ARCHITECTURAL ENGINEERING

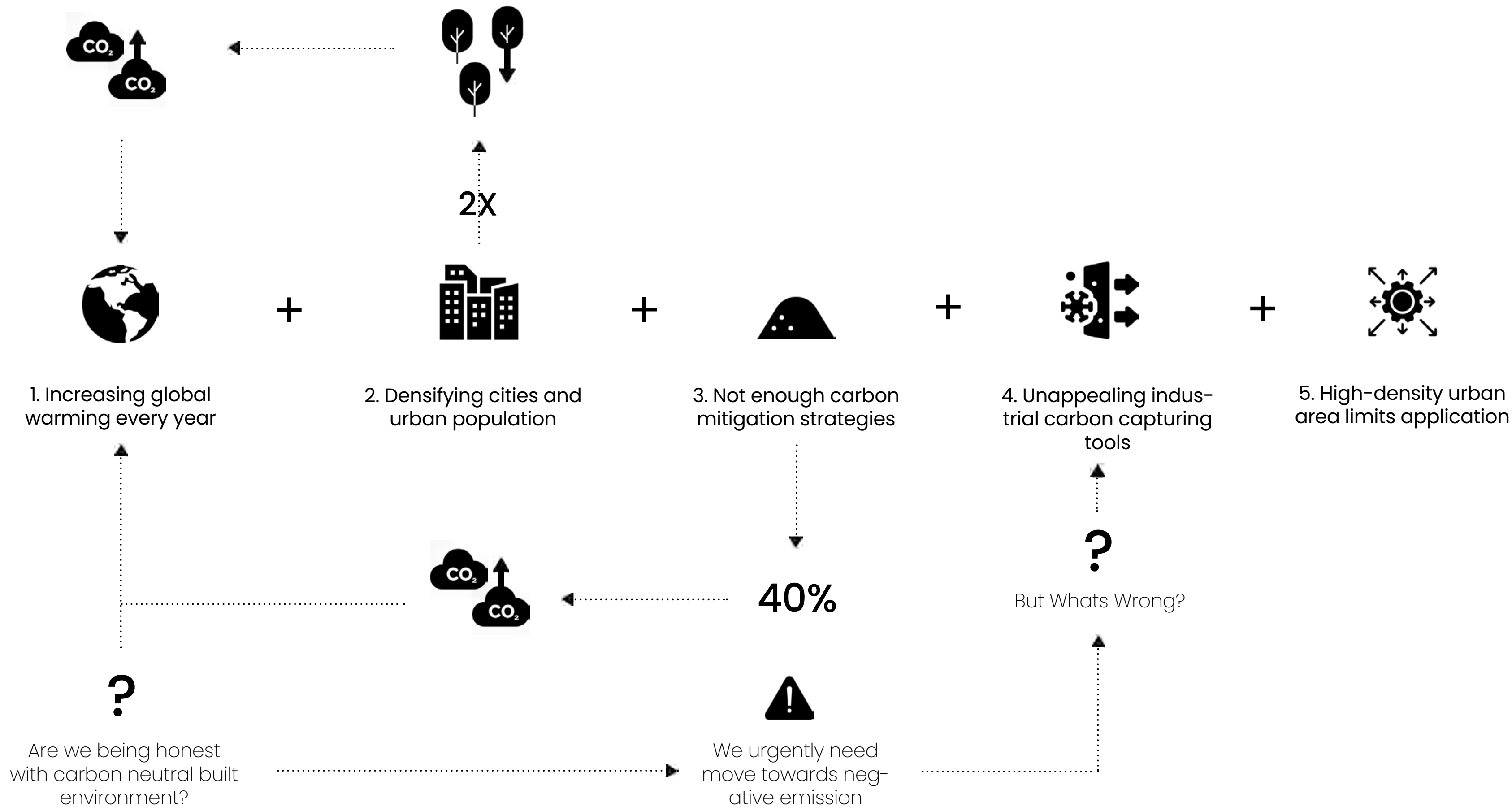
# BOTANICAL RESEARCH INSTITUTE, SHANGHAI

Integration of carbon-capture technology for agricultural sciences

Junhyeon Song

20/06/2024 P5 Presentation

# RESEARCH OVERVIEW: THE GLOBAL PROBLEM

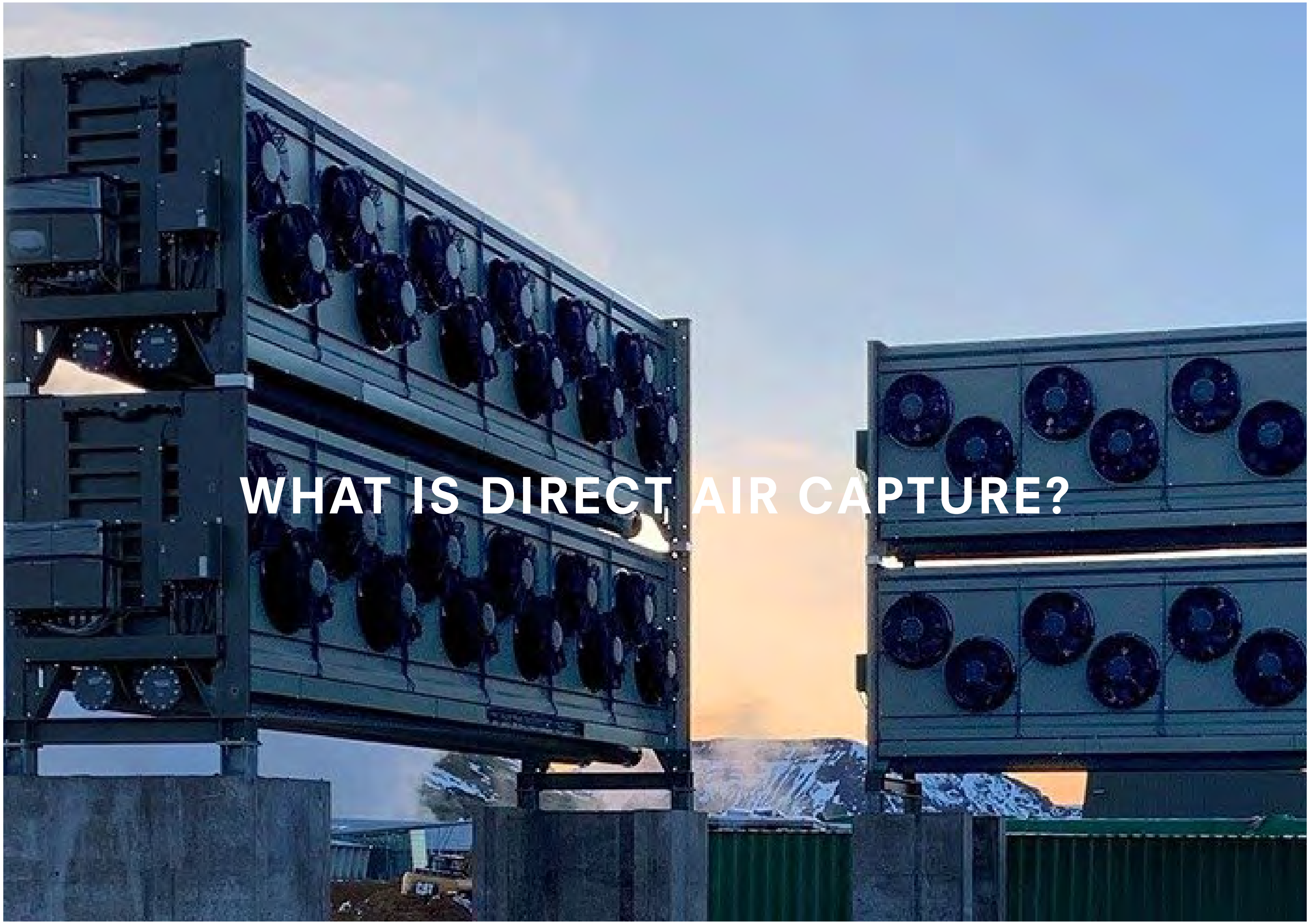



What if our **buildings**

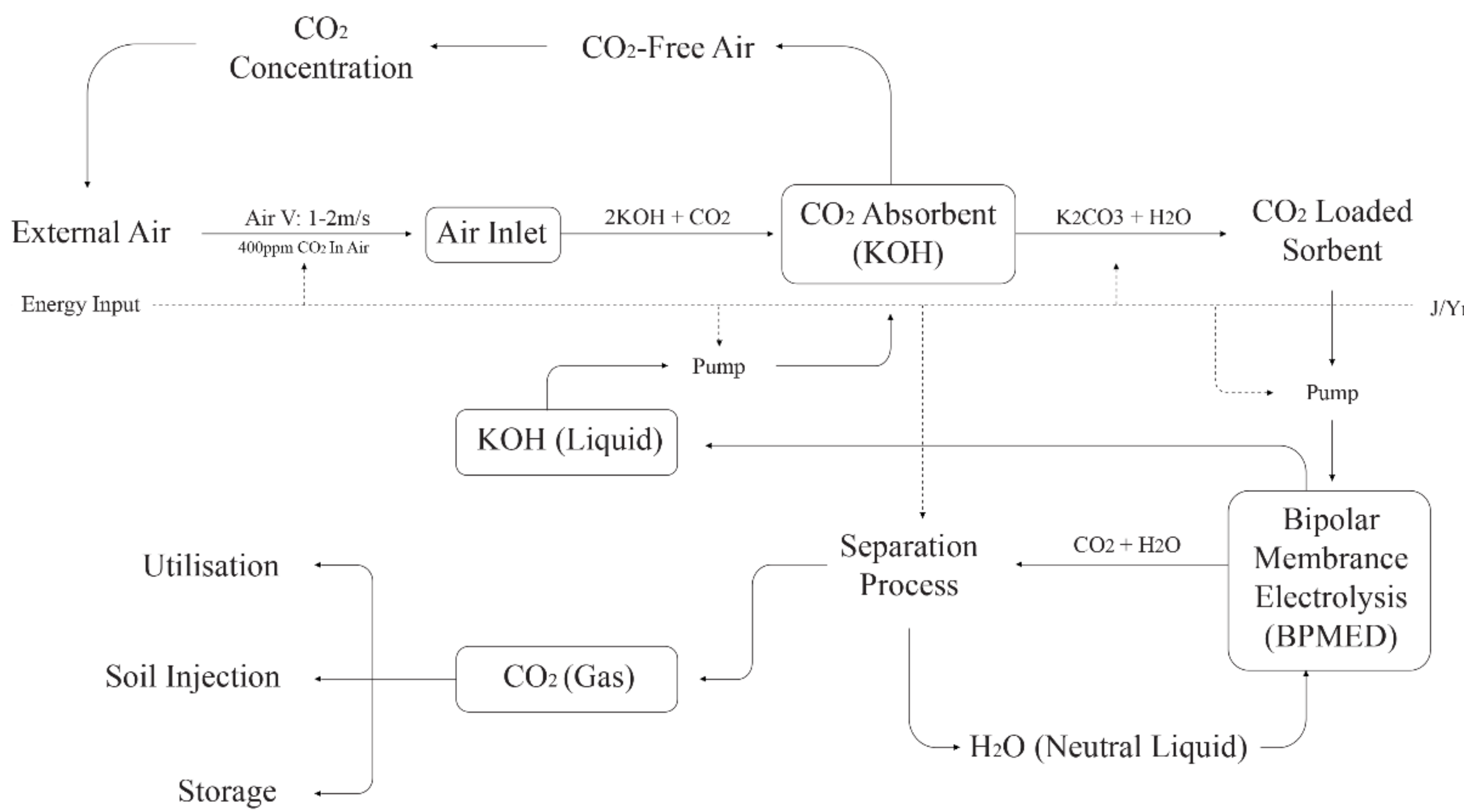

Were more likeTrees?

Capturing Carbon DIrectly from the Atmosphere

# INTRODUCING THE TECHNOLOGY

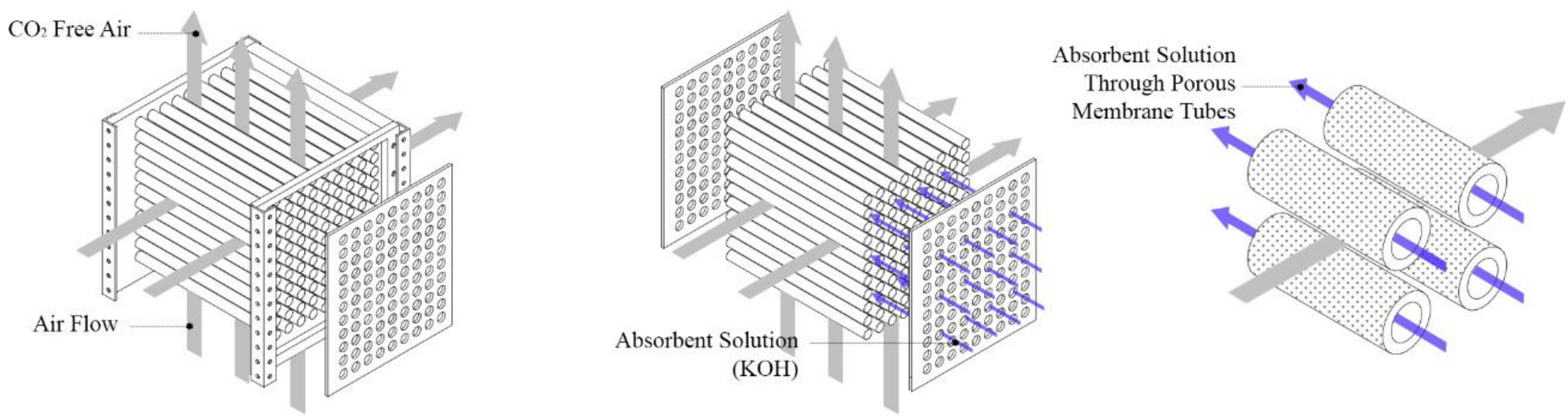


# HOW DOES DAC ACTUALLY CAPTURE CARBON?

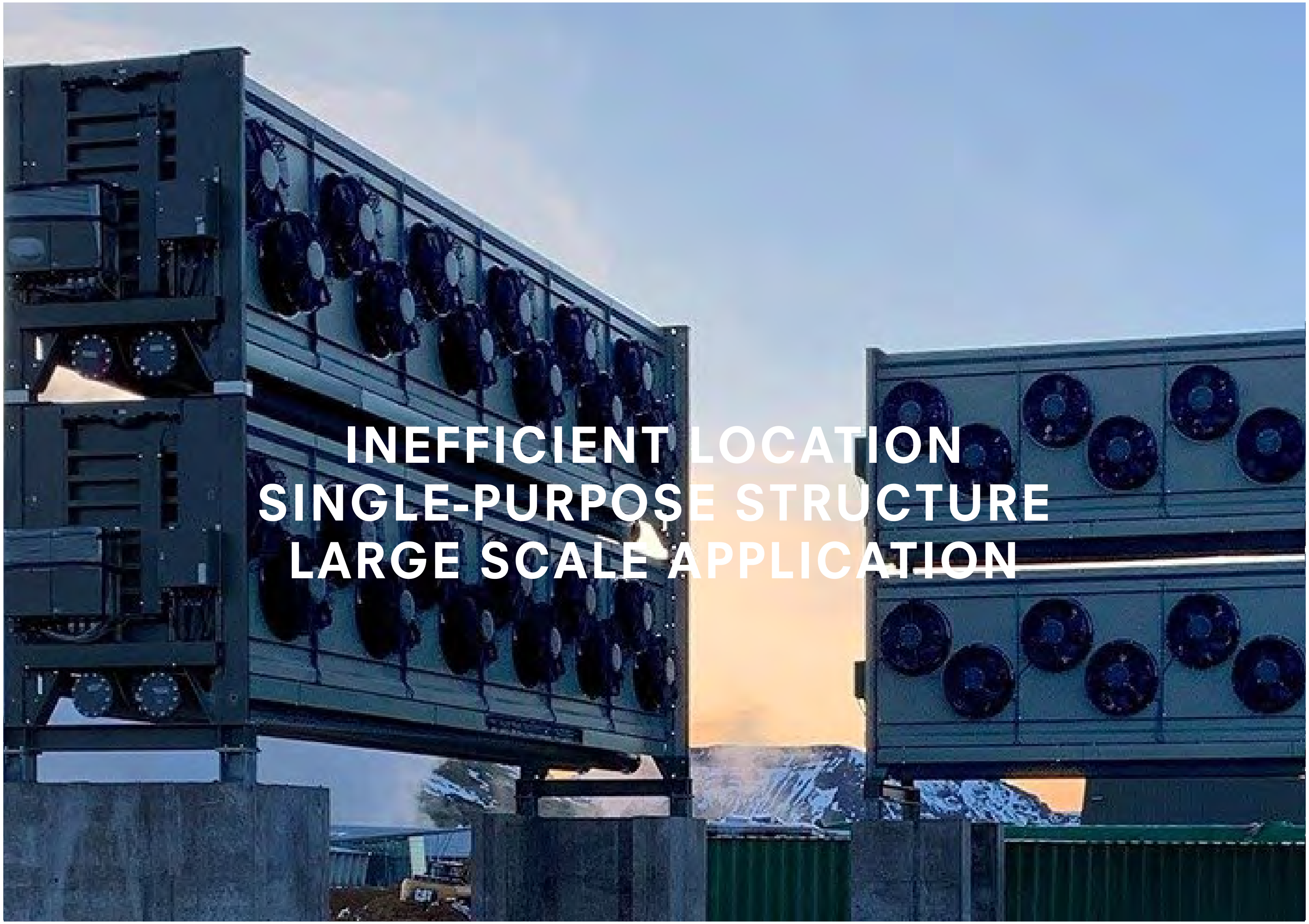



Understanding the general flow of Direct Air Capture Process

# ZOOMING INTO PROCESS



# CRITICAL ISSUES TO CONSIDER



# RESEARCH QUESTION

*“**How*** can architecture strategically incorporate emerging $CO_2$ capturing technology into its design methodology***?”***

# IMPLEMENTING ENGINEERING DATA

Table 1. Specified Cost Optimization model equations from Carbon Engineering Ltd

| Equation | Name | Formula | Units |
|---|---|---|---|
| 1.1 | $CO_2$ Capture Flux | $F = f_{op} PCO_2 V\,(1 - e^{-\varepsilon\, SSA\, D\, K_L/V})$ | $kg\ m^{-2} yr^{-1}$ |
| 1.2 | Pressure Drop in Packing | $\Delta P = D7.4V^{2.14}$ | Pa |
| 1.3 | Energy for Fans | $E = f_{op}\, \Delta PV / \eta\, fan$ | $J\ m^{-2} yr^{-1}$ |
| 1.4 | Capital Cost | $C_{capital} = C_A + C_{pack} D$ | $\$\ m^{-2}$ |
| 1.5 | Operating Cost | $C_{operating} = EC_{elec} + M\&O\ C_{capital}$ | $\$\ m^{-2} yr^{-1}$ |
| 1.6 | Total Cost Minimization | Min $C_{CO_2} = (C_{operating} + CCF\ C_{Capital})$ / FV, D | \$ per ton $CO_2$ |

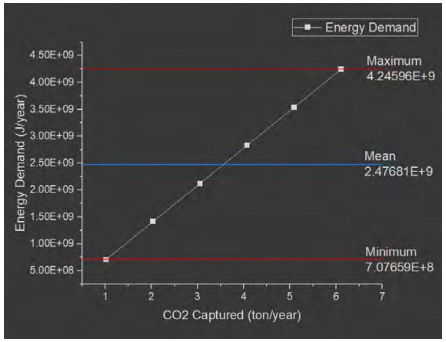
Table 2. Specified Cost Optimization Variables, Values and Units from Carbon Engineering Ltd

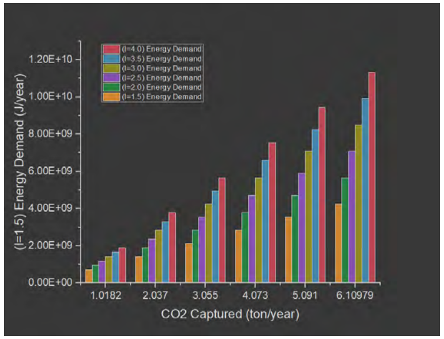
| Variable | Units | Value | Notes |
|---|---|---|---|
| $\eta\ fan$ | % | 56 | Fan efficiency |
| $C_{elec}$ | $\$\ J^{-1}$ | $2.2 \times 10^{-8}$ | Cost of electricity (80\$ per MW h) |
| $C_A$ | $\$\ m^{-2}$ | 3700 | Capital cost per frontal area |
| $C_{pack}$ | $\$\ m^{-3}$ | 250 | Packing and fluid distributor cost |
| $f_{op}$ | s per year | $2.7 \times 10^{7}$ | Assumed annual operation fraction (85%) |
| CCF | % per year | 15 | Capital charge factor |
| M&O | % per year | 5 | Maintenance and operation |
| $\varepsilon$ | % | 80 | Packing efficiency |

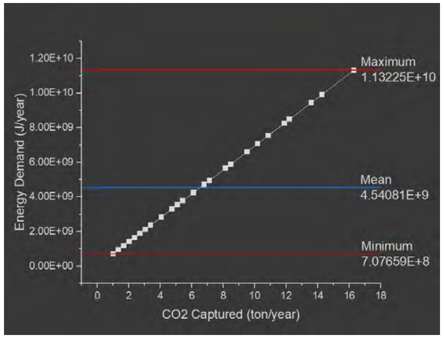
Process of DAC remains consistent and reliability of engineering data

# SIMULATIONS AND CALCULATIONS

| | | | | |
|---|---|---|---|---|
| ATD (Air Travel Distance) | | 3 | m | air travel distance |
| L (Length of Inlet) | | 1.5 | m | length |
| H (height of Inlet) | | 0.35 | m | height |
| V (Air Velocity to Inlet) | | 2 | m/s | air velocity |
| Total Volume of DAC | | 1.575 | m3 | |
| | | | | |
| Calculations | | | | |
| Capture flux | F | 12408.21366 | kg/m2/year | |
| CO2 captured | | 6.514312173 | ton/year | |
| | | | | |
| Pressure drop | deltaP | 97.84917429 | Pa | |
| Energy Per m2 | E | 9.44E+09 | J/m2/year | |
| Energy Required For Module | E | 5.E+09 | J/year | |
| | | | | |
| Capital cost | C_capital | 2336 | $ | |
| | | | | |
| Operating cost | C_operating | 226 | $/year | |
| | | | | |
| Total cost | | 88 | $/ton | |
| | | | | |
| | | | | |
| Energy | E | 183.47 | J/s | |
| Energy | E | 0 | kW | |
| | | | | |
| Solar Panels 400 Watt 8hrs/Day | (730kWh/Year) | | | |
| | 730kwh = 2,628,000,000 Joules | 1.884937005 | *5 Solar Panels/ Module (utilise Hydro Power and Nearby Wind Energy if Possible)* | |
| Number of Modular Units | | 1 | | |
| CO2 Capture Per year By Building | | 7 | ton/year | |
| CO2 emitted for construction(Acurate data can be calculated once the design is developed) | | 31.5 | kg Co2 | |
| For a unit with a volume of 21 m³ (cubic meters), this would translate to 21 x 1 to 1.5 metric tons of CO2. | | | | |
| Years to Offset | | 4.835506675 | Year | |

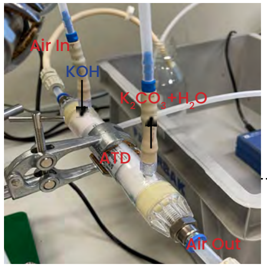


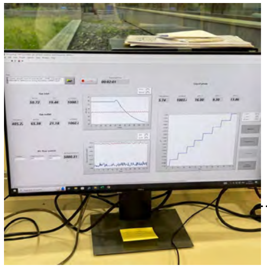



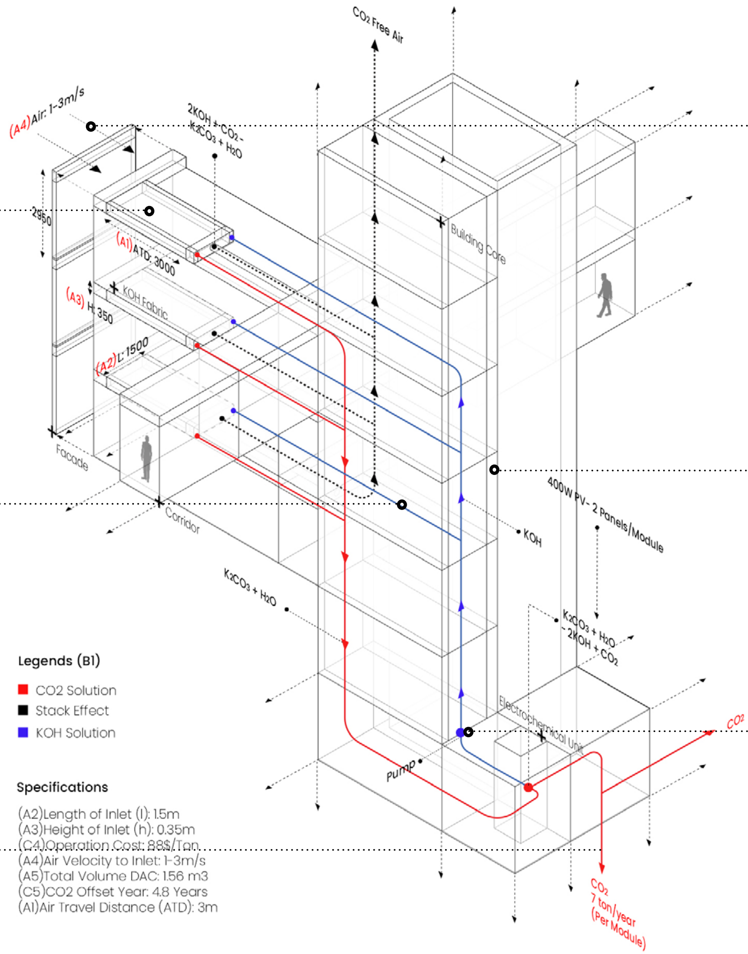

Converting engineering data into architectural parameters

# LAB SIMULATIONS

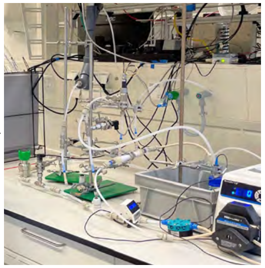










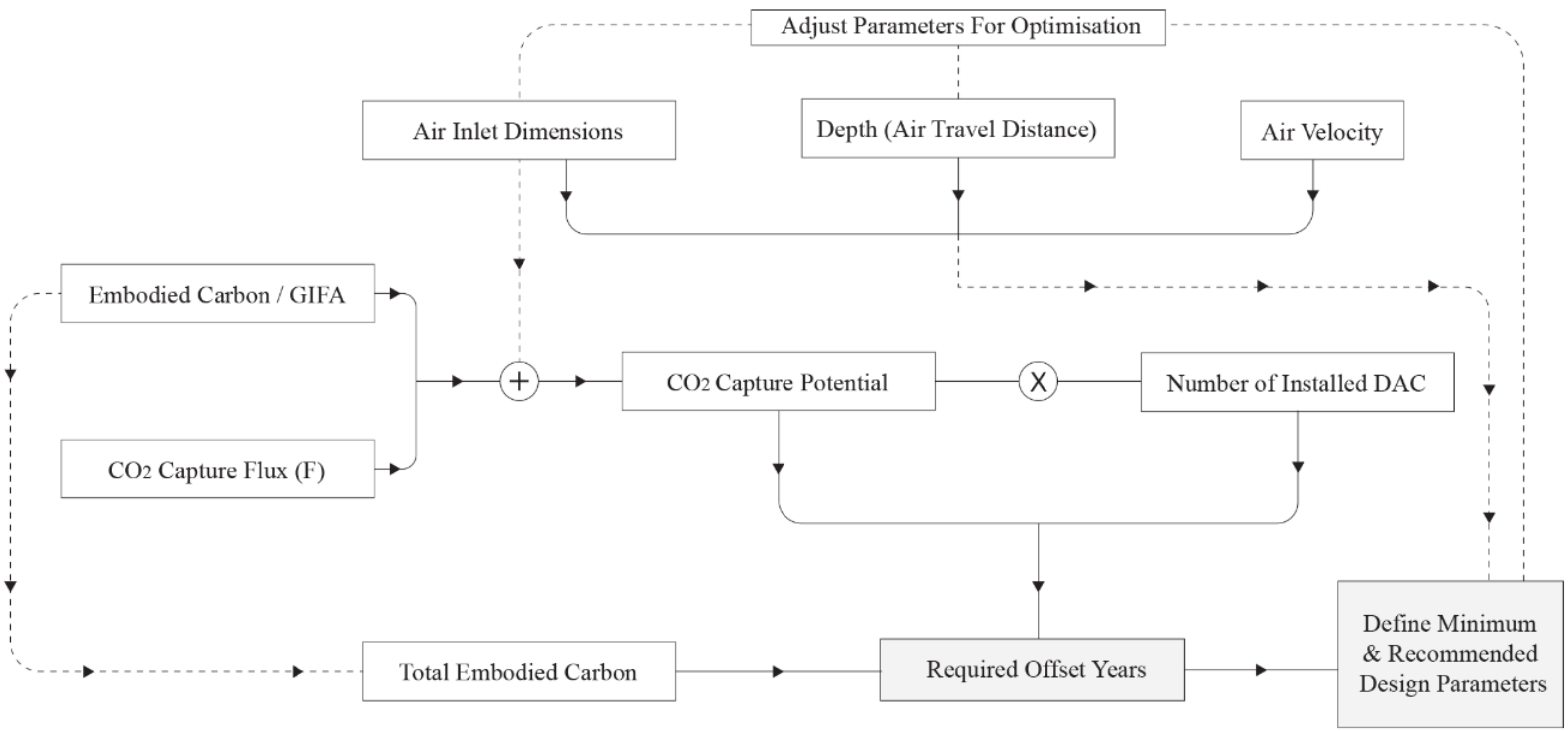


Chemical flow of DAC process translated into architecture

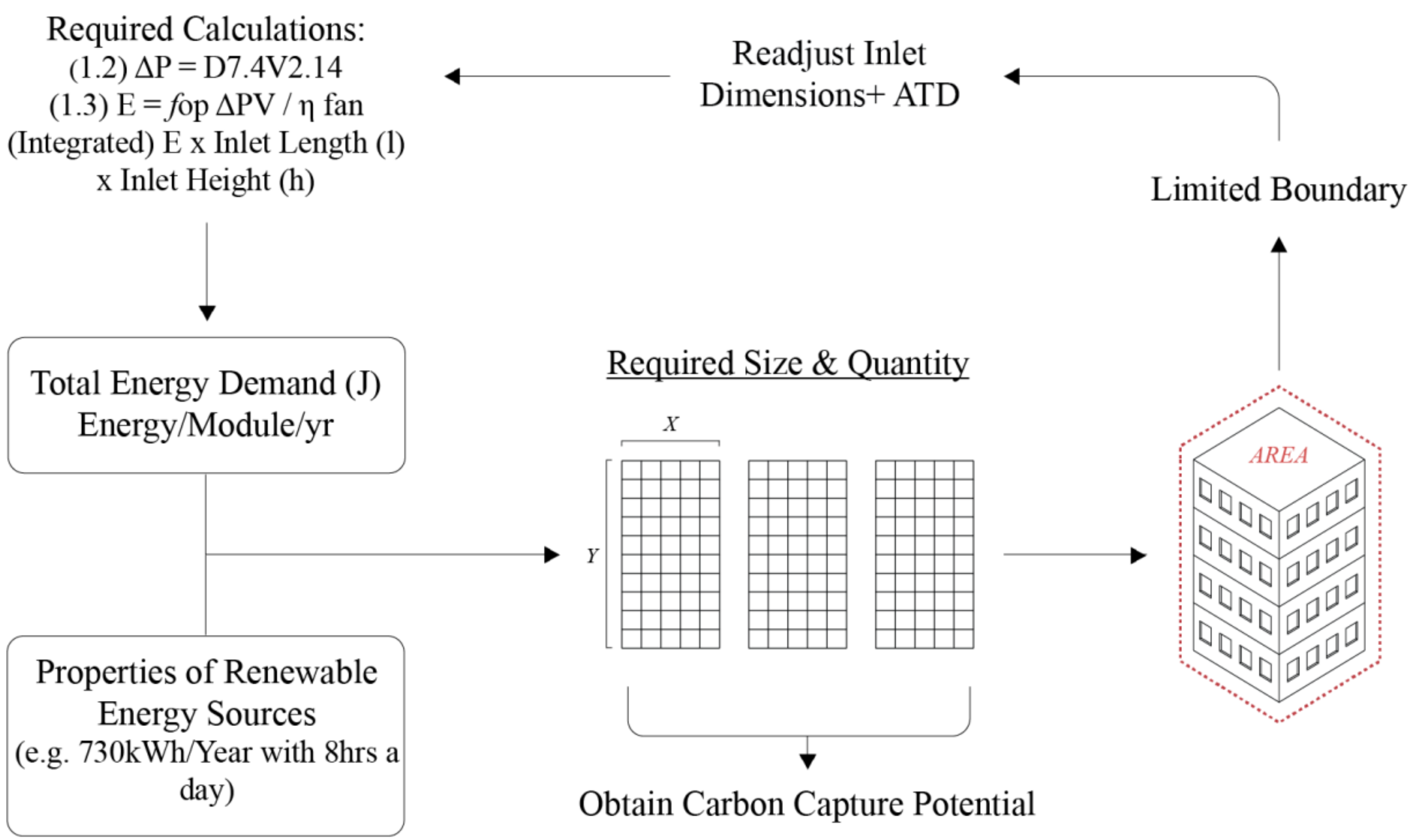
Comparing Embodied Energy and $CO_2$ absorption capacity

