



Controlled Environment Agriculture to Renovation

Bio-base Materials Element to Global Scale

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Advisors: Andrew Jenkins & Mo Smit

Building Technology | Climate and Sustainable Design



Introduction

Framework

Research
&
Analysis

Circular Design

Urban Story

Conclusions

Introduction

Dwelling and Resource Challenge



Introduction | Dwellings Challenge

Construction

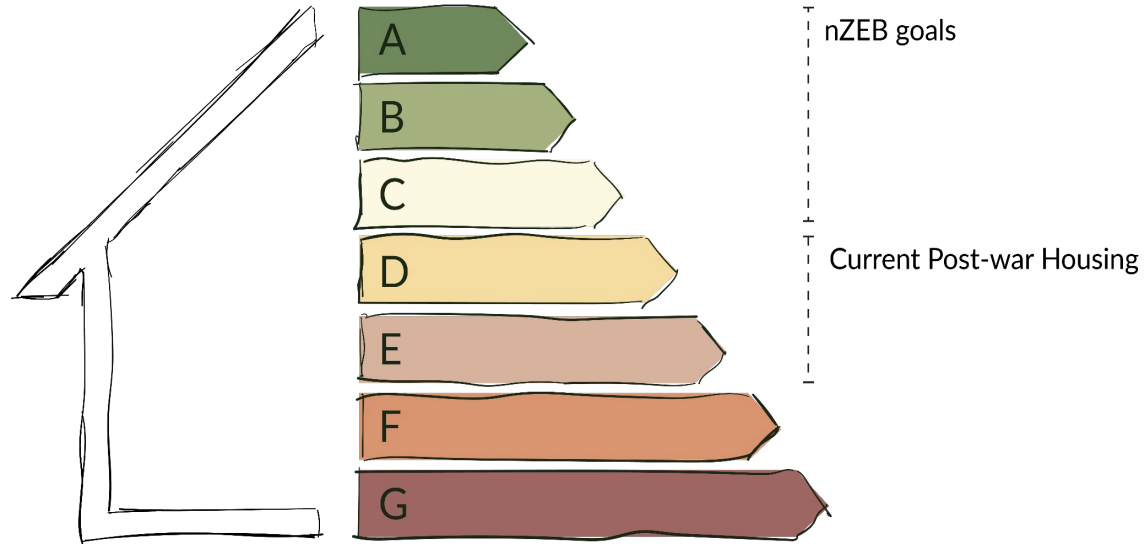


Rehabilitation

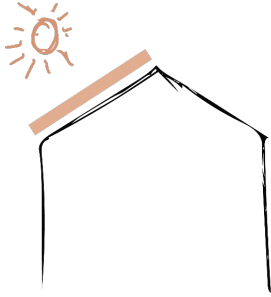


Renovation

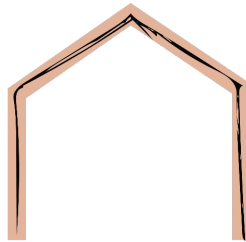




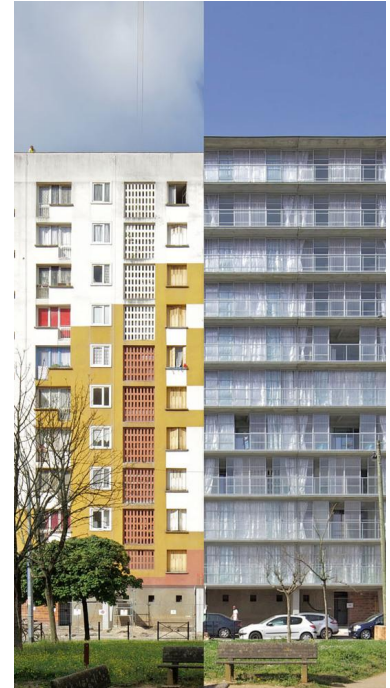
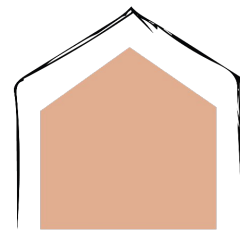
Renewable Energy



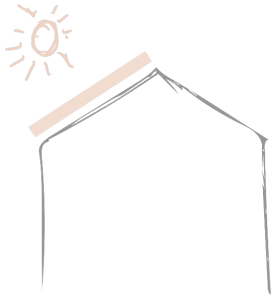
Building Envelope



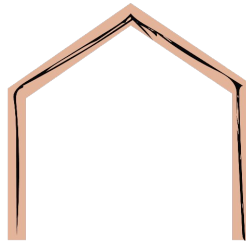
Building Services



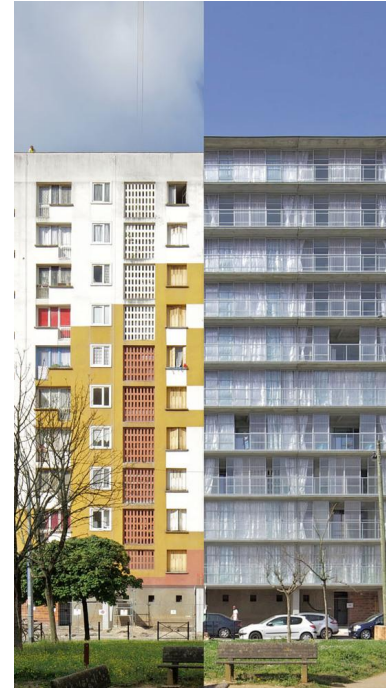
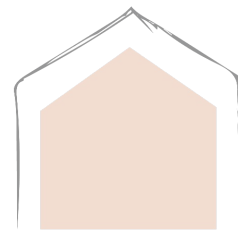
Renewable Energy



Building Envelope

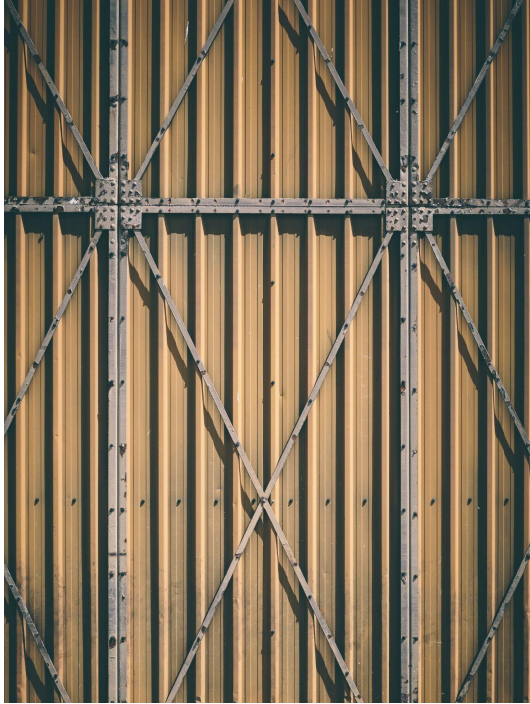


Building Services



Introduction | Dwellings Challenge

Steel Facades and Structures



Fiberglass Insulation



Gypsum Walls



Introduction | Dwellings Challenge

Acoustic Recycled Burlap



Acoustic Mycelium Tiles



Wall + Insulation Reed



Introduction | Resources Challenge

Soil Degradation



Drought

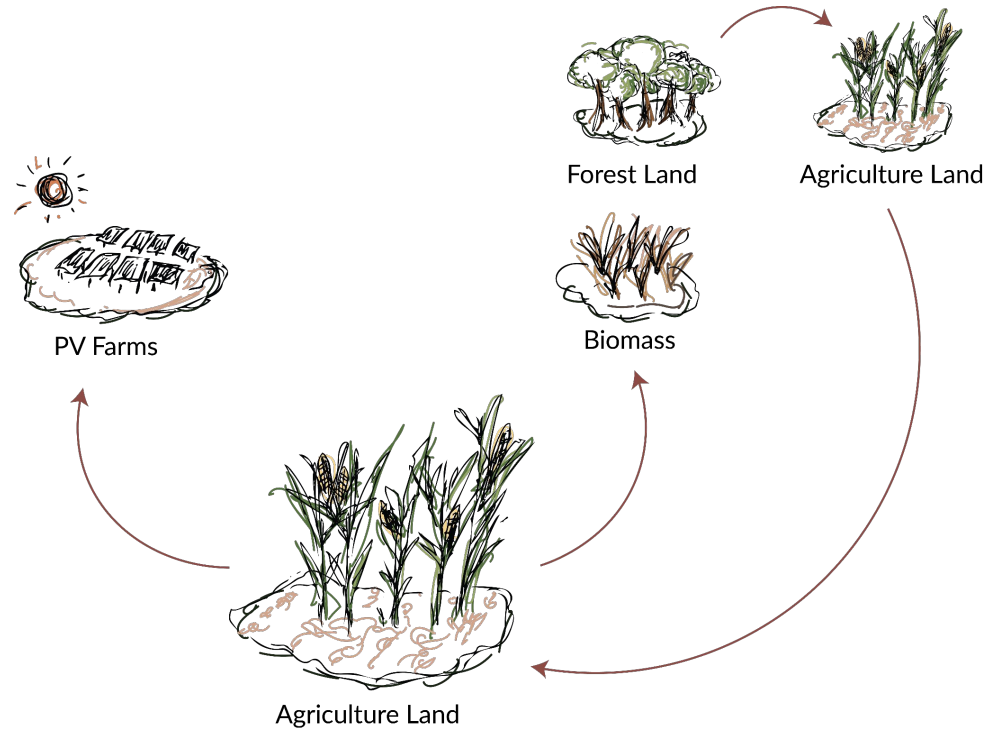


Flooding



Pesticides





Introduction

Thesis



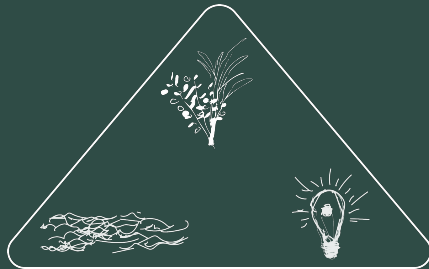
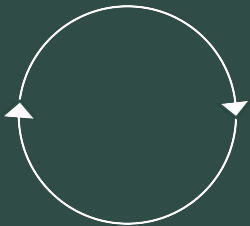
To declare agriculture bio-based materials a sustainable material for renovation, the method of **growth and harvesting bio-based material** crops and by-products should be **responsibly sourced** and **resilient to land competition and environmental hazards**, which is not possible in the current state of the agriculture industry

To what extent can **Controlled Environment Agriculture** be a viable alternative to field crop and plant growth for **agriculture bio-based construction** materials for **building renovations**?

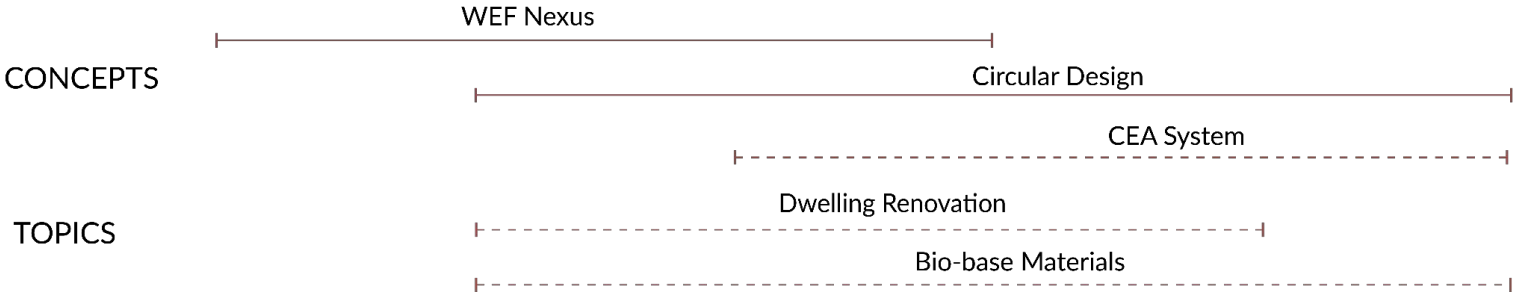
MUWI post-war housing constructions are able meet thermal performance nZEB goals through **panel renovations** that are primarily assembled from responsibly sourced **agriculture bio-based material** grown in a localized **Vertical Farm**, which provides opportunity to foster **resilience to land competition** and **environmental hazards** while also acknowledging **circular economy practices** and the **Water-Energy-Food Nexus**

Framework

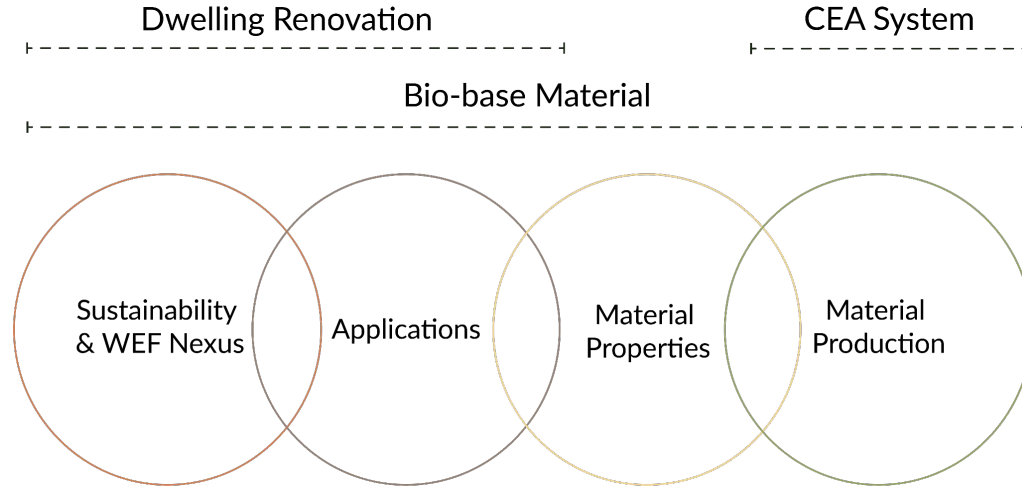
Themes and Concepts

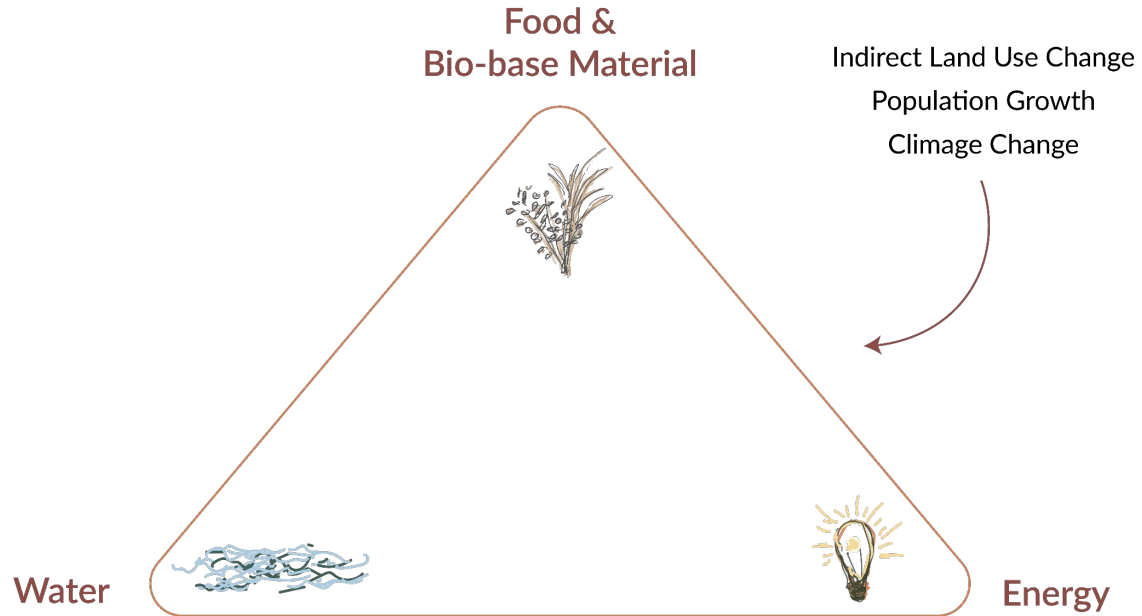


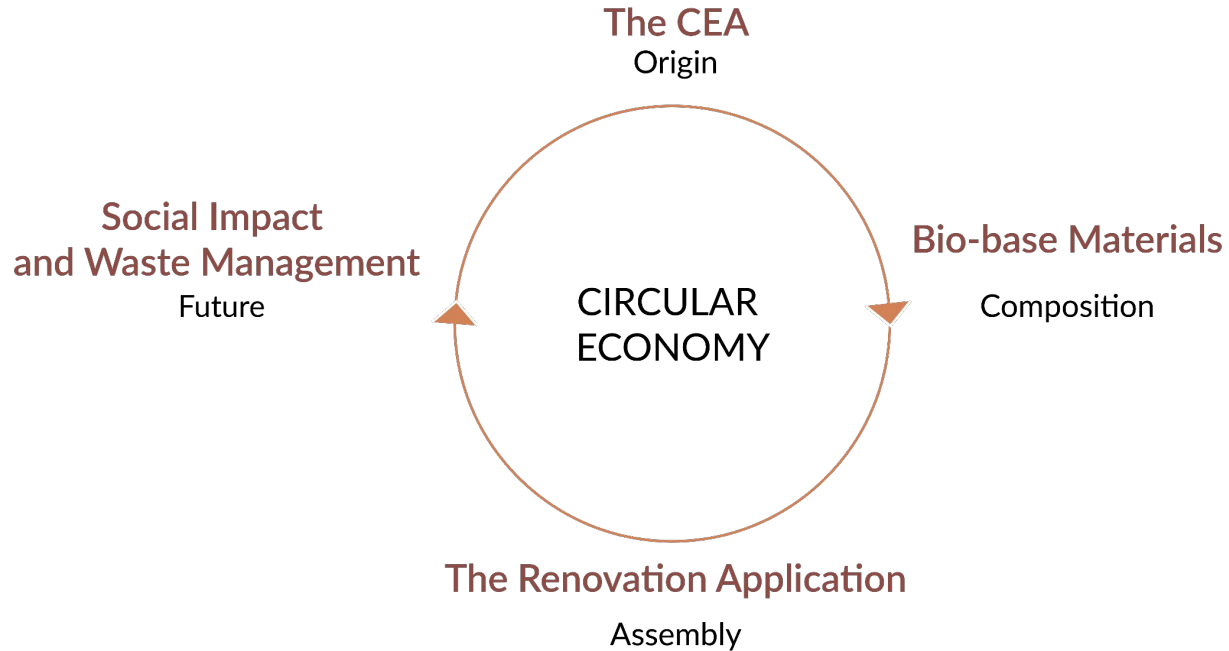
Framework | Globe to Element Scale



GLOBAL	NATIONAL	REGIONAL	LOCAL	ELEMENT
Demand for Construction and Renovation	EU nZEB goals	Post war Housing Renovations	New Character of Post war housing	Panel Application
Resilient Enviroment and Structures	Petroleum Free Materials		Building Application	
	Water and Nutrient Resource Conservation	Reduce strain on supply chain	Bio-base Material Collection	Panel Composition
Land Conservation	Agriculture and Circular Economy	CEA Application	Food Supply	Material Growing



