Advanced School of Architecture / ASA

Director Pierre-Alain Croset

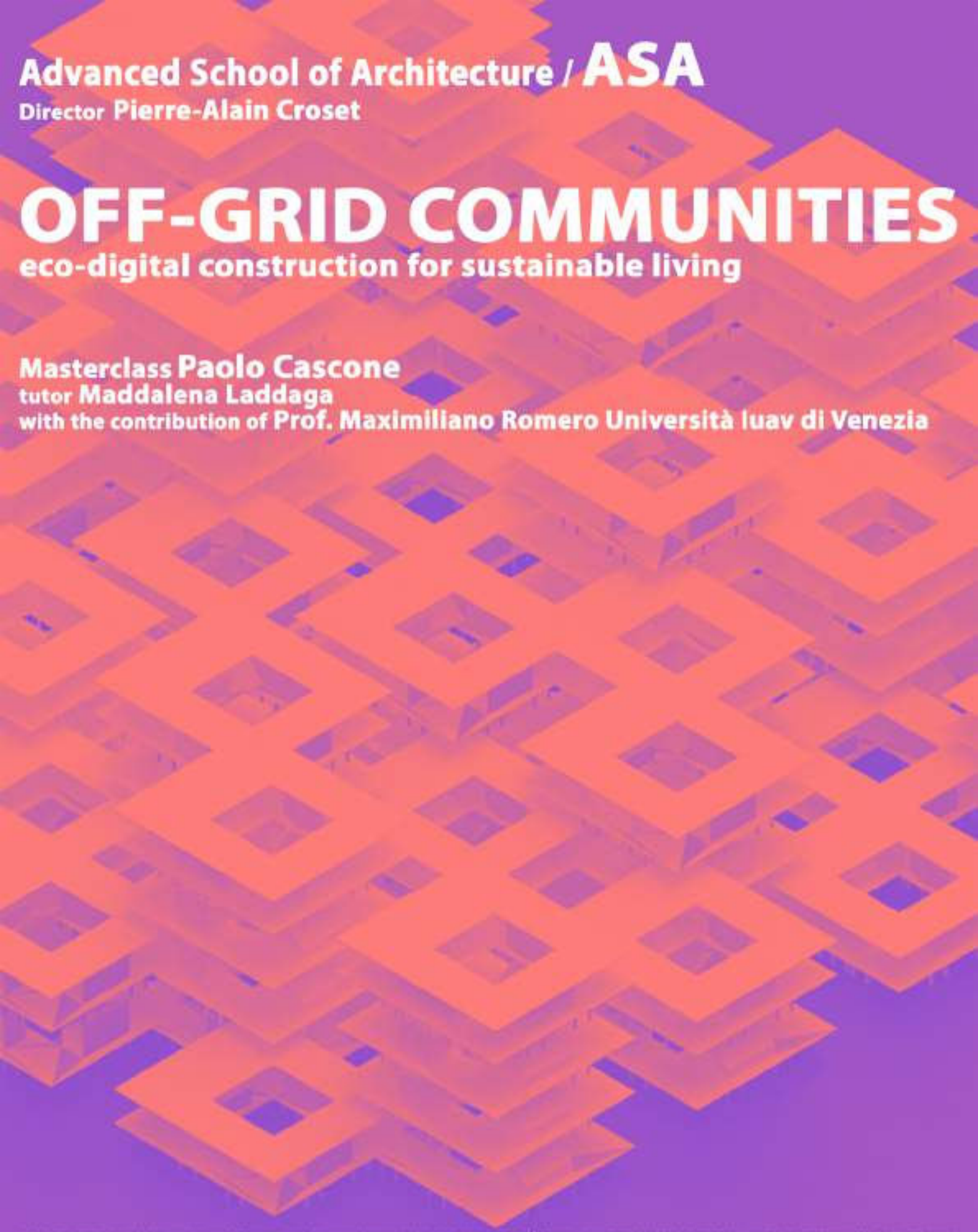
# OFF-GRID COMMUNITIES

## eco-digital construction for sustainable living

Masterclass Paolo Cascone

tutor Maddalena Laddaga

with the contribution of Prof. Maximiliano Romero Università Iuav di Venezia



**ASA STUDENTS:** NOORA KHALED ALI EBRAHIM HUSAIN ALHASHIMI CARLOS DAVID ARCOS JÄCOME DAVIDE FRANCESCO AVESANI ANDREA DI TOMMASO SARA IBRAHIM DENIS KAPITANOV SHIRYU KAWAMURA ALINA KIM GABRIELE LICCIARDI ALICE MILONI SIMON JOHAN MULLER MONA NHEILI NEHIR ÖZDEMIR ALESSIA SASSONE MILENA SHARKOVA EMILY MARIE SHIGA ZIRONG SONG MARCO STRINGHETTI SELIN YAVUZ UMMI FATHIMA ZAKIR HUSSAIN

**UoW STUDENTS:** AGATHE ALEXANDRE METTE PEDERSEN EDOARDO RIPAMONTI ROFAYDA SALEM

POLITECNICO MILANO 1863

SCUOLA DI ARCHITETTURA URBANISTICA INGEGNERIA DELLE COSTRUZIONI

Gruppo Bonomi Patrimi

# OFF GRID COMMUNITIES

## eco-digital construction for sustainable living

**ASA - Advanced School of Architecture**
**Director Prof.  Pierre-Alain Croset**

**Masterclass Paolo Cascone  2022**
**Paolo Cascone**
Senior Lecturer University of Westminster, Visting professor PoLIMI
**Maddalena Laddaga**
Tutor
/with the contribution of Prof. Maximiliano Romero Università Iuav di Venezia

*Carlos Arcos · Selin Yavuz · Zirong Song*
*Booklet layout and graphic support*

POLITECNICO MILANO 1863
SCUOLA DI ARCHITETTURA URBANISTICA INGEGNERIA DELLE COSTRUZIONI

Gruppo Bonomi Pattini

# Case Studies



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# OFF-GRID COMMUNITIES
# eco-digital construction for sustainable living

## BRIEF

Given the global consequences related to the climate change, the post-pandemic dynamics and the Ukrainian conflict an ecological approach is needed in order to respond to the growing request of affordable housing solutions for different social and environmental scenario. Such approach will have to face the dramatic rising cost of living, particularly in relation to energy, food and construction materials towards off-grid communities.
Therefore, the master class will explore an innovative idea of a sustainable construction industry able to provide a catalogue of possible site-specific and off-grid housing configurations. Such ecological industry will be based on a network of manufacturing laboratory dislocated in different climatic regions able to provide on demand solutions transforming and assembling local material systems onsite. In order to make such production chain sustainable the network will share some constraints in terms of design to manufacture methodology, construction components and performative criteria. For the above-mentioned reasons, the master class will work on a collective project where the students will be split in groups by different climatic regions.
Each group will be asked to develop a site-specific catalogue of diversified housing solutions based on the following key concepts:

CLIMATE Vs MATERIAL SYSTEM
-Timber will be the main construction material: the kind of timber and its physical properties will change according to what is available onsite in relation to the different climatic regions
-By selecting the different kind of wood students have to take in account its embodied carbon with the aim to minimise green gas emissions for the whole process.

