man 4	Brukerveileder		0	0	0	0
Hea 8	Ventilasjonsløsning for å sikre innendørs luftkvalitet			0	0	0
Hea 9	Forurensning i innemiljø			0	0	0
Hea 20	Fuktsikring			0	0	0
Ene 2	Delmåling av betydelig energibruk			0	0	0
Ene 1	Energieffektivisering				0	0
Ene 23	Bygningskonstruksjonens energiytelse				0	0
Man 3	Byggeplassen				0	0
Ene 5	Energiforsyning med lavt klimagassutslipp				0	0
Wst 3	Lagring av gjenvinnbart avfall				0	0

Minstekrav oppnåd fra Scenario 2

BREEAM-NOR Minste antall poeng		Pass	Good	Very Good	Excellent	Outstanding
Man 1	Teknisk driftsstart	0	0	0	0	0
Mat 1	Materialspesifikasjon (unngå miljøgifter)	x	x	x	x	x
Hea 4	Høyfrekvent lys	0	0	0	0	0
Man 4	Brukerveileder		0	0	0	0
Hea 8	Ventilasjonsløsning for å sikre innendørs luftkvalitet			0	0	0
Hea 9	Forurensning i innemiljø			0	0	0
Hea 20	Fuktsikring			0	0	0
Ene 2	Delmåling av betydelig energibruk			0	0	0
Ene 1	Energieffektivisering				0	0
Ene 23	Bygningskonstruksjonens energiytelse				0	0
Man 3	Byggeplassen				0	0
Ene 5	Energiforsyning med lavt klimagassutslipp				0	0
Wst 3	Lagring av gjenvinnbart avfall				0	0

Oppnådd BREEAM-klassifisering i raden "med hensyn til minstekrav" er den gjeldende klassifiseringen for prosjektet. Denne tar hensyn til hvilke minstekrav som er oppnådd i pre-analysen.

Raden "uten hensyn til minstekrav" viser hva som er mulig å nå utifra poengstatus. Hvis denne viser en kategori som er høyere enn raden under, kan tabellene til venste brukes til å finne hvilke minstekrav som ikke er oppnådd.

Kommentar

The full pre-assessment estimator is attached digitally.

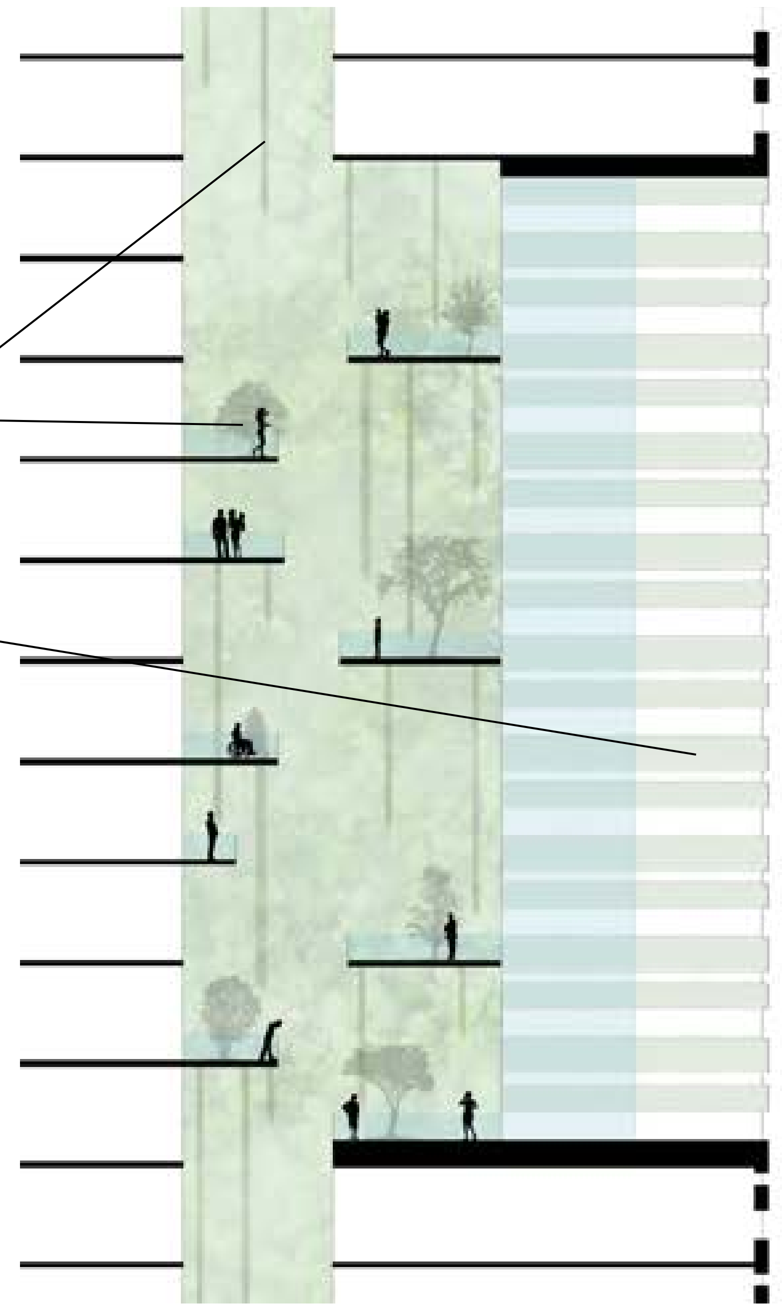
ECO-EFFICIENCY
Biodiversity - in the building

Our biodiversity strategy is to increase the biodiversity on the property and use this biodiversity for ecosystem services such as improved indoor climate, reduced cooling energy and watering of the plants from rain harvesting. Ecosystem services are the direct and indirect contributions of ecosystems to human well-being and support directly or indirectly our survival and quality of life.

We do this by making a unique, green cave which performs both as a symbolic feature and as a supportive part of the building's technological system.

The outer part of the grotto with it's moss panels, turns the inside out, and will work as a starting point for making varying micro climates in addition to having a visual effect from the outside.

three layers of green in the grotto:
- The intimate green:
shrubs and plants on the balconies
- The big green:
hanging and climbing plants filling the height of the grotto
- The system green:
moss panels on the façade as part of the outside of the grotto



Examples of plants in grotto:

Areca palm *Chrysalidocarpus lutescens*

Ficus *Ficus macleilandii 'Alii'*

English ivy *Hedera helix*

Boston fern *Nephrolepis exaltata 'Bostoniensis'*

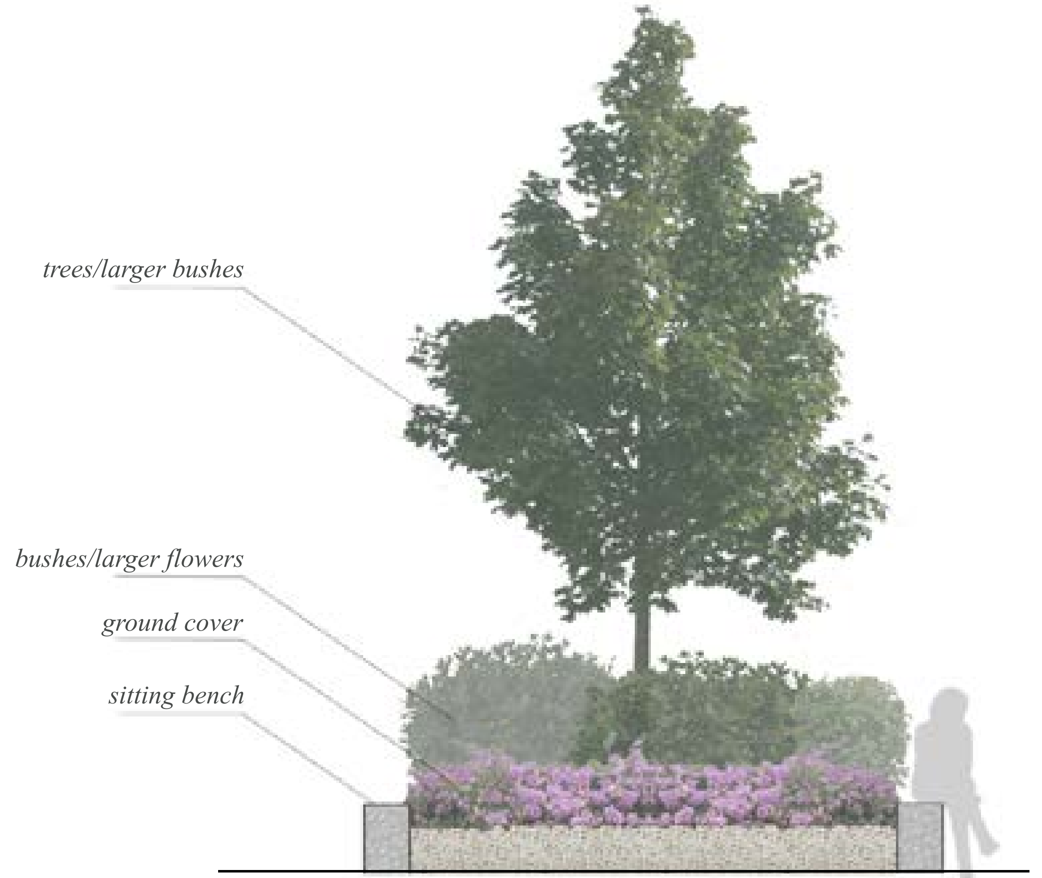
ECO-EFFICIENCY
Biodiversity - in the immediate surroundings

Akerselva
Akerselva and the nature along the river are characterized as a biologically important ore with regional value for bio-diversity. It represents an important living environment for birds and fishes, like, amongst other things, being an important wintering area for waterbirds, and for sea trout and salmon wandering upstream to spawn. It functions as a significant green corridor through the city which birds and plant species can spread along.

Varied and continuous vegetation should be developed/re-established along the river where there is lacking today. Variation in tree-species helps to increase diversity and the use of native bushes and trees builds on and strengthens the existing diversity. It should be considered to re-establish a zone of natural herb-/swamp vegetation alongside the river, as such transition zones are important for the living environment.

We propose planting native species as Hazel/Hassel (*Corylus Avellana*), Willow/Selje (*Salix Caprea*), Rowan/Rogn (*Sorbus Aucuparia*), Buckthorn/Hegg (*Prunus Padus*), Honeysuckle/Leddved (*Lonicera Xylosteum*) and rosebushes which are common along Akerselva.
As a part of opening up the Vaterland Park to its surroundings, the existing linden trees are proposed to be replanted in an irregular pattern across the park to gain openness across. The trees will function as the "top layer" in the wide planters, having layers of ground cover and bushes added to them.

Following are a few examples of the uses of local plants, as habitats or food source for insects, birds and mammals:
- Rowan/Rogn (*Sorbus Aucuparia*) can provide an abundance of fruit for wildlife. It is tough plant which birds adores, and it has 28 associated species of insects.
- Buckthorn/Hegg (*Prunus Padus*) The fruit is fairly bitter, but the birds don't seem to mind.
- Linden tree/Lind (*Tilia Cordata*) Have sweet leaves and flowers rich in nectar with delicious smell which are a magnet for bees.
- Turkish rocket/Russekål (*Bunias Orientalis*) is a very vigorous and tough creature. It's edible, with mild cabbage flavour.
- Elderberry/hyllebær (*Sambucus species*) serves nectar and berries to birds and humans.
- Roses/nyperoser (*Rosa Rugosa*) serves as shelter for birds and small mammals, general nectar source, fruits and fragrance.



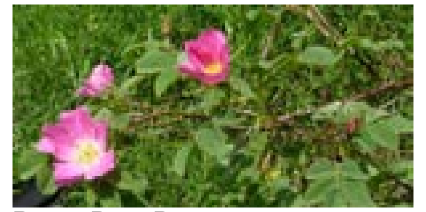
Circular concrete planters:
are of three sizes/diameters:
S (5m), M (7,5m), and L (10M) and filled with layers of vegetation, and the sizes of plants are selected for each size.

Layers in the planters:
- Canopy/tall tree layer
- Sub canopy/large shrub layer
- Shrub layer
- Herbaceous layer
- Groundcover/creeper layer
- Underground layer
- Vertical/climber layer

Examples of plants in the park:

Rowan *Sorbus Aucuparia*

Buckthorn *Prunus Padus*



Roses *Rosa Rugosa*

Roses *Rosa Dumalis*

Honeysuckle *Lonicera xylosteum*

OSLOSOLAR

URBANISM

OsloSolar places itself upon the urban network, becomes part of it, and transforms the area – making a new urban place with the cyclist in focus and Vaterland Park as a square for the neighbourhood. Existing linden trees are moved and spread out on the square, loosening up the strictness of the place. Each tree becomes a place to be, with layers of diverse plants native to Akerselva area, enhancing biodiversity.
The square folds down towards the river with both hard and soft surfaces. The slope can function as an atrium for concerts and outdoor movie theatre on special occasions, and as a park for morning yoga, exercise, barbecue etc. on a regular day.

The Urban+ project draws on the advantages of a site ideal for continuing the high rise structures of down town Oslo and in being close to all transport lines in and out of the city, giving easy connections between home and workplace. The challenge thus lies on the ground floor, how the building can give a new spur to an area now suffering from being a place of vagrants and feelings of unsafety at night. The lack of program on the ground floor of the existing buildings surrounding the Vaterland Park creates dead facades and little bustle.

As a programmatic response to the urban context, we propose a building with an urban lobby, public activities on the two first floors and a green, urban "grotto".

THE URBAN LOBBY
The urban lobby is accessible both from Lilletorget and Vaterland Park, being a passage through the building which can be accessible at all hours of the day. The urban lobby serves as a bicycle hub with workshops, coffee, and restaurants etc. both for the visitor and the employees. In the proposal there are entrance doors in both ends (as in Operapassasjen) creating a middle zone on ground level, making the space possible for different use depending on program and activities in the building and to close it off during the night.

The passage opens up towards Vaterland Park forming the main entrance for cyclists and pedestrians. The entrance from Stenersgata/Lilletorget will in addition to creating the connection to the park, also function as a drop-off zone for people coming by taxi etc. The reception for the offices has its entrance from the urban lobby, and is a defined space within the building which can be closed off disregarding how the urban lobby is used.
The lobby could also function as a complete outdoor space - like "Strøget" between Torggata and Storgata, but this has to be considered in context with what type of program is put here. Restaurants/bars and cultural venues in the passage will give life to the place at night, but if there are only shops here, there's no point in creating an outdoor, "dead" passage which in turn would make unwanted loitering a possible issue.

URBAN PROGRAMMING
The corners of the two-storey base of the building facilitates for the use of restaurants and/or shops, so that the facades are active towards the streets. Entrances to these spaces are from all sides – Stenersgata/Lilletorget, the lobby, and the park. The project should aspire to rent out spaces to various businesses on the first two floors, securing a lively and varied atmosphere. Fish and vegetables market draws in the people running through on their way from work, high end fish restaurant draws in (for example) business lunches, and the combo coffee-&-bike-workshop draws in the morning fixers, etc. Some small spaces for short term rental would make it possible for a space to be an ice-skate rental during the winter and maybe an office for the Bylarm festival during other parts of the year, allowing cultural venues to pop up.
The atmosphere of the "hub" is created by the businesses settling here. A building managing to be something in between Mathallen (for the foodies), Operapassasjen (for the cultural), and Brugata (for the local), would give new life to the street level, 24/7.

THE TRUCK RAMP
The alley between Spektrum and OsloSolar is kept as it is functioning mainly for delivery, with the ramp and an access pathway. As discussed in the midterm meeting, this part of the design is left for later stages. Delivery to Spektrum will thus be the same, and delivery to OsloSolar will use the same ramp to get to the floors underground.

In this stage of the design process we have discussed two other possible solutions as well:
- *The upgrade*: Treat the alley as a part of the new urban park folded down to perform as a ramp for trucks. The surface will be the same as for the bike ramp by the main entrance and the rest of the park. The idea would be to make one coherent urban field that connects different levels, and welcomes different use.
- *The rebuilding:* Expanding the underground space for truck logistics, removing the trucks completely from the square/park. In this case the urban park will be folded over to make a continuous surface that covers the underground space, and is treated as a small "hill" in front of the building with no use of stairs.
Our proposal shows an attempt to reduce the barriers in the existing situation by replacing the concrete parapet with a slope with vegetation outside Spektrum emergency exit. In this proposal the truck ramp becomes an integral part of the urban field of the new Vaterland Park. The suggested solution might require minor adjustments regarding the logistics in the concert hall.

illustration the Urban Lobby

BICYCLE AS ACTIVATOR
The bike entrance forms part of the main entrance from Vaterland Park. The ramp down to the bike parking is wide and articulated as an integrated part of the architecture. There is a service station for bikes clearly visible from the square in front of the building. It is positioned by the ramp on ground floor and stretches down to facilities also in U1. U1 has wardrobes and shower services, making it easy and comfortable to bike to work. The prominent place of the ramp gives importance to the bicycle and shows the bike as an important part of the building. The ramp will provide a low threshold access to the bike services, promoting the bike as a natural part of everyday life.
In our proposal, the cornerstone of the public program is the new bicycle hub for Oslo. A two storey location putting the everyday bike-use up front, with: bike hotel, air-pump station, hanger rental, docking stations for el-bikes, el-bike rentals, service and a shop; fronting Oslo as a new bike capital.