# DESIGN GUIDELINE 1: OFFSET YEARS

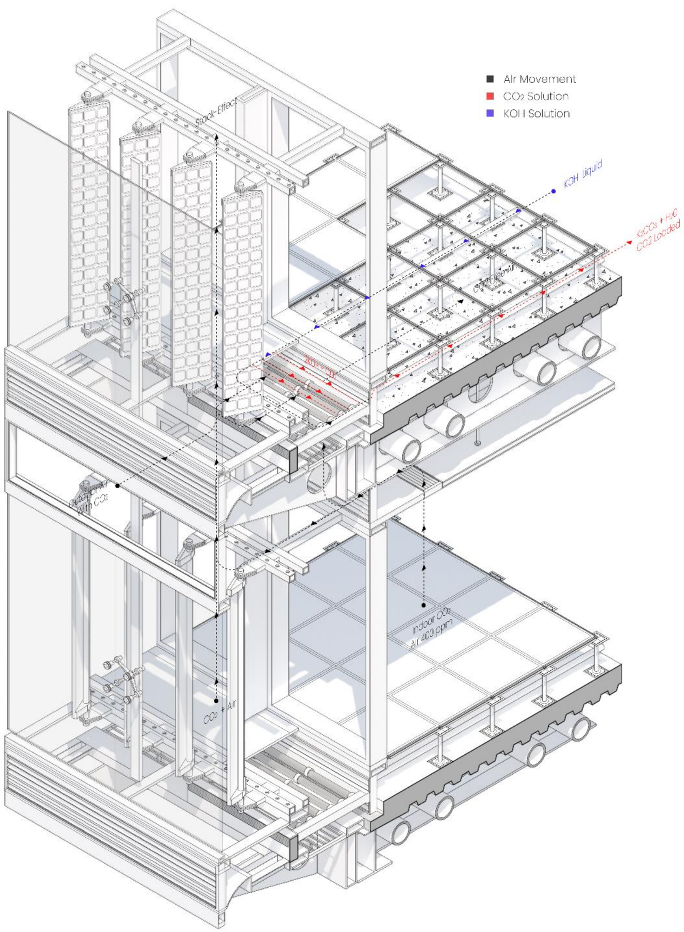
$$CO_2 \text{ Offset Years} = (\text{Total Embodied Carbon}/m2) / [\{(\Sigma \text{DAC Units}) \times (CO_2 \text{ Capture potential/Unit})\}/\text{GIFA}]$$

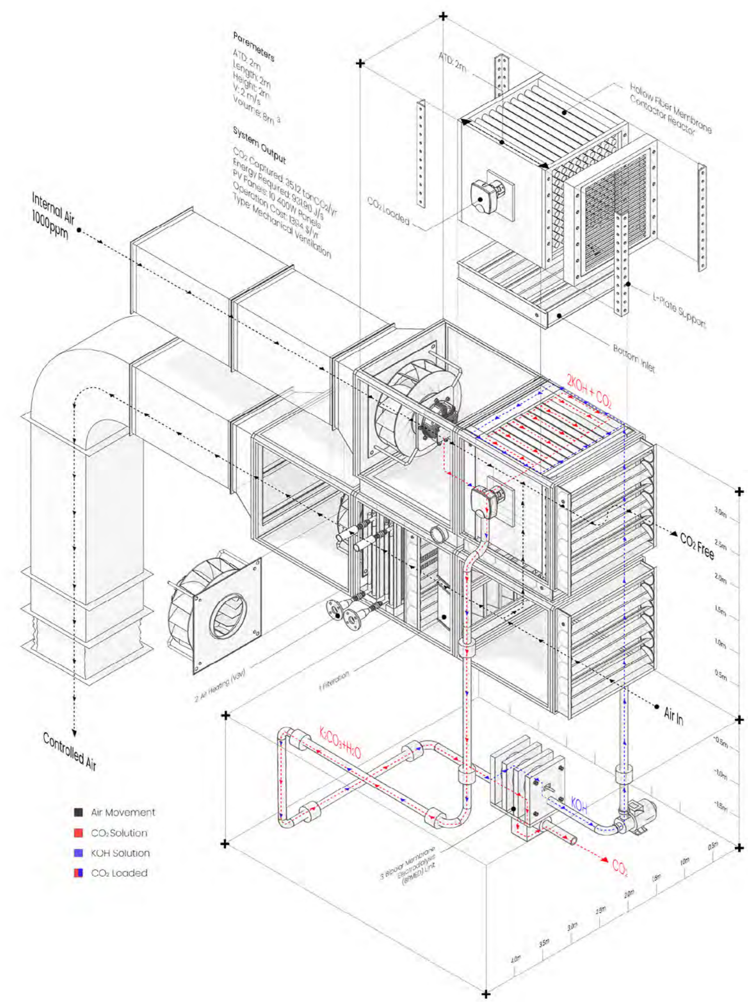


# DESIGN GUIDELINE 2: ENERGY REQUIREMENT



# THE PROTOTYPES




- At the end of air circulation
- Capture from in and out
- Using existing fan power
- Pre-filtered air through DAC
- Lower Costs Involved

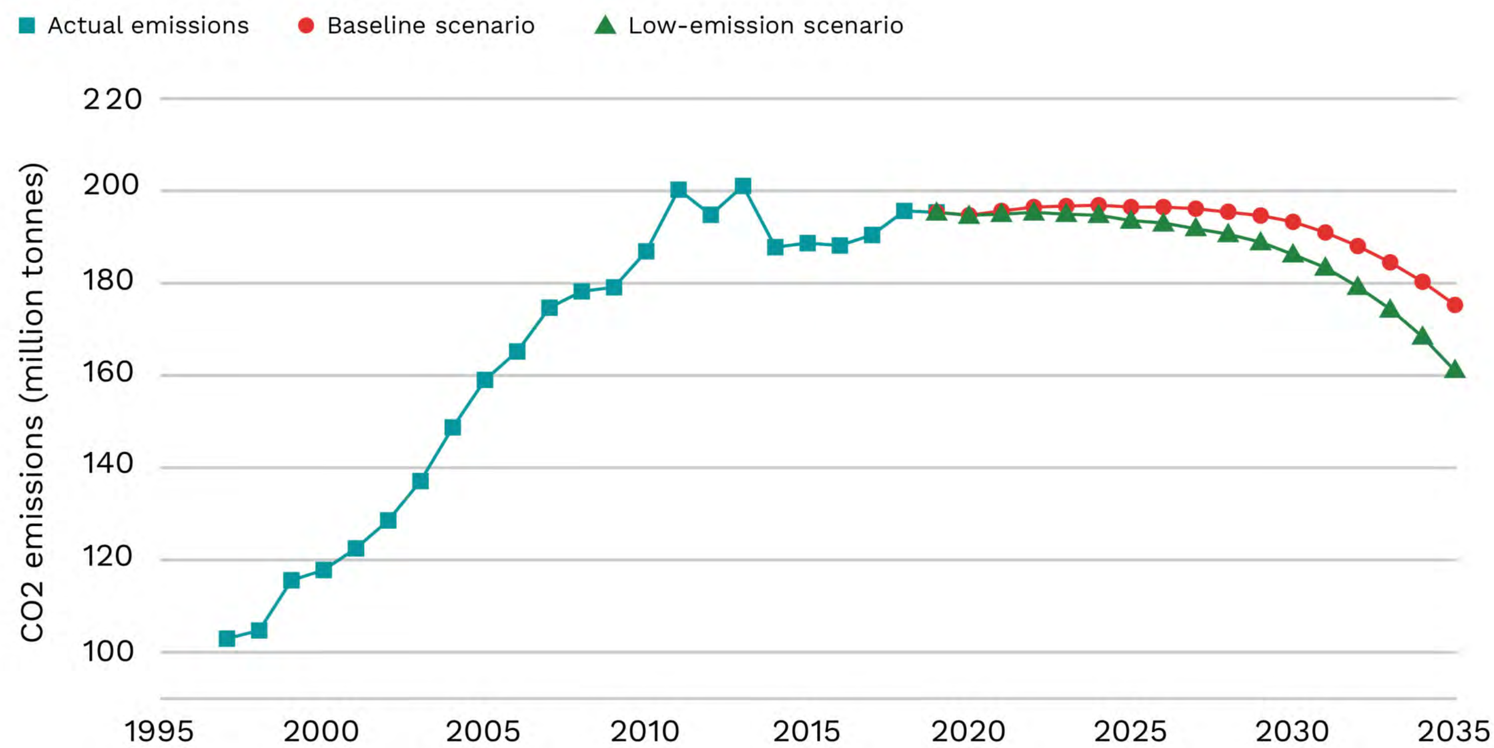
# APPLICATION

*“**How***can we establish this through a real-life application?*“*

The research reaches the design application in Yangpu, Shanghai

Reason 1

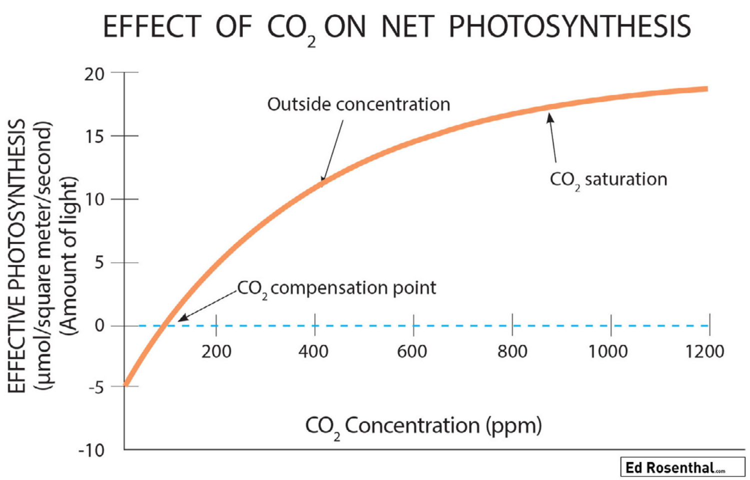
# SHANGHAI CARBON EMISSION TREND




**Source:** Zhang Zhe et al. "Urban CO2 emissions peaking and low-carbon development: can Shanghai achieve its peaking target?", Environmental Engineering, April 2021.

Reason 2: Growing CO2 farming interest and research

# SUITABLE APPLICATION OPPORTUNITY




## Dutch farmers boost production with CO2 waste

Laura Stevens 10/26/2006

A Dutch company is turning a profit and helping the environment at the same time by pumping residual carbon dioxide from Europe's largest refinery to greenhouses.

The Netherlands has 100 million square meters of greenhouses

Image: BilderBox

## China's efforts reduce carbon emission intensity in agriculture: report

Xinhua | Updated: 2023-03-31 16:49

A technician examines rice seedlings at a smart farm in Chongqing's Yongchuan district on Monday. [Photo by Chen Shichuan/For chinadaily.com.cn]

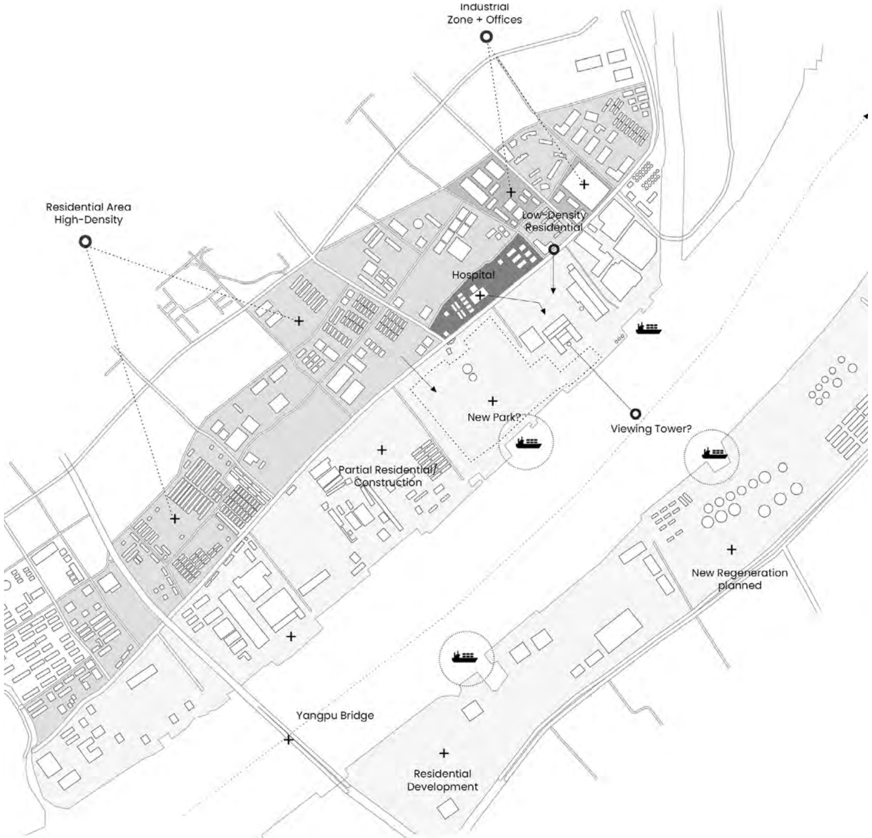
Reason 3: The location to reverse the role of the heritage

# GIVING BACK THE “QUALITY”

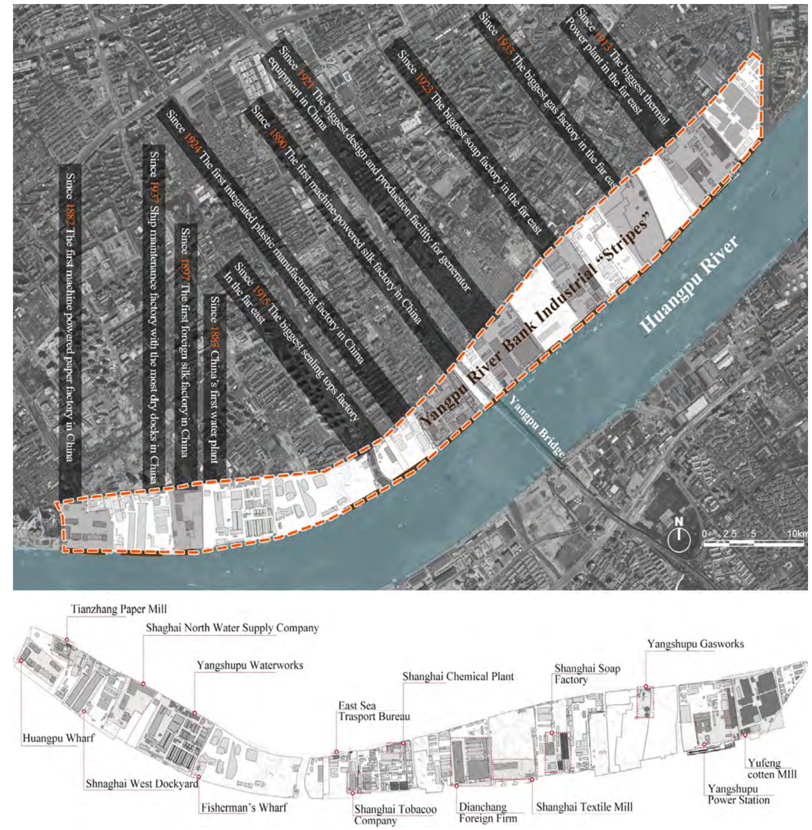
# THE CENTER OF RESEARCH

Reason 5: The regeneration opportunity

# CONTAMINATED INDUSTRIAL LAND

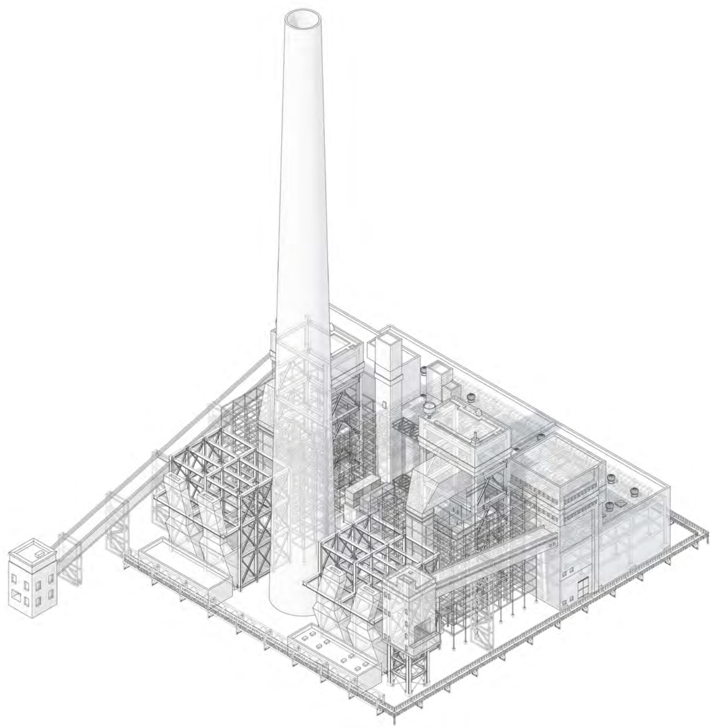



Zooming into Closer Neighbourhood

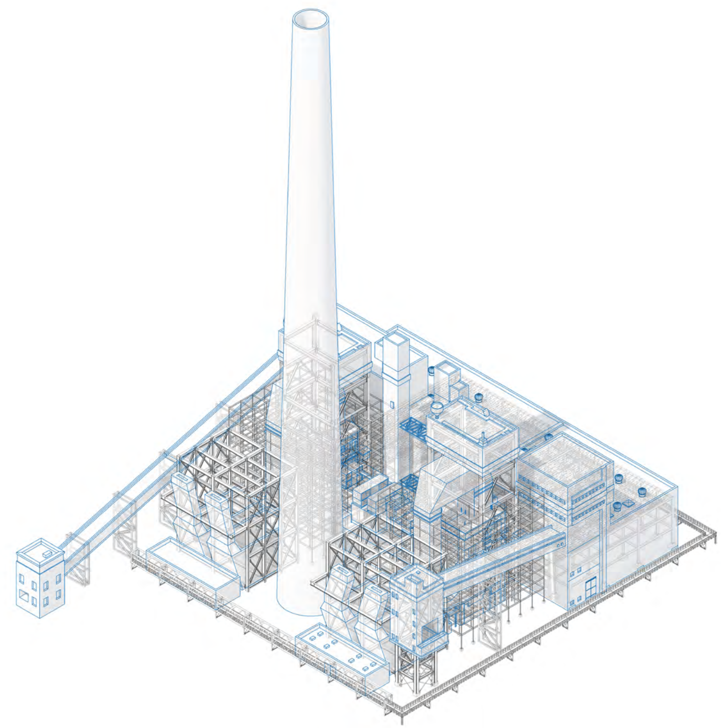



Yangpu Industrial Stripe - Leading to Poor Street Quality

# THE ABANDONED STRUCTURE



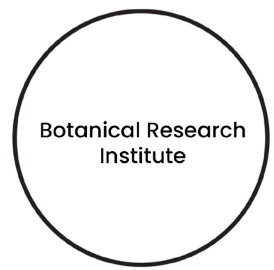
Existing Steel Frame Structure - Preserve



Existing Generation Components

The Facility that Responds to the Context

# THE PROJECT - BOTANICAL RESEARCH INSTITUTE



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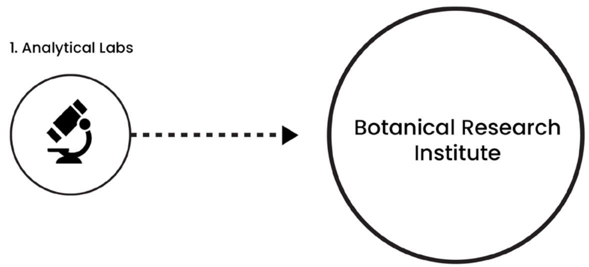

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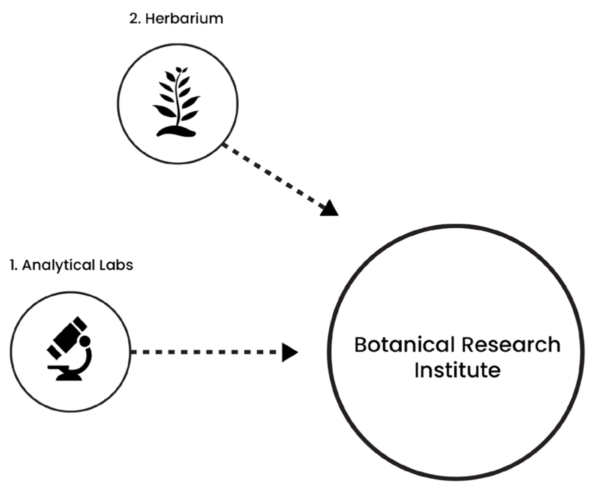

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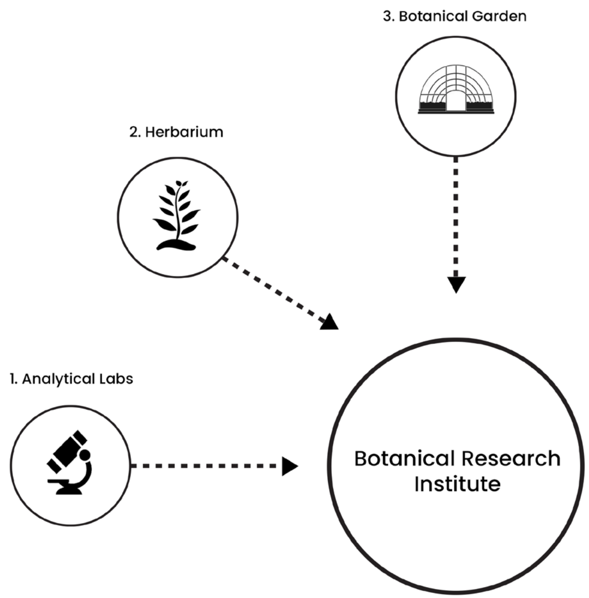

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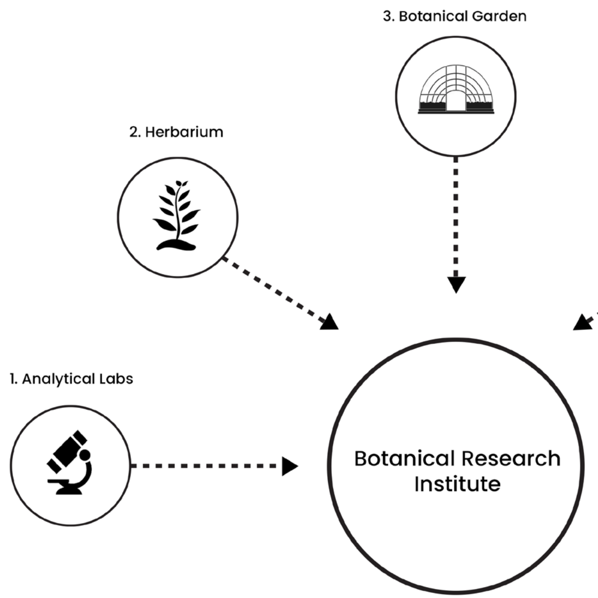

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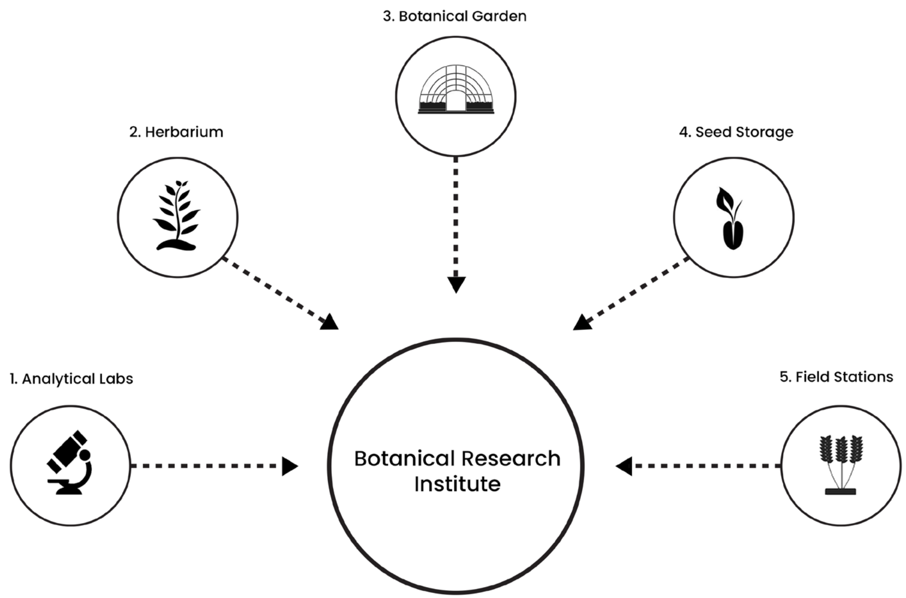

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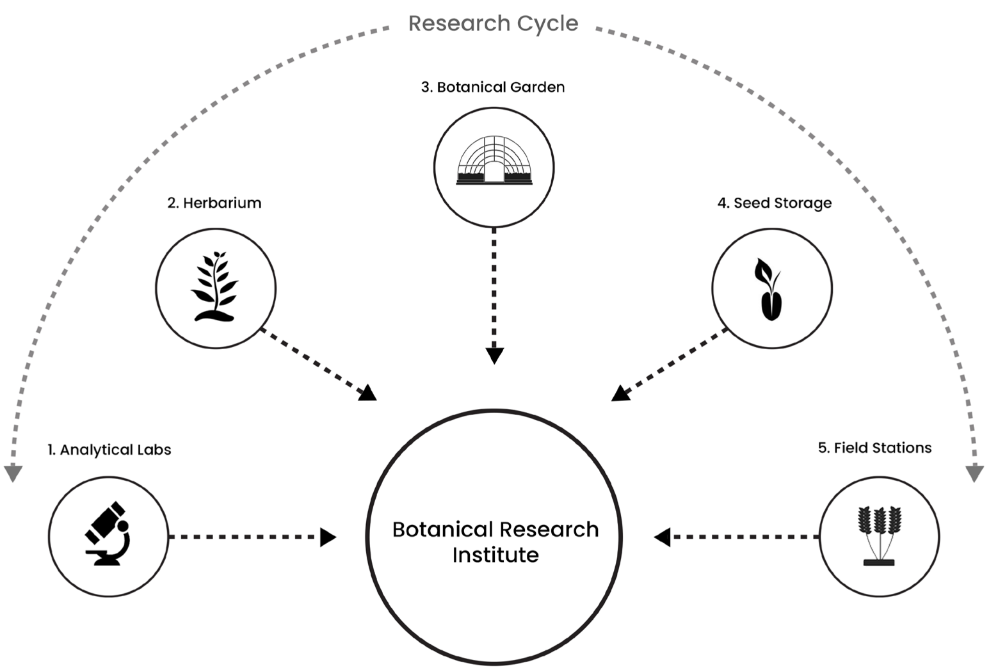

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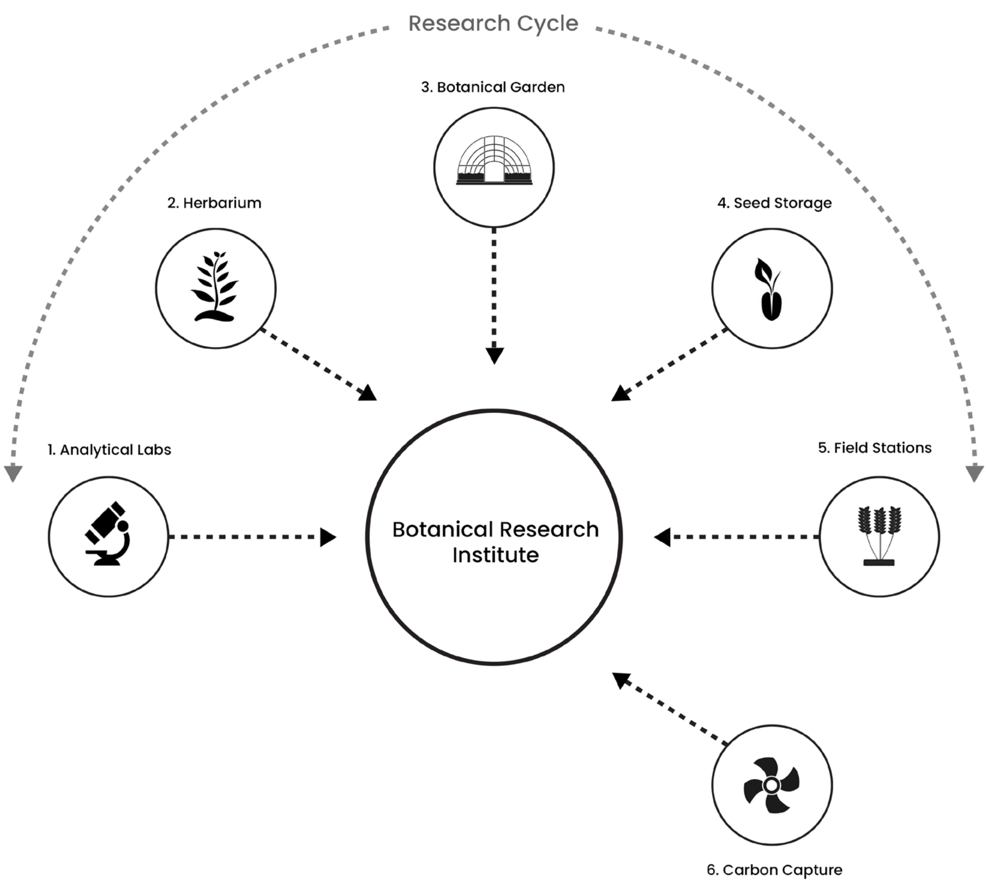