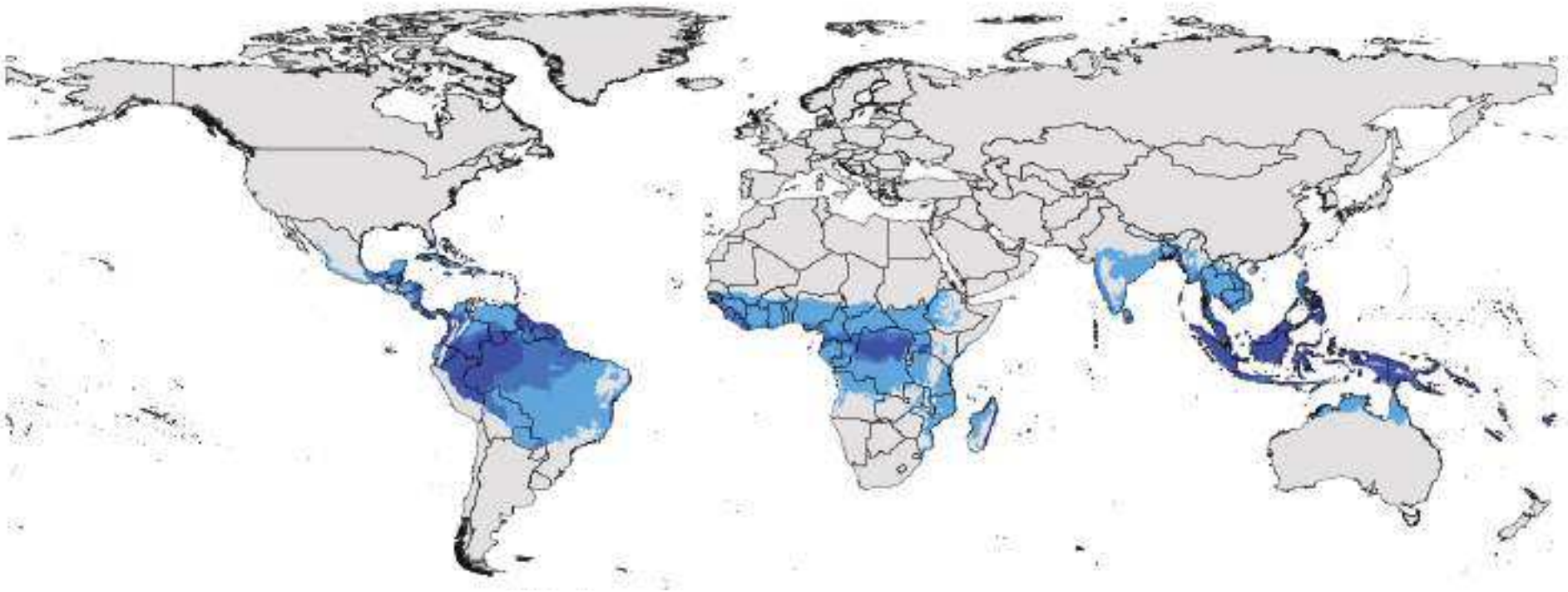
BUILDING COMPONENT Vs CONSTRUCTION SYSTEM
-The main building component will be the same for each group: wood structural panel of 300x600 cm. The thickness could change according to different strategies.
-The construction and assembly systems will change according to different strategies in relation to the interaction between digital technologies and local techniques.
-The construction system will have to be easy to mantle and dismantle onsite.
CLIMATE Vs OFF-GRID STRATEGY
Each group will have to develop an off-grid strategy according to their specific climatic analysis:
-passive: thermal insulation/passive ventilation/daylight
-active: renewable energy /water and sanitation /food self-production
SOCIAL SCENARIO Vs HOUSING DIVERSIFIED TYPOLOGIES
-the housing units typologies will have to respond to the spatial needs of different users including students, disadvantaged people, migrants etc.
-the housing cluster would need to be assembled with the aim to generate mixed use programmes and shared facilities.
PREFABRICATION Vs CUSTOMISATION
-each group would need to develop catalogues of possible variations at different scales:
.building component/panel variation (perforations, joints etc) .housing units variations .cluster variations with more units assembled together horizontally and vertically
-each group will have to provide an incrementality strategy explaining the project possible spatial and volumetric evolution over time.

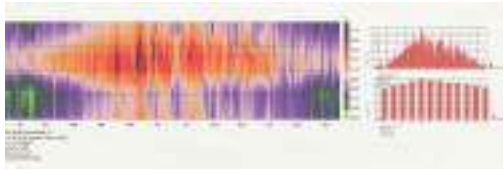
# OFF-GRID COMMUNITIES
# eco-digital construction for sustainable living

## TROPICAL CLIMATE
## Chennai - India

Tropical climate affects the belt between the Tropic of Cancer and the Tropic of Capricorn, thus affecting countries such as Africa, the Indian Peninsula, Australia, Oceania and parts of Central and South America. Within these torrid areas, temperatures are always high with a constant high percentage of humidity present in both rainy and dry seasons, causing different environmental phenomena: from water crises due to droughts to flooding due to heavy rainfall.
The design strategy devised, particularly for the location in Chennai, India, aims to realize an eco-sustainable housing project, compatible not only with the particular environmental conditions of the area, but also with the difficult social realities of the slums, plagued by both the housing problem and the presence of dangerous diseases such as malaria.
The initial approach was the study of vernacular housing types, which led to an understanding of the useful passive and active strategies to be adopted in the design and also to the local materials with a low environmental impact.
The most detailed part of the design concerns the panel system, that is imagined as breathable and adaptable skin wrapping itself around the skeleton of the living units. The system, inspired by tradition Jaali screens commonly found in the southern regions of India, is therefore a skin protecting from rain and from direct sunlight, allowing for a shaded and ventilated space within. The panels are reactive, opening and closing depending on the rain and weather directions, but always permitting ventilation and light penetration. The panel composition consists of a wood skin system, malleable and flexible taking inspiration from typical weaved palm frond cladding used in vernacular tropical housing.
The housing unit is thus configured as a protected core, a sort of heart of the house, entirely covered by the climatically and energetically performing skin. The result of the housing units design is thus an ecological taxonomy of accessible and interscalar solutions, adapted not only to the climatic aspect of natural ventilation, sun exposure and orientation but also to the different types of users of the social reality of non-organized settlements. Moreover to meet the growing demand for affordable housing solutions, the units were designed with simple and prefabricated wood pieces and joints, in order to have a quick and simple assemblage.
The cluster design was an experiment on how the housing units work together, in the perspective of creating an off-grid community. The tropical climate has given its respective context a lifestyle that functions 30% inside and 70% outside the housing unit. While the basic needs and amenities are provided on the interior of the housing unit, the life of the tropical people is reflected on the outside. Elements like courtyards, terraces, streets and shops are the catalyst to bring life into this scenario. The units of mixed typology surrounding a courtyard is a module that replicates vertically with spaces for incrementality at its bottom, in order to showcase that a simple housing unit is flexible to adapt to the high density demand needed for the tropical settlements.