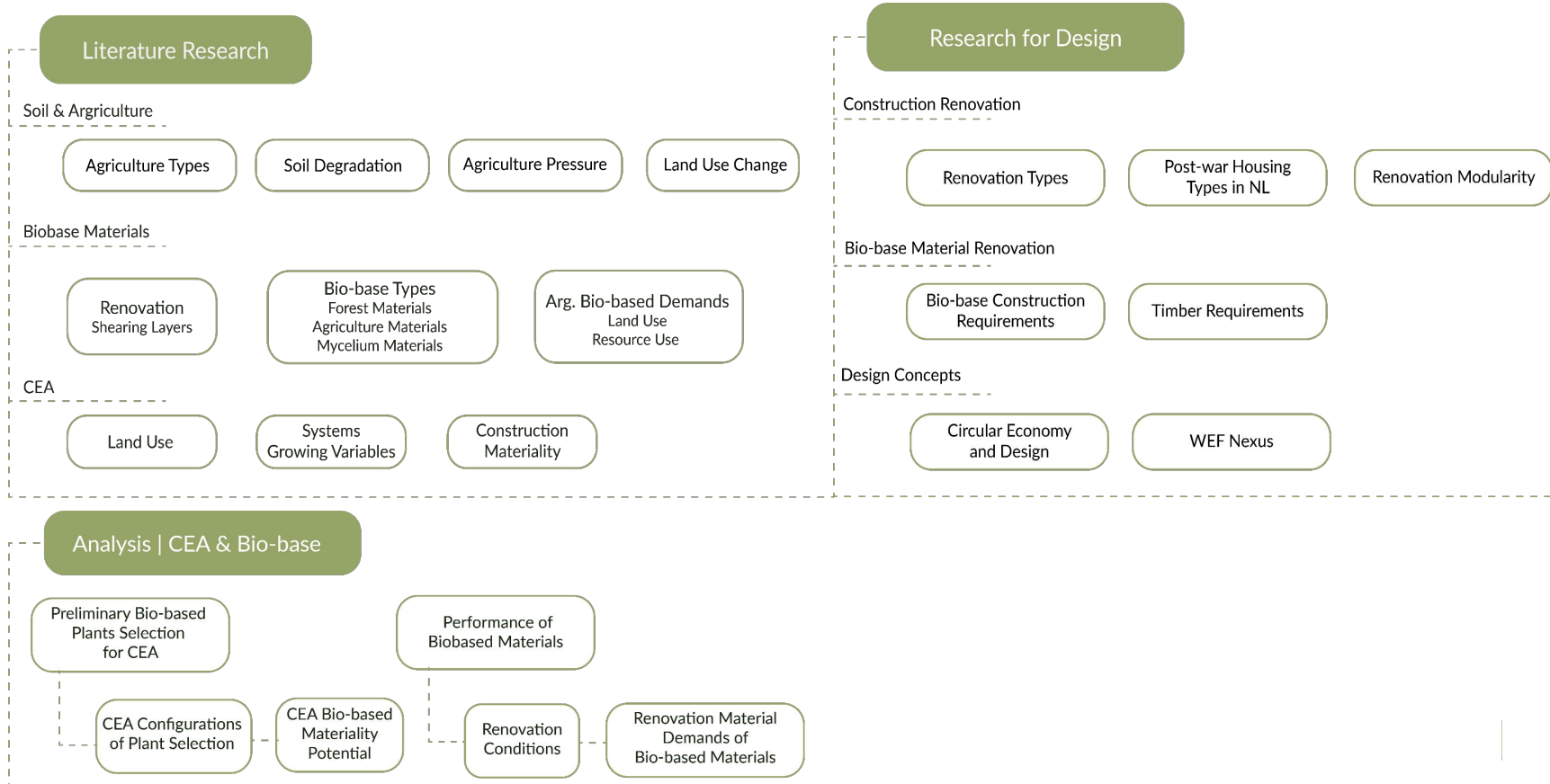




Framework

Research & Analysis

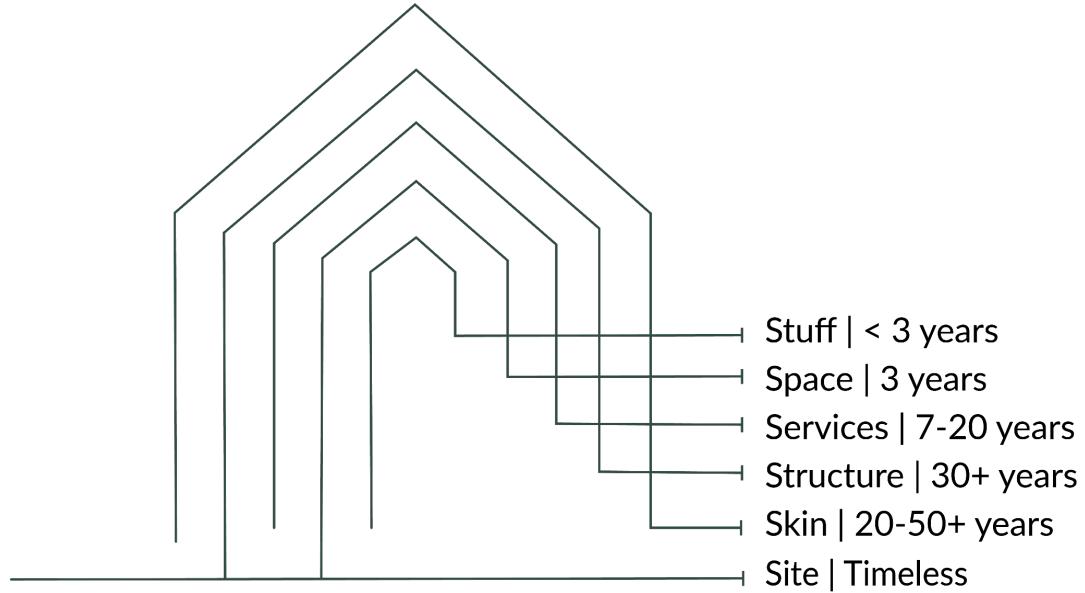


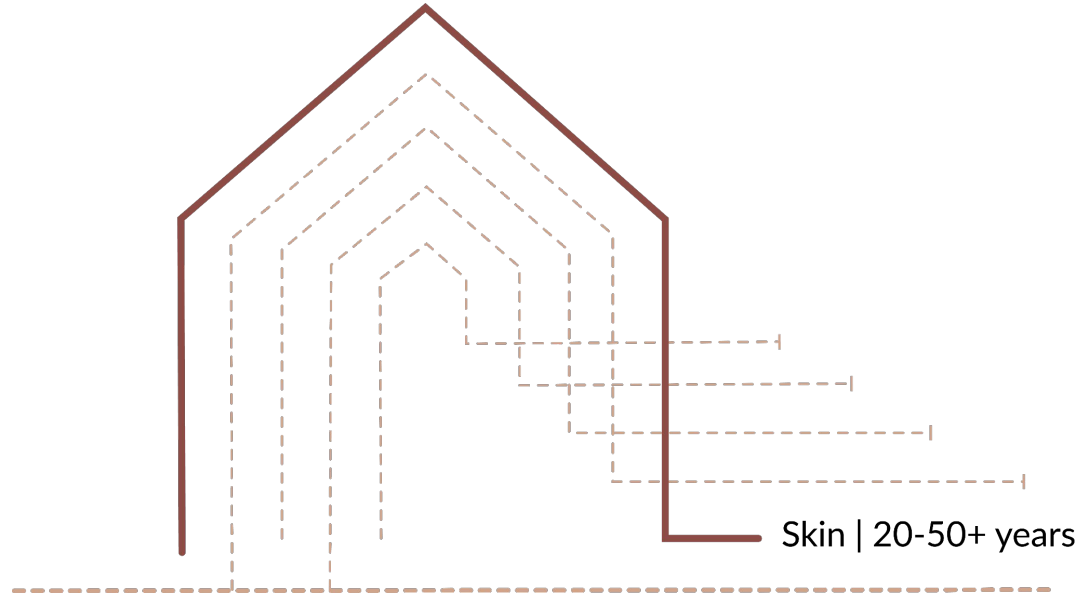


Renovation

Research & Analysis

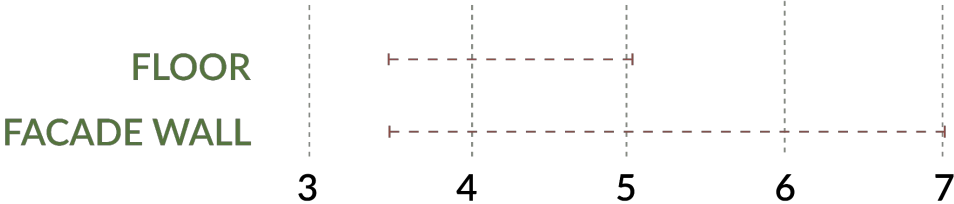






	R-value of walls
Before 1970 (1)	0.19 - 1.39
1970 (1)	1.66
2014	3.5
2015 - 2020 (2)	4.5
nZEB 2020 onwards (2)	5

Nearly Zero Energy Building | R-value Requirements



Exteriors

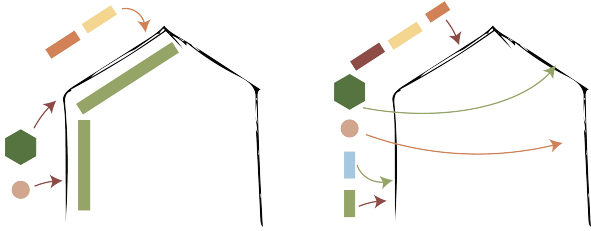


Interiors



Renovation | Renovation Methods

Design Renovation +
Combination Renovation



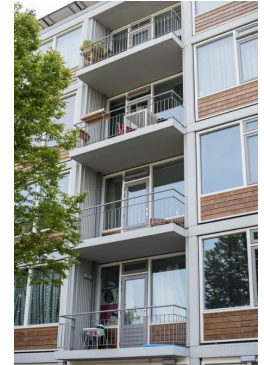
Le Lignon, CH



Park Hill, UK

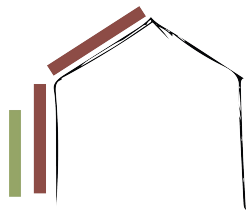


Rozemaai, BE



Camera
Obscuradreef, NL

Panel Renovation



Plug and Play



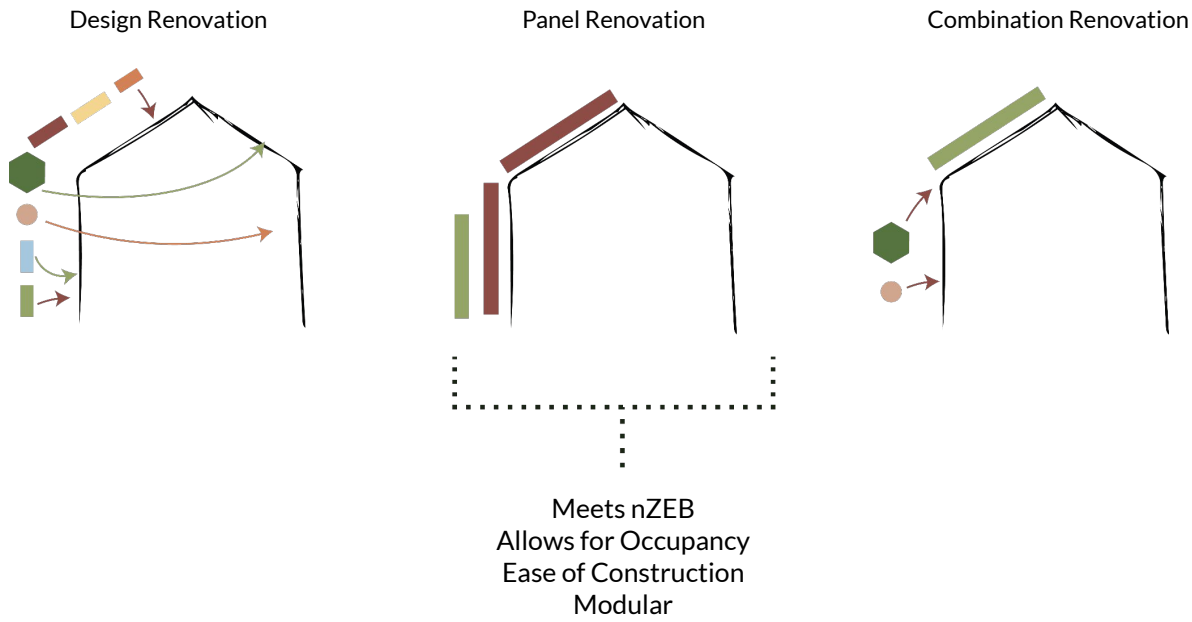
Rc Panel



BGDD Panel

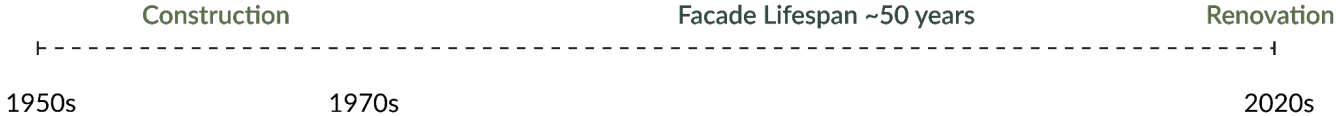
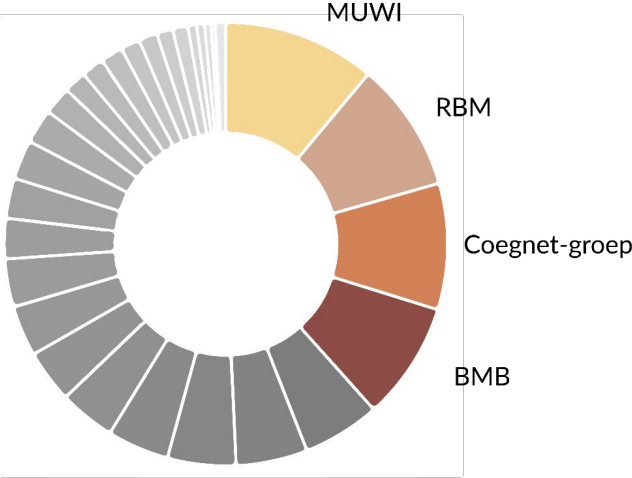


