MODERN INDUSTRIAL HERITAGE:
A CATALYST TO NEW SUSTAINABLE DEVELOPMENT

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TU Delft

Problem statement

300

Over Coal powered plants in EU

18%

Total Greenhouse emissions of EU came from burning coal

€62.3b

The health costs of coal

4x

Employment in renewables

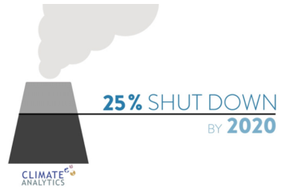
2030

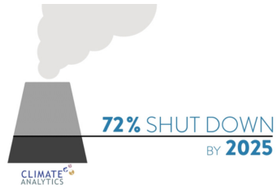
EU’s phase out plans

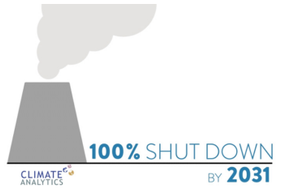
Source: CanEurope.org

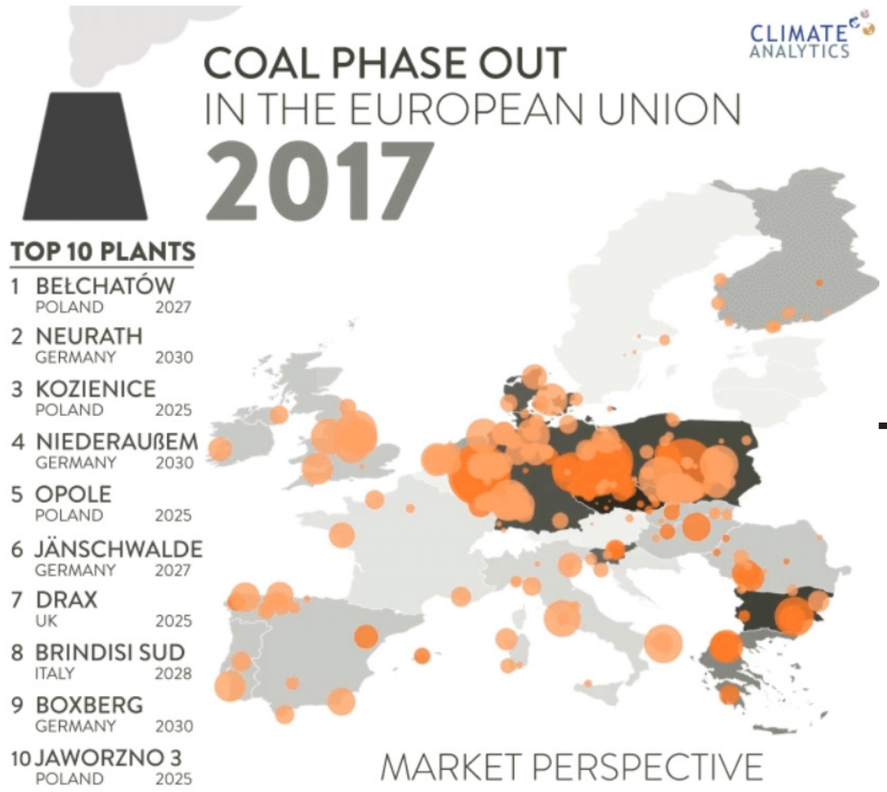
OBJECTIVE

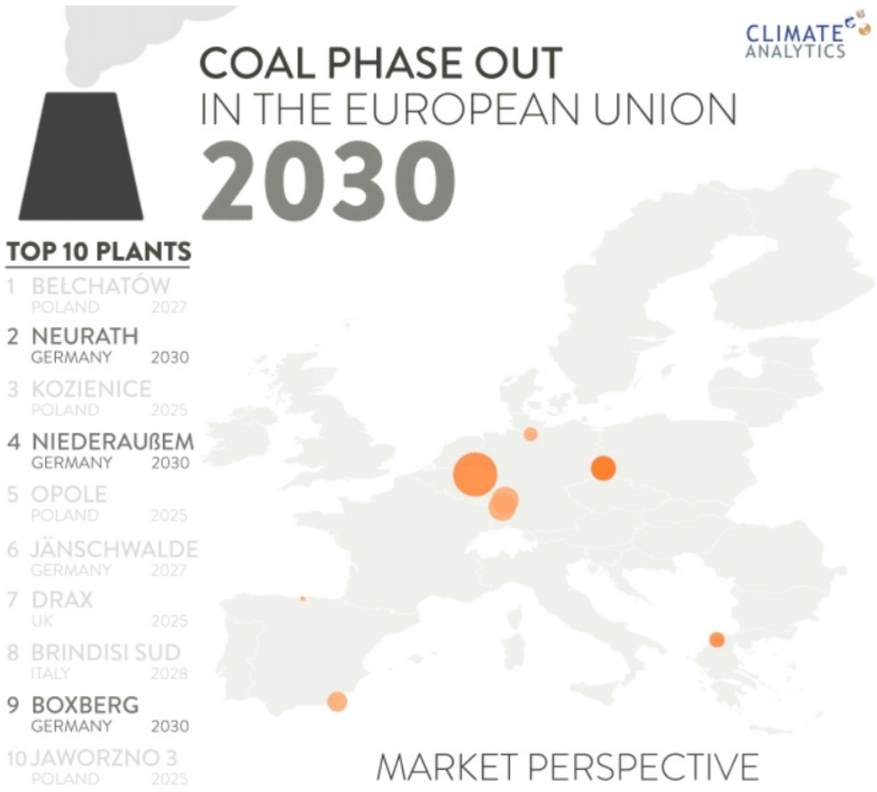
Under the Paris agreement, coal power plants are being decommissioned in EU to reduce carbon emissions. In the next few decades defunct thermal power plants are going to pop-up all over EU.











In the next decades, around 300 power plants across EU are going to close.

Objective: To re-purpose vacant industrial landscapes(thermal power plants) to integrate them within the expanding city and create a multi-cultural hot-spot promoting circular and sustainable future.

Sustainable development goal

Coal power plants can act as protagonist in achieving these sustainable development goals (SDG) by 2030.

Research Question

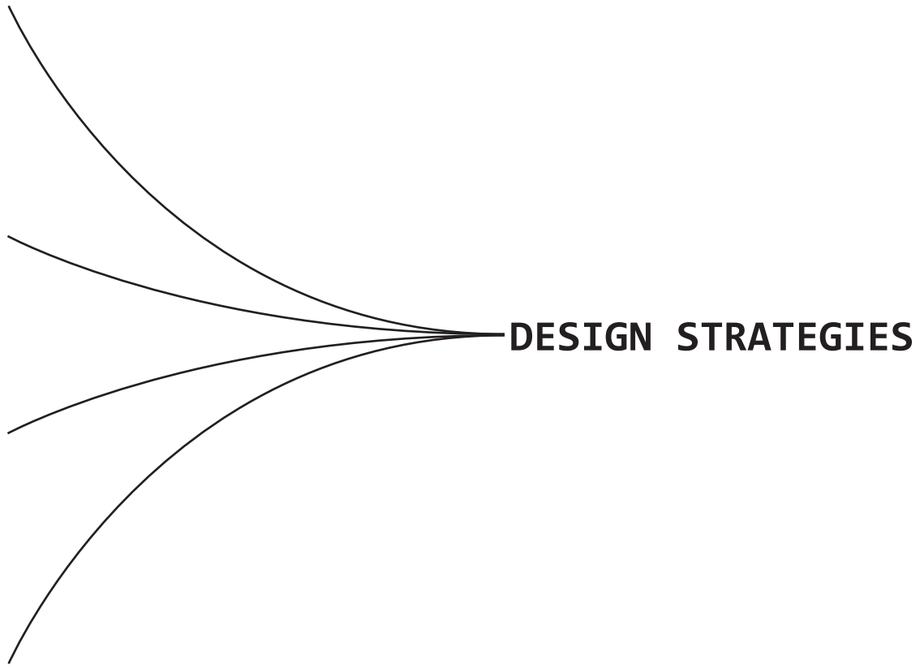
How does the refurbishment of vacant thermal plants using existing structures and materials on site promote sustainability and circularity in a social way?

Building: Understanding the functioning of power plant

Urban scale: Urban strategies and context of power plants

Harvest: Analysis of components

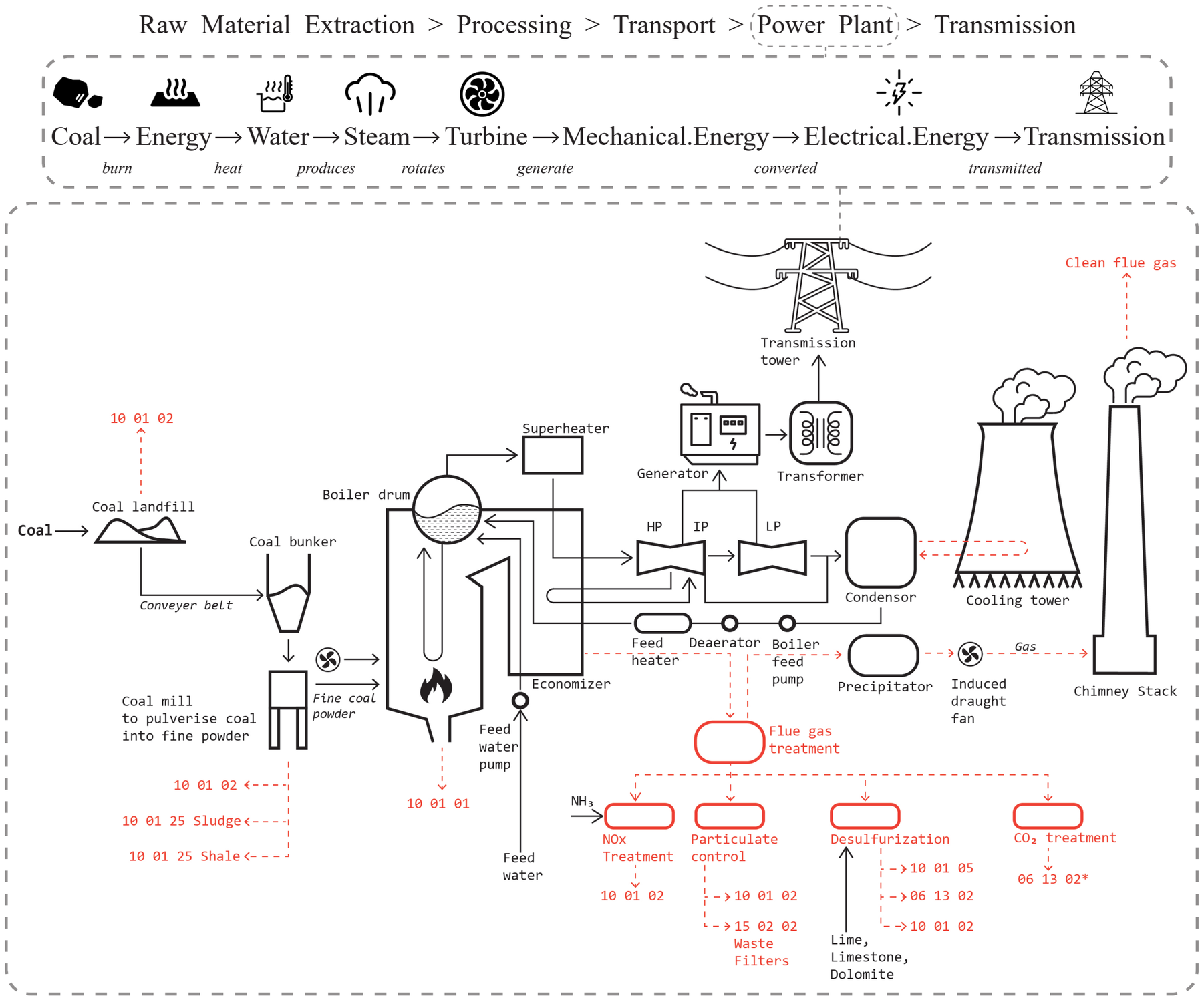
Redevelopment strategies: Plant decommissioning and phase redevelopment



Building scale

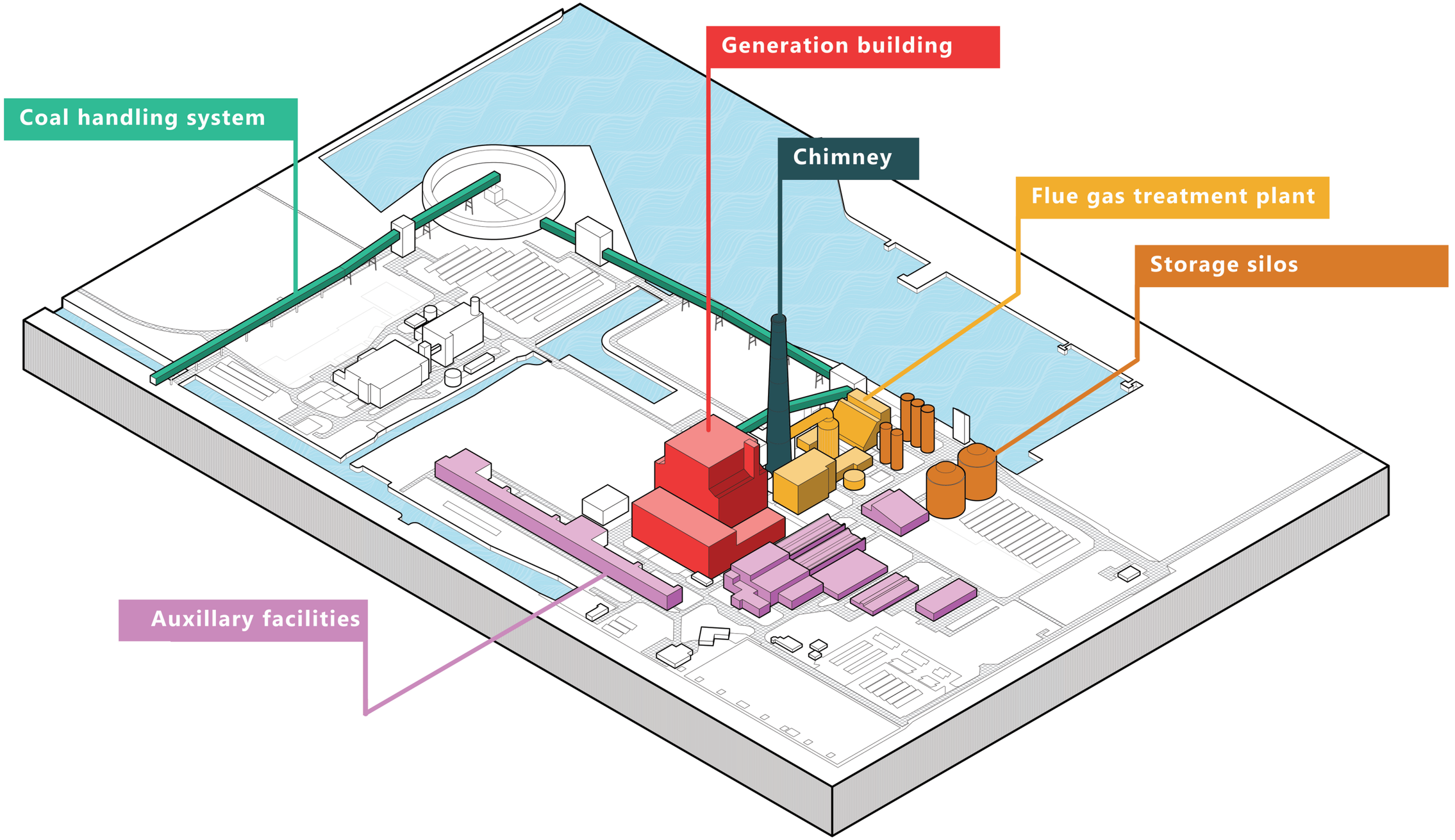
What is the general functioning flow of coal power plants? How are the spaces utilized and what is the composition of the machinery, instruments and structure? What are the environmental impacts of coal utilization on the ecosystem (constraints upto site boundaries)?

Understanding the functioning of coal powered plant is crucial in revealing the possibilities and reusing the site or building. It provides a better understanding of the various components, building, planning and structure which is vital information for the sections to follow.



Schematic diagram of the functioning of coal power plant and waste points.

Facilties

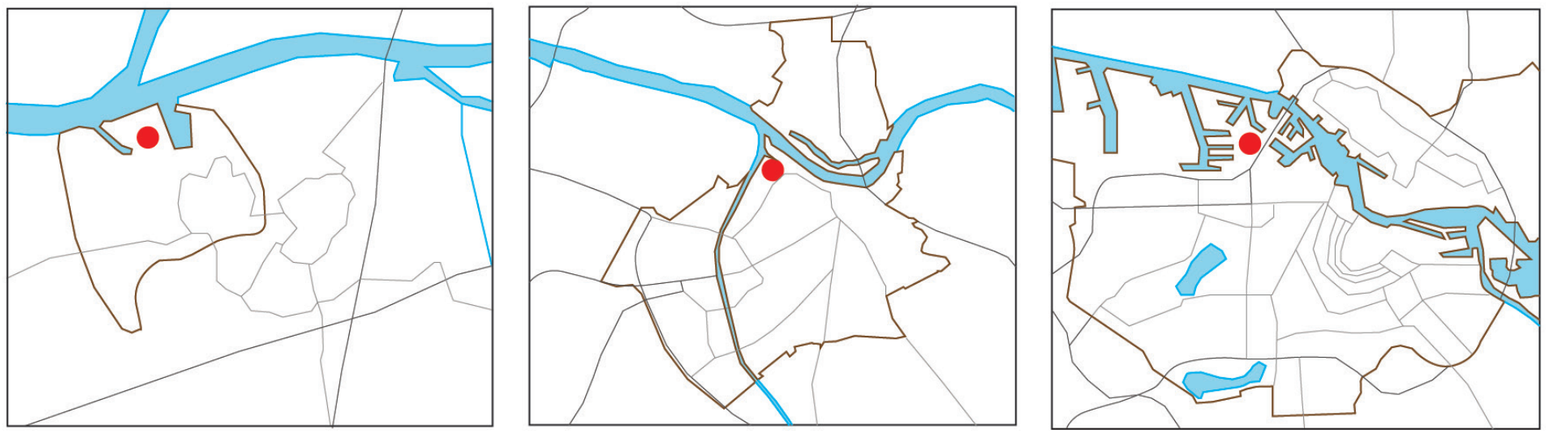


Major agglomerations of facilities on site

Urban Scale

Where are the coal power plants situated and what is the context?

It help reflect the potential reuse opportunities, program ideas and provide a better understanding of the urban contexts of coal power plants to incorporate them in the design.



Schematic diagram of coal power plants in Nijmegen, Geertruidenberg and Amsterdam marking the location of power plants in respect to cities. (The diagrams are not relatively scaled.)

The site chosen for intervention is Vattenfall coal power plant in Amsterdam is the site chosen as primary source and design site. The coal power plant in Amsterdam is close to the harbour, industrial area, Sloterdijk and Havenstad.

Harvest

How can we harvest from industrial landscapes? Which existing conditions on site should be reused/recycled/ repurposed and why?

Assessment is beneficial for the designer in decisions regarding intervention, like re-use/ demolition/conservation.

	1. Age value	2. Historical value	3. Non-Intentional commemorative value	4. Use value	5. New-ness value	6. Art value (relative)	7. Rarity value	8. Re-sale value	9. Other relevant values	10. Intentional commemorative value
1. Surroundings/Context										
2. Site										
3. Skin (exterior)										
4. Structure										
4.1 Generation Building										
4.2 Silos										
4.3 Chimney										
4.4 Cooling tower										
4.5 Coal handling system										
4.6 Flue gas treatment										
4.7 Workshop										
4.8 Auxiliary structures										
5. Surfaces (interior)										
6. Services										
7. Machinery & equipment										
8. Spirit of the place & Story										

Legend: :Low value, :Medium Value, :High value

Heritage Value Matrix

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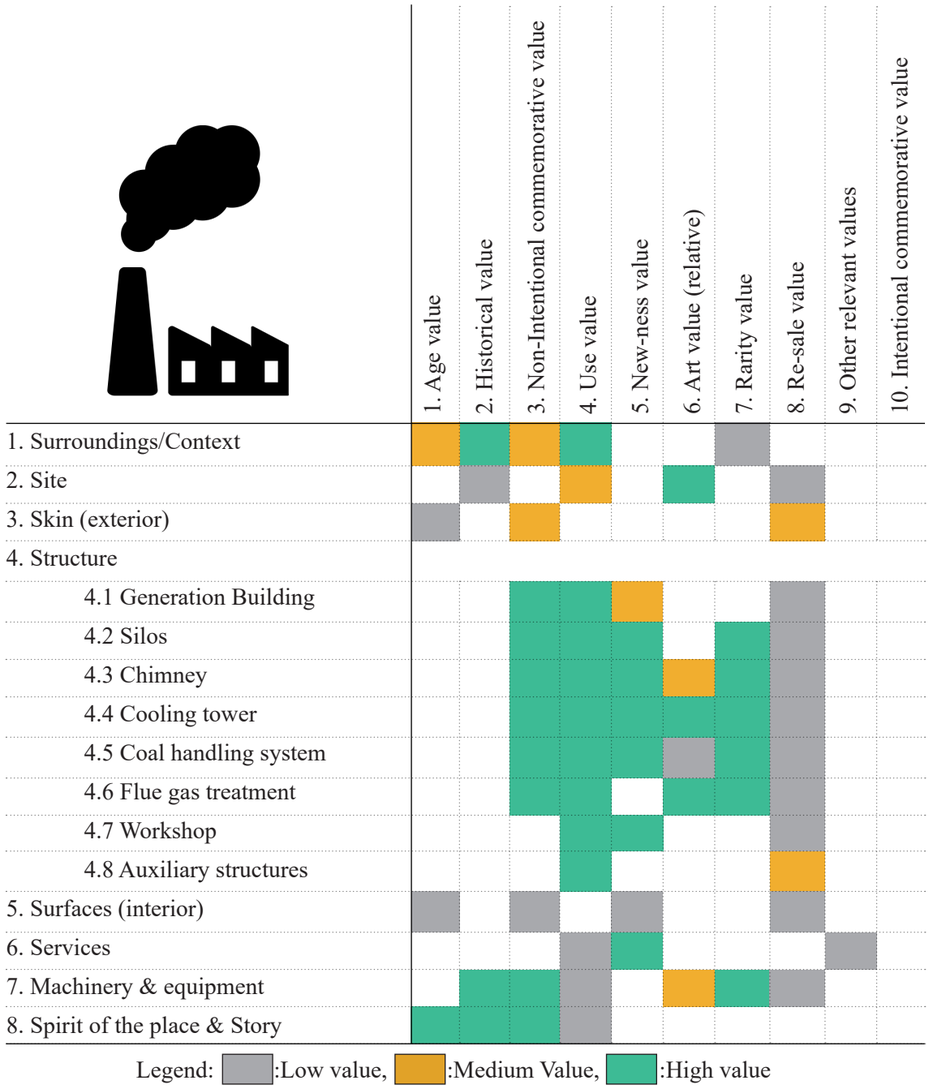
Legend: :Low value, :Medium Value, :High value

2	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Site		Relation to water, harbour and city.		Large plot: sites have big plots and ample empty space.
	Newness value	**Art value**	**Rarity value**	**Resale value**
		Agglomeration of unique objects		Site has low re-sale value due to finances involved in decommissioning.

Heritage Value Matrix

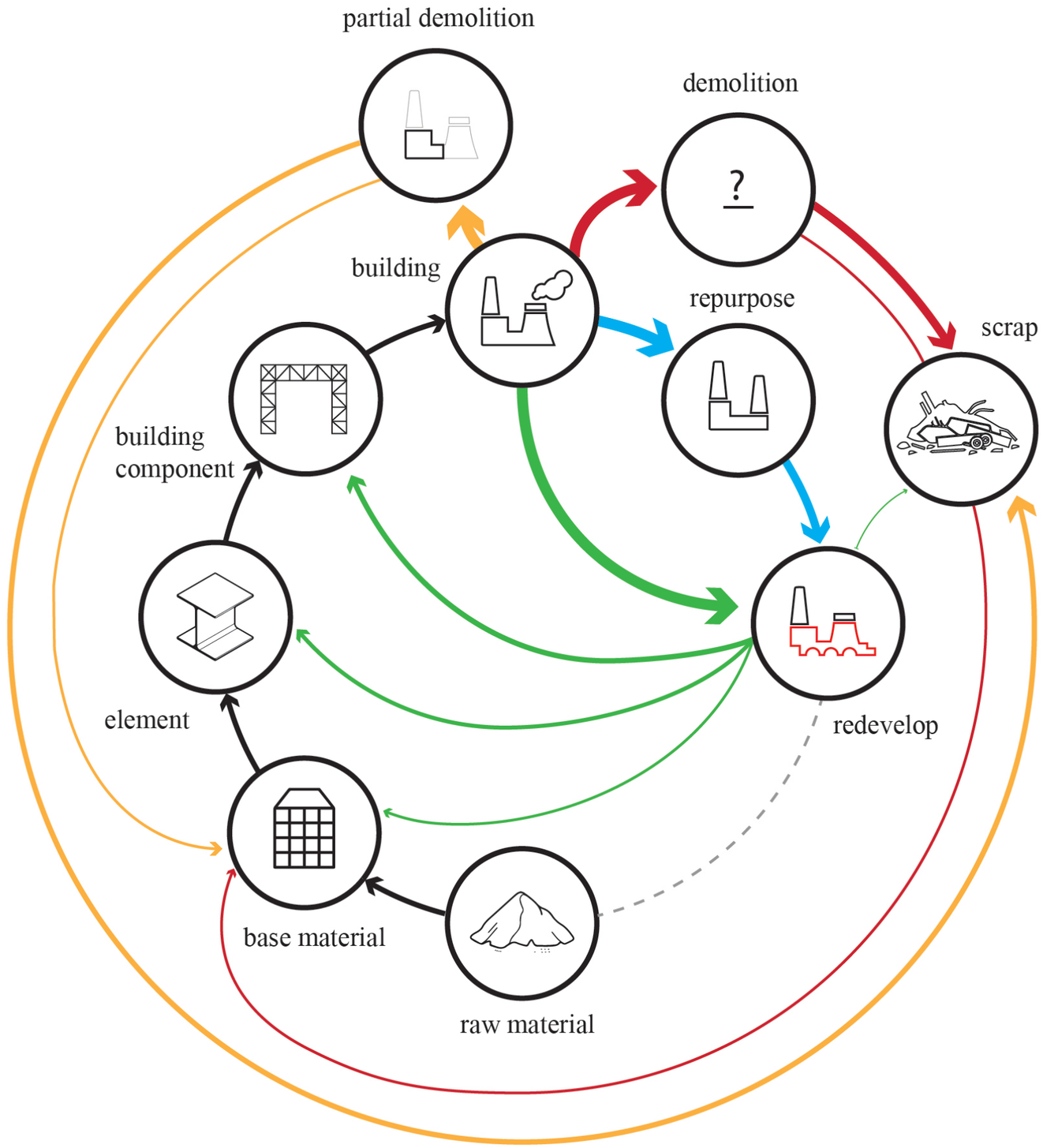


14	Age Value	Historical Value	Non-Intentional commemorative value	Use value
Machinery & equipment		Embody scientific and technological development.	Organs of the industry.	No functionality post-decommissioning
	Newness value	**Art value (relative)**	**Rarity value**	**Resale value**
		Aesthetically pleasing in their own way.	Customized to the industry and plant.	Except a handful machines most have scrap value.

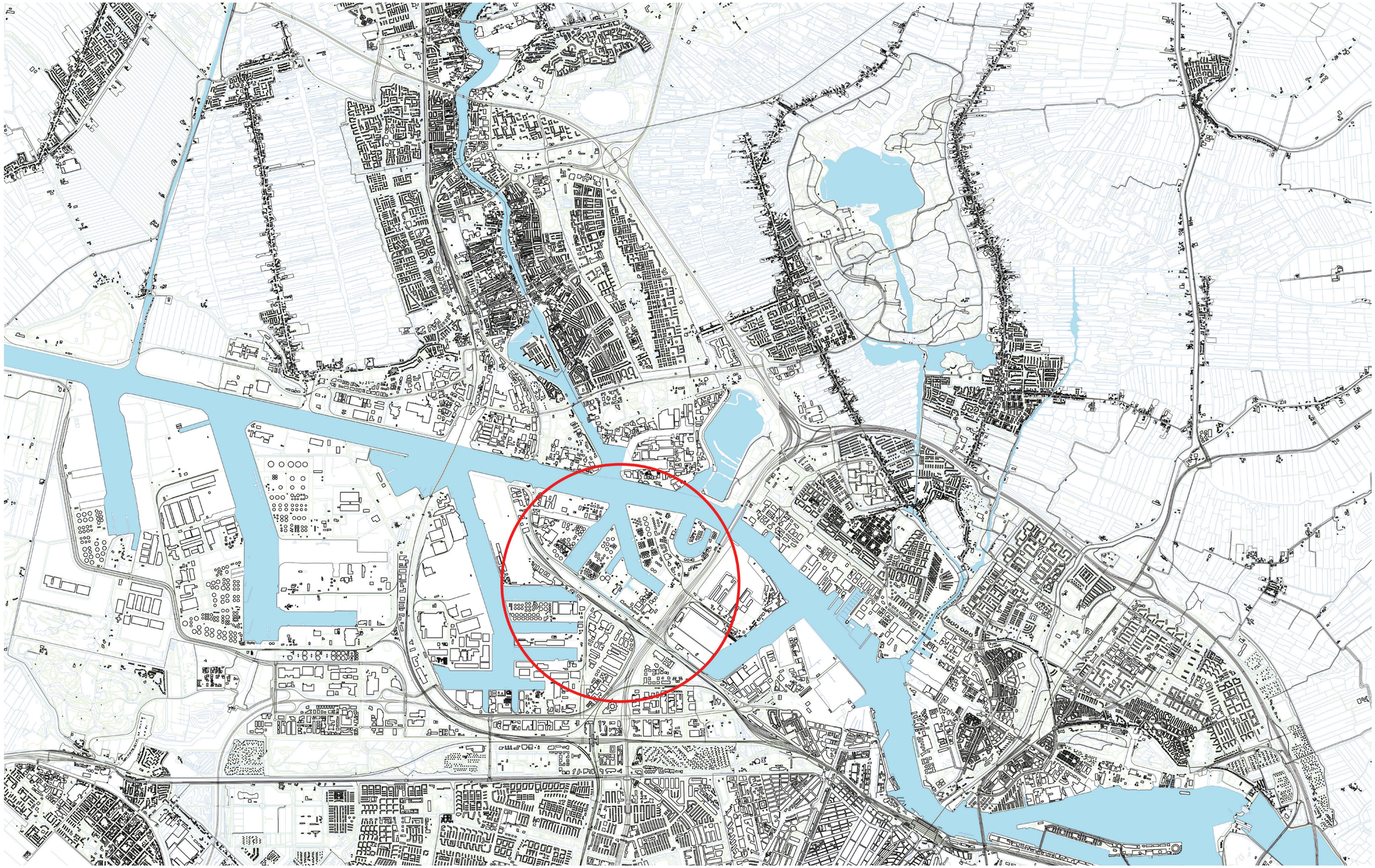
Redevelopment Strategies

What are the reuse opportunities for these sites? How can the rejuvenation of industrial plant bring added value on a neighborhood scale in contributing to sustainable development goal?

Various methods of re-purposing the power plants. Possibilities of integrating industrial landscapes within the expanding cities.