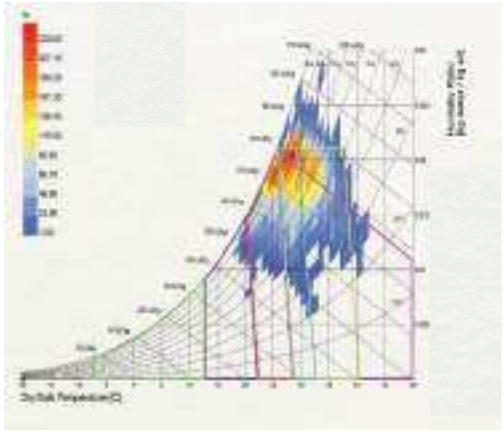
**ASA STUDENTS:** CARLOS DAVID ARCOS JÁCOME · SHIRYU KAWAMURA · ALINA KIM
SIMON JOHAN MULLER · ALESSIA SASSONE · UMMI FATHIMA ZAKIR HUSSAIN



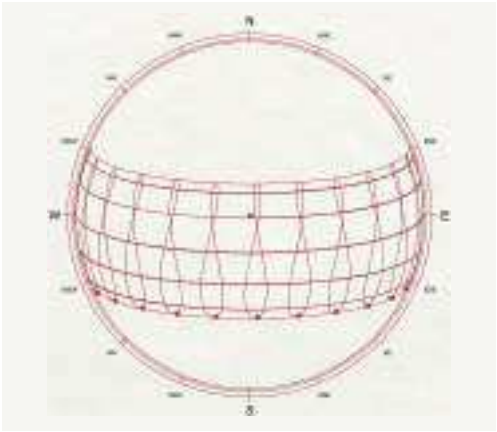


Dry Bulb Temperature - Chennai

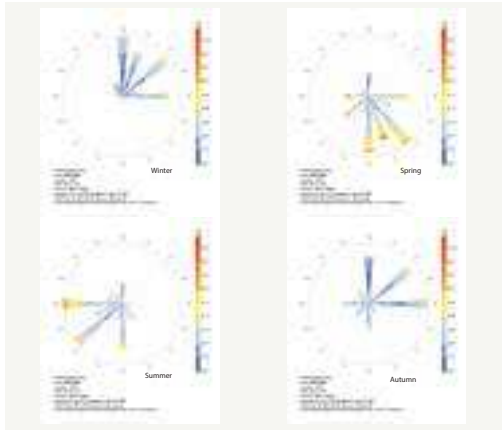
Sun Path - Chennai



Psychometric Chart - Chennai

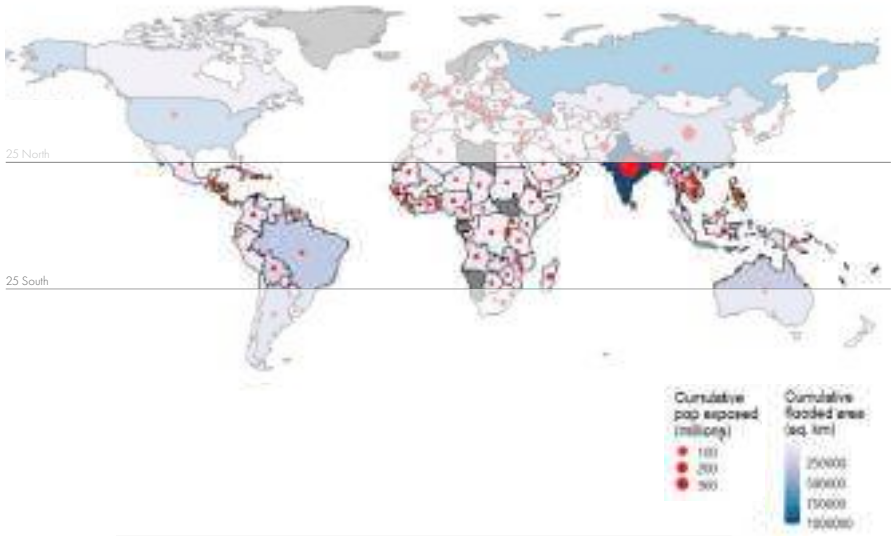


Sun Path - Chennai

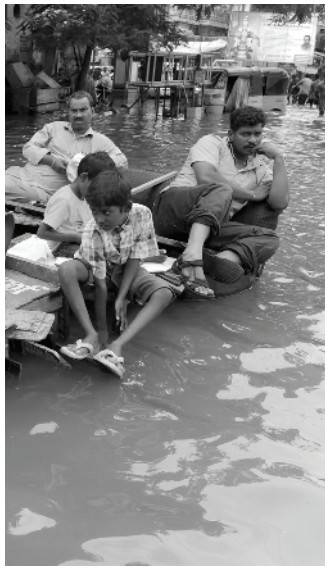



Season Wind Rose - Chennai

## FLOOD RISK

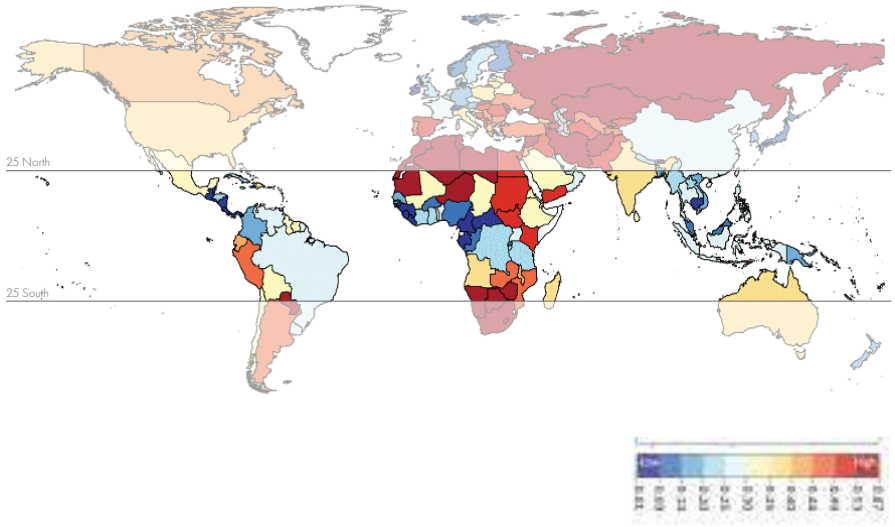



Population exposed to flood risk map

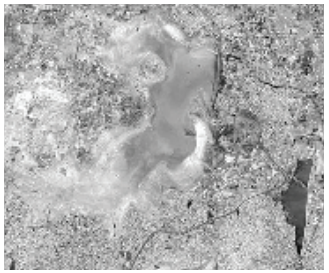


Flood event in Chennai - 2015

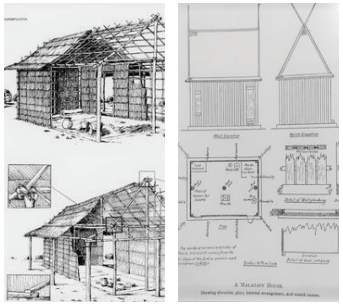
## DROUGHT RISK

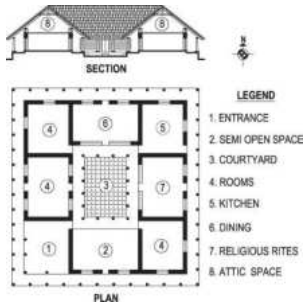


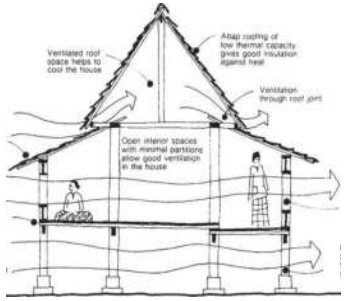

Drought risk map



Drought event in Chennai - 2019




SECTION
LEGEND
1. ENTRANCE
2. SEMI OPEN SPACE
3. COURTYARD
4. ROOMS
5. KITCHEN
6. DINING
7. RELIGIOUS RITES
8. ATTIC SPACE
PLAN


Ventilated roof space helps to cool the house
Attap roofing of low thermal capacity gives good insulation against heat
Ventilation through roof joint
Open interior spaces with minimal partitions allow good ventilation in the house

## TIMBER - Acacia Mangium Willd

Acacia mangium is an important multipurpose tree for the tropic lowlands. Mangium is one of the major fast-growing species used in plantation forestry programs throughout Asia, the Pacific, and the humid tropics.

- Low thermal capacity material
- Local availability in tropic regions
- Hard wood

## BAMBOO

Bambusa tulda, commonly known as Indian Timber Bamboo, is a fast growing medium-sized tropical clumping bamboo native to the Indian subcontinent. It is considered to be one of the most valuable multipurpose bamboo species and, due to its nearly solid culms, it is also an excellent and strong timber used extensively also in construction and scaffolding.

- Low thermal capacity material
- Local availability in tropic regions
- Soft wood
- High tenside strenght
- Low weight
- Hight elasticity

## MOSQUITO SHADE NET

In the design of house unit in the tropical climate it's essential to take into consideration the use of mosquito net as a constuction material, in order to oviod the development of nasty diseases.
This use improves not only the hygiene and wellbeing of the local inhabitants, but also demonstrate how innovative solutions can come from interchanging cultural knowledge.

- Light weight material
- Usefull to protect from insects
- Allow natural vantilation and solar shading