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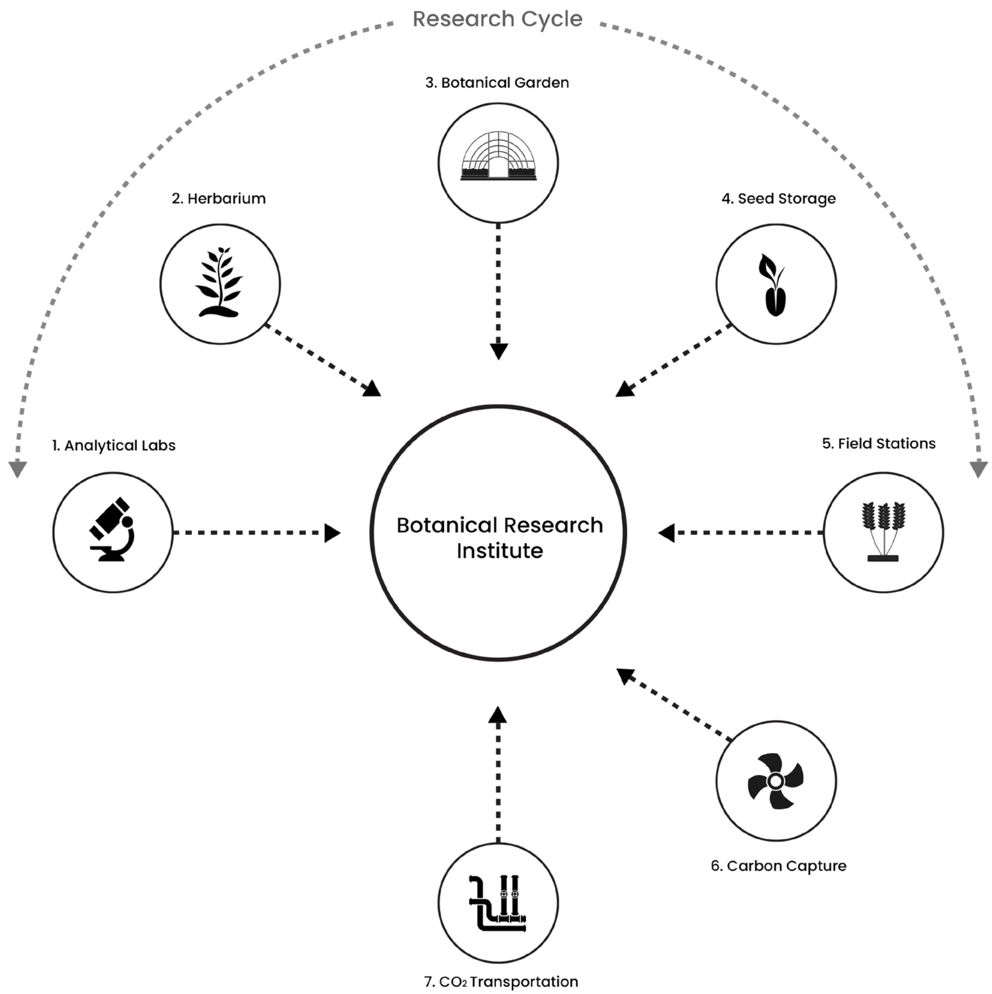

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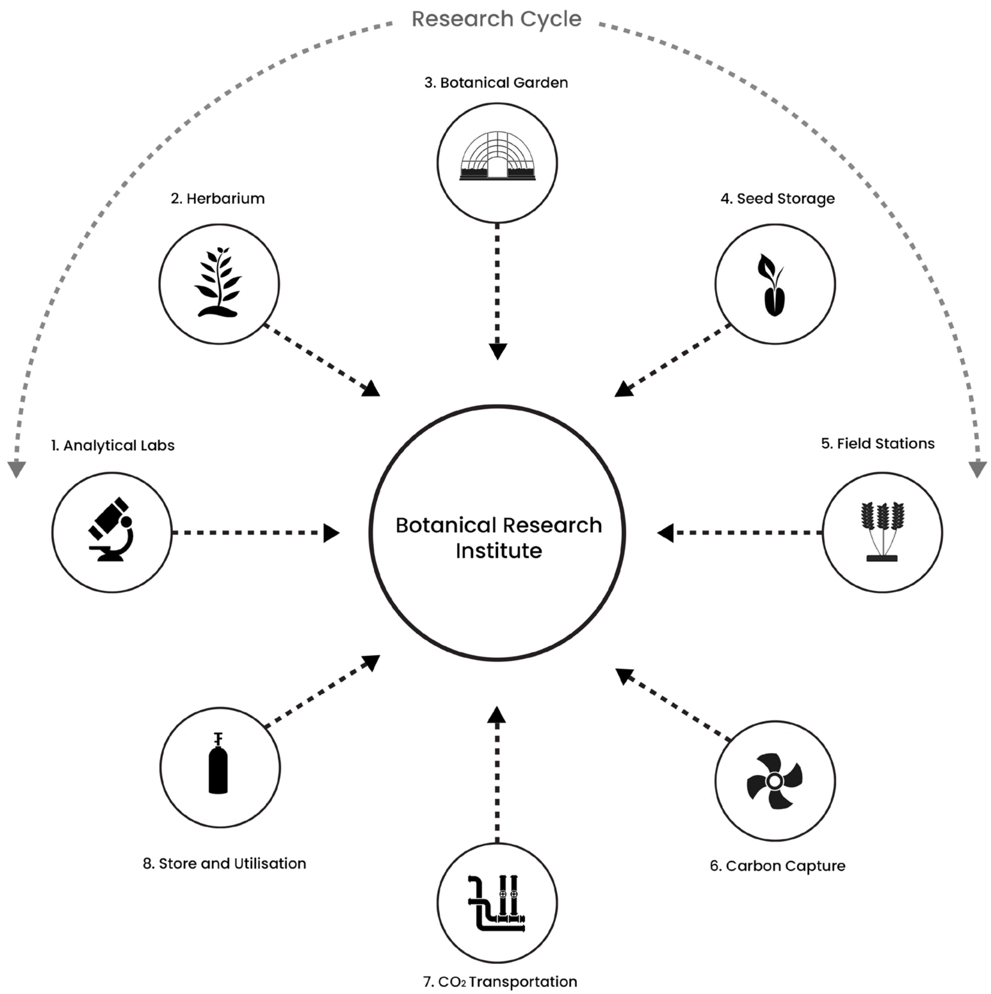

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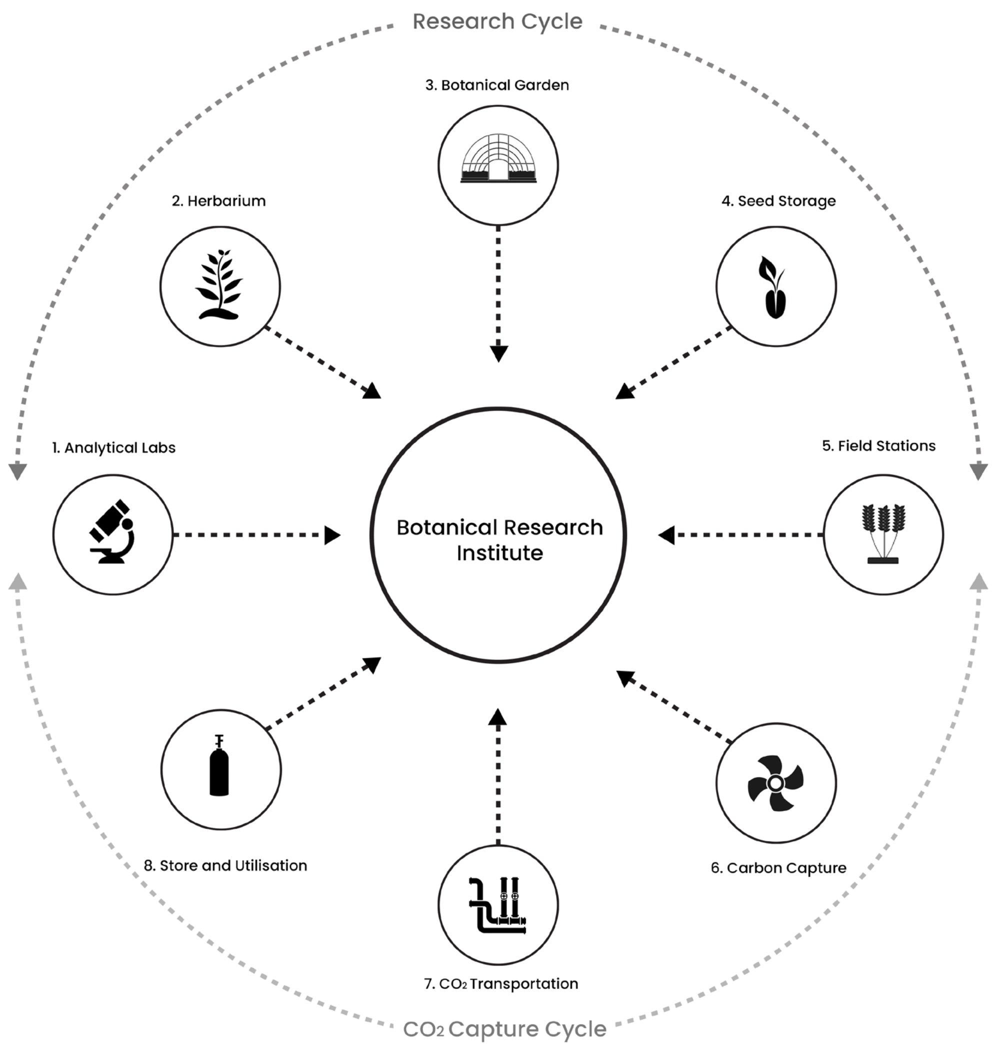


How does the research get delivered in architecturual intervention?

# KEY DESIGN OBJECTIVES

## 1. HERITAGE PRESERVATION

NO DEMOLITION OF EXISTING STRUCTURES BUT INSTEAD COVERED WITH GREENSPACES. COVERING THE OLD WITH THE NEW

## 2. $CO_2$ RESEARCH AND UTILISATION

SELF-SUFFICIENT CAPTURE PROCESS AND REPURPOSING $CO_2$ AS FERTILISER FOR BOTANICAL RESEARCH AND CROP TESTING INITIATIVES

## 3.PUBLIC ENGAGEMENT AND EDUCATION

VISITORS OBSERVE THE RESEARCH PROCESS WHILE PROGRESSING THROUGH DIFFERENT SECTIONS SHOWCASING $CO_2$ UTILISATION

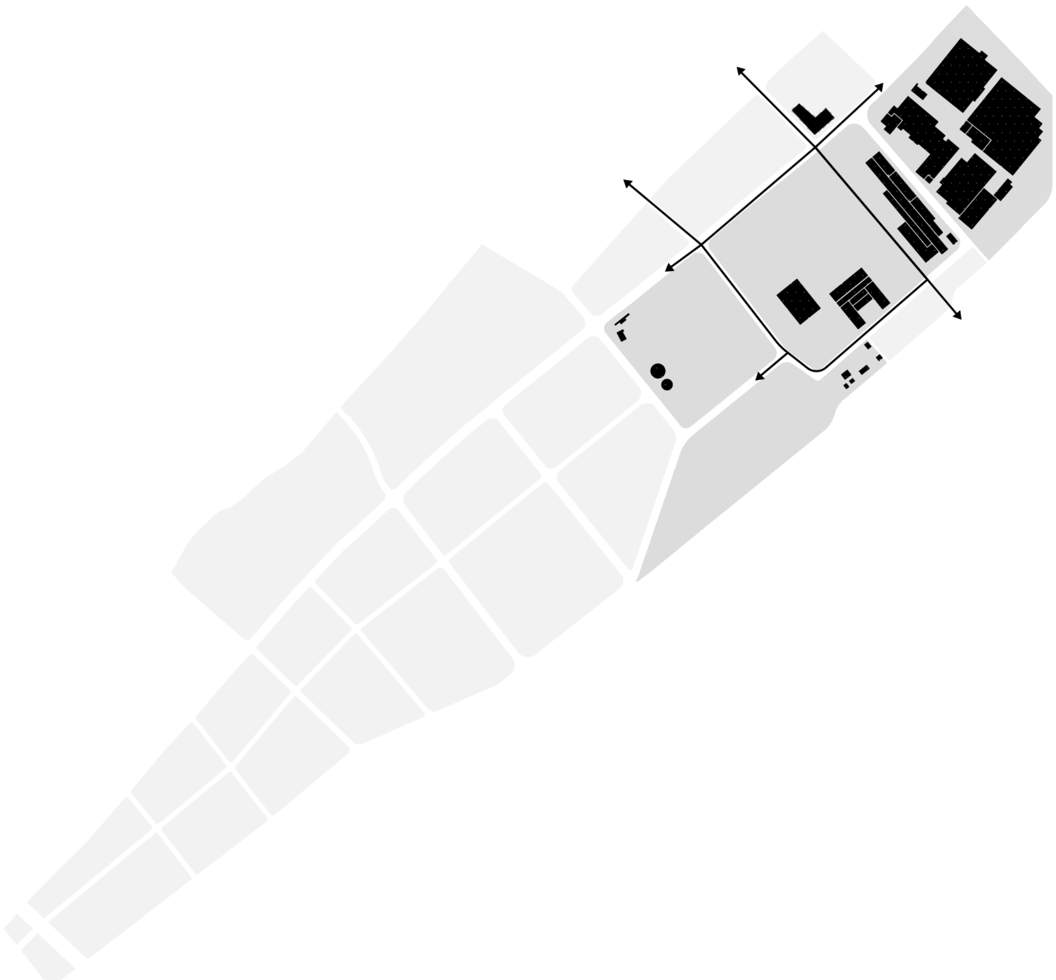
## 4. INTEGRATING TRADITION

INTERCONNECTED GARDENS AND UNIFIED INDOOR CIRCULATION PROVIDING DIFFERNT EXPERIENCES

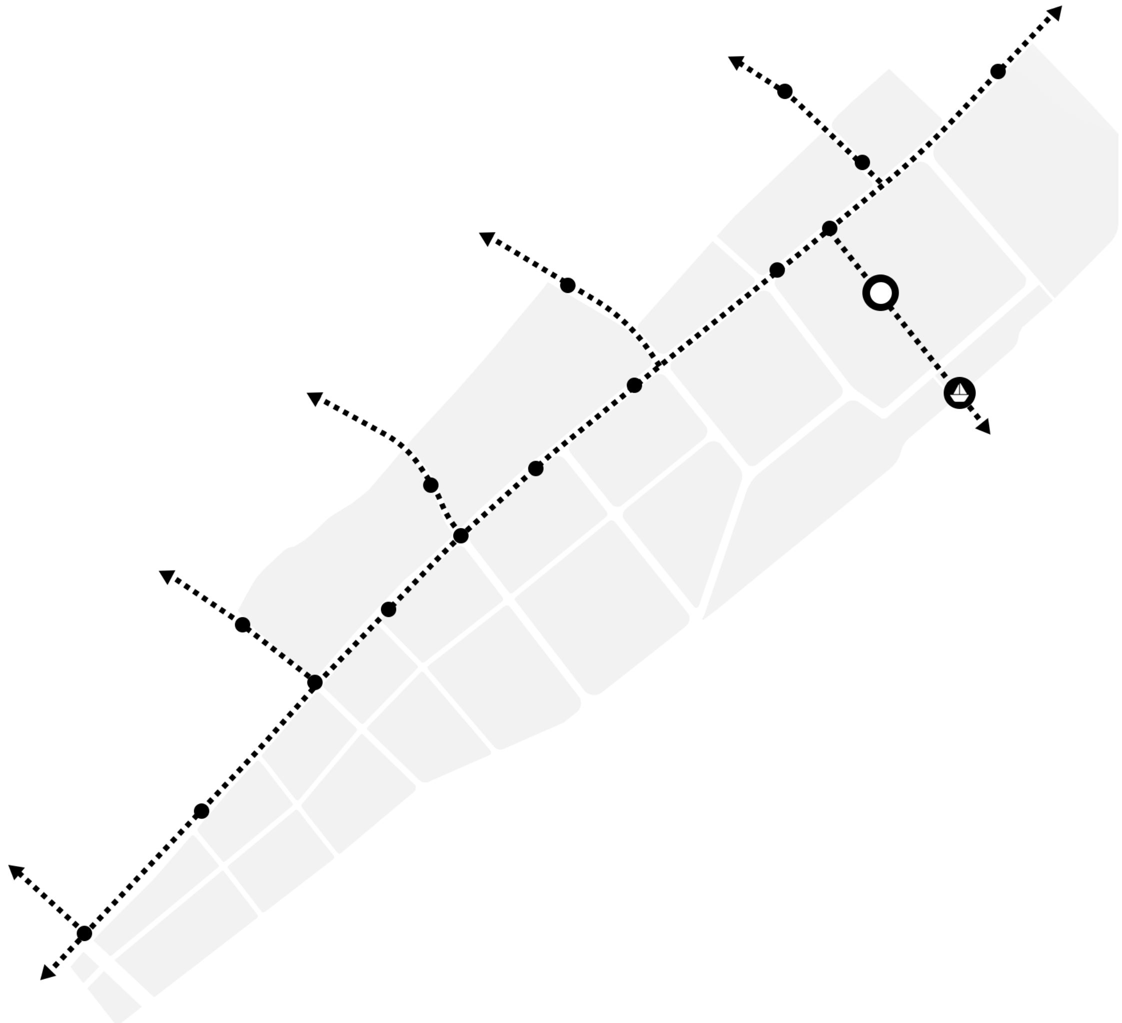
## 5. SUSTAINABILITY + ACCESSIBILITY

A SAFE FLOW OF MOVEMENT THROUGH INTERCONNECTED GREENSPACES

# THE ABANDONED BUILDINGS

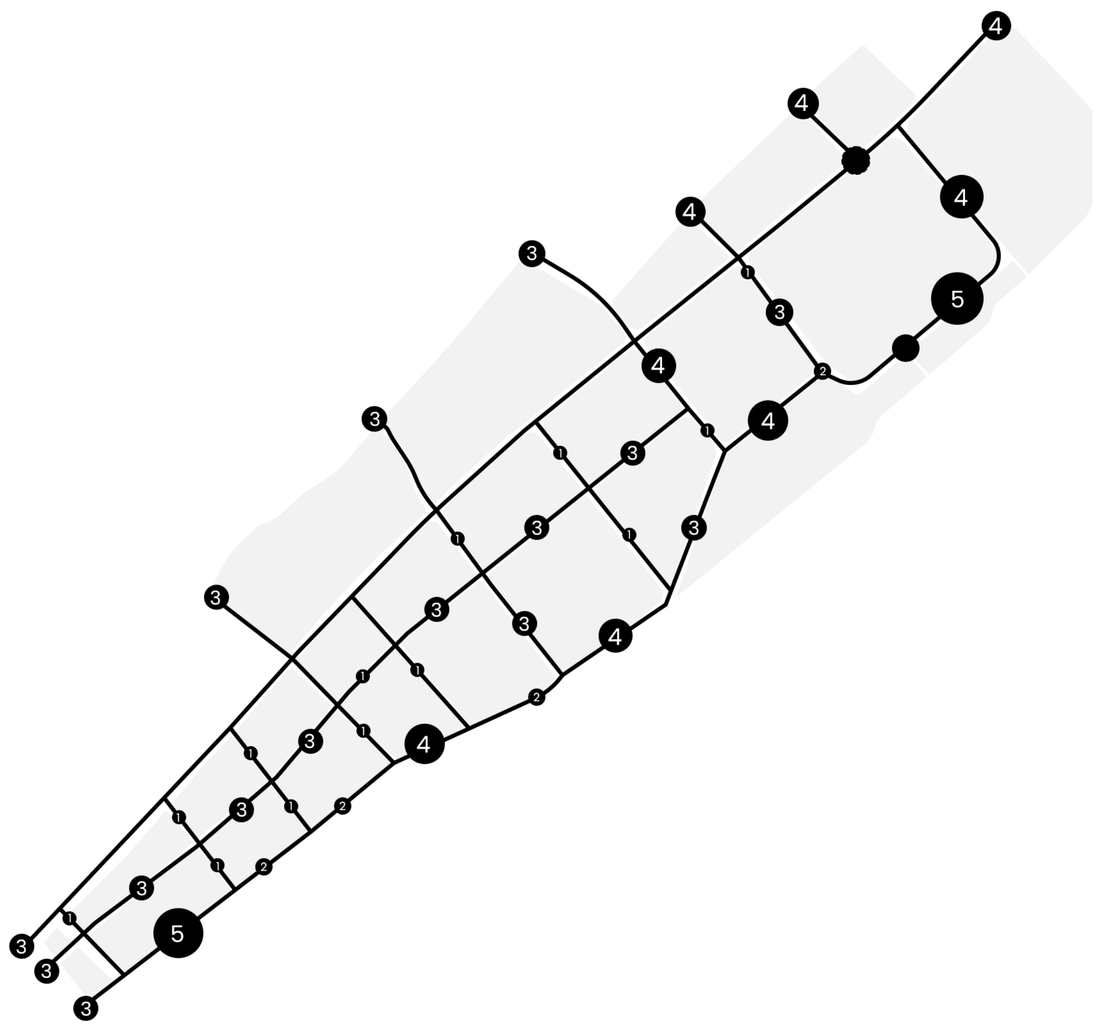


# EXISTING ROAD NETWORK

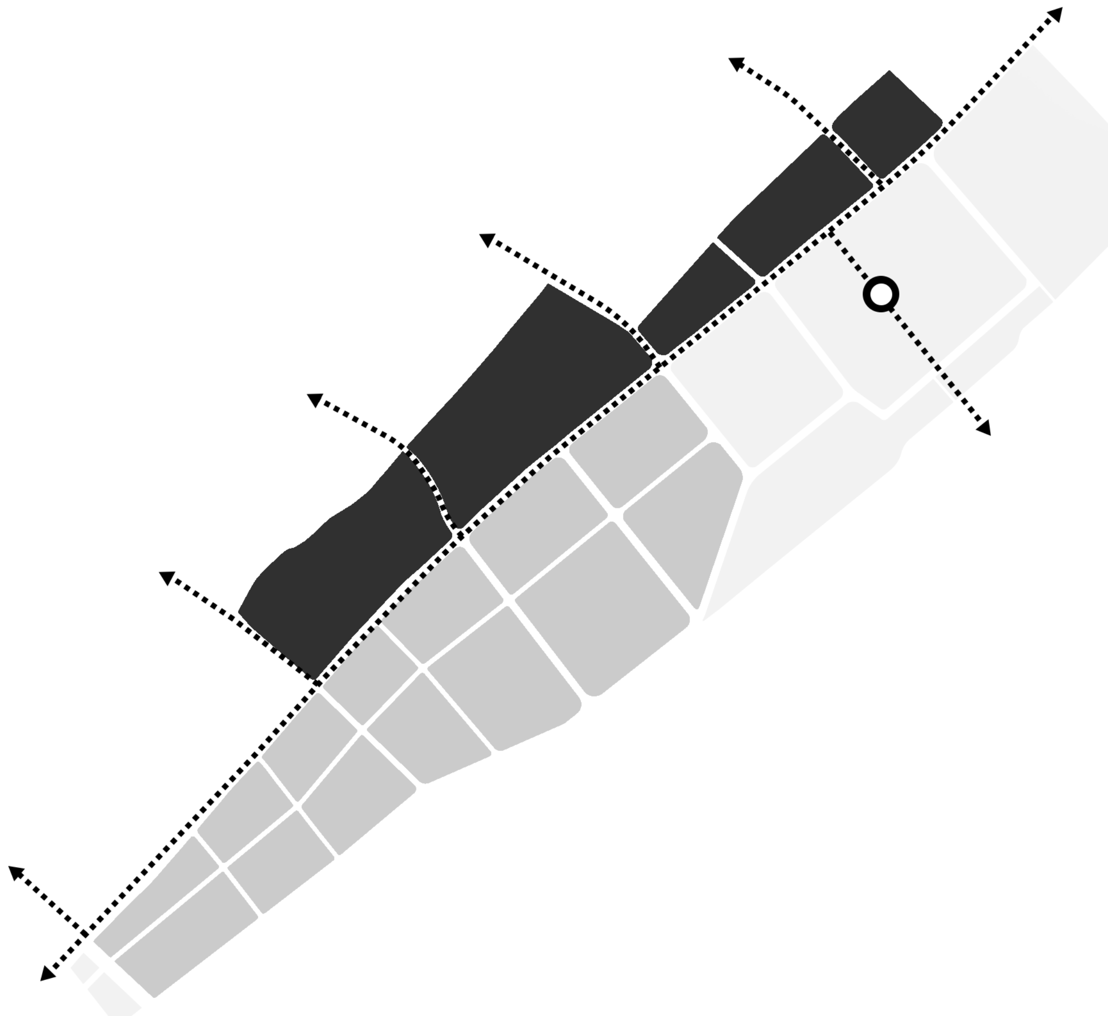


The Site that Responds to the Context

# UNHEALTHY STREETS

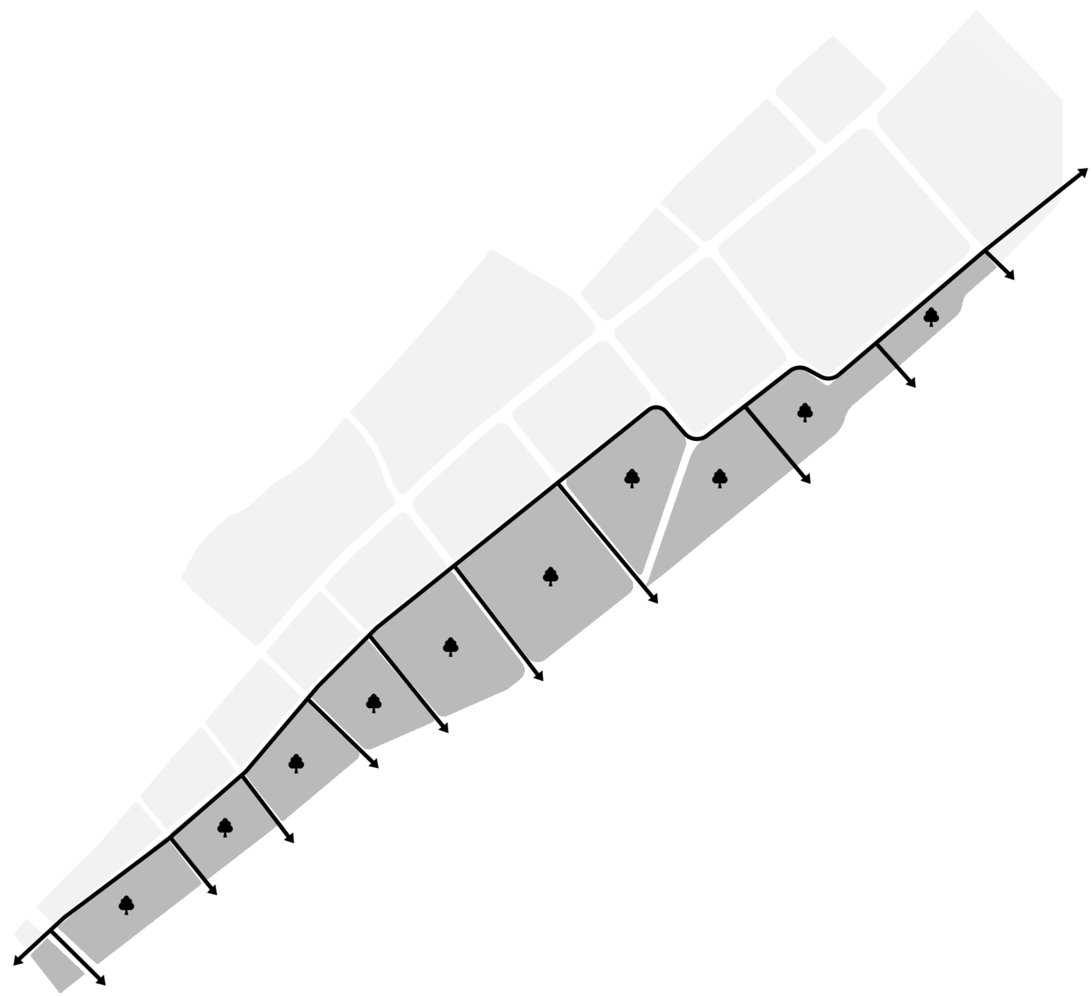


# SURROUNDING HIGH-DENSITY LIVING

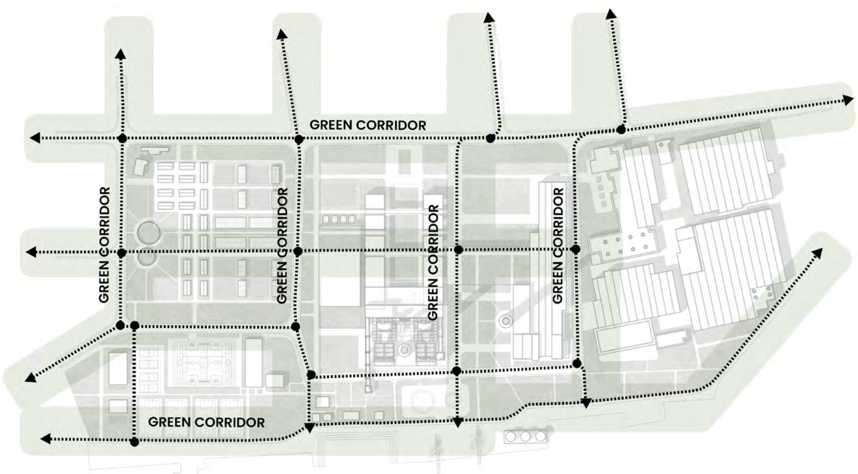


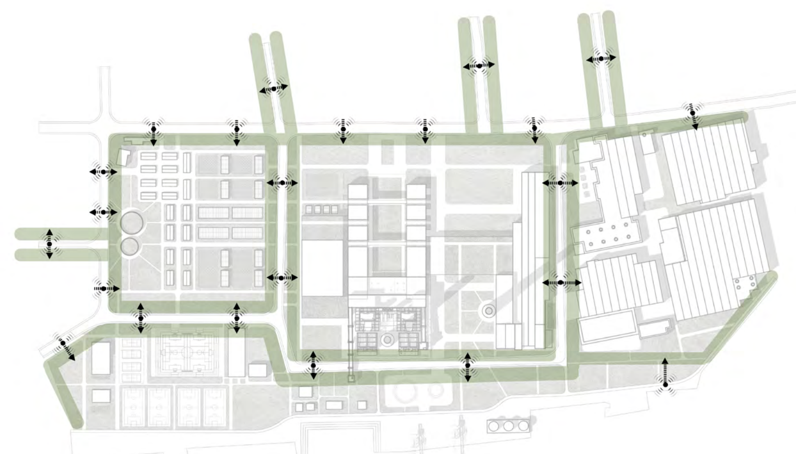
The SIte that Responds to the Context

# OPPORTUNITY FOR BIODIVERSITY



# REVITALISATION PLANS



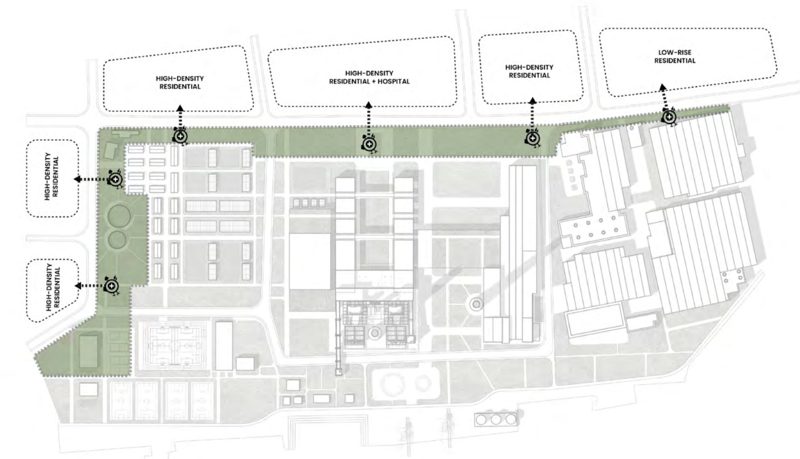
### 1. Greenbelt

Connects the greenspace as a single route through establishing green corridors. The greenbelt gurantees natural undeveloped lands that surround urban areas. The greenbelt alleviates the heat island effect from  the high-density concrete buildings and asphalt roads.