Gap3 Skin Panel

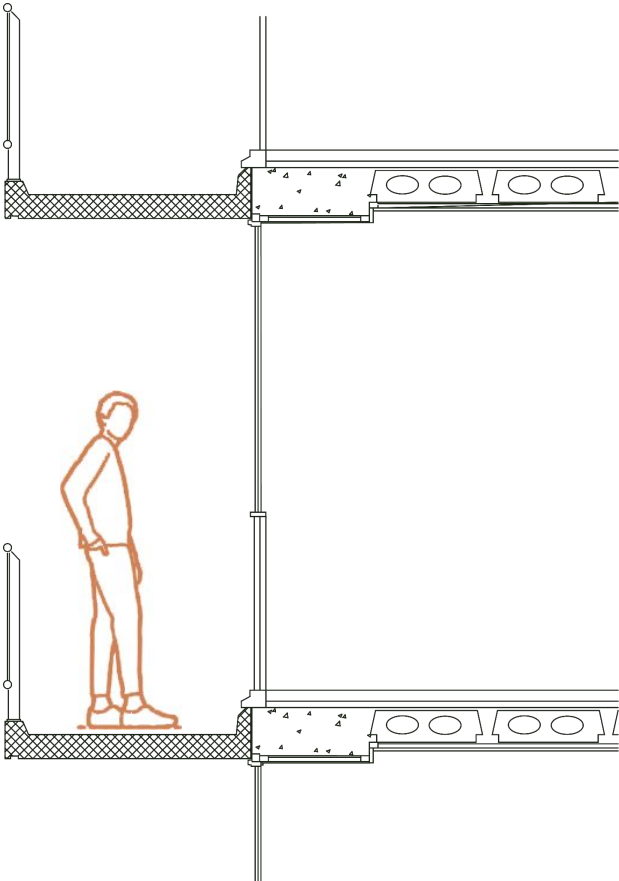
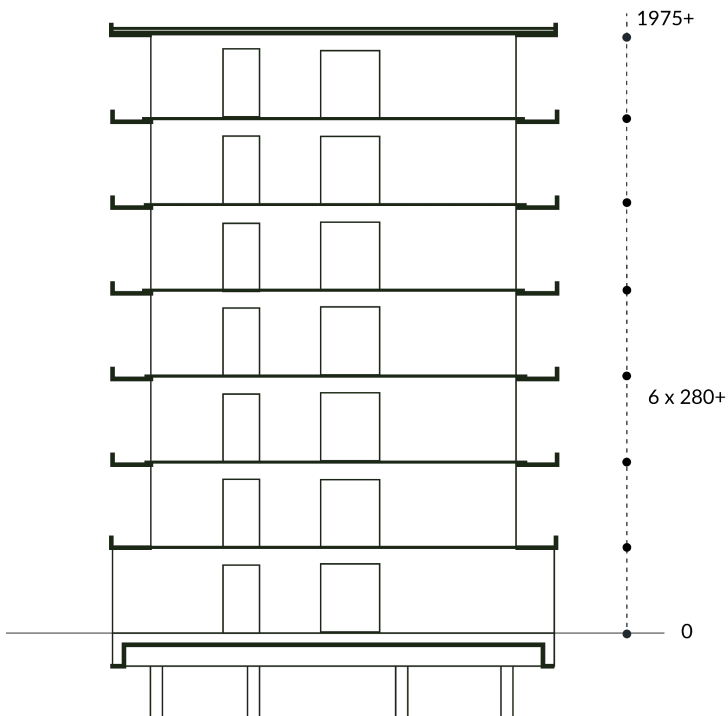


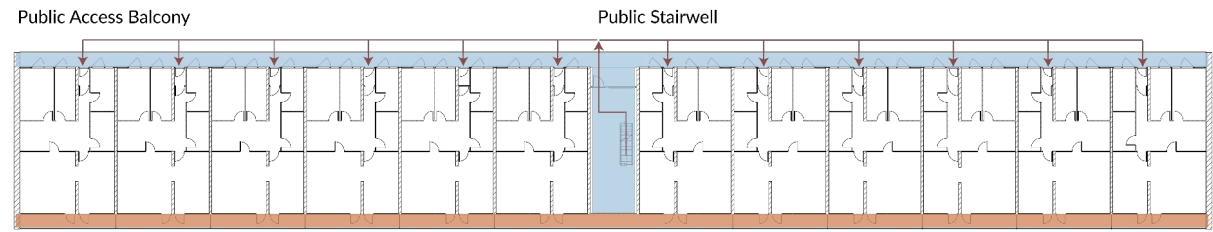
Renovation | Renovation in Netherlands





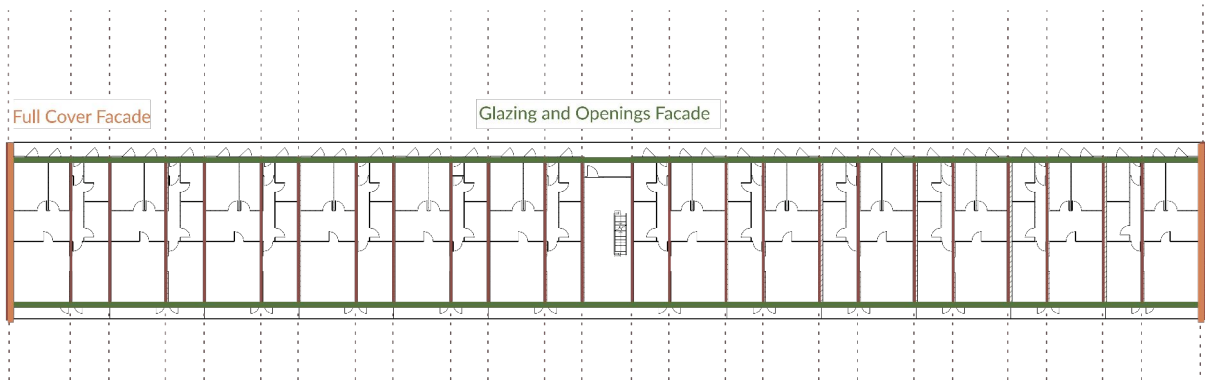


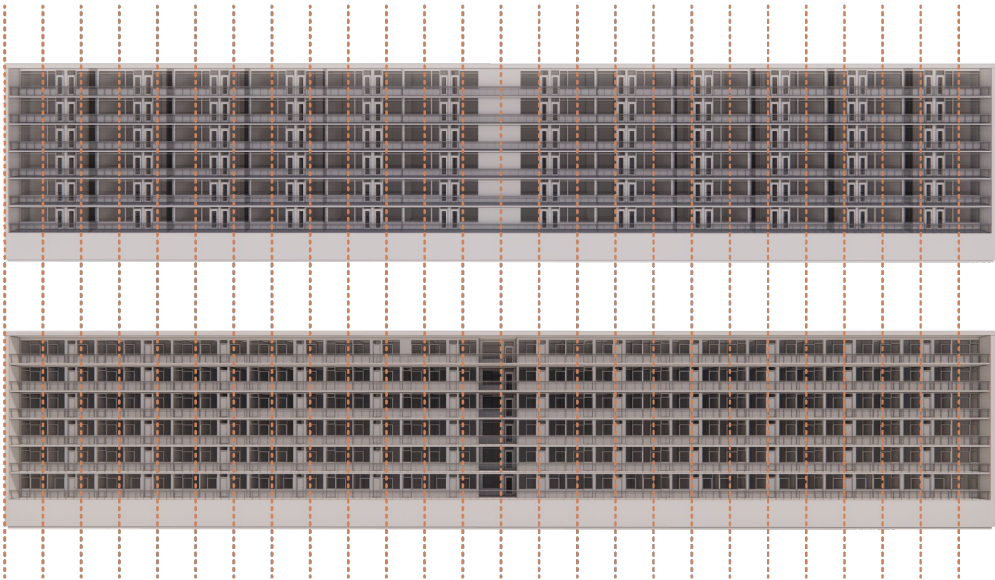
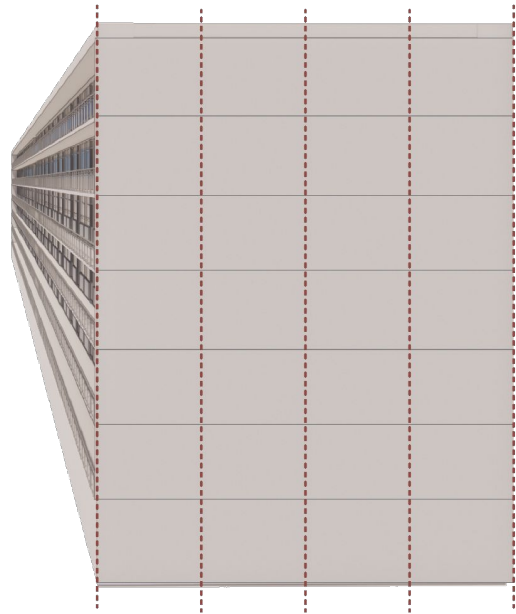




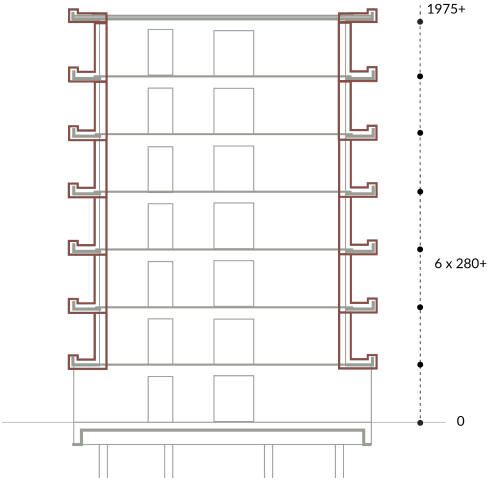
Private Balconies

Structural Elements in Existing

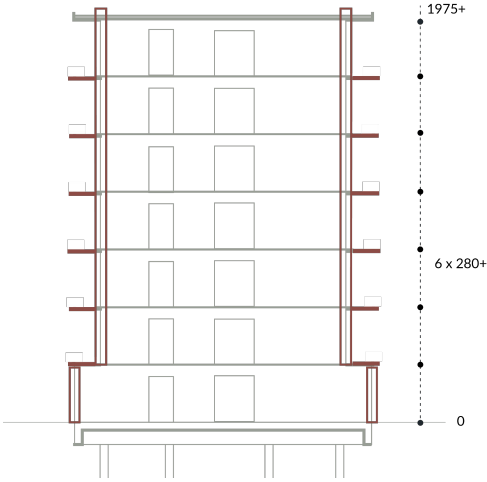




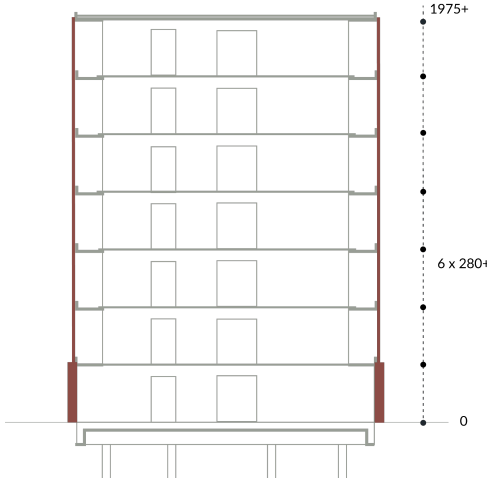
Renovation | MUWI Panel Renovation



Balcony Wrap

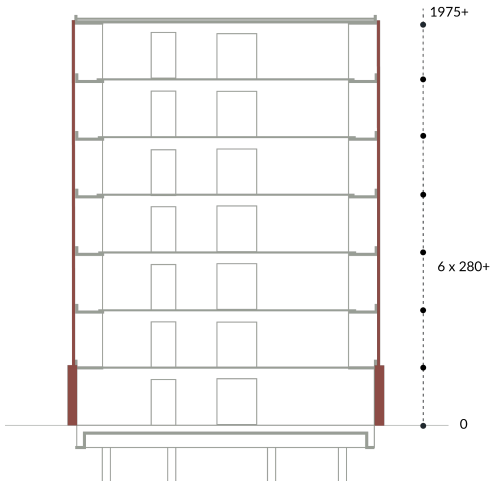
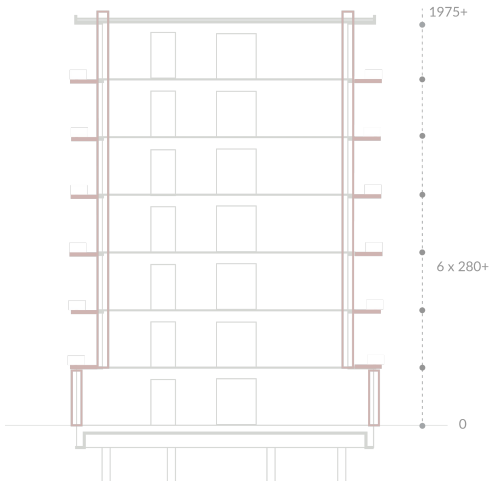
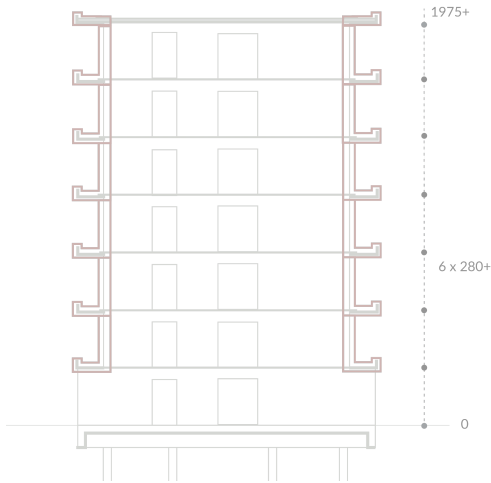


Balcony Replacement



Second Skin Facade

Renovation | MUWI Panel Renovation

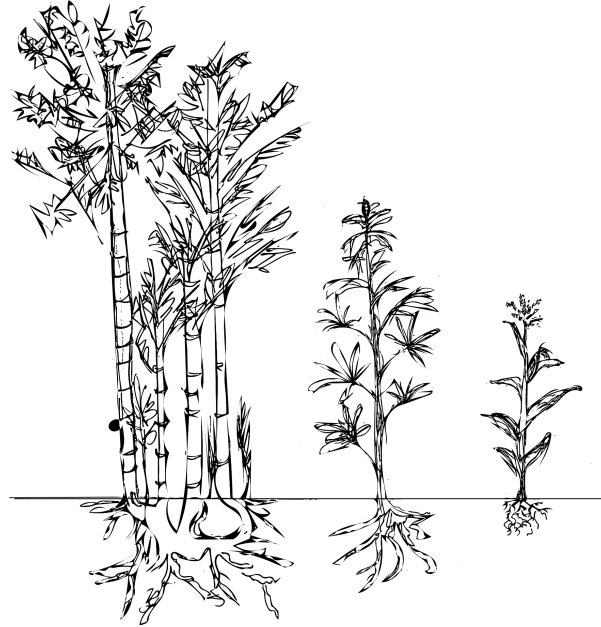


Second Skin Facade

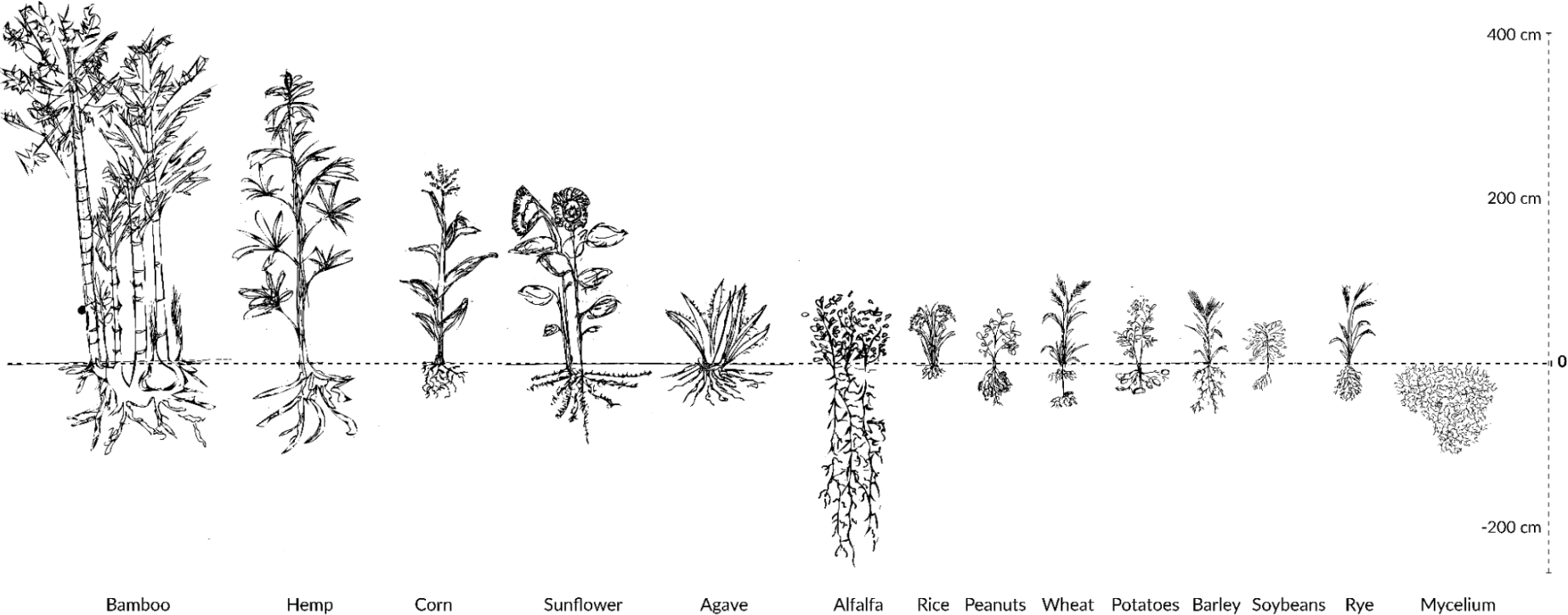
Bio-base Materials

Research & Analysis

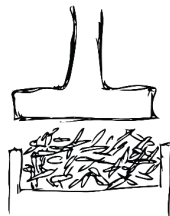
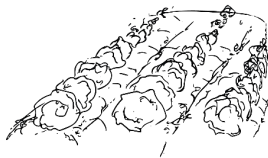
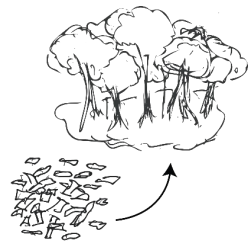
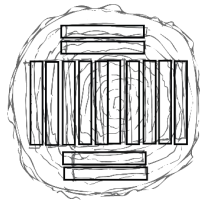