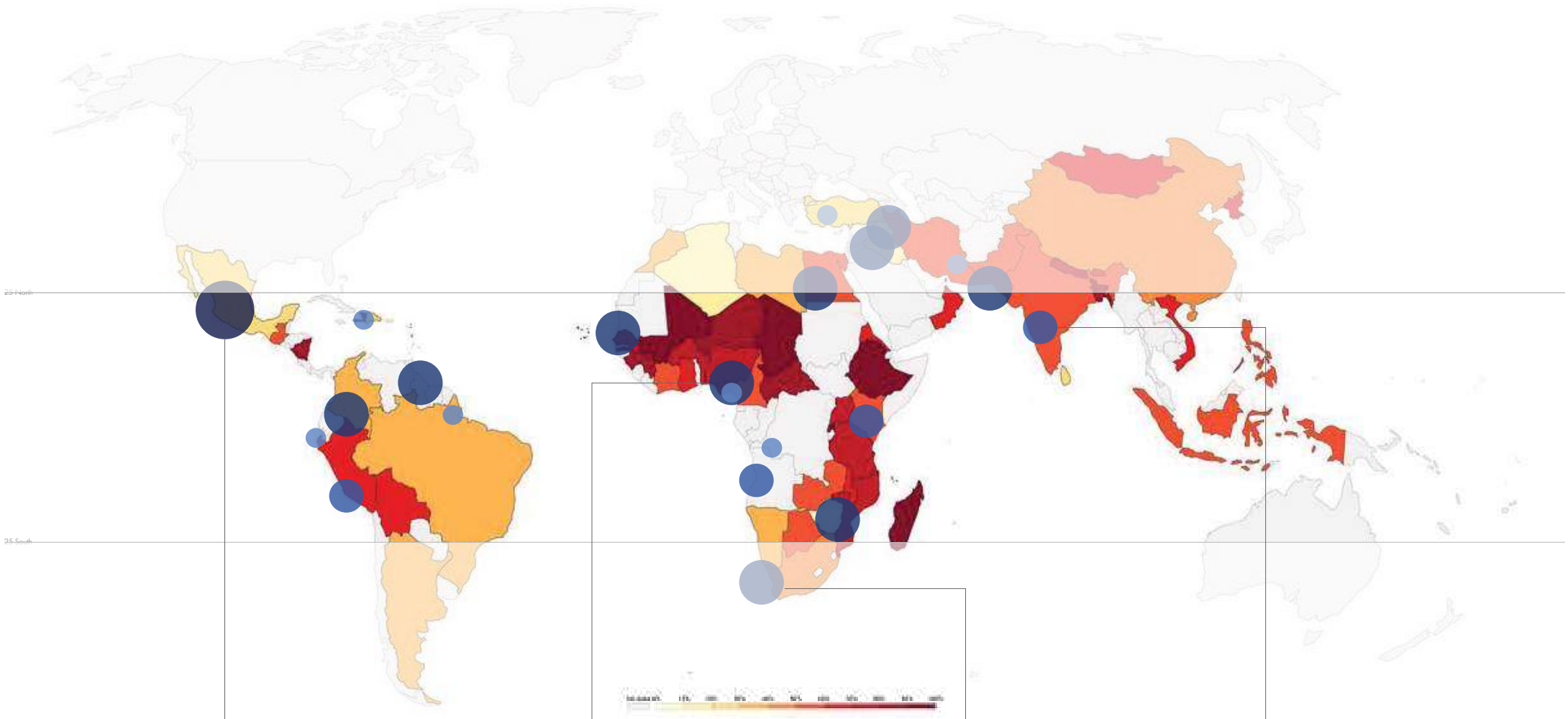
## WOOD JAALI

Jaali is a local term for "perforated block", made of different type of materials like wood, that create beautiful patterns of light and shadow while ventilating indoor spaces. The play of solid and void has become a cultural symbol of Indian architecture.

- Permint natural ventilation
- Permit solar shading and adjustment of day light

DATA

Slums World Population : 1,6 billion ( 1/4 of the world's urban population)
Slums Indian Population : (37 % of




Ciudad Nezahualcoyotl
Mexico City, Mexico
Population: 1.1 million

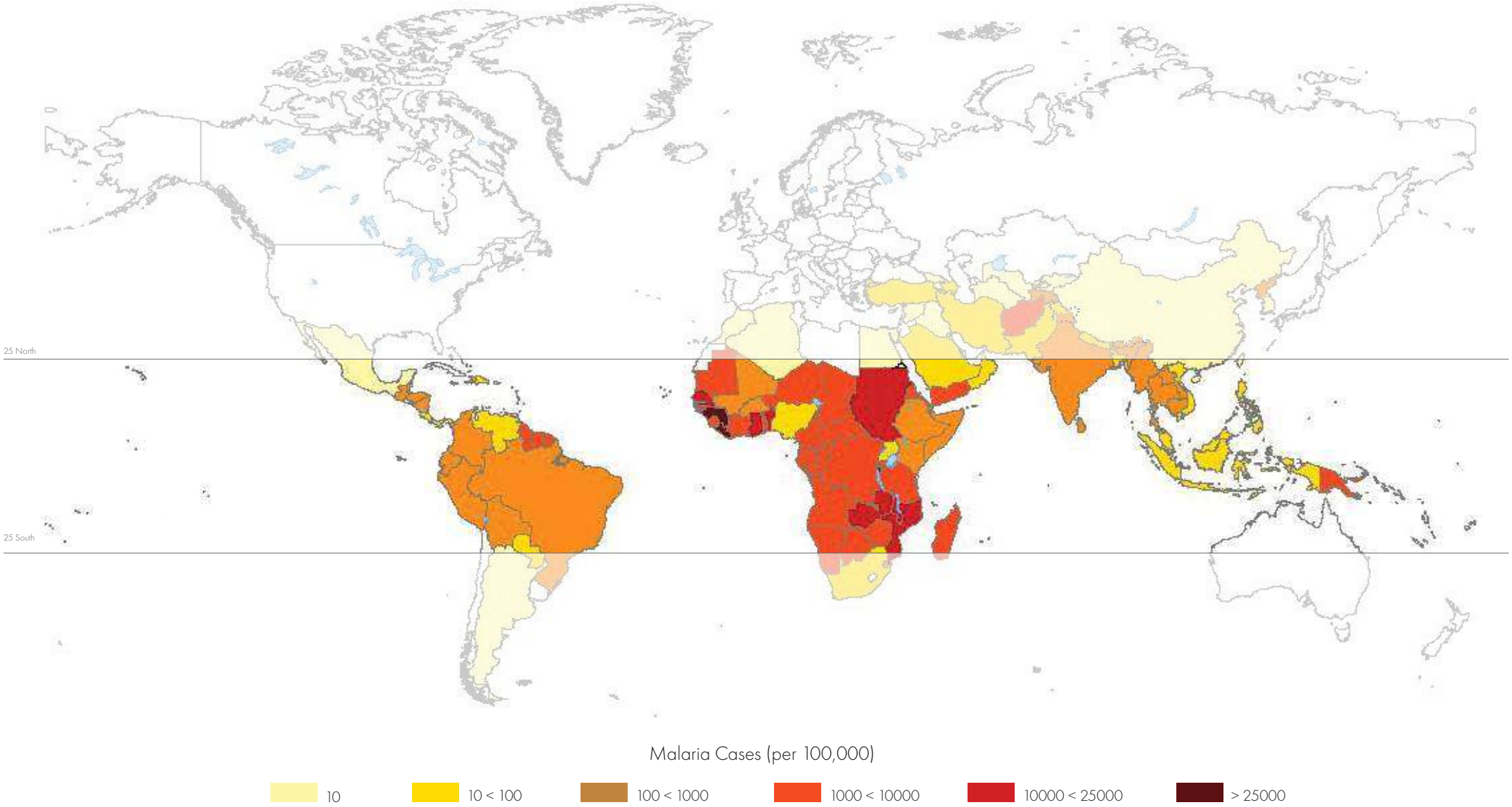
Makoko
Lagos
Population: 300,000

Khayelitsha
Cape Town, South Africa
Population: 400,000 to 1.2 million

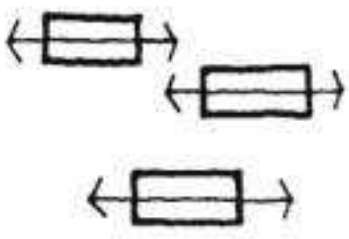
Dharavi
Mumbai, India
Population: 1 million

DATA

Number of cases in the world: 223 milion
97% of malaria cases occurred in the Tropics