### 2. Green Barrier

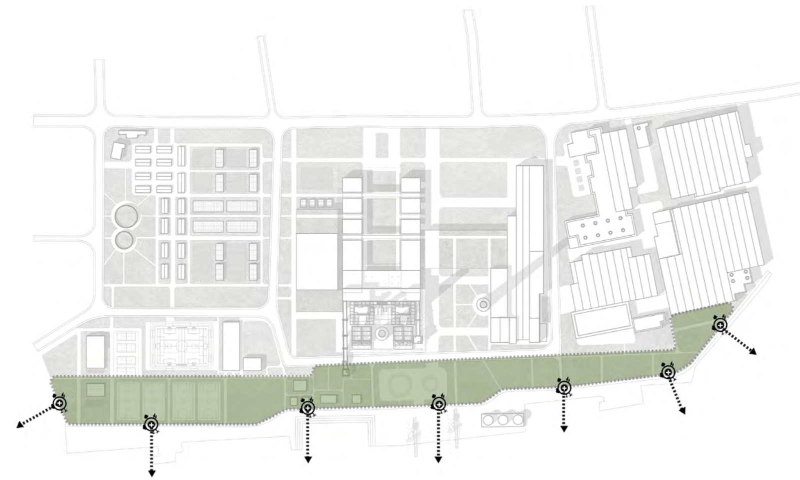
The Greenbelt aims to create natural green corridors, protecting the site from high noise level from the main raods and pollution from vehicles. It effectively becomes the pollution buffer. Also offers safer pedestrian movements and establish greener roads.

# REVITALISATION PLANS




### 3. Green Extension

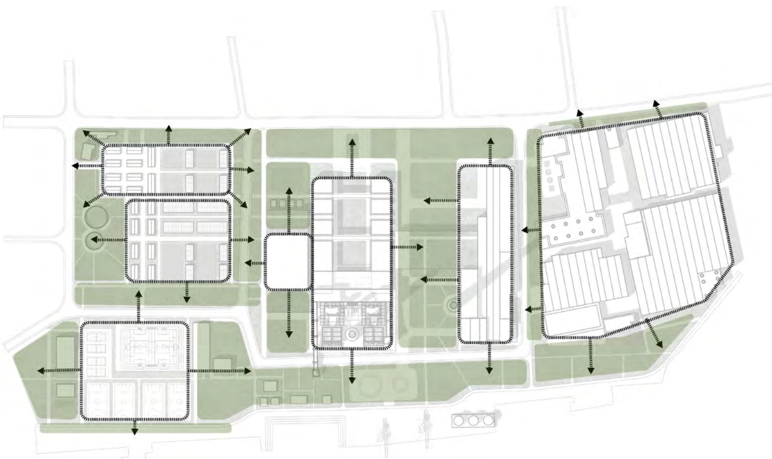
All surrounding residential areas, including a private hospital in the north, are offered with new greenspaces. These areas are high-density zones where the access to green space are limited. The green extension also offers improved privacy.



### 4. Green Waterfront

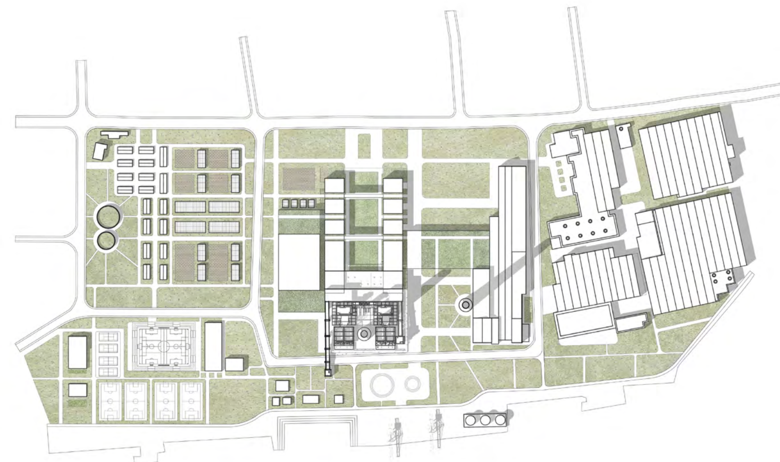
The waterfront area is designated as a large greenspace facing the river. This aims to increase biodiversity of the Yangpu riverside, and also offer beautiful green cycing path with facilities for well-being. The level of greeness increases towards the river.

# REVITALISATION PLANS



### 5. GreenToAll

All the above strategy form a complete green fortress. Every service and program are linked with at least one greenspace, offering green environment for both occupants and pedestrians. Thus, all green spaces are linked as a single path,



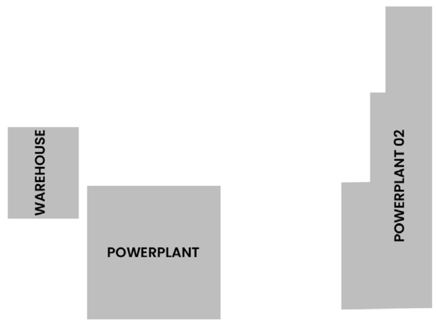
### Green Site

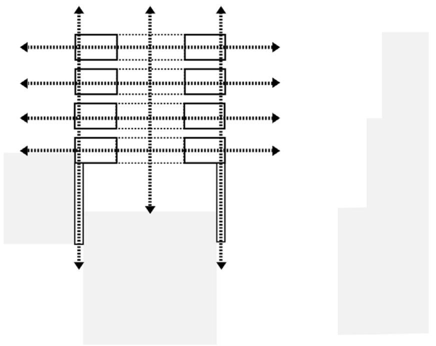
The complete site has been formed. The agricultural area provides a new layout mixed with markets located close to the residential, and the greenhouses and farms located close to the research building to share resources and equipment. The site aims to bring back the quality.

The Facility that Responds to the Context

# THE REVITALISED VISION

# INITIAL DESIGN PROCESS - THE OBJECTIVES



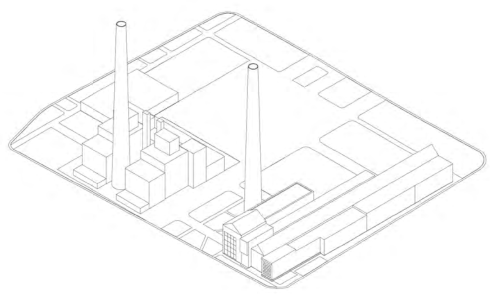



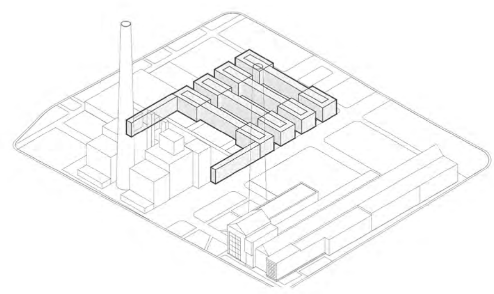
## 1. Existing Buildings

Within the research site, there are 3 main buildings remaining, which are abandoned: The powerplants and a warehouse that was used to store coal.

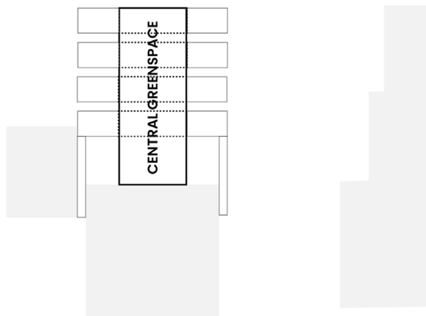
## 2. Connecting Greenspace

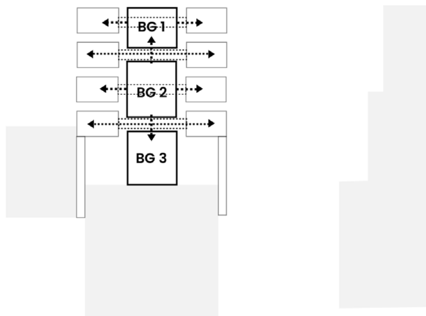
The program links the existing green corridor to the building for continuous greenspace. The blocks of greenspace become the diverse access points.





# INITIAL DESIGN PROCESS - THE OBJECTIVES



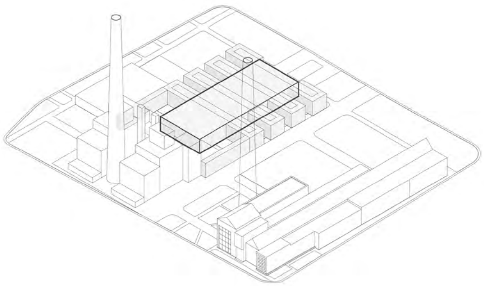



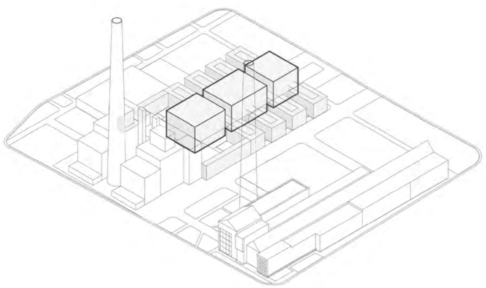

## 3. Central Greenspace

A large central greenspace is offered within the building, to have a central point that links all the programs in the building, and connect with the created green corridor.

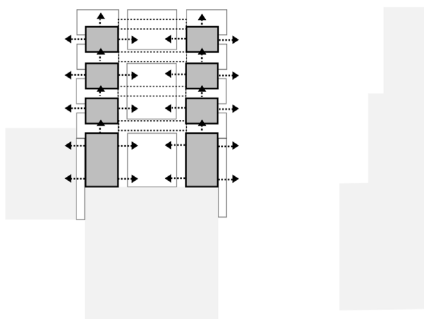
## 4. Siheyuan Botanical Gardens

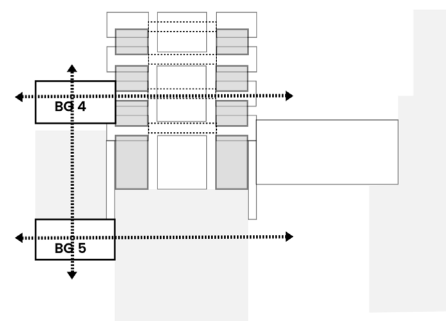
The 3 stages of botanical gardens are provided, crossing the green corridors. The divided gardens offer different types of plants, following the traditional concept of Siheyuan.





# INITIAL DESIGN PROCESS - THE OBJECTIVES



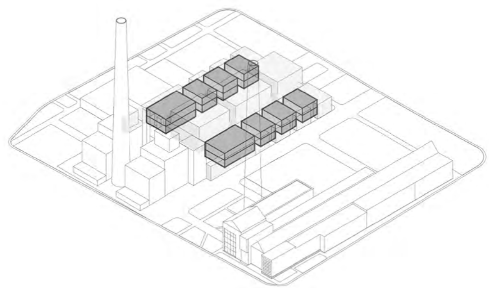


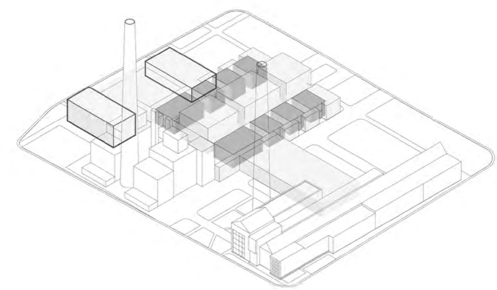

## 5. Embracing Research

Within the blocks of greenspace, the new research and service blocks are added. This allows all the research areas are offered with greenspaces and easier circulation.

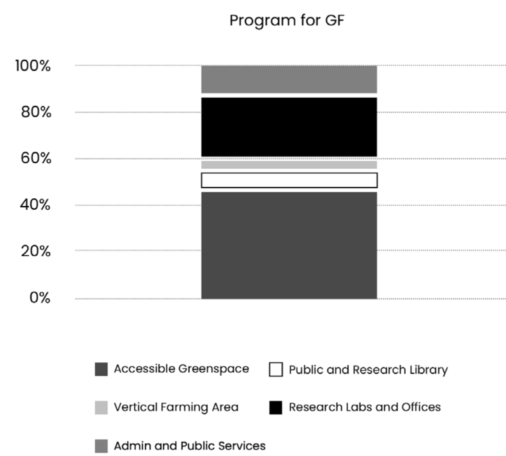
## 7. Surrounding the Existing

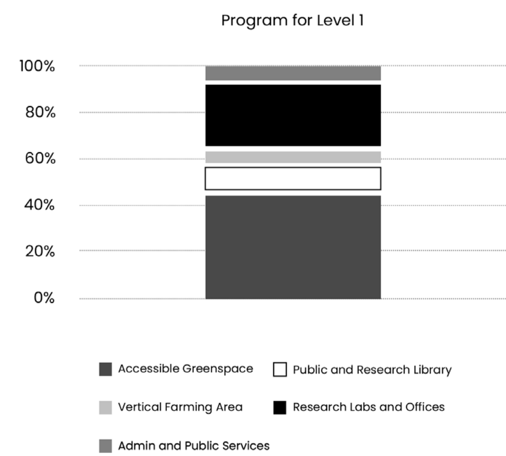
Rather than completely renovating the structure, the strategy is to surround the existing warehouse with new research purpose botanical gardens.

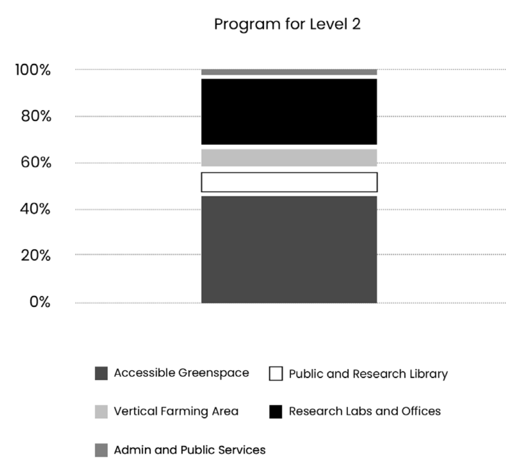


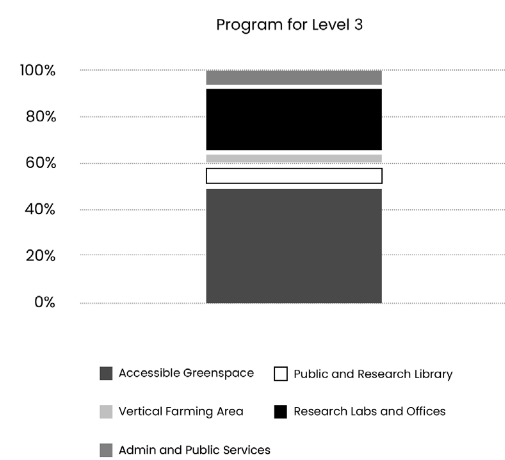


# THE PROGRAM


Program for GF
100%
80%
60%
40%
20%
0%
Accessible Greenspace
Public and Research Library
Vertical Farming Area
Research Labs and Offices
Admin and Public Services


Program for Level 1
100%
80%
60%
40%
20%
0%
Accessible Greenspace
Public and Research Library
Vertical Farming Area
Research Labs and Offices
Admin and Public Services


Program for Level 2
100%
80%
60%
40%
20%
0%
Accessible Greenspace
Public and Research Library
Vertical Farming Area
Research Labs and Offices
Admin and Public Services


Program for Level 3
100%
80%
60%
40%
20%
0%
Accessible Greenspace
Public and Research Library
Vertical Farming Area
Research Labs and Offices
Admin and Public Services

# POSITIONING PROGRAM

**Positioning Building Program: Type of Green Areas (Subtropical)**

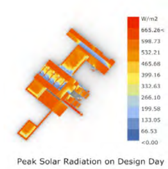
| Type of Green Spaces (Subtropical) | Indoor Botanical Garden | CO2 Greenhouse (Accelarated Photosynthesis) | Outdoor Botanical Garden (Vegatative) | Green Roof (Flowering Inclusive) | Indoor Garden (Small Plants) | LED Vertical Farms |
|---|---|---|---|---|---|---|
| Maximum Lux Required (Winter lux) | 7500 | 130,000 | 50000 | 70000 | 10764 | 50000 |
| Minimum Lux Required (Summer Lux) | 2500 | 3500 | 15000 | 45000 | 270 | 0 |
| Maximum Lux Conversion to W/m2 (Energy) | 59.25 | 1027 | 395 | 553 | 85.0356 | 395 |
| Minimum Lux Conversion to W/m2 (Energy) | 19.75 | 27.65 | 118.5 | 355.5 | 2.133 | 0 |
| Maximum Provided W/m2 | 842.79 | 936.44 | 936.44 | 936.44 | 749.15 | 465.68 |
| Minimum Provided W/m2 | 199.58 | 532.21 | 399.16 | 665.26 | 332.63 | 66.53 |
| Lux to W/m2 Sun Conversion (W/m2) per Lux | 0.0079 | 0.0079 | 0.0079 | 0.0079 | 0.0079 | 0.0079 |
| Ideal Plants For Area (Identify Growing Requirements and Space) | Vetchia Merrilli, Strelitzia Nicolai, Licuala, Howea Foresteriana, Caryota Species,Bambusa Old Hamii | Pendula, Salix Babylonica, Vetchia Merrilli | Pendula, Salix Babylonica, Ficus Spieces, Cyathea Species, Bambusa Old Hamii | Flowers. Tomatoes, Morus Alba, Salix Babylonica | Strawberries, Philodendron Selloum and Species | Rhapis Species, Lettuce, Cabbages |
| Requirement Reached? | Yes | Yes | Yes | Yes | Yes | Yes |

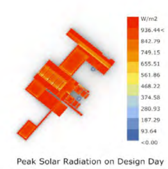
**Positioning Building Program: Type of Indoor Areas (Subtropical)**

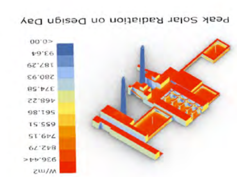
| Type Indoor Areas | Research Lab (Bright Accurate Conditions) | Research Lab (Low-Light General Tasks) | Exhibition/Showroom (Ambient Light) | Monitoring Office (Digital - Low Light) | Meeting/Seminar Rooms | Library |
|---|---|---|---|---|---|---|
| High Lux Required (lux) | 1000 | 300 | 300 | 500 | 500 | 300 |
| Low Lux Required (Lux) | 500 | 200 | 200 | 300 | 300 | 200 |
| Maximum Lux Conversion to W/m2 | 7.9 | 2.37 | 2.37 | 3.95 | 3.95 | 2.37 |
| Minimum Lux Conversion to W/m2 (Energy) | 3.95 | 1.58 | 1.58 | 2.37 | 2.37 | 1.58 |
| Maximum Provided W/m2 | 842.79 | 280.93 | 187.29 | 468.22 | 468.22 | 374.58 |
| Minimum Provided W/m2 | 187.29 | 66.53 | 93.64 | 133.05 | 133.05 | 266.1 |
| Lux to W/m2 Sun Conversion (W/m2) per Lux | 0.0079 | 0.0079 | 0.0079 | 0.0079 | 0.0079 | 0.0079 |
| Ideal Type of Area | GMO and Crop Science, Biology Lab, CO2 Agriculture Lab | Soil and Water Anaylsis Lab, GMO Science, BPMED, CO2 Storage | Gallery, Exhibition Area | CO2 Monitoring Lab, BPMED | Offices, Lecture Rooms, Meeting and Seminar Rooms | Research and Public Library, Media Lab |
| Requirement Reached? | Yes | Yes | Yes | Yes | Yes | Yes |

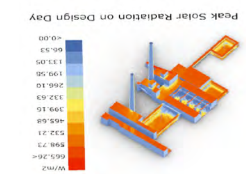
**Annual Solar Energy Input and Output (Roof)**

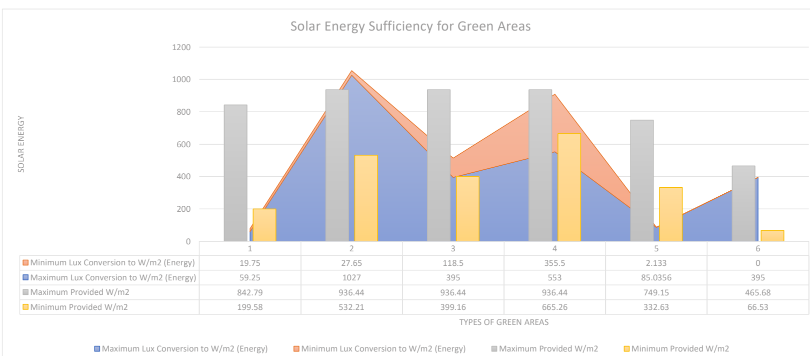
| | |
|---|---|
| Solar Energy Provided W/m2 (Maximum) | 936.44 |
| Solar Energy Provided W/m2 (Minimum) | 66.53 |
| Total Roof Surface Area | 20396.7 |
| Total Energy Generated Through Roof (Maximum Watt) | 19100285.75 |
| Total Energy Input Throguh Roof (Minimum Watt) | 1356992.451 |
| Energy Input Through Roof (Average Watt) | 10228639.1 |
| Estimated Energy Generated Through 1 - 400W PV - 7hrs (Wh) | 2800 |
| Number of PV Panels Installable (1.6m2) | 12747.9375 |
| Total Estimated Energy Output in 1 Day (Wh) | **35694225** |
| **kWh** | 35694.225 |

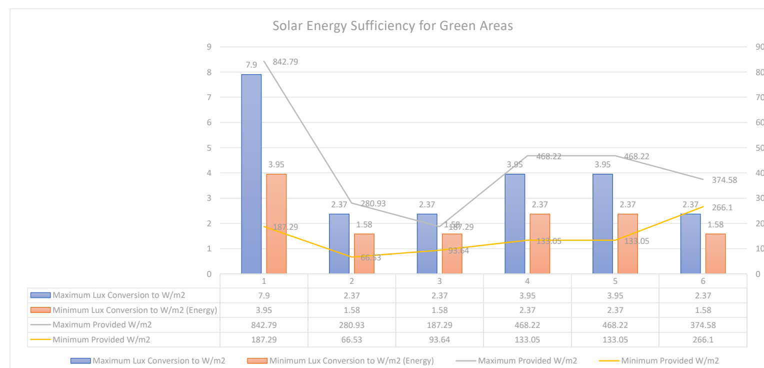




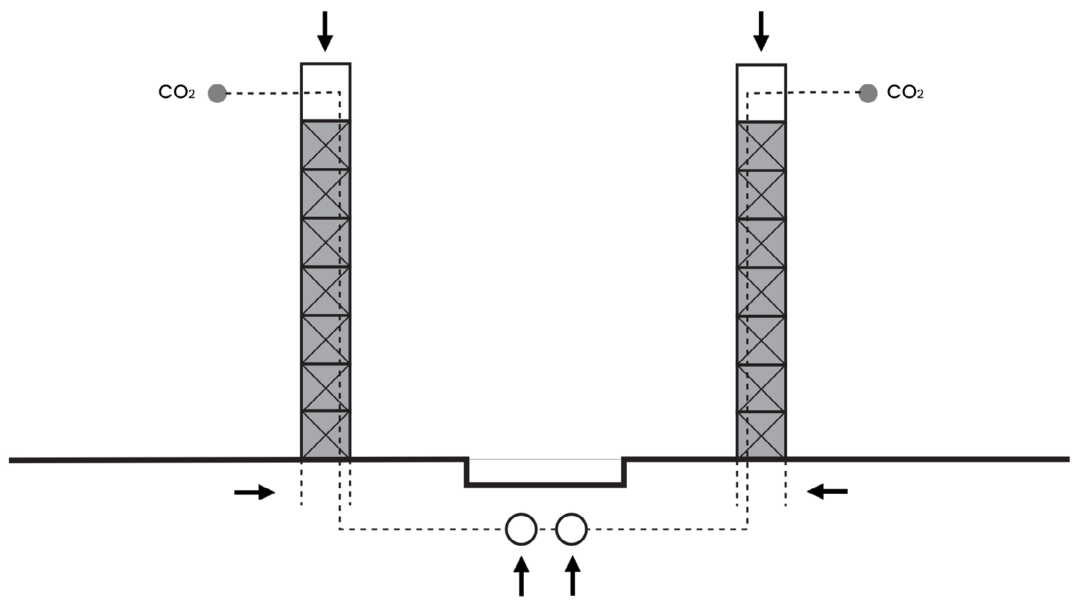


How to accomodate various program requirements with $CO_2$ capture?