All the bike parking is equally accessible for visitors and employees, but differentiated to relate to different needs:
- Unsheltered parking in the park for the quick visits
- Sheltered bike parking on the ground floor with access from the alley and direct entrance to the reception
- The main parking and service station for cyclists in the basement with access via a broad ramp from the park
Floor U1 has 350 bike parking lots, if floor U2 is built, the number is doubled. The parking with access from the alley has room for at least 60 bikes and 4 HC-bikes.

Today, the bicycle path coming from the east of Oslo ends at Lilletorget. Oslo is far behind on making bike routes throughout the city, but the focus is there, and this building is ideal as a junction and citymark for cyclists and a new era in the city planning as a whole. People living on the north- and east-side (Sinsen, Gamlebyen, Nordstrand, etc) biking to work, pass this point before scattering all over the town. The site is ideal as a place where “you tank up” before going home; Imagine riding from Sinsen in the morning, parking your bike to get it fixed at the OsloSolar, take the metro to work, pick it up on your way home together with some fresh fish from Flyvefisken.
The municipality of Oslo are planning to continue the bike route into town past Lilletorget in Stenersgata. We propose additional routes crossing the park and in front of the building making an even easier route to Oslo Central Station.
The intersection at Lilletorget between Grønlandsleiret and Christian Kroghs gate is proposed as a shared space where pedestrians are prioritized instead of a regular crossing. The surface has a structure that makes cars slow down, bike routes are marked, and light signals are removed as to enhance people’s attentiveness.
The biking lanes past the building and across the park will be given another surface so the bike traffic is visible and the potential for conflict between pedestrians and bicyclists is minimized.

THE URBAN GROTTO
The urban grotto exposes you to nature both from the inside and outside. It is visible in the facades and from the lobby - and makes the building relate to the surroundings, and towards the park, it keeps an eye on the public life.
The symbiosis between the park and the building will make the whole greater than the parts. The park becomes a corridor for possible bird life in the outside of the urban grotto. A restaurant in the building wanting to focus on local food and permaculture, can grow and harvest from right here.

…AND THE SURROUNDINGS
Putting program and activity on the ground floor in the new building is an evident solution to bring new life to the area, but this should also be followed up by the surroundings. We propose that Lilletorget is formed as a shared space and regains its position as an actual place, and not leftover space, where pedestrians are prioritized. Lilletorget and Vaterland park will flow into each other when the floor is treated as one and the rows of trees are rearranged as to loosen up the visual barrier between the two.
The urban lobby invites from here, the building changes the city floor from dominated by cars to a shared space with universal designed traffical solutions that promote alertness, safety and movement by foot and bike.
Apart from the direct health benefits the park has as a green lung in the city cleaning air, it also gives the people living in the area an opportunity to get in direct contact with nature. Upgrading and opening the park up to a plural, modern urban square, could make citizen ownership and easier let activity spill out from the buildings. A park which offers training apparatuses and barbecue areas are popular places for a wide range of people.

The SAS Radisson hotel wing that is partly responsible for the dead facades along the park, should with the planned extension propose a public program on the ground floor that allows people and light to spill out from that side as well.

Akerselva is open as a waterway to the fjord, but due to shallow water and low height in the culvert, it’s only suitable for small boats and kayaks. A kayak-club situated on the riverbank opposite of Vaterland Park would be a good activator for the area; The park is already connected to the forest area surrounding town, Marka, by walking paths along the river, so bringing to use the connection to the fjord and Bjørvika, would complete the urban-nature loop which lies latent in the site.

Connecting the flea market under the road bridge on the other side of the river, the foot path leading past the park, and the park itself with a lighting concept, could be the smallest intervention, able to make the area around the river as a whole a safe and beautiful attraction at night. There could be held a competition for a lighting scheme that also was to integrate possibilities for outdoor concerts, market place during the weekends, etc.

Though it is on quite a greater scale, Brooklyn Bridge Park is a good example of a very successful upgrading of an area left unused. Lots of space for activities and possibilities to meet and play makes the people living in the area take the place back all hours of the day. In the same way, Vaterland Park has the potential to be such a place.

Cityscape
The height of the building makes it a part of the cluster of high-rise buildings in the centre of the city. The tilted roof gives the skyline a distinct member that softens the appearance of the two others. Though the top point is of the same height as SAS Radisson, the great slope of the roof makes the height relative, and makes it work as a mediator between the tall buildings and the general height of the city. The illustrations show that the tilted roof formally work together with the Radisson Plaza.

Form
The property borders have given the building's footprint, and further, the building is shaped to collect maximum energy from the sun. Two of the sides of the volume are punctuated by the urban grotto, drawing down the scale and giving views into the shape. The PV-panels and glass covering the façades gives the Plaza and OsloSolar a kinship of expression.

The tilted roof is also covered with PV panels. Angled about 45 degrees and faced directly south, the roof receives a maximum of sunlight during a year in Oslo. The roof of the building is placed above the shadows of the two tall buildings south of the site, making the building 110 meters in height with 27 floors.

For setting the height of OsloSolar, we have used Radisson Plaza in the digital map as starting point. Though the Plaza is said to be 117 metres high (c+121), the height of the ridge is c+114 metres in the digital map. So, depending on how you measure, OsloSolar is either just the same height as the Plaza, or 7 metres lower.

ARCHITECTURE
Impact of the building on the surroundings

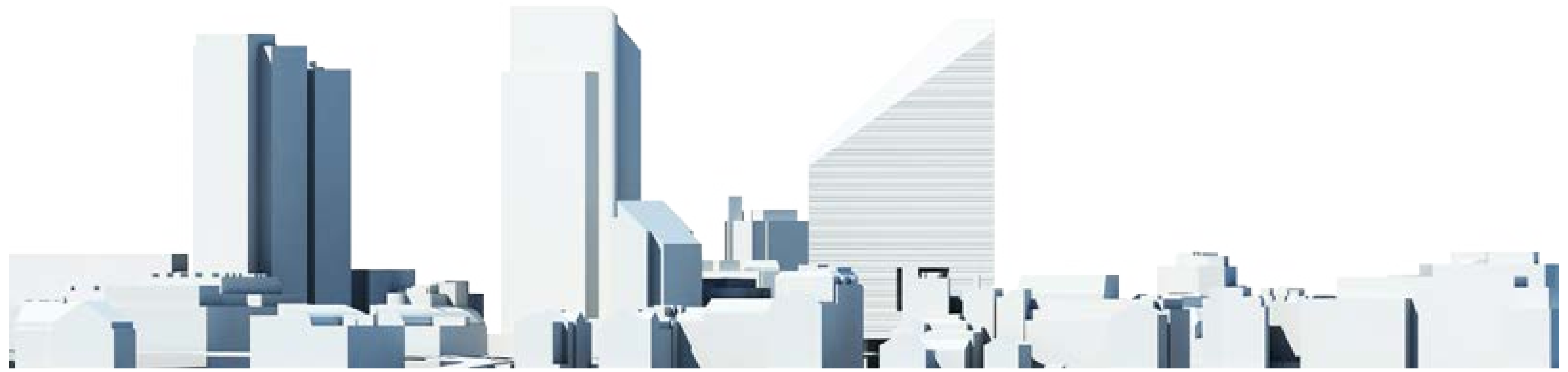
OSLOSOLAR

From West

From North-East

Volumestudies showing the remote effect of OsloSolar.

ARCHITECTURE
Impact of the building on the surroundings



From East

From South

OSLOSOLAR

View from Festningen

View from Tøyenparken

ARCHITECTURE

Impact of the building on the surroundings

Volumestudies showing OsloSolar from adjacent streets.

View from Brugata

View from across Akerselva

ARCHITECTURE

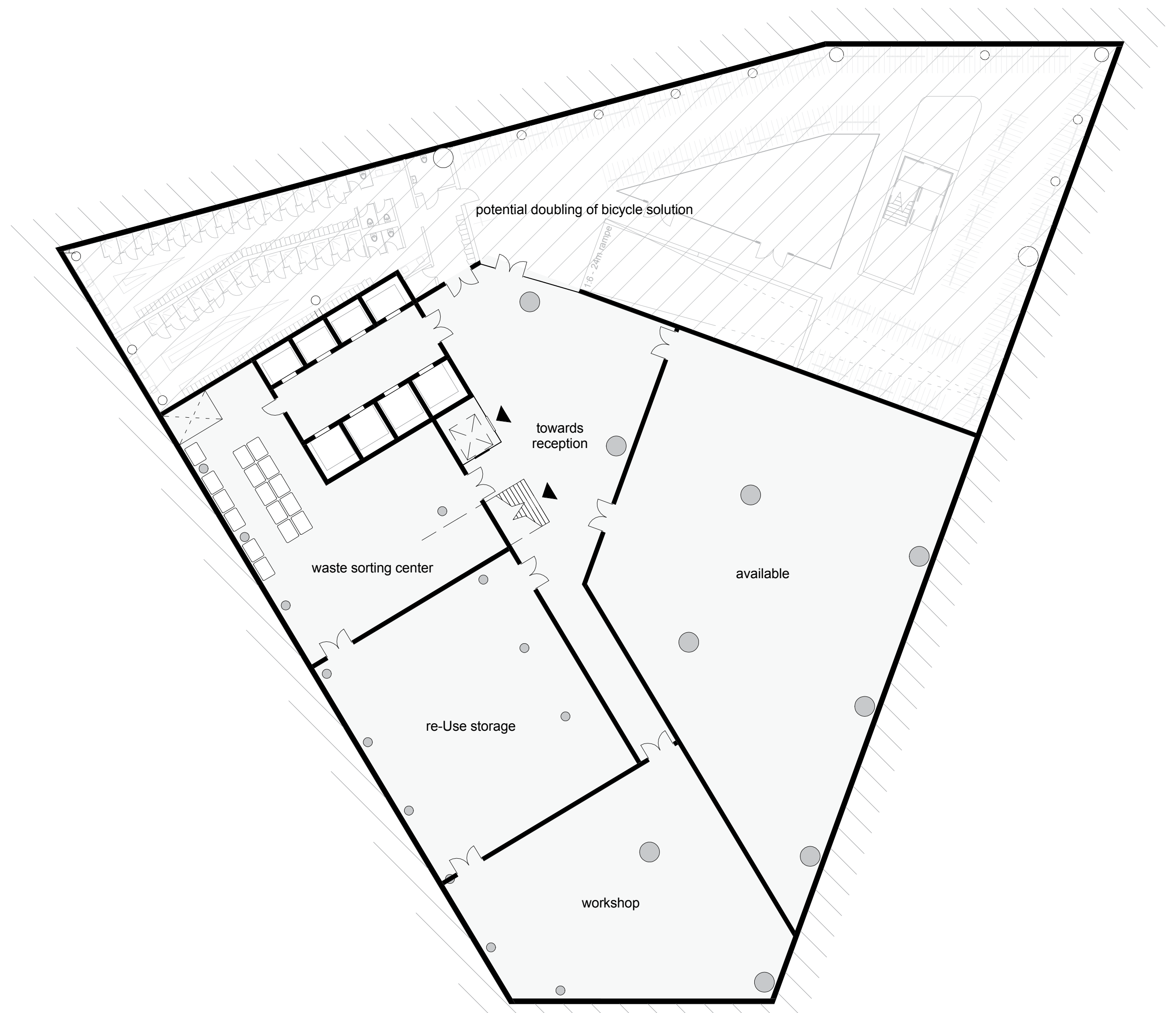
Impact of the building on the surroundings

View from Kroghs gate

View from Stenersgata

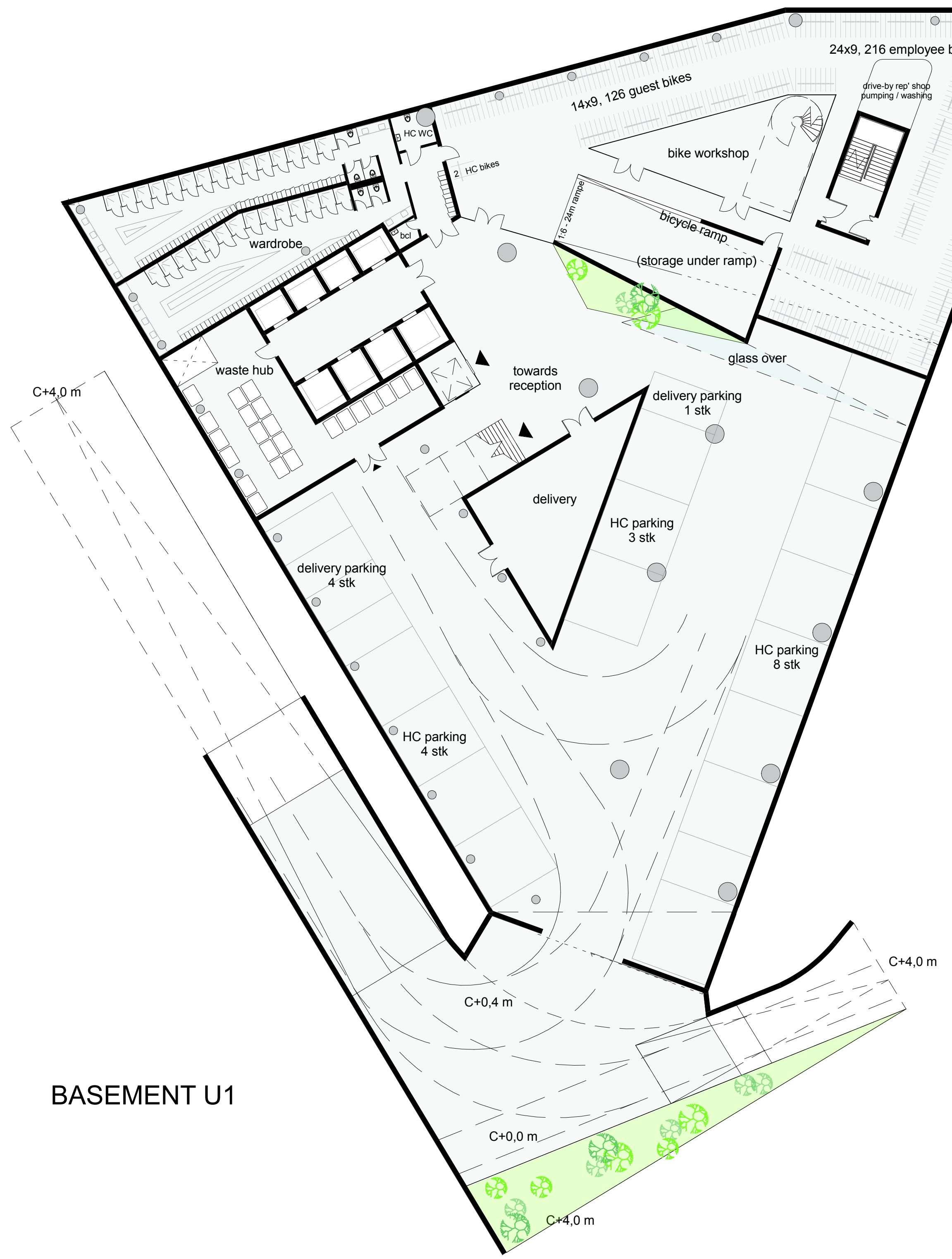
ARCHITECTURE

floor plans 1:400 (A3)



BASEMENT U2

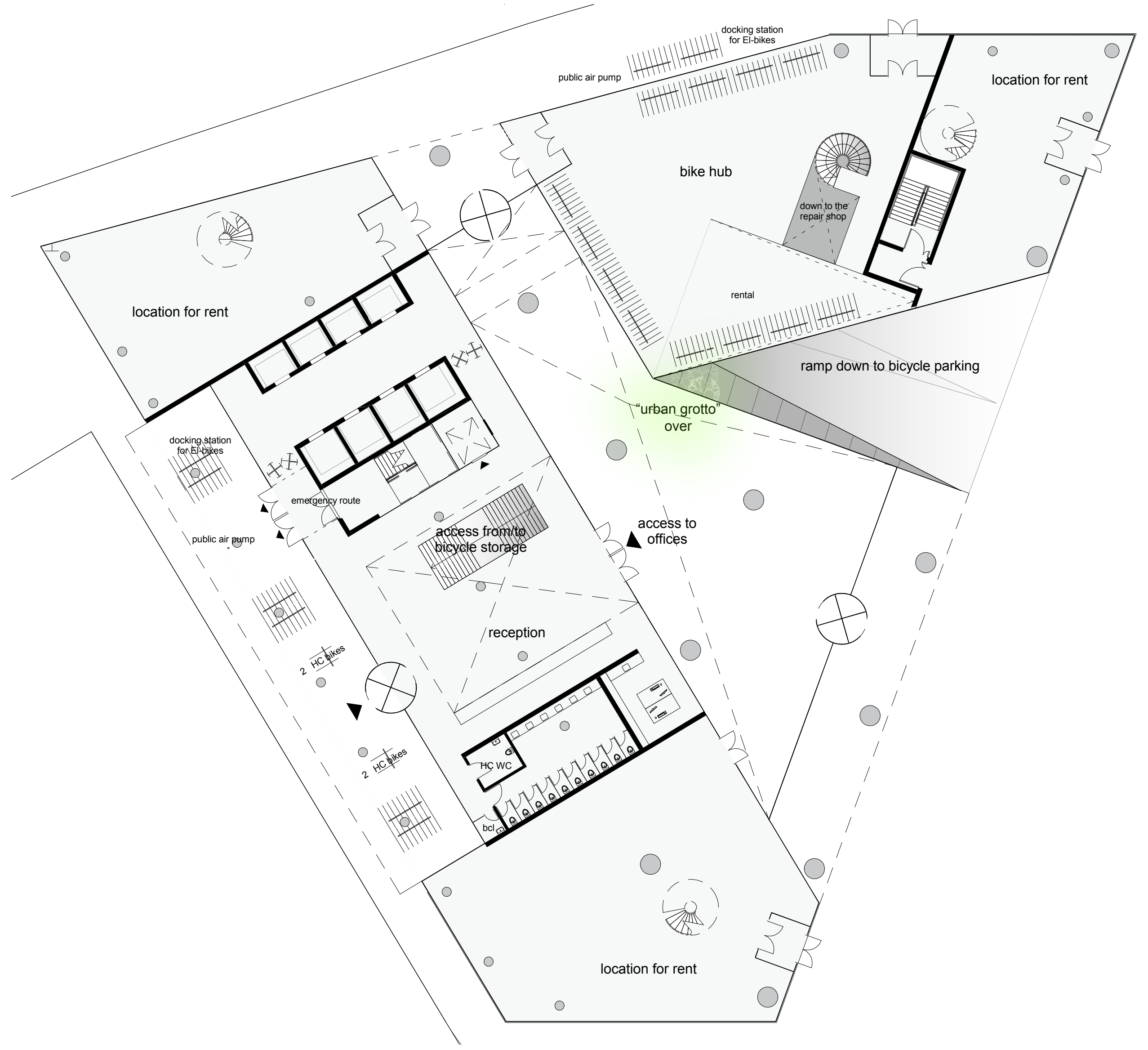
Our proposal is based on building plan U2; giving more room for storage, waste handling, and bike parking. But, as seen in the construction analysis, the plan U2 is not needed for the structure of the building and can be removed.