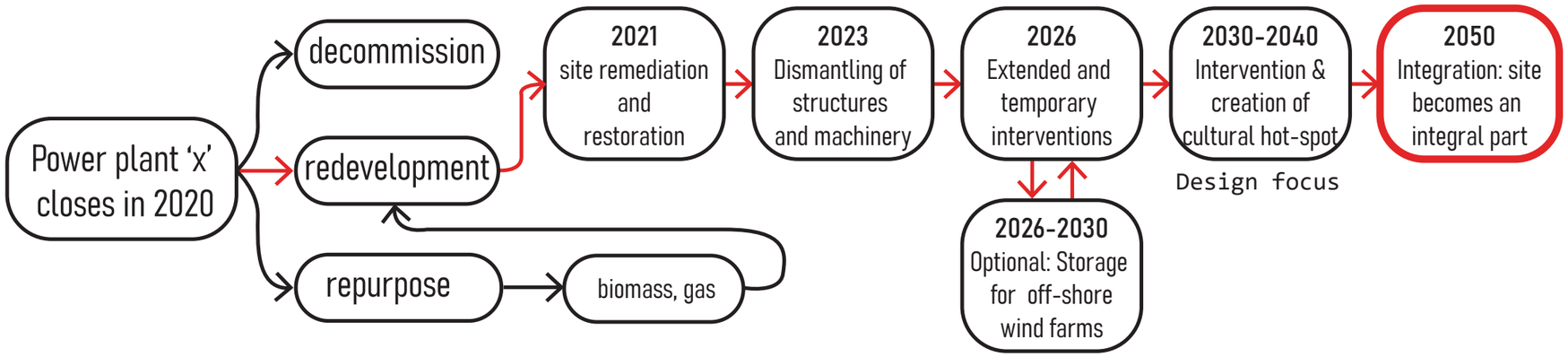


Site



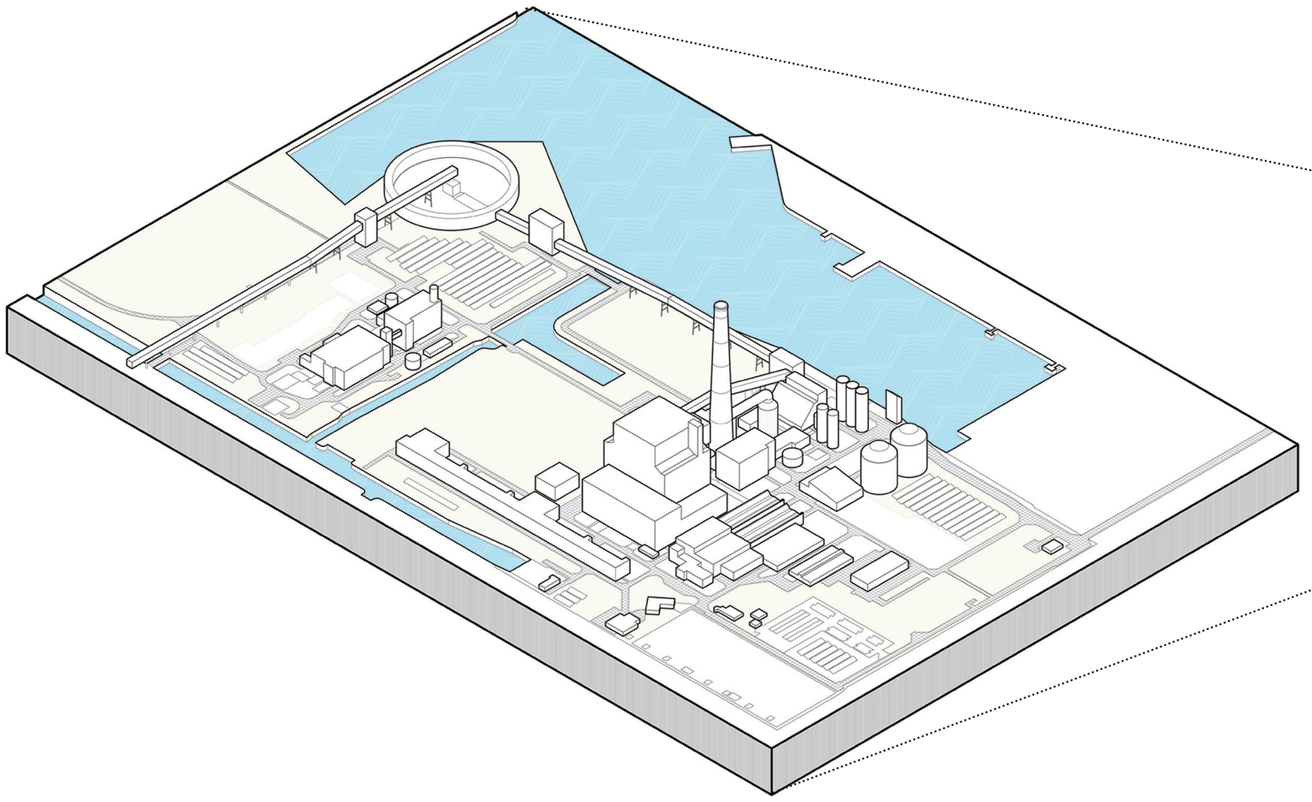
Redevelopment Phase Timeline

Creating a time-line of redevelopment for a power plant from the above-mentioned strategies. Assuming a coal-power plant ‘x’ closes in the year 2020. It would be faced with 3 viable strategies. Adopting the ‘Planned reuse’ redevelopment strategy for a power plant considering a close collaboration between the owner, state government and public organization; a stepwise elaborated strategy is illustrated in the diagram.



Timeline

2018-2019



Remediation and cleaning of site from contamination.

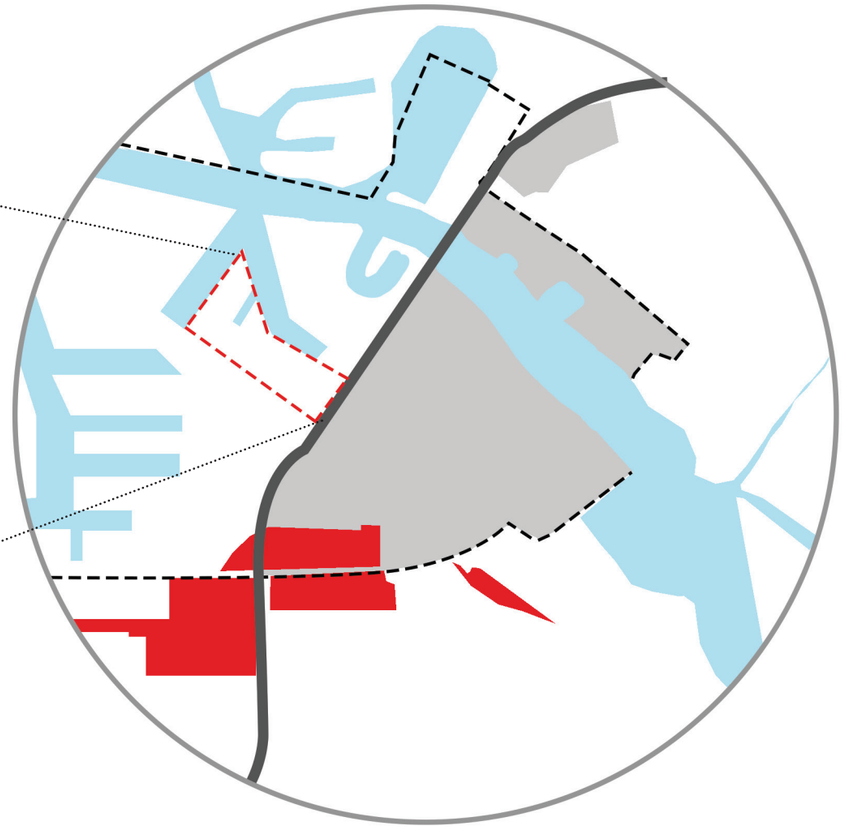
Removal of Unwanted Structures.

Planning of future re-use strategies.

>2018a:

Locations

Sloterdijk Centrum,
Sloterdijk I- Zuid,
Zaanstraat Emplacement.



1.800.000 m2 total BVO

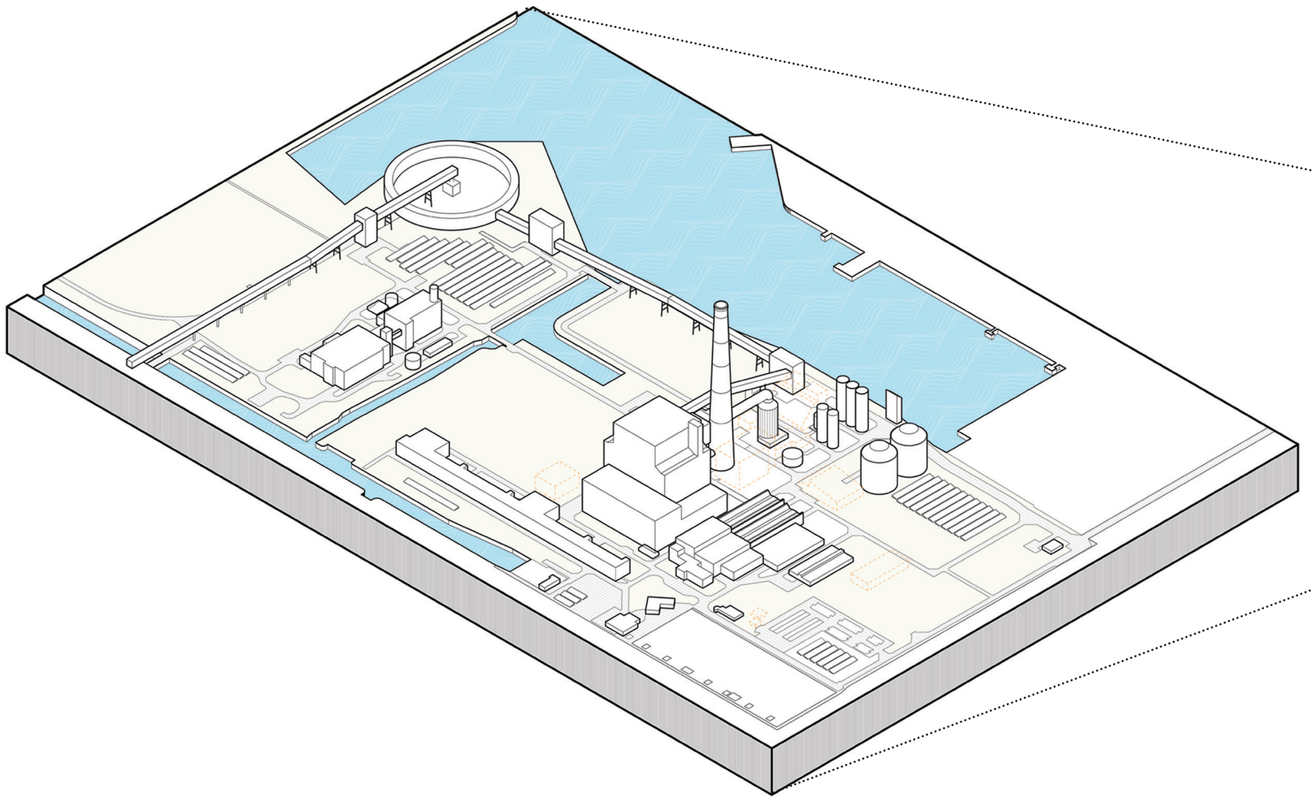
14.800 homes

614.000 m2 BVO non-residential

20.500 jobs

Timeline

2019



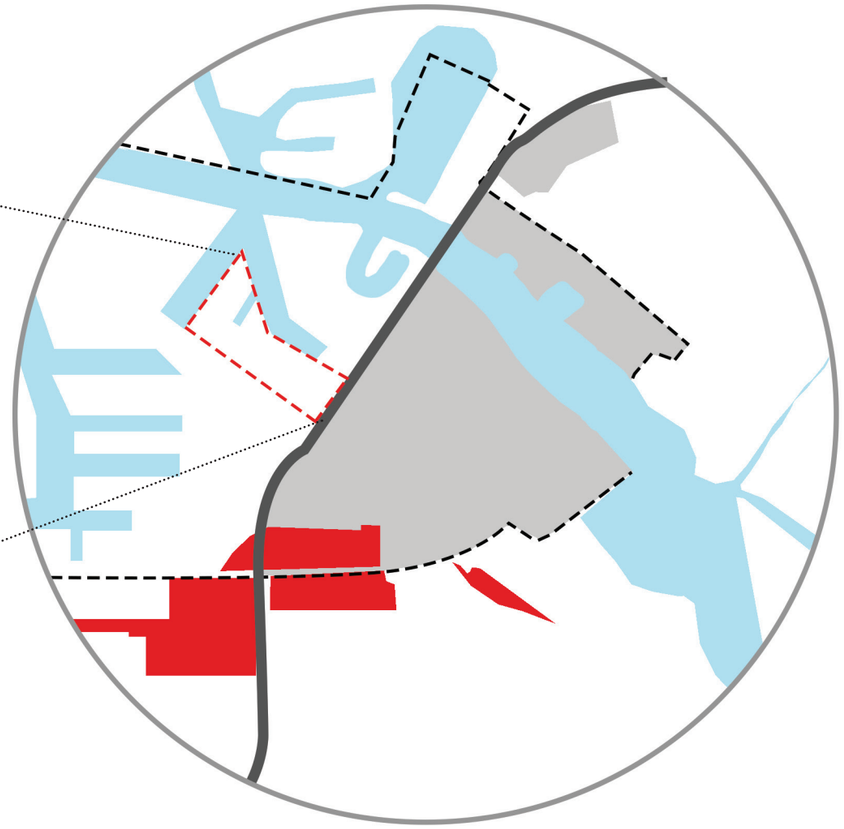
Dismantling structures and machinery

New program introduced.

Introducing the context to the city.

>2018b:
Locations

Sloterdijk Centrum-Noord,
Sloterdijk I-Noord.



627.000 m2 total BVO (Total 2.427.000)

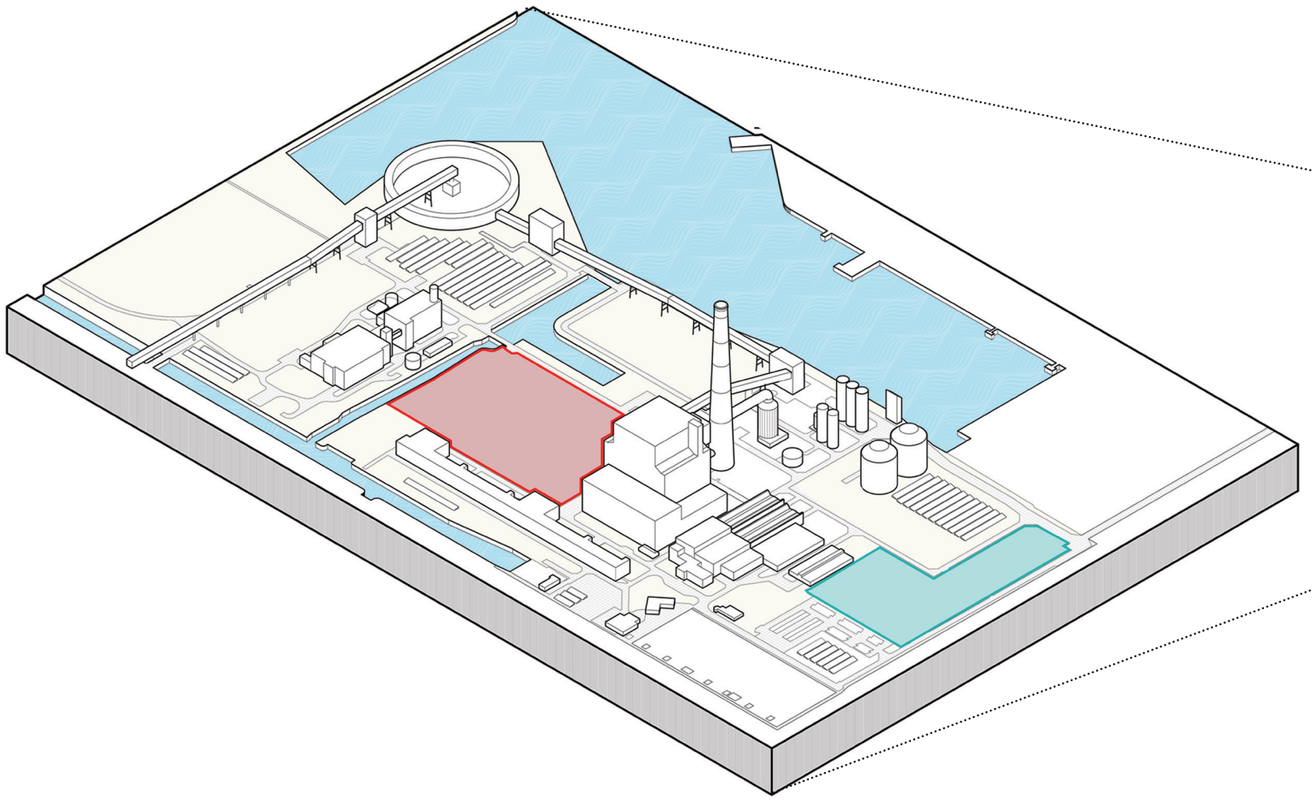
6.300 homes (Total 21,100)

125.500 m2 BVO non-residential
(Total 739.000)

4.200 jobs (Total 24.700)

Timeline

2023-2029



Dismantling flue gas treatment plant, auxillary functions and structures on site.

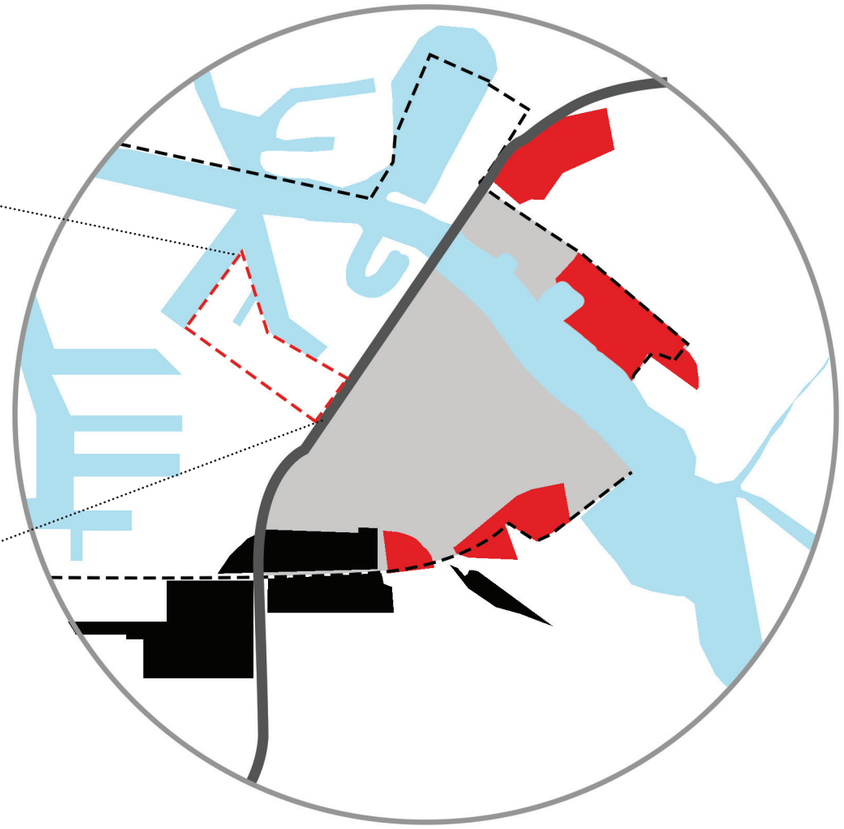
Programs like machine park and exoskeleton park opened.

Additional programs like concert spaces, pop-up exhibitions, expo, Dutch design weeks, sports activities introduced.

>2029a:

Locations

Sportak Transformatorweg,
Zonnehoek/ Minervahaven,
Cornelis Douwes,Melkweg Oostzanerwerf.



1.914.000 m2 total BVO (Total 4.341.000)

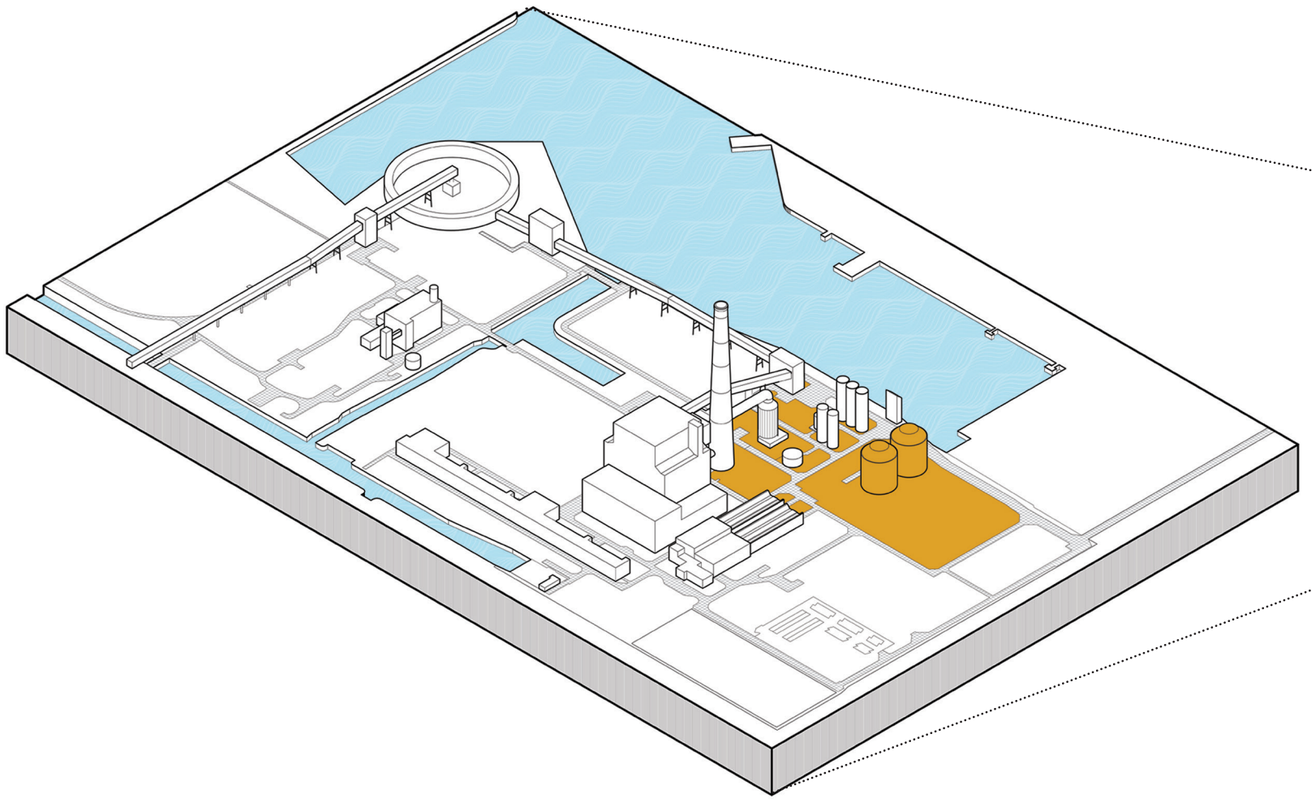
19.300 homes (Total 40,400)

372.000 m2 BVO non-residential
(Total 1.111.5.000)

12.000 jobs (Total 36.700)

Timeline

2030



Intervention and design focus.

Basalt Battery.

Integration of site with the context, thereby aiming to create a cultural-hotspot for the city

>2029b:
Locations

Alfadriehoek,
Hempoint/ Minervahaven-Noord,
Cornelis Douws 0-1.

1.753.000 m2 total BVO (Total 6.094.000)

17.500 homes (Total 57.900)

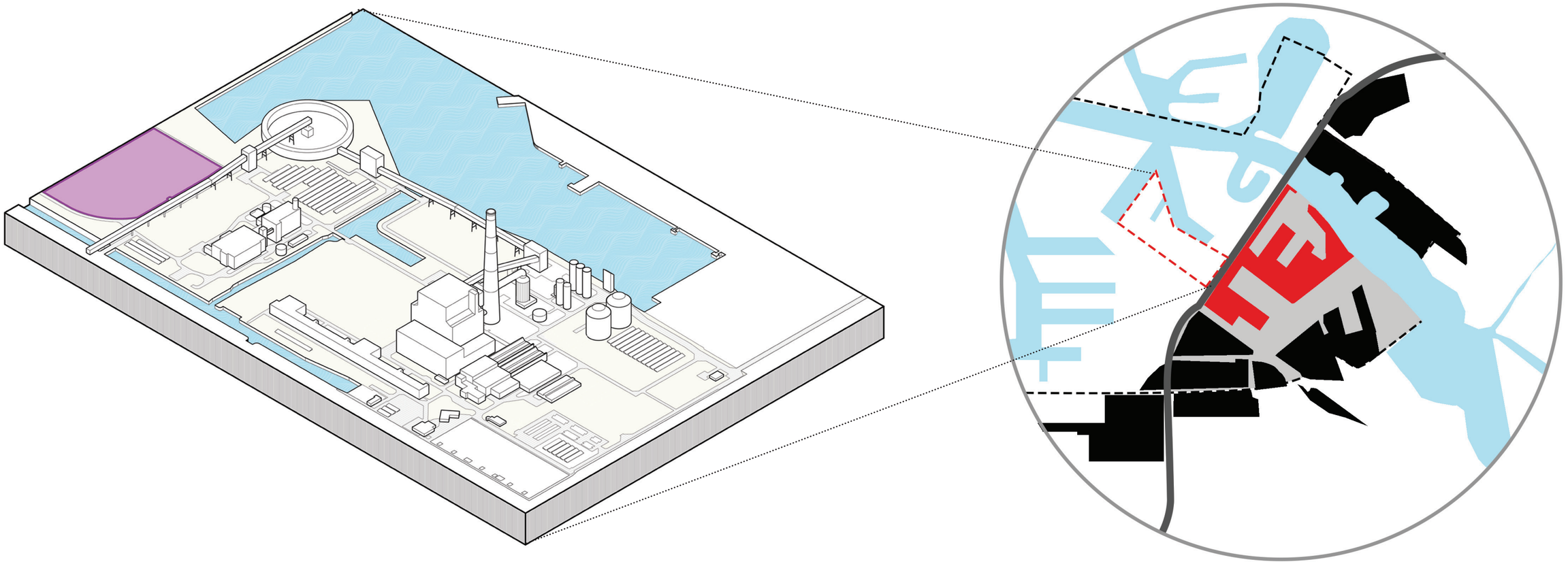
350.000 m2 BVO non-residential
(Total 1.461.500)

11.700 jobs (Total 48.400)

Timeline

2040

>2029b:
Locations
Coen-en Vlothaven.



Other side of the site goes under development.

Protagonist to new developments and a catalyst to the neighborhood.

1.540.000 m2 total BVO (Total 7.634.000)

15.400 homes (Total 73.300)

308.000 m2 BVO non-residential (Total 1.769.500)

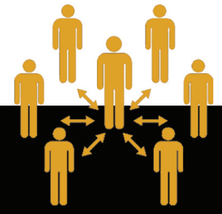
10.300 jobs (Total 58.700)

Collage 2050

Program

Center for material exploration

[Material exploration center for wood & steel, but also new experiments with sustainable materials. Building provides space for implementation.]
_Labs & rooms with necessary equipment
_Startup office spaces
_Workshop & Incubation spaces
_Meeting rooms/lecture halls
_Small auditorium (~50-75 people)
_Service rooms
_Site redesign & maintenance office



Recreational

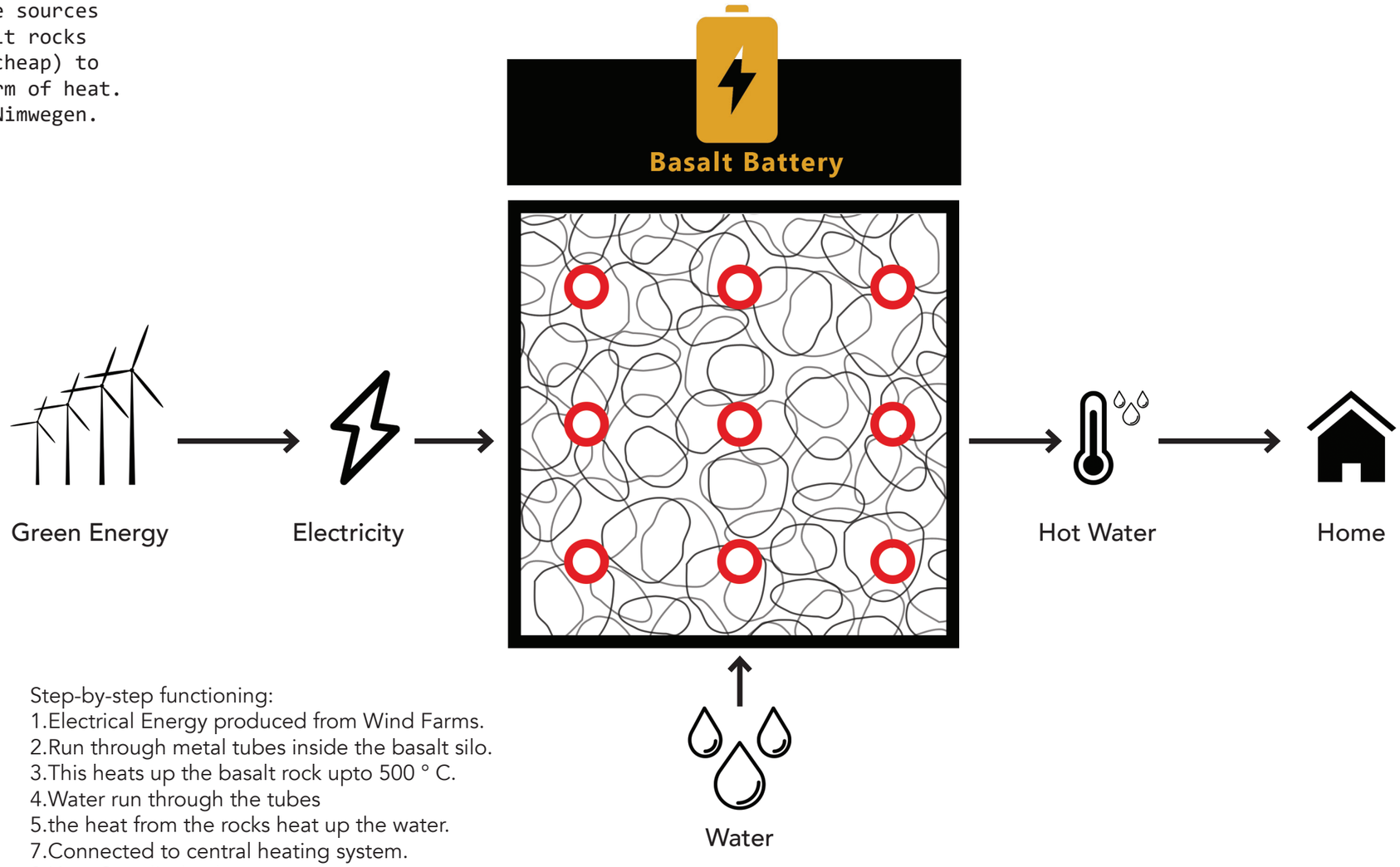
[Space for interaction between people-city-material exploration]
_Multipurpose rooms
_Indoor exhibition spaces
_Cafe, Shop & services
_Office for recreational activities

Basalt Battery

Use of Basalt rocks to store Green energy in the form of heat and supply it to nearby facilities for heating.
_Central basalt battery core
_Services and auxillary programs

Basalt Battery

When Green Energy is in abundance
- how do we store it?
2019 Climate agreement clearly
stats that we need to transition
from gas to sustainable sources
of energy. Use of basalt rocks
(easily available and cheap) to
store energy in the form of heat.
Developed by Cees van Nimwegen.



Step-by-step functioning:
1.Electrical Energy produced from Wind Farms.
2.Run through metal tubes inside the basalt silo.
3.This heats up the basalt rock upto 500 ° C.
4.Water run through the tubes
5.the heat from the rocks heat up the water.
7.Connected to central heating system.
8.Heat Supplied at home.