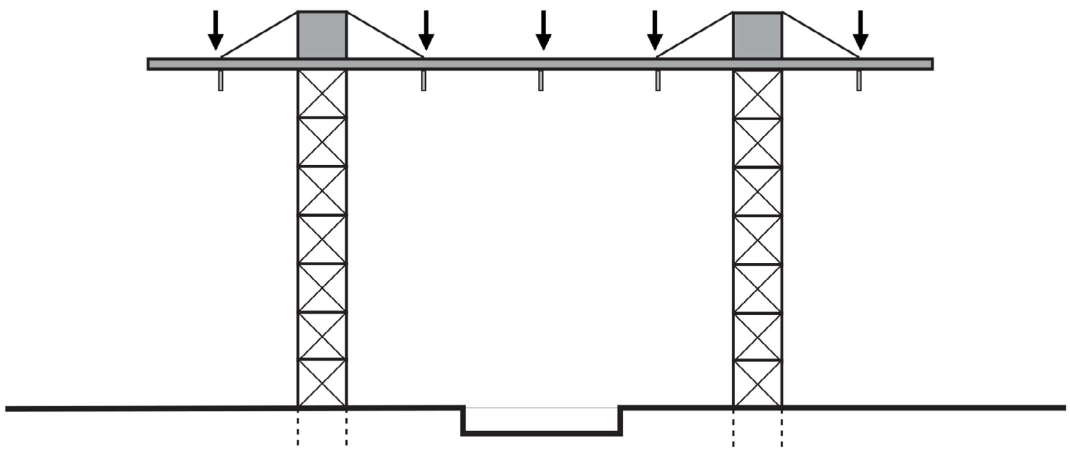
# DEPLOYING THE STRUCTURE FOR PROGRAM

1. Conventional Direct Air Capture of $CO_2$



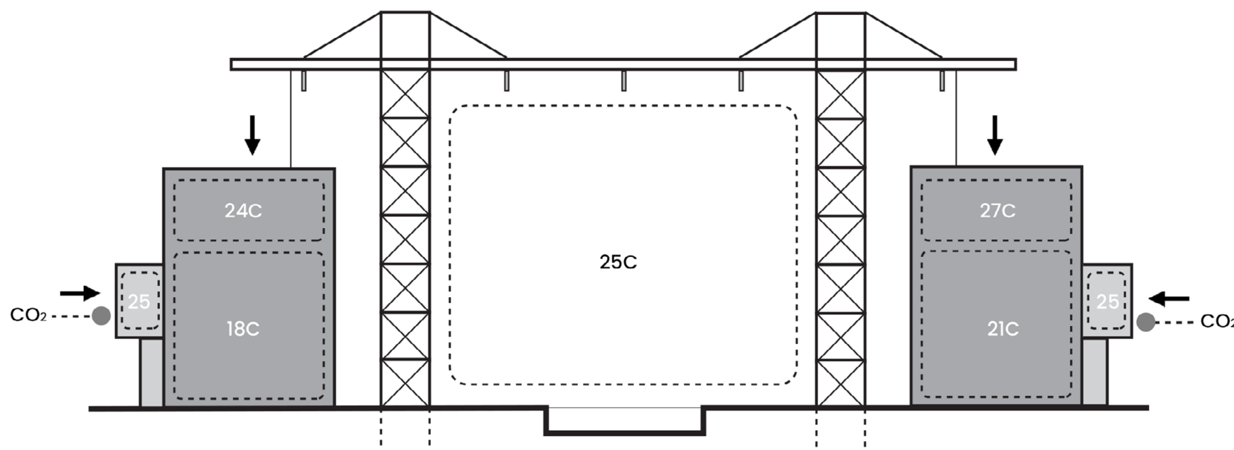
# DEPLYOING THE STRUCTURE FOR PROGRAM

2. Deploy Long Span Energy Roof Panel



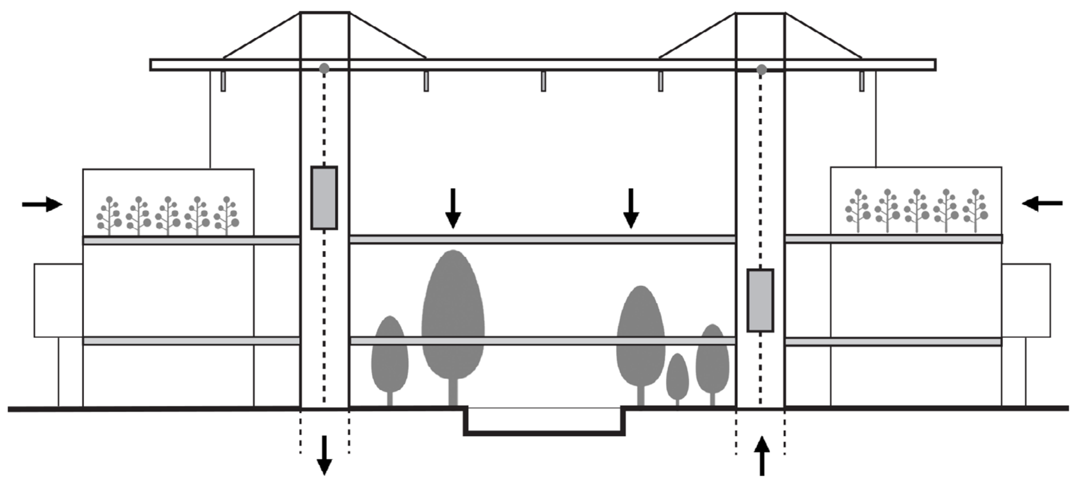
# DEPLOYING THE STRUCTURE FOR PROGRAM

3. Deploying Various Climate Zones

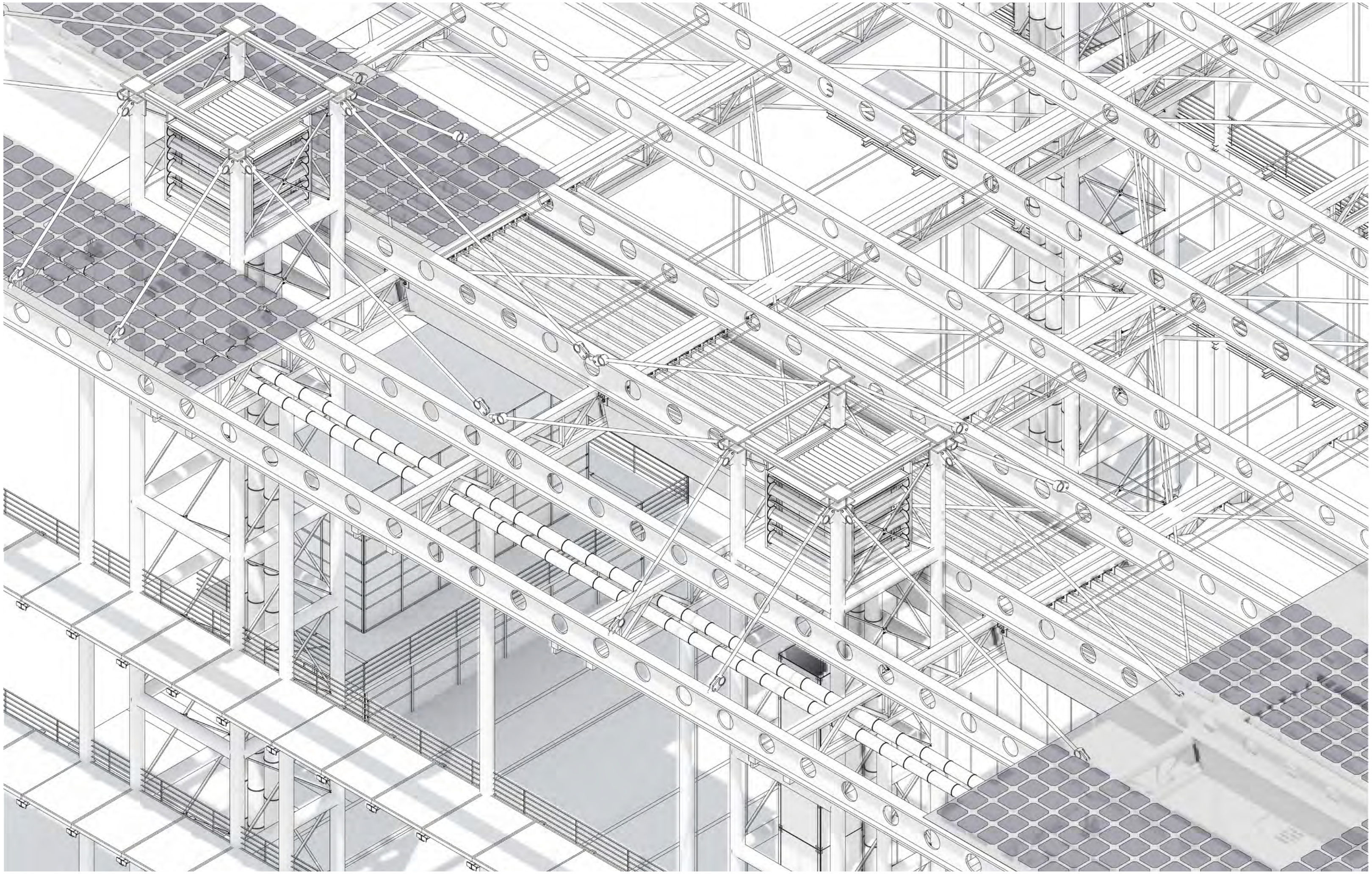


# DEPLYOING THE STRUCTURE FOR PROGRAM

4. Deploying Paths and Green Space

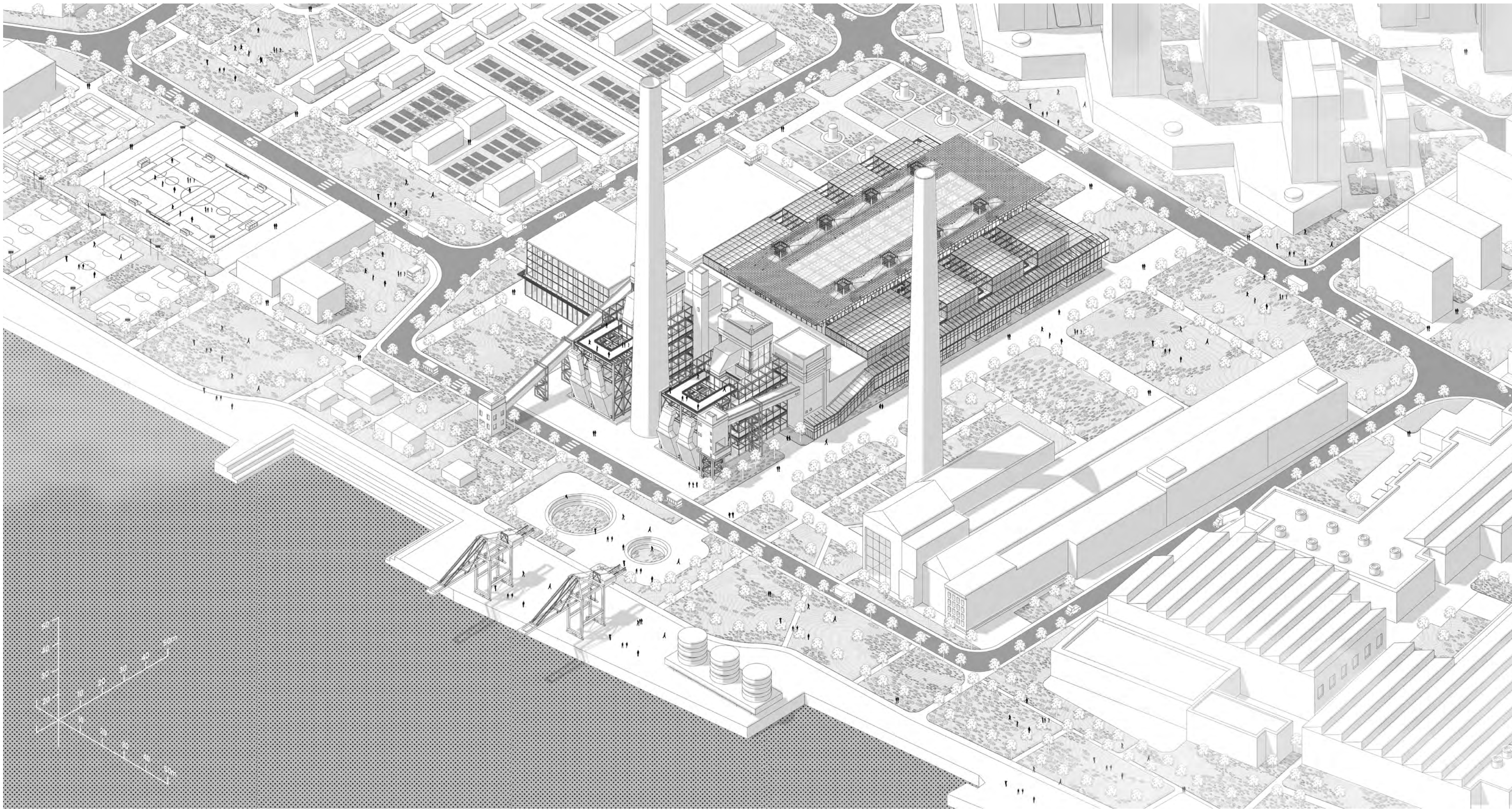


# THE FULL STRUCTURE



The Facility that Responds to the Context

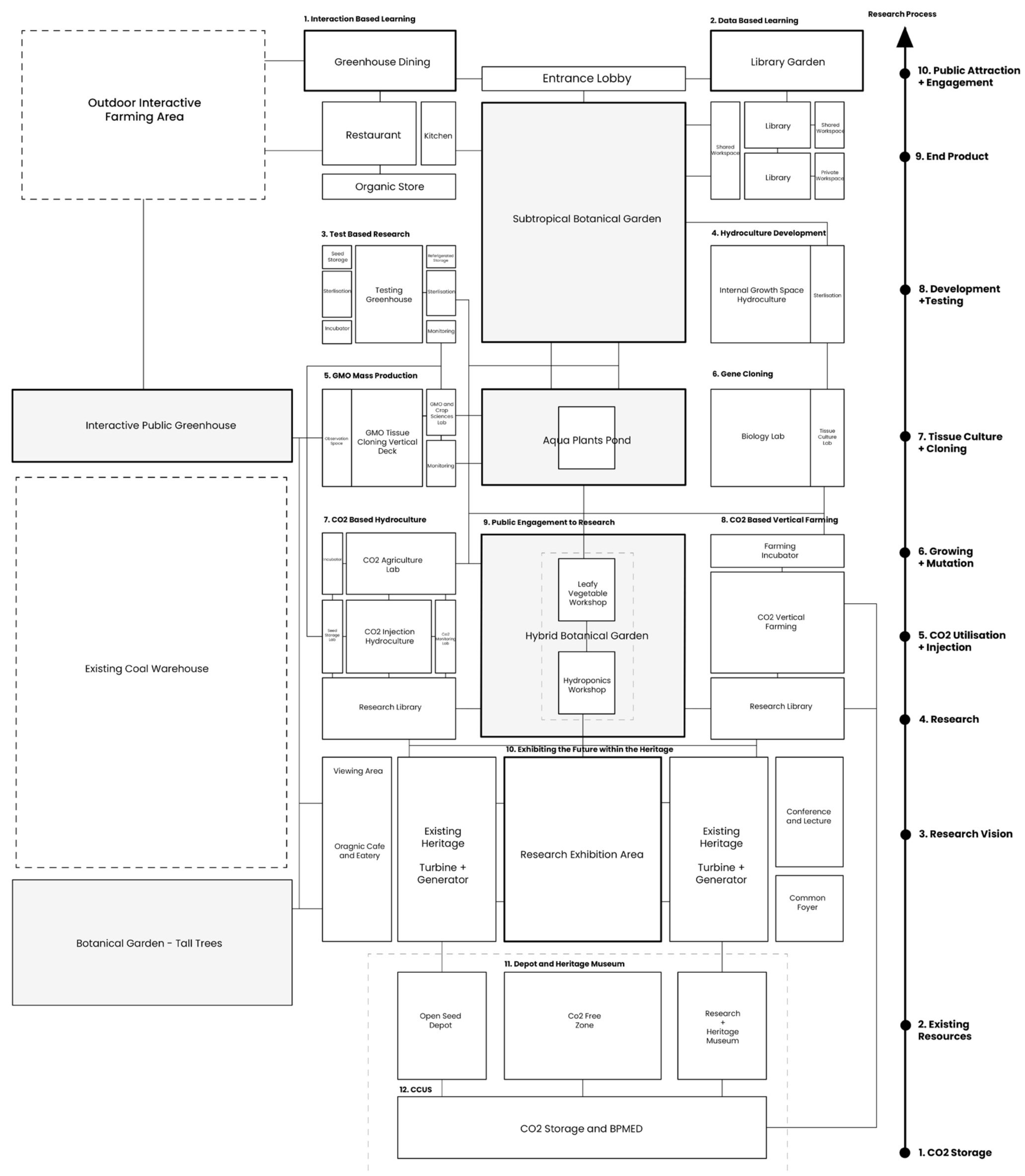
# THE COMBINATION



# ACHIEVING OBJECTIVES

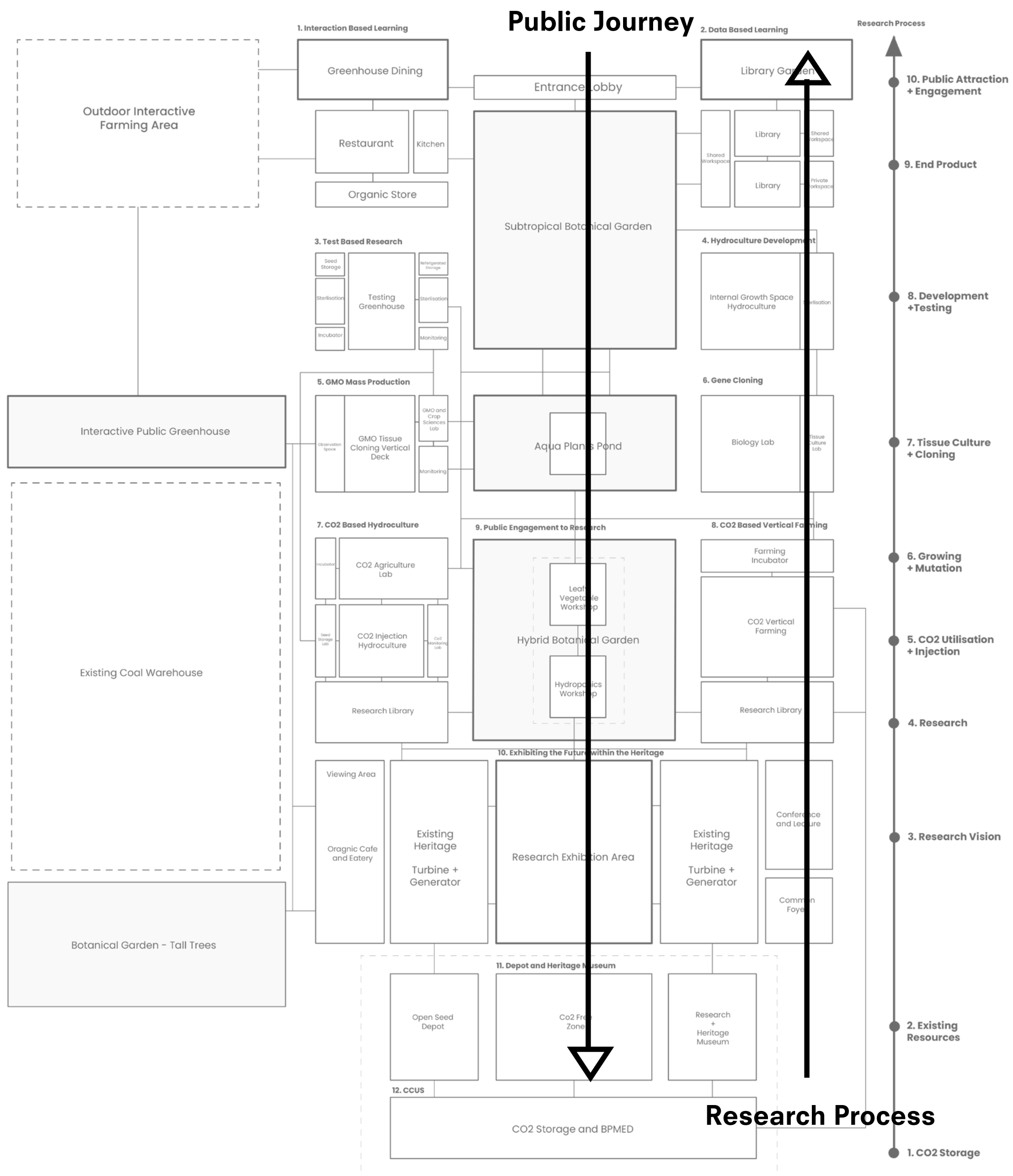
## HOW DOES THE BUILDING ACHIEVE 5 KEY OBJECTIVES?

# PUBLIC EDUCATION THROUGH JOURNEY



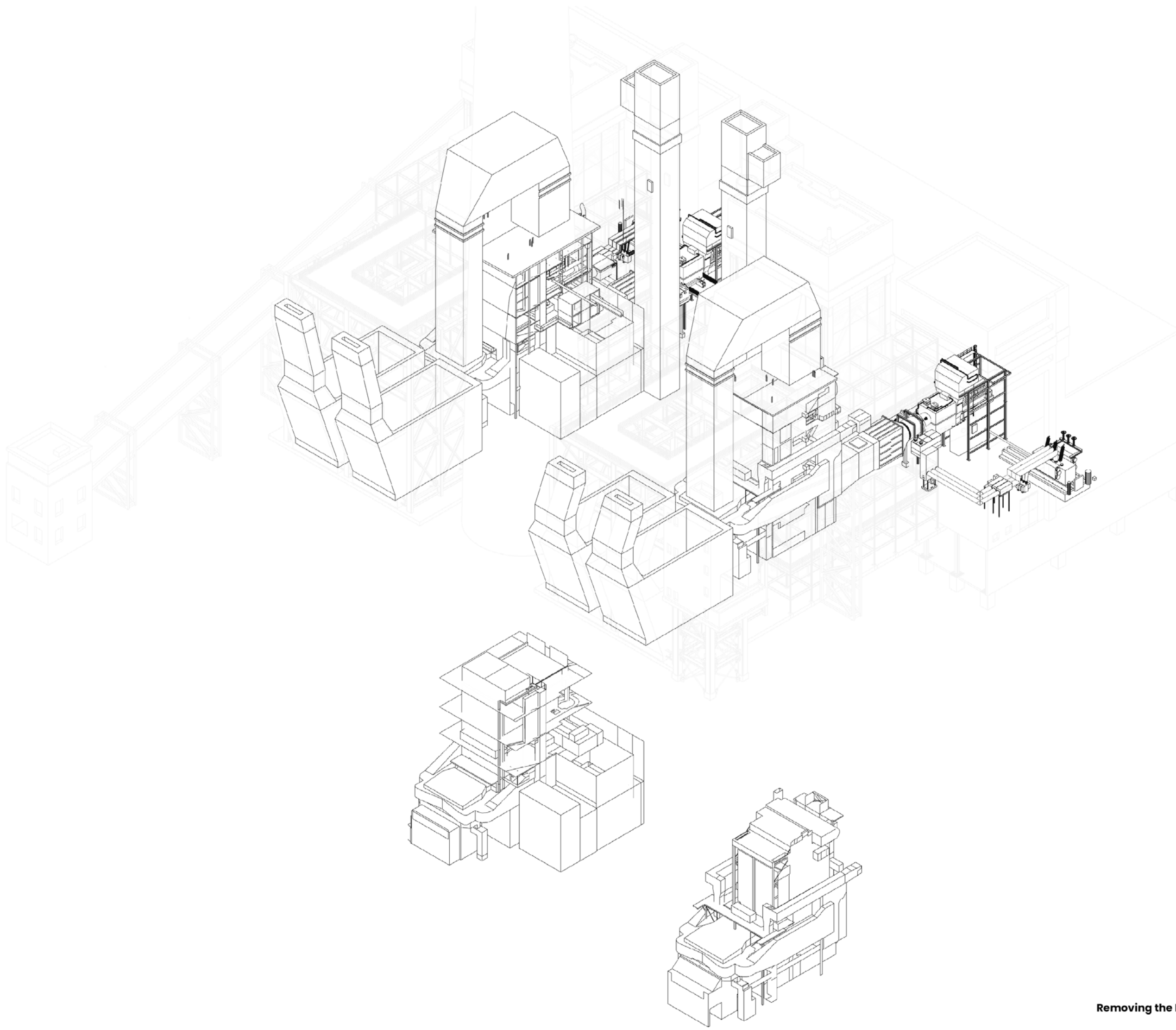
The Facility that Responds to the Context

# PUBLIC EDUCATION THROUGH JOURNEY



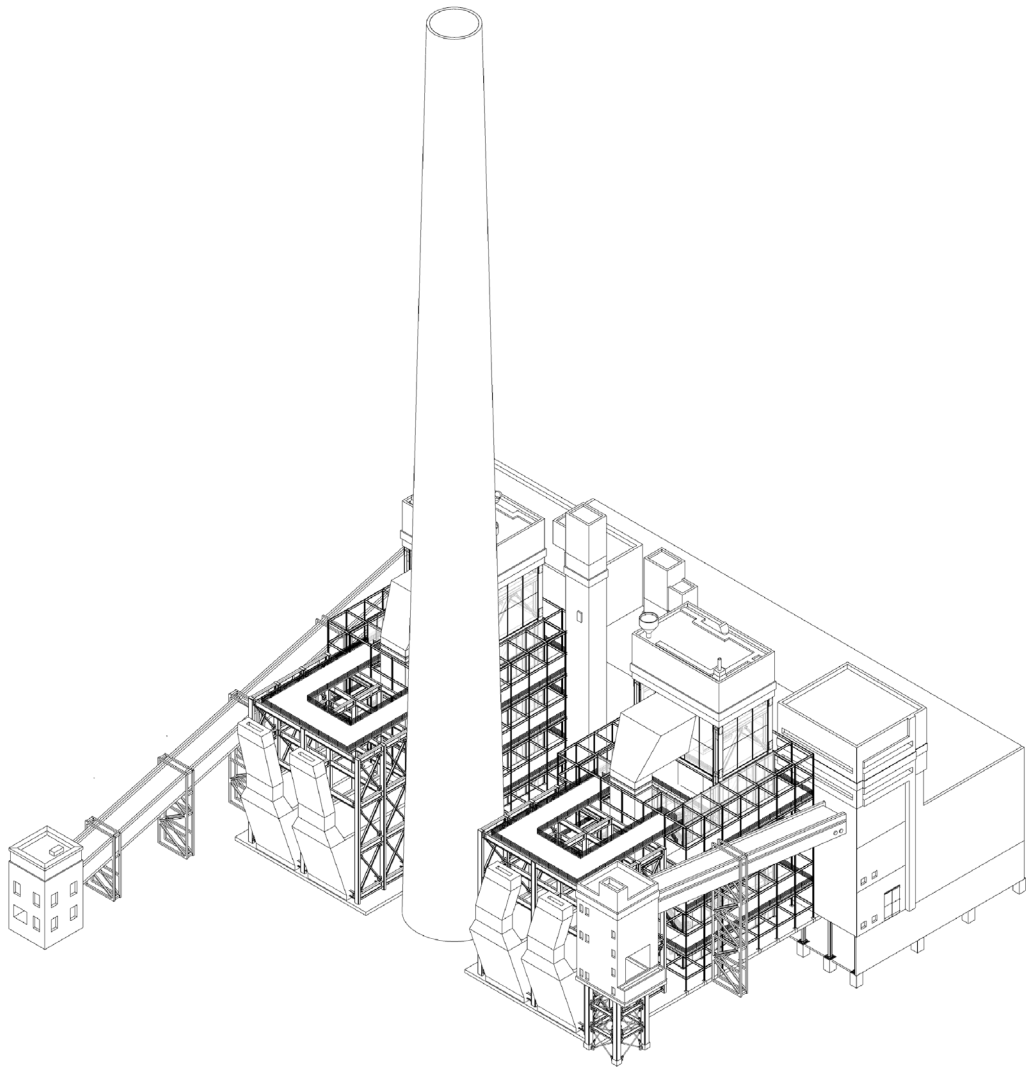
The Facility that Responds to the Context

# HERITAGE PRESERVATION



Removing the Boiler

# THE REPLACEMENT

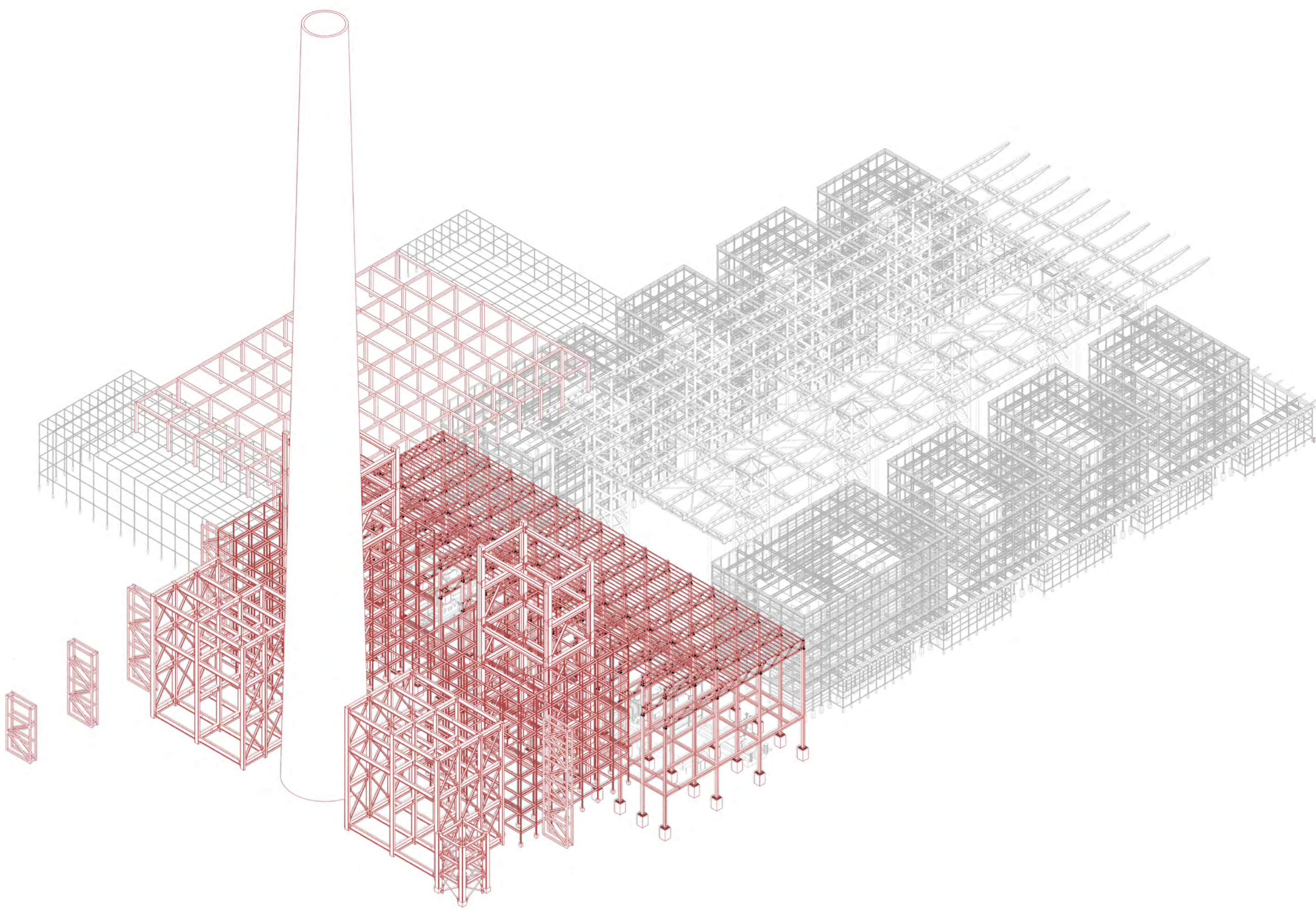


The Facility that Responds to the Context

# THE REPLACEMENT

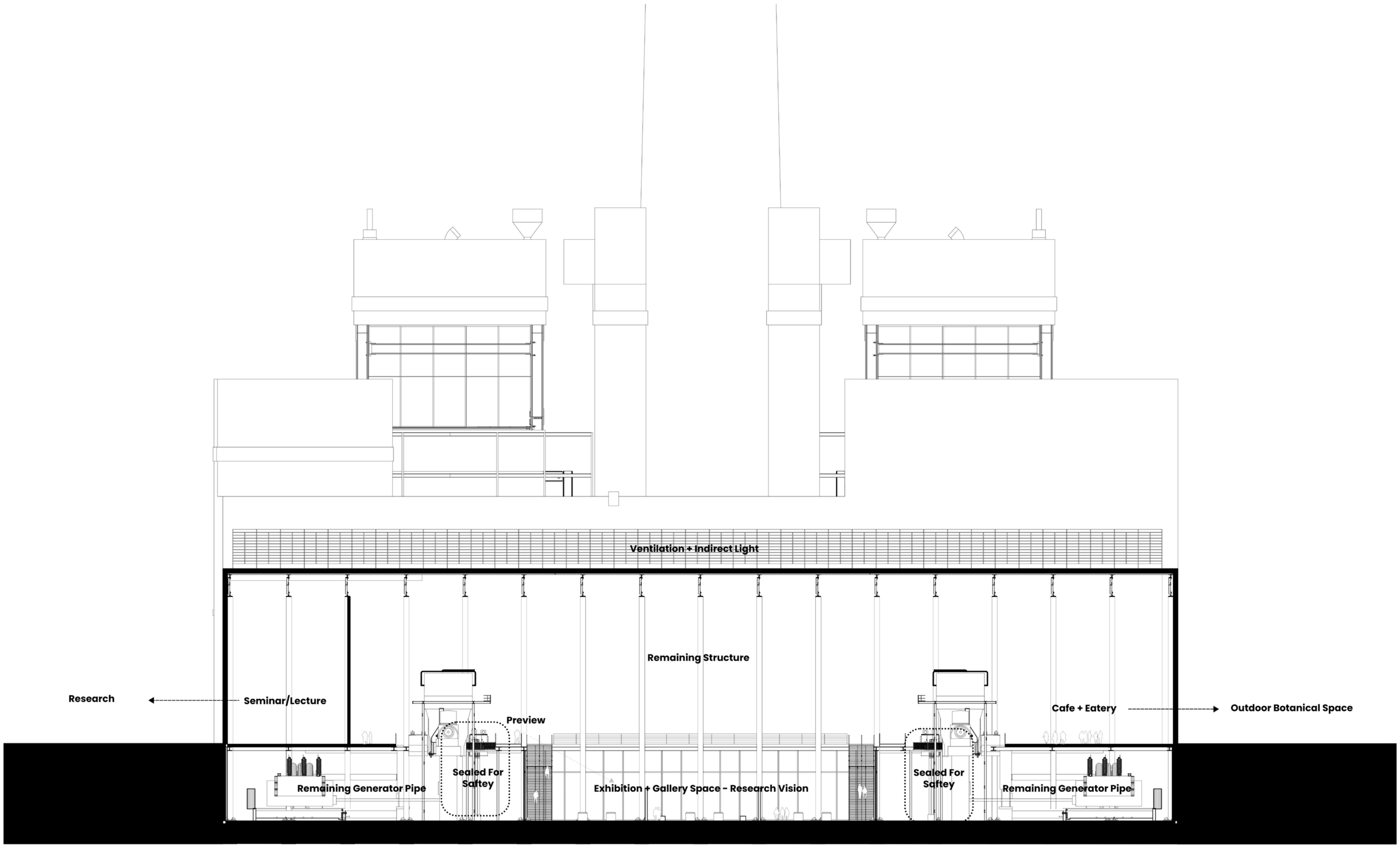
The Facility that Responds to the Context