BASEMENT U1

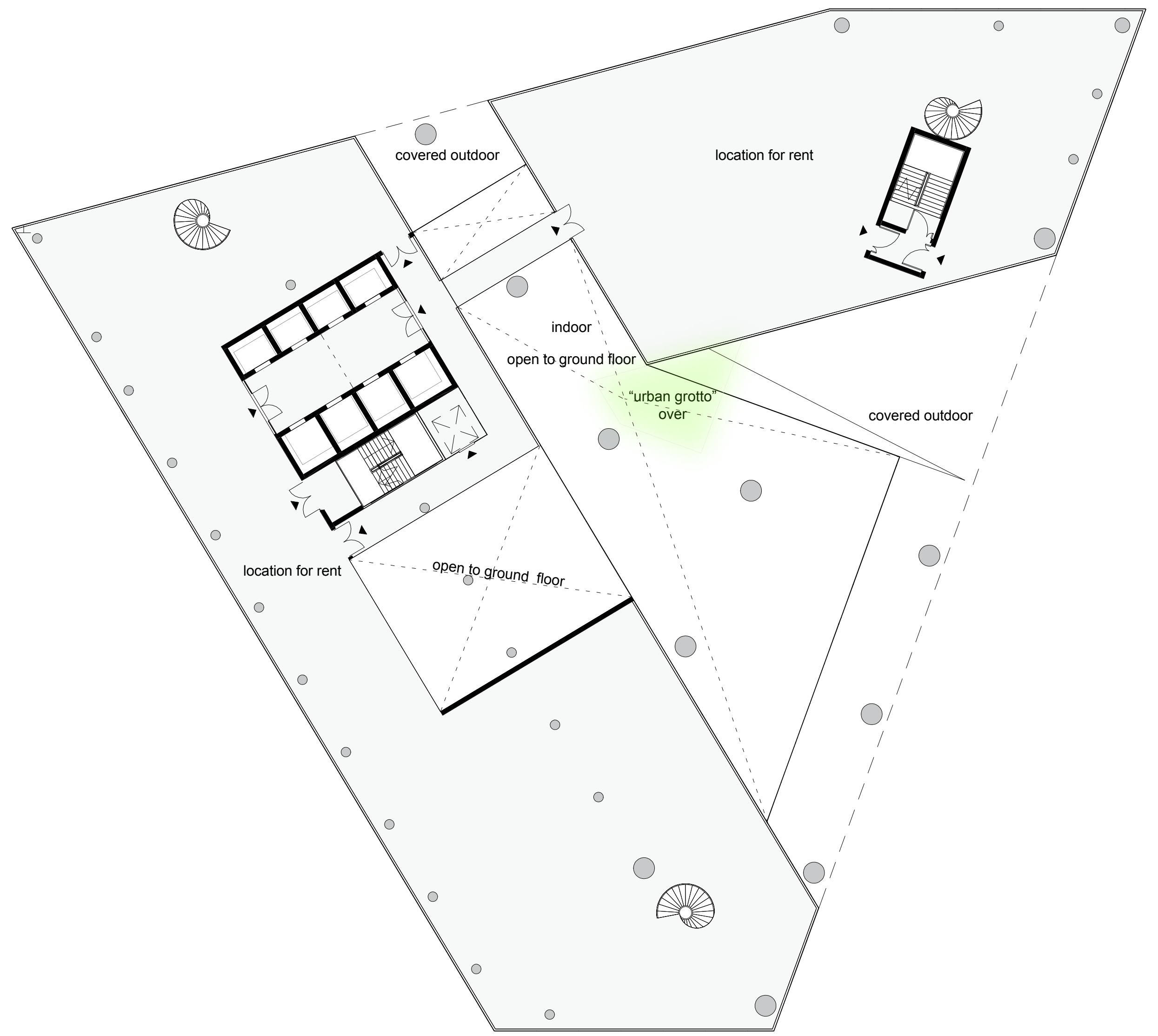
ARCHITECTURE

floor plans 1:400 (A3)



GROUND FLOOR

The lobby will not only be a new urban space in town, but also function as an entrance to prominent offices. The lobby thus should be specific and not generic, and show off some Norwegian, sober grandeur, and at the same time have room for the buzz of everyday life.
The urban grandeur should also be evident in the reception. The reception has entrance both from the alley and from the lobby, an airy place with good overview before you move up to the office floors.



1st FLOOR

ARCHITECTURE
floor plans 1:400 (A3)

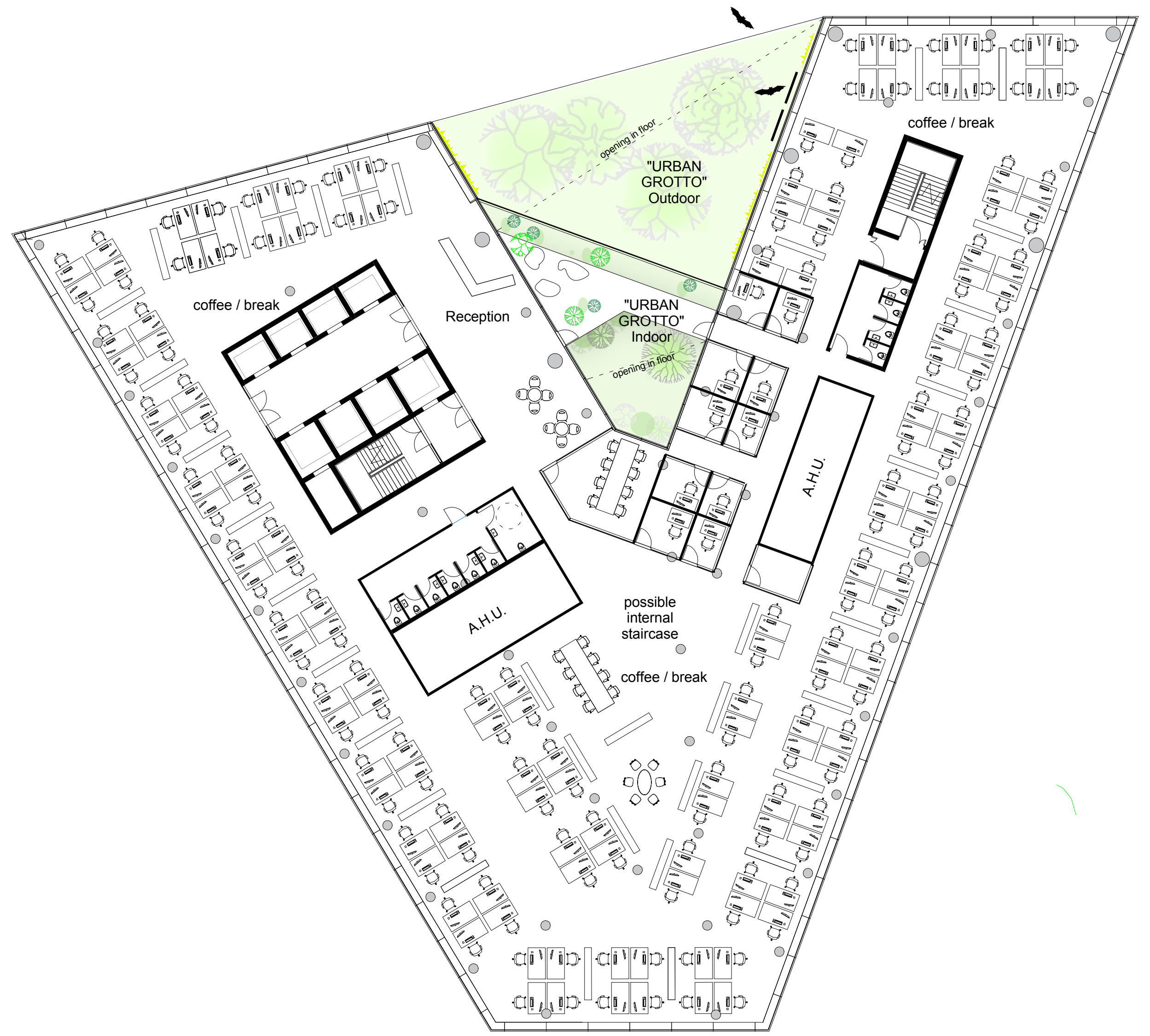
2nd and 3rd FLOOR - offices

Alternatively, 2nd floor could be used as a conference level.

4th to 7th FLOOR - offices

ARCHITECTURE
floor plans 1:400 (A3)

8th to 17th FLOOR - offices



8th to 17th FLOOR - alternative plan

OSLOSOLAR

OFFICE SPACE
The main concept of the floor plans is to have a maximum of areas with good daylight condition along the facade. The organisation of the floor plans allows for efficient use and clear organisation of cell offices or cubicles alongside the façade, with meeting rooms concentrated towards the atrium.

The atrium opens for views over the city and it brings daylight into the deepest parts of the floor. The atrium is articulated as an “urban grotto” with balconies offering space for informal meetings and green lounges. The grotto works as a point of orientation on each floor.

The atrium also gives good conditioning of the interior climate. Both daylight and the air conditioning lungs play an important part in the environmental concept of the building, reducing the energy demand for lightning and cooling and providing “freshness” to the offices.

The typical floorplan is organized in three main zones, each with its own distinct quality. The two wings have different width and offer different qualities and possibilities. The wings meet in an area well suited for an office landscape in the peak of the V-shape.

The three zones are also three independent ventilation systems (three AHUs on each floor). With three systems each floor can be parted in three different zones with three different tenants.

Common areas
Common areas are situated by the reception on each floor, and also as smaller, informal meeting points throughout the plan. The grotto gives another type of meeting place, out of the office zone.

8th to 17th FLOOR ALTERNATIVE: 3 TENANTS

ARCHITECTURE
floor plans 1:400 (A3)

22nd FLOOR - offices

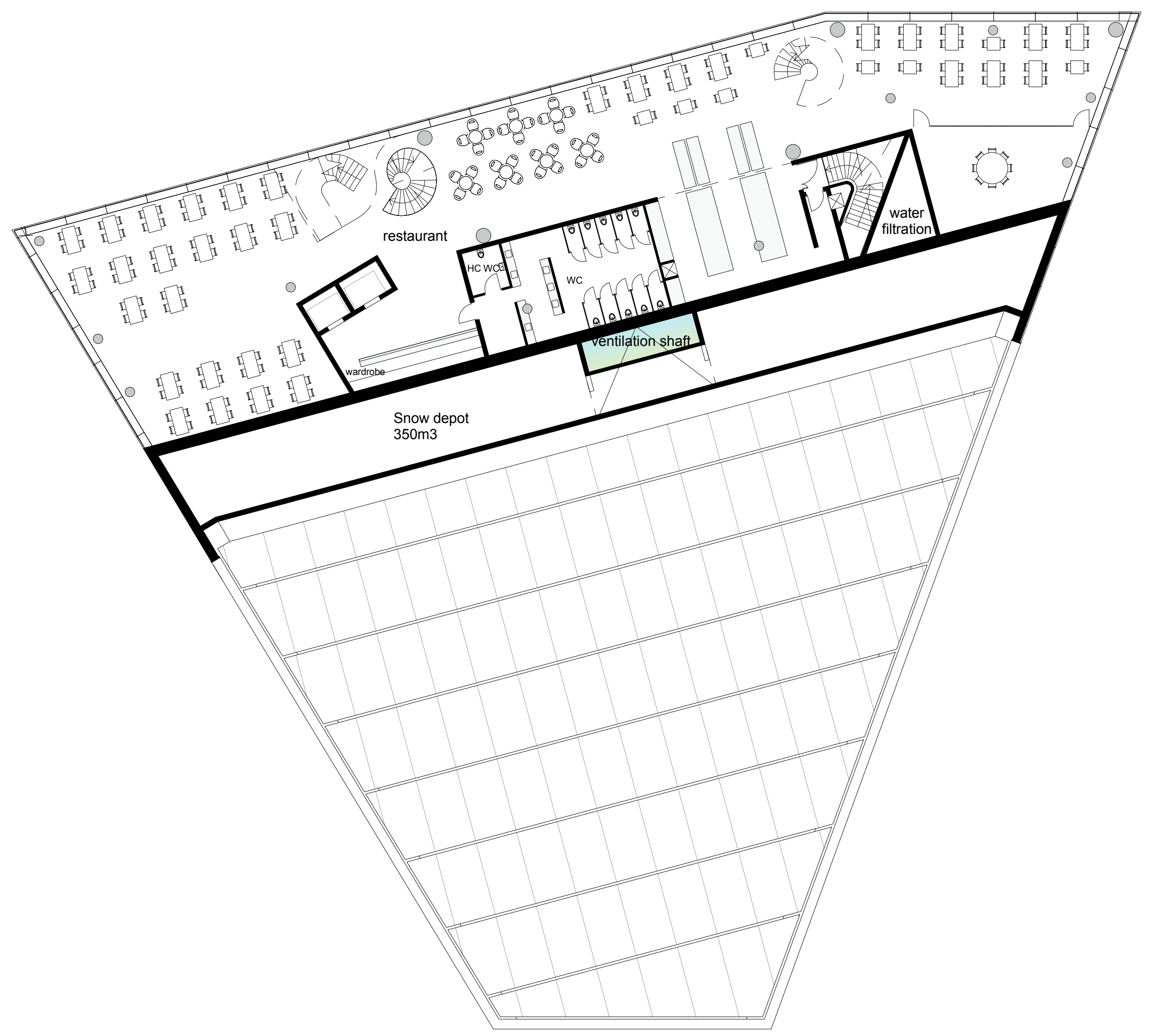
The canteen and restaurants
The geometry of the rooftop allows for airy spaces, maisonettes and views. This “mountain peak situation”, have potential to house an attraction or prominent offices. The proposal is illustrated with restaurants and conference area in the top of the building. The 23rd floor situates the everyday canteen, whilst the 24th and 25th floor shows possibilities for the more formal lunch meetings etc.