Bio-base Materials | Investigation



Bio-base Materials | Origin, Composition, Assembly, Future



Origin

Composition

Assembly

Future

Bio-base Materials | Selection

[illegible]



Rice



Barley



Flax



Wheat



Dandelions



Mycelium

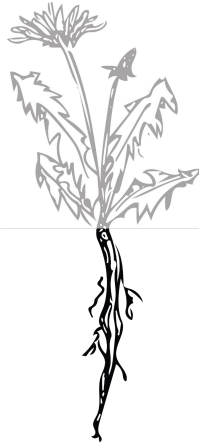


Grain

Agriculture Staple Grain
Food

Straw

Agriculture By-Product
Insulation, Facades, Particleboards



Leaves and Flowers

Crop Residue
particleboard, insulation

Roots

Natural Rubber
Sealant



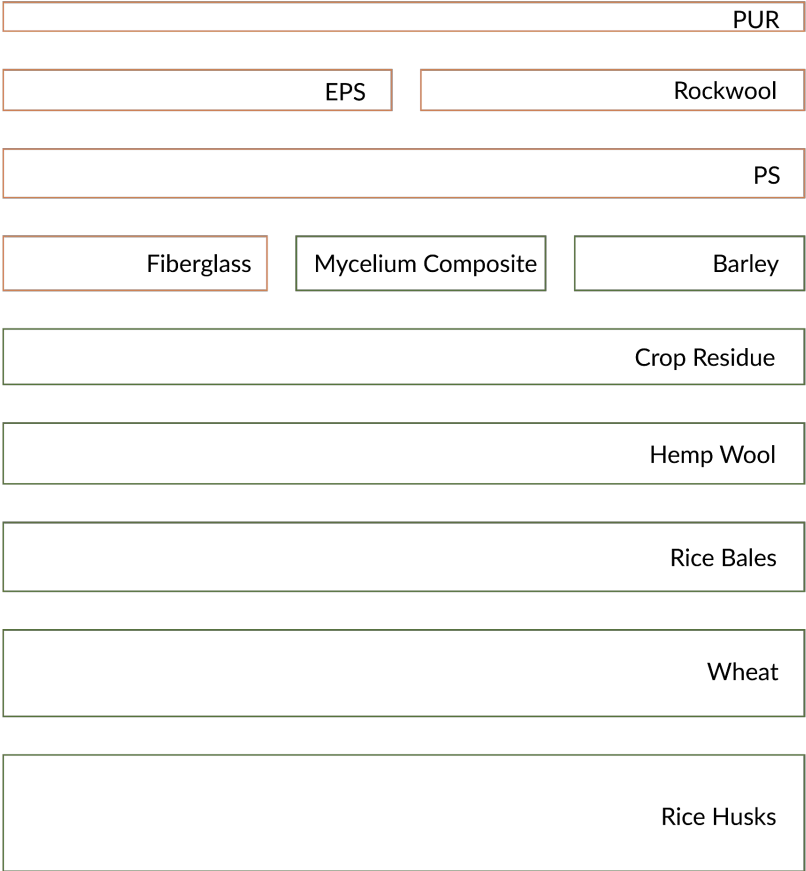
Mushroom

Funghi
Food

Roots

Mycelium
Adhesive in straw composite

R-value 7



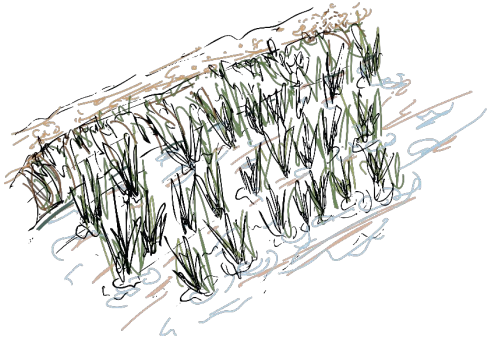
Processed Materials

Bio-base Materials

Controlled Environment Agriculture

Research & Analysis





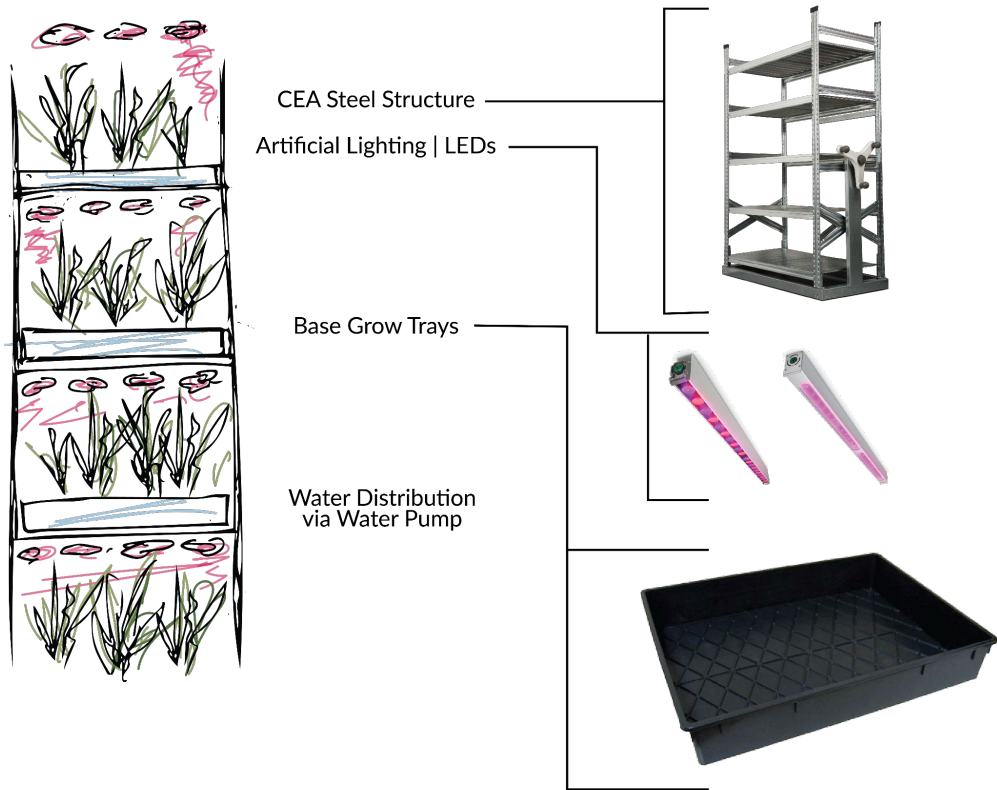