# STRUCTURE REMAINS



The Facility that Responds to the Context

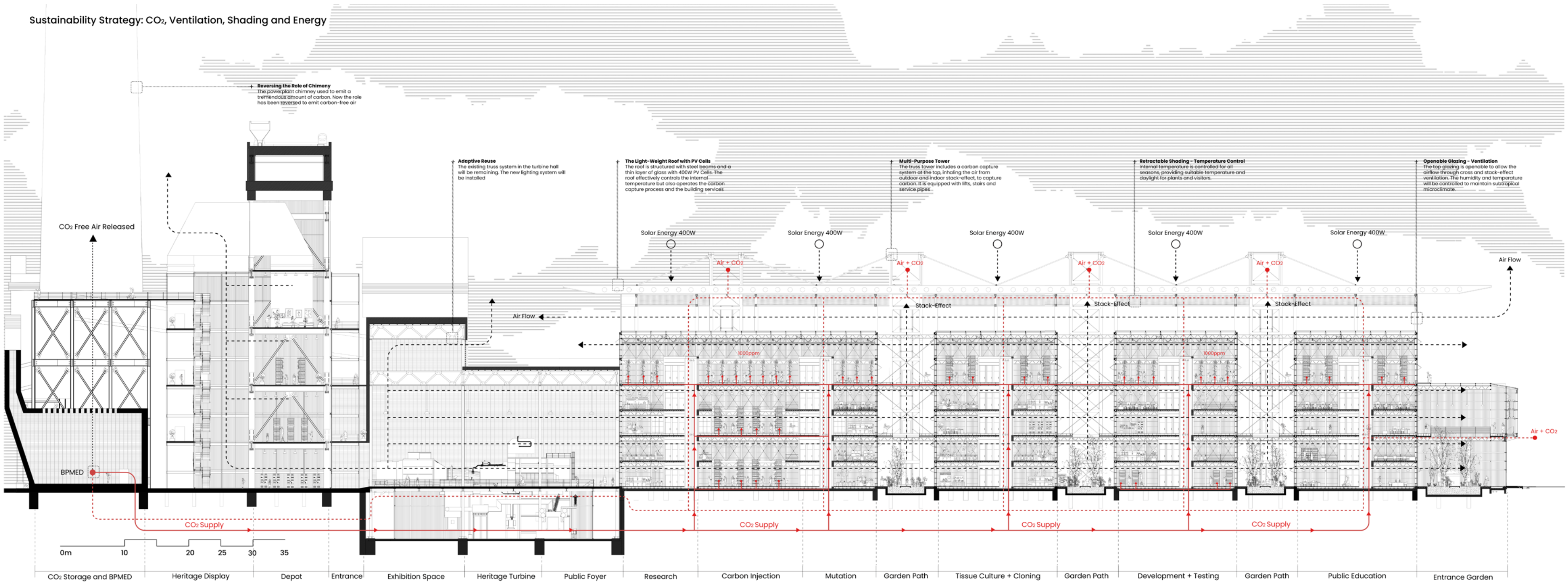
# END OF THE JOURNEY

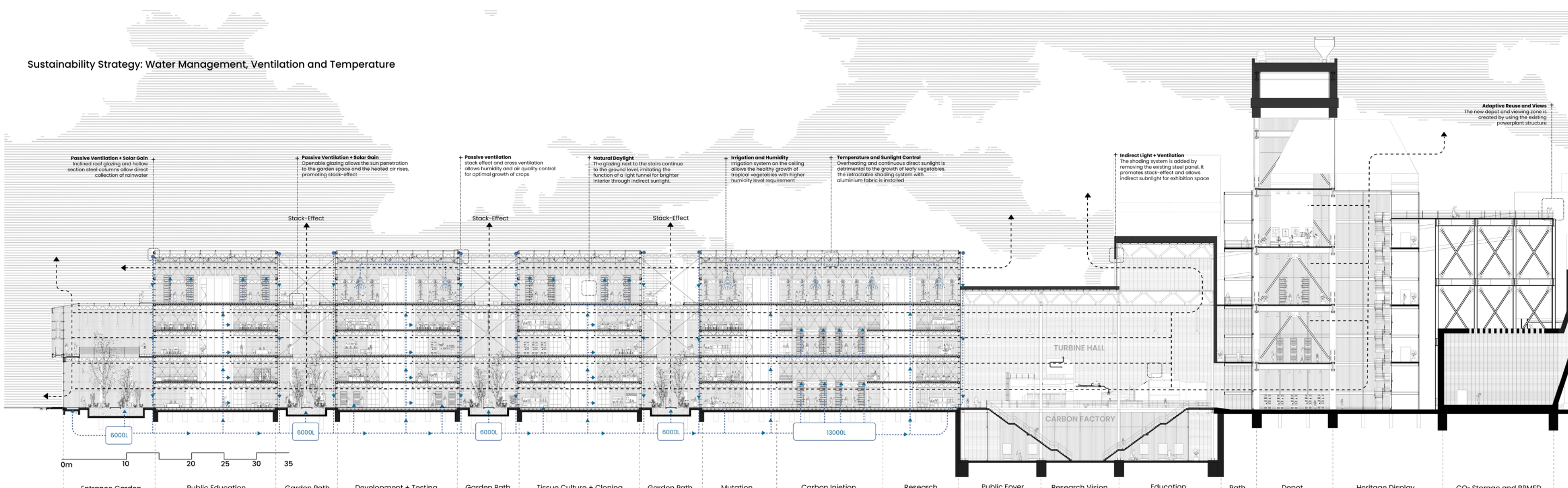



Section BB Scale 1:200 A1

Carbon-free chimney and connecting turbine hall

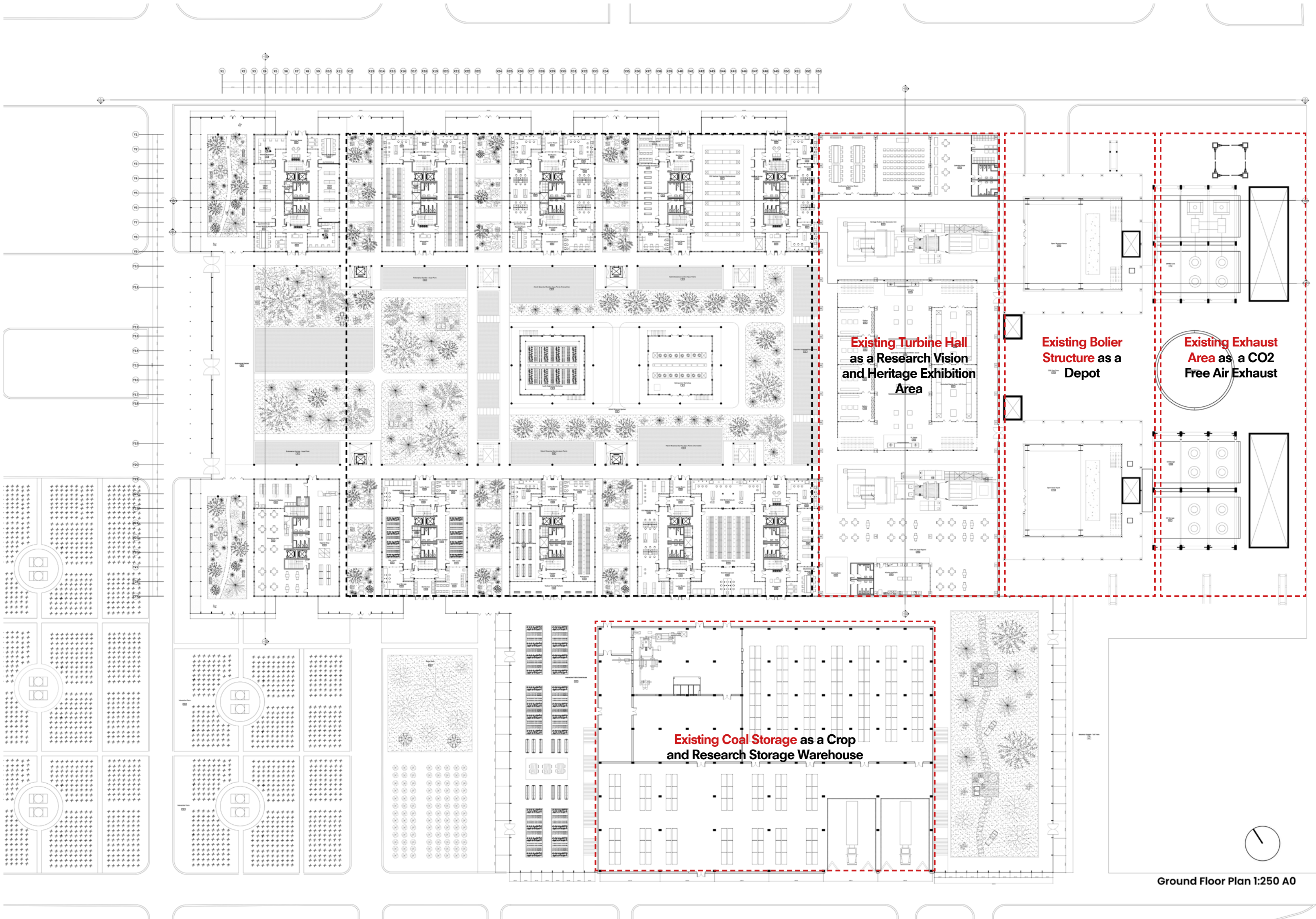
# THE HARMONY



Reversing the role of 4 main areas of the powerplant

# REVERSING THE ROLE



Provide what has been lost, take back what has been harmful

# REVERSING THE ROLE

**PAST**

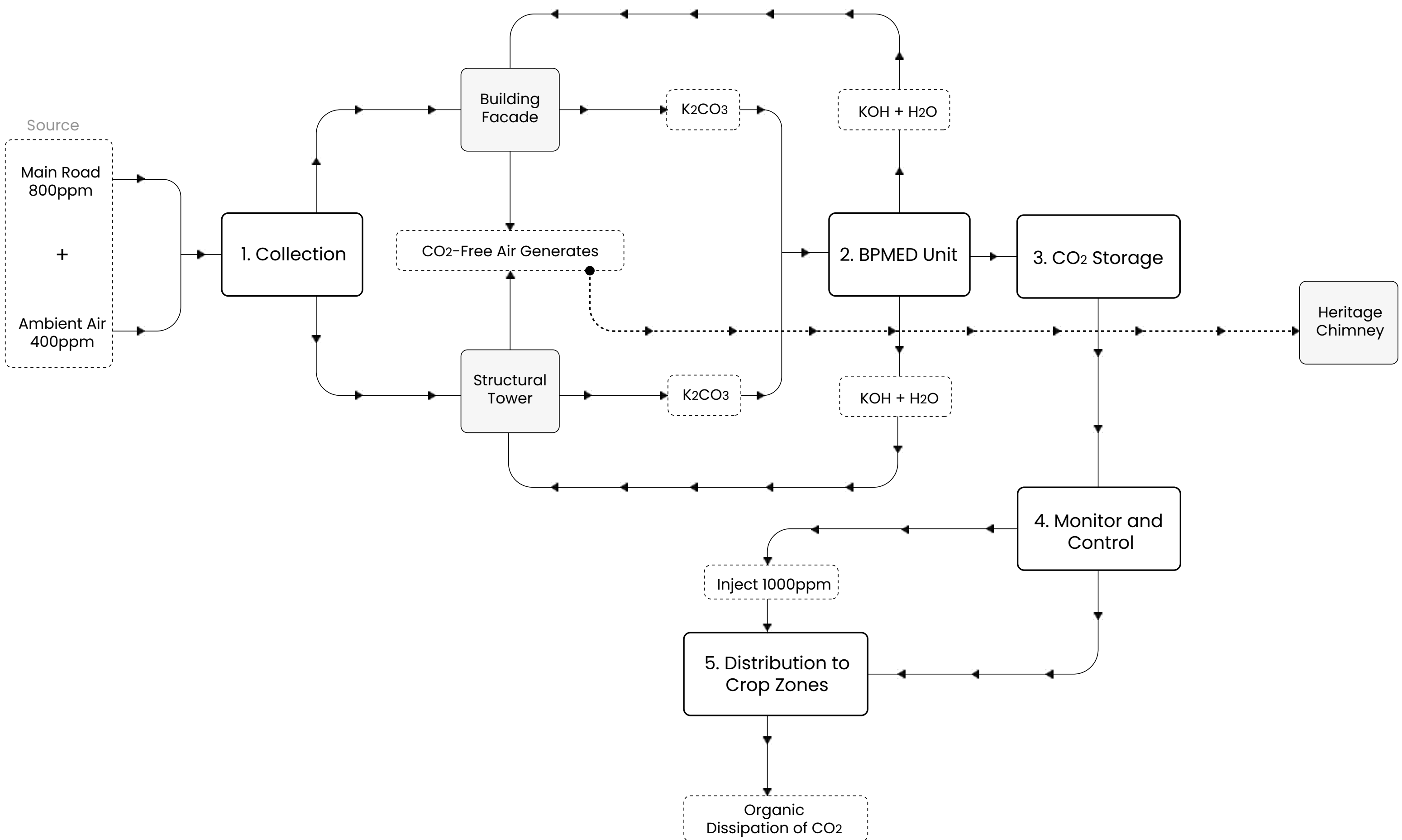
| RESOURCE | OUTPUT | RESULT |
|---|---|---|
| COAL | ELECTRICITY | $CO_2$ POLLUTION |
| LABOUR | FINANCIAL INCOME | HEALTH ISSUES |

**PRESENT**

| RESOURCE | OUTPUT | RESULT |
|---|---|---|
| $CO_2$ | INCREASED CROPS | $CO_2$ DISSIPATION |
| LABOUR | AGRICULTURAL RESEARCH | WELL-BEING |

**WHILE PRESERVING THE EXISTING STRUCTURE**

# OBJECTIVE 3 $CO_2$ RESEARCH AND UTILISATION



# THE OPTIMISATION

| Our Design Specifications | | | | Units |
|---|---|---|---|---|
| ATD (Air Travel Distance) | | 1 | m | air travel distance |
| L (Length of Inlet) | | 1.2 | m | length |
| H (height of Inlet) | | 0.25 | m | height |
| V (Air Velocity to Inlet) | | 2 | m/s | air velocity |
| Total Volume of DAC | | 0.3 | m3 | |
| Calculations | | | | |
| Capture flux | F | 4666.74274 | | kg/m2/year |
| CO2 captured | | 1.400022822 | | ton/year |
| Pressure drop | deltaP | 32.61639143 | | Pa |
| Energy Per m2 | E | 3.15E+09 | | J/m2/year |
| Energy Required For Module | E | 9.E+08 | | J/year |
| Capital cost | C_capital | 1185 | | $ |
| Operating cost | C_operating | 80 | | $/year |
| Total cost | | 184 | | $/ton |
| Energy | E | 34.95 | | J/s |
| Energy | E | 0 | | kW |
| Solar Panels 400 Watt 8hrs/Day | (730kWh/Year) | | | |
| | 730kwh = 2,628,000,000 Joules | 0.35903562 | | *5 Solar Panels/ Module (utilise Hydro Power and Nearby Wind Energy if Possible)* |

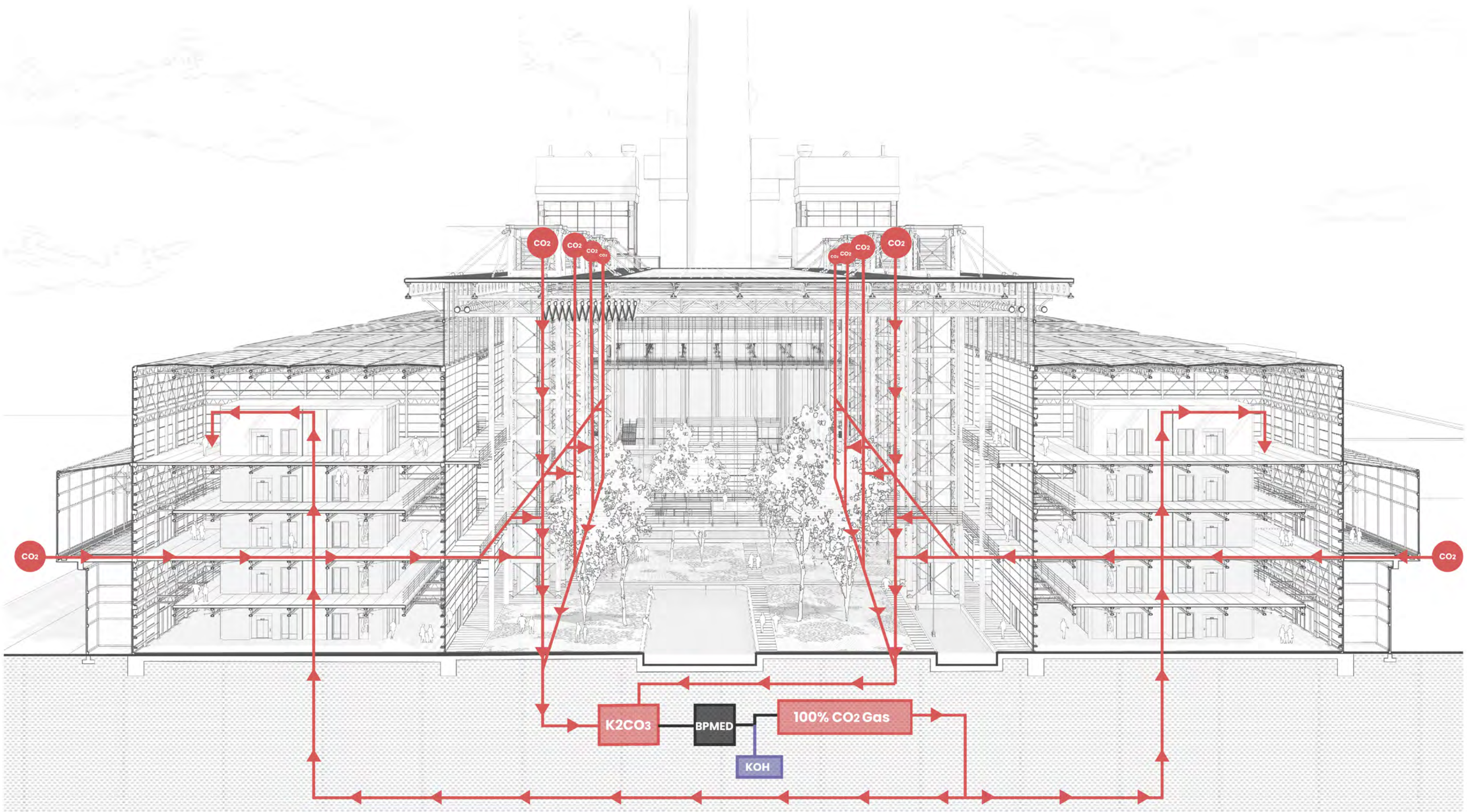
Optimised Parameters of Facade

| Our Design Specifications | | | | Units |
|---|---|---|---|---|
| ATD (Air Travel Distance) | | 1.25 | m | air travel distance |
| L (Length of Inlet) | | 2.5 | m | length |
| H (height of Inlet) | | 3 | m | height |
| V (Air Velocity to Inlet) | | 2 | m/s | air velocity |
| Total Volume of DAC | | 9.375 | m3 | |
| Calculations | | | | |
| Capture flux | F | 5744.408008 | | kg/m2/year |
| CO2 captured | | 43.08306006 | | ton/year |
| Pressure drop | deltaP | 40.77048929 | | Pa |
| Energy Per m2 | E | 3.93E+09 | | J/m2/year |
| Energy Required For Module | E | 3.E+10 | | J/year |
| Capital cost | C_capital | 30094 | | $ |
| Operating cost | C_operating | 2153 | | $/year |
| Total cost | | 155 | | $/ton |
| Energy | E | 1092.07 | | J/s |
| Energy | E | 1 | | kW |
| Solar Panels 400 Watt 8hrs/Day | (730kWh/Year) | | | |
| | 730kwh = 2,628,000,000 Joules | 11.21986312 | | *(utilise Hydro Power and Nearby Wind Energy if Possible)* |

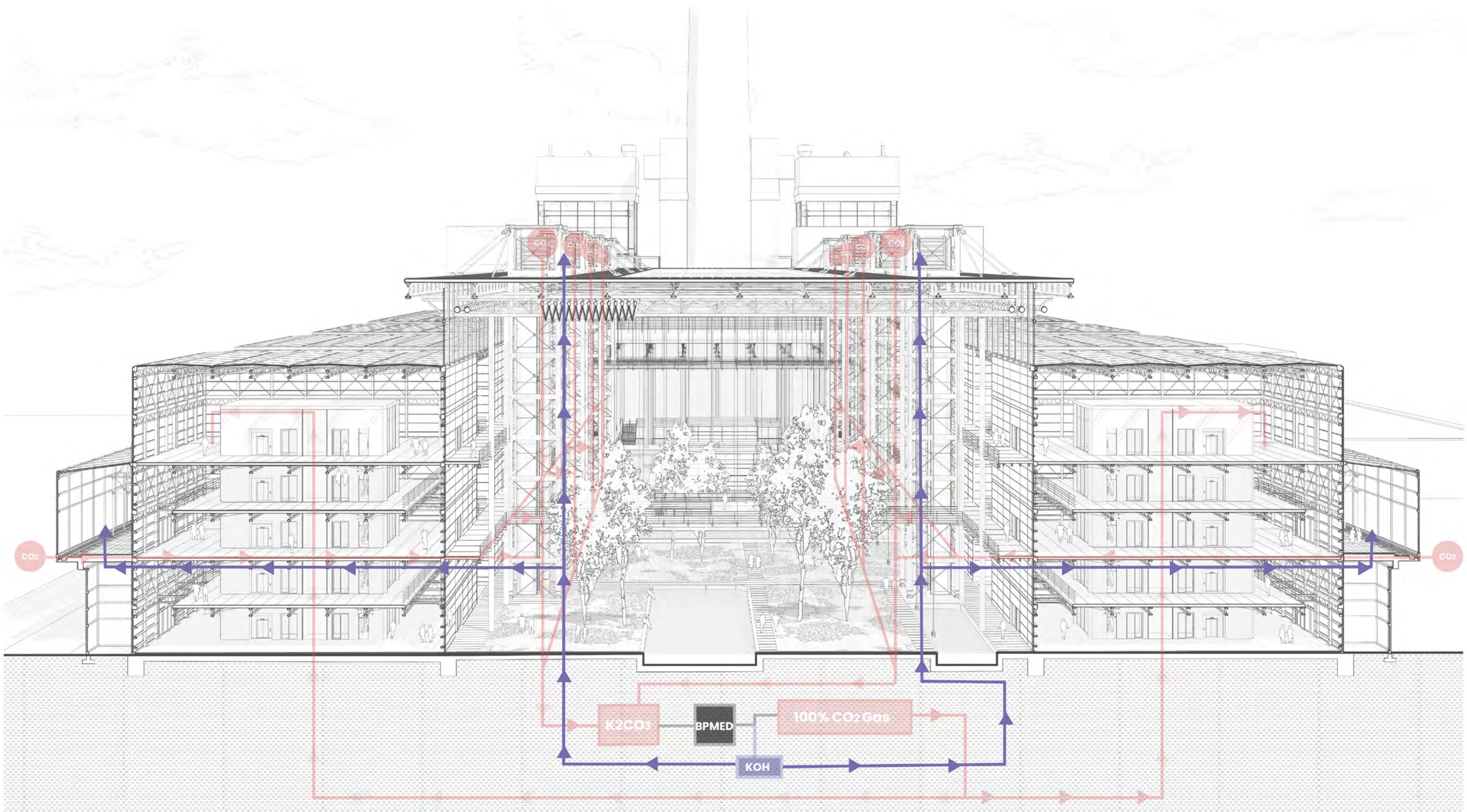
Optimised Parameters of Towers

The Facility that Responds to the Context

# FOLLOWING THE RESEARCH OUTCOME

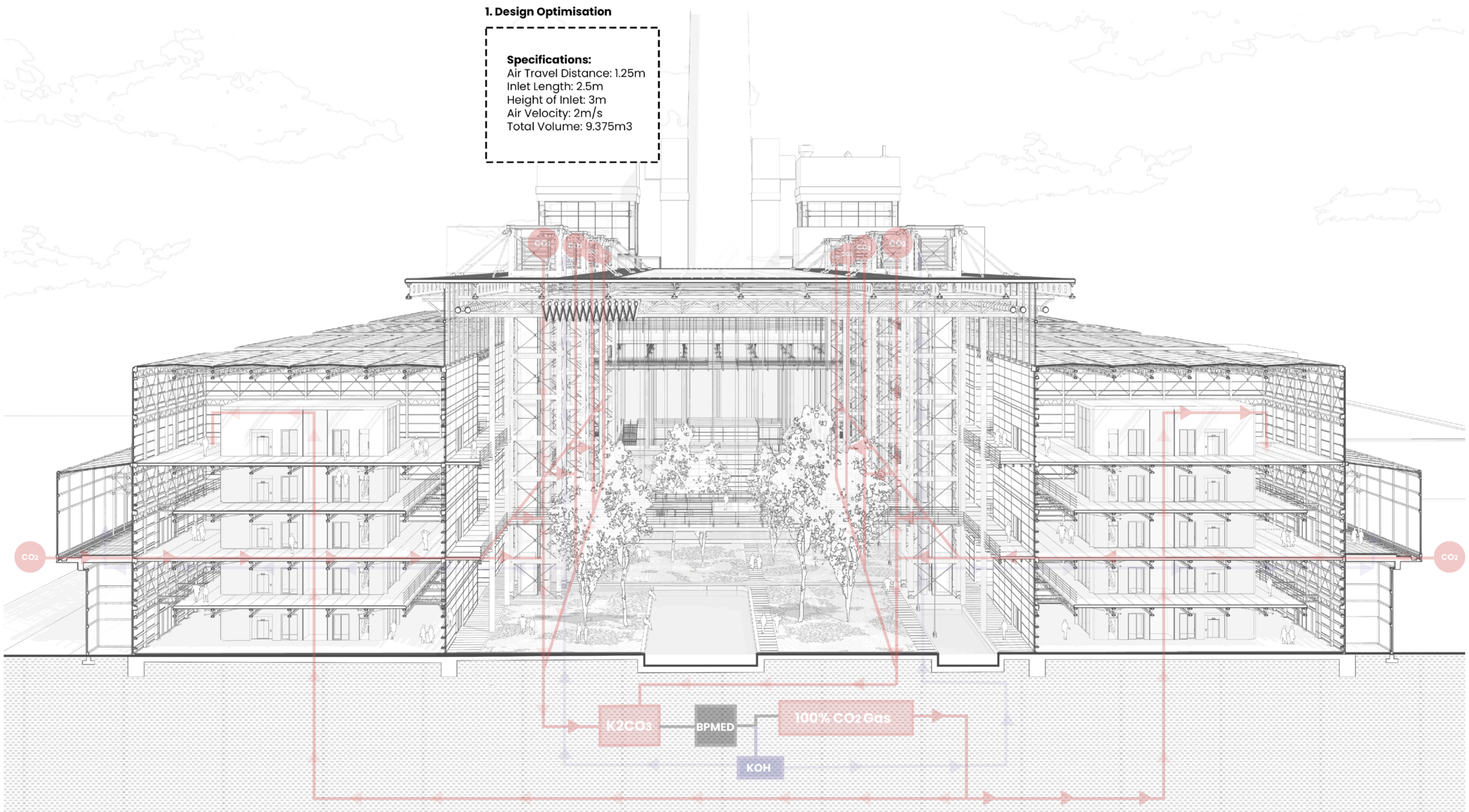


# FOLLOWING THE RESEARCH OUTCOME



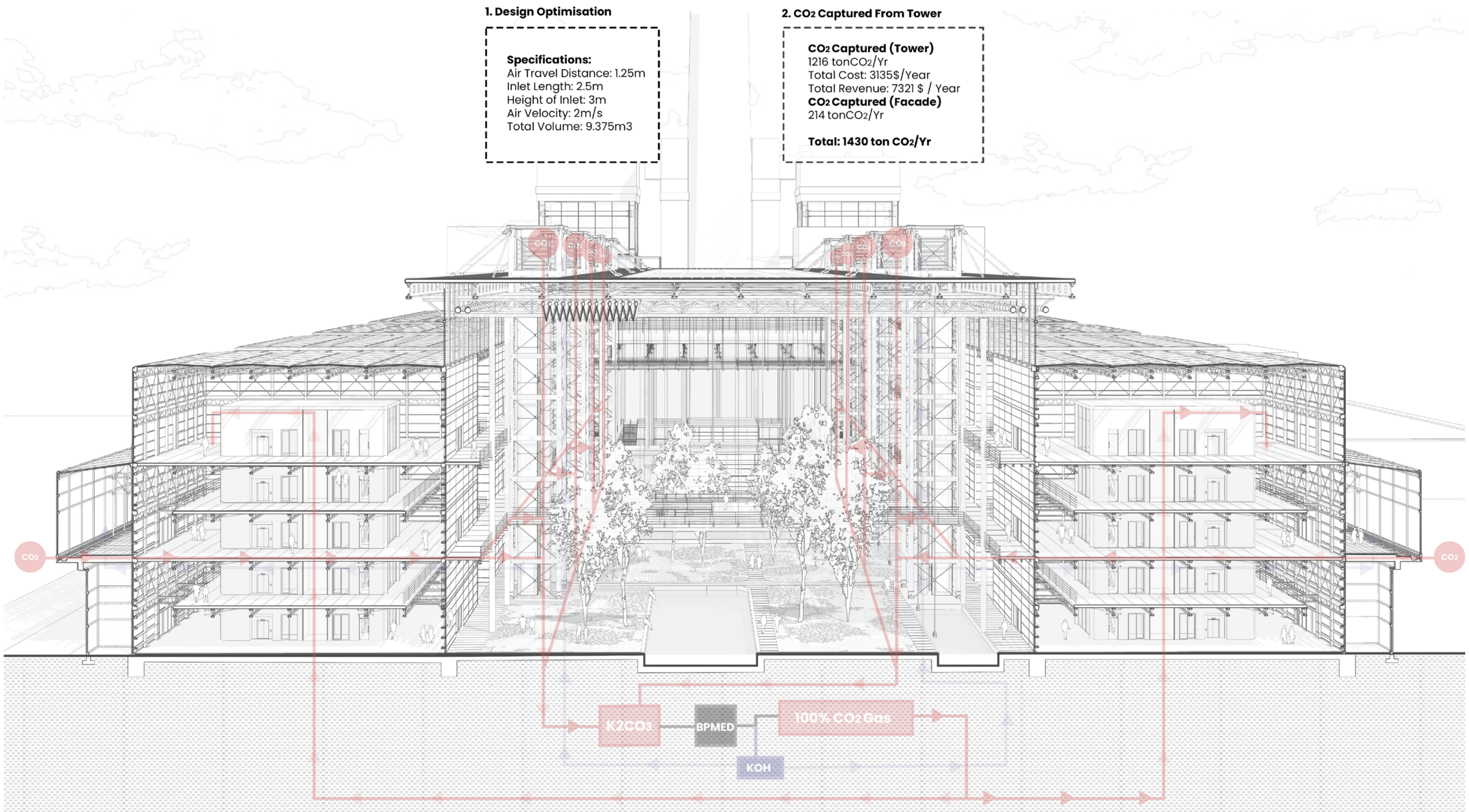
The Facility that Responds to the Context