23rd FLOOR - canteen / Restaurant

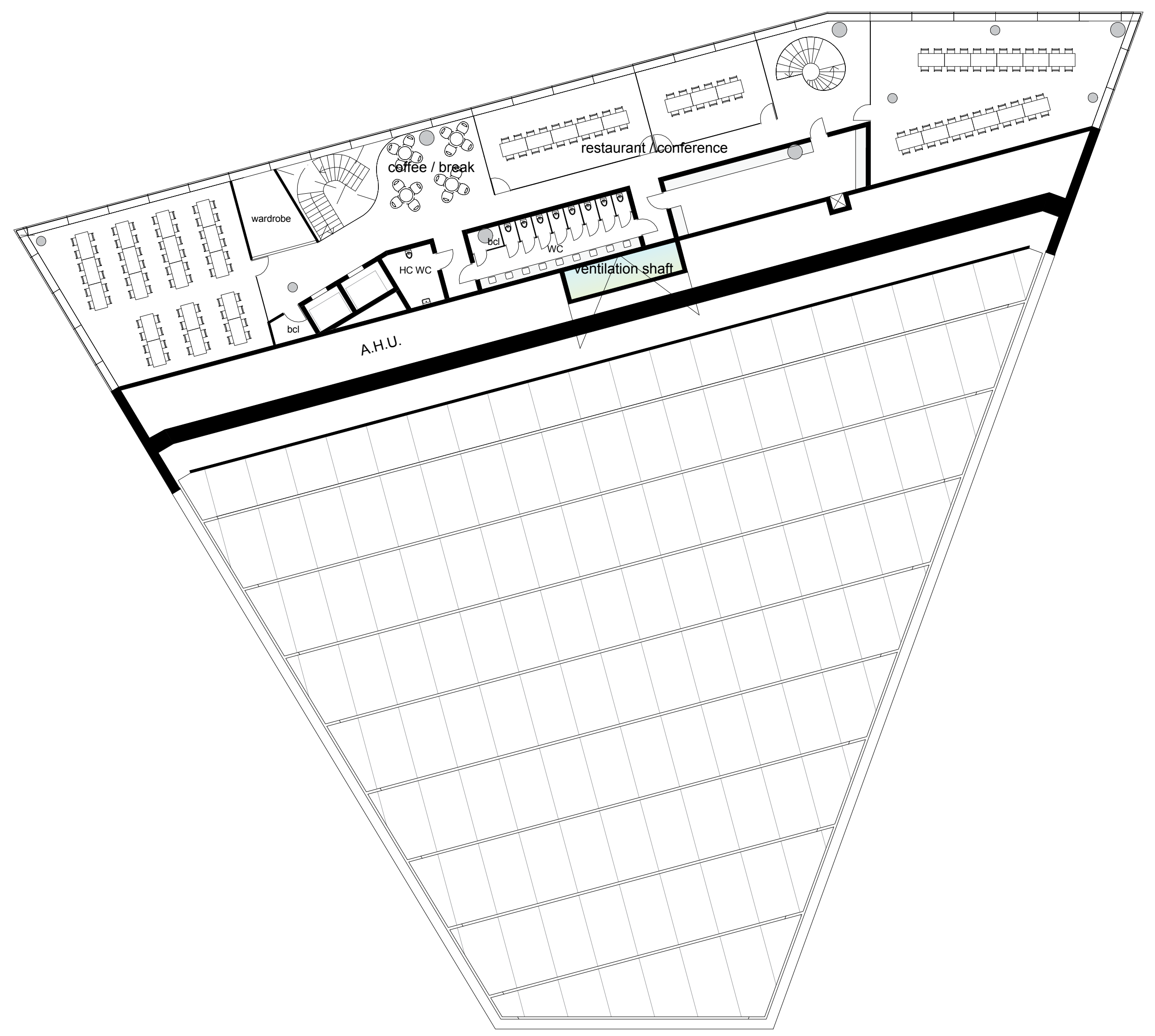
OSLOSOLAR

ARCHITECTURE

floor plans 1:400 (A3)



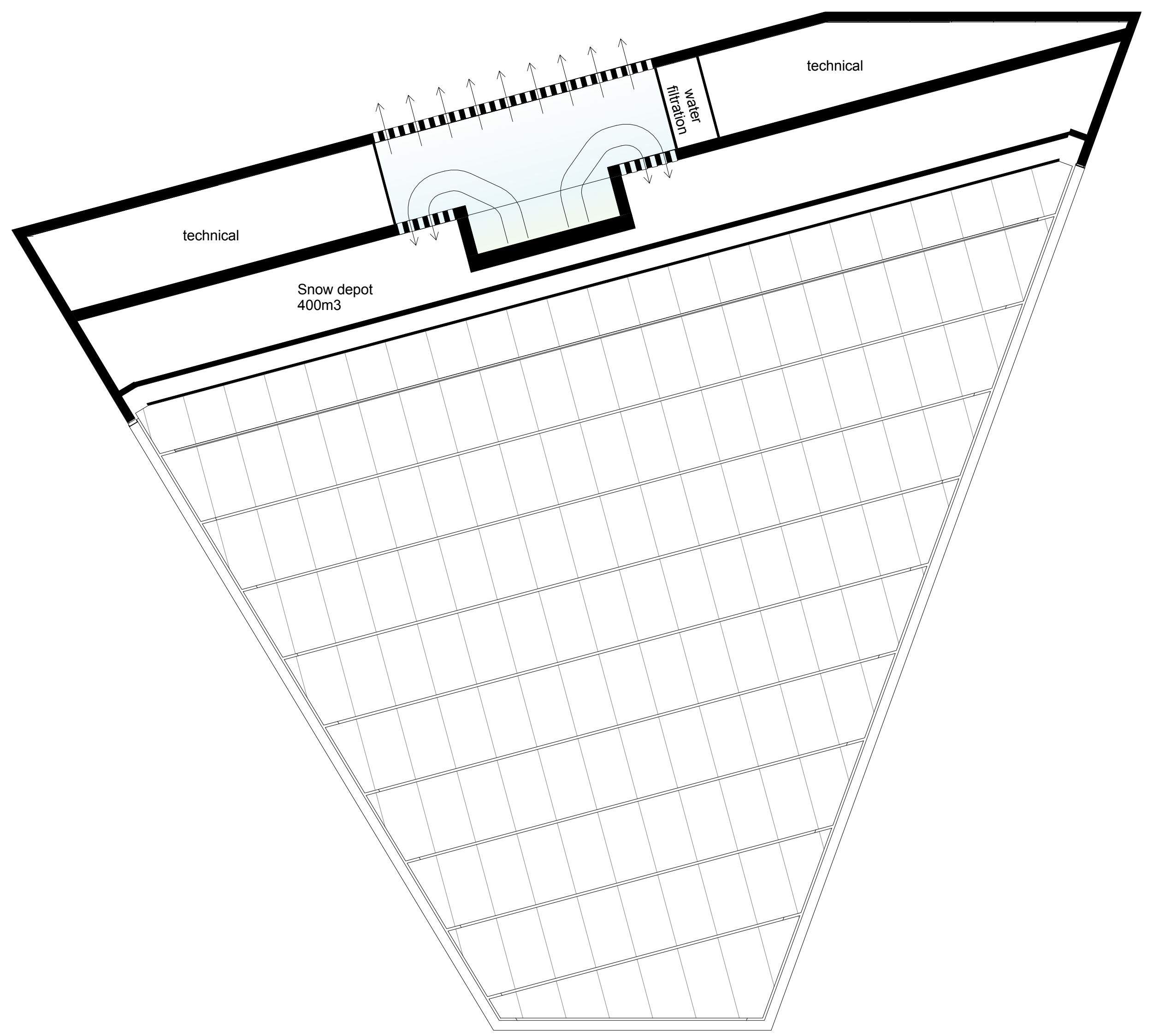
24th FLOOR - canteen / Restaurant



25th FLOOR - conference level

ARCHITECTURE

floor plans 1:400 (A3)



26th FLOOR - technical floor

The Urban Grotto

The atrium is an “urban grotto” of daylight and fresh air running as a green spine through the building. The grotto is an attraction and a central point everything is organized around. The grotto is a place for interaction and inspiration with informal spaces like leisure gardens and lounges.

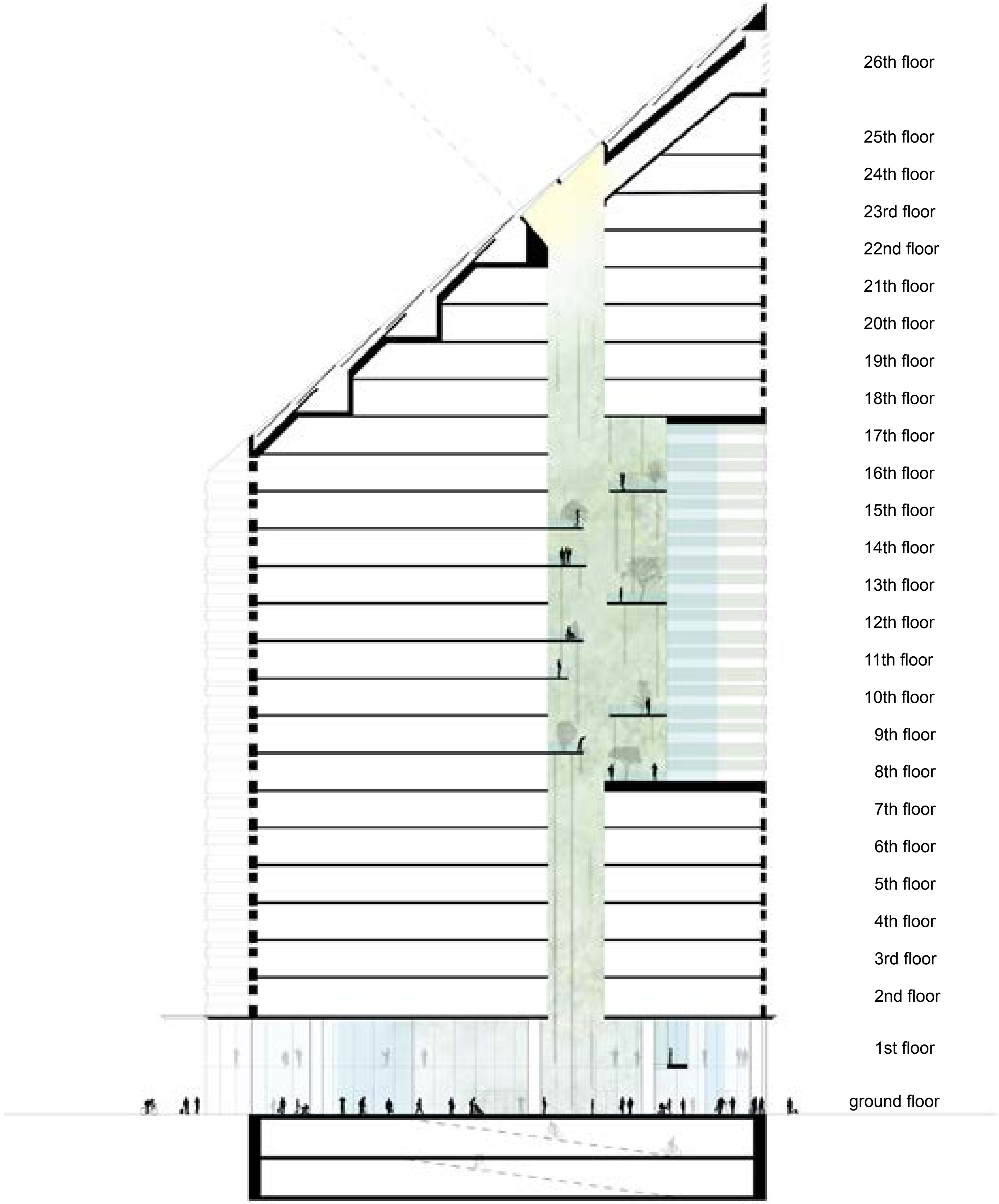
Except in the upper part, each floor has a balcony in the atrium. The balconies are informal spaces for meeting and green lounges. The design of the balconies should allow contact between the different floors.

The atrium has a lower part facing southeast, a part in the middle facing north, and a top part working as a chimney.

Thermodynamically, the lower southeast atrium heats up the air in the morning, the middle part distributes the air, and the chimney on top provides updraft (for further explanation, se technical description).

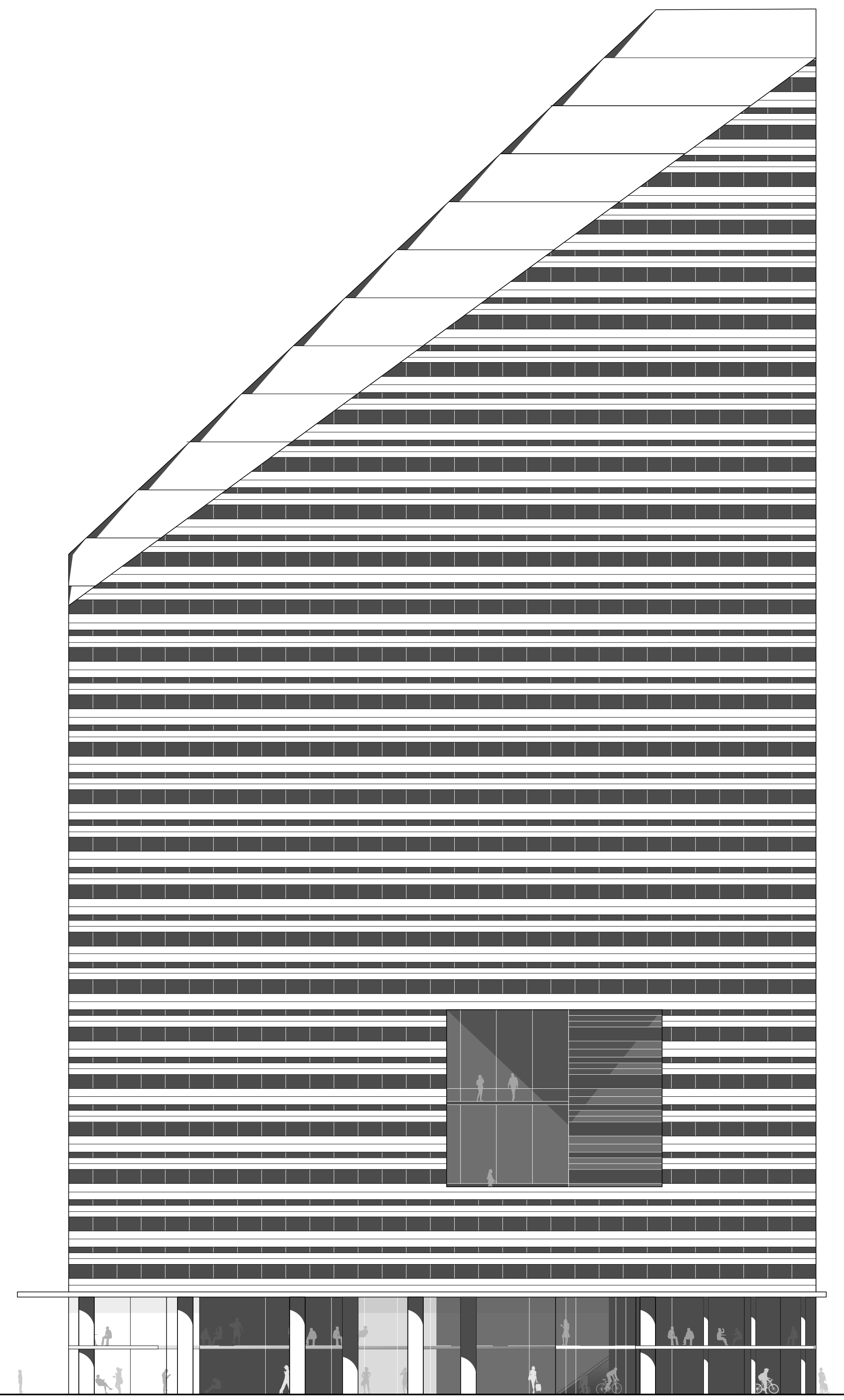
The top part of the atrium is mainly for air exhaust and the speed and quality of the air is not suitable for stay. The space is narrow and not accessible. The atrium has glass walls and a glass roof on the top. The light coming through the roof is mainly for the plants hanging in the atrium, but since the atrium has glass walls, the “grotto” is visible and a point of orientation also in this part of the building.