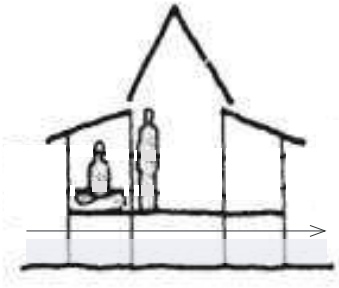
## ORIENTATION



- E-W direction in order to minimize  areas exposed to solar radiation
- Staggered position to create wind channels

| Panel | Unit | Cluster |
|---|---|---|
| ☐ | ☑ | ☑ |

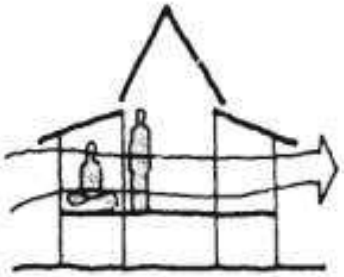
## DETACHMENT FROM THE GROUND



- Prevent from floods
- Catches winf of high velocity refreshing pavemen

| Panel | Unit | Cluster |
|---|---|---|
| ☐ | ☑ | ☑ |

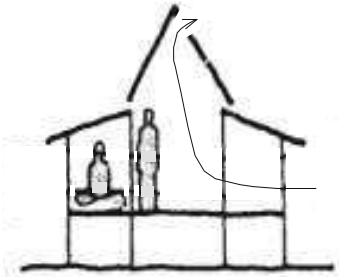
## NATURAL VENTILATION



- Garantee easy passage of air and cross ventilation
- Avoid the use of cooling electic systems

| Panel | Unit | Cluster |
|---|---|---|
| ☑ | ☑ | ☑ |

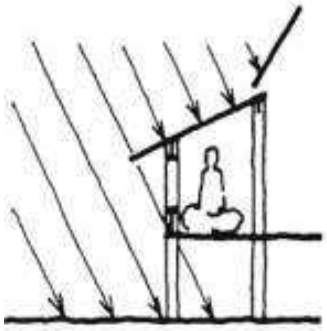
## ACCENTUATE PITCHED ROOF



- Permit quick drain of rainwater
- Permit chimney effect to regulate inside temperature

| Panel | Unit | Cluster |
|---|---|---|
| ☐ | ☑ | ☑ |

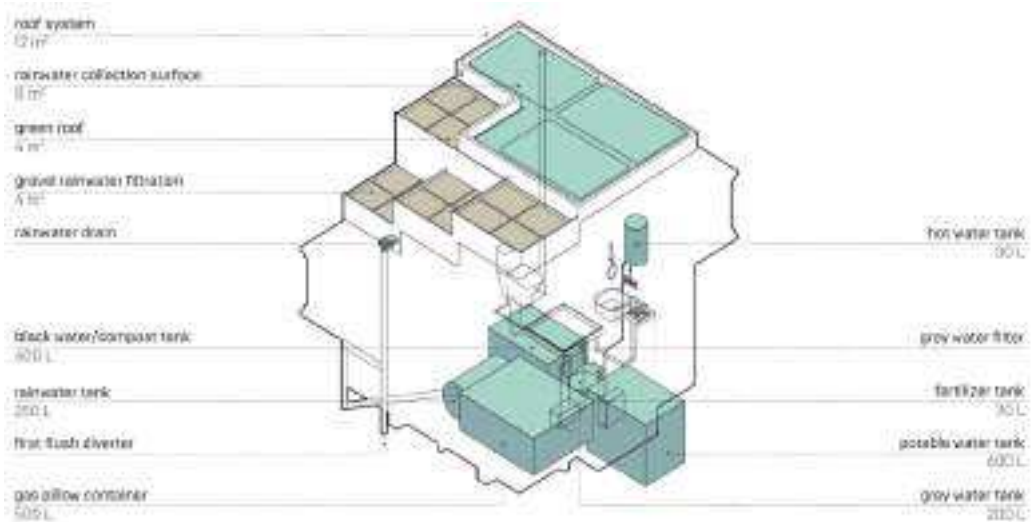
## OVERHANGS and LOW EXPOSED VERTICAL SURFACES



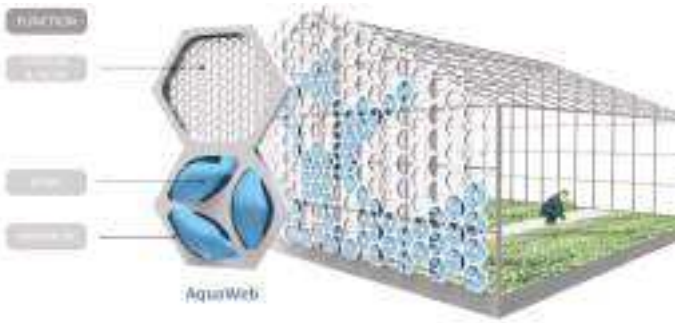
- Protection to rain
- Good shadow from solar radiations

| Panel | Unit | Cluster |
|---|---|---|
| ☑ | ☑ | ☑ |

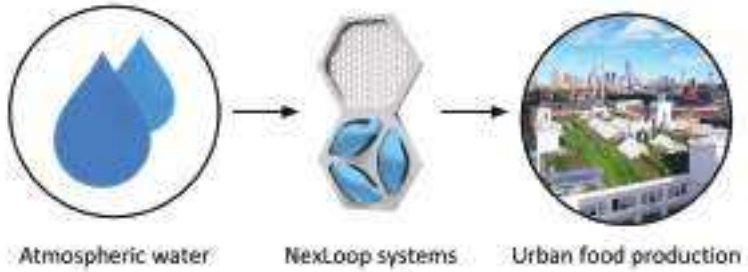
## WATER SYSTEM REFERENCE




*"Gallery of the Voxel Quarantine Cabin / Valldaura Labs - 28." ArchDaily. Accessed November 28, 2022. https://www.archdaily.com/958366/the-voxel-quarantine-cabin-valldaura-labs/60493f6ef91c811380000286-the-voxel-quarantine-cabin-valldaura-labs-axo.*

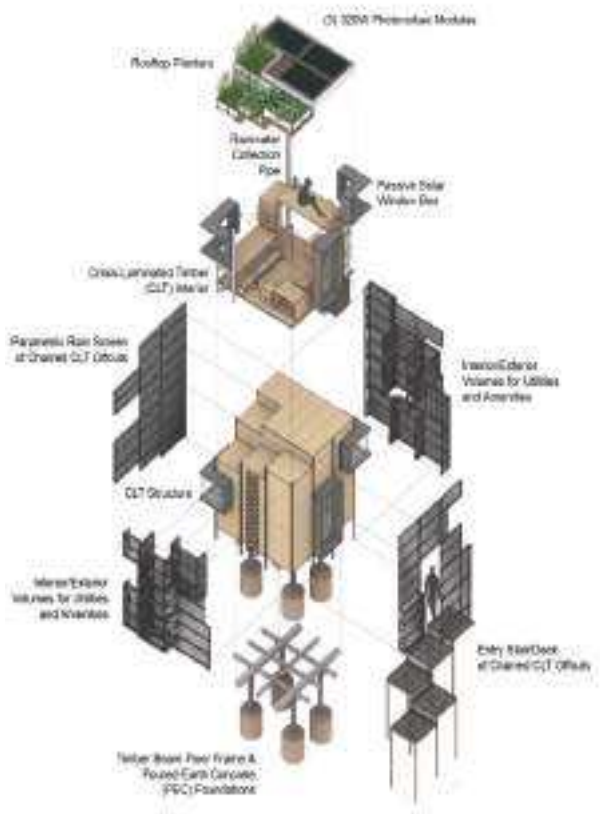



### Water Collection




*Romeo, Jim. "Designing for Environmental Sustainability." Digital Engineering, January 1, 2019. https://www.digitalengineering247.com/article/designing-for-environmental-sustainability/*