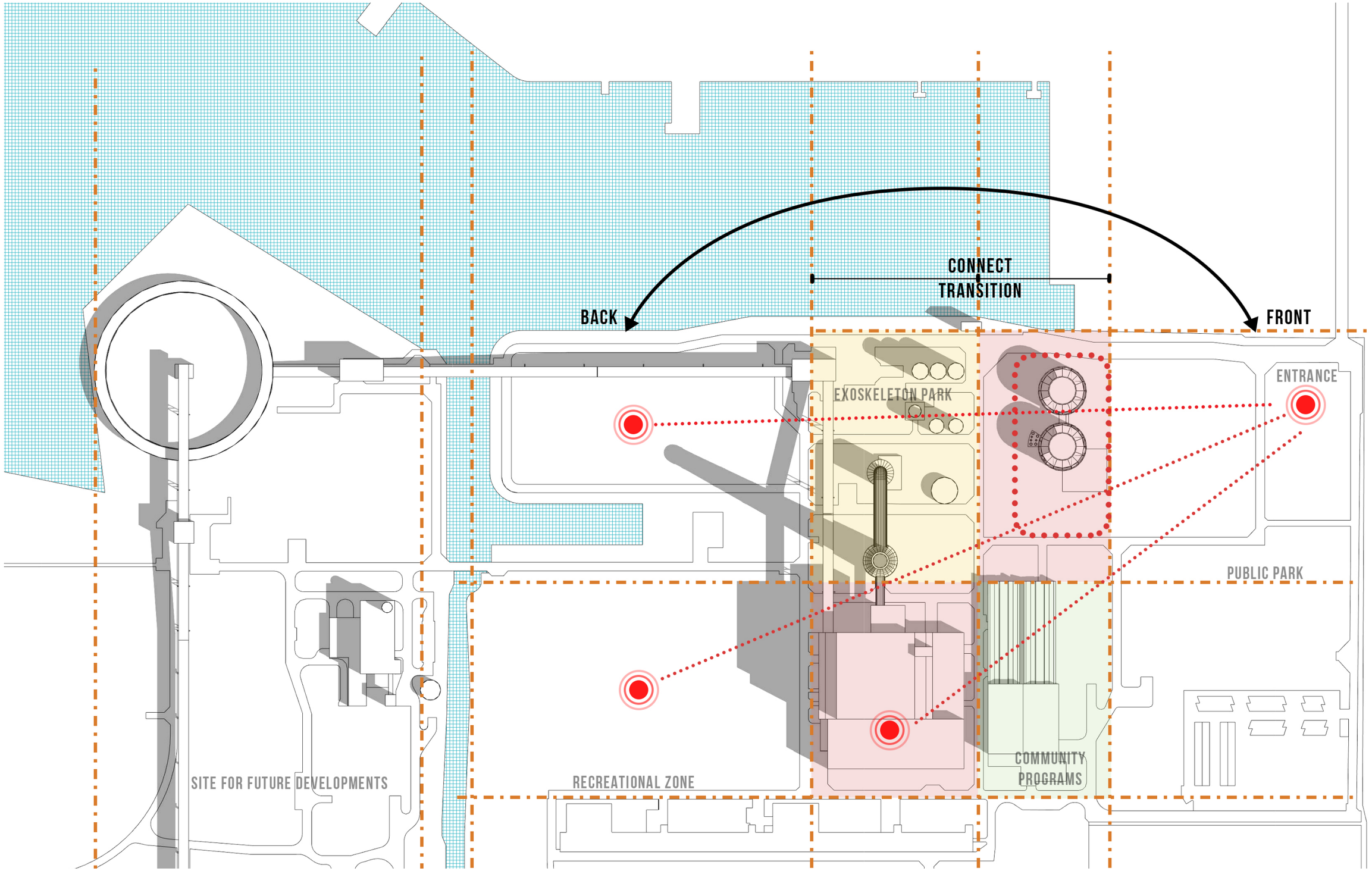
400 Cubic. Meter of volume → **80.000kW hours** → **20 homes**

Basalt battery in my design.

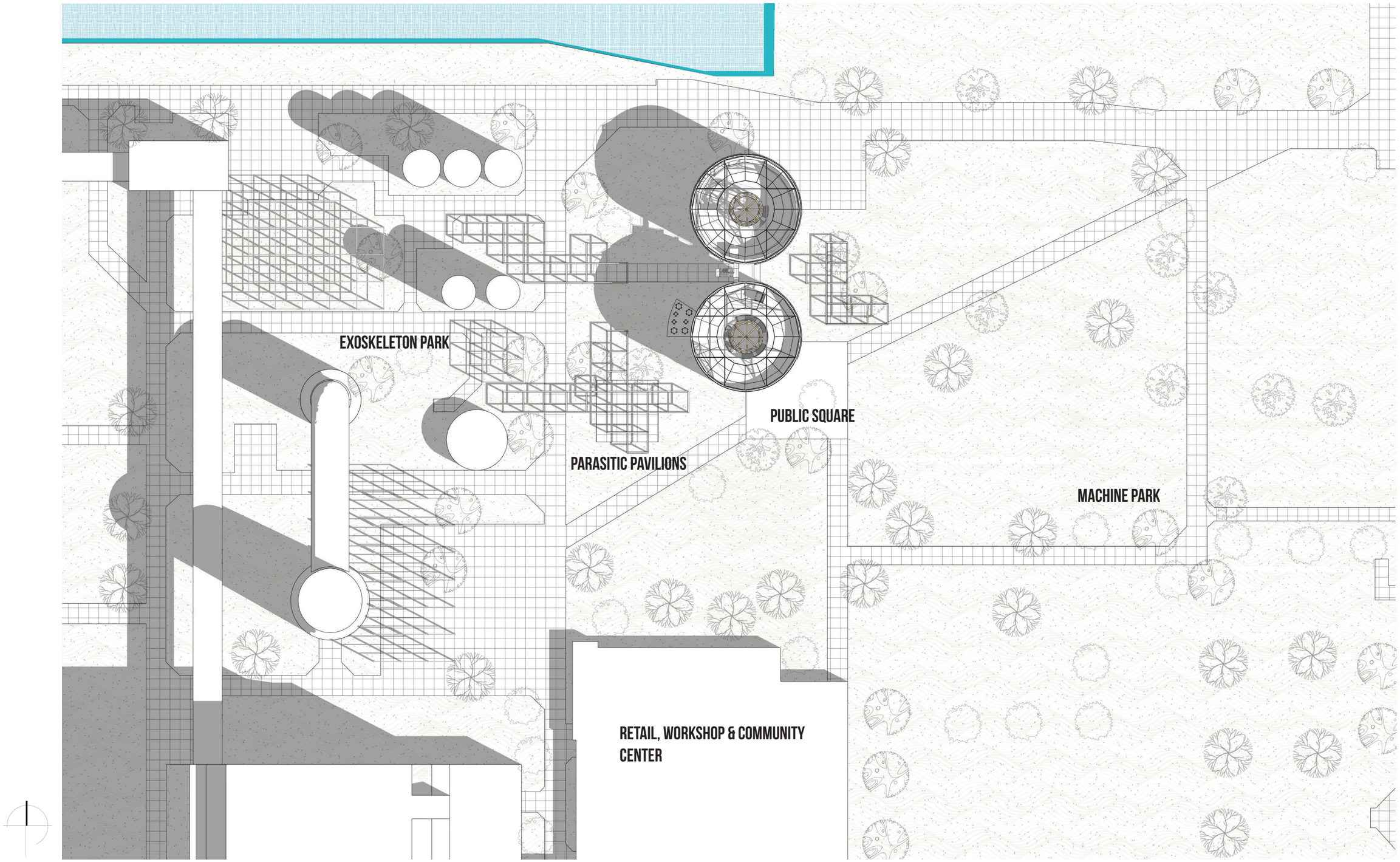
~3800 Cubic. Meter of volume → **~760.000kW hours** → **~200 homes**

Source: 'The story behind a rock-solid idea:the basalt battery' *https://www.vpro.nl/programmas/tegenlicht/lees/artikelen/2021/het-verhaal-achter-een-steengoed-idee-de-basalt-batterij.html*

Site Plan Concept

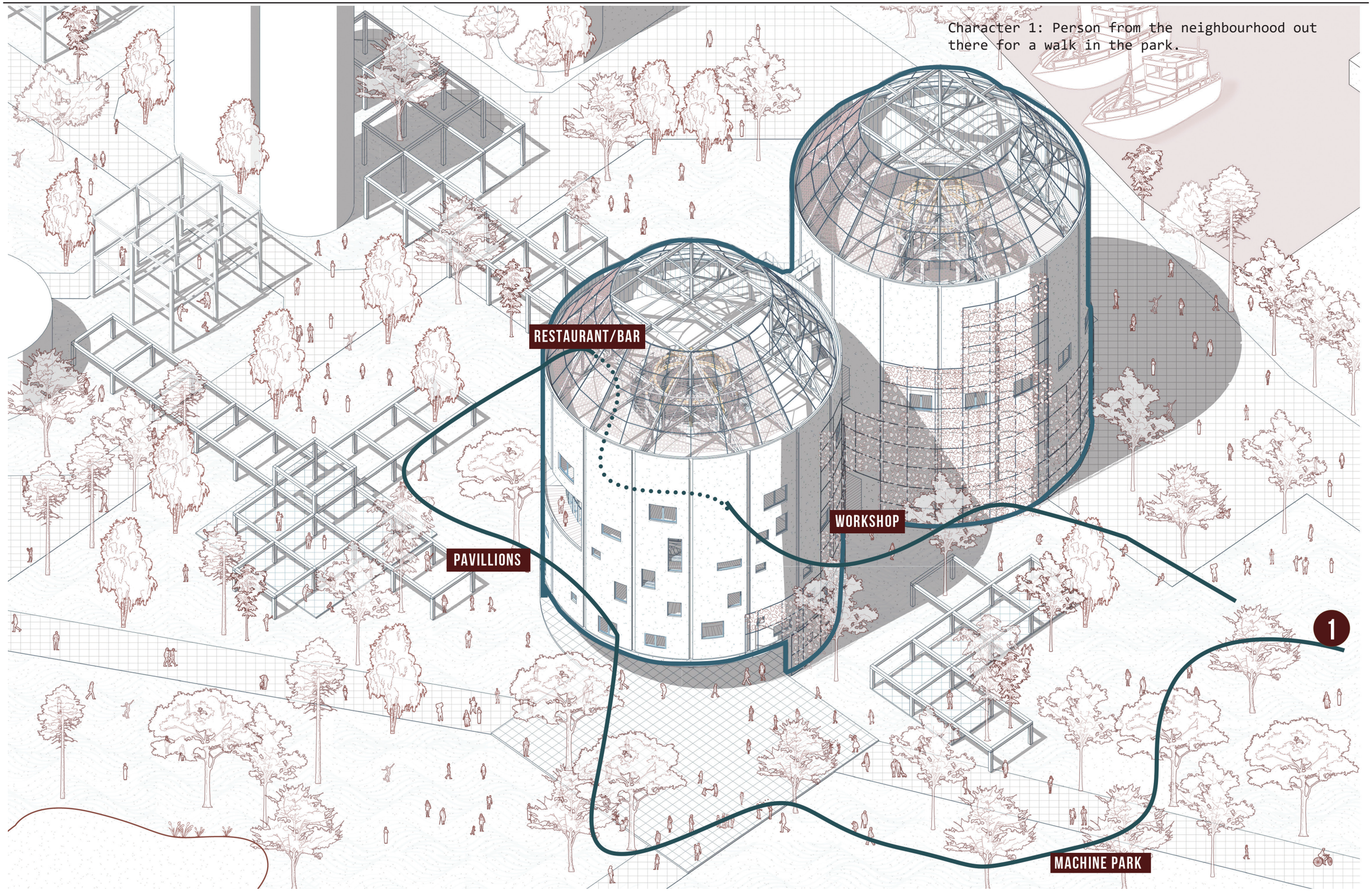


Site Plan


EXOSKELETON PARK
PARASITIC PAVILIONS
PUBLIC SQUARE
MACHINE PARK
RETAIL, WORKSHOP & COMMUNITY CENTER
0
15
30
45M

Machine Park Collage

Transitions and Connections



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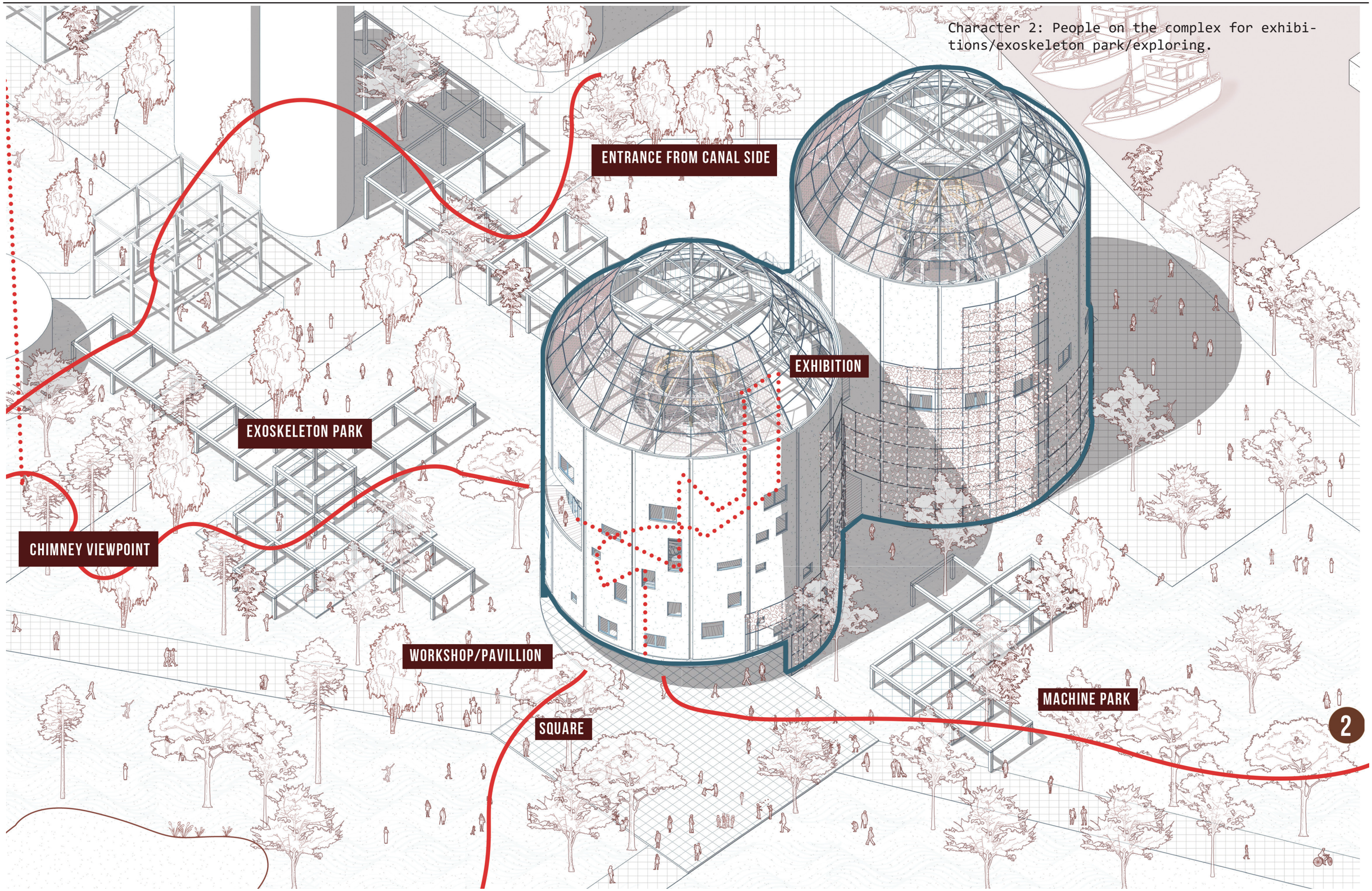

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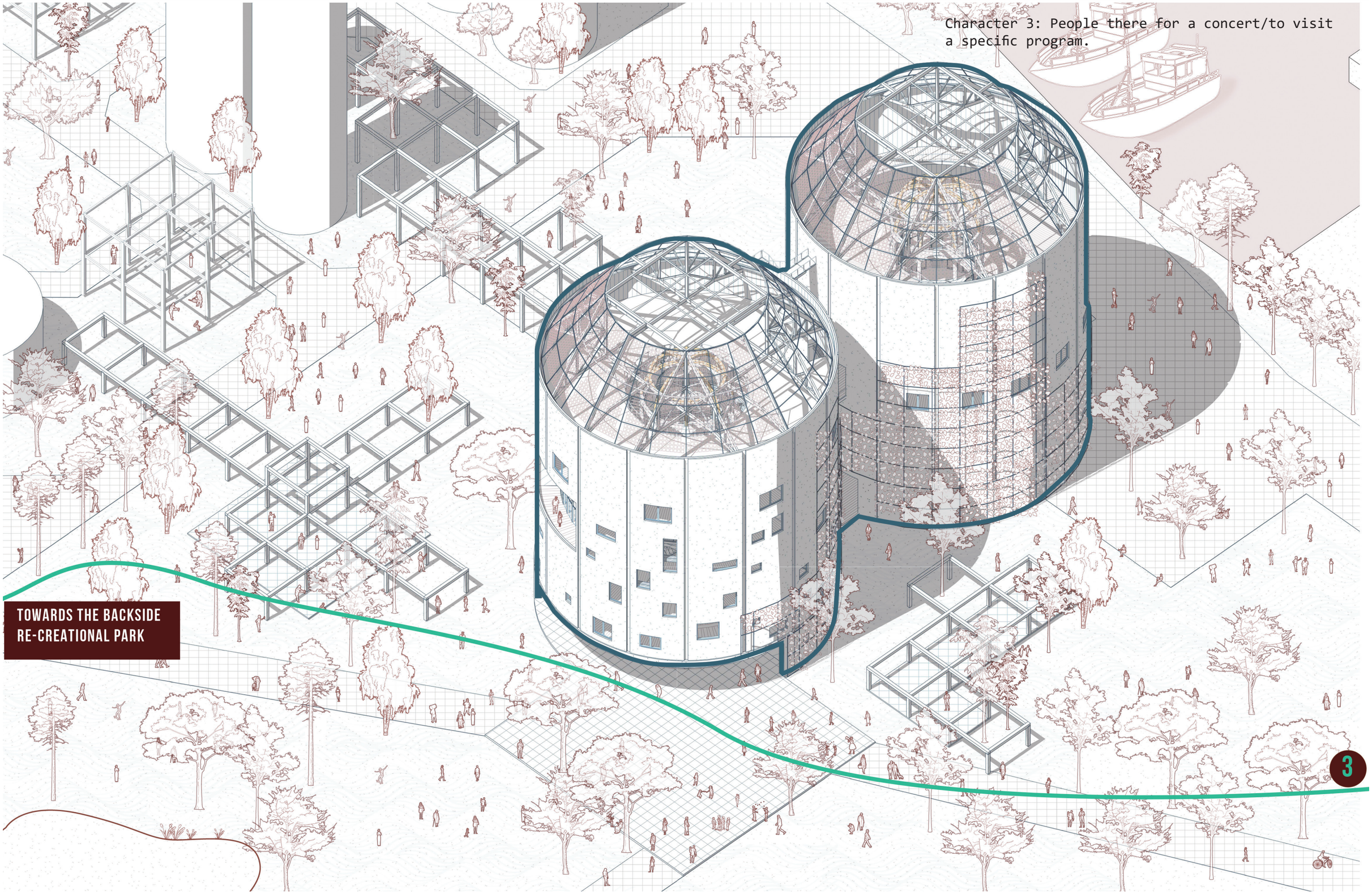

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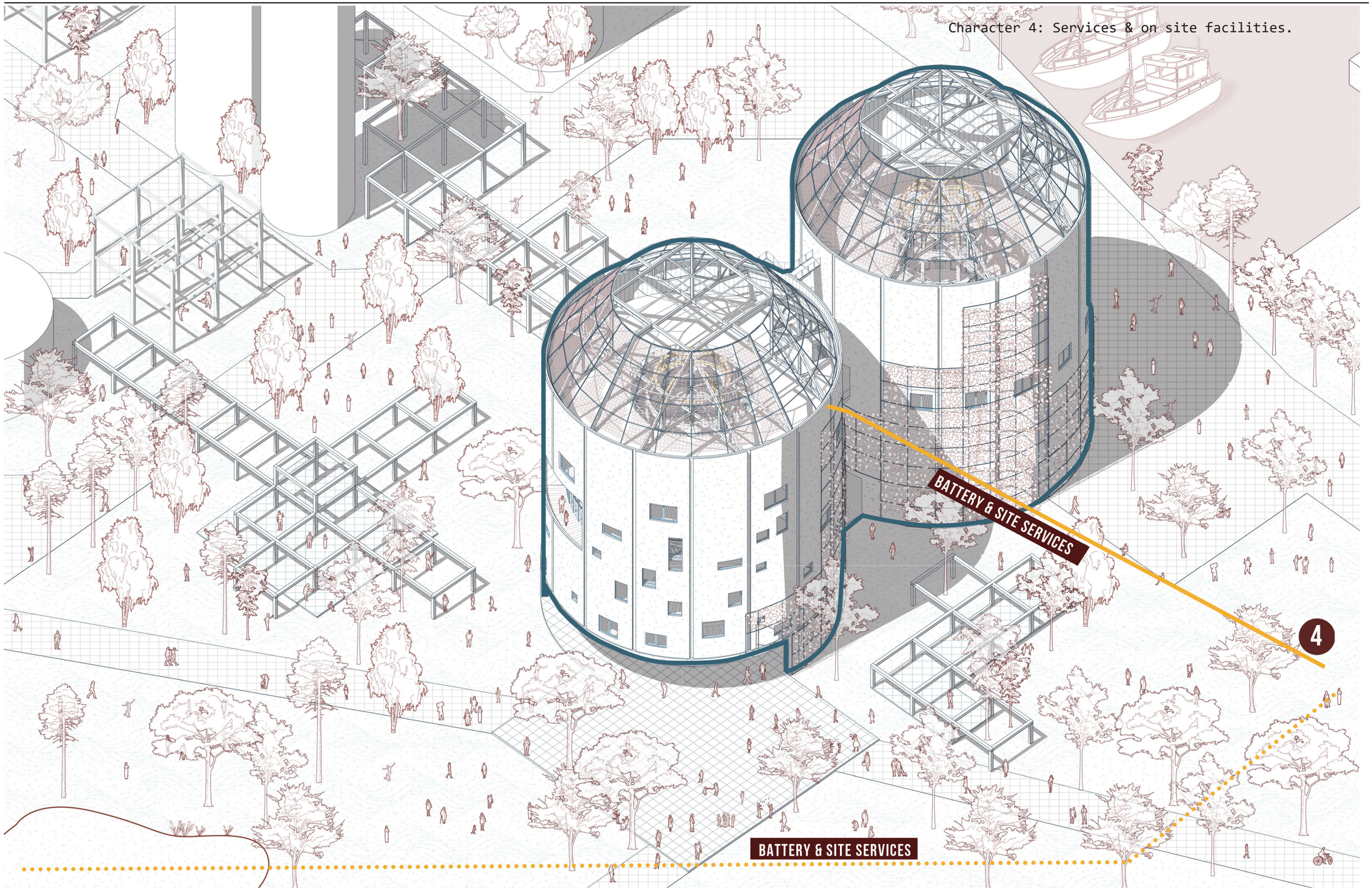

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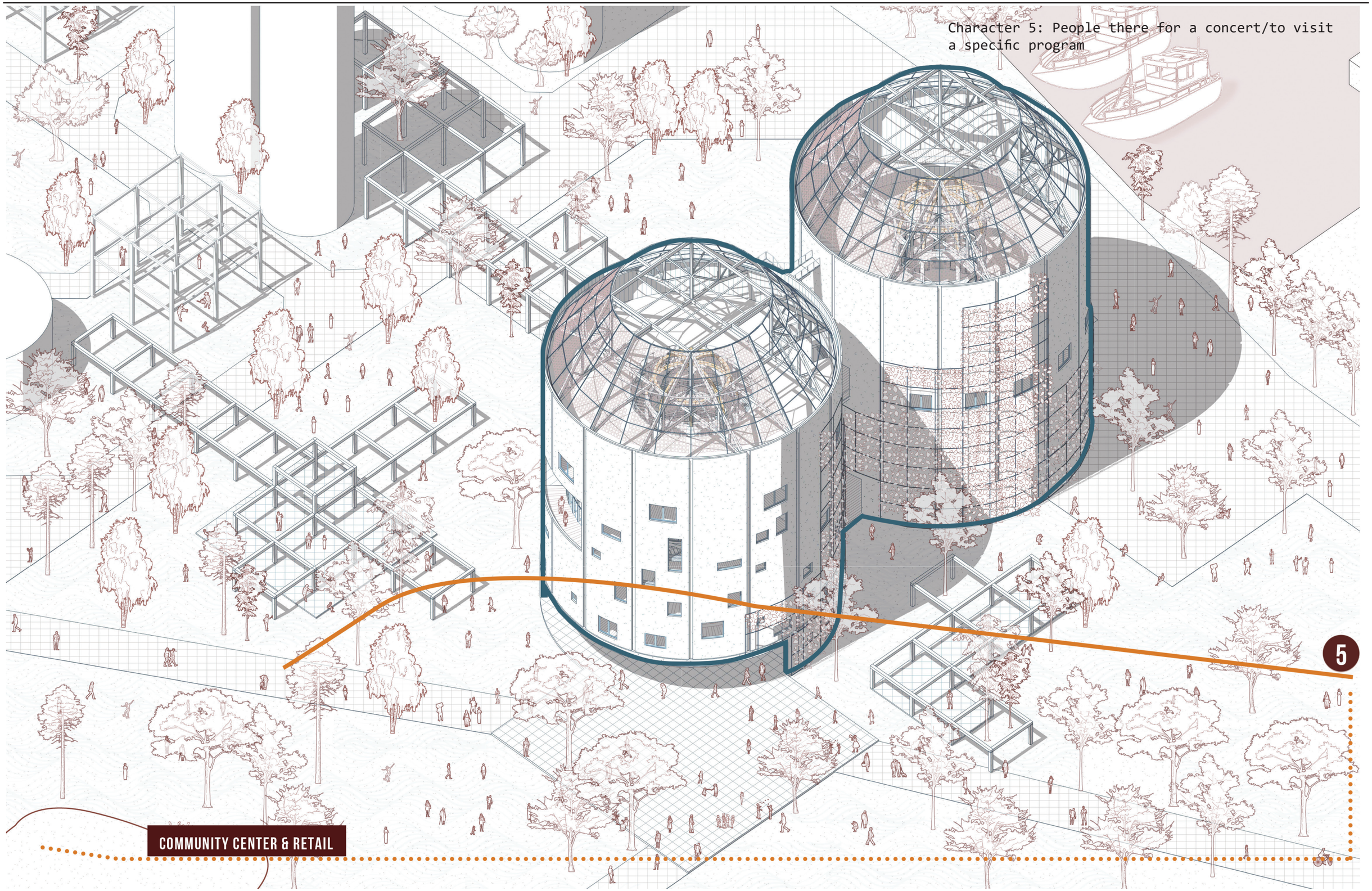
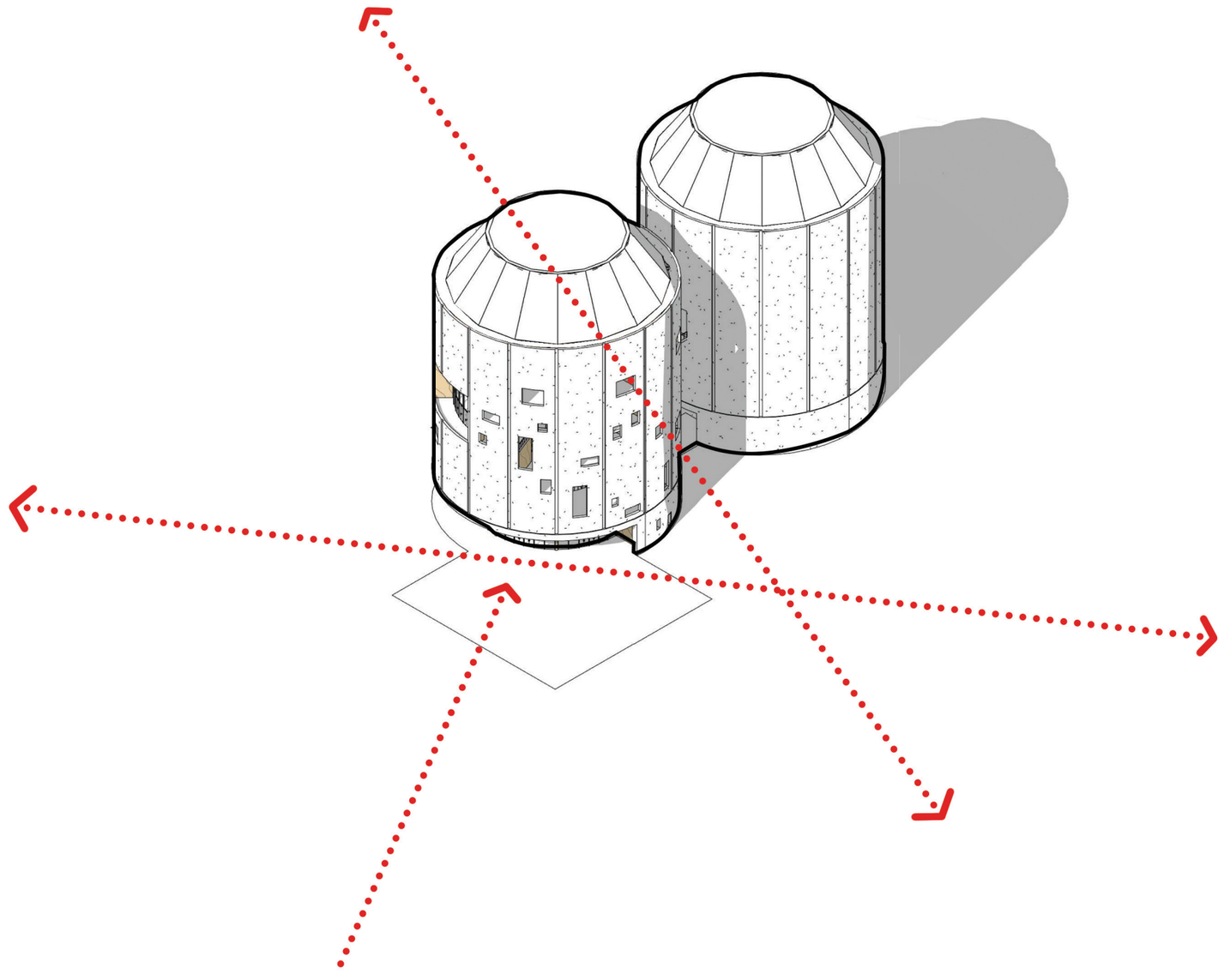


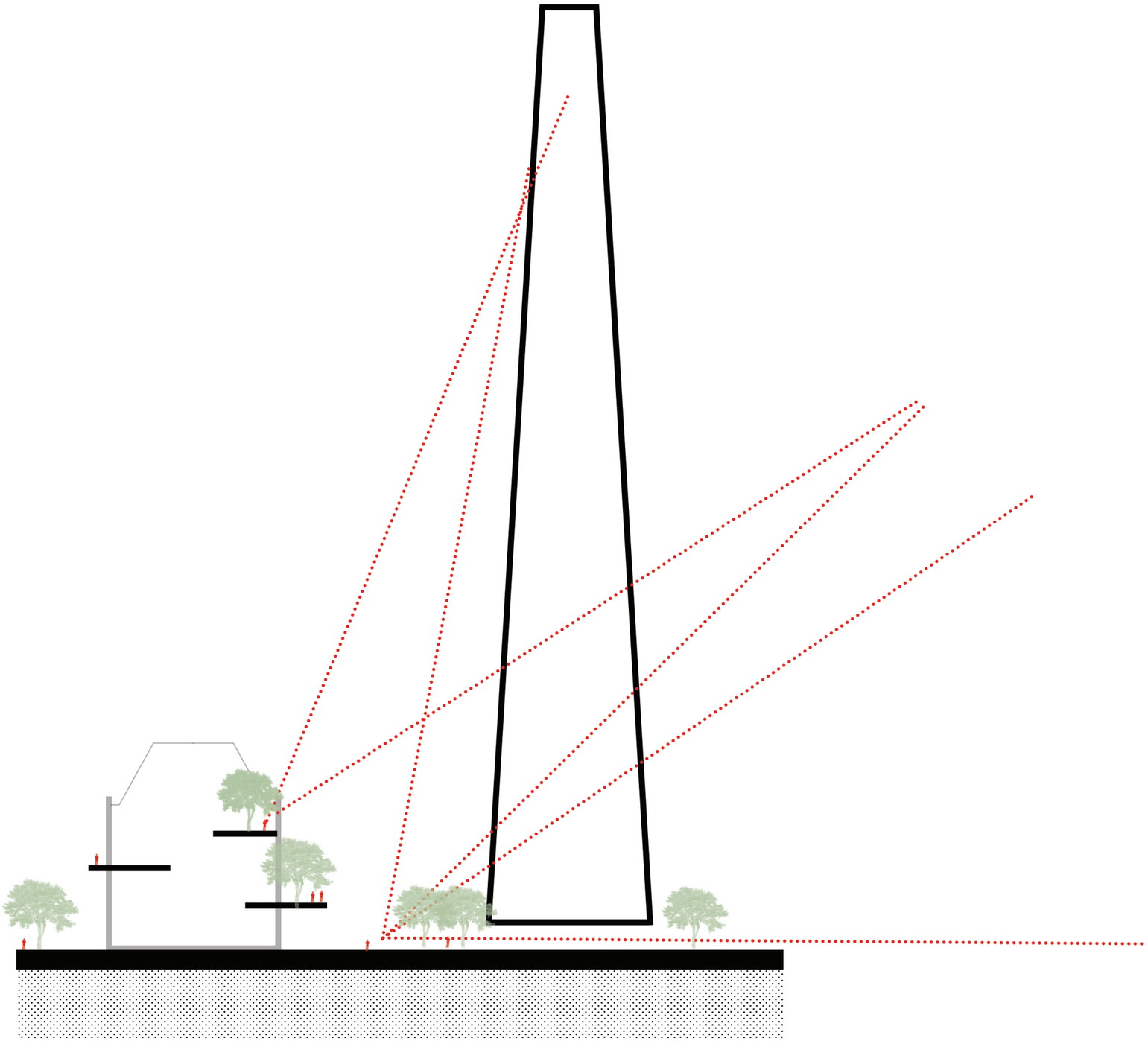
Design Concept : Open Ground floor

Since the building is essential in connections towards the back of the site; opening up the ground plane to facilitate a porous and continuous flow of movement.