Section 1:500 (A3)

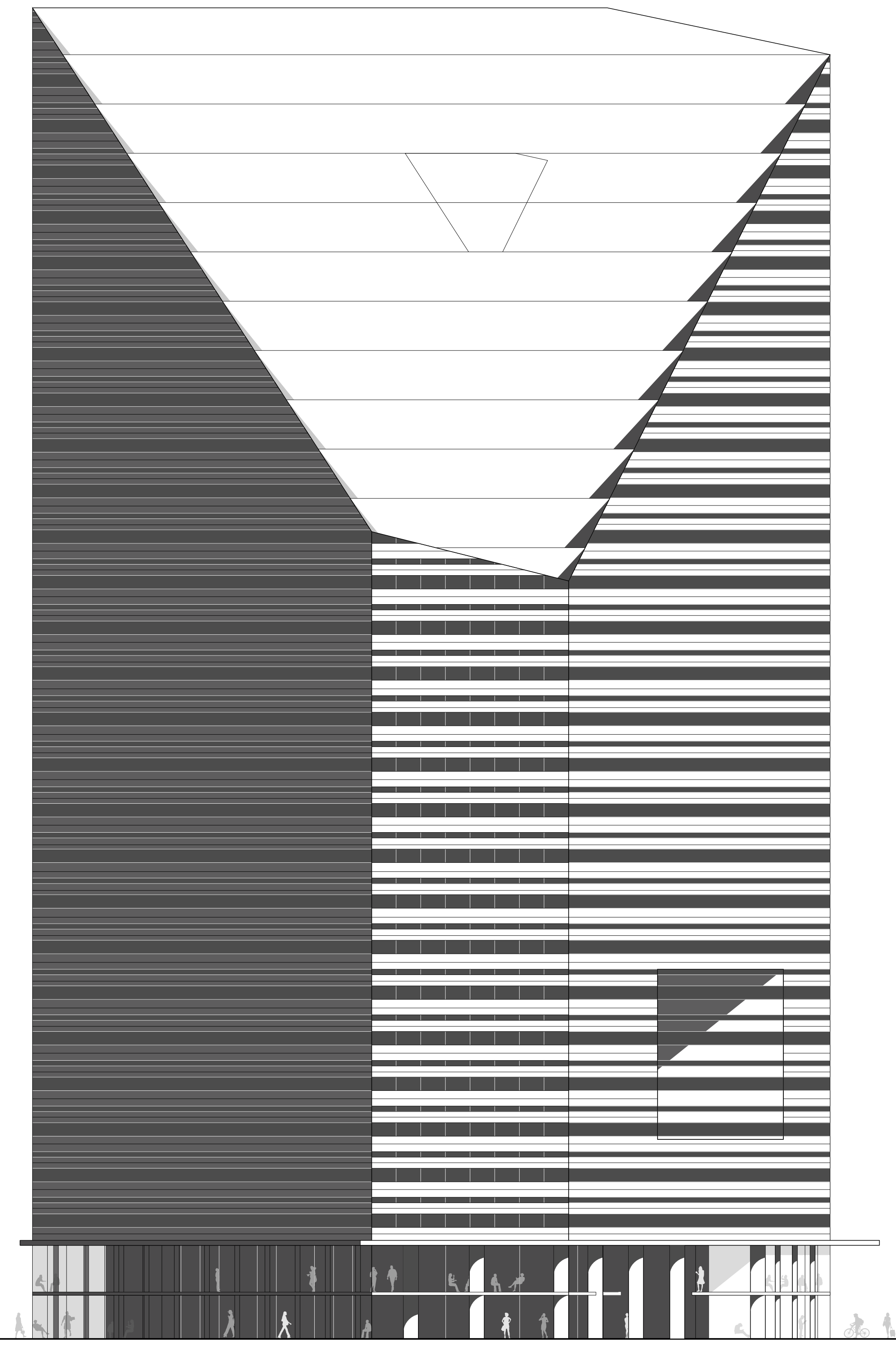


ARCHITECTURE

facades 1:500 (A3)



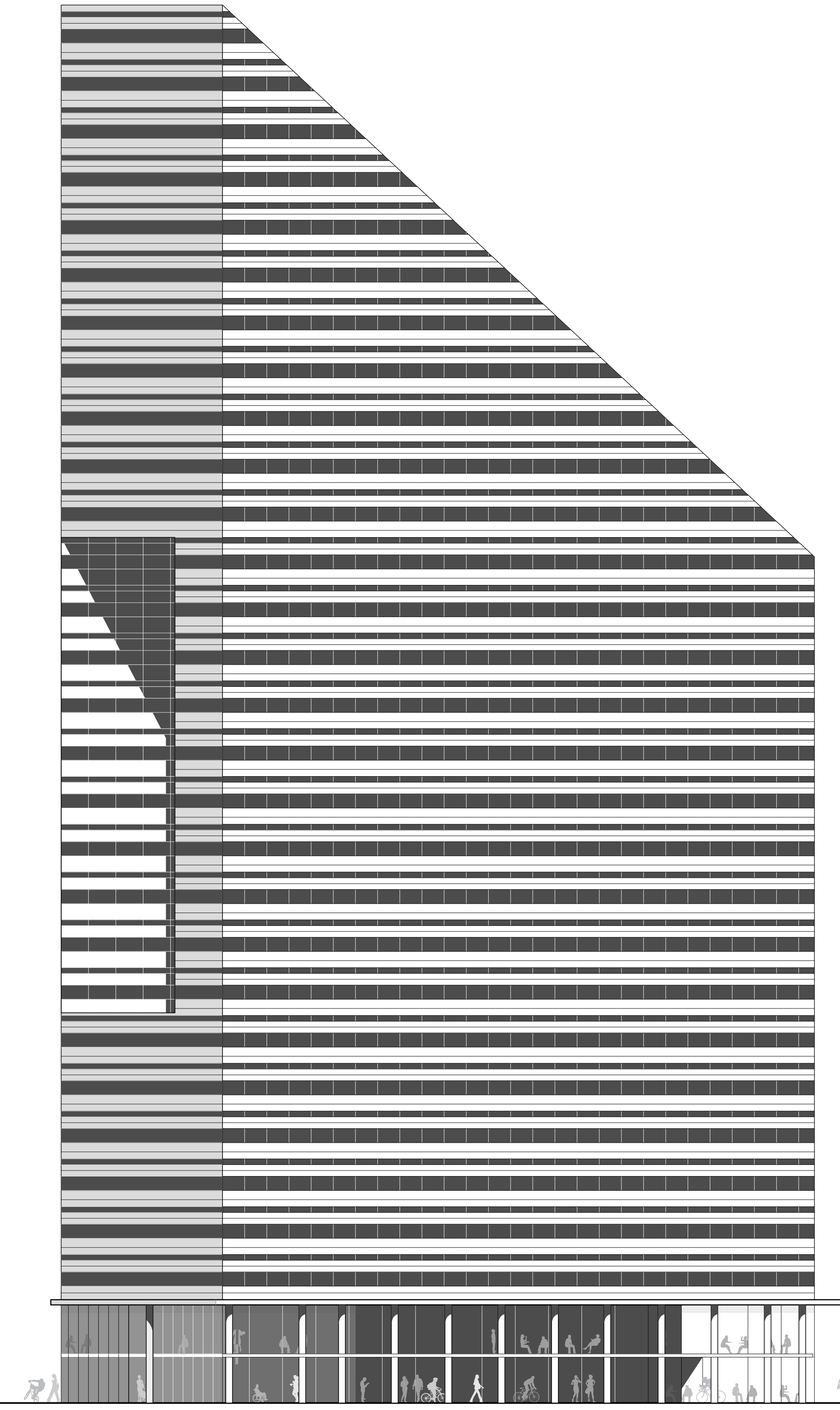
EAST



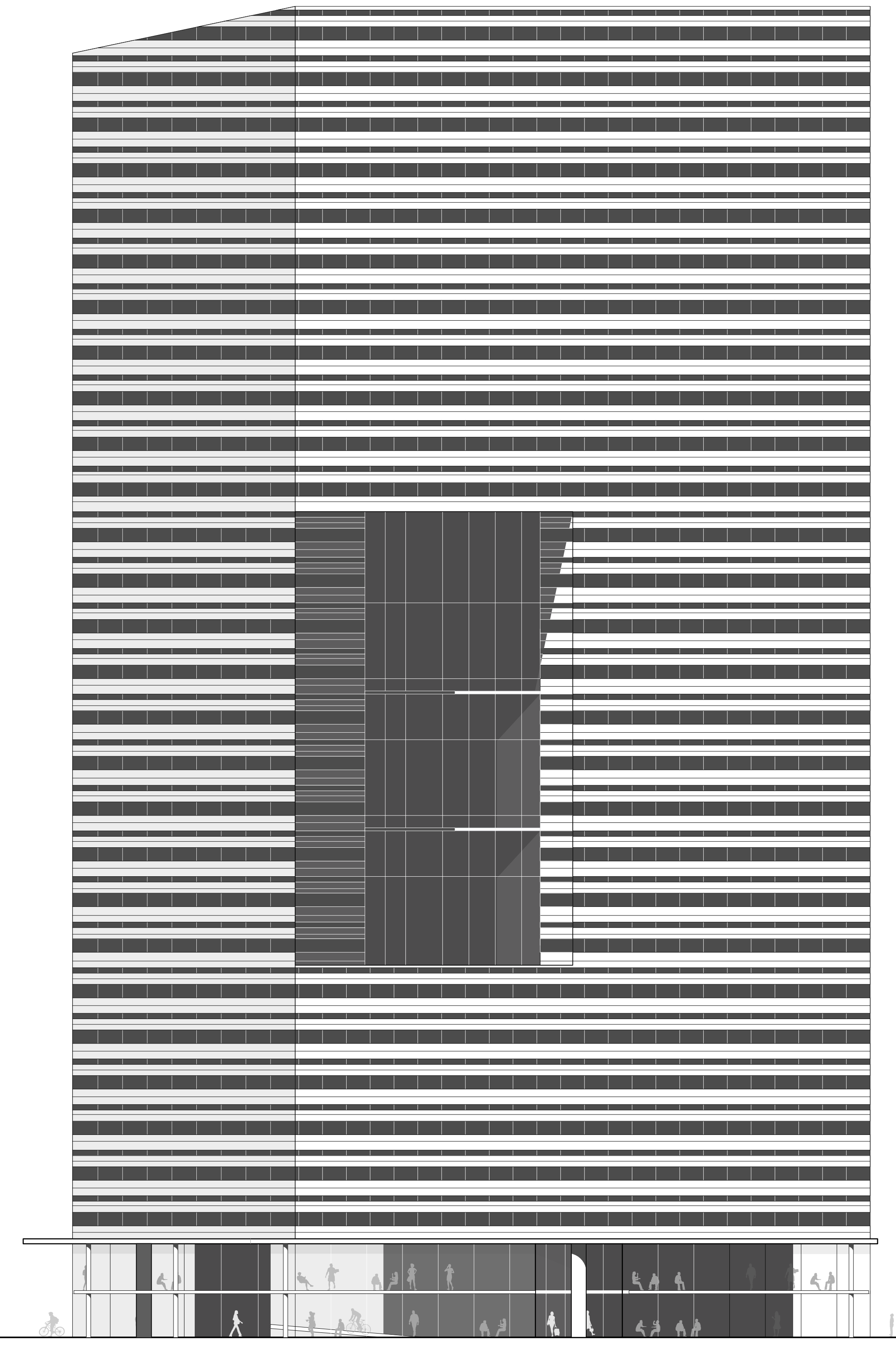
SOUTH

ARCHITECTURE

facades 1:500 (A3)



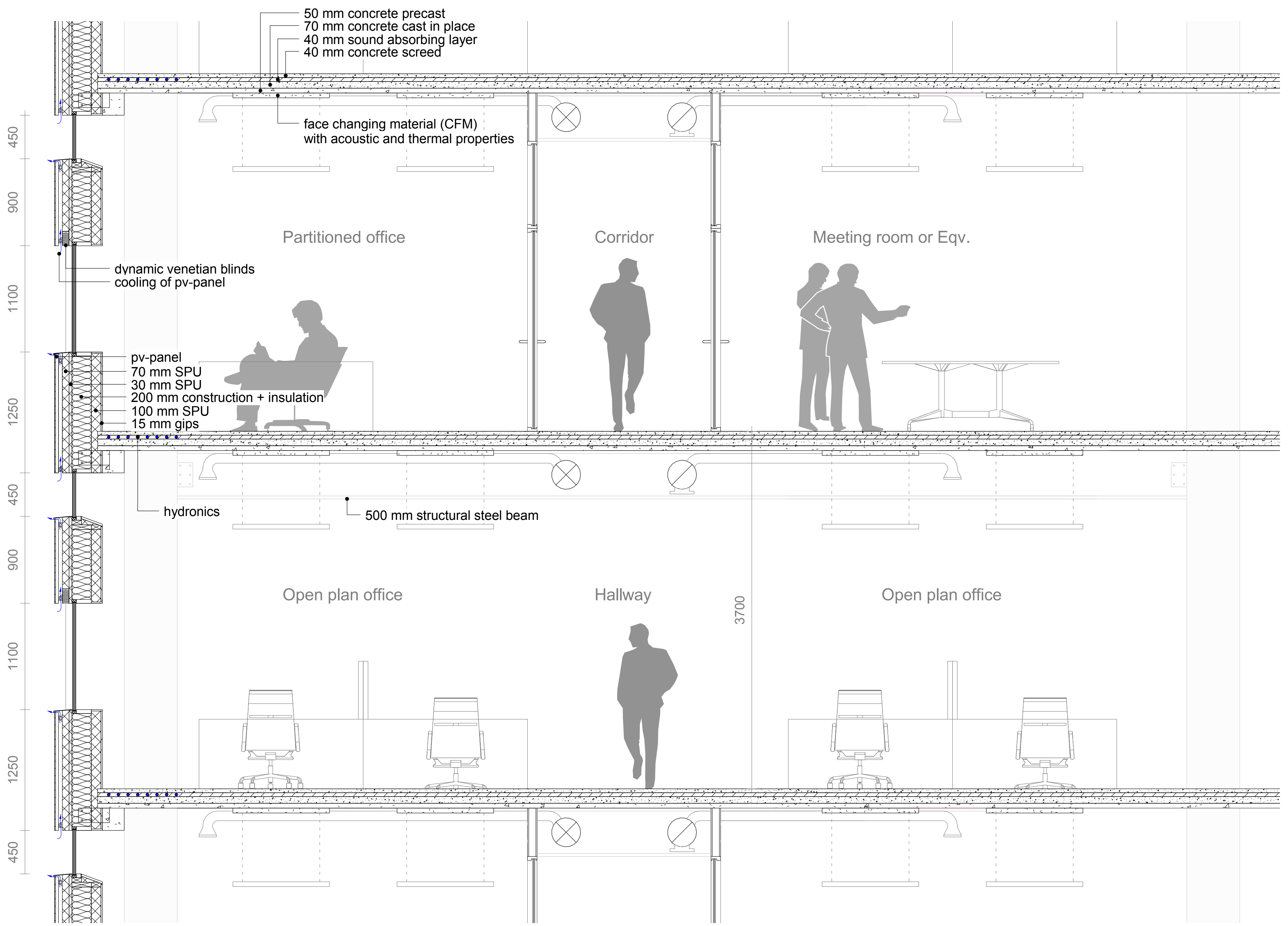
WEST



NORTH

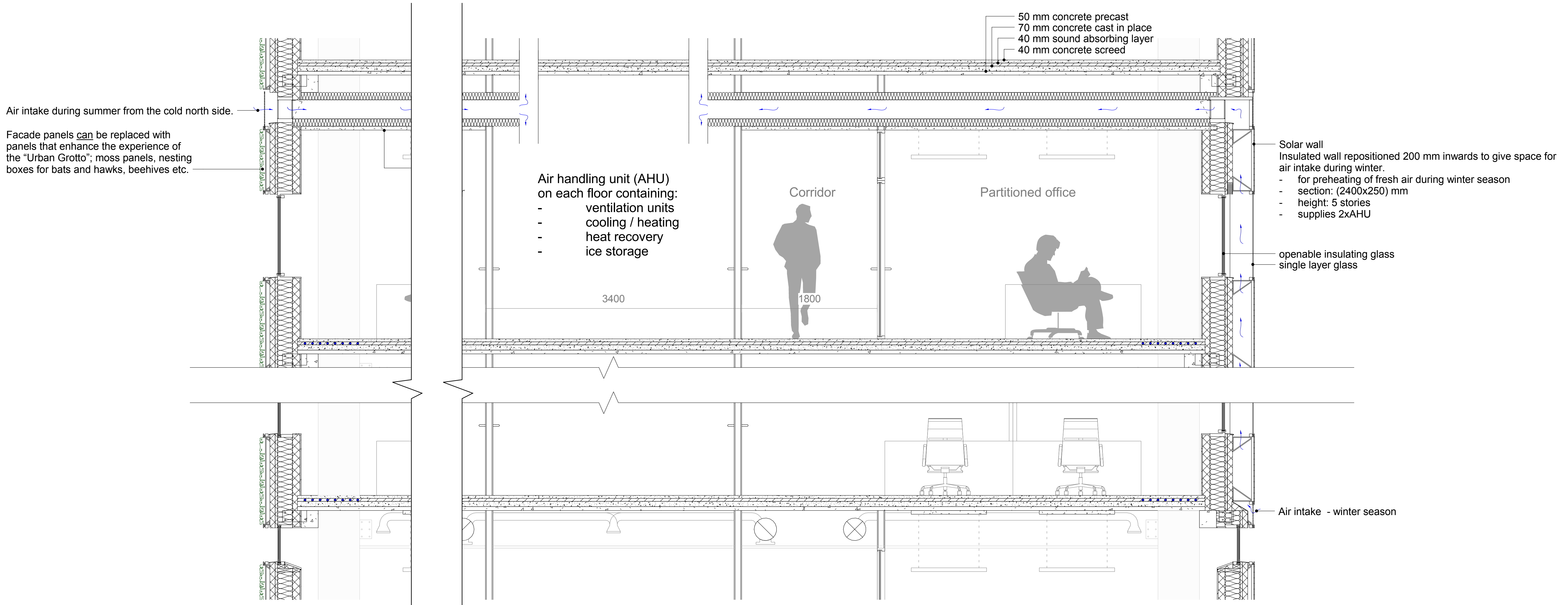
OSLOSOLAR

facade section 1:50 (A3)



The building of the facade and principals of the ventilation system.

Facade section 1:50 (A3)



FAÇADE AND DAYLIGHT
The V-shaped plan have facades for photovoltaic panels exposed to sun from early morning to late afternoon on the outside, and on the inside, green lungs for natural air conditioning and daylight.
The façade is designed to let in maximum daylight with minimum glass. Minimum glass is important for reducing heat loss and need for sun shading, but also for maximising the surface for solar panels.