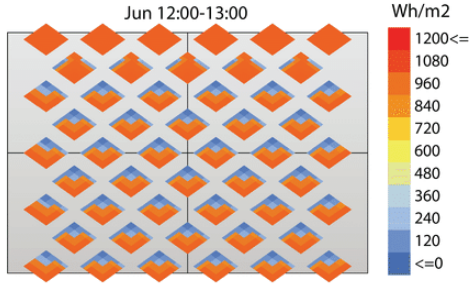
## ENERGY SYSTEM REFERENCE




*"Gallery of the Voxel Quarantine Cabin / Valldaura Labs - 28." ArchDaily. Accessed November 28, 2022. https://www.archdaily.com/958366/the-voxel-quarantine-cabin-valldaura-labs/60493f6ef91c811380000286-the-voxel-quarantine-cabin-valldaura-labs-axo.*

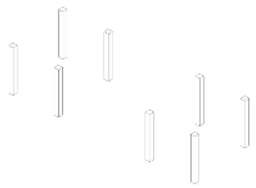
### Energy Collection

### Solar Panels




*"Adaptive Solar Facade Prototype at the House of Natural Resources at ..." Accessed November 28, 2022. https://www.researchgate.net/figure/a-Adaptive-solar-facade-prototype-at-the-House-of-Natural-Resources-at-the-ETH-Zurich_fig10_311922852.*