# FOLLOWING THE RESEARCH OUTCOME



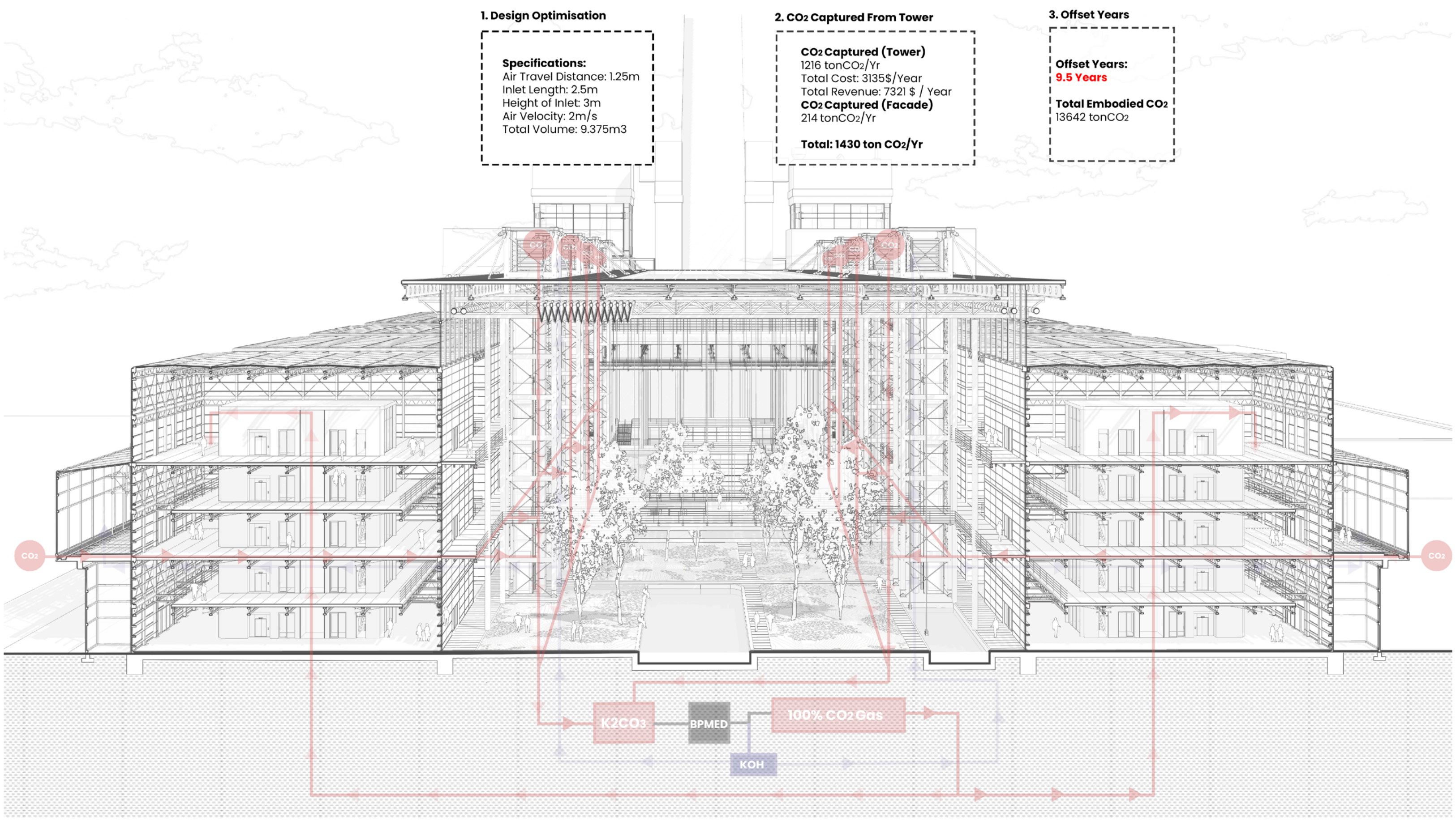
The Facility that Responds to the Context

# FOLLOWING THE RESEARCH OUTCOME



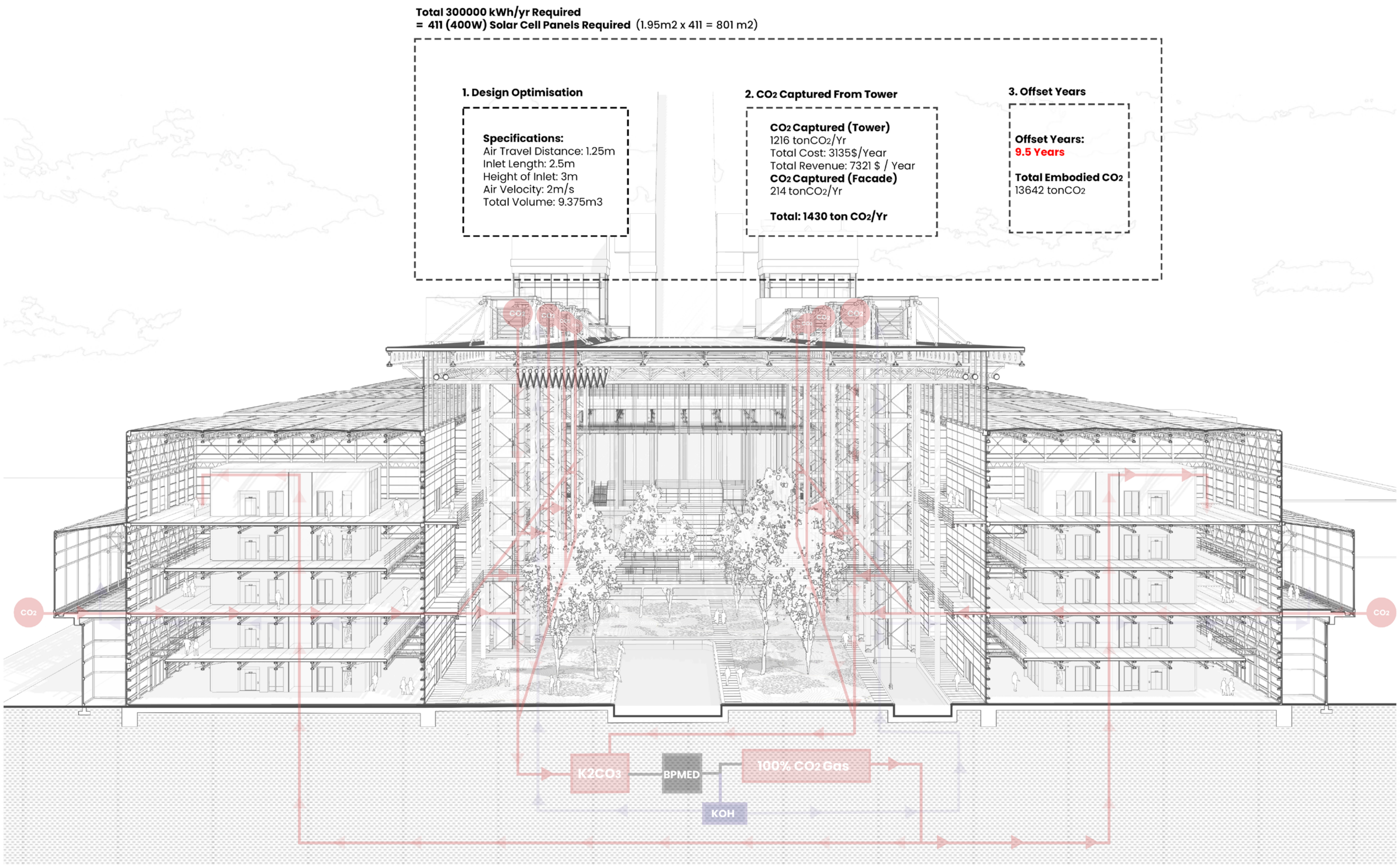
The Facility that Responds to the Context

# FOLLOWING THE RESEARCH OUTCOME

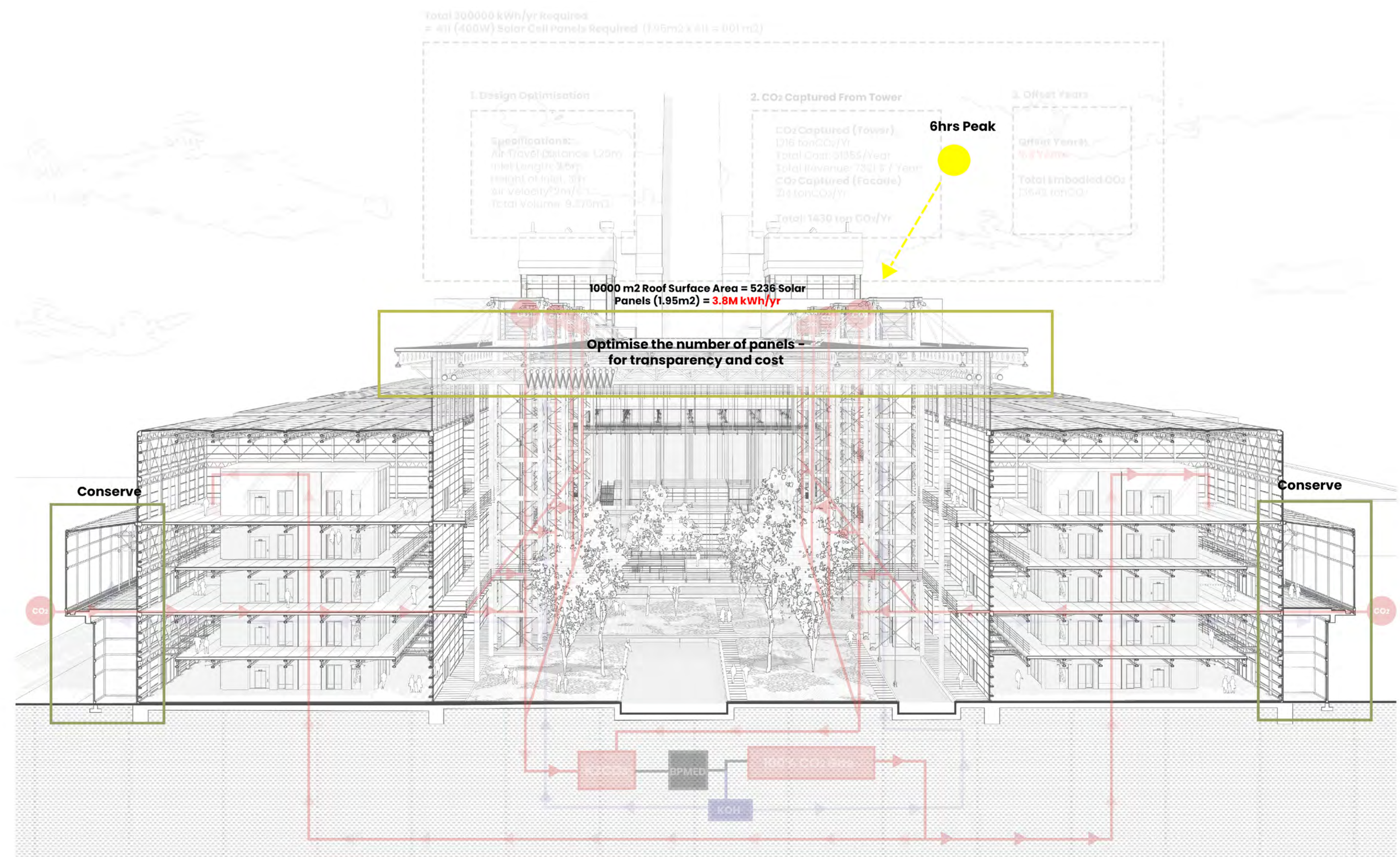


The Facility that Responds to the Context

# FOLLOWING THE RESEARCH OUTCOME

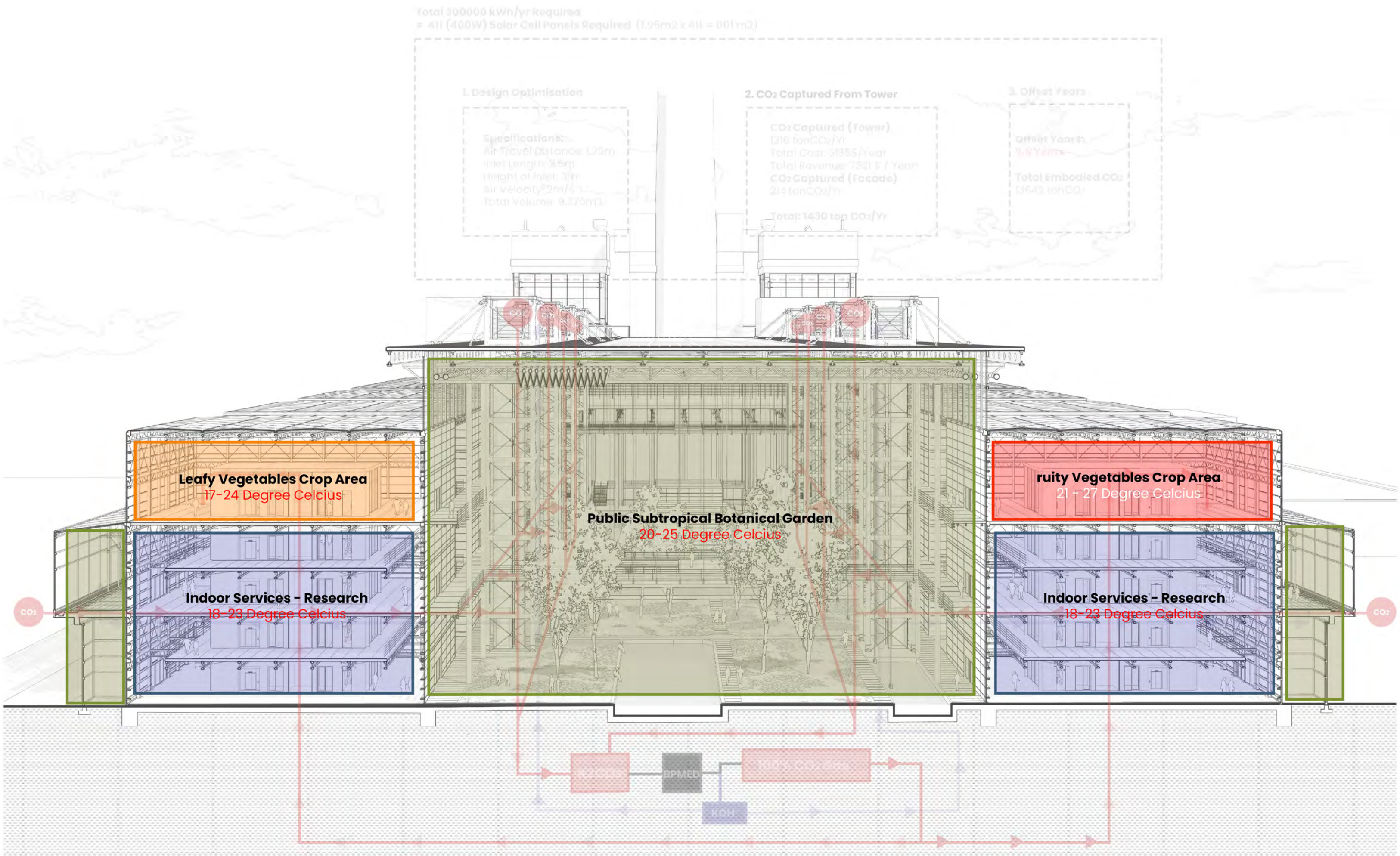


# FOLLOWING THE RESEARCH OUTCOME



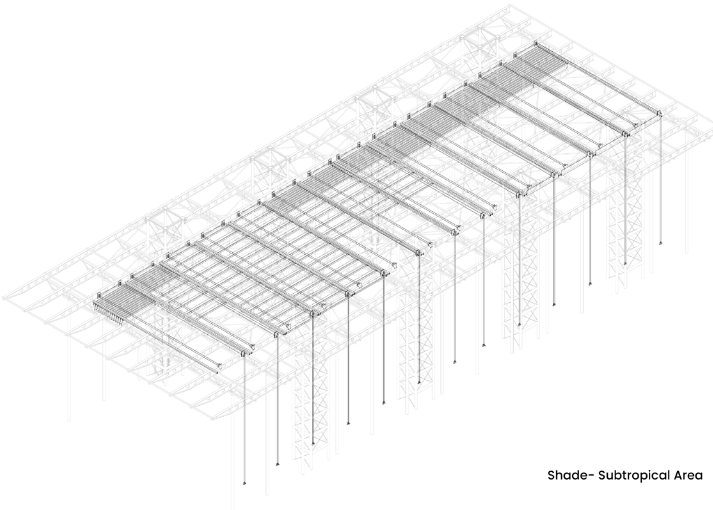
The Facility that Responds to the Context

# FOLLOWING THE RESEARCH OUTCOME

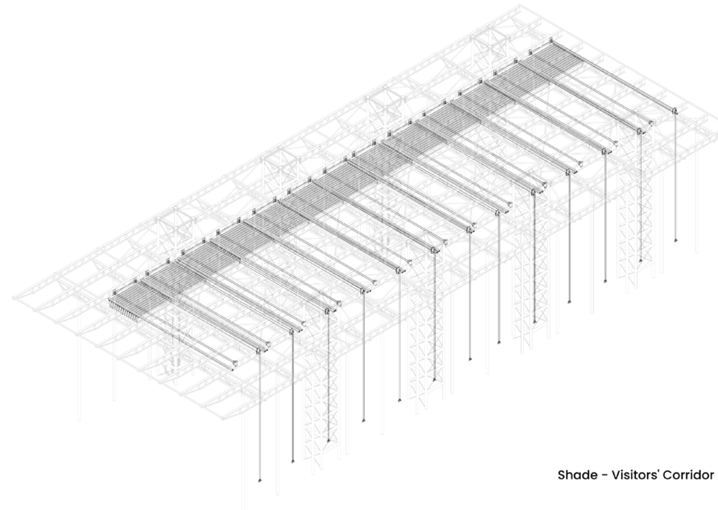


The Facility that Responds to the Context

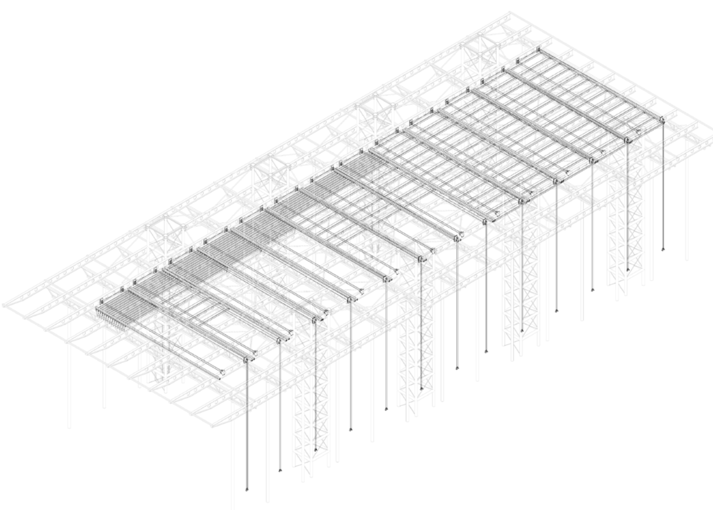
# CLIMATE CONTROL



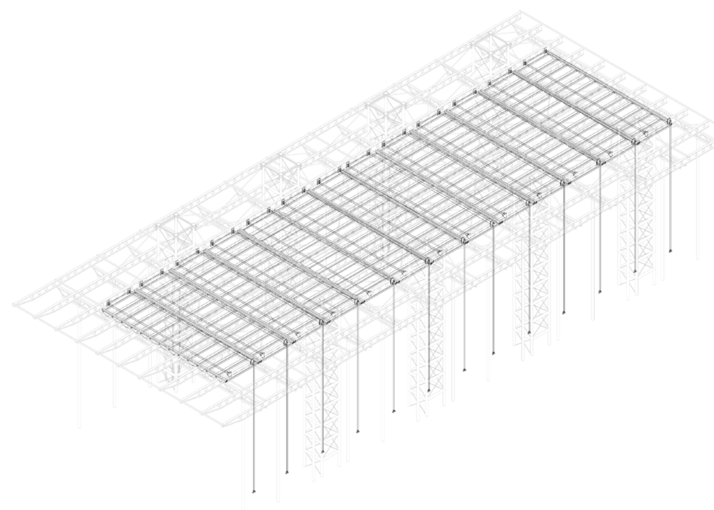
Shade- Subtropical Area



Shade - Visitors' Corridor



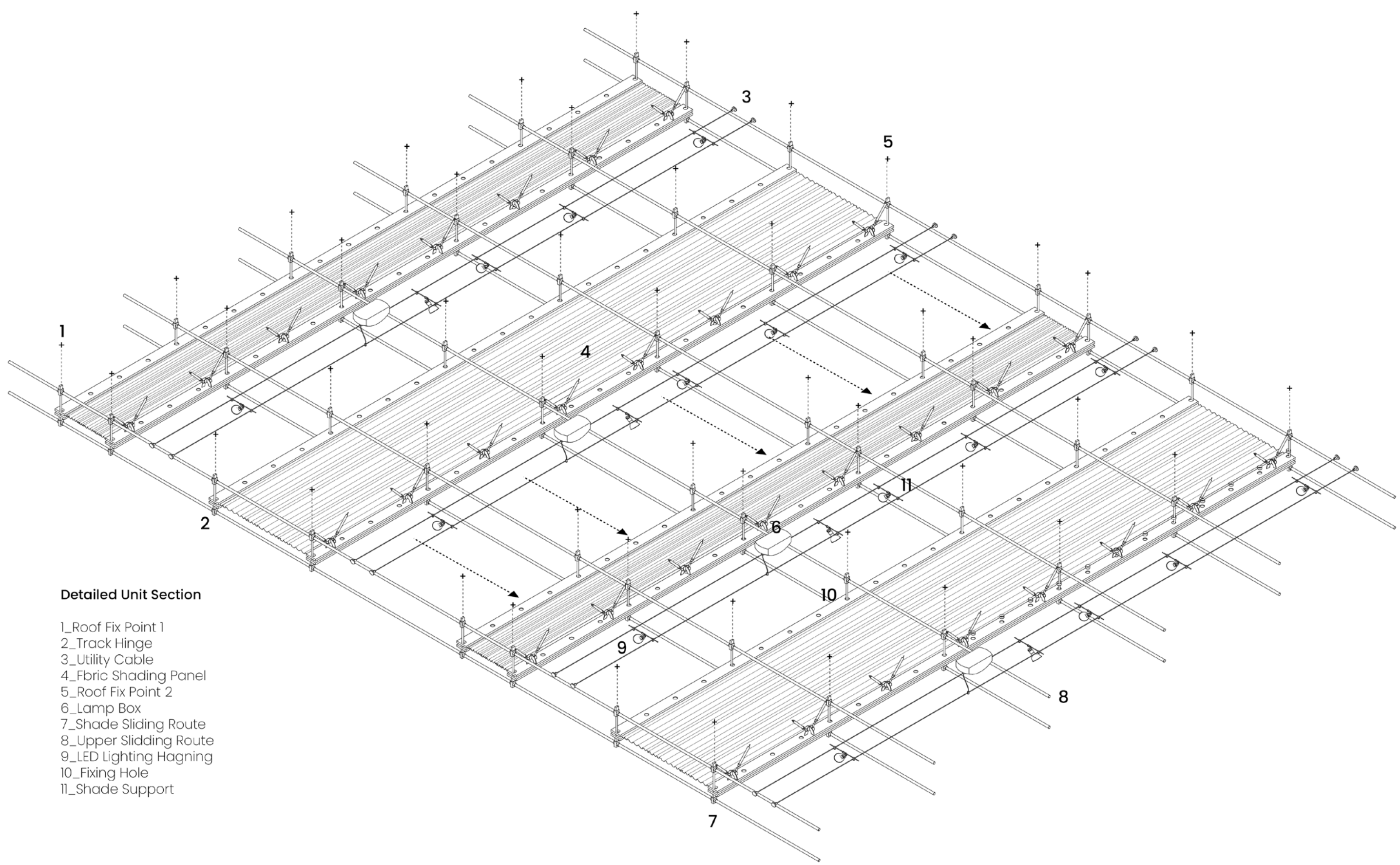
Shade- Workshop Area



Shade- Full Coverage

The Facility that Responds to the Context

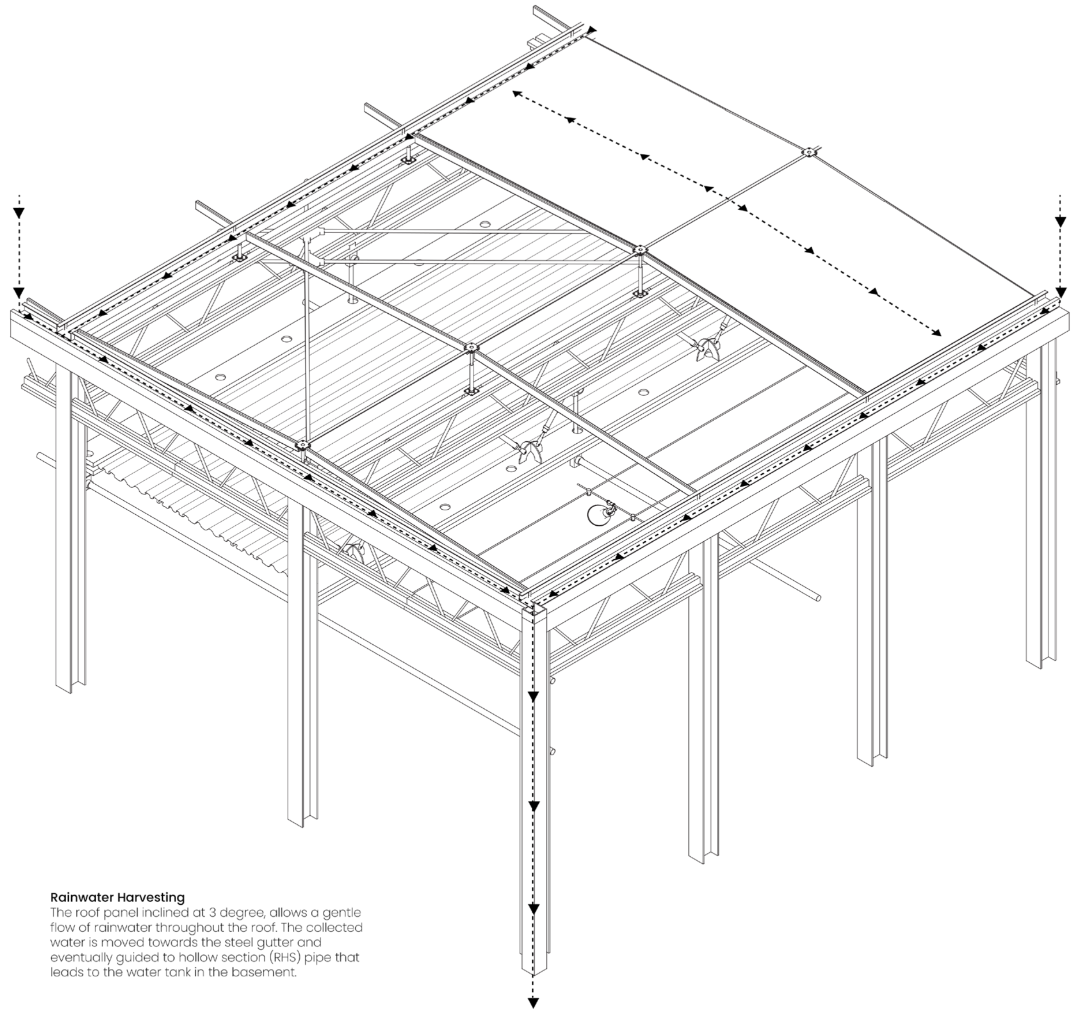
# CLIMATE CONTROL - CROP AREA




**Detailed Unit Section**

1_Roof Fix Point 1
2_Track Hinge
3_Utility Cable
4_Fbric Shading Panel
5_Roof Fix Point 2
6_Lamp Box
7_Shade Sliding Route
8_Upper Sliddng Route
9_LED Lighting Hagning
10_Fixing Hole
11_Shade Support

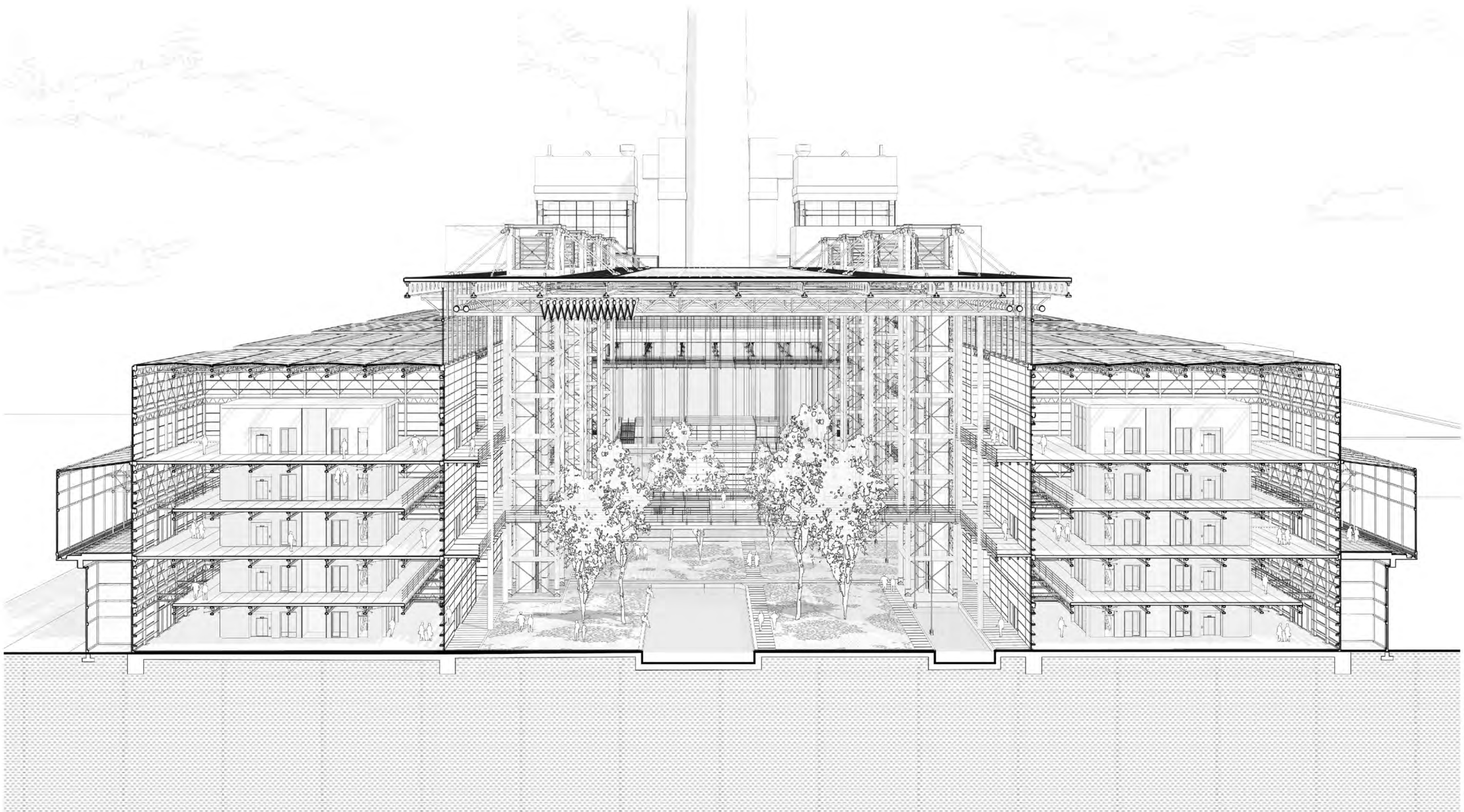
# THE CROP AREA - WATER COLLECTION



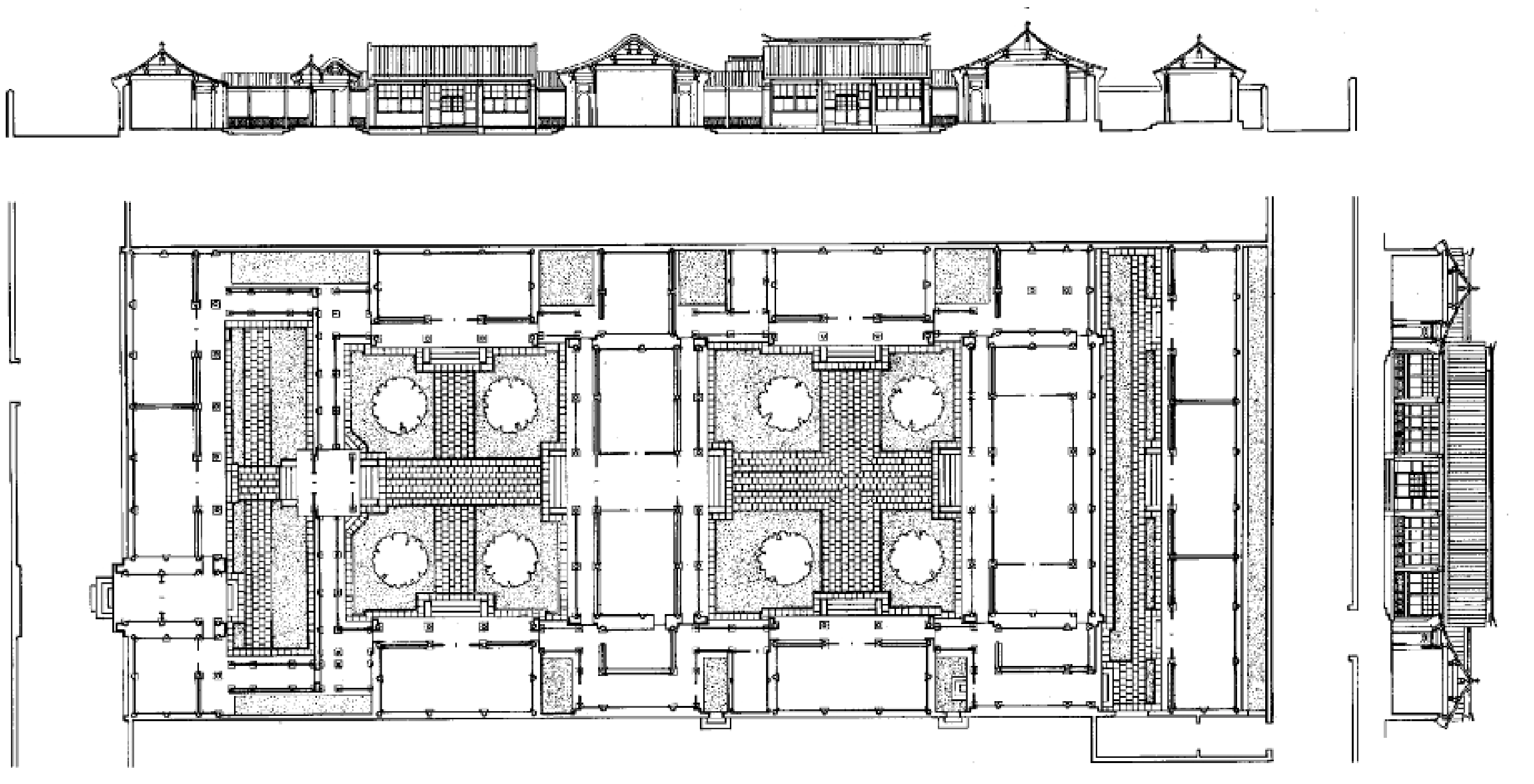
**Rainwater Harvesting**

The roof panel inclined at 3 degree, allows a gentle flow of rainwater throughout the roof. The collected water is moved towards the steel gutter and eventually guided to hollow section (RHS) pipe that leads to the water tank in the basement.