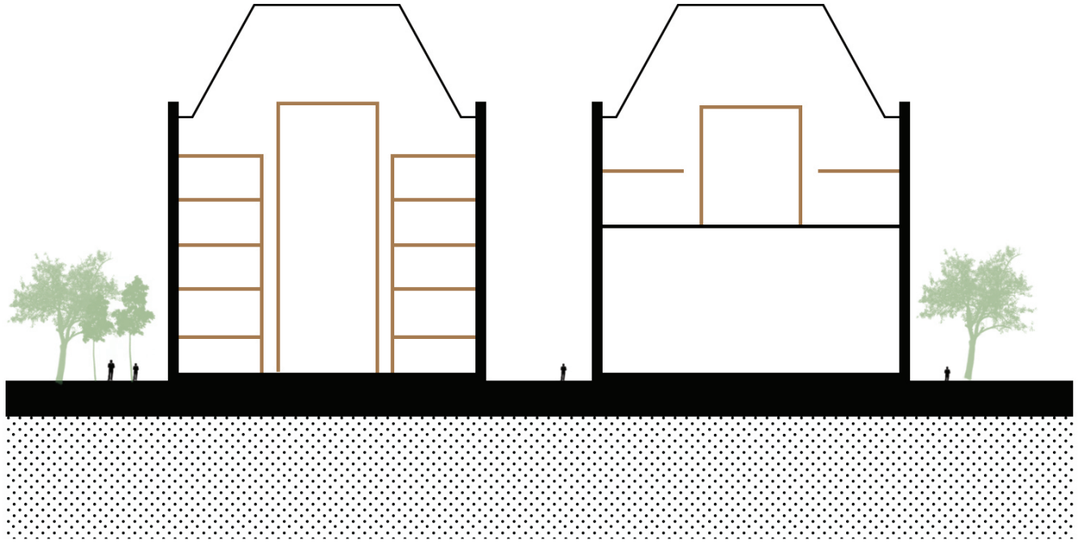
Design Concept : Scale

With the inhumane scales of the site, with chimney and generation building being as high as 180M and 90M in height respectively, the design aims to scale to down to more human levels.
But also having visual connections towards the facilities on site.



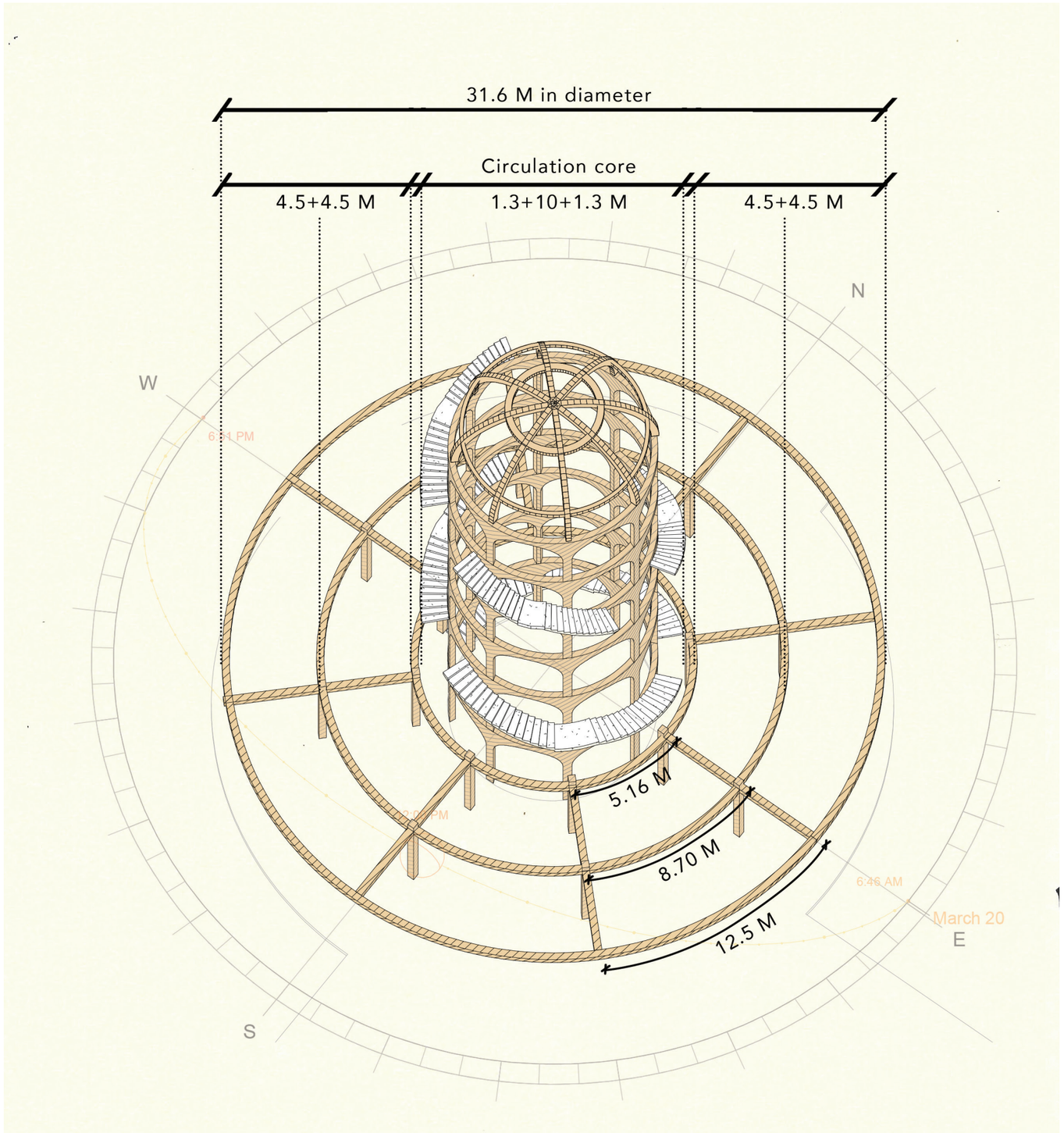
Design Concept : Parasite

Parasitic design inside the
existing silo. It is exaggerated
in the materiality, by using
a lighter material like wood
in contrast to the existing
concrete shell.



Design Concept : Materiality & Structure

Laminated veneer lumber column and beam structure with CLT slabs. The central arcade atrium is independent to which the staircase is cantilevered. BauBuche and CLT structure is anchored to the existing concrete shear walls. The dramatic circulation core in contrast to the banal industrial exterior is the guiding theme inside the building.

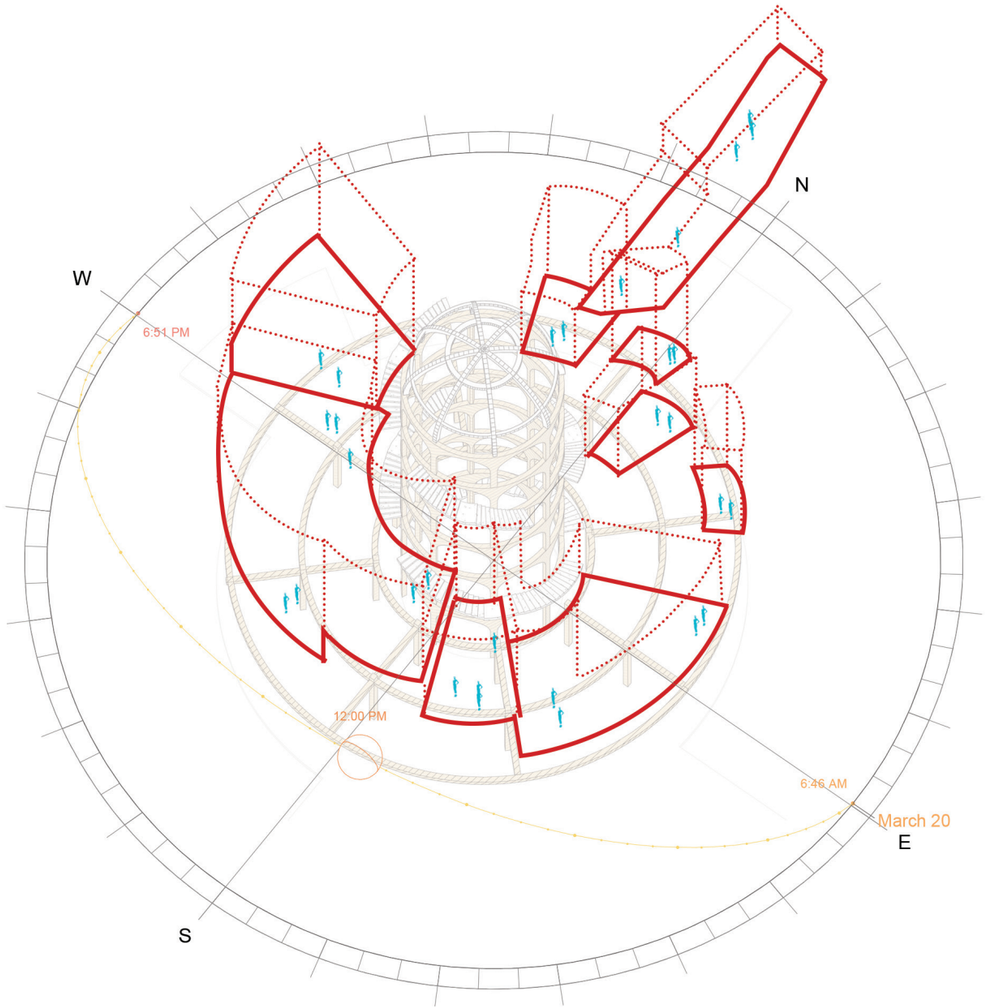


Design Concept : Terraces

The terraces connect the various levels physically and also visually. Adding another layer to the circulation with varying heights facilitating larger openings and bring light inside the building.

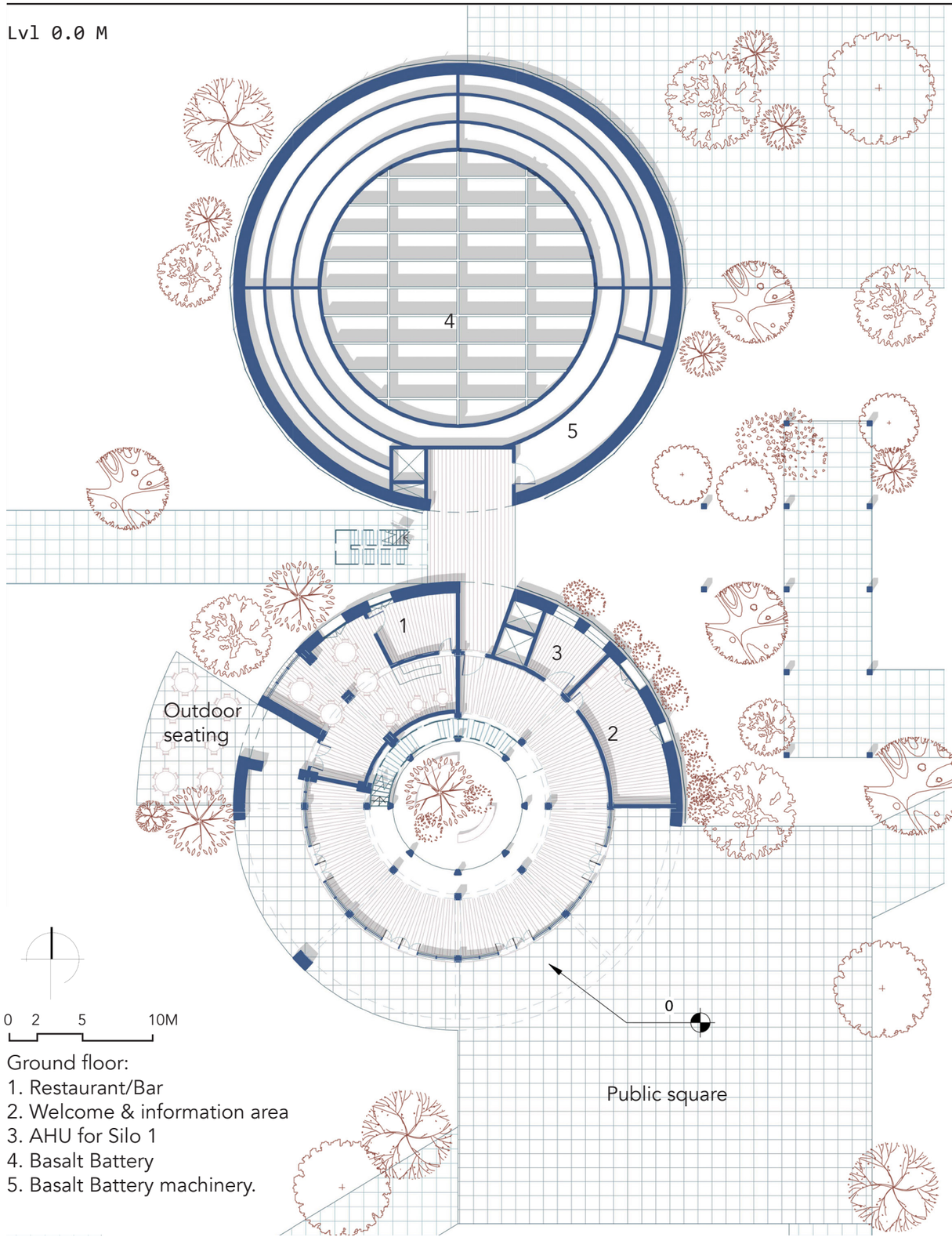
They also help breaking the mass down and the monotonous circulation. These cascading terraces connect various levels up to the winter garden on the top floor.

Aligned towards the south, south-west and west facade they bring light inside the building. They’re also aligned to have a visual connection to the rest of the site.



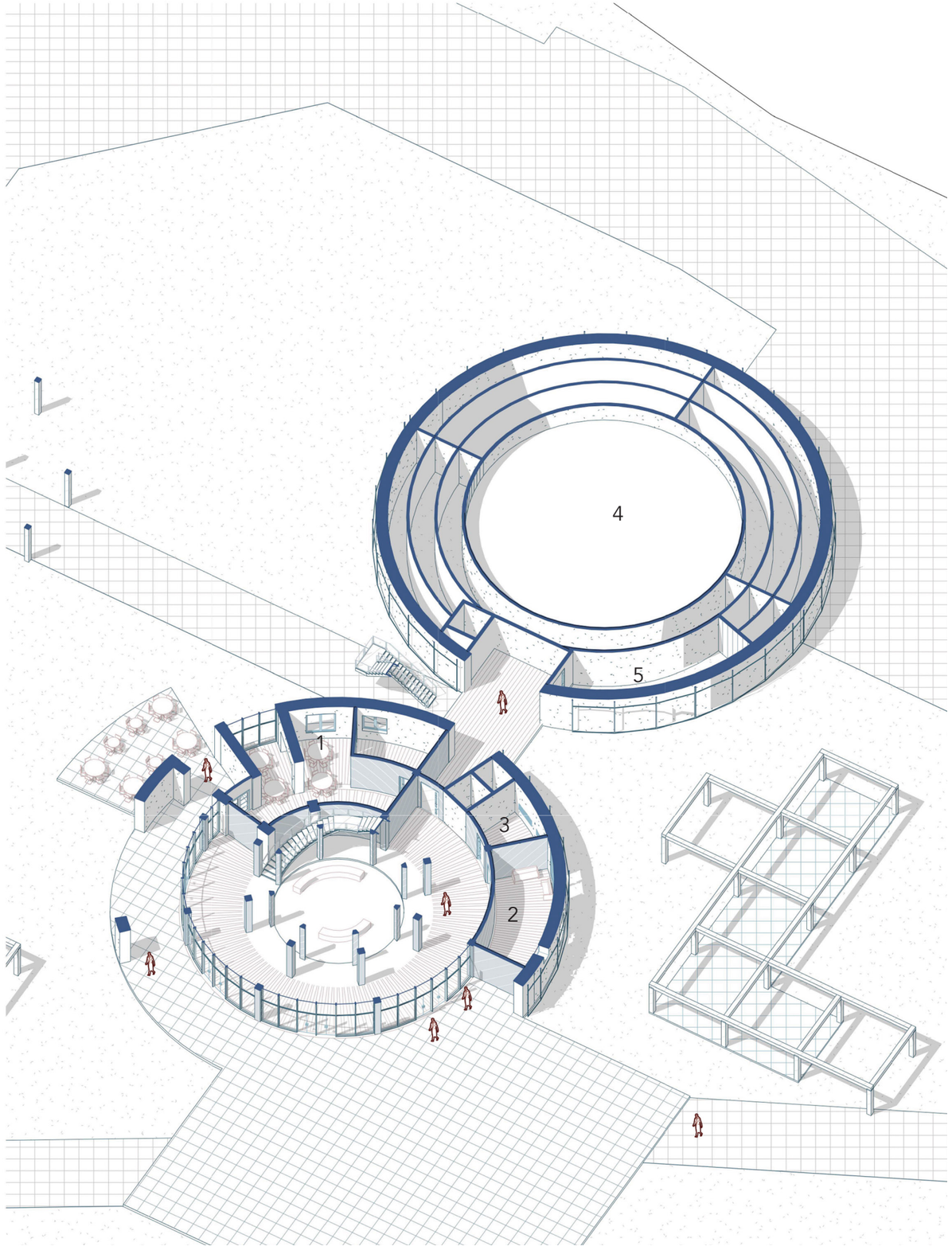
Ground Floor Plan

Lvl 0.0 M



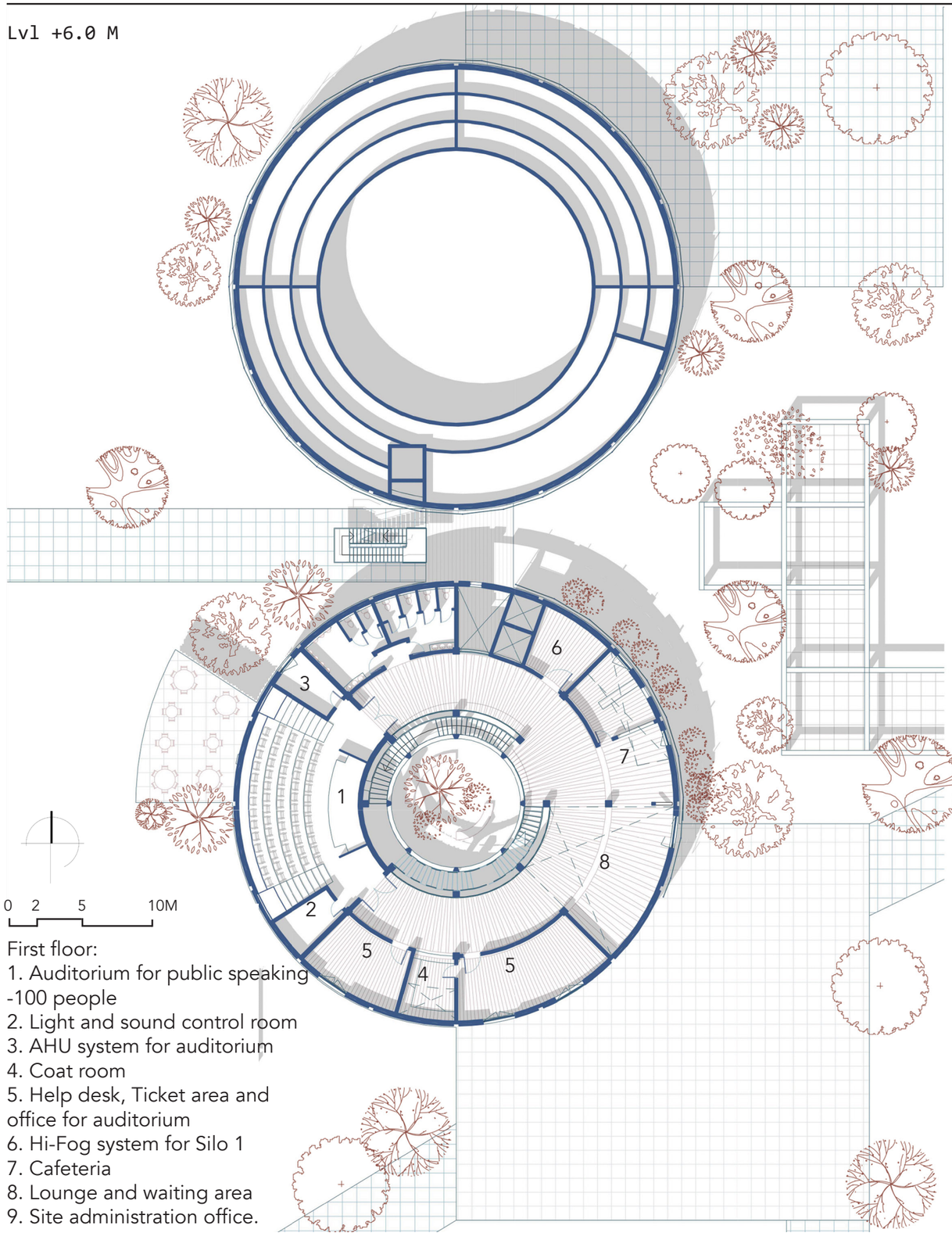
0 2 5 10M

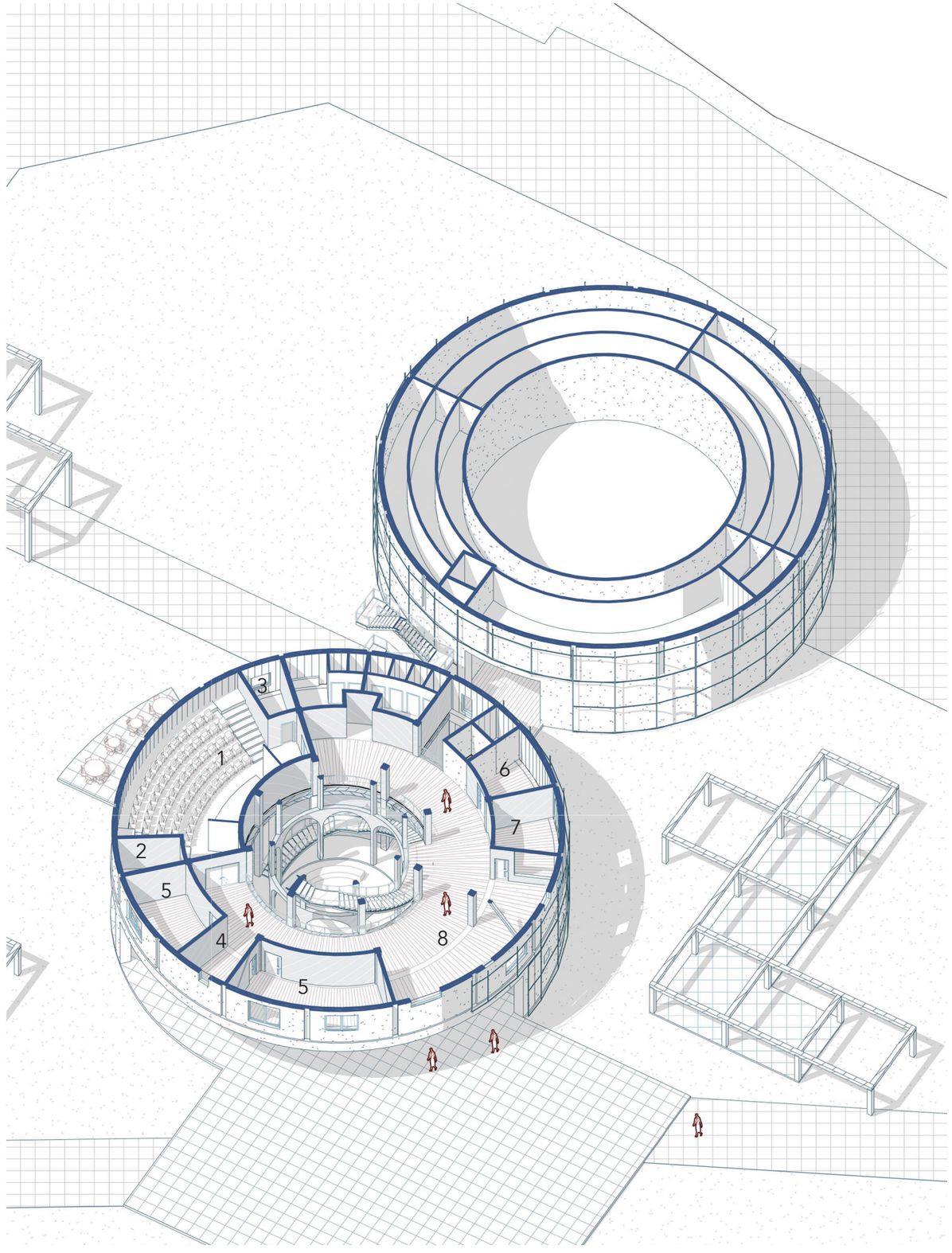
Ground floor:
1. Restaurant/Bar
2. Welcome & information area
3. AHU for Silo 1
4. Basalt Battery
5. Basalt Battery machinery.



First Floor Plan

Lvl +6.0 M

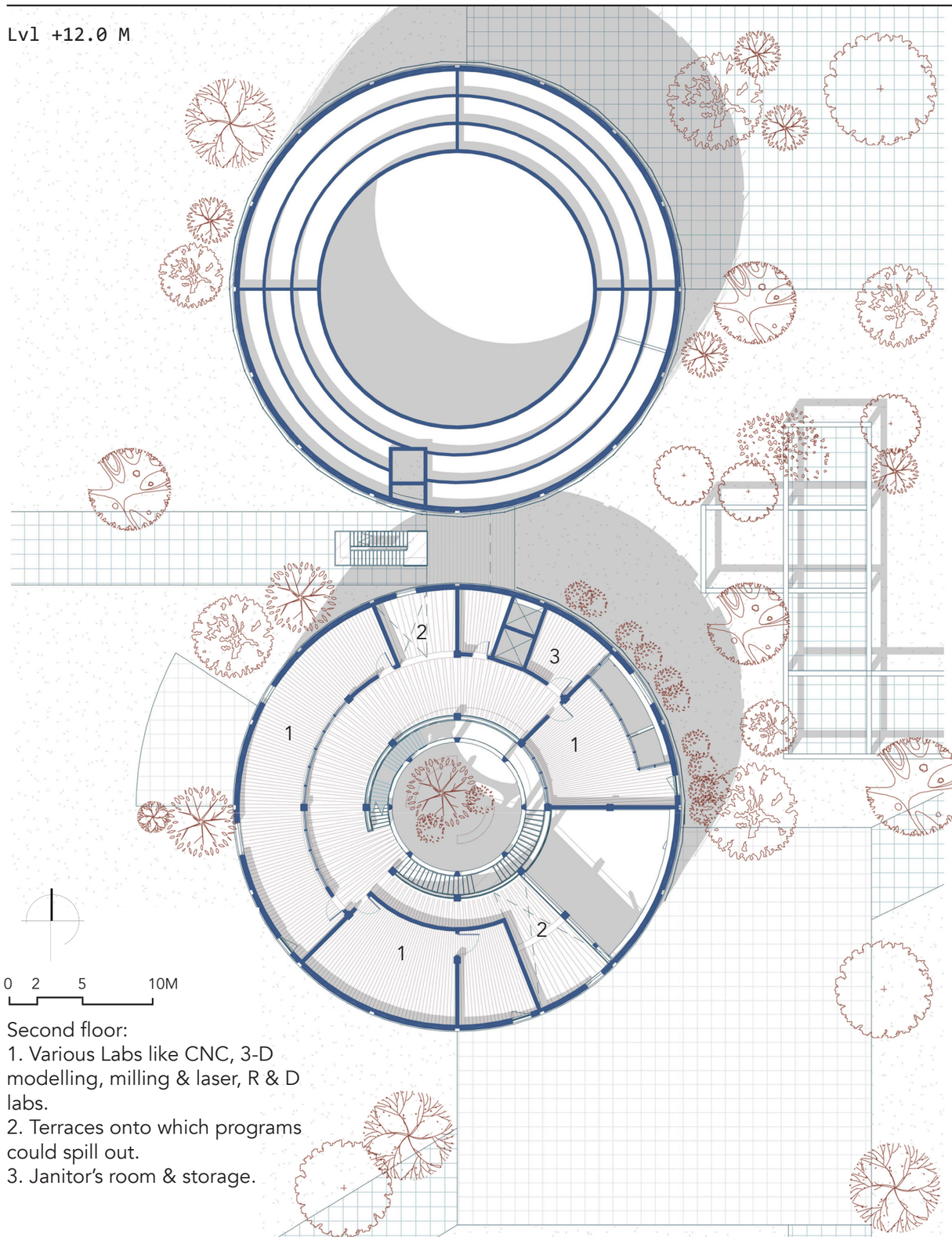




First floor:
1. Auditorium for public speaking -100 people
2. Light and sound control room
3. AHU system for auditorium
4. Coat room
5. Help desk, Ticket area and office for auditorium
6. Hi-Fog system for Silo 1
7. Cafeteria
8. Lounge and waiting area
9. Site administration office.