## CONSTRUCTION PROCESS

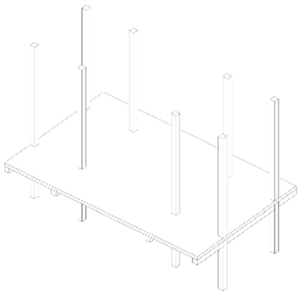


Ground floor columns



Ground floor beams

Platform



First floor columns



First floor beams



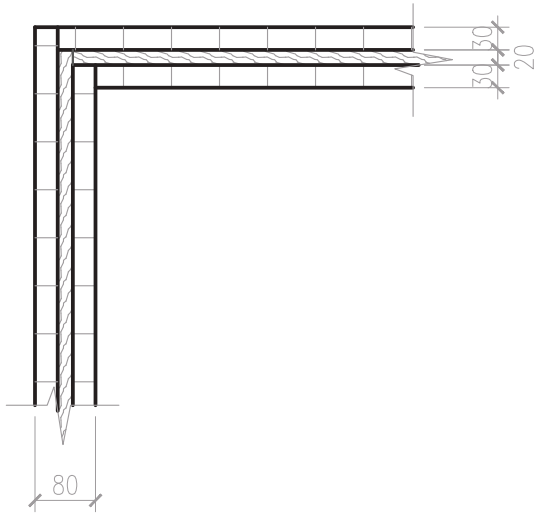
Unit walls



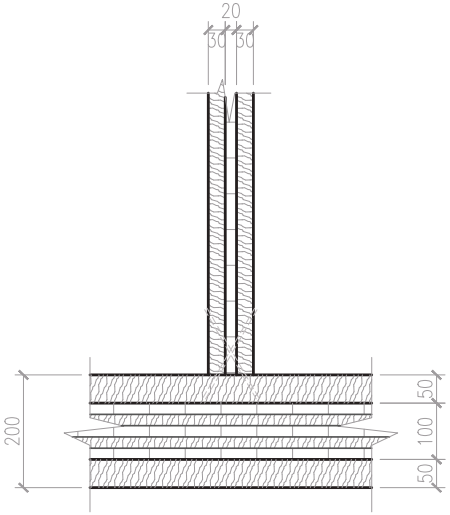
Primary roof structure

Secondary roof structure

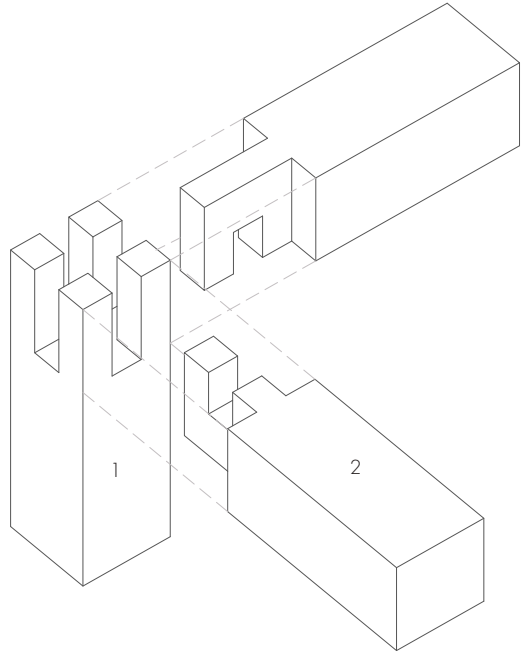
Kinetic skin




CLT corner joint



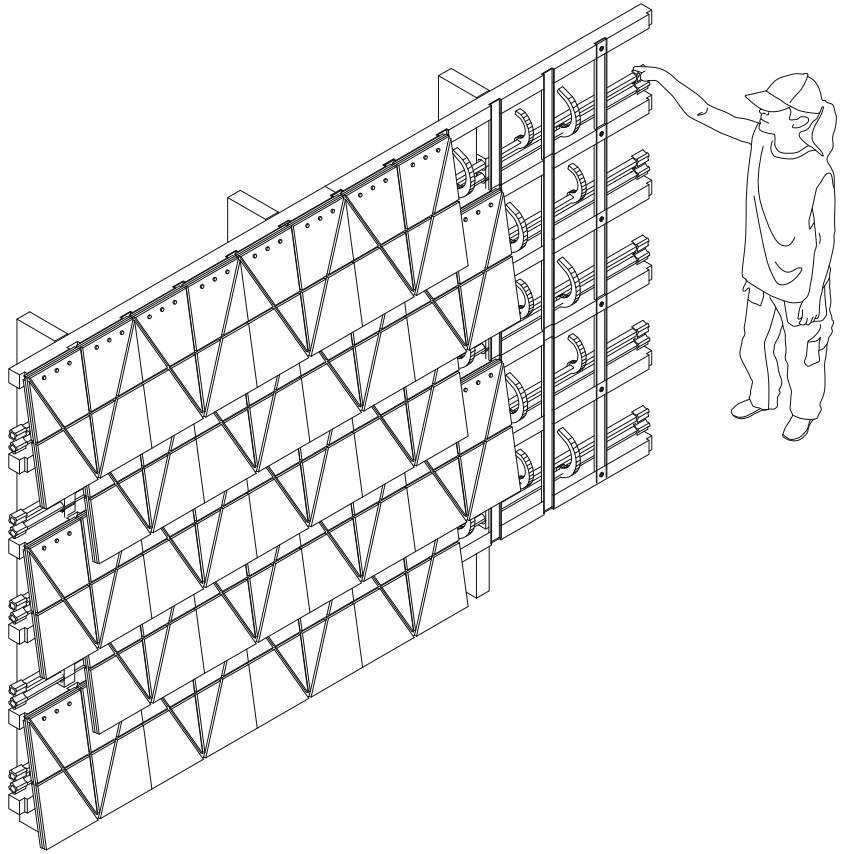

CLT wall - floor joint



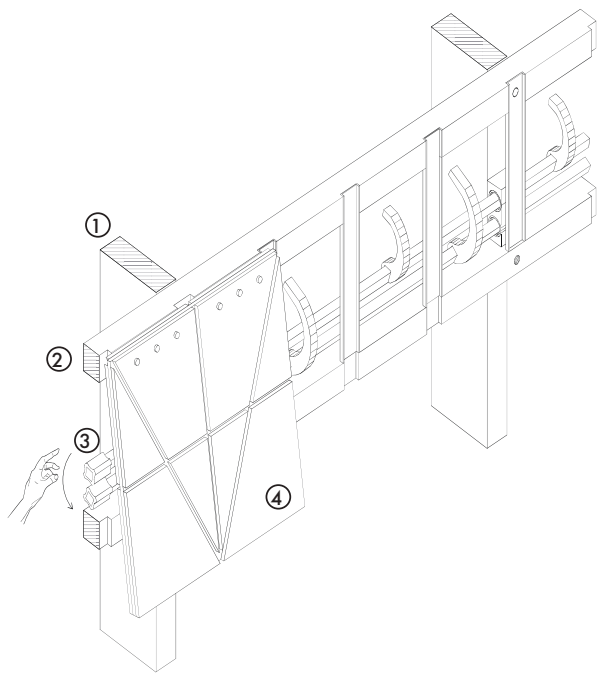

Framing joints

Yakisugi technique