The partition of the façade in two horizontal stripes of glass on each floor is the most efficient way to combine the three needs. Although very technically motivated, the partition has architectural qualities. With narrow horizontal ribbons the façade seems to be working better in relation to the shape of the building and the holes cut out for the atrium. More important is that the way of parting the façade have potential to become outstanding both technically and architecturally without the use of expensive and carbon consuming solutions.

OSLOSOLAR – CONSTRUCTION

Job	**Futurebuilt Urban+ OsloSolar – Arcitecht Competition Phase II**
Client	**Code Arkitekter // Entra Eiendom**
Date	**June 08, 2015**
To	**Code Arkitekter**
From	**Øyvind Sætre**
Copy to	**Ramboll Project Team**
Job	**Futurebuilt Urban+ OsloSolar – Arcitecht Competition Phase II**

Dato 08-06-2015

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T +47 2251 8000
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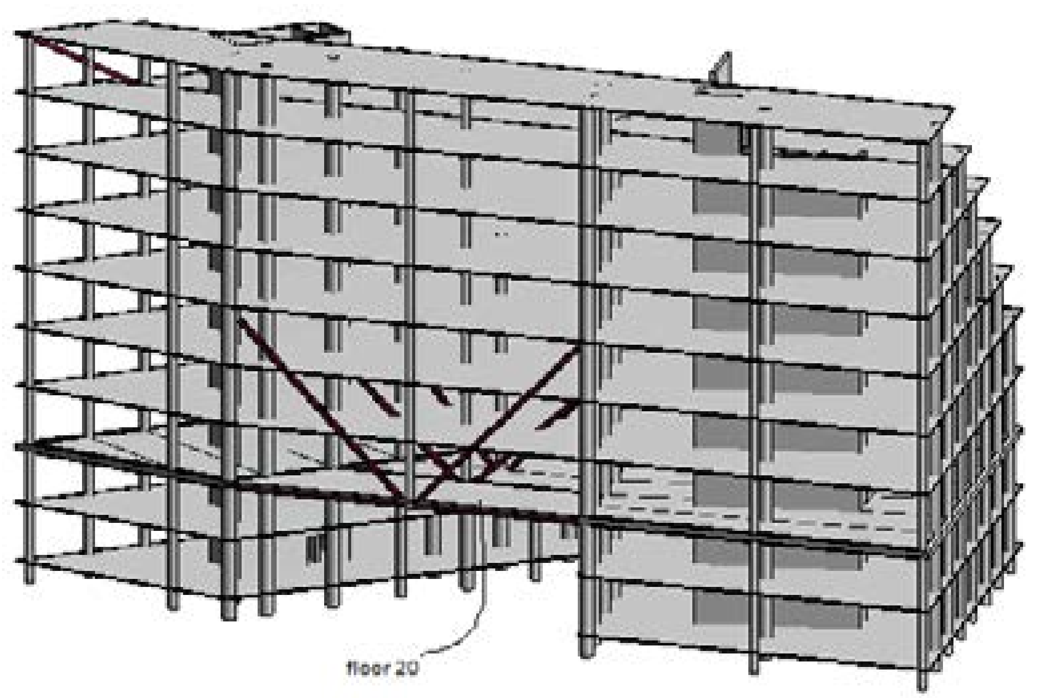
Ref Oslosolar RIB

1. Supporting structure

The supporting structure is designed to be versatile to different slab-systems, giving room for adjustments in span widths, materials and production methods as the project evolves. Spans between columns are typical 4,8m x11,0m.

Vertical concrete shafts combined with steel diagonals in one facade ensures the buildings resistance to horizontal loads due to wind and seismology.

Over the atriums the coulumns are carried by trusses or diagonals over 1-3 floors depending on the spans.



Figur 1 Diagonals carrying the coulumns over the north atrium

2. Building materials

We are using low carbon concrete (Class A) and steel beams with a high grade of recycleing. Currently at EPD-norge.no there are no environmental declaration for the type of steel beams we are using, but it is safe to assume they are available with high grade of recycleing as they are welded out of simple steel plates.

3. Columns

Concrete columns are chosen to minimize $C0_2$ from building materials. As the project evolves we will concider using composite or steel columns in certain positions or levels to reduce dimensions. In the process of deciding building materials we calculated the $C0_2$ equivalent emission for one reinforced concrete column (Ø500, 100% recycled reinforcement) and one steel column (Cold formed hollow section 300x300x12, 13% recycled, including fire protective paint) with the same load bearing capacity, and the concrete column had substantial better numbers regarding $C0_2$ equivalent emission, 197 kg vs. 1047 kg.

4. Slab systems

4.1 Composite beams

In traditional concrete slabs we are only utilizing roughly the top half of the slab for the compressive strength of the concrete. The bottom half of the concrete is mostly to keep the reinforcement in place and at a fixed distance to the top half of the slab. Therefore we see products such as hollow core slabs and Bubbledeck®, to reduce the weight of the slab while maintaining the distance between the reinforcement and the top of the slab. In this phase

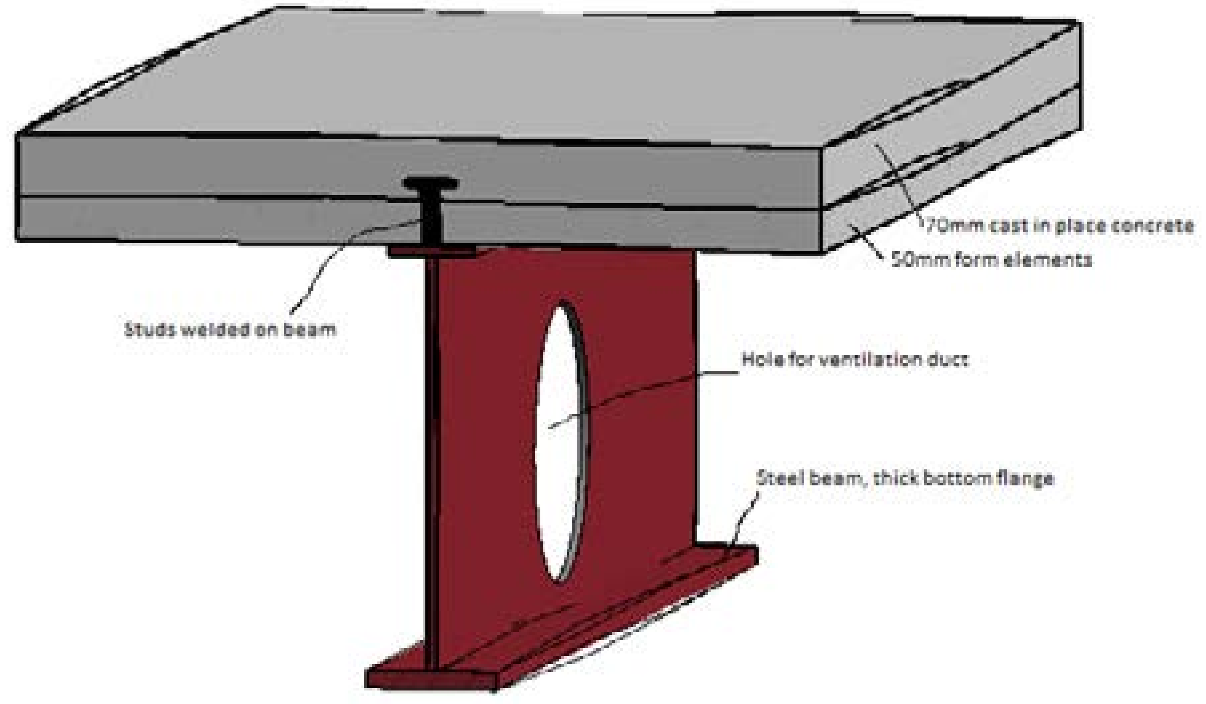
we have chosen a system of composite beams, utilizing the different qualities of steel and concrete. High steel beams in stead of traditional bottom reinforcement, and on top of the steel beams we have av concrete slab working as "the upper half" of the slab. The slab is 50mm of precast concrete formwork, and 70mm of cast in place concrete, a total of 120mm concrete slab.

We have designed the steel beams to be high enough to have ventilation ducts, pipes and cables passing throug holes in the web. To reduce the steel weight we have welded the beams of steel plates, allowing us to have different thickness of the 3 parts of the beams, as we need most of the material at the bottom flange. From C2C point of view it might be better to use standard IPE-beams, it should be studied in more detail as it would require slightly more steel per m².

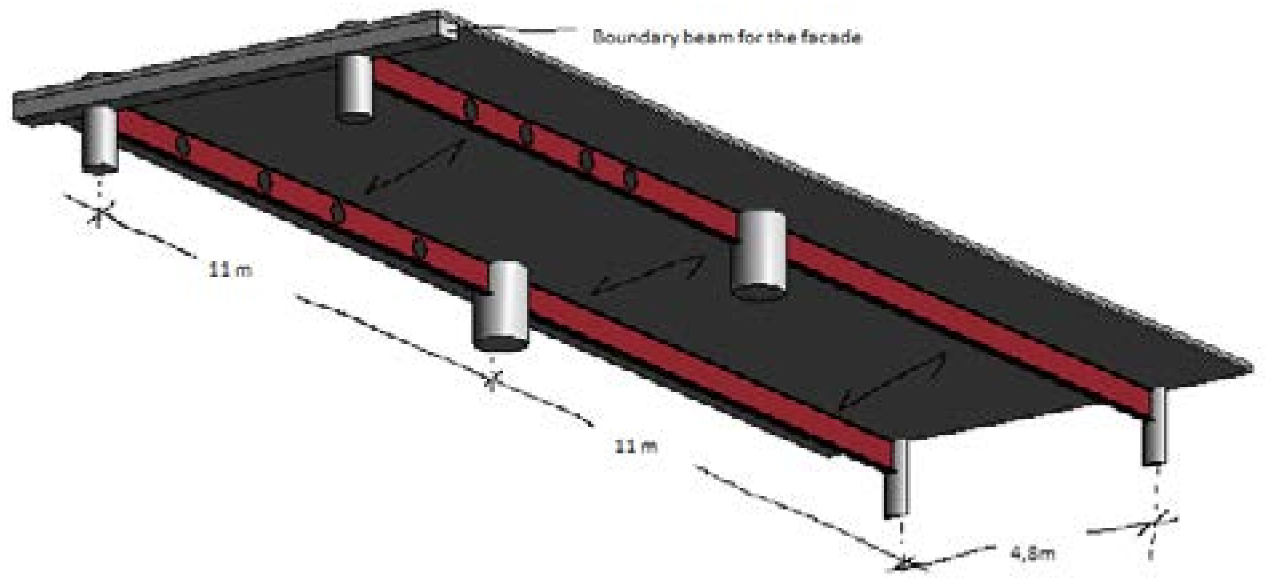
This construction method is common in other parts of the world, particularly when building high rise buildings, because of the low weight and high stiffnes of the system.

For a typical slab span this system requires the following materials (with $C0_2$ emission) :

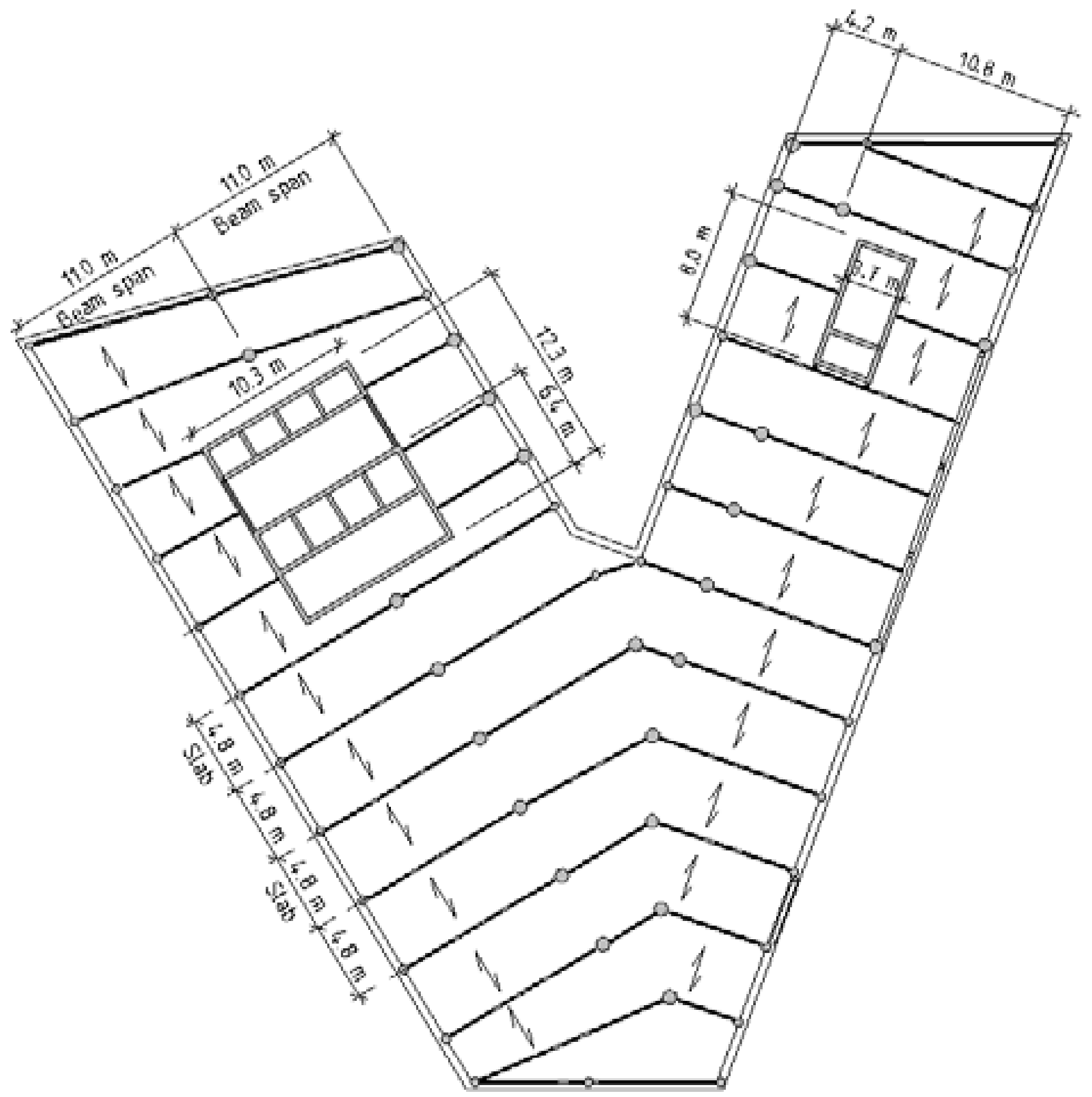
- Concrete: 300 kg/m² (31,3 kg $C0_2$)
- Reinforcemnet: 8 kg/m² (41,2 kg $C0_2$)
- Steel beam: 14,3 kg/m² (48,3 kg $C0_2$)
- $C0_2$ emission in total: 121 kg/m²



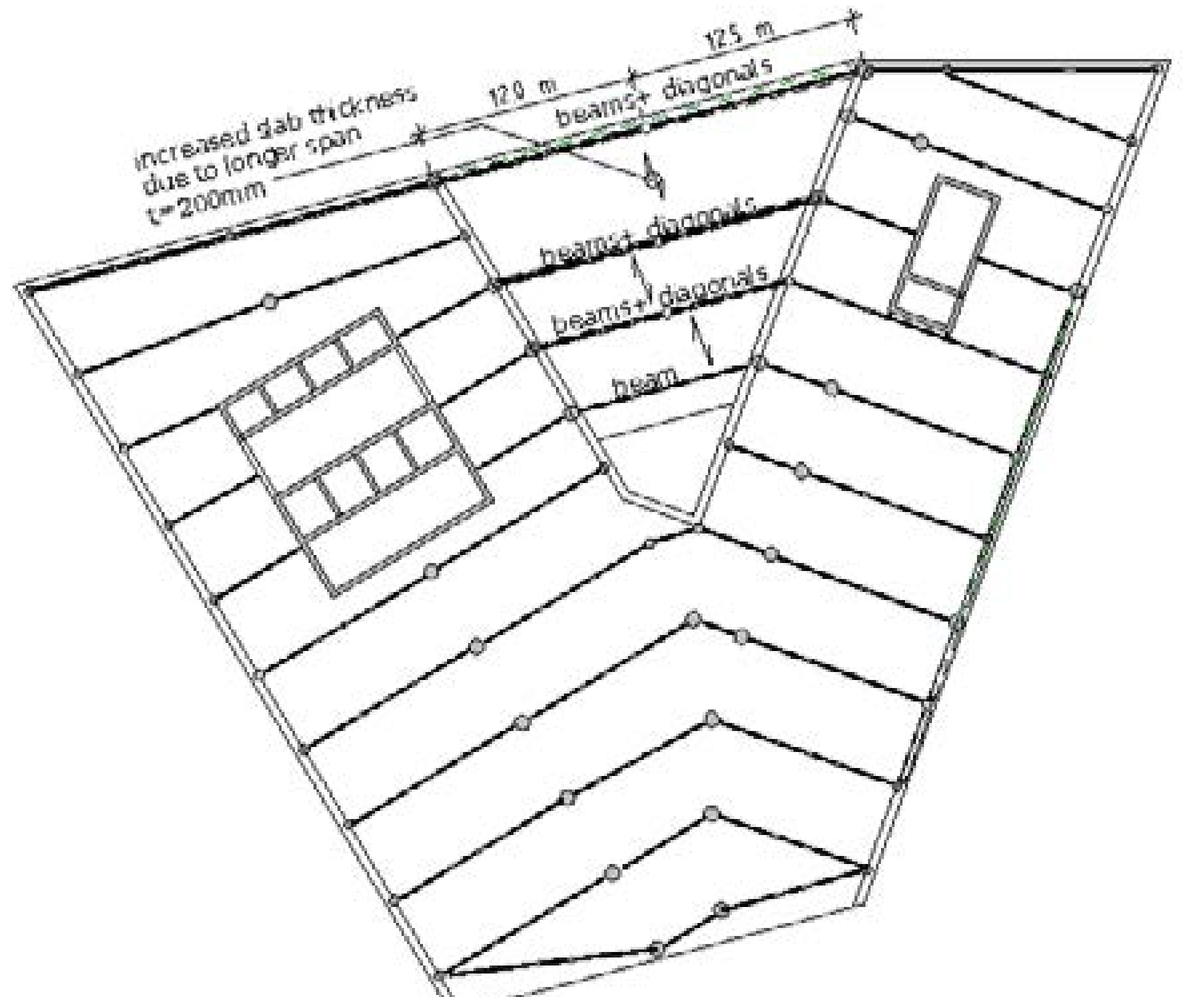
Figur 2 detail of the composite slab/beam