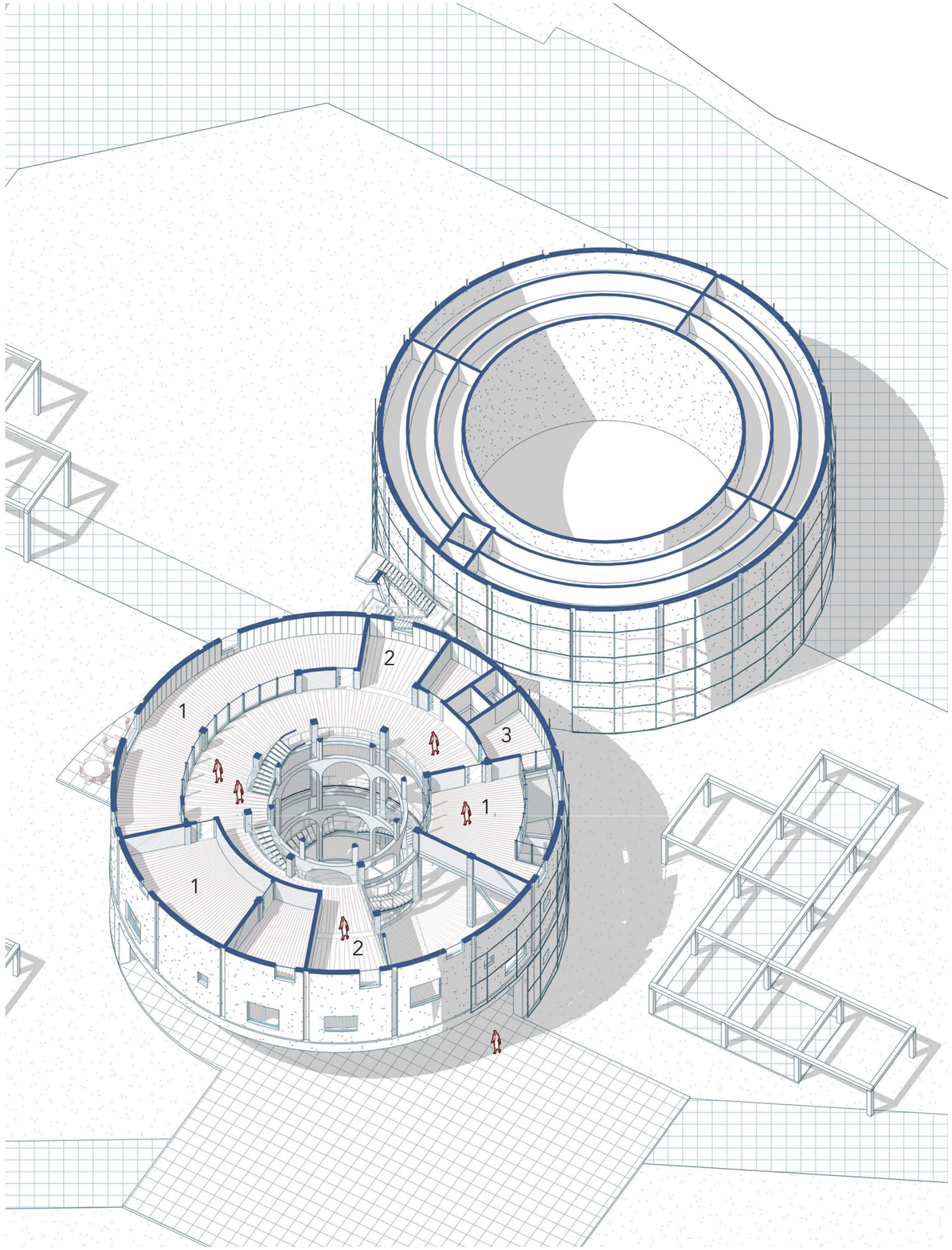
Second Floor Plan

Lvl +12.0 M



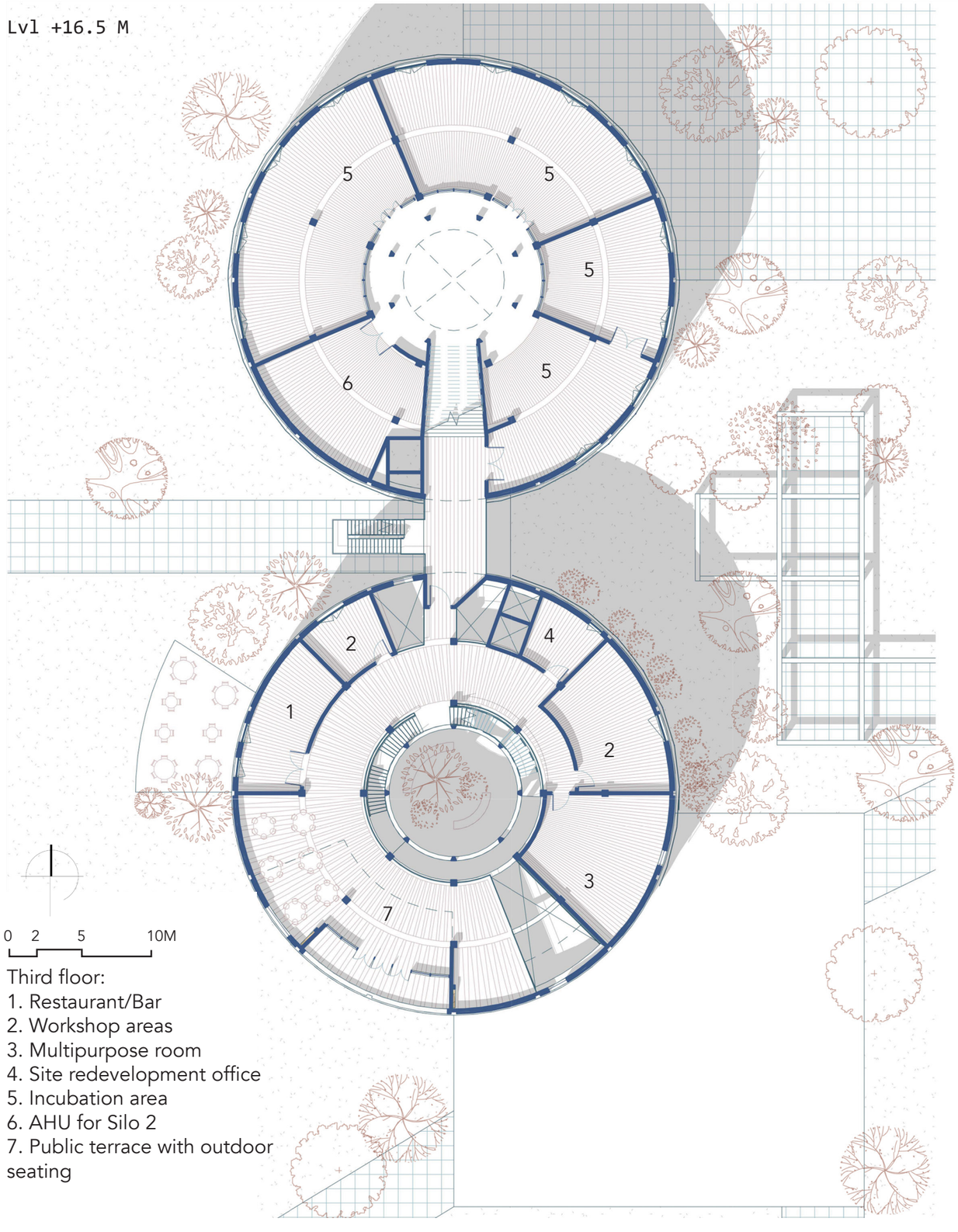
0 2 5 10M

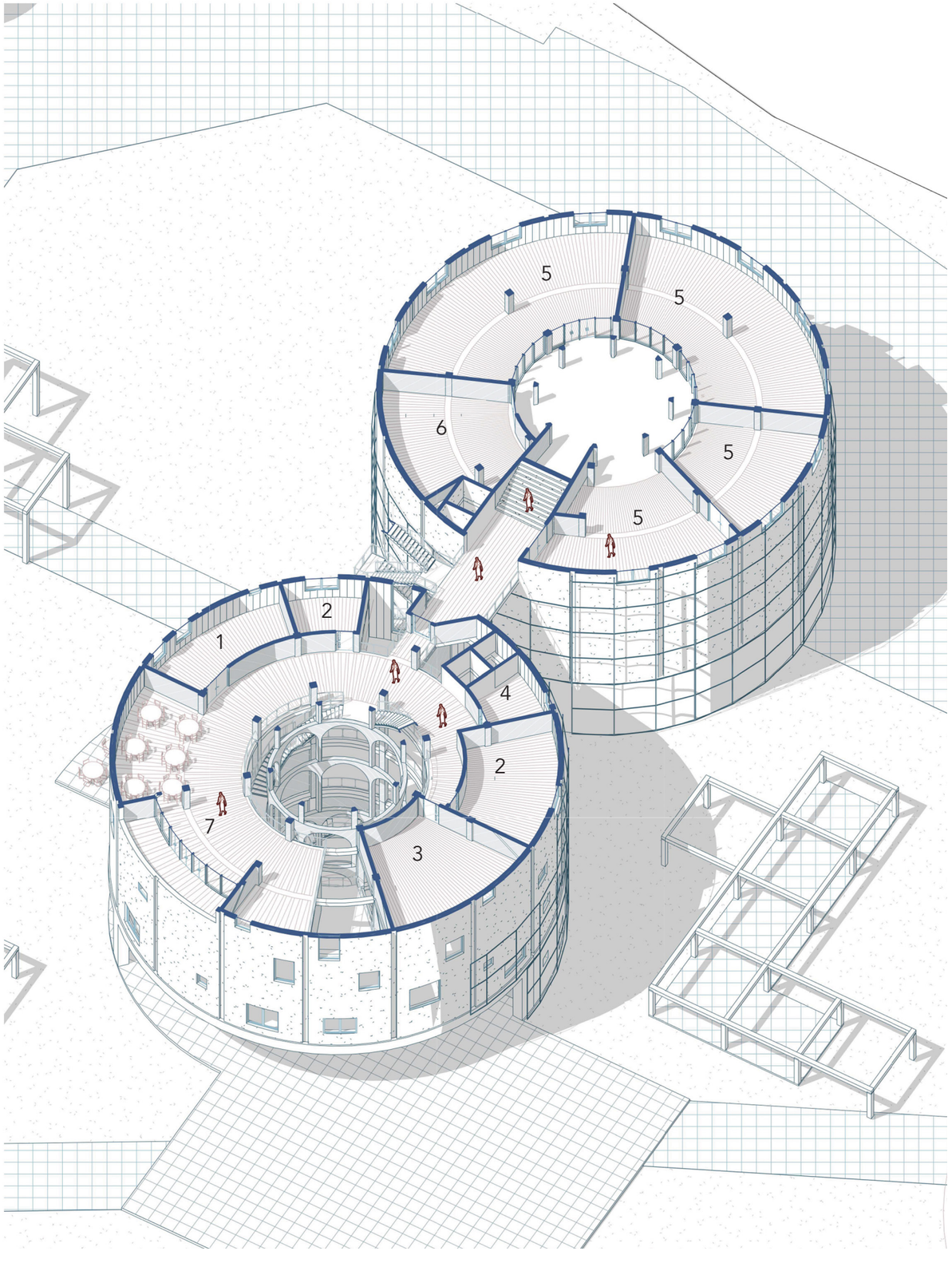
Second floor:
1. Various Labs like CNC, 3-D modelling, milling & laser, R & D labs.
2. Terraces onto which programs could spill out.
3. Janitor's room & storage.



Third Floor Plan

Lvl +16.5 M

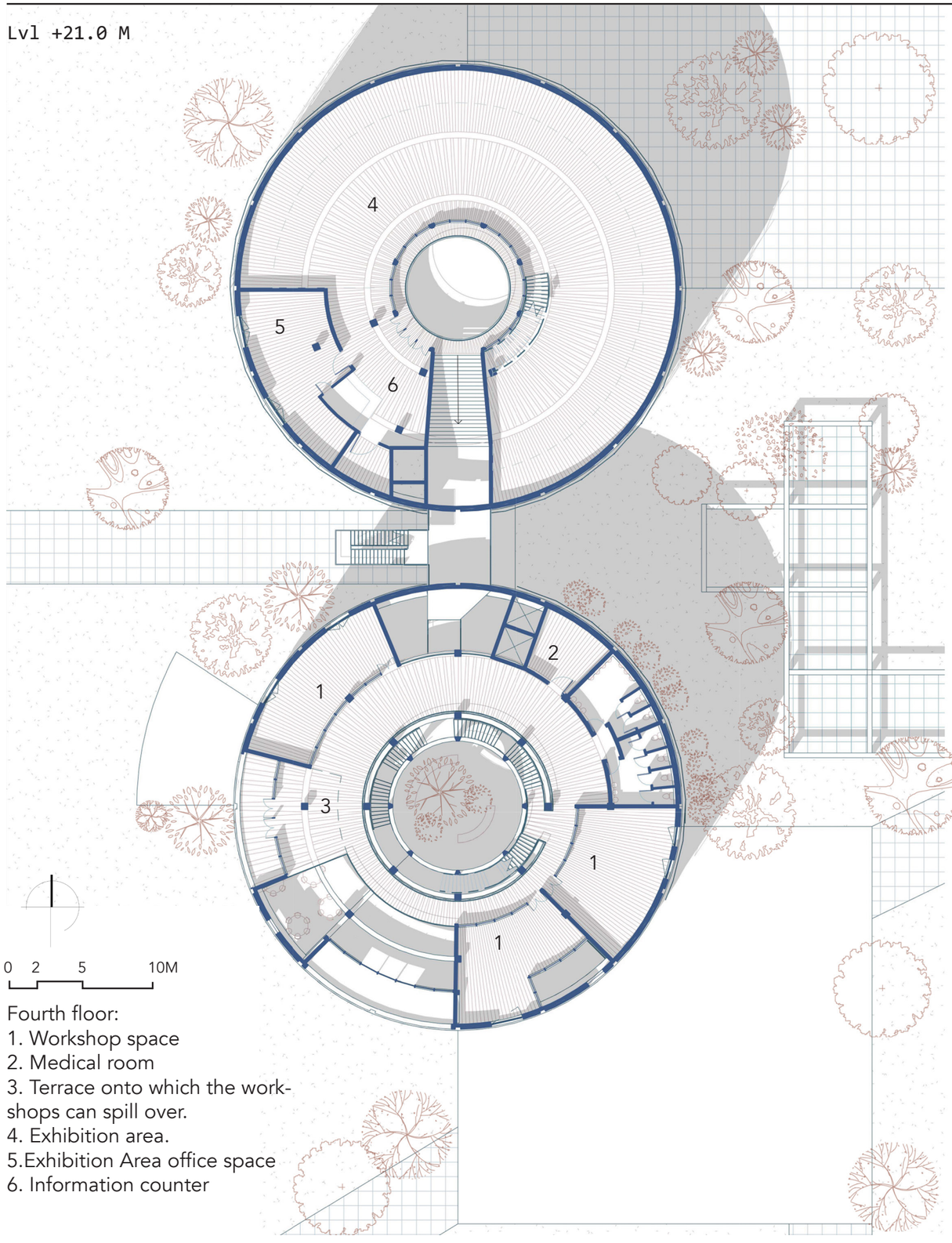


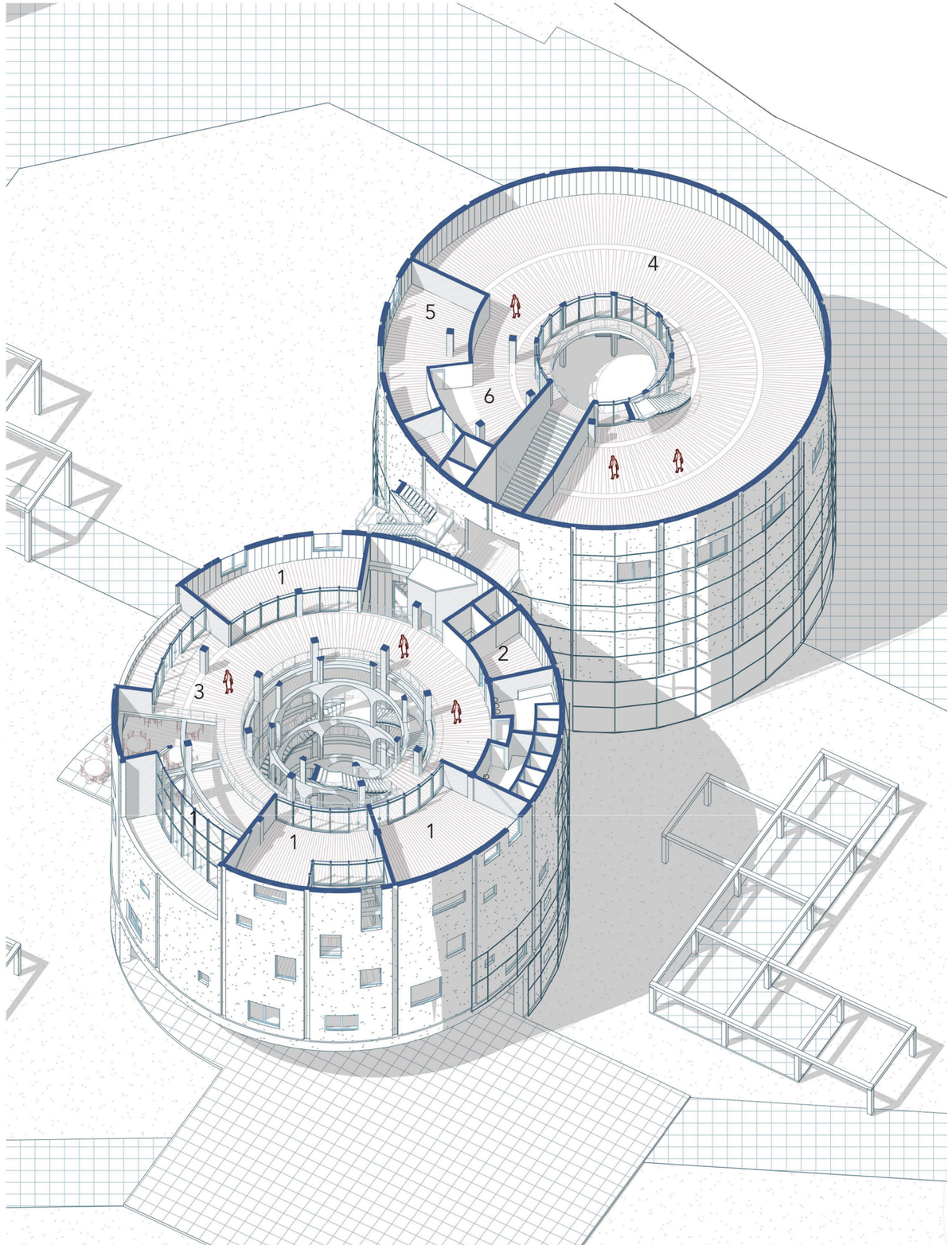


Third floor:
1. Restaurant/Bar
2. Workshop areas
3. Multipurpose room
4. Site redevelopment office
5. Incubation area
6. AHU for Silo 2
7. Public terrace with outdoor seating

Fourth Floor Plan

Lvl +21.0 M



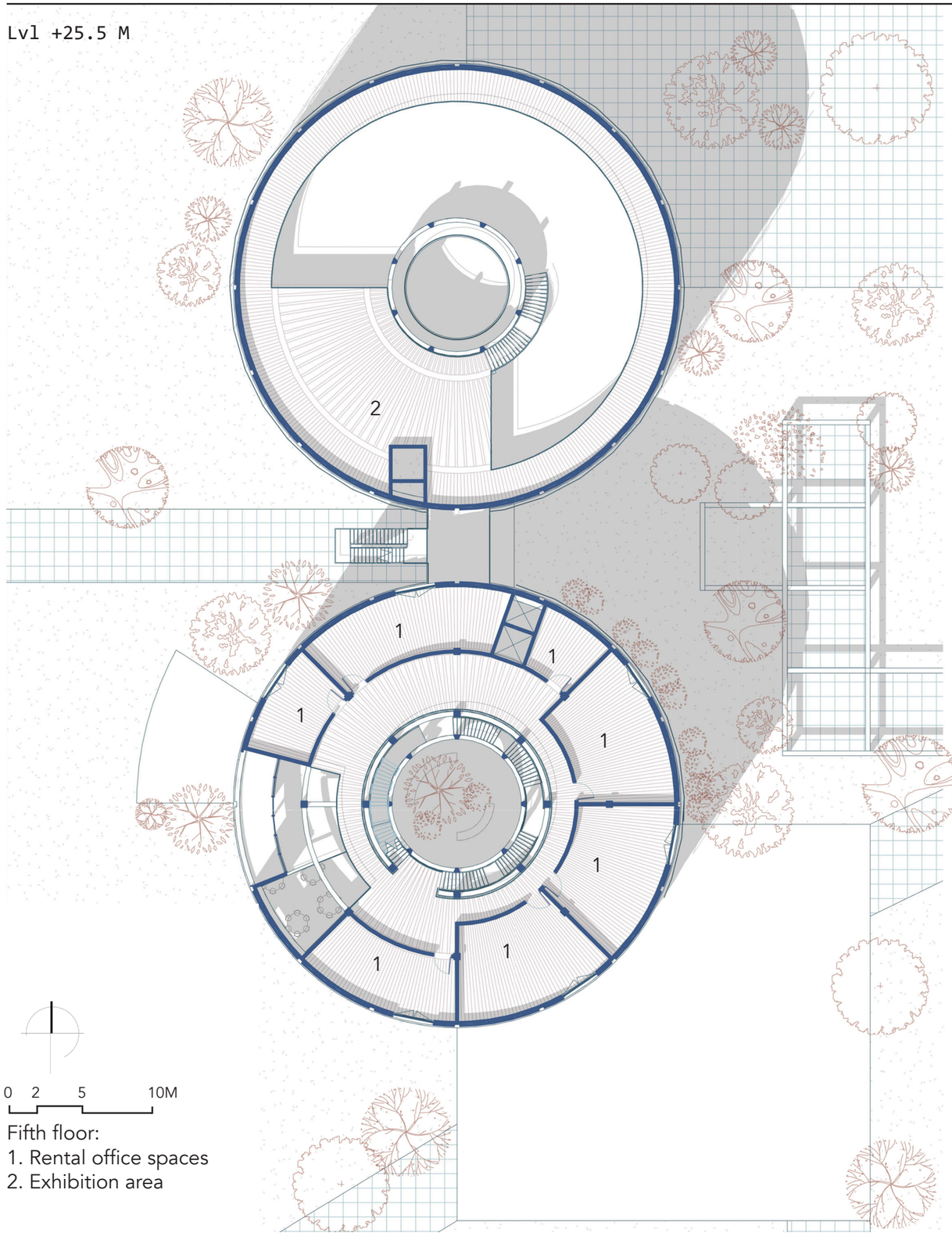


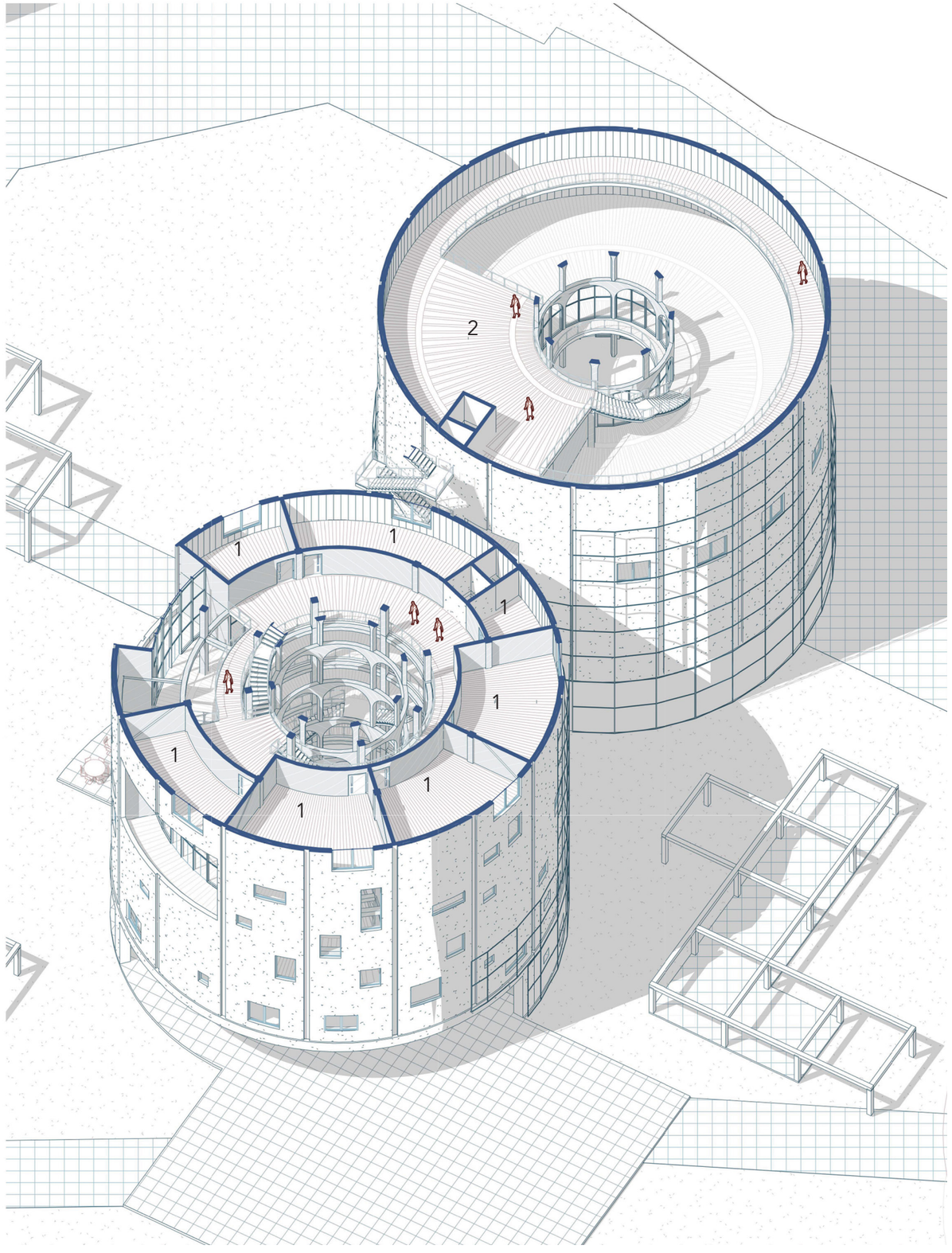
Fourth floor:
1. Workshop space
2. Medical room
3. Terrace onto which the workshops can spill over.
4. Exhibition area.
5.Exhibition Area office space
6. Information counter


NO TIME FOR SAFETY!
DRILL, BABY, DRILL!
ONE TREATY TO RULE THEM ALL
The ever-expanding Energy Charter Treaty and the power it gives corporations to halt the energy transition
CEO tni
WORK
A LIFE WELL WASTED
DIRTY BUSINESS
"CLEAN COAL" AND THE BATTLE FOR OUR ENERGY FUTURE
CLIMATE ACTION
ENERGY CHARTER TREATY

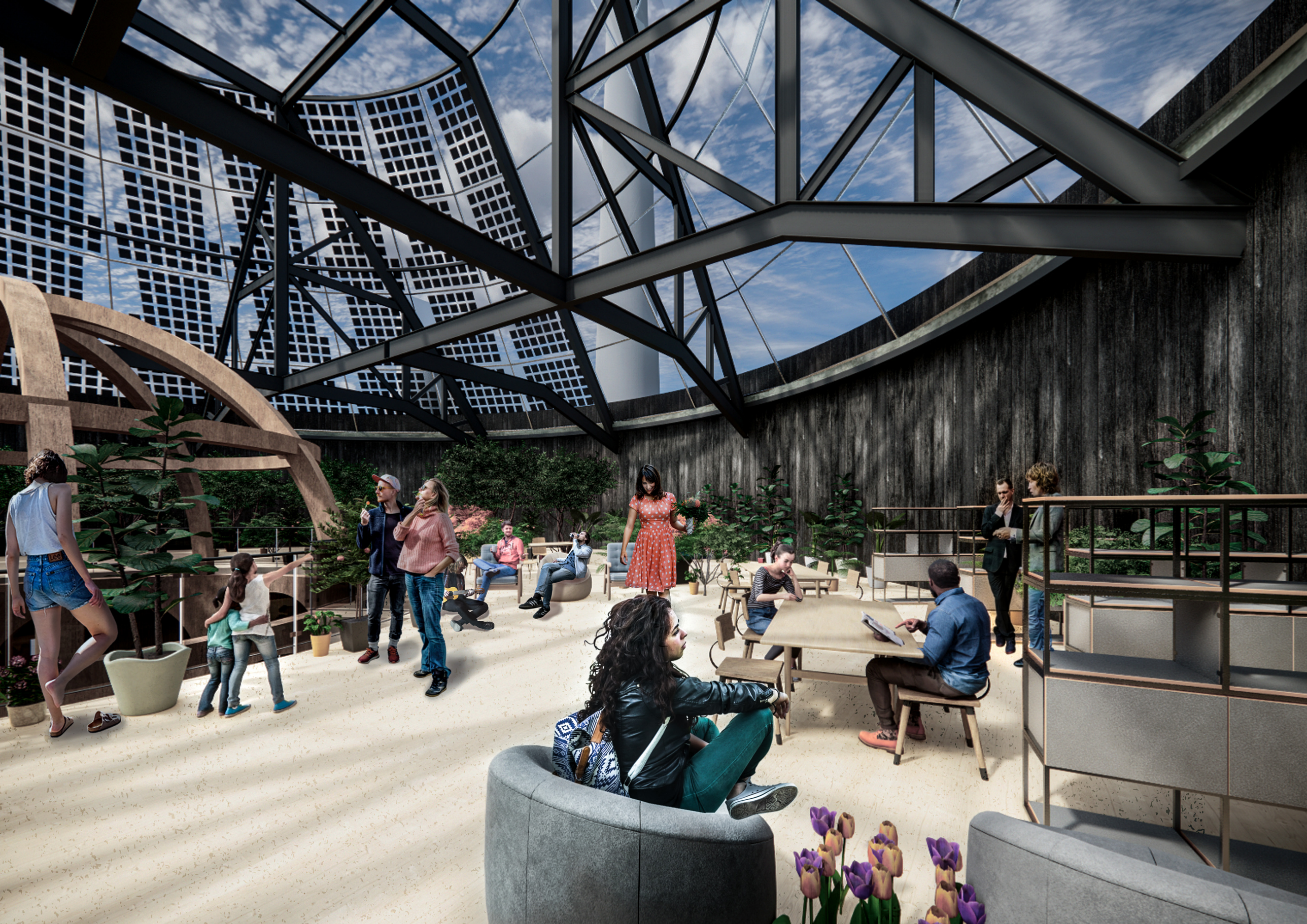
Fifth Floor Plan

Lvl +25.5 M

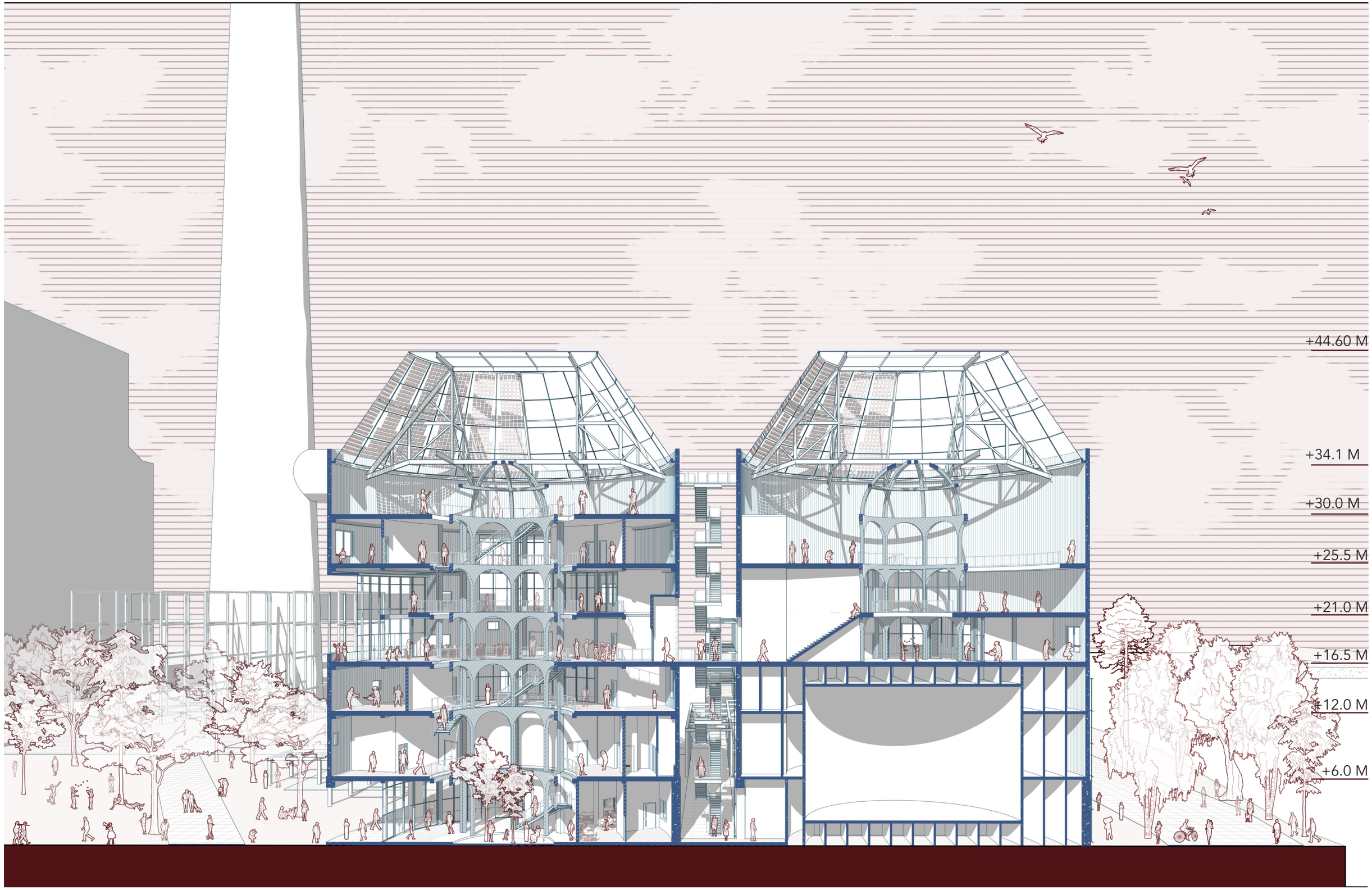




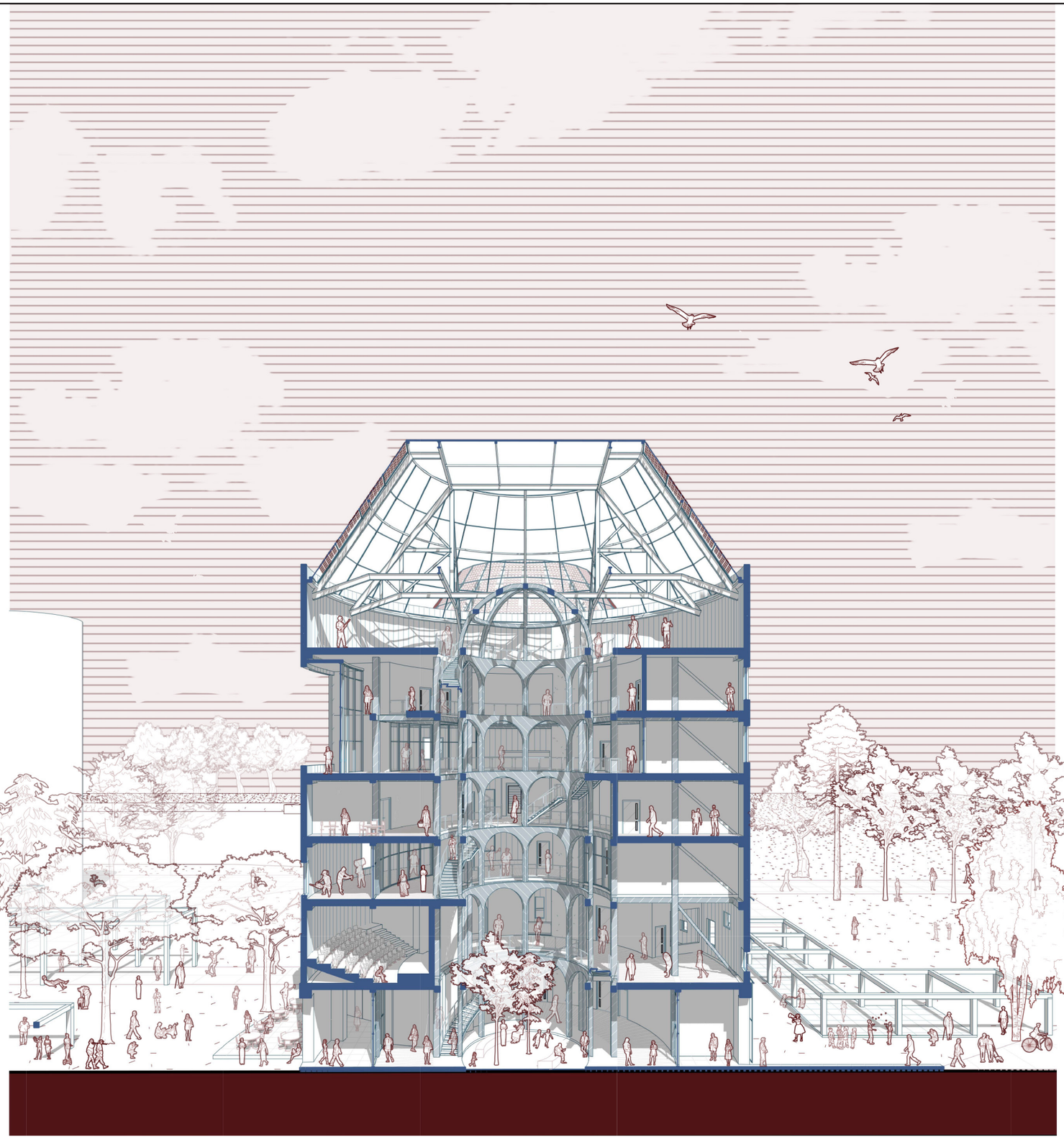
Fifth floor:
1. Rental office spaces
2. Exhibition area