Open Field

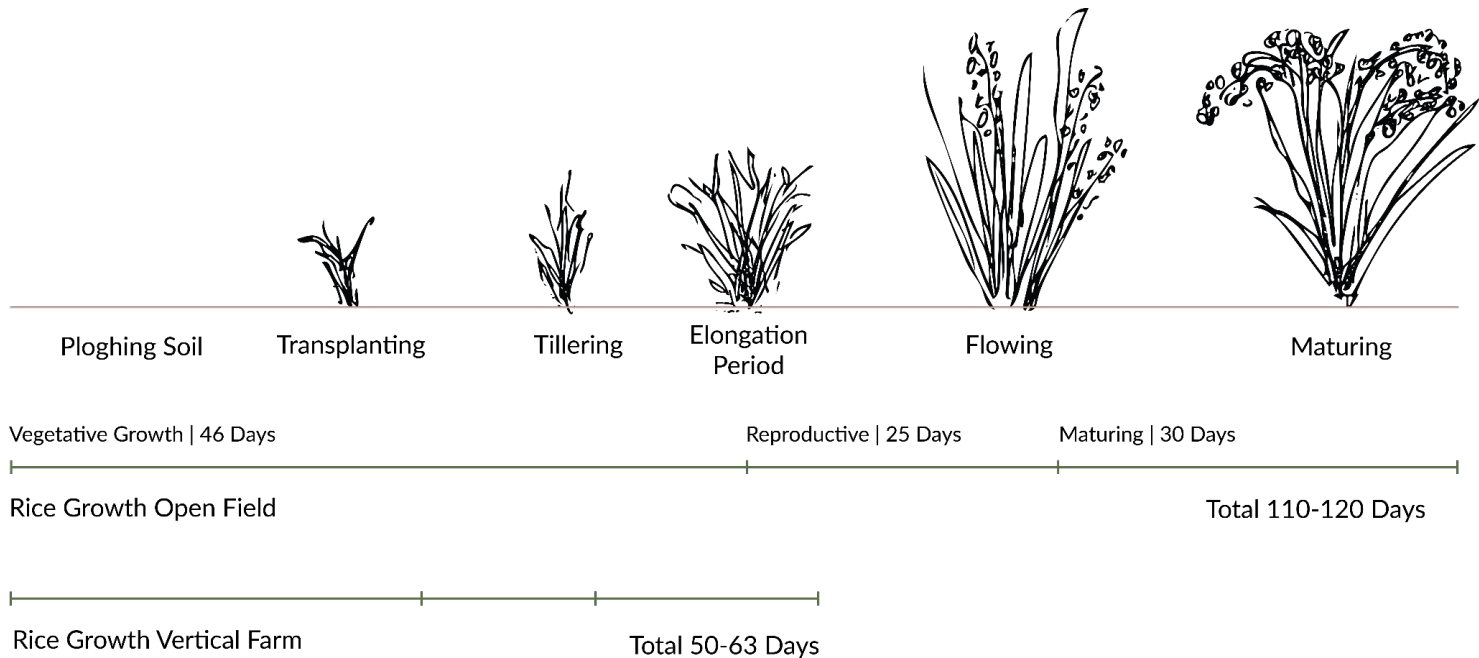


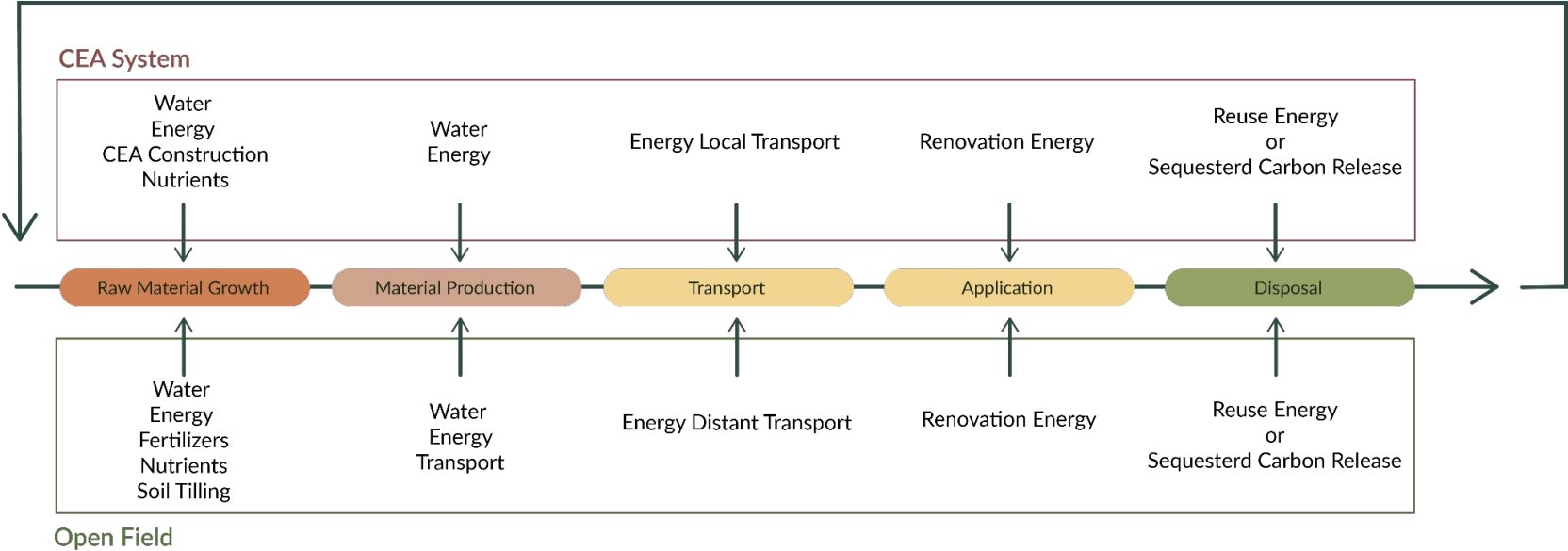
Controlled Environment Agriculture



CEA | Vertical Farm Components



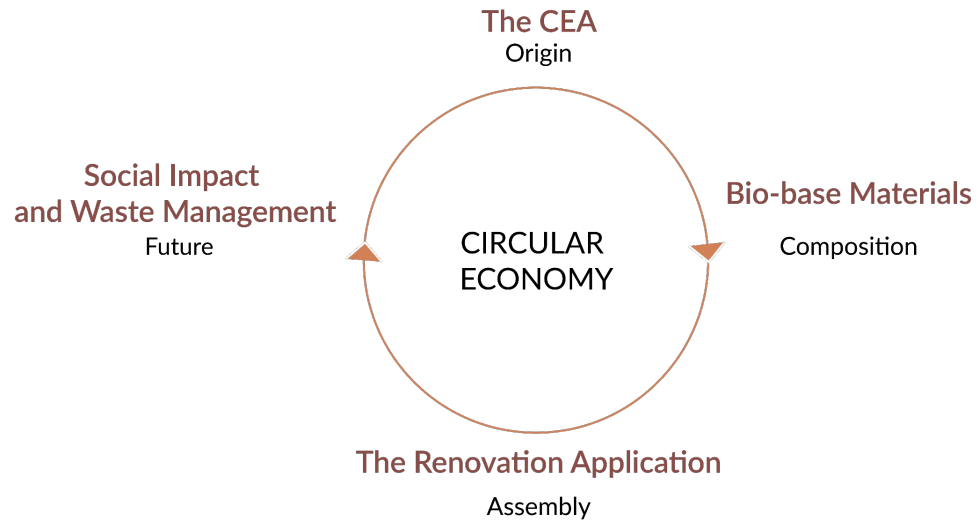




Design

Circular Design





ORIGIN |



Rice



Barley



Flax



Wheat

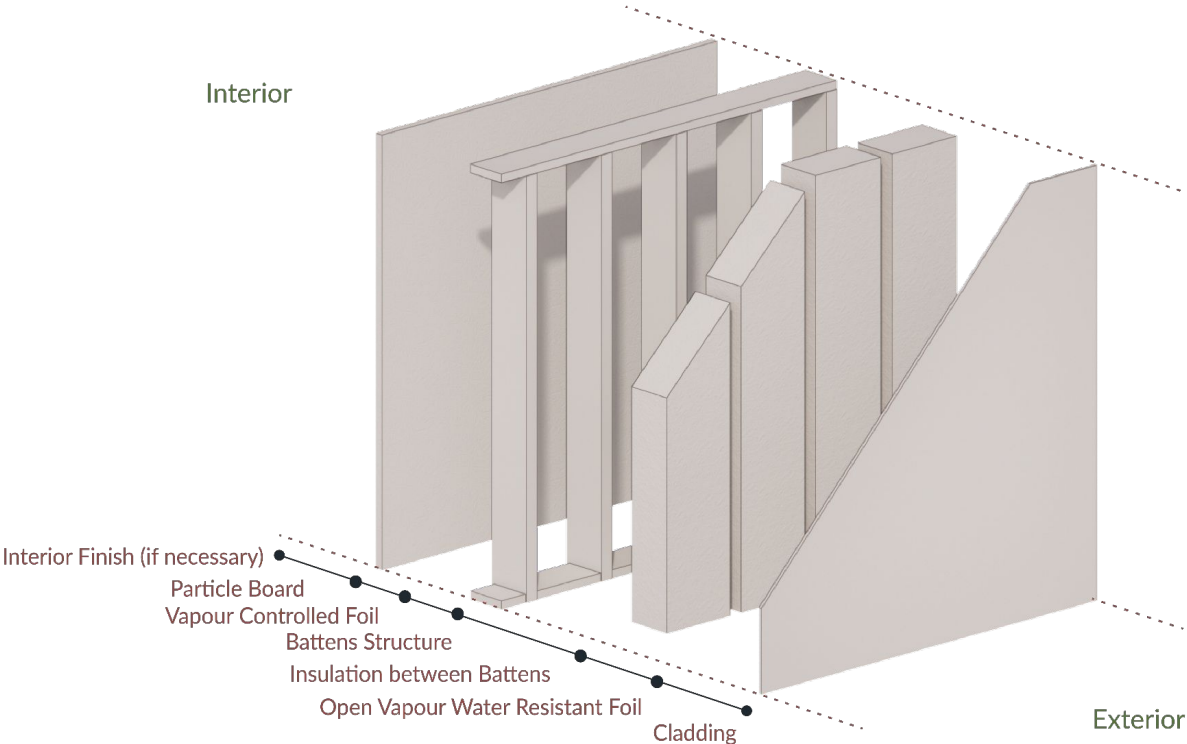


Dandelions



Mycelium

COMPOSITION |



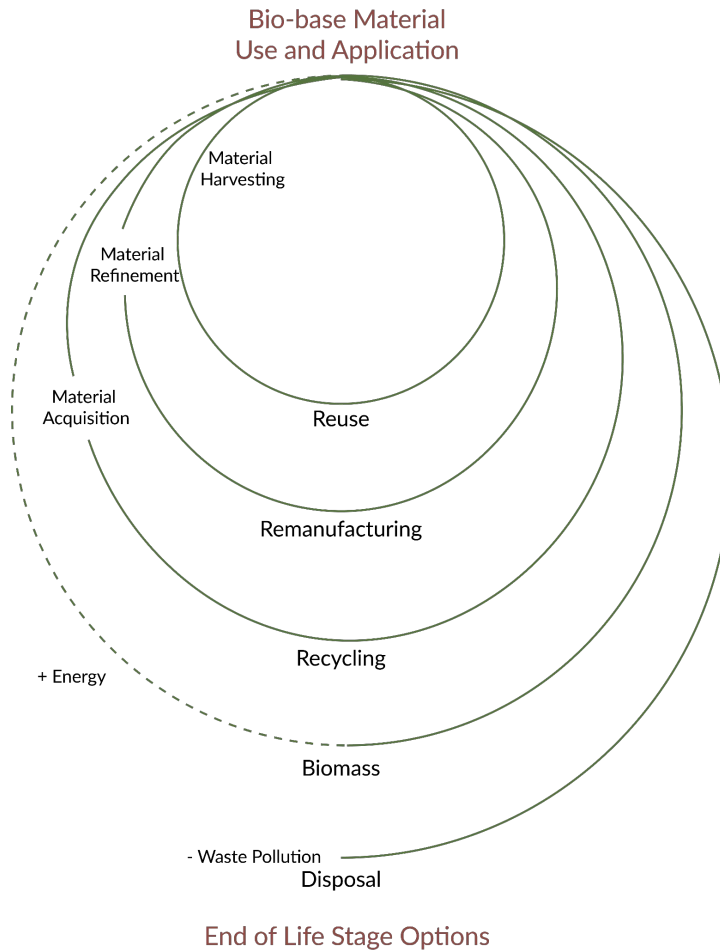


Barley

Flax

Rice

Mycelium and Timber



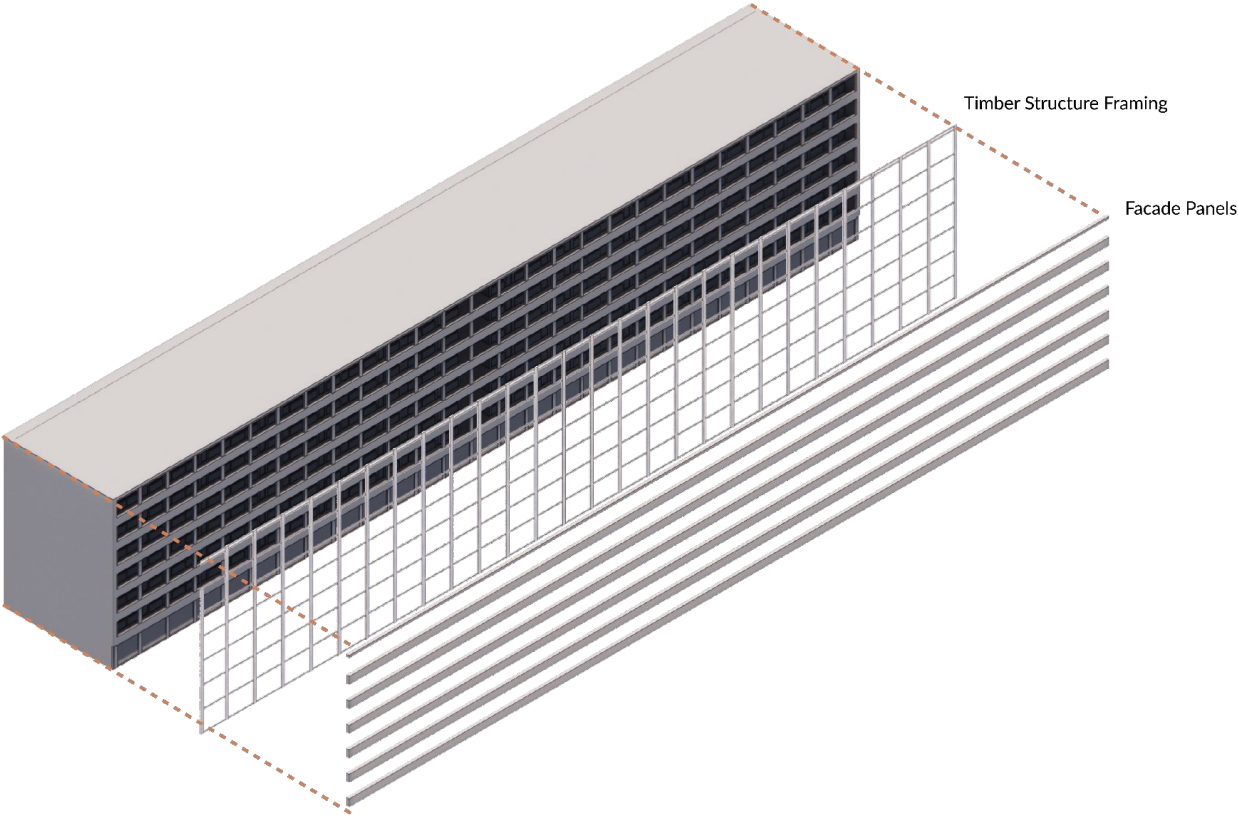
Assembly

Circular Design

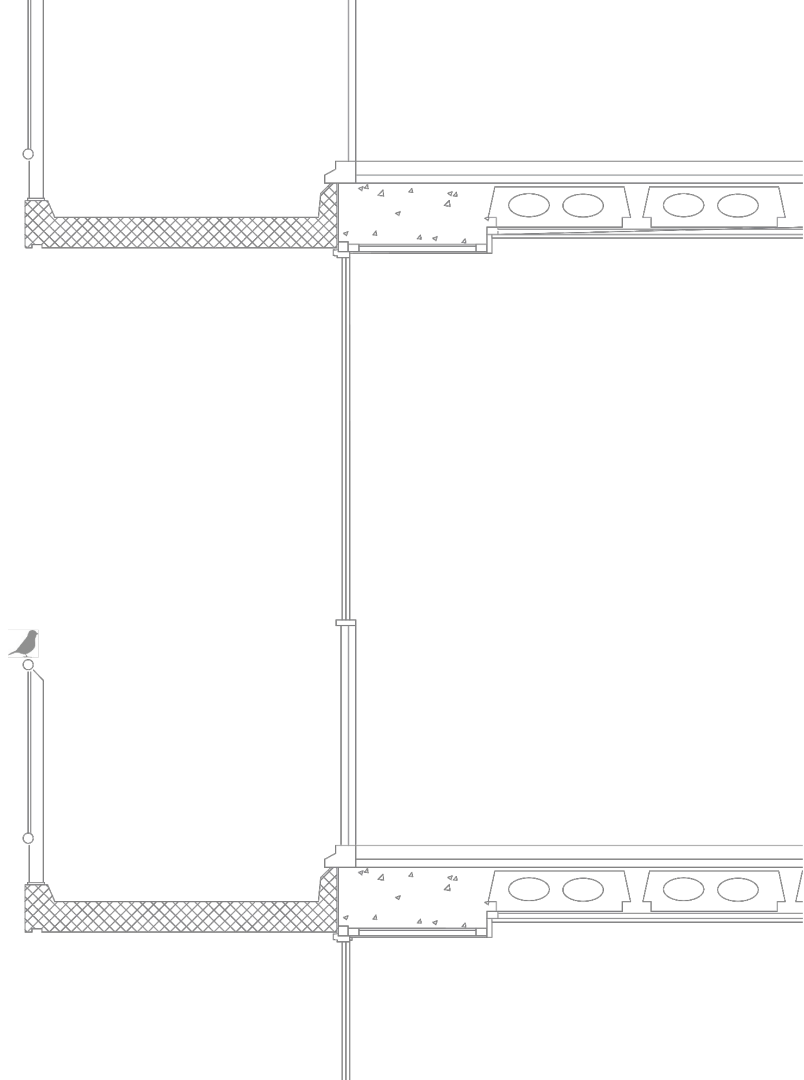




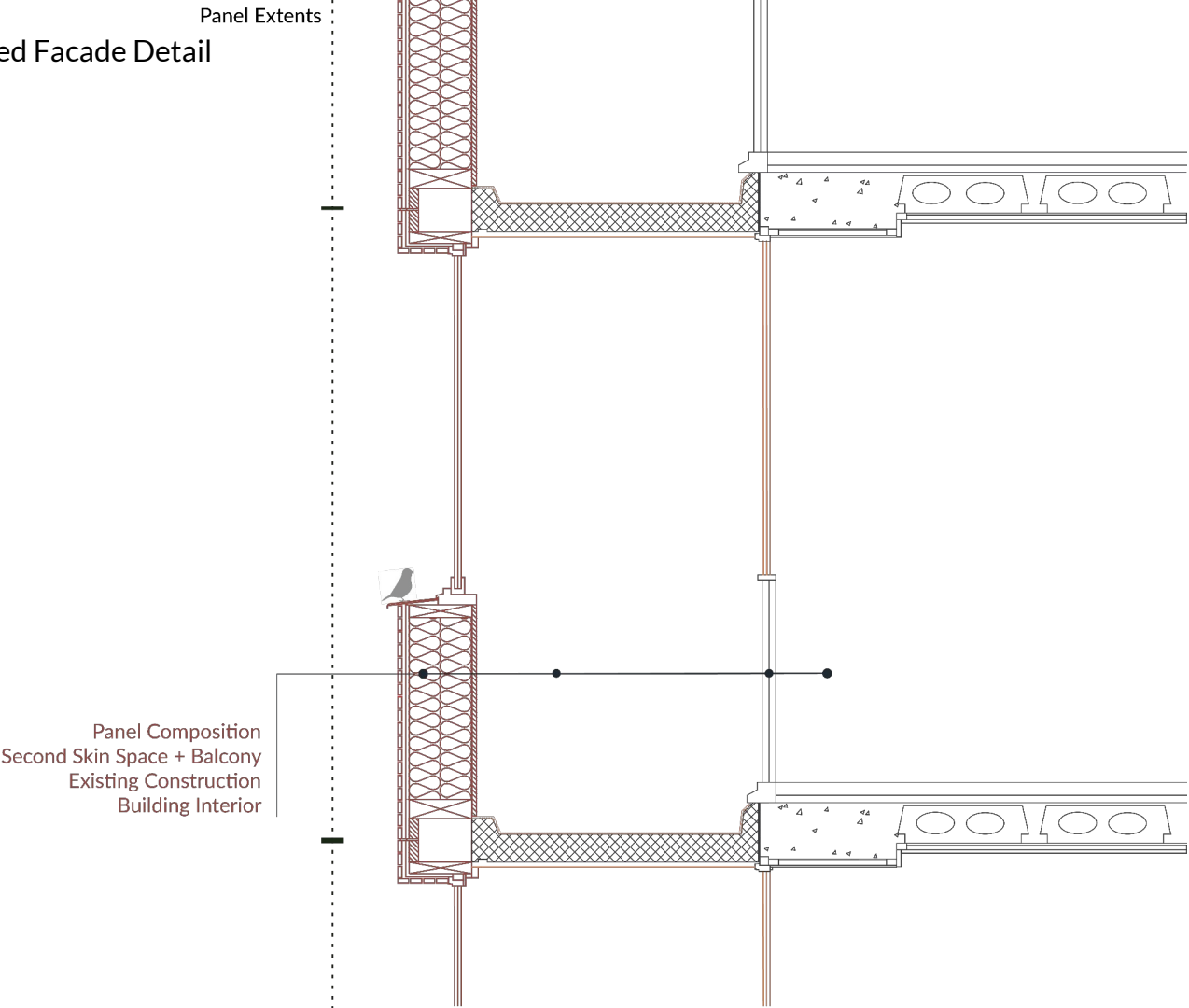
ASSEMBLY | Glazed Facade



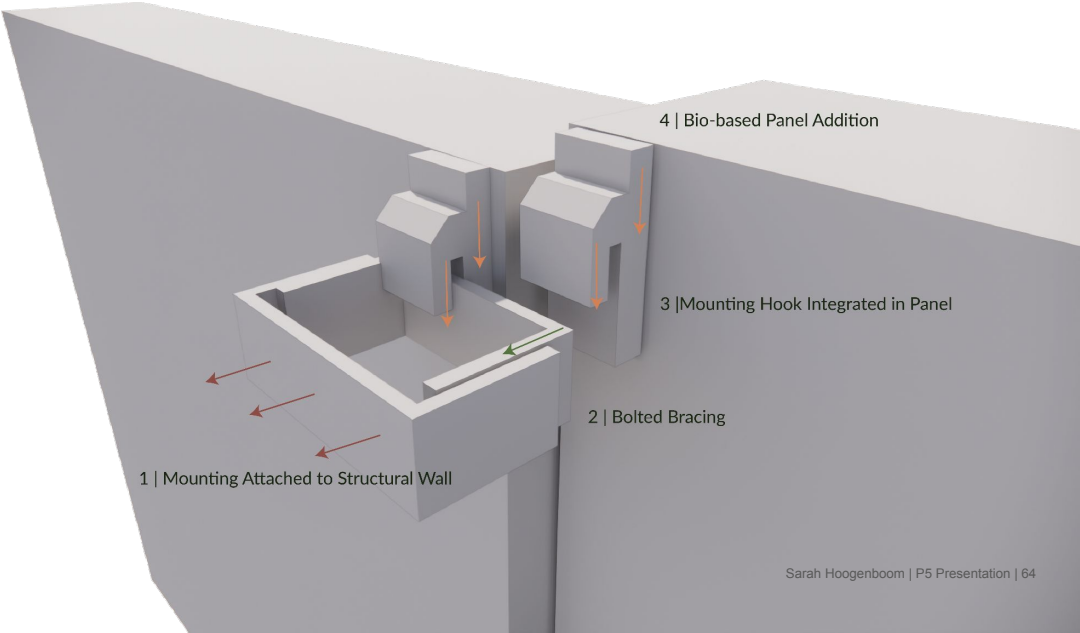
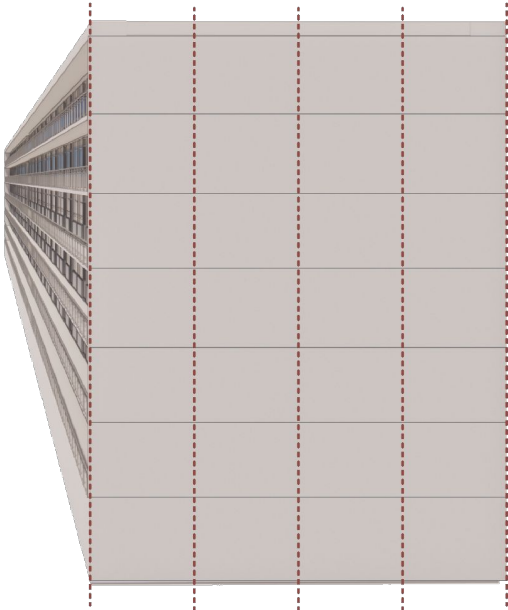
ASSEMBLY | Glazed Facade Detail