Figur 3 Typical spans for the composite beams and slab



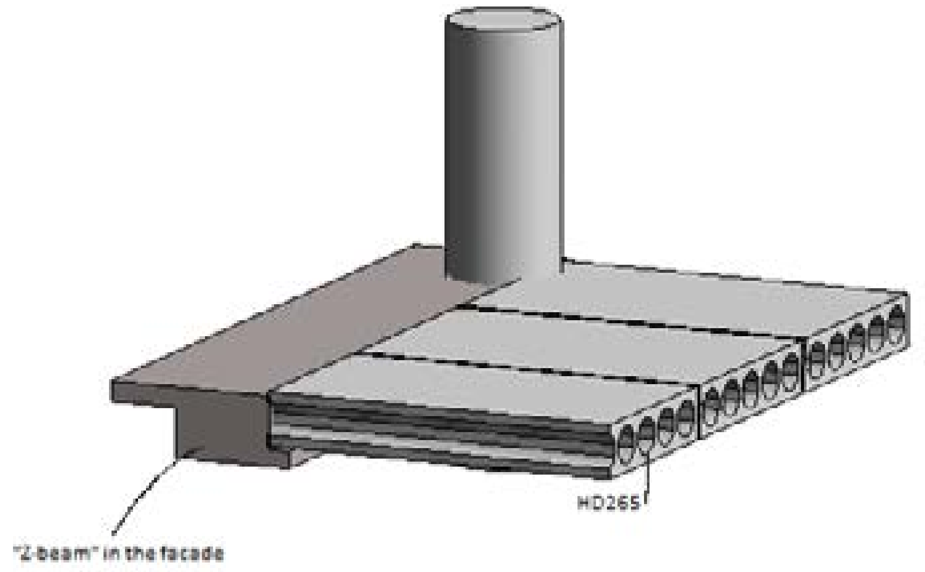
Figur 4 Typical plan(10-18) with composite beams/slab



Figur 5 composite beams/slab over north atrium

4.2 Hollow core slabs

As an alternative to the composite slab/beams, the column grid is also well suited for using hollow core slabs in combination with prefabricated concrete beams. This is a fast and efficient building-system and is well known i Norway. We have indicated the use of concrete beams in stead of the more typical steel beams, as concrete is better in terms of climate impact.

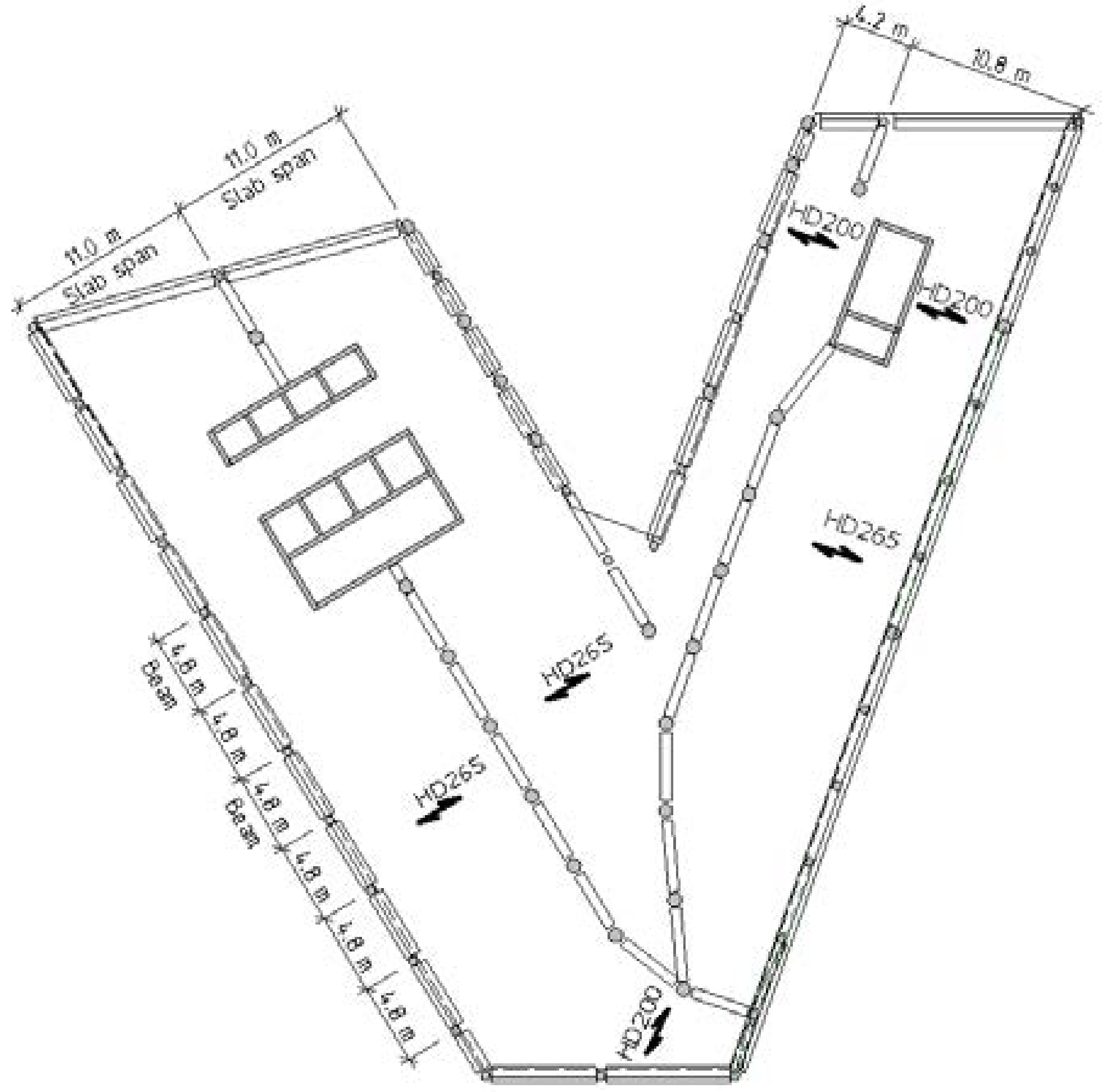


When using low carbon concrete, the concrete needs more time to harden. This affects the production time in the factories, and therefore the cost of the slabs and production capasity of the factory. In recent, large scale projects in the Oslo region, the suppliers have not been able to deliver enough slabs using low carbon concrete. New tecnology might improve production time in the future.

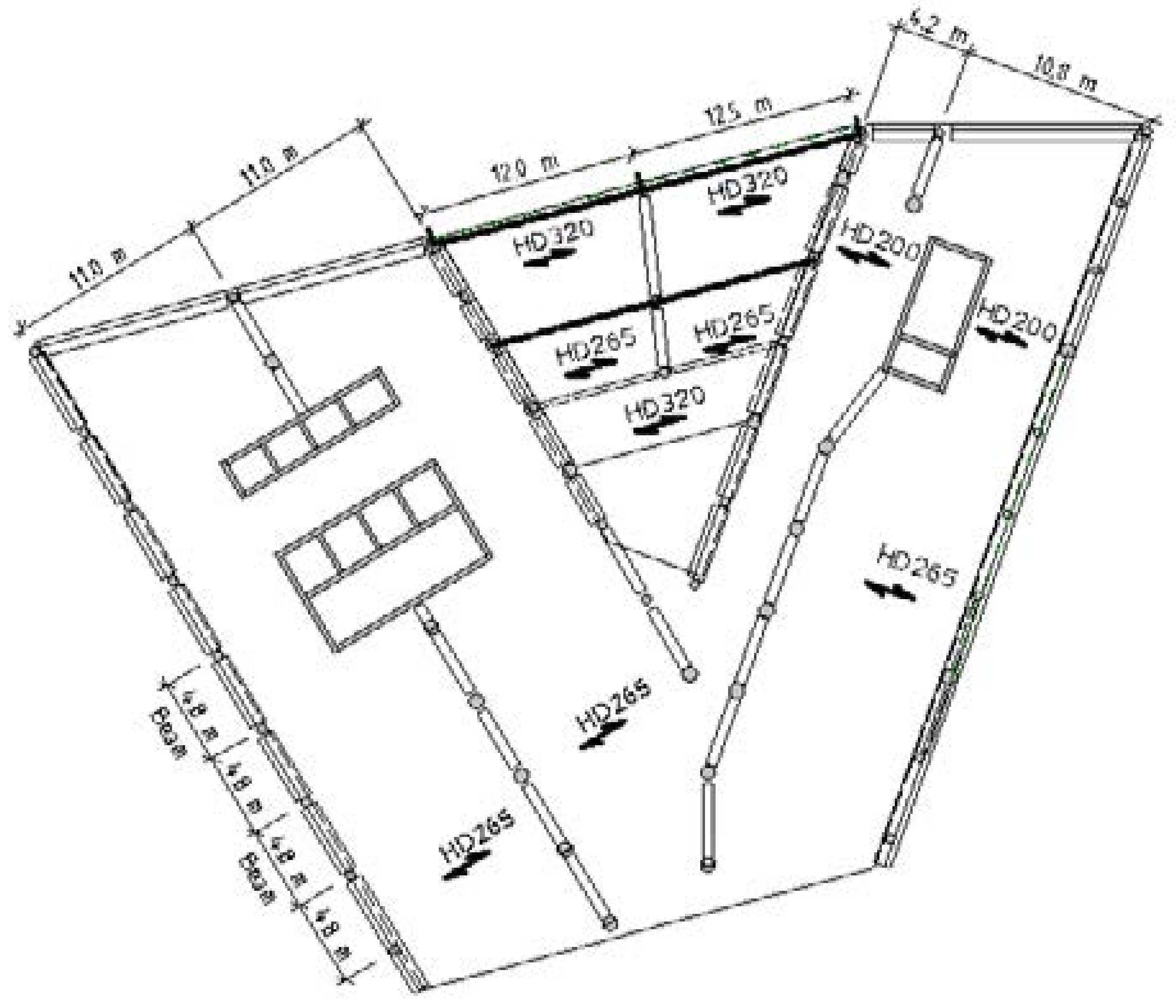
We are concidering using water-borne heating/cooling in the slabs, which would be more difficult using hollow core slabs.

For a typical slab span this system requires the following materials (with $C0_2$ emission) :

- Concrete: 430 kg/m² (60,8 kg $C0_2$)
- Reinforcemnet: 14 kg/m² (41,7 kg $C0_2$)
- $C0_2$ emission in total: 102,5 kg/m²



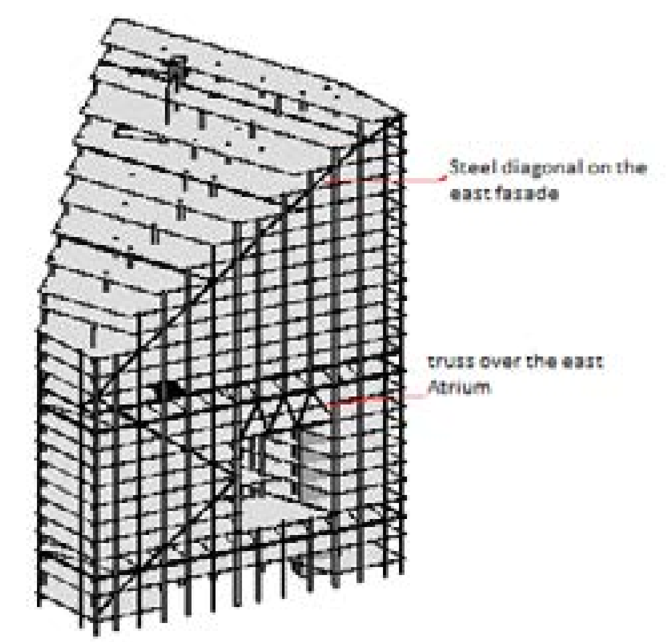
Figur 6 Typical plan with hollow core slabs



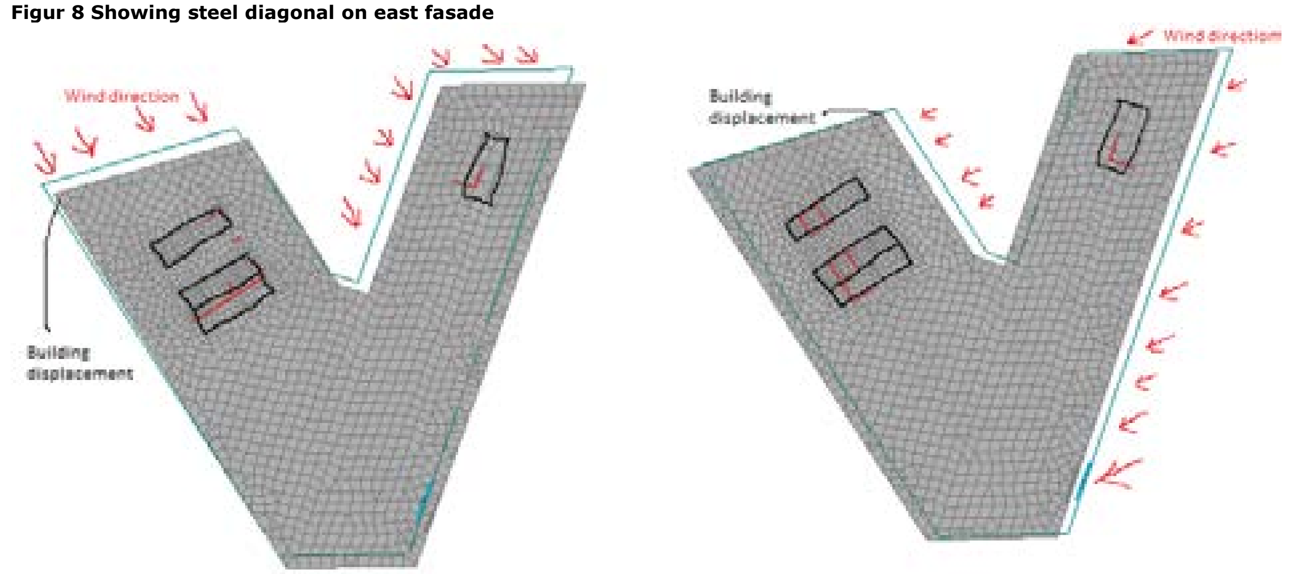
Figur 7 floor plan (20) with hollow core sections above north atrium

5. Stiffnes and stability of the structure

As mentioned the stiffnes of the structure is provided by concrete shafts and a steel diagonal in one facade. The steel diagonal was implemented as most of the concrete shafts are in the west wing of the building, and the shaft on the east wing did not contribute enough to keep the building from rotating. A full stability analysis has not been performend, but we have studied the two first major eigenfrequencies (with around 70% modal mass in each direction), and they both have mostly translation motion, almost no rotation. This indicates that the system should be robust if seismic forces should be larger than the wind-forces on the building.