Sectional Perspective



Sectional Perspective

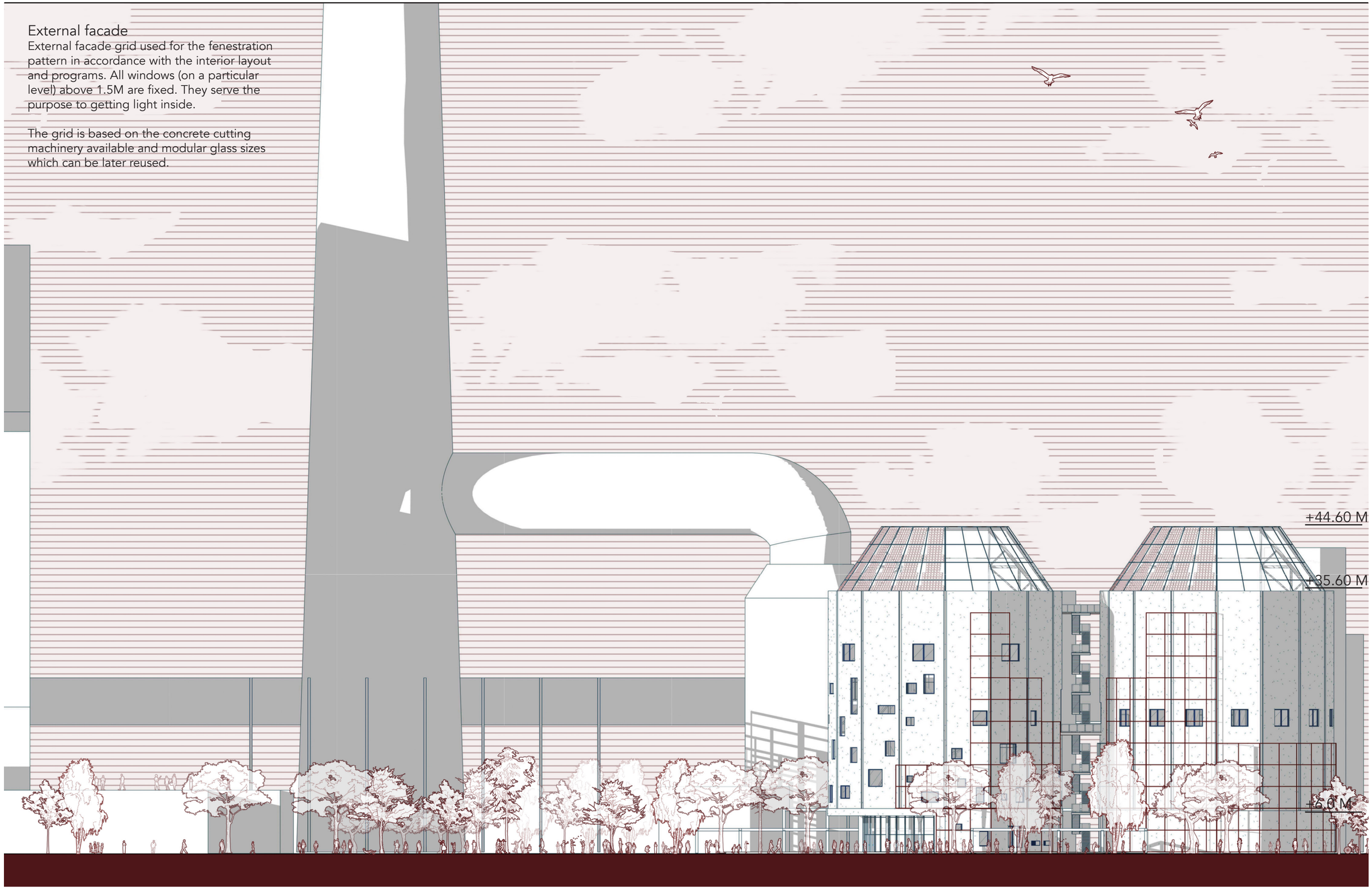


East Elevation

External facade

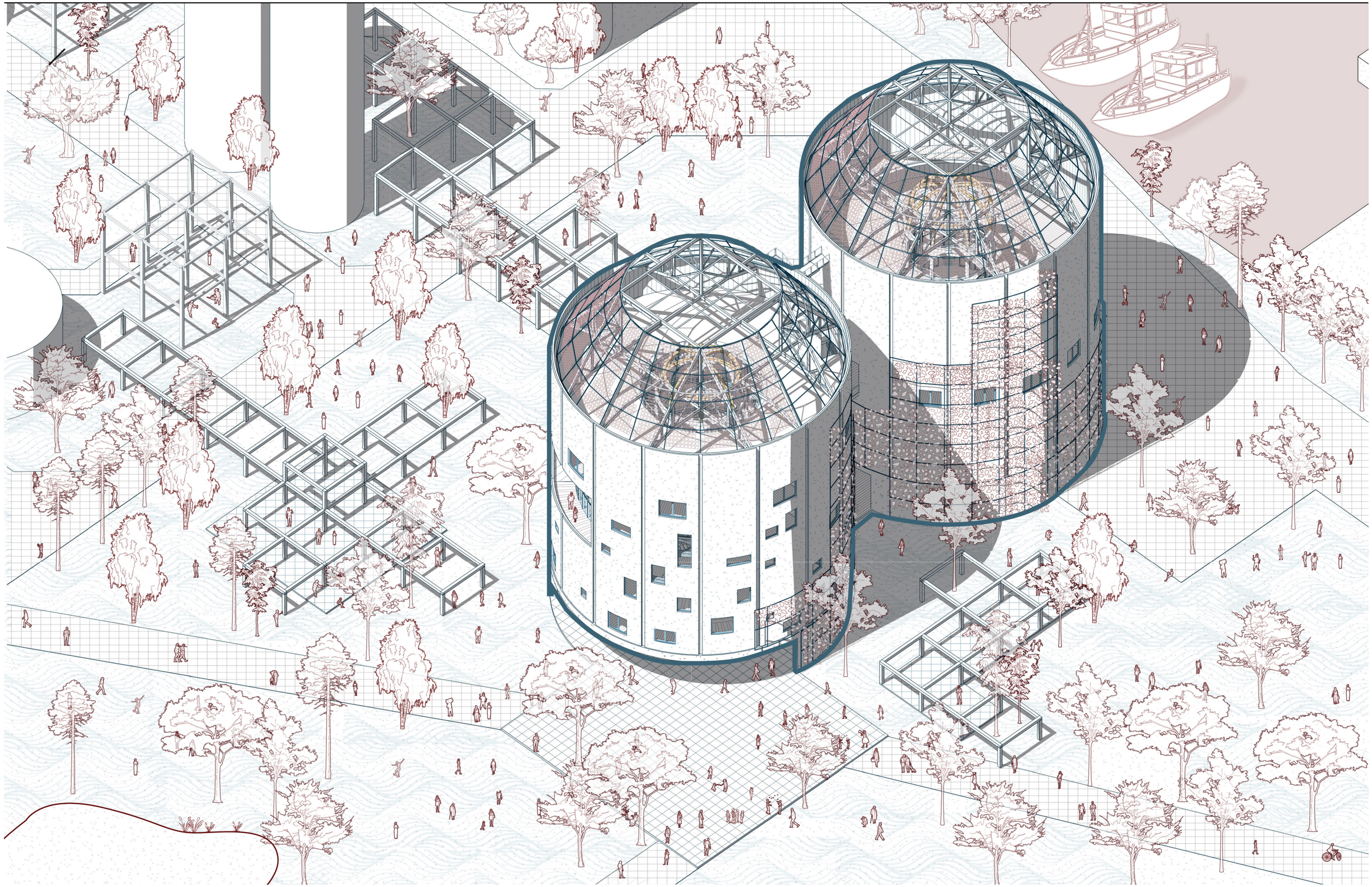
External facade grid used for the fenestration pattern in accordance with the interior layout and programs. All windows (on a particular level) above 1.5M are fixed. They serve the purpose to getting light inside.

The grid is based on the concrete cutting machinery available and modular glass sizes which can be later reused.

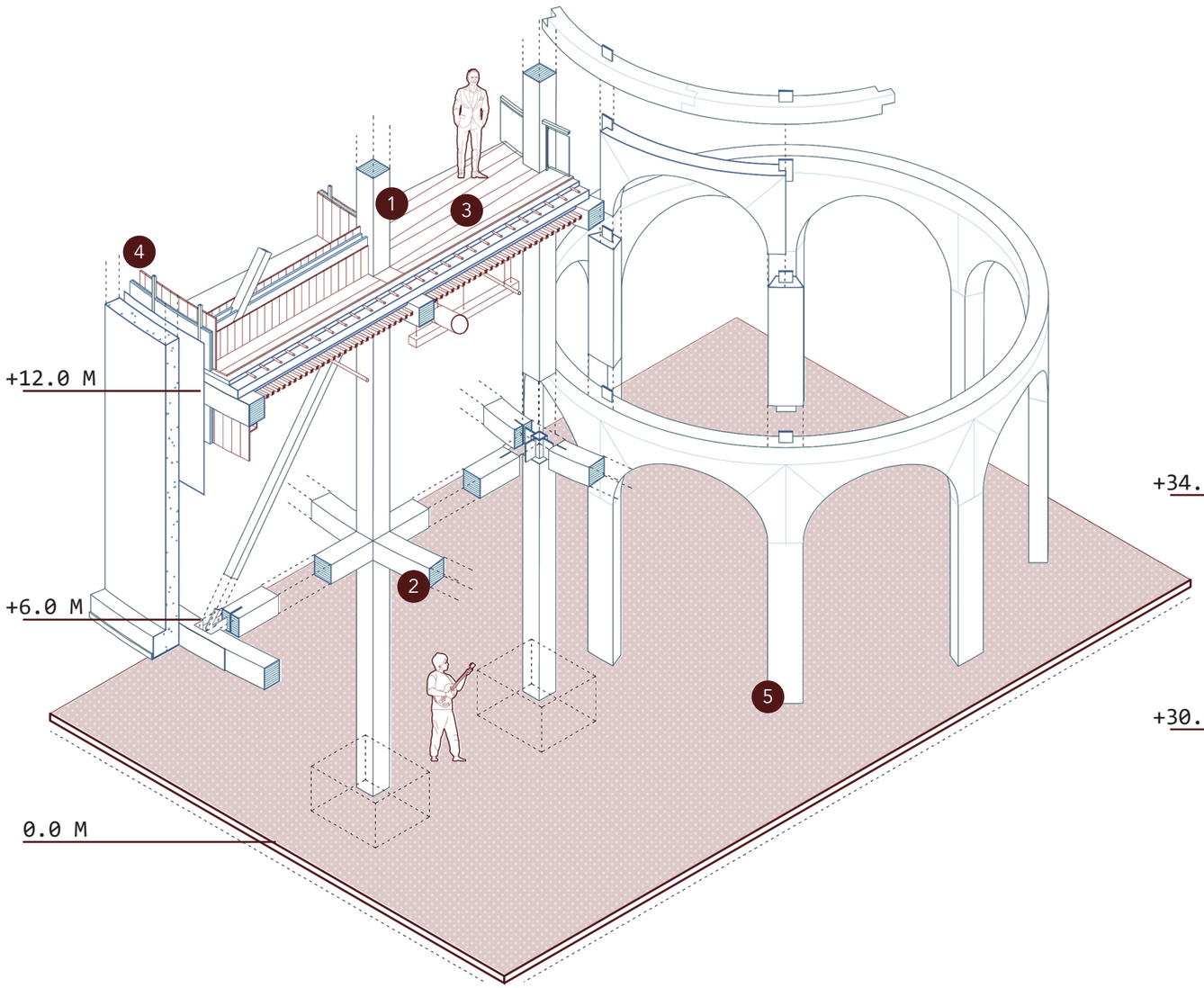


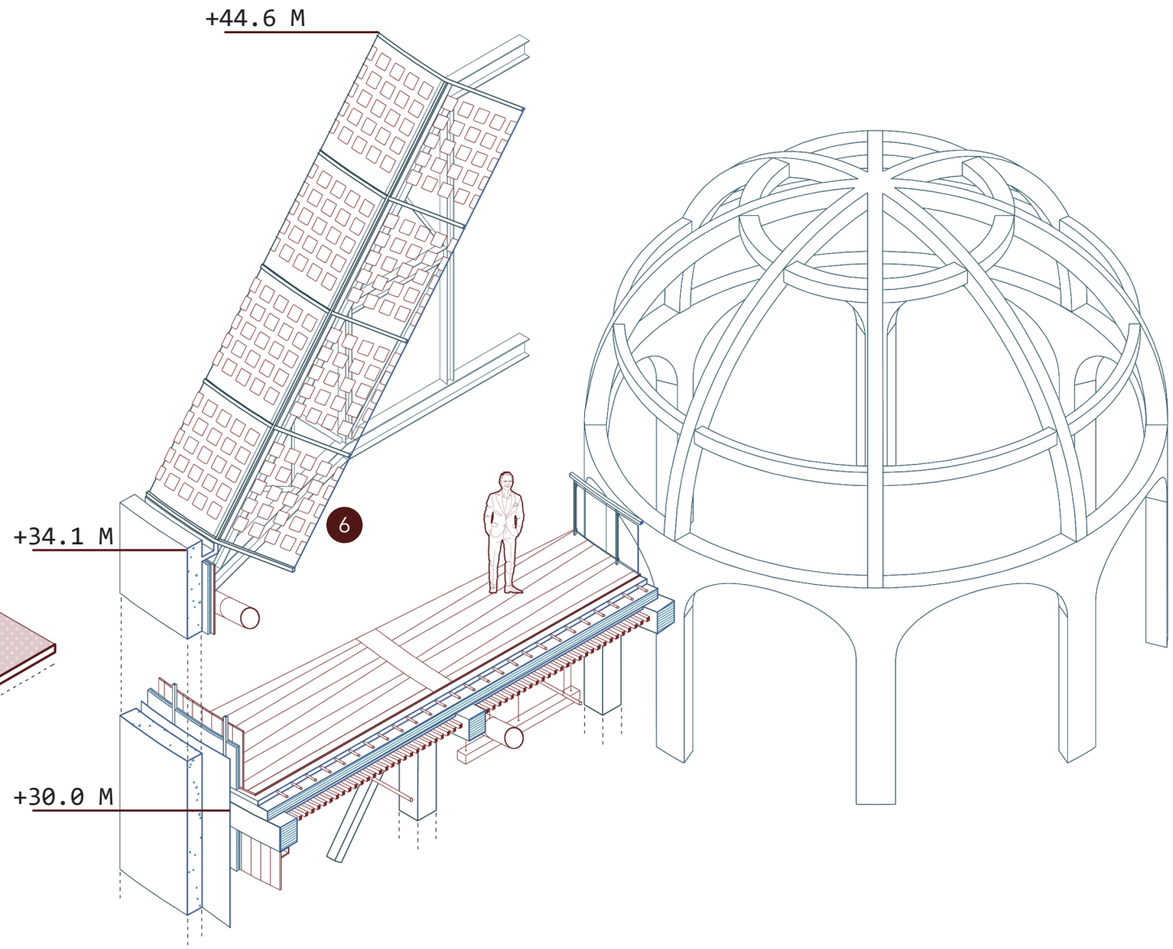
South Elevation

Axonometric



Structure & Details

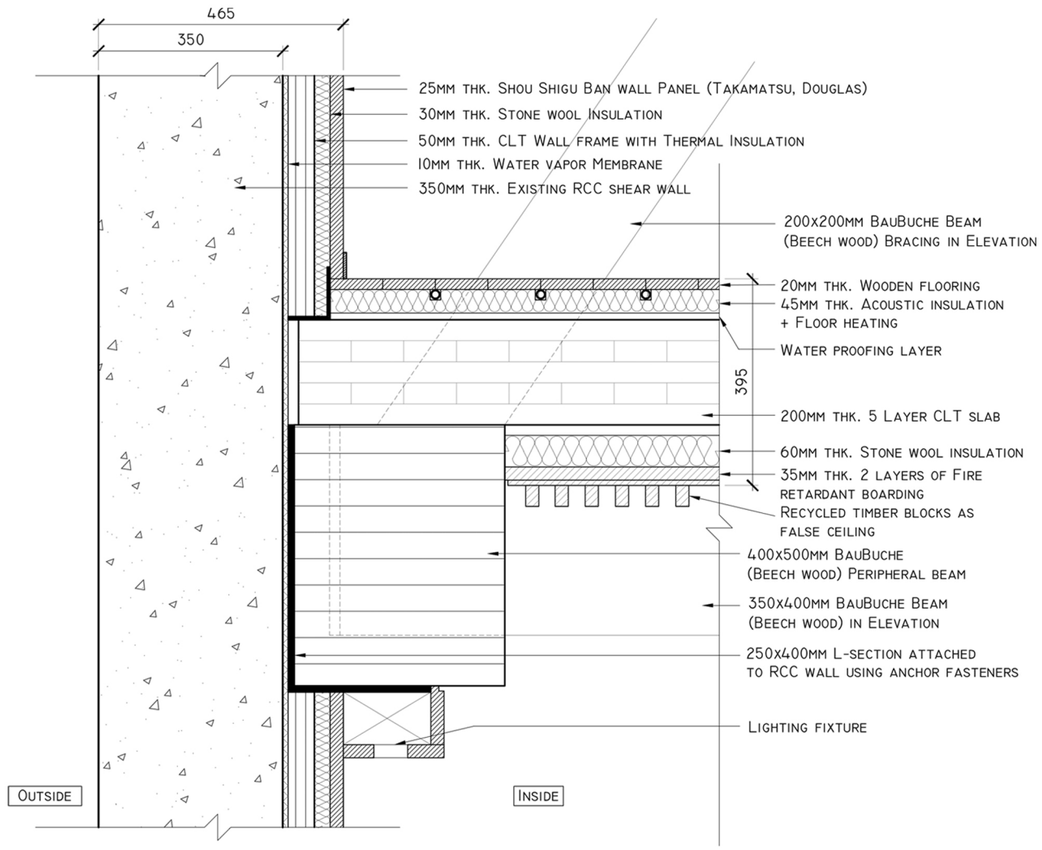


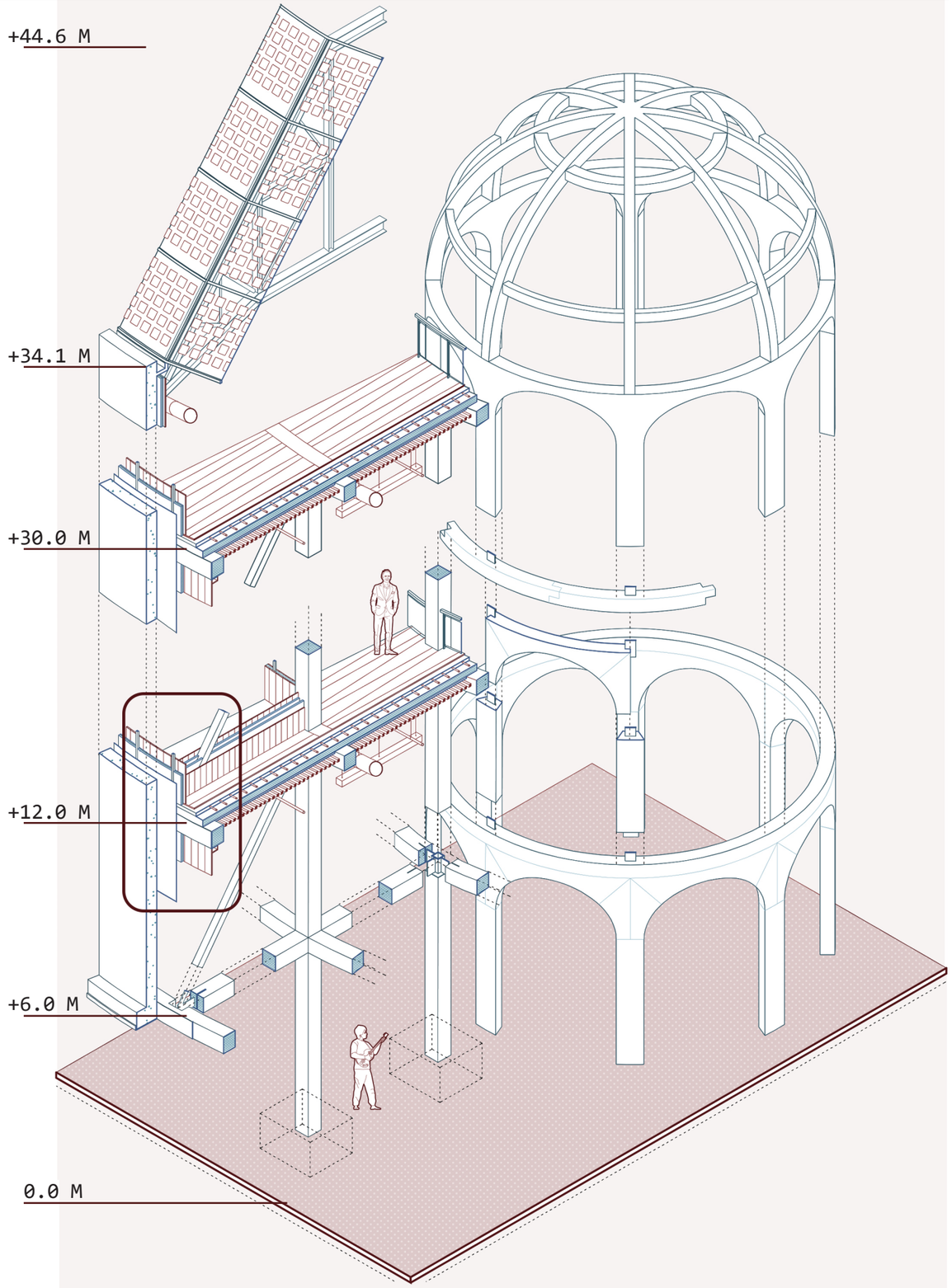


1.400x450mm BauBuche Beech wood column.
2.350x400mm BauBuche Beech wood beam.
3.Slab : 20mm thk. Wooden Flooring
Acoustic insulation + Floor heating
Water proofing layer
200mm thk. 5 Layer CLT Slab
60mm thk. Stone wool insulation
35mm thk. 2 layers of fire retardant boarding
Recycled Timber blocks as False ceiling
Service Level

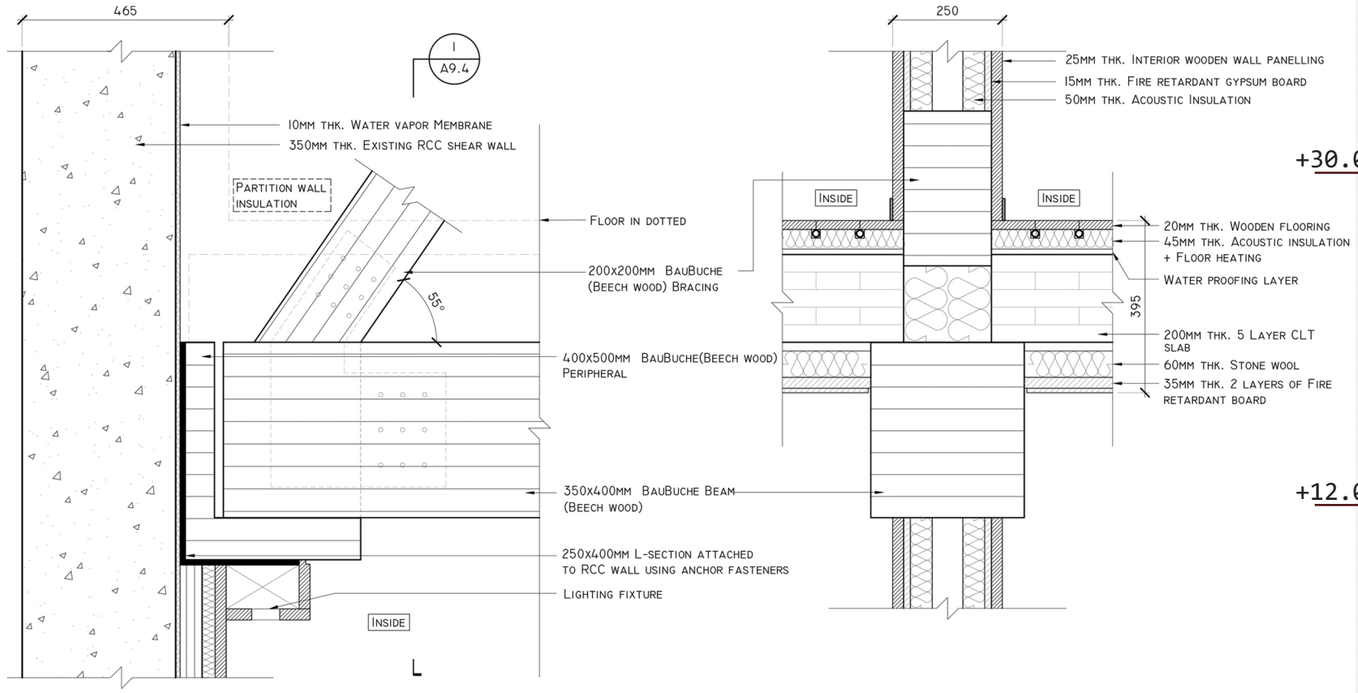
4.External Wall: 25mm thk. Shou Shigu Ban panel. (interior)
30mm thk. Stone wool insulation
50mm thk. Thermal wool insulation + CLT wall frame
Water Vapor Membrane
350mm thk. Existing RCC Shear Wall.(External)
5.Arch-Atrium
6.Roof: Semi-transparent solar panels
Automated curtain system with beige fabric to prevent sunlight
During summers.