ASSEMBLY | Glazed Facade Detail



ASSEMBLY | Full Cover Facade



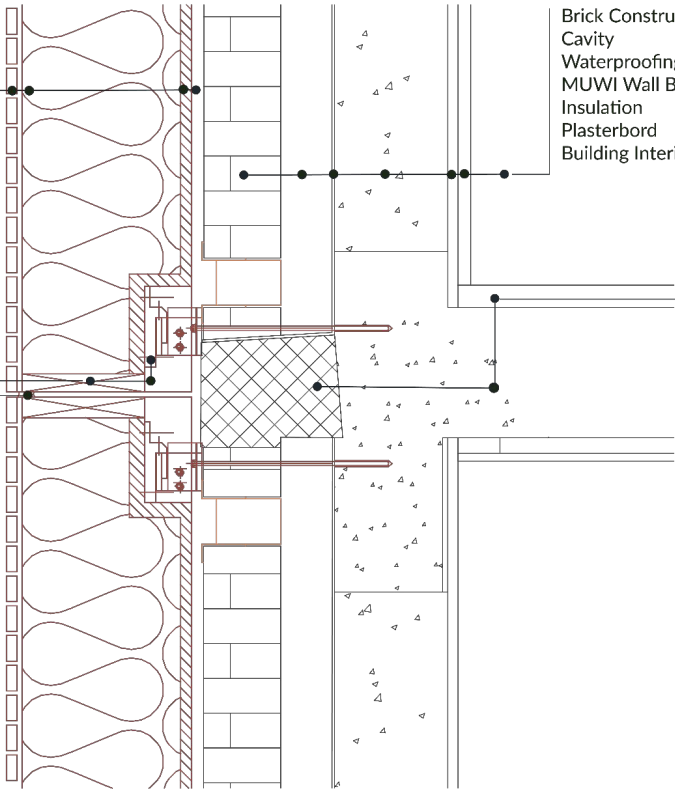
ASSEMBLY | Full Cover Facade Detail

Proposed Full Cover Facade Solution

Cavity + Vapour Control
6cm Rice Particle Board
28cm Baley Bale Insulation
Open Vapour Foil
1cm Rice Cladding
Building Exterior

Hanging Mounting System
Mounting Cavity
Timber Batten Frame

Between Panels 1cm
Dandelion Waterproofing



MUWI Existing Exterior Walls

Brick Construction
Cavity
Waterproofing finish
MUWI Wall Blocks
Insulation
Plasterbord
Building Interior

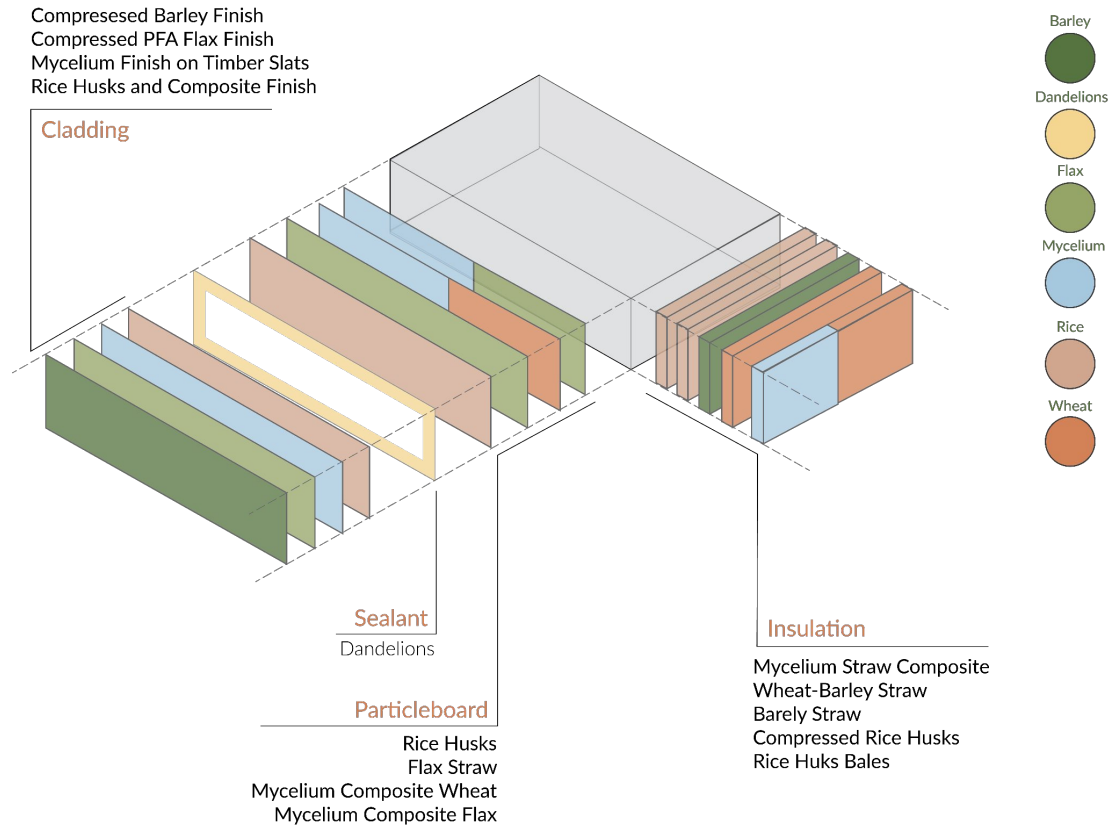
MUWI Existing Flooring
Prefabircated Concrete Section
Poured Gravel Concrete
Preabricated Flooring Blocks

Composition

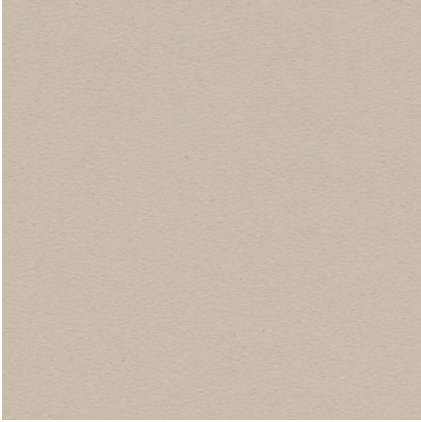
Circular Design



COMPOSITION | All Bio-base Materials



COMPOSITION | Facade Materials



Barley



Flax



Rice

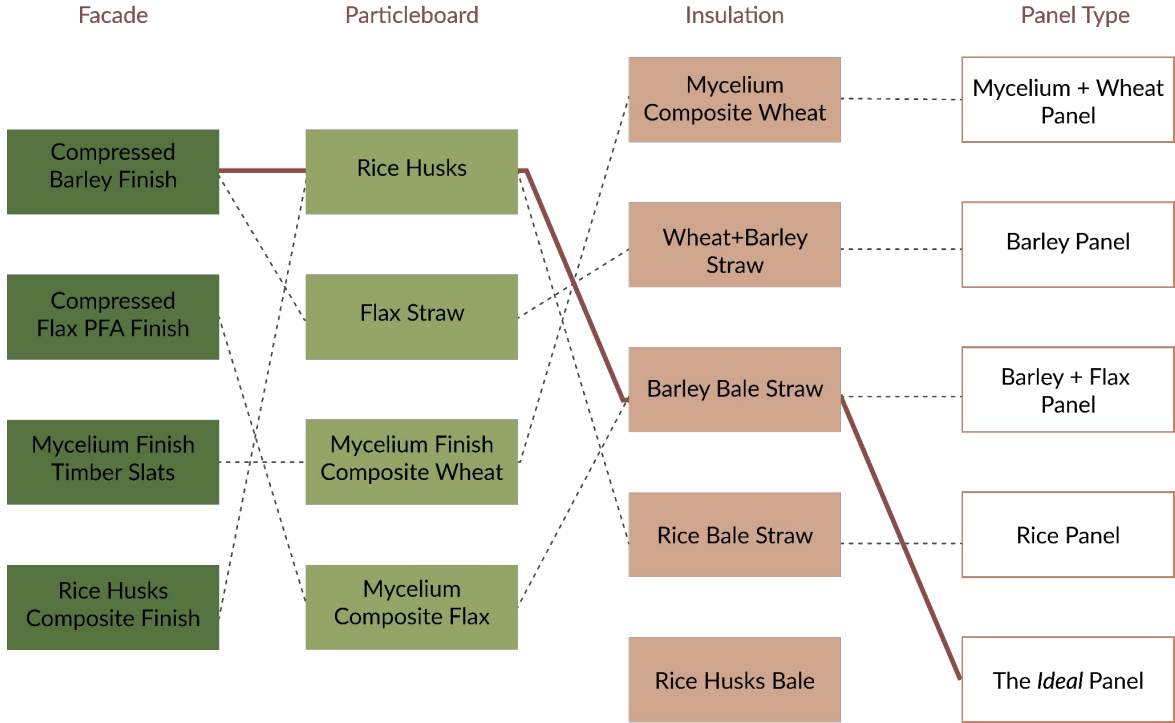


Mycelium and Timber

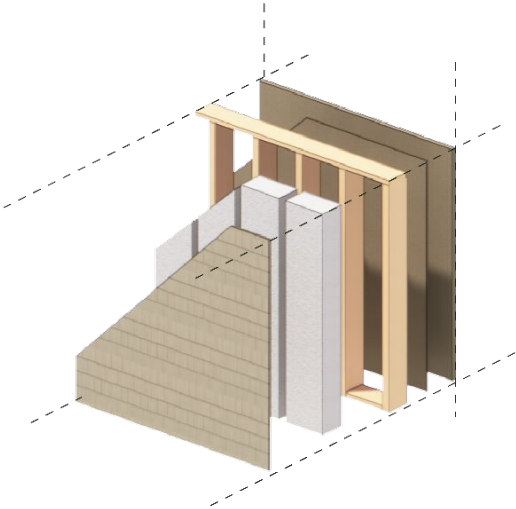
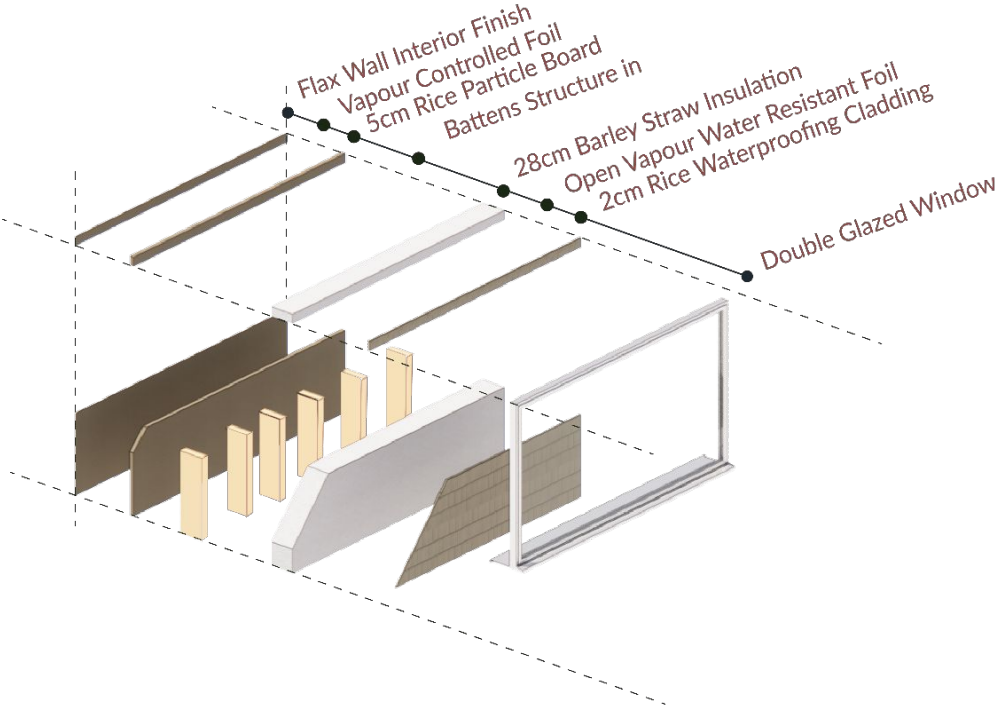
COMPOSITION | Insulation Materials