Figur 8 Showing steel diagonal on east fasade



Figur 9 Displacements due to wind from two directions

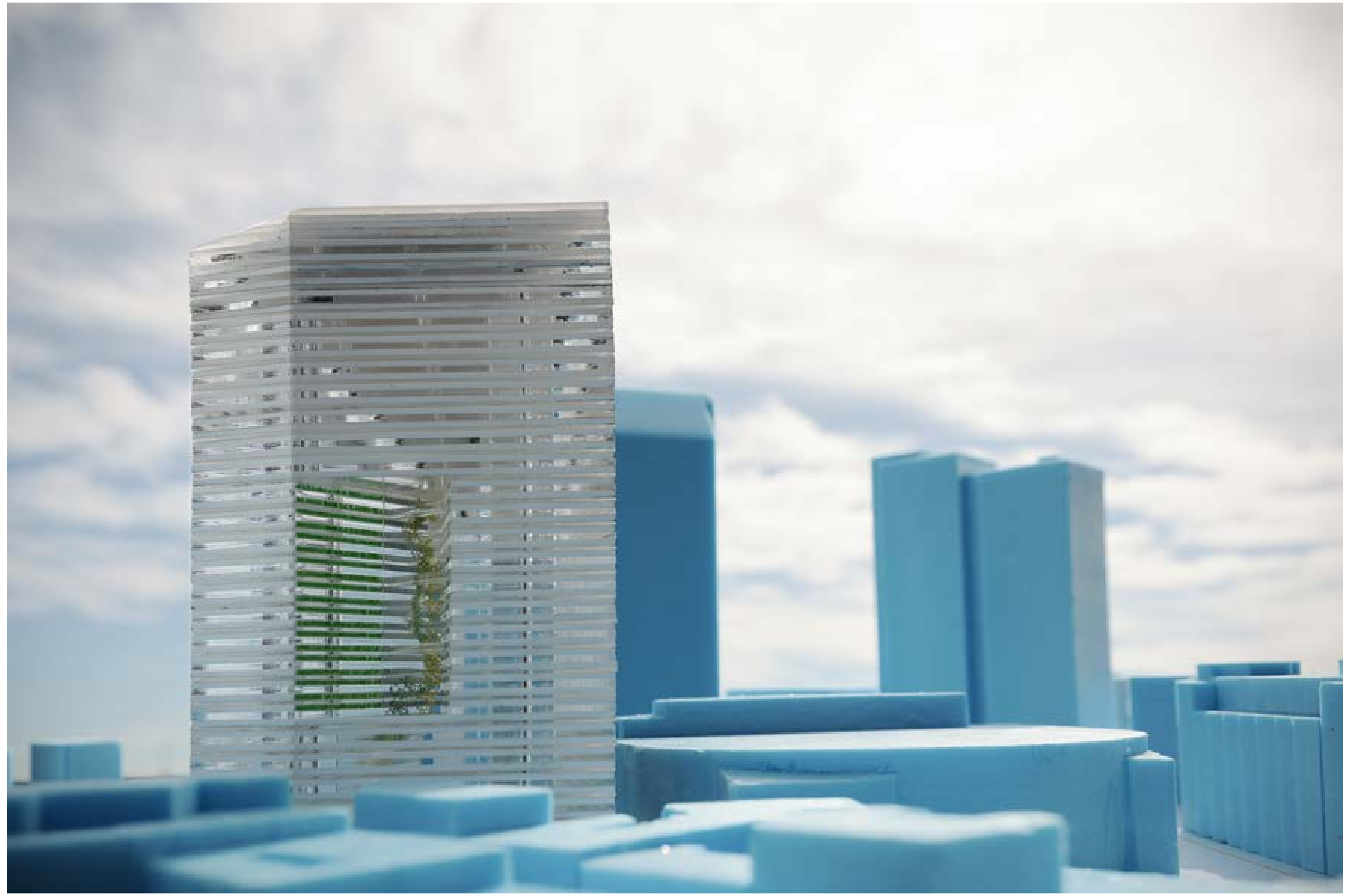
6. Base and foundations

The foundation plate and exterior walls are watertight structures with thickness of 500- and 300mm. All slabs below the ground floor are traditional cast in place slabs due to large horizontal forces between the shafts and exterior walls. Ribs are cast against wall to support building frame and increase load bearing capacity of exterior walls against soil and hydrostatic pressure.

From the base plate we have piles extended to bed rock. We have considered both steel core piles, and drilled piers (cast in place reinforced columns). The drilled piers have high

load bearing capacities and will reduce the need for pile-caps in places where we would need more than one steel-core pile. The best option regards to $C0_2$-emission is by far the drilled piers, compared to steel-core piles they have about 25% of the $C0_2$-emission, in total 530 tonne $C0_2$ eqv. while steel core piles would have about 2000 tonne. Depending on the need for tension anchorage below the shafts, we might need some steel core piles either way.

We have considered using only 1 basement floor. This would reduce building costs substantial. If so, we need to analyze further if we can mobilize enough earth pressure against the basement walls, elevator pits and cantilevered sheet piling to withstand the horizontal forces from wind or seismic forces.



ARCHITECTURE
Model photos

ARCHITECTURE
Universal design

UNIVERSAL DESIGN
The proposed building and its surroundings is designed with the idea that the building provides a universally designed work environment that is universally connected to the surrounding city and the Central Station. The idea is that this project can be used in promoting universally designed urban developments in the new station-citys around the city centre as well, making green mobility universal.
We suggest a focus on universal design on three levels:

The floorplans:
The V-shaped floorplans allows for simple and intuitive use, featuring:
- A clear organisation with clear lines of sight.
- Lobby in close connection to the elevators.
- All columns at the perimeters to ensure maximum flexibility.
- Use of contrasting colours and textures to make elements more visible.
- Use of both tactile and perceptible information boards.
- A central point of activity and orientation in the “green lungs”.

The street level:
- A defined entrance with a clear connection to the park and the route to the central station.
- We suggest that the car lanes in Stenersgata are “cut off” by a shared space crossing of the street to lower the physical effort in crossing the Stenersgata and improving the connection between the building and Brugata.
- Make the lobby a part of the surrounding by using the same kind of surface in the lobby as in the urban fields right outside.

The urban surrounding:
We suggest that the project uses the potential the site has for a universally designed connection of the Central Station with the pedestrianized Brugata and the Akerselva River. By making a universally designed connection to the Central Station, the 42 000 m2 building is made universally accessible for a large number of people living in and around Oslo. Imagine a person in wheelchair living in a future Kolbotn: The person can work in the building and travel by train, shop groceries in Brugata and have lunch at the riverside one fine day in the springtime.

ARCHITECTURE
Climatic Challenges

ADAPTABILITY TO CLIMATE CHANGE
Adapting building designs for climate change is about managing the unavoidable. While there is debate around what level of adaptation is needed, there is growing awareness that design practices need to take into account predictions of increased risk and intensity of extreme events.
The proposal recognises that the nature of weather events is unlikely to remain the same throughout a building’s lifetime.

Challenges we see in the future:
Rising temperatures - impact on external surfaces, and the thermal performance of building:
The atrium/inner cave will be a possible regulator and a place where structural changes or planting strategies can be made.

More intense rainfall - greater intensity of runoff: issues of structural integrity; drainage; opportunities for capturing rainfall:
Water run-off from roof is collected and used internally in the building and excess water is led into pools for drainage in the Vaterland park.

Increased humidity – mould, condensation, decreased thermal perfomance of building:
Solutions in flexible ventilation systems and separate layers of the façade which makes elements demountable and thus being able to change parts of damaged construction.

DRAFTS AND TURBULENCE
Above the ground and first floor there is a brim. The size of the brim varies around the sides of the building. Towards the park the brim is around 4 metres wide, marking the entrance as well as giving shelter. The final design of the brim is a result of the effect it has on sheltering the ground floor areas around the buildings from falling winds.

In the site plan we have shown vegetation close to the corner towards Lilletorget. This vegetation can be supported with architectural structures with the main purpose to soften winds and avoid turbulence. Both the brim and the local shelter close to the corner is based on the knowledge that local and “light” structures are most efficient when it comes to sheltering street level areas from winds.

RAINWATER, SNOW AND ICE
To prevent snow and ice from falling, the roof is divided in ribbons that are angled to form a rasp. Snow and water flows under the ribbons into basins. From the basins the water is led to water the plants in the atrium.

It is possible to use snow melting PV panels to prevent the snow from covering the roof during heavy snowfall. The angel of the roof is steep enough to make all snow slide off even without the use of snow melting panels.

The area of the roof is 2200m2 (projected horizontally). The volume of the basins is 1500 m3 and large enough to hold all the snow from a heavy snowfall. Increased rainfall due to climatic change can result in over flooding. The basins have a system for leading flooding water to the drainage system in the park.

Round the edge of the roof there is a parapet framing the solar panels and the basins .The parapet is tall enough to ensure that no water, snow or ice will fall over the edge.

Vaterland in the evening

Fire Safety Description

The building will have a total of 26 floors excluding the basement floors. The second and ground floor will function as retail and public floors for visitors. The rest of the floors will function as office spaces. The basement will be used for bikes, electric car parking and technical spaces. The building will as a result of its use be in Risk Class 2 and 5. Because if the height and numbers of floors the building will be listed in Fire Class 4. This means that the buildings fire concept will be fully based on a fire engineering analysis to document the functional requirements of TEK10.

The building is at this stage designed so that it is capable to adapt to current regulatory requirements in terms of fire safety. The building has good flexibility in terms of escape routes, and it has made good choices in terms of material use to ensure safety in a building of such great size. It will fulfill requirements relating to human safety, safety for extinguishing and the rescue crew in case of fire, and social interests for the environment.

The building's height requires good safety measures against vertical fire spread in the facade. This is considered solved constructively with dividers in the facade, as well as full reach automatic extinguishing systems throughout the building in accordance with its size.
Evacuation of the building is ensured with a combination of technical and constructive measures.
It could also be mentioned that it will have to be established staircases with advanced smoke controls customized for high-rise buildings, as well as firefighter lifts.

The building is also planned with a distinctive atrium, which ensures light on the inside of the building and provides architectural value. This atrium will have partitions through the open space towards the surrounding volume. The partitions could be of glass and could be transparent. Fire requirement for these partitions could be reduced due to how the atrium is planned with smoke ventilation combined with the buildings fire sprinkle system. This solution make it possible to have an atrium extending over several levels.

Time is an important parameter in relation to fire safety, especially in high-rise buildings. Therefore, it is important to take into account long evacuation time and long response time in the building. To ensure that this will not be a problem, the building has extra safe escape routes that preserve its safety against fire and smoke longer than what is common in smaller buildings. In addition to this, the building is facilitated with equipment that reduces fire crew response time, good communication with the fire station, firefighter elevators, internal connection points for fire hoses and aid for assisted evacuation and rescue.

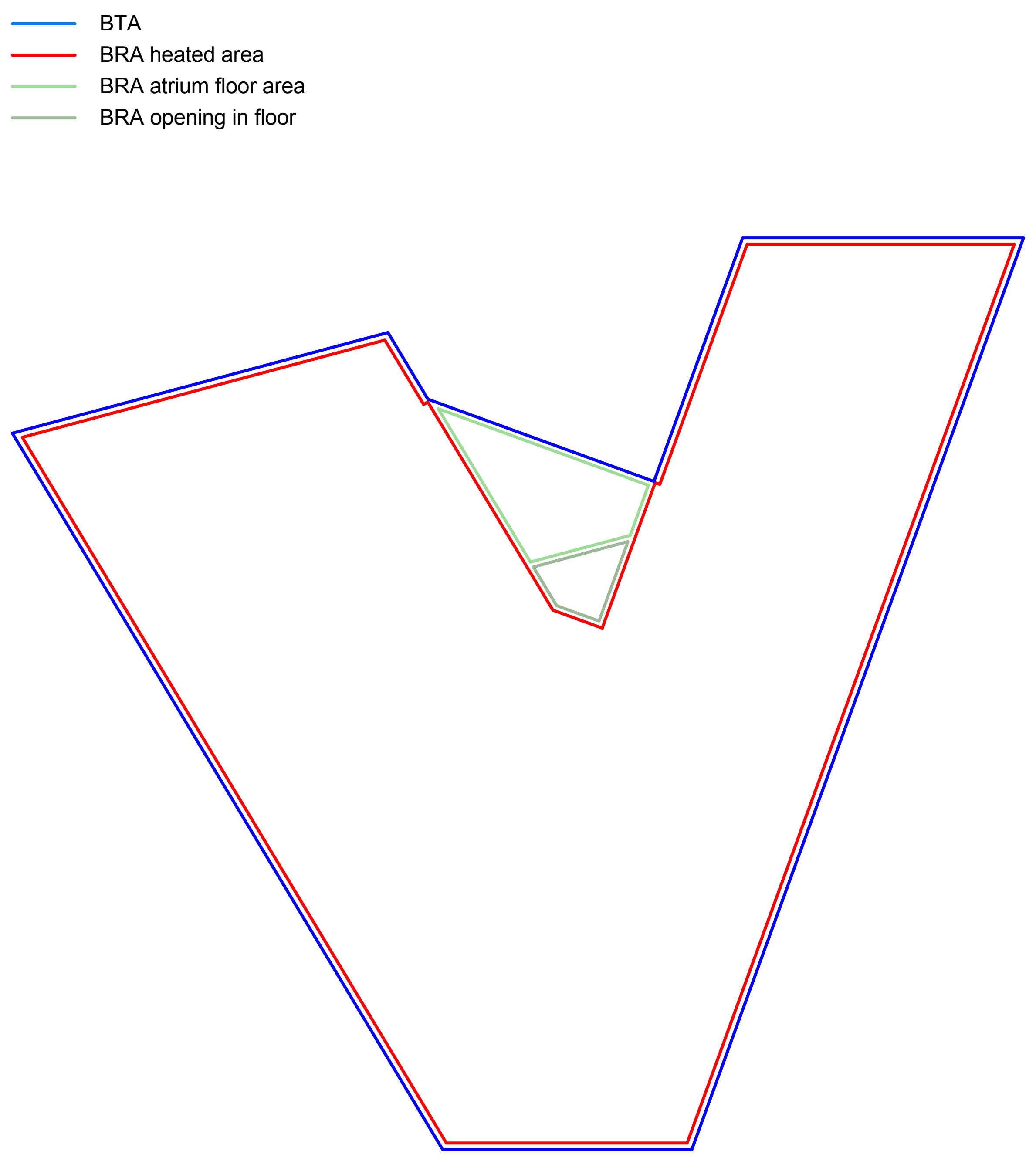
OSLOSOLAR IN THE MARKET

When we think of the building, we want it to represent the many, not only a few. We want it to be experienced as including and understood, not excluding and alien. We see it in line with Norwegian culture. It represents efficiency, hard work and technical, innovative sustainability.

We think the way the building works with the city is important for the image of the building, also in the market. The building softens the impact the two high-risers have had on the skyline, making them look better, and it brings new urbanity with bicycles, openness and life to Vaterland; all this working together will be the best promotion of the offices in the market.

It´s not only the building as an object that makes it stand out in the market. We think it´s what it communicates and the impact it has on the city. We believe the building can be appreciated by the public.

We also think that the concept of the building is about innovation that works. The solutions, both architecturally and technically, can provide efficient, flexible and comfortable work conditions. Although the focus has been on “good” rather than “fancy”, the architecture does not lack the element of the spectacular. The many corner offices, “mountain top” restaurants, the urban grotto, bicycle logistics, the passage with the airy lobby; these are all elements that can be developed to beauty and fascination. Nevertheless: it’s the connection with the city and the public appreciation of the building that we believe will make it stand out in the market.



	Function	BRA heated area/ m2	BRA atrium floor area / m2	BRA included atrium floor area / m2	BRA "opening in floor" / m2	BRA included "opening in floor" / m2	BRA unheated area (basement) / m2	BRA included unheated area (basement) / m2	BTA / m2
Ground floor	commercial & reception	1773		1773		1773		1773	1931
1st floor	commercial	1444		1444	476	1920		1920	1940
2nd floor	office	2081	30	2111	21	2132		2132	2216
3rd floor	office	2081	30	2111	21	2132		2132	2216
4th floor	office	1918	119	2037	21	2058		2058	2144
5th floor	office	1918	38	1956	102	2058		2058	2144
6th floor	office	1918	57	1975	83	2058		2058	2144
7th floor	office	1918	38	1956	102	2058		2058	2144
8th floor	office	1859	68	1927	18	1945		1945	2033
9th floor	office	1859	25	1884	61	1945		1945	2033
10th floor	office	1859	33	1892	53	1945		1945	2033
11th floor	office	1859	33	1892	53	1945		1945	2033
12th floor	office	1859	25	1884	61	1945		1945	2033
13th floor	office	1859	33	1892	53	1945		1945	2033
14th floor	office	1859	33	1892	53	1945		1945	2033
15th floor	office	1859	25	1884	61	1945		1945	2033
16th floor	office	1788	33	1821	53	1874		1874	1964
17th floor	office	1788	33	1821	53	1874		1874	1964
18th floor	office	1835		1835		1835		1835	1949
19th floor	office	1835		1835		1835		1835	1949
20th floor	office	1552		1552		1552		1552	1661
21st floor	office	1552		1552		1552		1552	1661
22nd floor	office	1192		1192		1192		1192	1297
23rd floor	restaurant	1203		1203		1203		1203	1297
24th floor	restaurant	779		779		779		779	872
25th floor	conference	765		765		765		765	833
26th floor	technical space	311		311		311		311	375
Total area above ground		**44523**	653	45176	1345	46521		**46521**	**48965**
1st basement floor	parking & delivery	190		190		190	2189	2379	2238
2nd basement floor	parking & storage	190		190		190	2147	2337	2193
Total area		**44903**		45556		46901		**51237**	**53396**

OSLOSOLAR