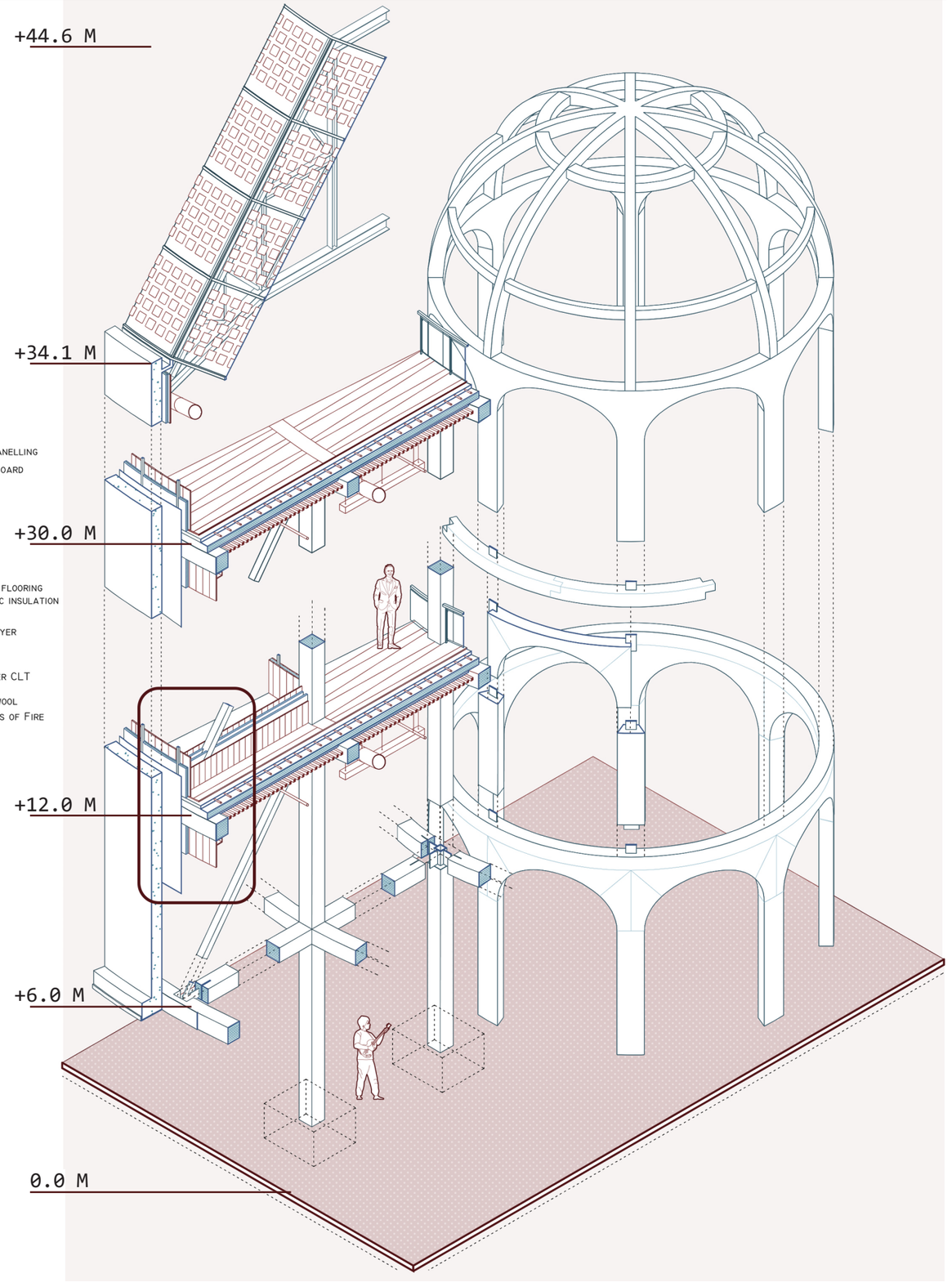
Structure & Details



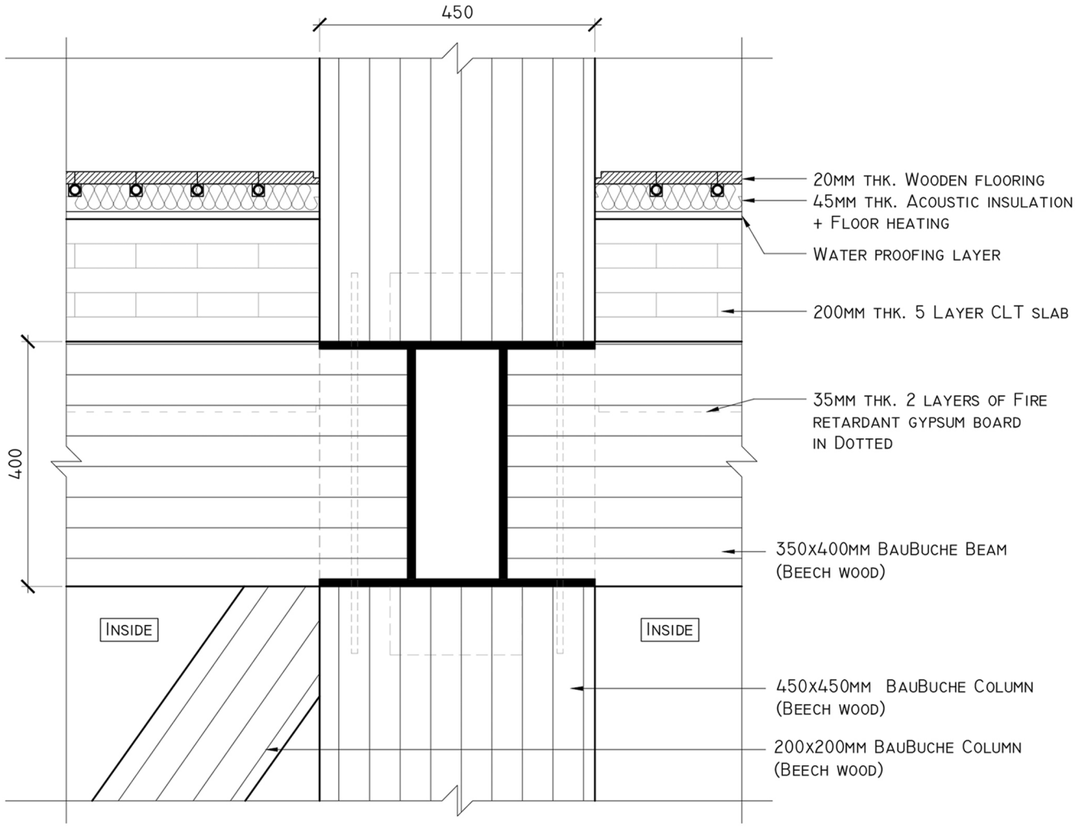


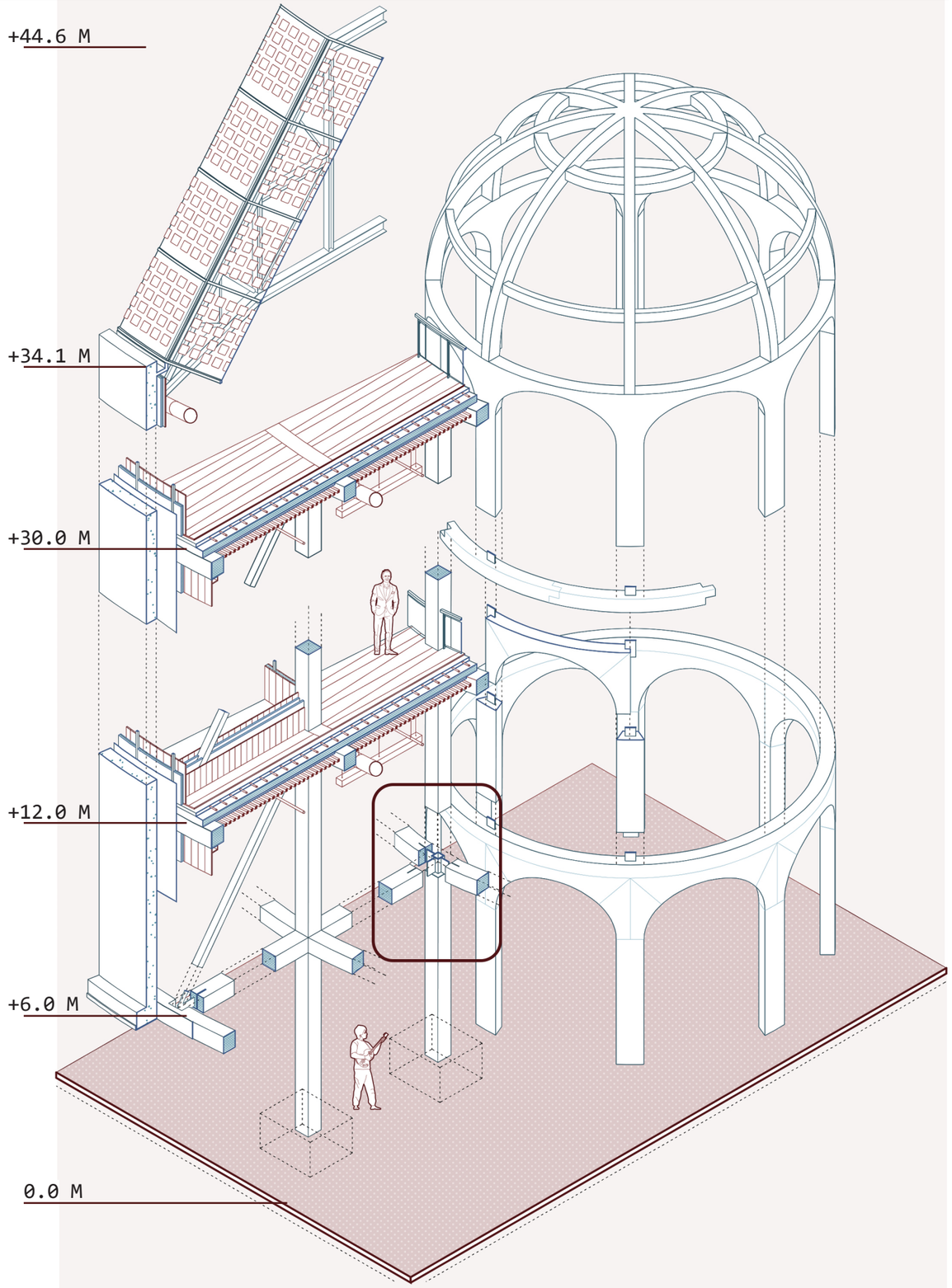
Structure & Details



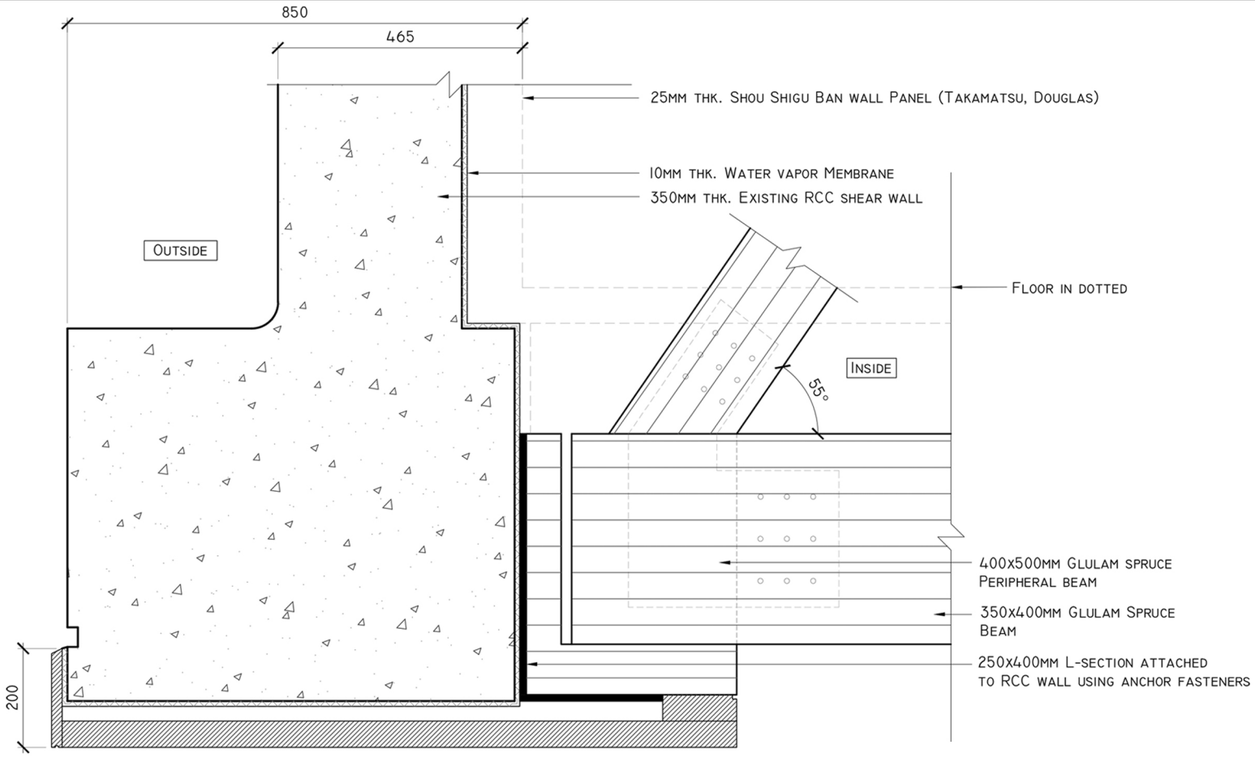


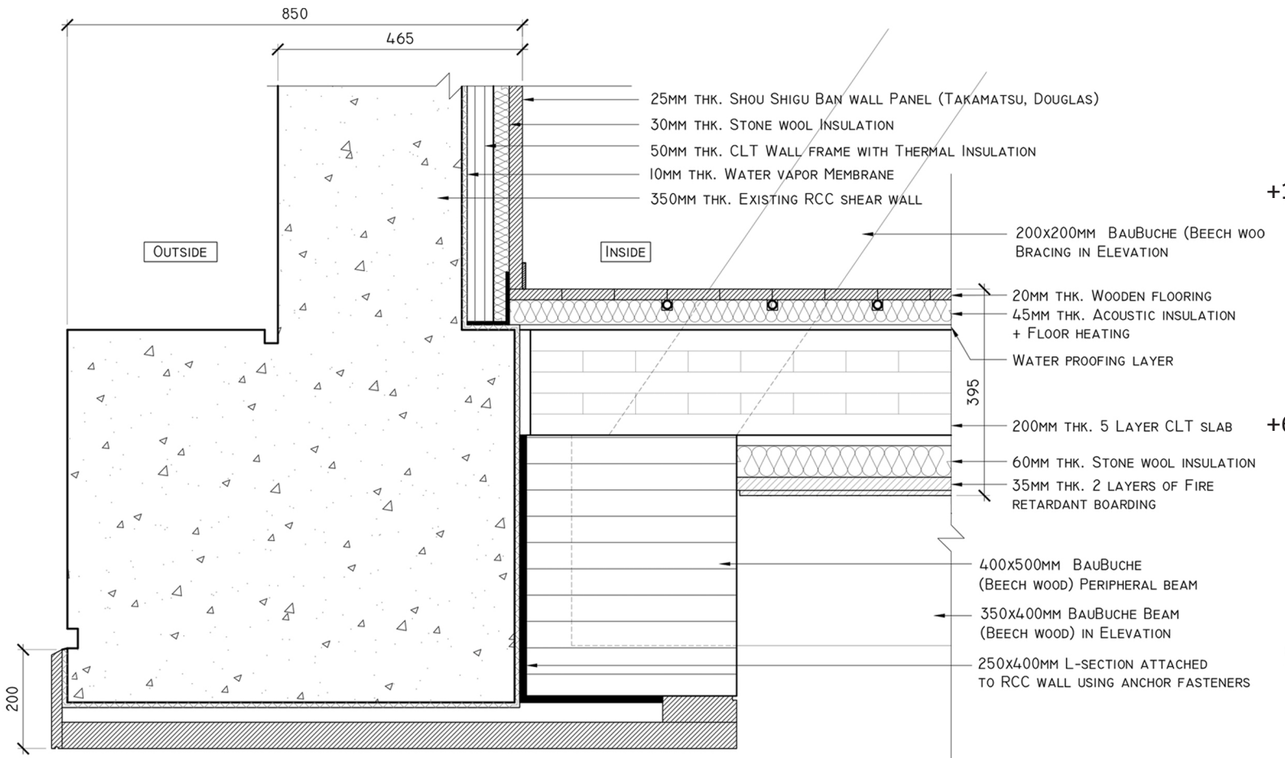
Structure & Details

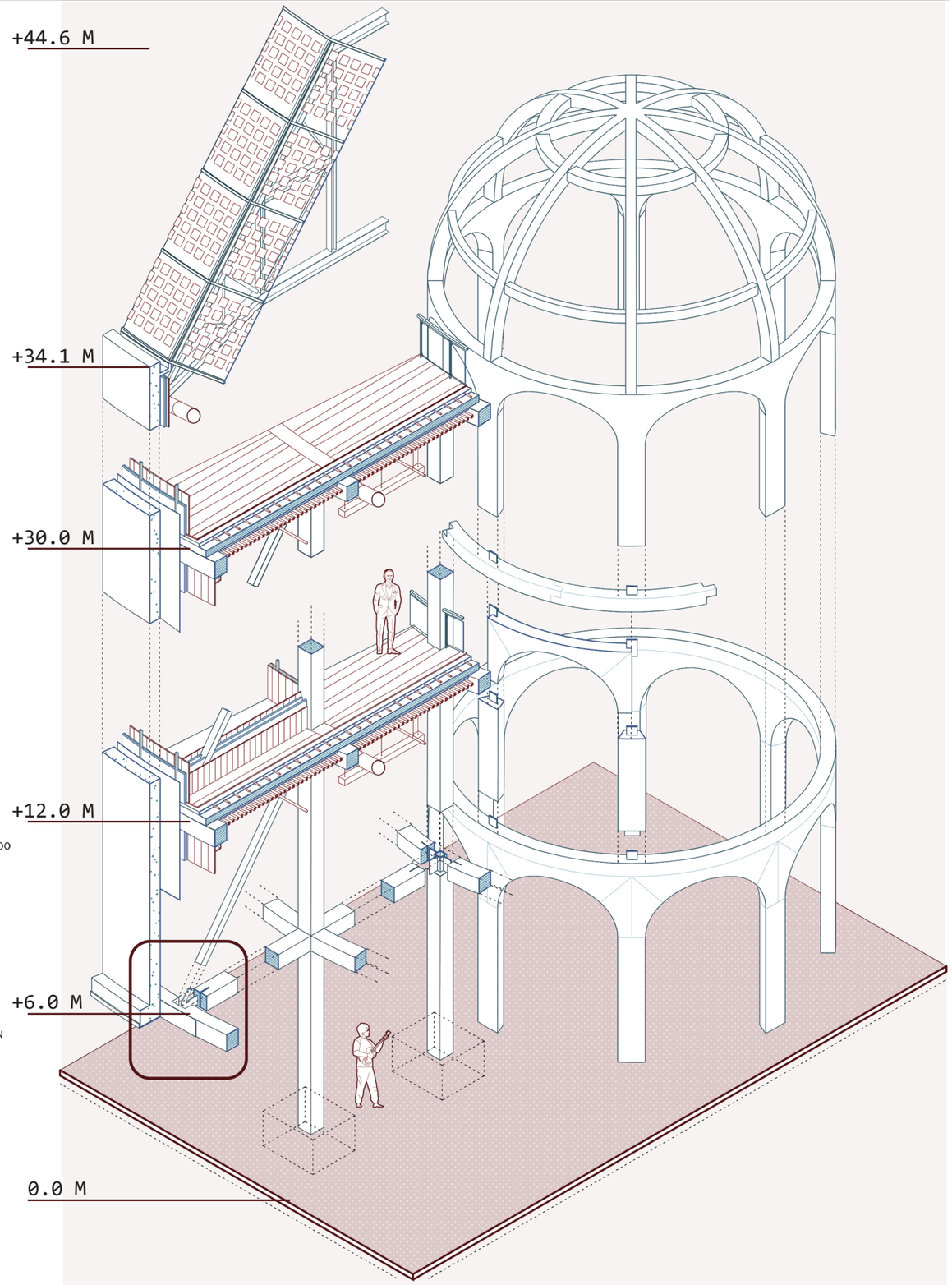




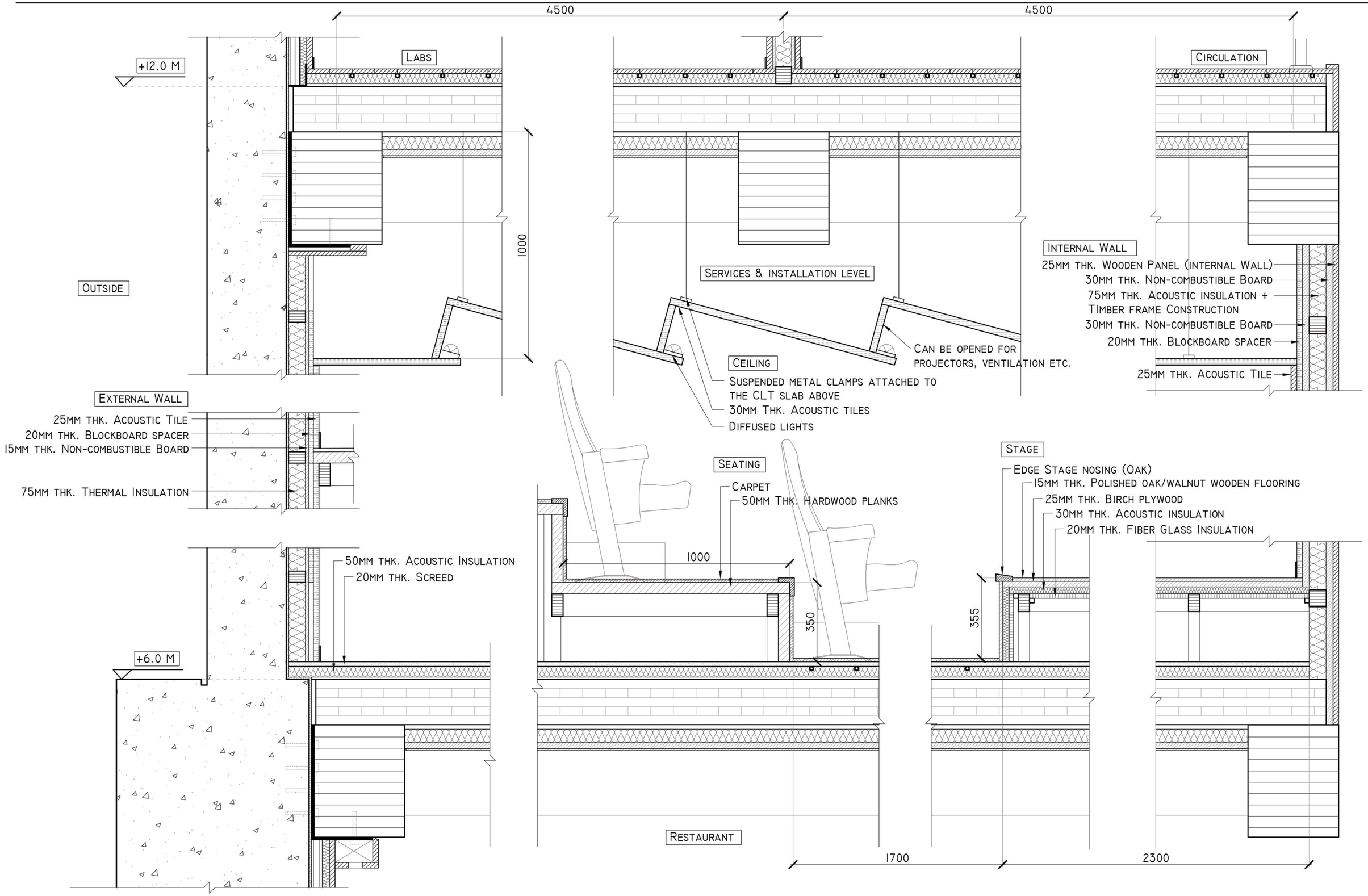
Structure & Details





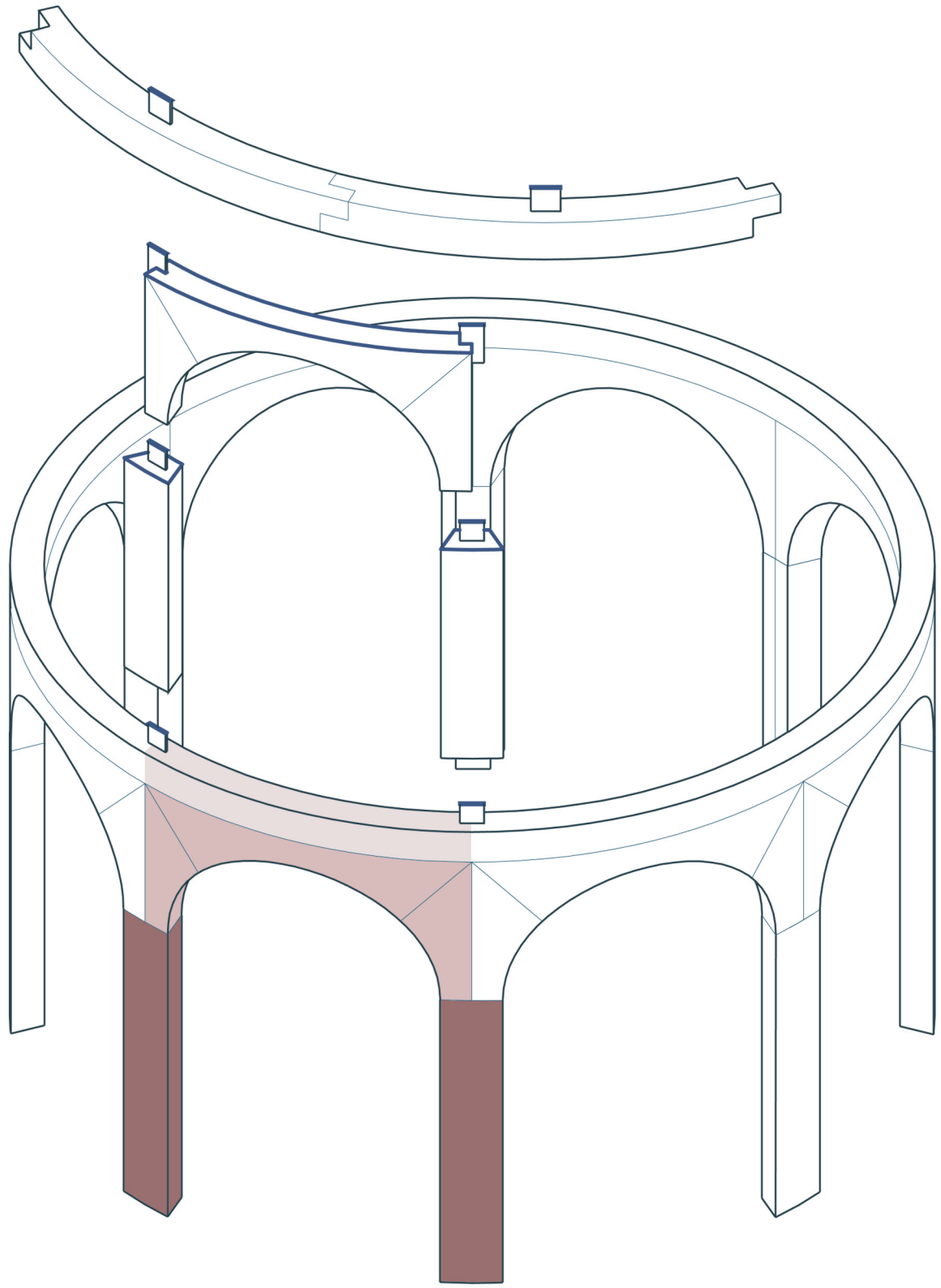


Auditorium Details



Arch-Atrium

Central Arch-Atrium assembled using two separate method of production.
1.Digitally Cutting the profiles.
2.Removing Moisture from the wood and bending the wood. (using self-bending timber method)
3.Mechanically Bending the members

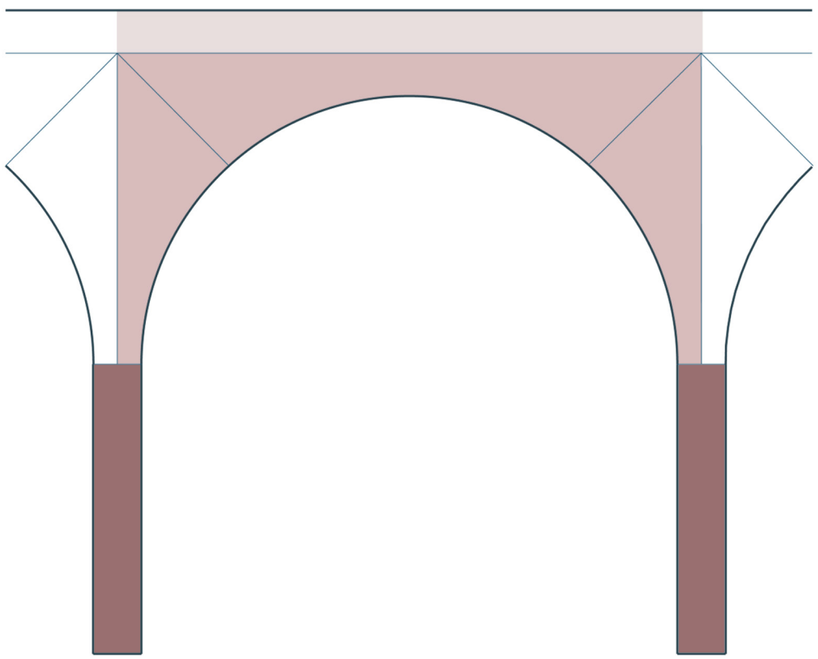


Self-bending timber developed by researchers from ETH Zurich, Empa And Uni. Of Stuttgart.

[Image on the right is a 14meter Urbach Tower designed using this wood. It consists of twelve Spruce panels, composed of multiple bilayer panels with a length of 5meters each.] *https://ethz.ch/en/news-and-events/eth-news/news/2019/09/self-shaping-wood.html*

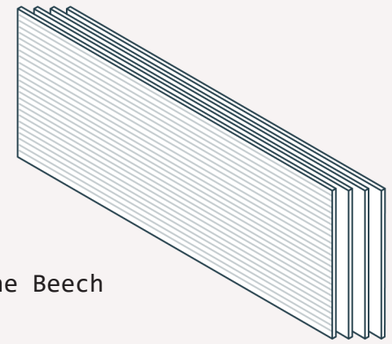
An Arch is built in 3 segments of spruce panels which are then connected together to create the arcade.
Top - Tie beam (bent in 1 direction, ie 'X' Axis)
Middle - Arch Beam (bent in 1 directions, ie 'X' and digitally cut in 'Z' Axis)
Bottom - 400x400mm BauBuche Beech wood.

Process:
Members are digitally cut to sizes > Slight bent by using the method for 'Self bending timber' > Mechanically bent to shape > Assembled and stacked.

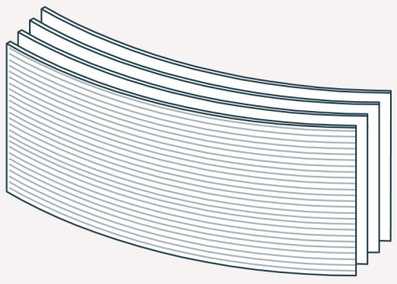


Arch-Atrium

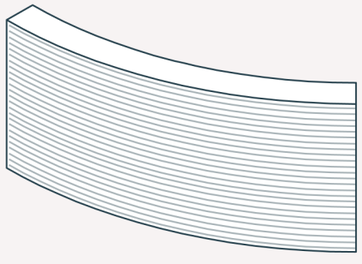
Bending



A
BauBuche Beech
wood

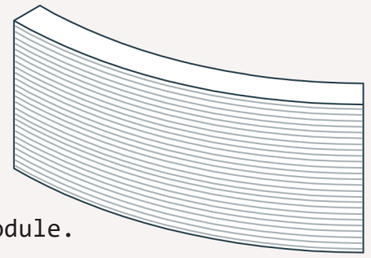


B
Selfing bending by removing moisture +
Mechanical force.

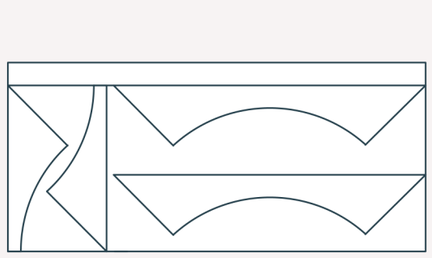


C
Bent pieces stuck together.

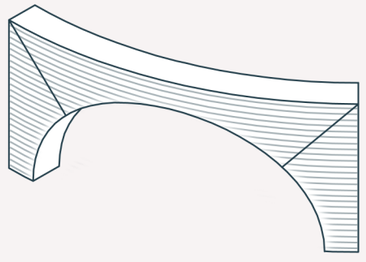
Digital cutting



A
Bent module.

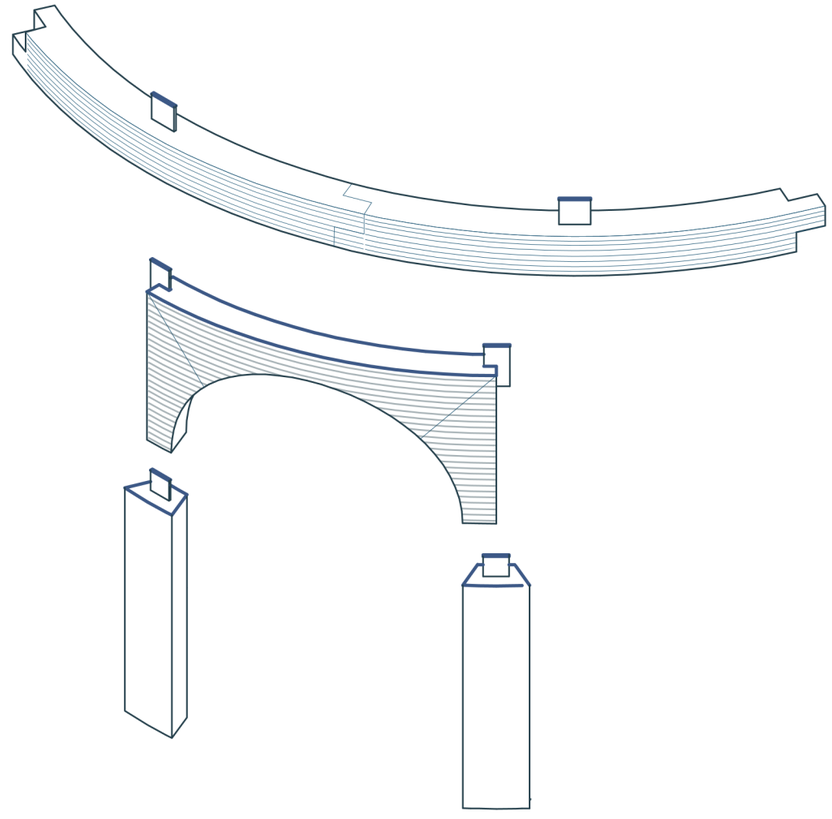


B
Digitally cutting individual members to
minimise waste.