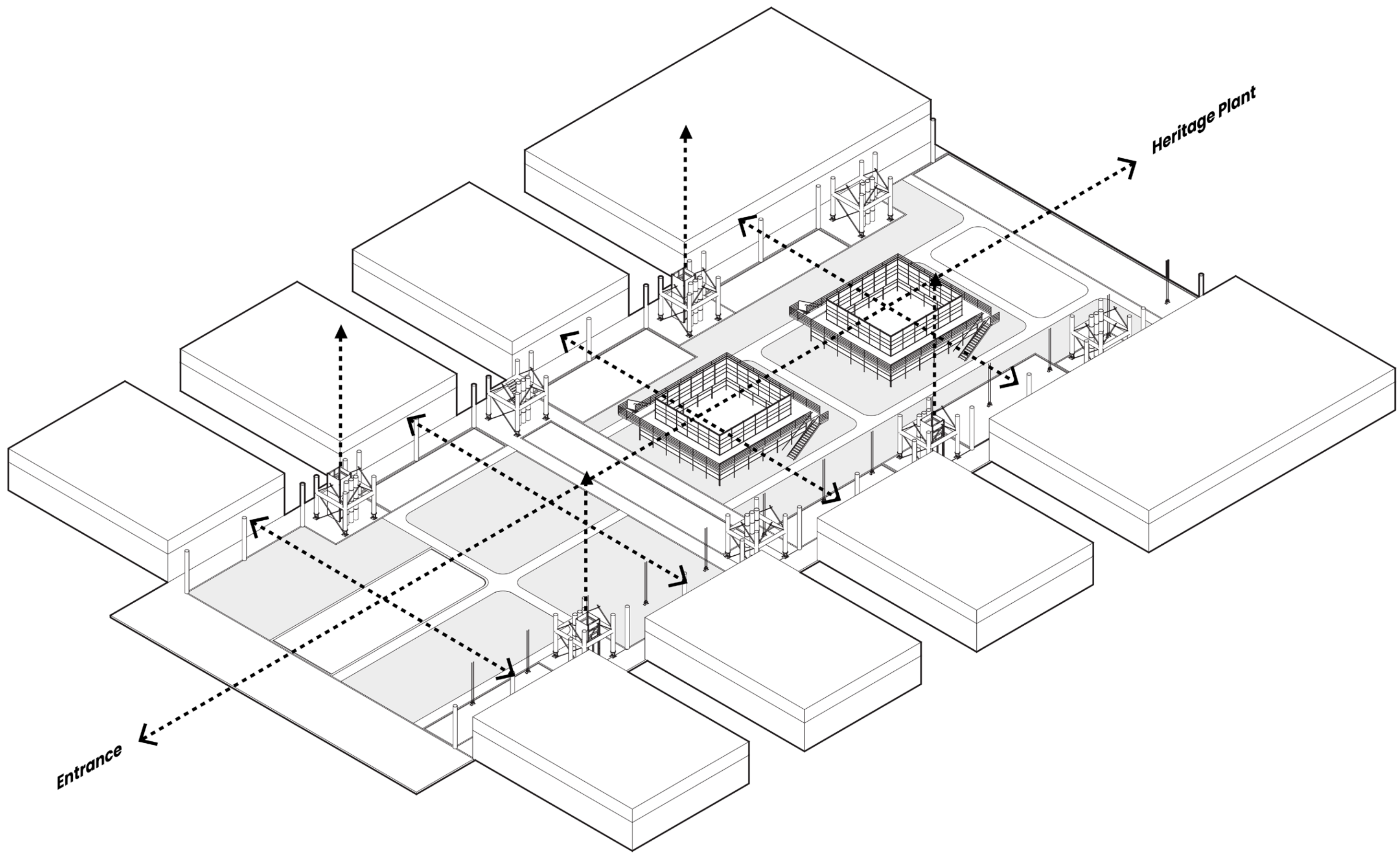
# FOLLOWING THE RESEARCH OUTCOME



# OBJECTIVE 4: INTEGRATING TRADITION

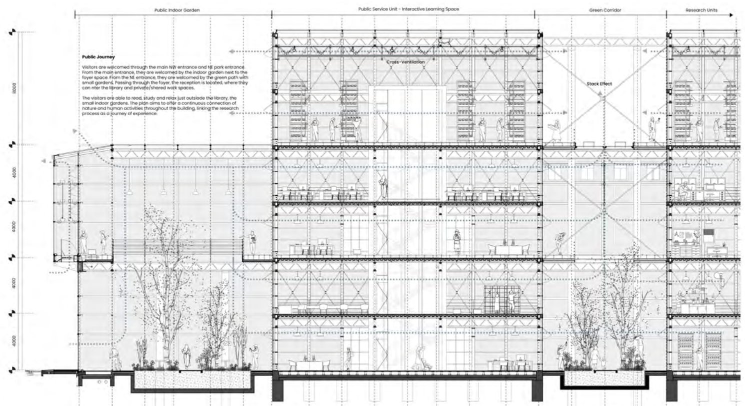


# OBJECTIVE 4: INTEGRATING TRADITION

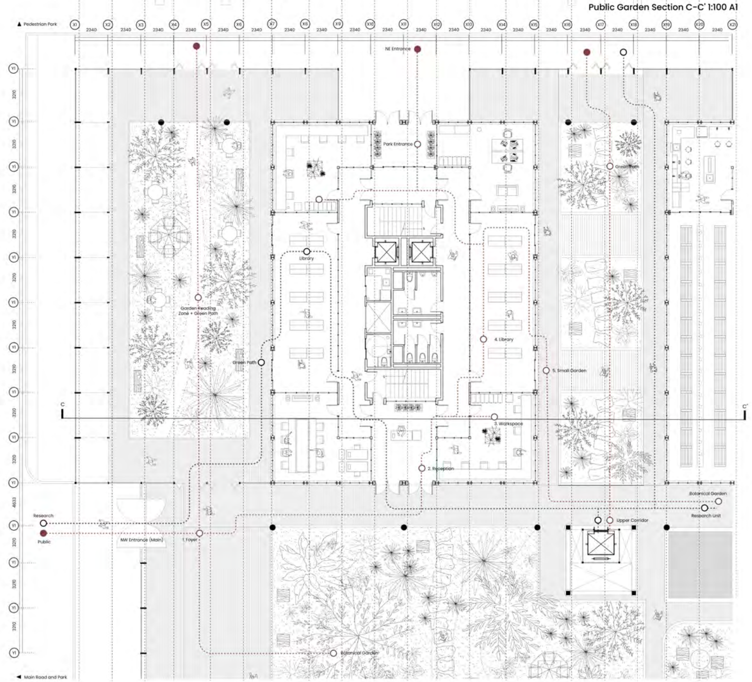


The Facility that Responds to the Context

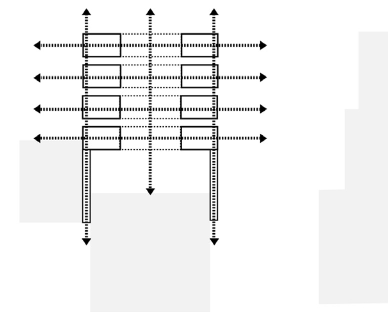
# OBJECTIVE 5 ACCESSIBILITY STRATEGY



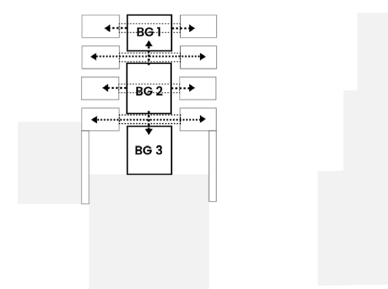
Public Garden Section C-C' 1:100 A1



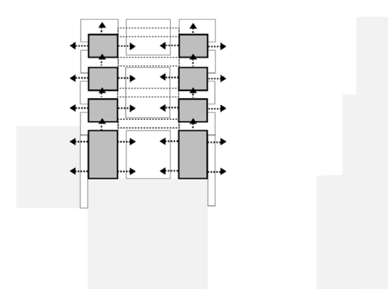
Public Garden Section 1:100 A1



1. CONTINOUS GREEN CORRIDOR




2. CENTRAL ACCESS THROUGH GARDENS

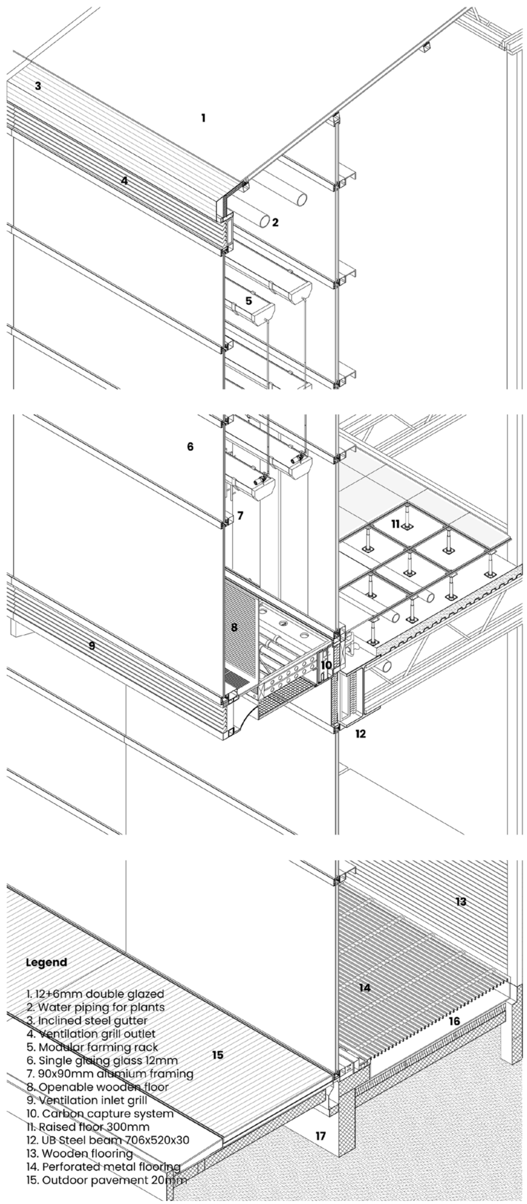


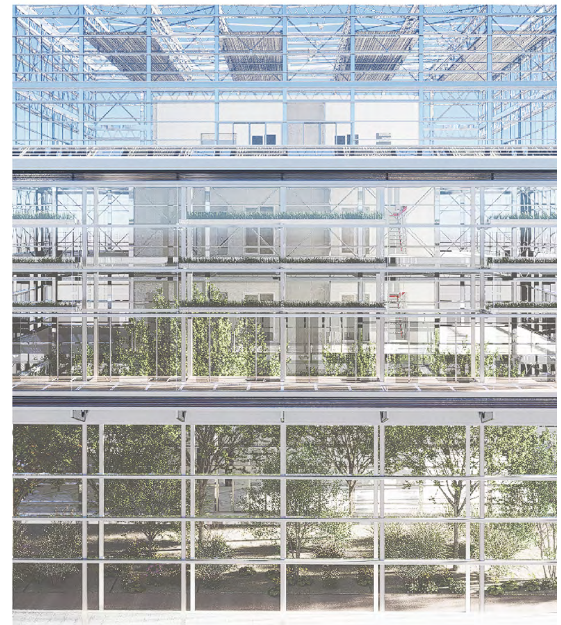
3. RESEARCH AND SERVICE ACCESS POINTS

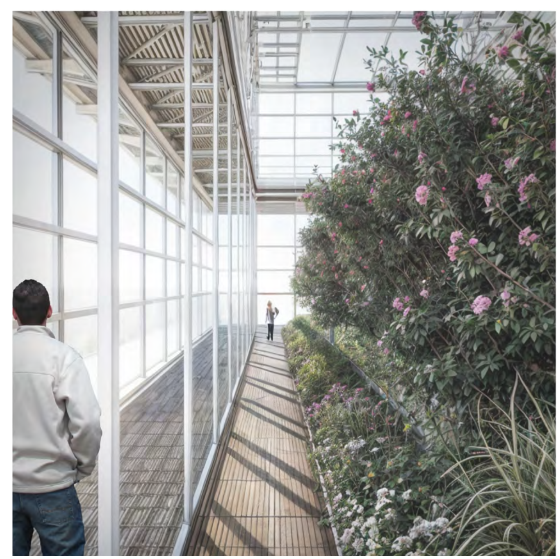
# APPROACHING THE BUILDING

## The Facility that Responds to the Context

# ENTERING THE BUILDING





# ENTERING THE FOREST

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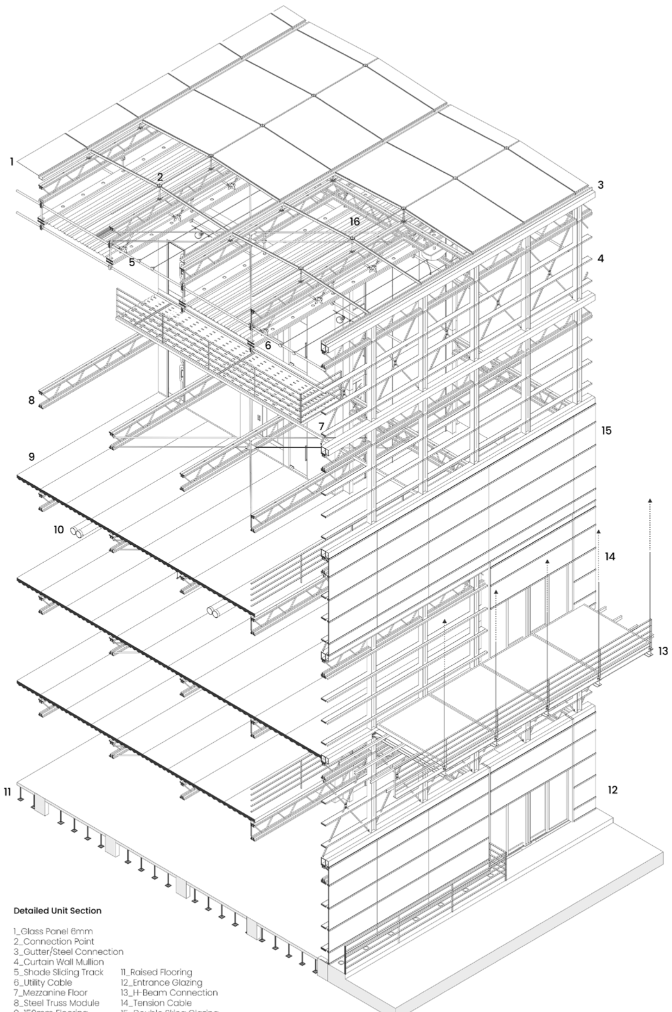
# WALKING THROUGH THE GREEN

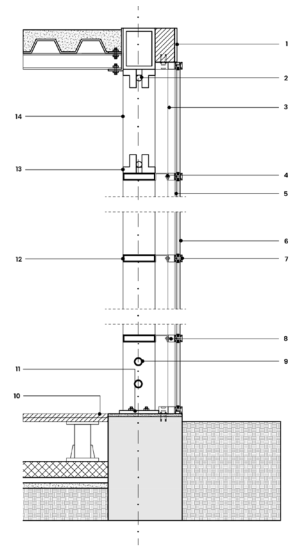
# THE TRANSPARENT RESEARCH

# THE TRANSPARENT RESEARCH




**Detailed Unit Section**

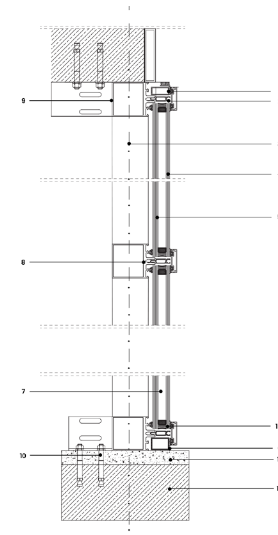
1_Glass Panel 6mm
2_Connection Point
3_Gutter/Steel Connection
4_Curtain Wall Mullion
5_Shade Sliding Track
6_Utility Cable
7_Mezzanine Floor
8_Steel Truss Module
9_150mm Flooring
10_Service Pipe
11_Raised Flooring
12_Entrance Glazing
13_H-Beam Connection
14_Tension Cable
15_Double Sking Glazing
16_retractable Shade



**Research Facade**
**1:20**

**LEGEND**

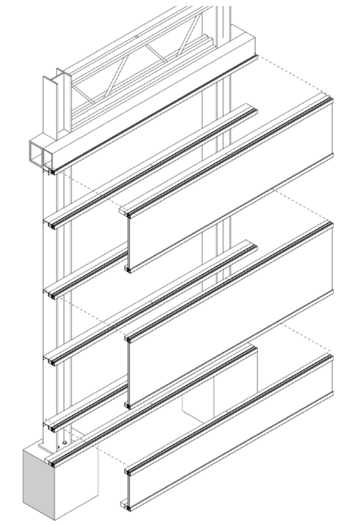
1. 15mm Steel plate cap
2. 660 x 200 mm steel truss
3. 42 mm Aluminium facade rod
4. 80 x 45mm steel purlin, hot dip galvanised
5. 6mm inner clear glass
6. 4mm outer clear glass
7. Steel cap + EPDM Gasket
8. Glazing bolt connection
9. Heating pipes 51mm through coloumns
10. 25mm x 2 raised floor tile 60x60 width
11. Steel column bolted base plate
12. 200 x 45mm Hollow section steel purlin
13. 650 x 200 mm steel truss base
14. 200 x 200 H-section steel column



**Glazing Joint**
**1:5**

**LEGEND**

1. 38 x 17mm plastic box
2. Thermic barrier
3. 42mm aluminium facade rod
4. 4mm outer clear glass
5. 6mm outer clear glass
6. 45mm aluminium profile
7. 10mm air gap (argon gas)
8. Transom profile
9. Galvanized steel anchor
10. Bolted joints for steel base plate
11. Concrete pad
12. EPDM gasket
13. Concrete pad foundation



**Detail Axo**
**1:30**

**DETAILS**

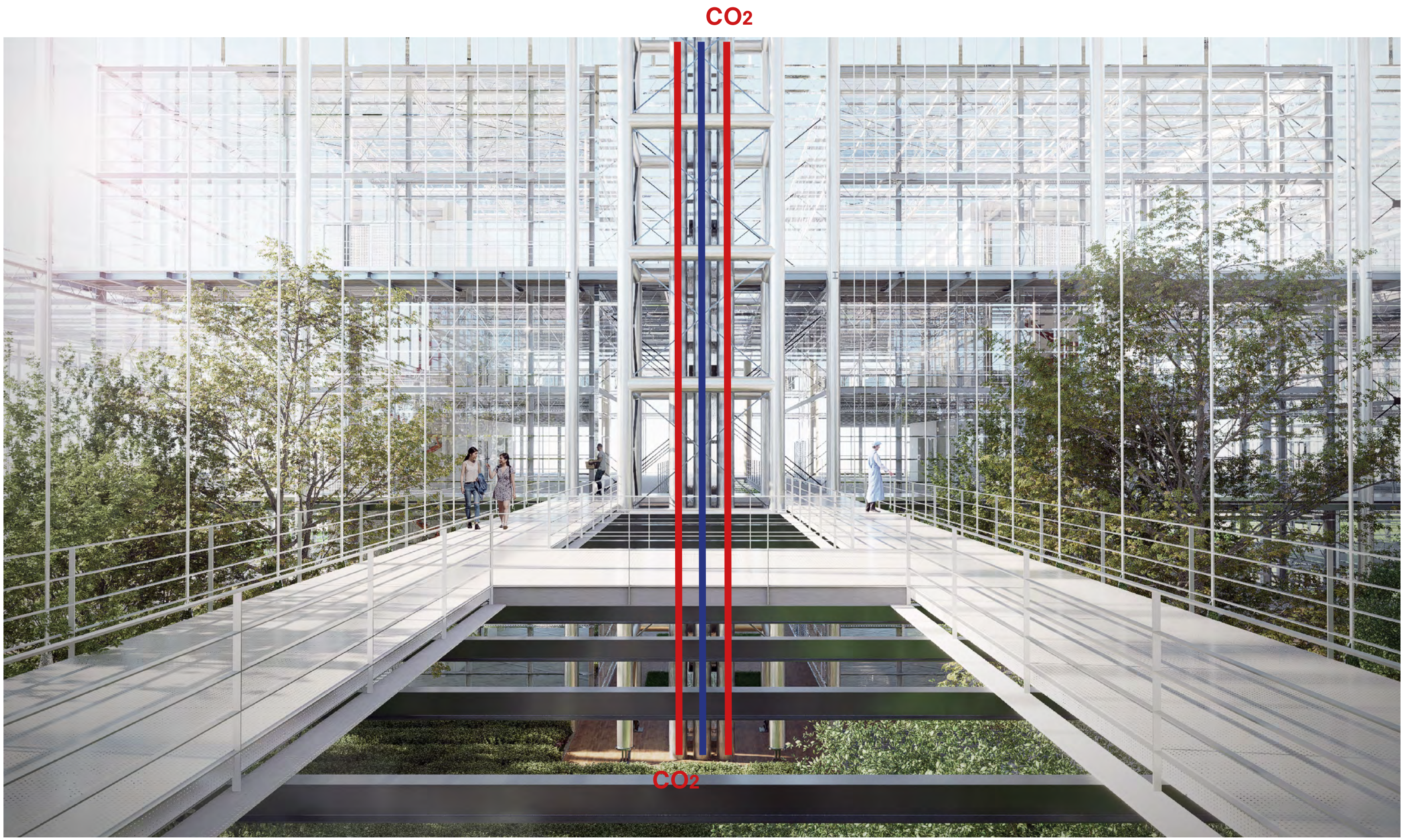
1. Demountable curtain wall system for the inner research "boxes"
2. Transparent research process opened to public, controls direct access to the research areas.
3. Steel construction with truss and H beams, connected by steel purlins.
4. Double glazed for the thermal performance with 10mm air gap

The Facility that Responds to the Context

# WALKING ABOVE THE FOREST

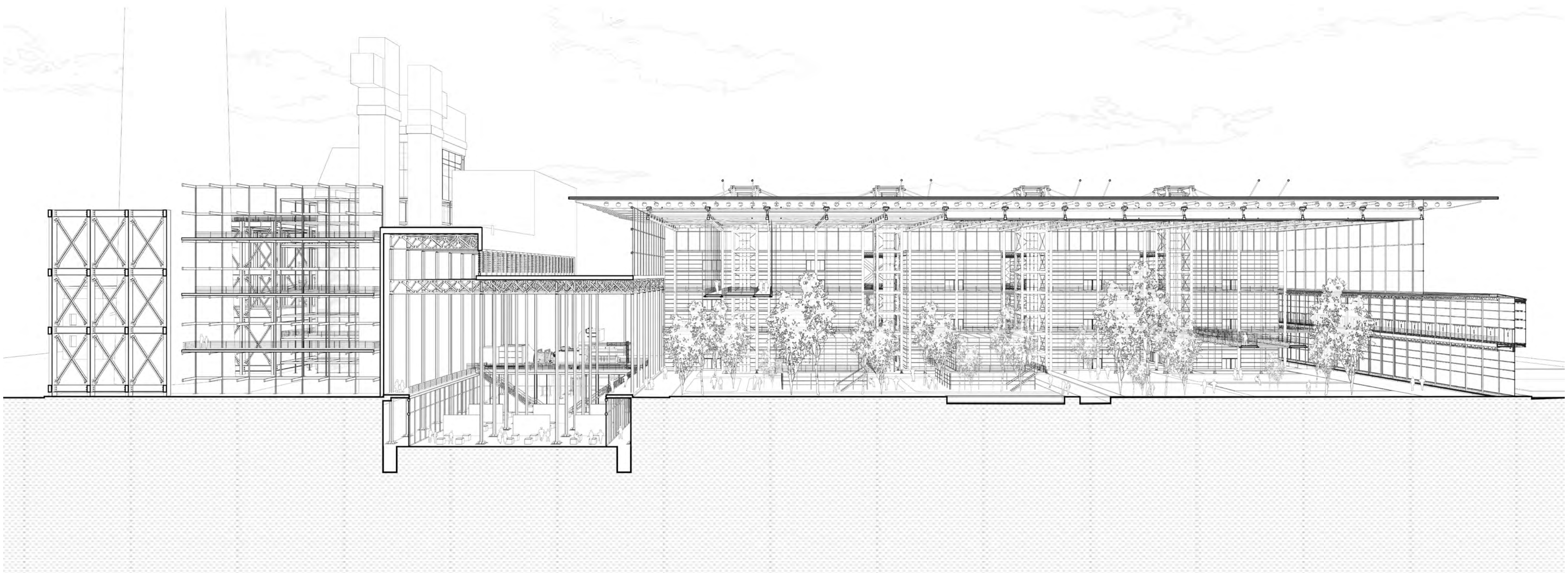
The Facility that Responds to the Context

# WALKING ABOVE THE FOREST



The Facility that Responds to the Context

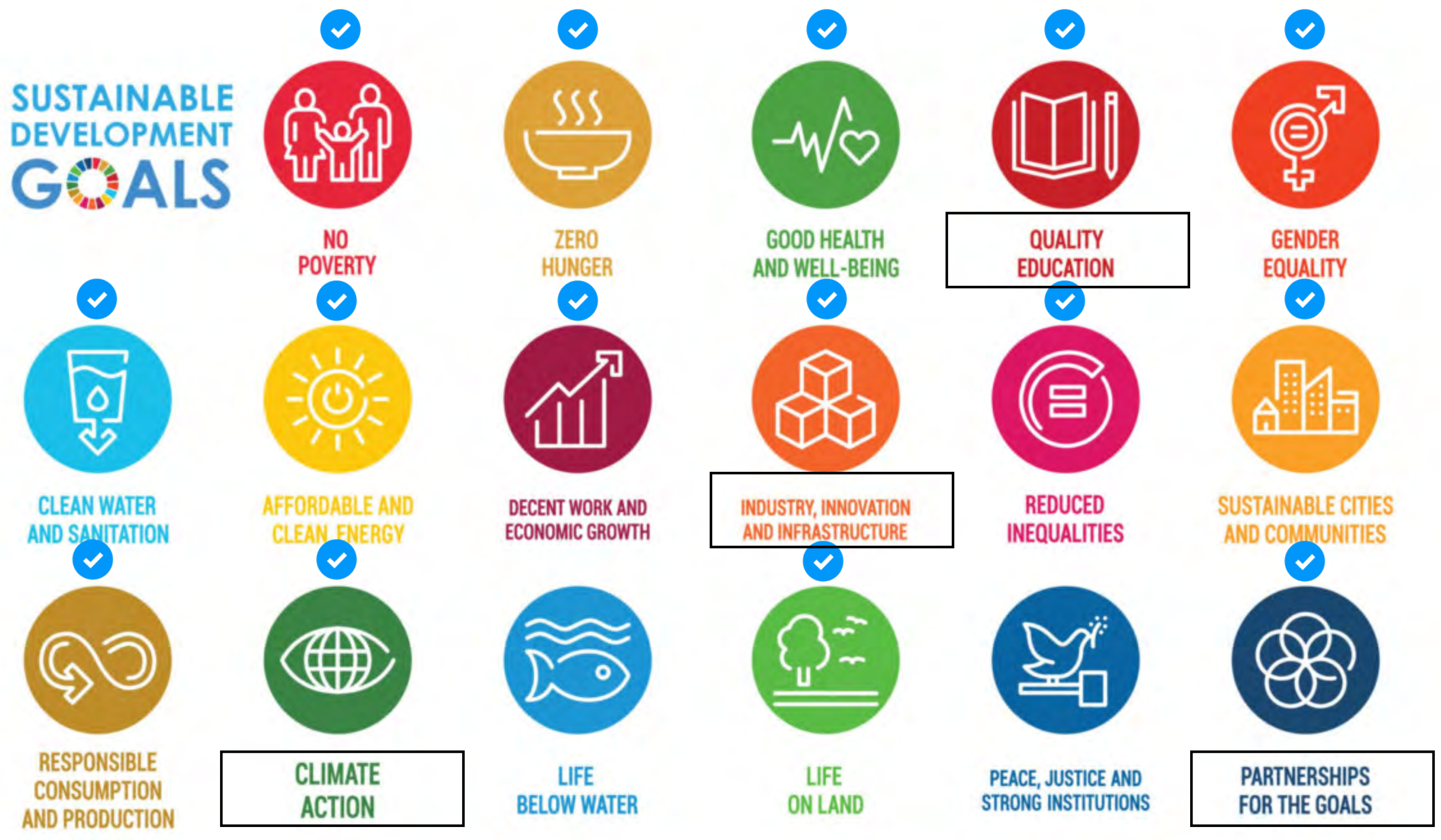
# WALKING THROUGH THE FOREST



The Facility that Responds to the Context

# TOP OF THE FOREST

# THE PROJECT IN RELATION TO SDGS




Acheive at least 15 out of 17 goals  and 4 main focuses

# THE END