COMPOSITION | Design Material and Panels



COMPOSITION | Selected Panel

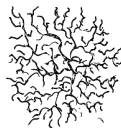


Origin

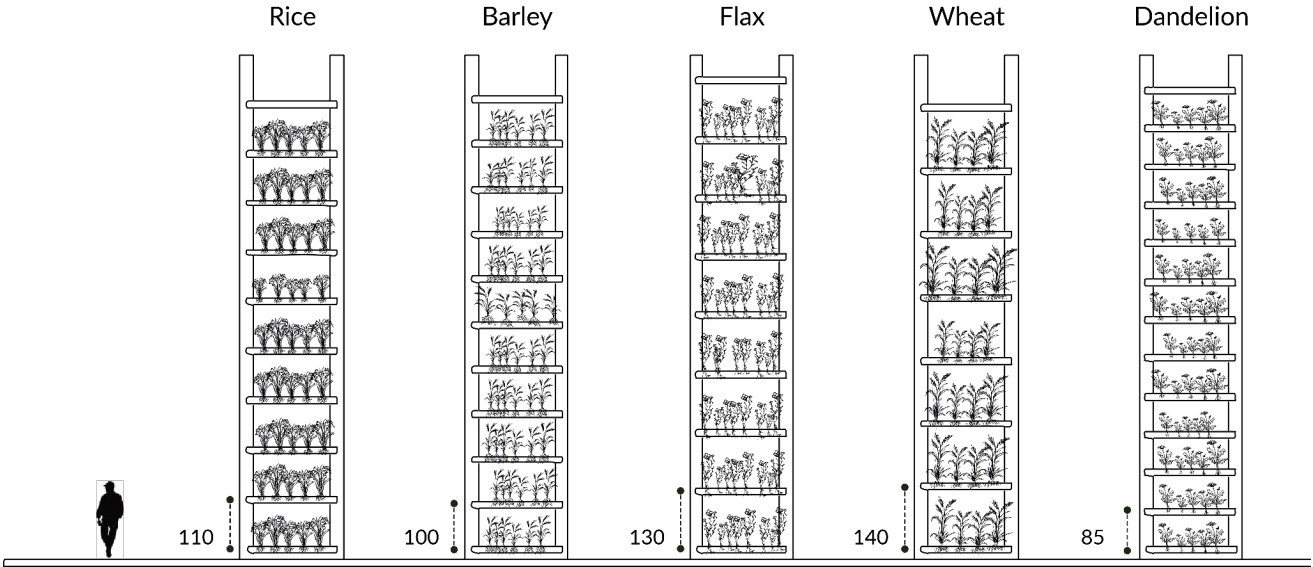
Circular Design



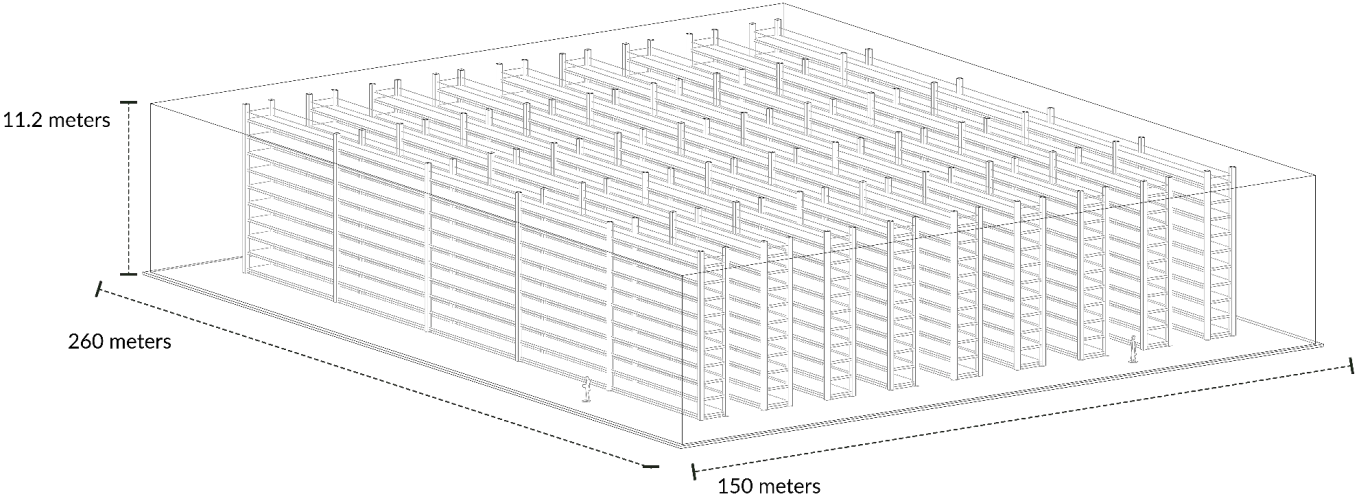
ORIGIN | Background Materials



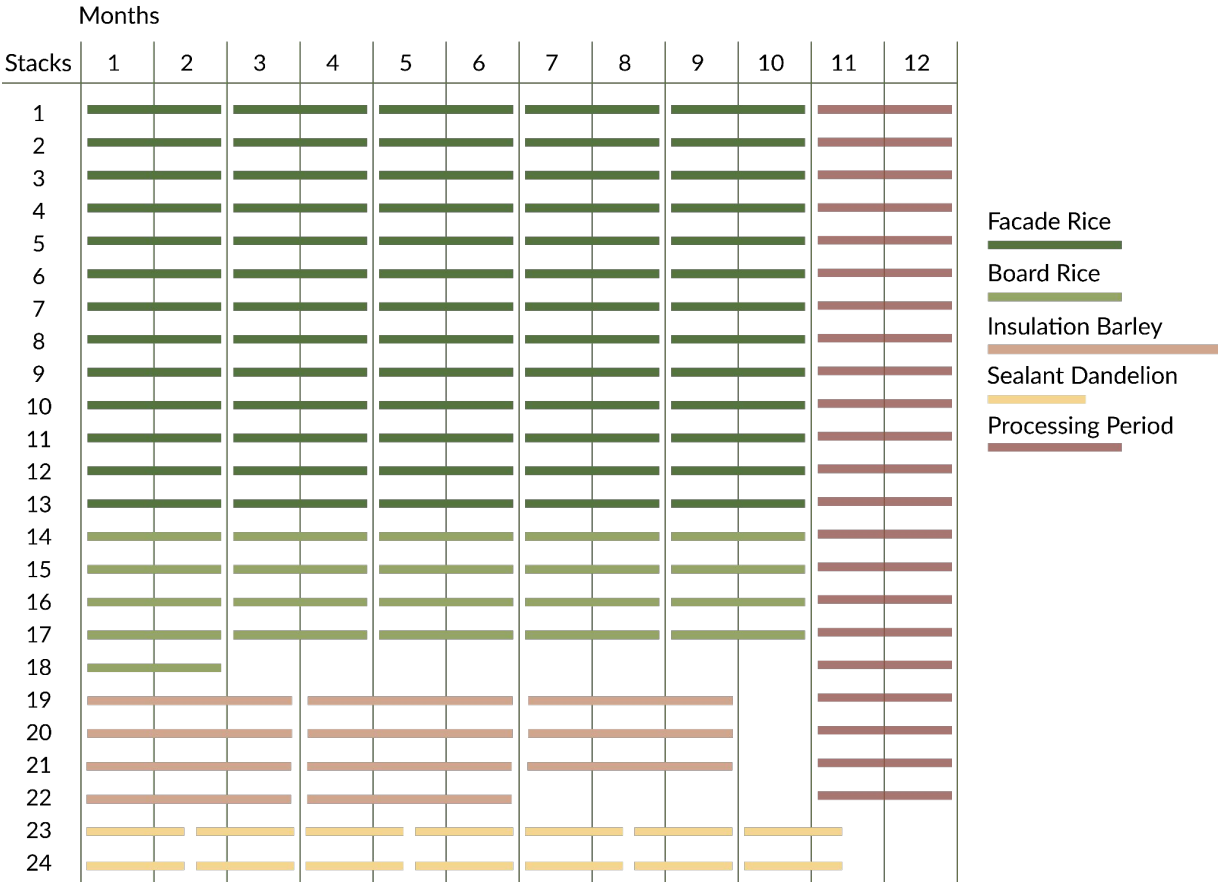
Harvests (per year)	6	4	4	5	7	6
Growing Height (cm)	70	60	90	100	45	Panel Based
Harvest Grain Index (%)	33%	28%	55%	31%	-	-
Component	Straw	Straw	Straw	Straw	Root Residue	Fungus Growth