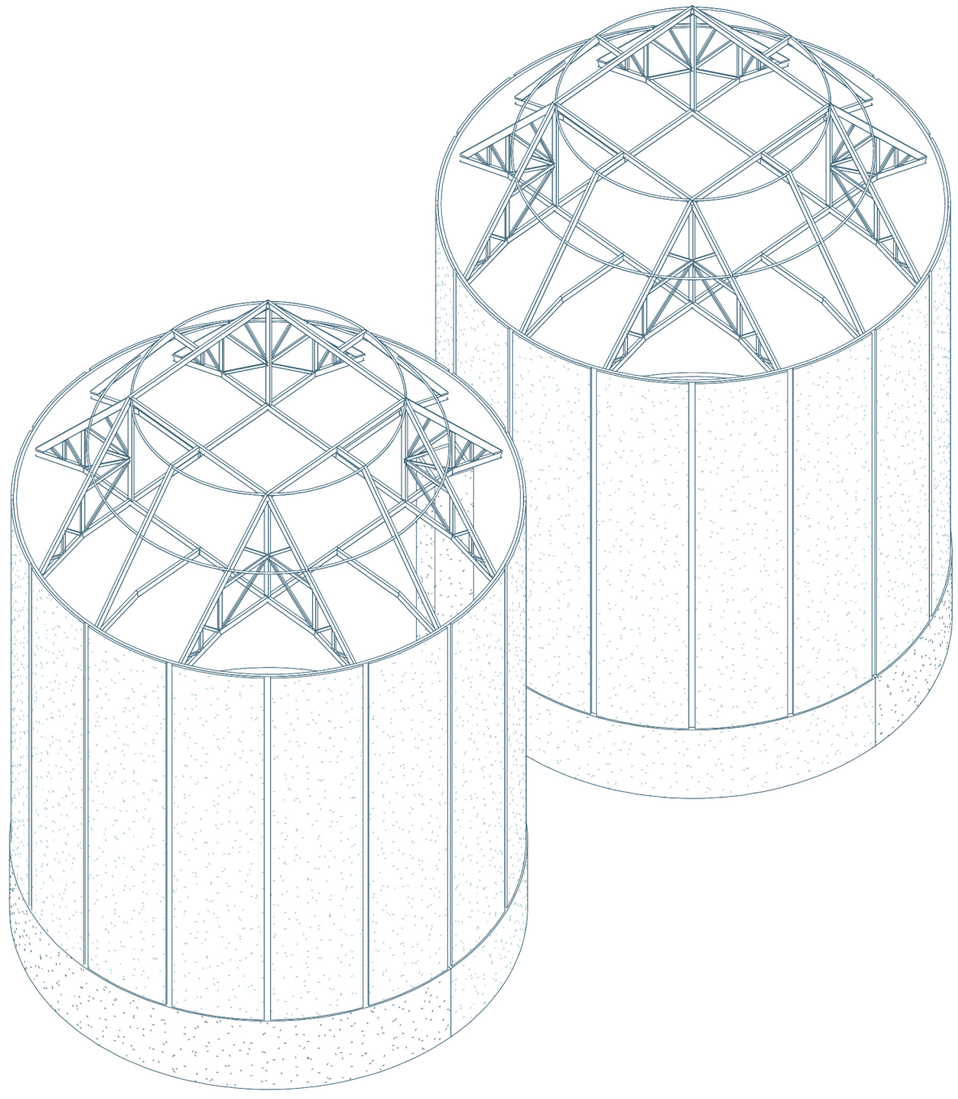


C
Cut members assembled together.

Assembly

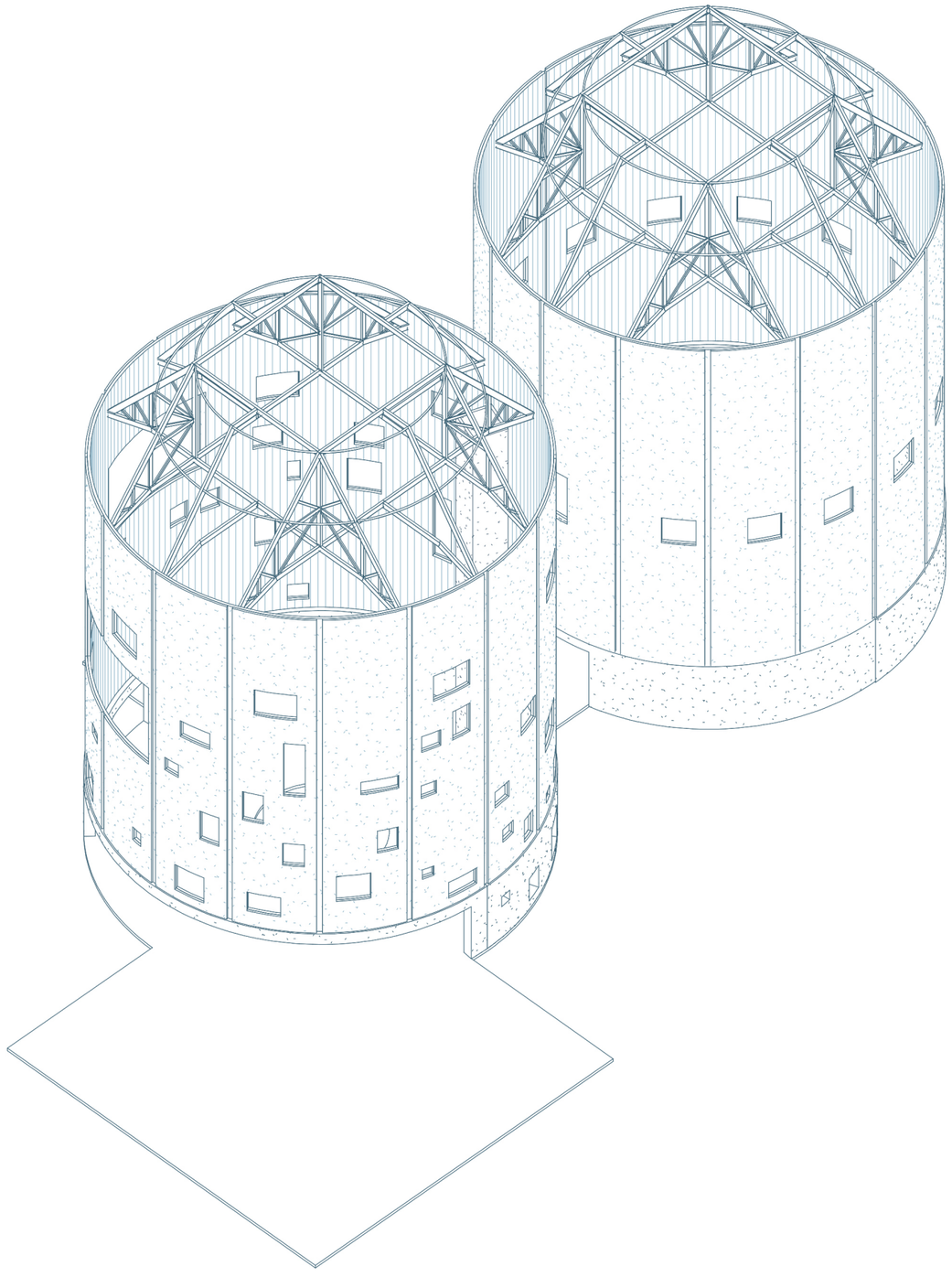


Assembly



Step 1:
Cleanup of the silos.
Removing hazardous materials and machinery if any.
Removal of PV roof.

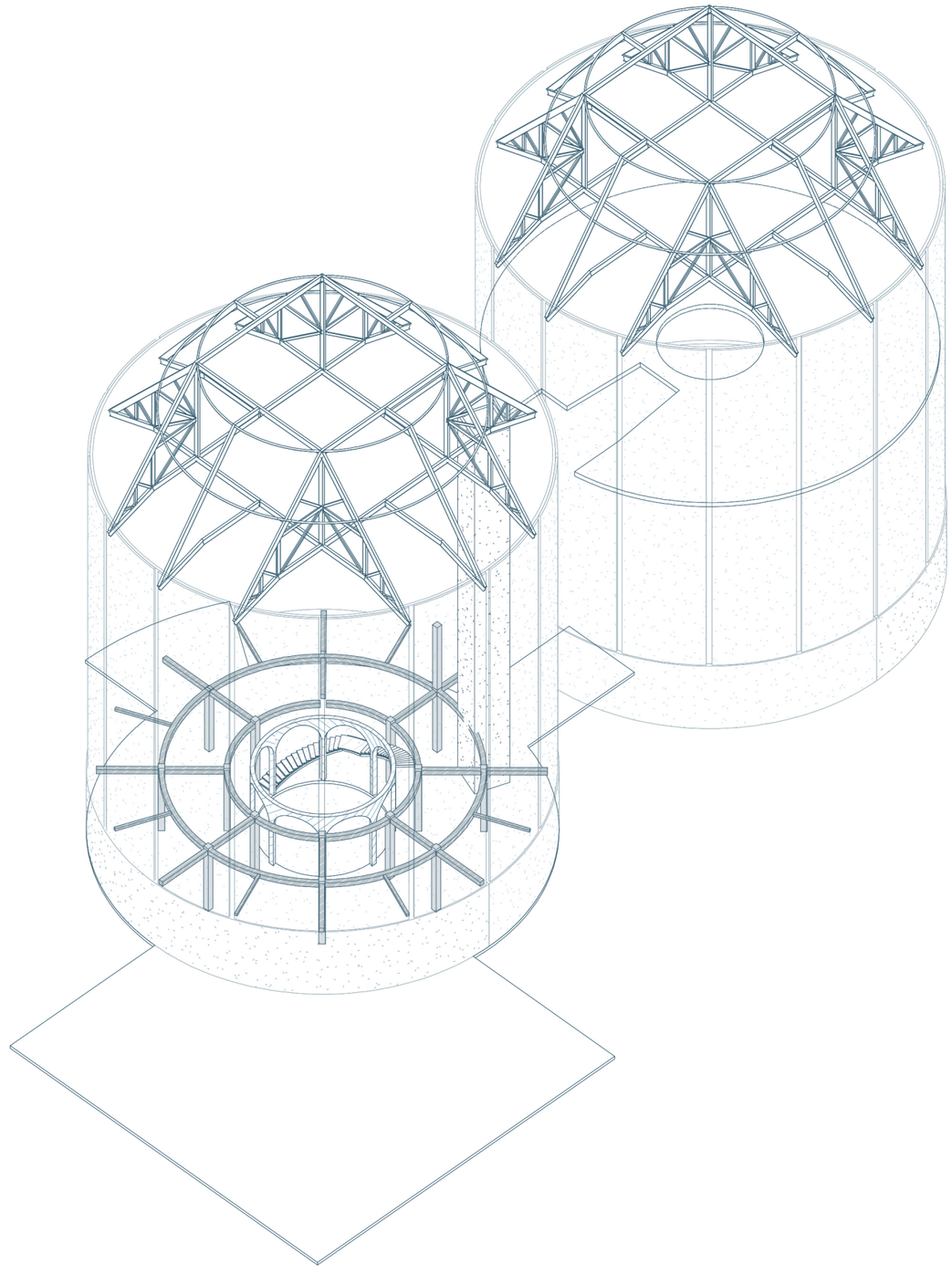
Assembly



Step 2:
Partial openings from the bottom.
Intiation of construction of basalt battery.
Construction of Concrete service and lift core.
*the construction of the basalt battery starts when the openings have been made. The concrete removed is reused for the construction of the battery.

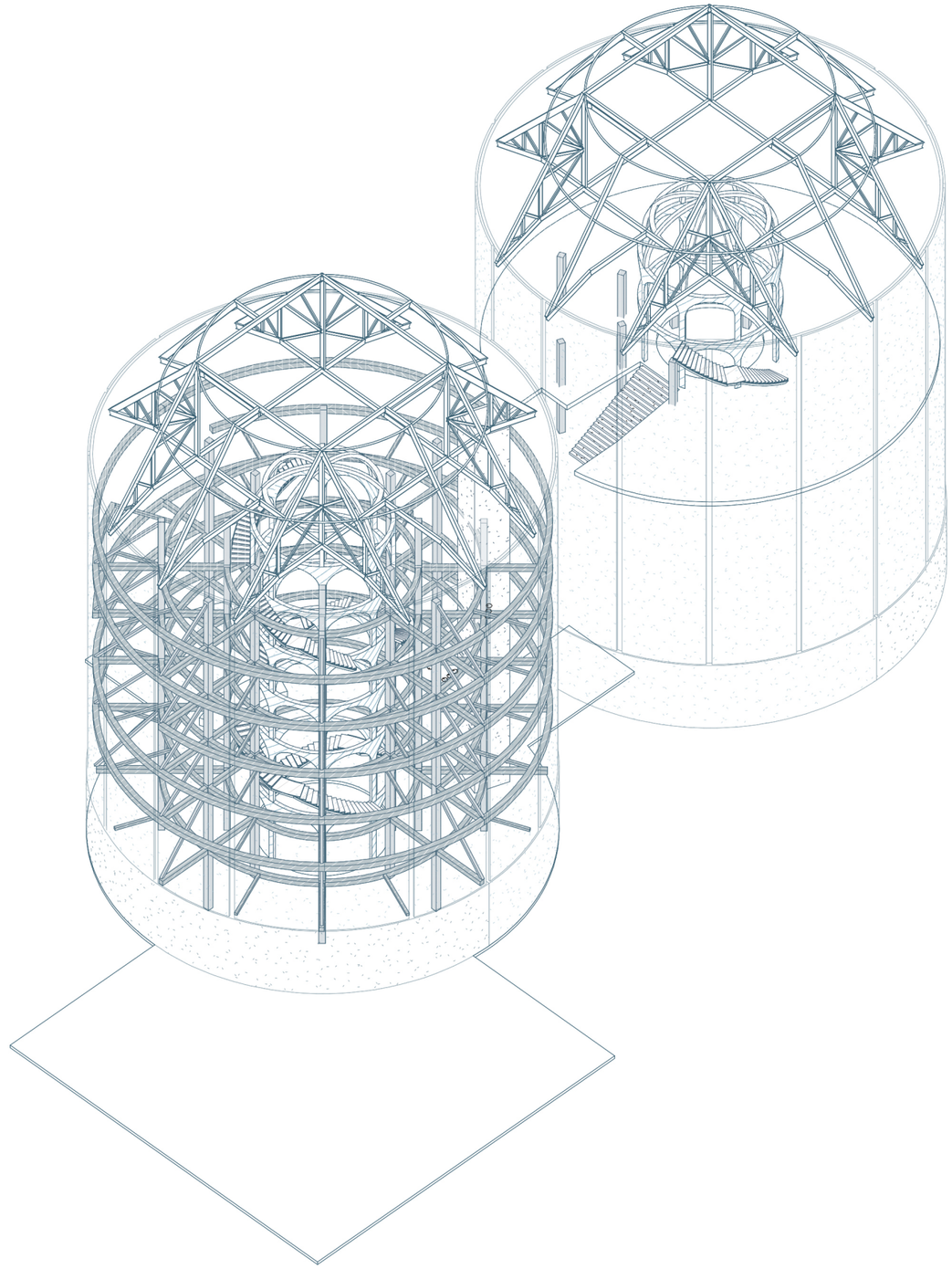
Assembly

Step 3:
Installation of construction components through the roof and bottom openings. The Circular opening on the roof is of 17.5M, which means (most) construction components should be able to pass through it in plan. This would also define the compartments for fire proofing. Construction of central circulation system and other structure happen together followed by slabs and walls.

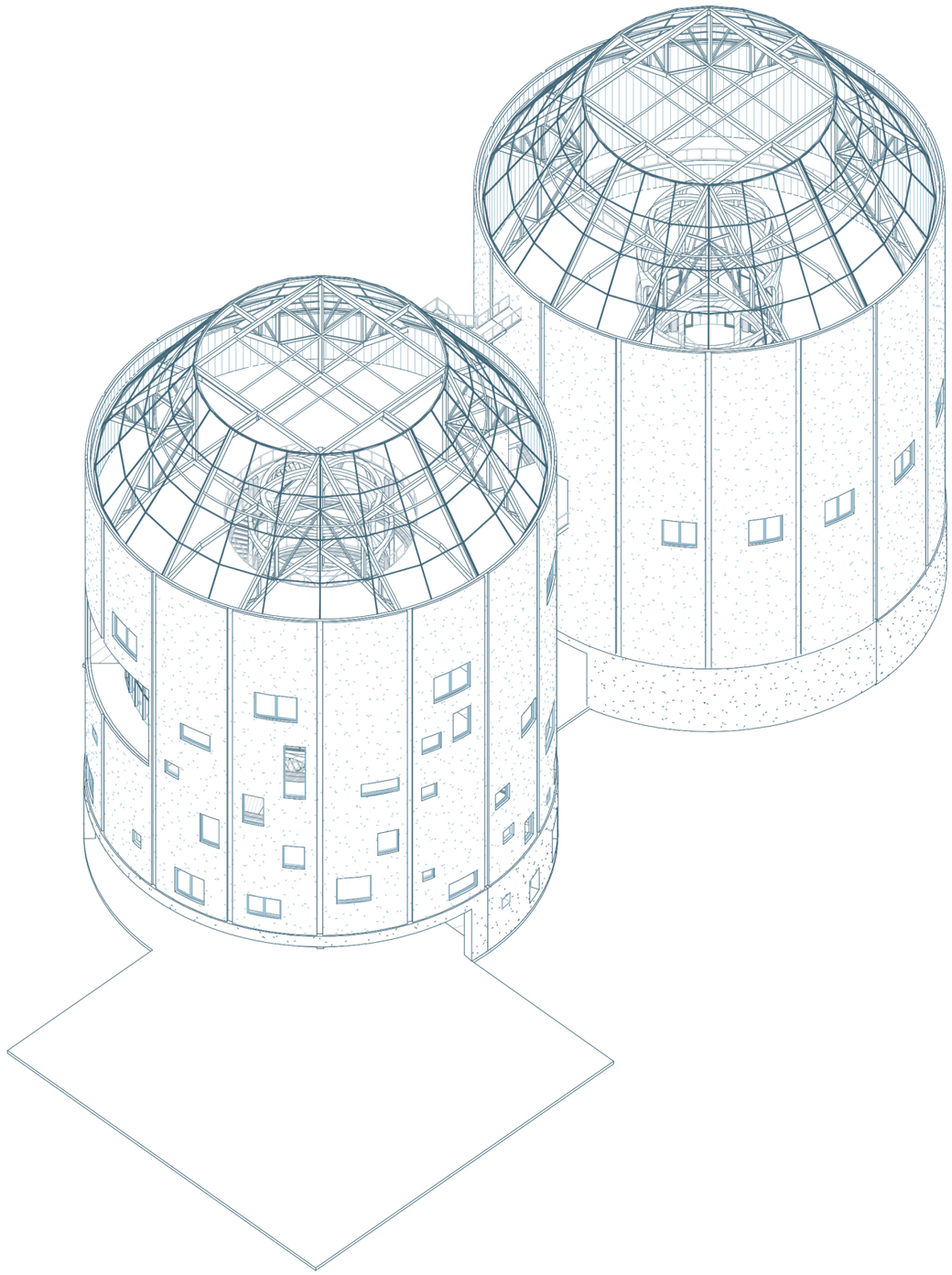


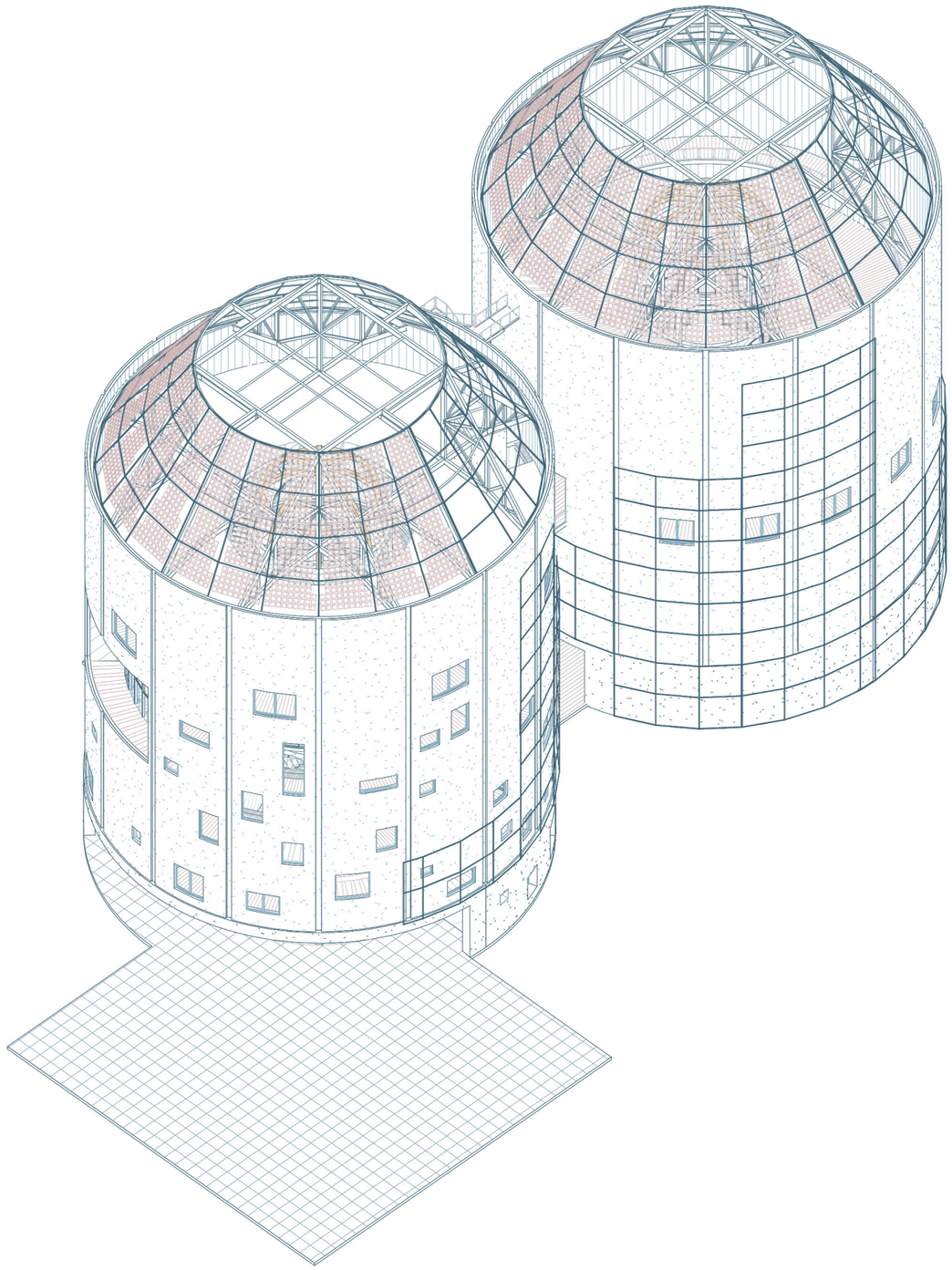
Assembly

Step 4:
Construction of the structure above. Addition of diagonal beams. The super structure along with the beams is built.



Step 5:
Interiors, finishes and fenestrations.



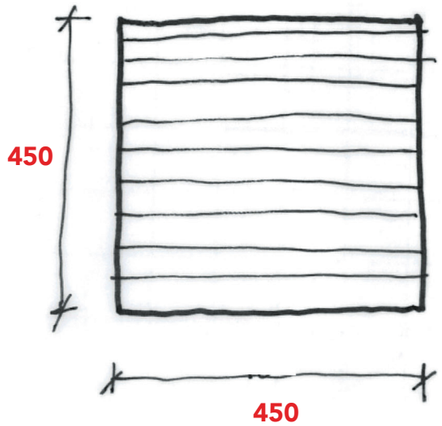


Step 6:
Roofing (solar panels) and green facade.

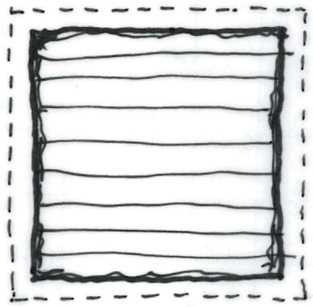
Fire & Module

Structure is designed for total of 120mins.
90mins from the structure with an additional 30mins from
Hi-fog system and active fire-fighting.

Glulam Spruce Column
450x450mm

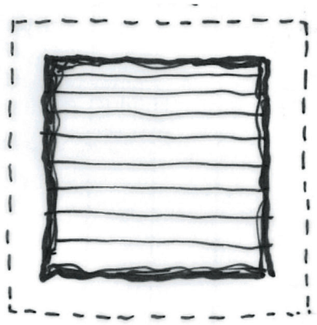


30mins



Charring= 0.7mm/min
=0.7x30
=**21mm**

60mins



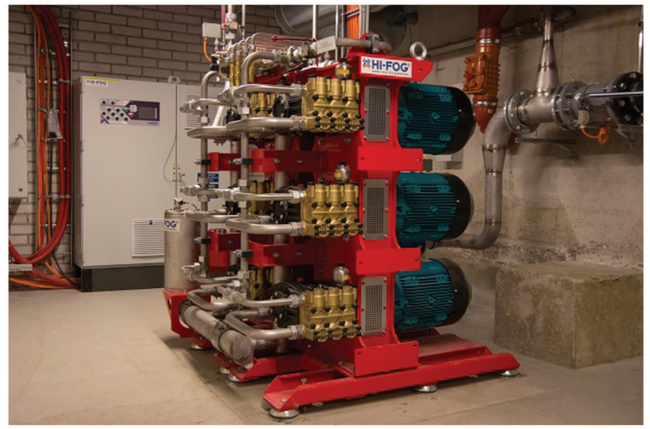
Charring= 0.7mm/min
=0.7x60
=**42mm**

90mins

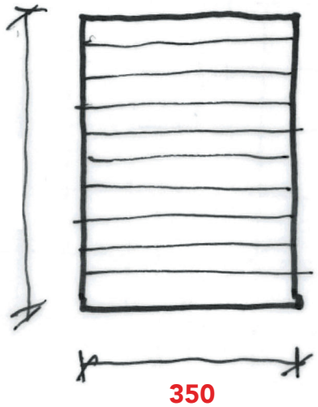
Charring= 0.7mm/min
=0.7x90
=**63mm**

120mins

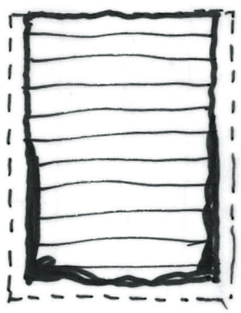
Hi-fog sprinkler system.



Glulam Spruce Beam
400x350mm

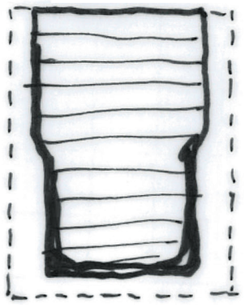


30mins



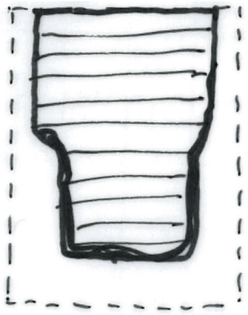
Charring= 0.7mm/min
=0.7x30
=**21mm**

60mins



Charring= 0.7mm/min
=0.7x60
=**42mm**

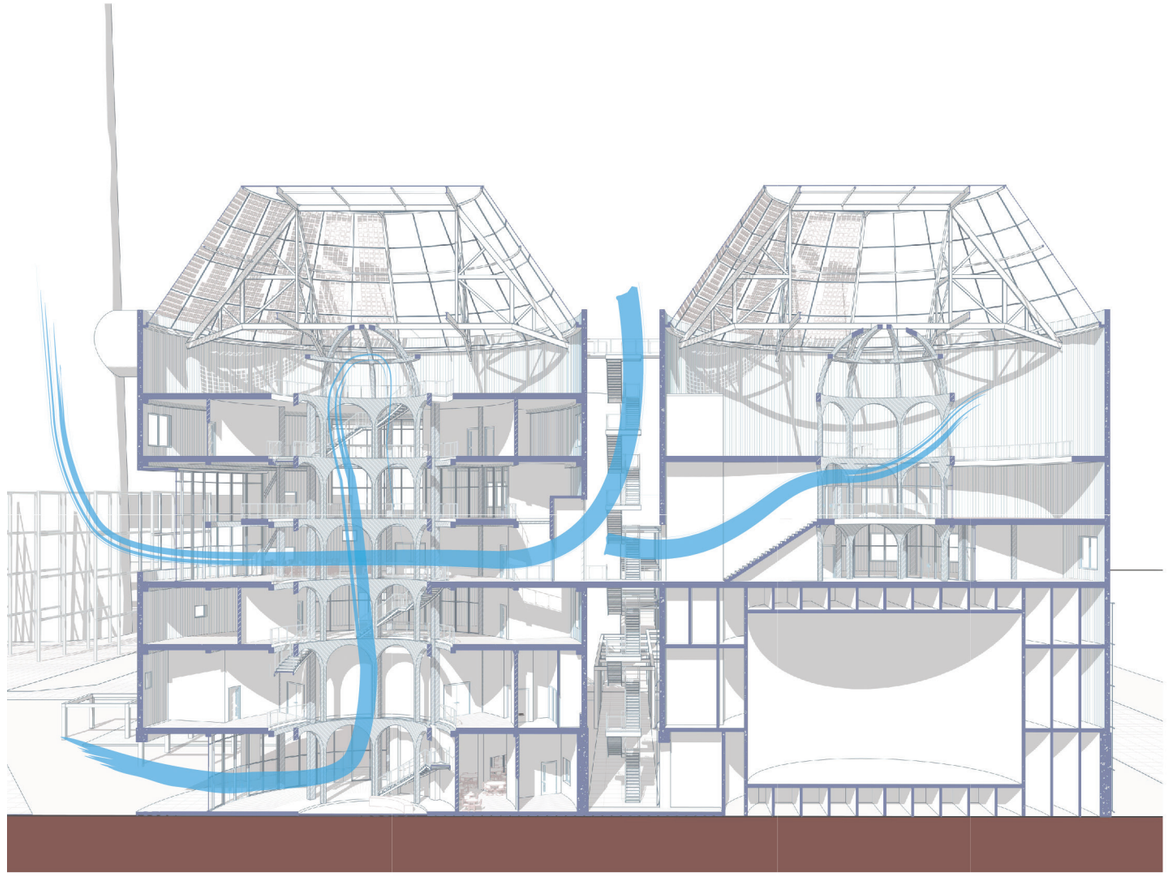
90mins



Charring= 0.7mm/min
=0.7x90
=**63mm**

Climatic Adaptation

Summer
Opening up the terraces and various openings in the building to allow cross ventilation. Green facade blocks the harsh sunlight but allows the wind to go through, cooling down the interiors. Using the atrium space for vertical air-circulation.
Systems used for cooling:
Passive cross-ventilation.
Floor cooling. (During summer afternoons when temperatures sore around +26degree C, during that time water from the Underground water tank can be run through the pipes to cool the structure)
Mechanical Ventilation system



Winter
The central atrium helps in ventilation and heat trapped from the transparent solar panel roof and terraces help heat up the interiors.
Heat is supplied from the basalt battery.
Systems used for heating:
Floor heating.
Mechanical ventilation system.
Thermal insulation.