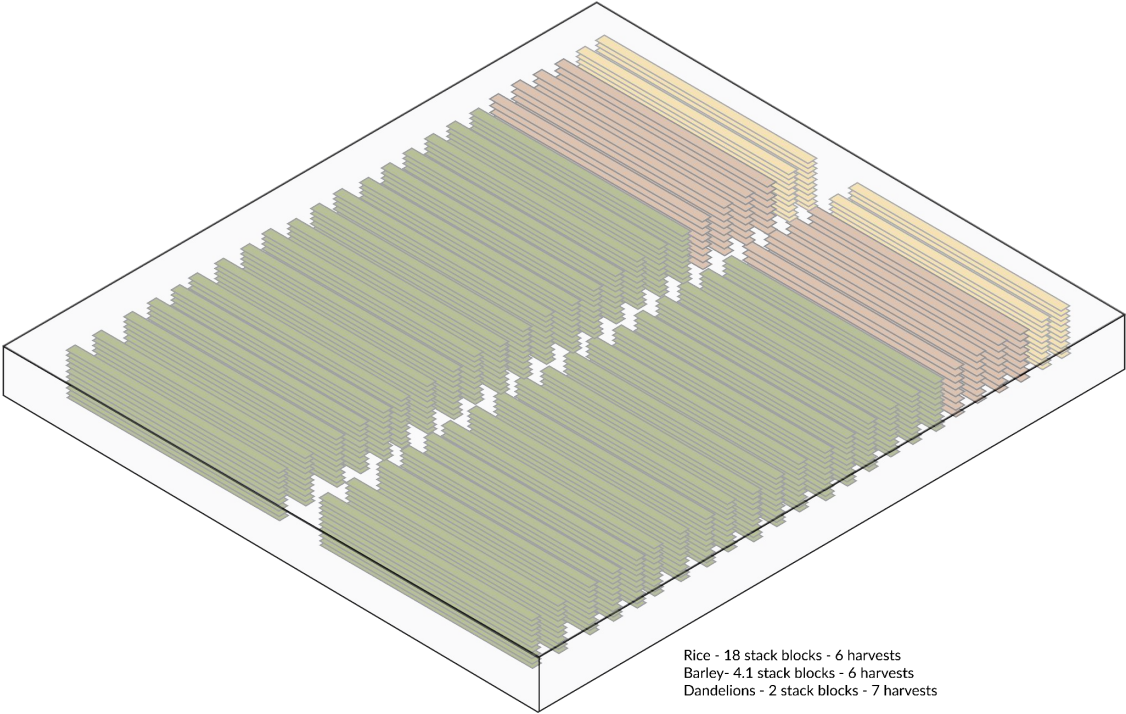


Plant Height + 40 cm = Tier Height



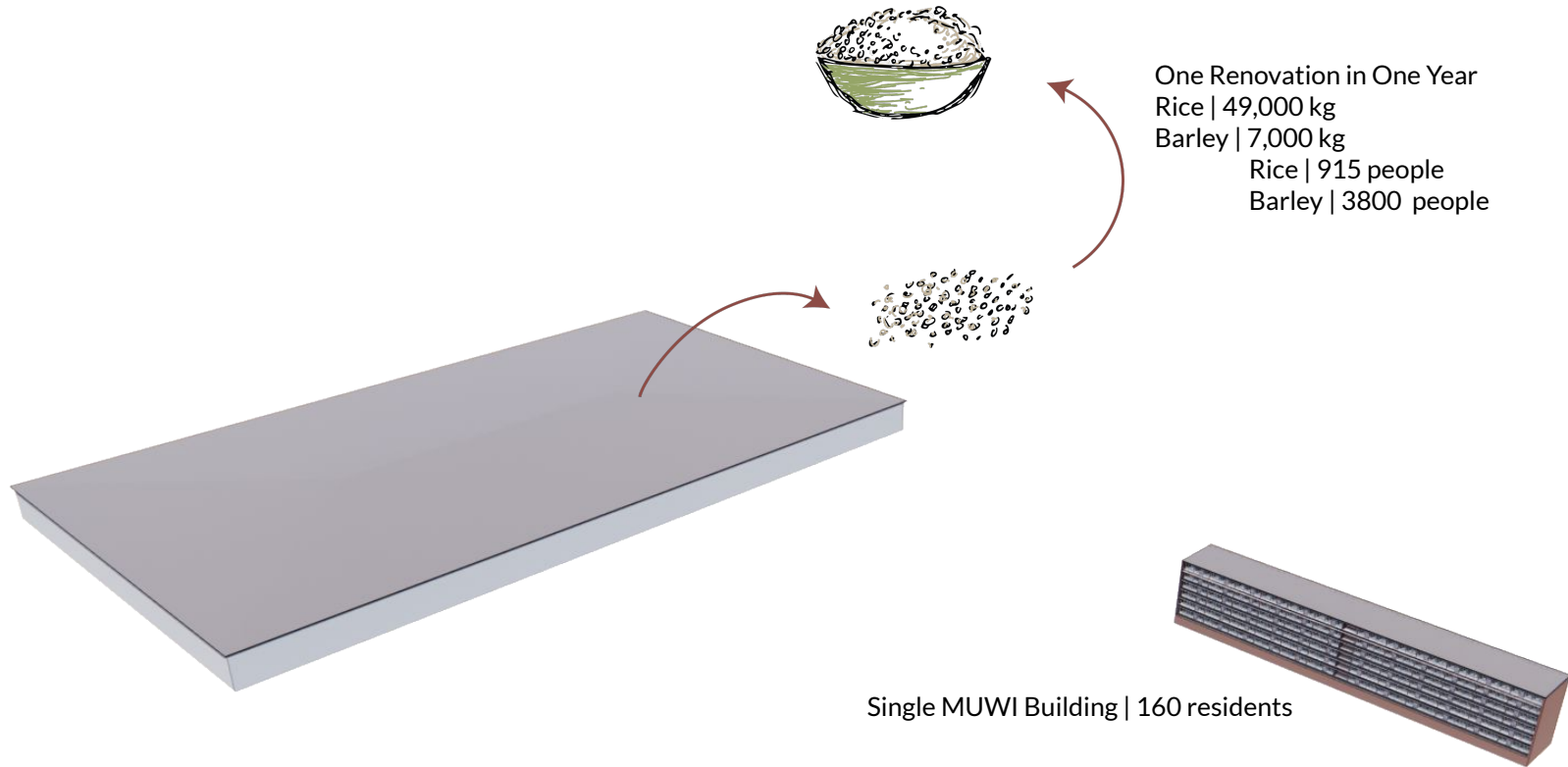
ORIGIN | Harvesting Schedule

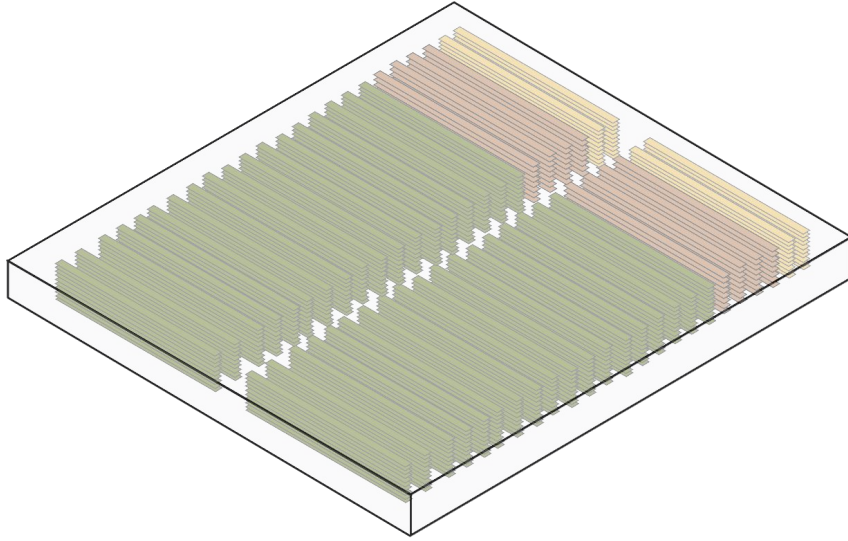




Future Circular Design

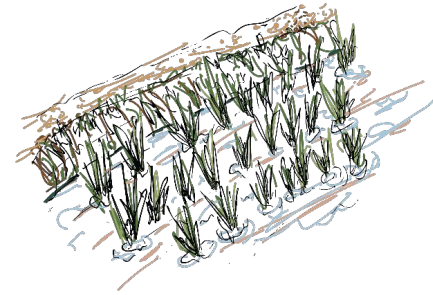






1 CEA Construction | 0.03 km²

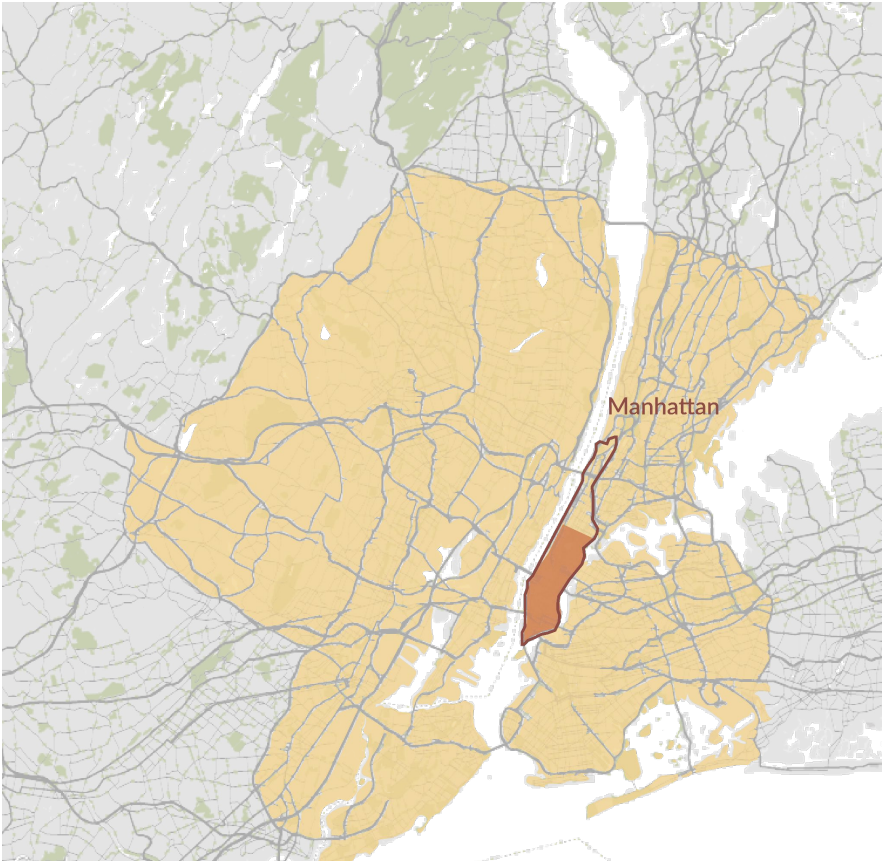
4.5 Futbol Fields

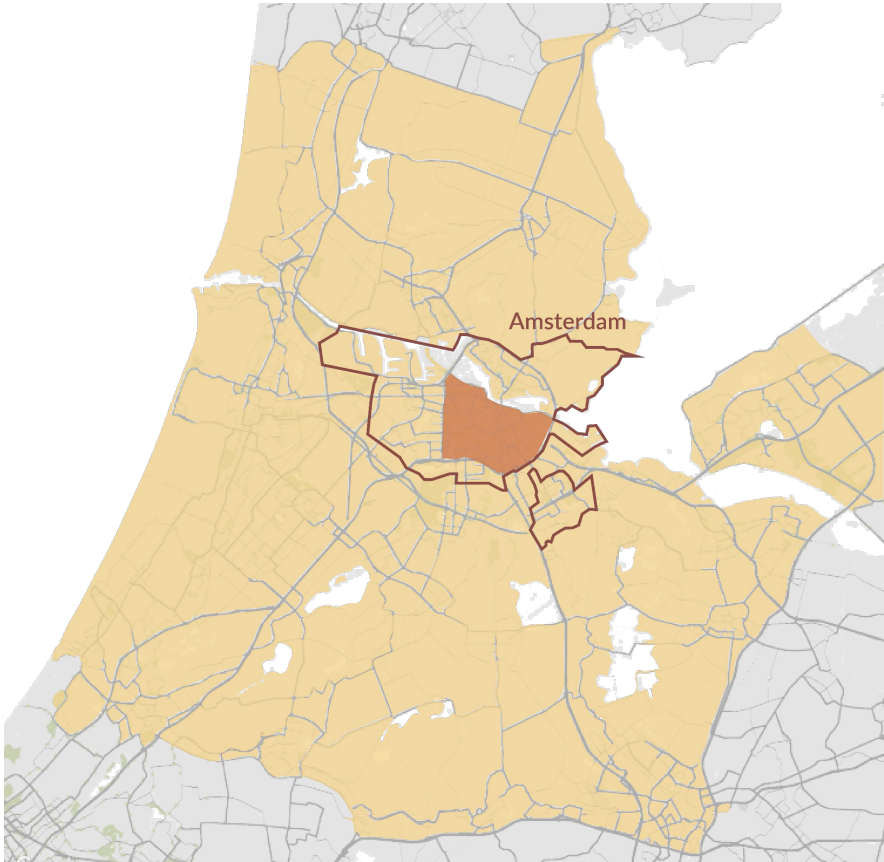


1 Open Field | 1.9 km²

260.5 Futbol Fields

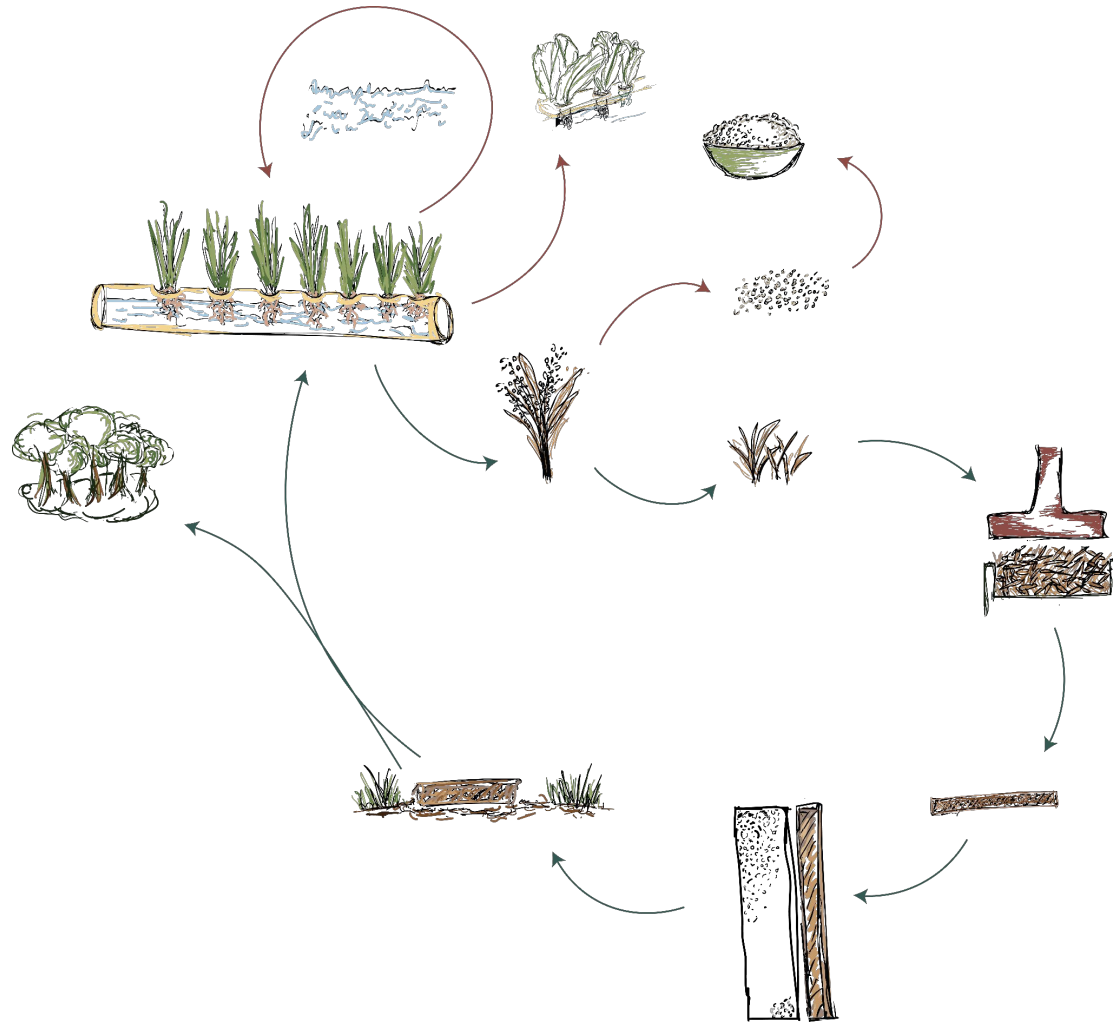




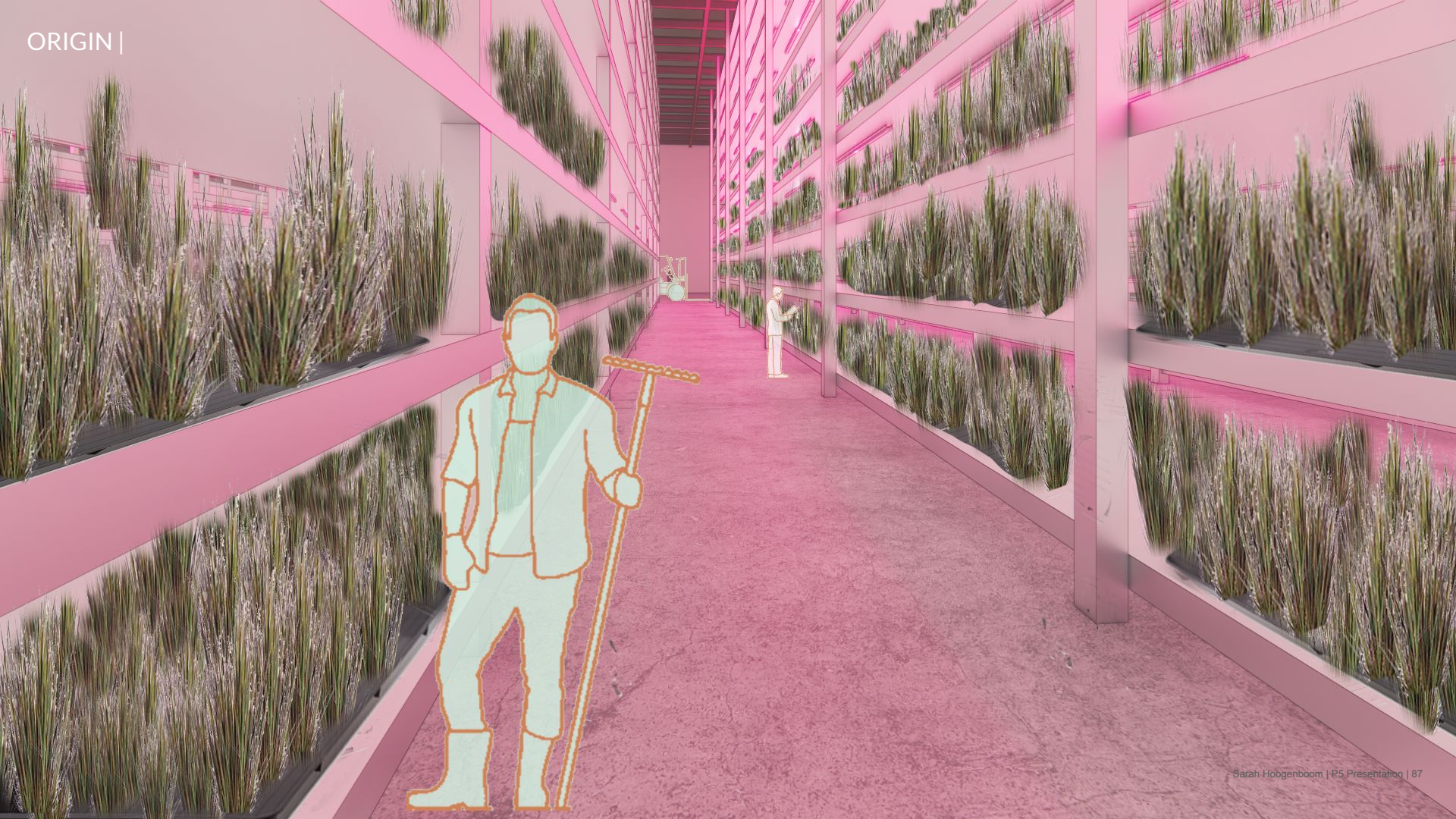


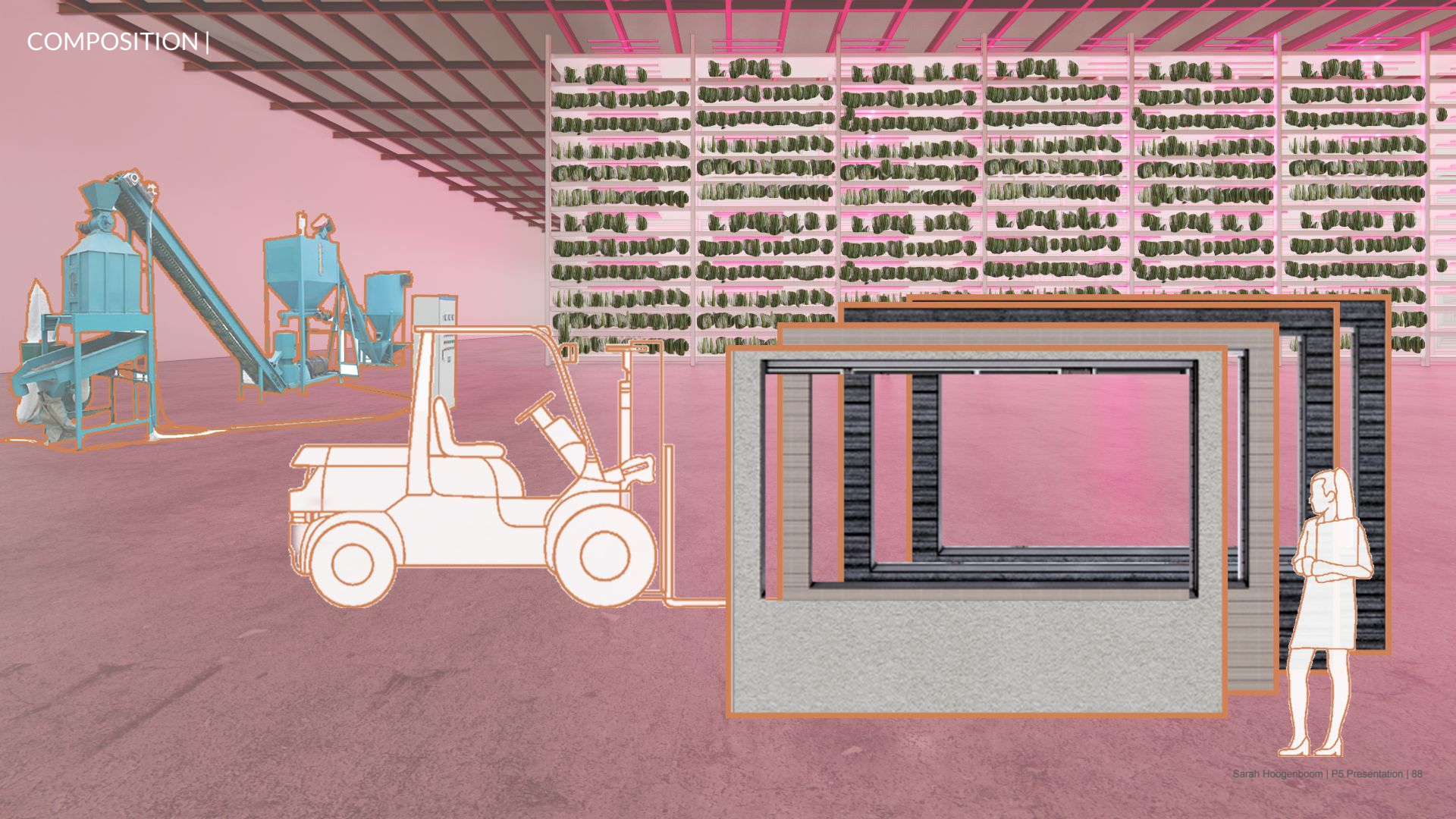
Urban Story











ASSEMBLY |



FUTURE



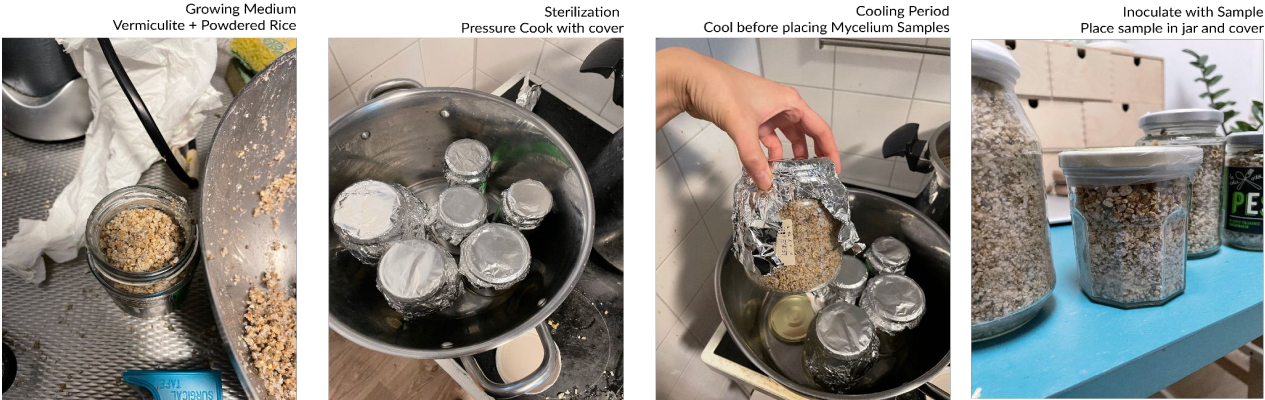
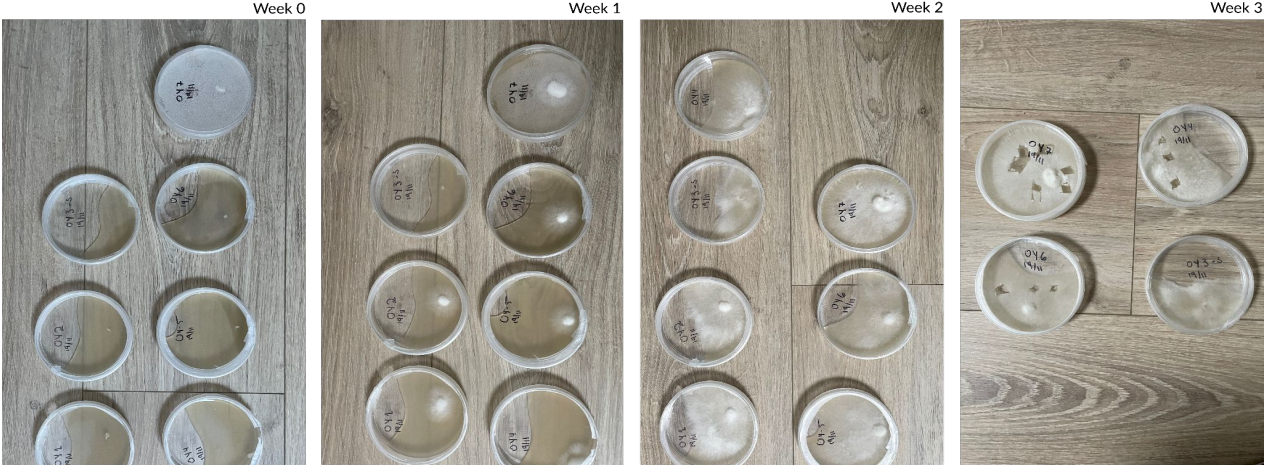
Conclusions & Reflection



Conclusion



Conclusion



Conclusion



Reflection



Thank you

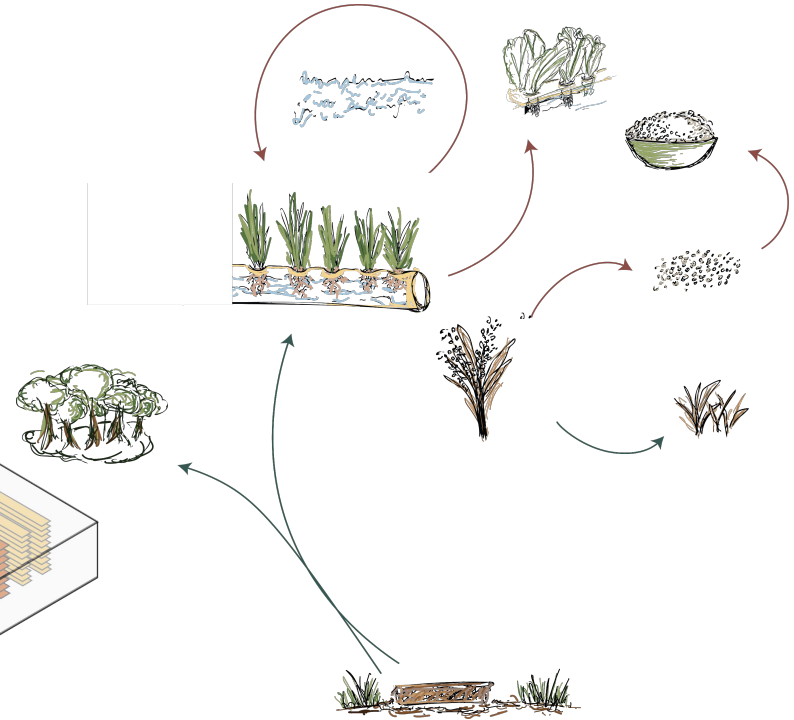
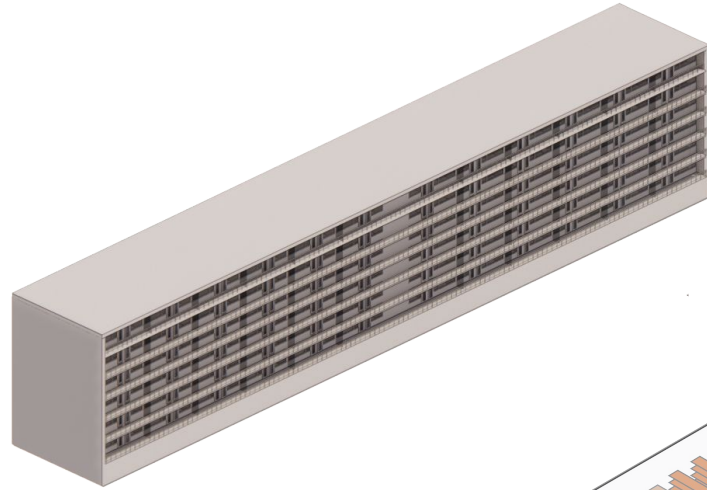


Conclusion





ORIGIN



Rice - 18 stack blocks - 6 harvests
Barley- 4.1 stack blocks - 6 harvests
Dandelions - 2 stack blocks - 7 harvests