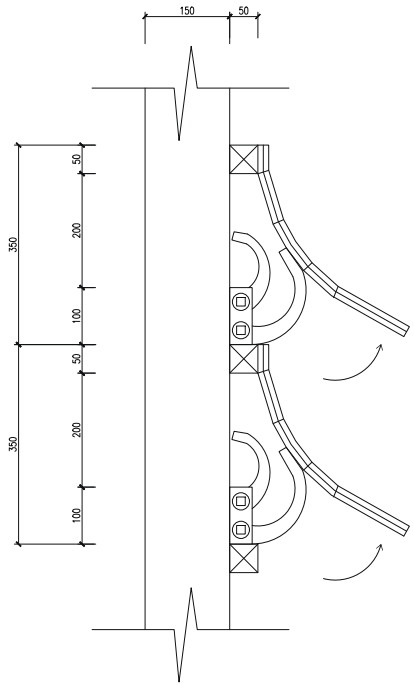
LEGEND:
1 – Timber Columns
2 – Timber Beam
3 – CLT wall acacia magnum wild exterior with softwood interior panelling
4 – CLT floor acacia magnum wild exterior with softwood interior panelling



PANEL CLADDING AXO




PANEL CAM SYSTEM




PANEL CLADDING SECTION

LEGEND:

1 - Primary Timber Framing 150mm x 50mm

2 - Secondar Timber Framing 50mm x 50mm @ 350mm spacing

3 - Manual Cam System

4 - Woodkin Bamboo Composite Panel 500mm x 500mm

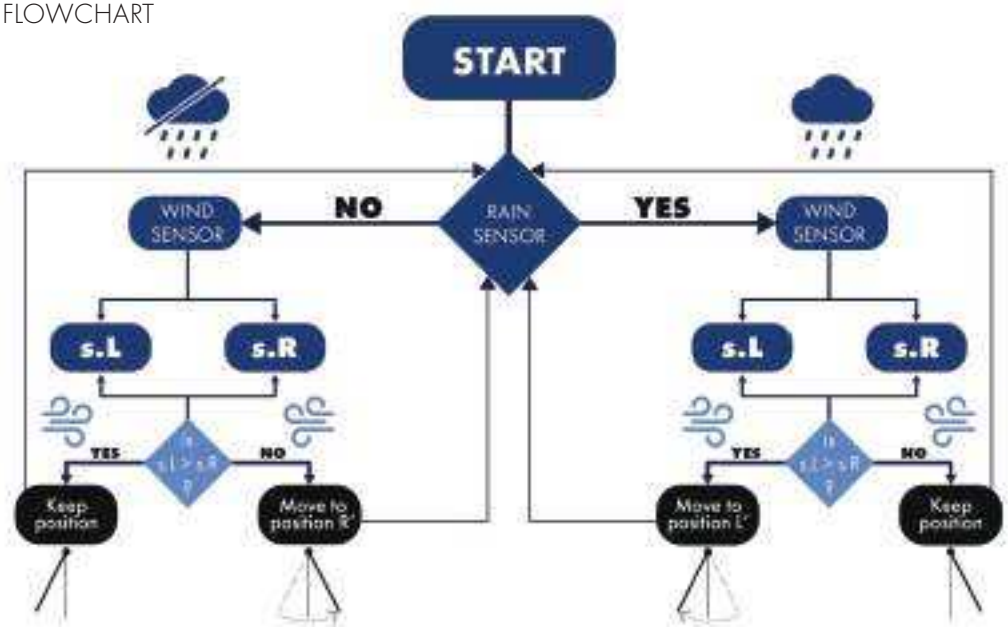
Woodskin System

Bamboo Composite Panels

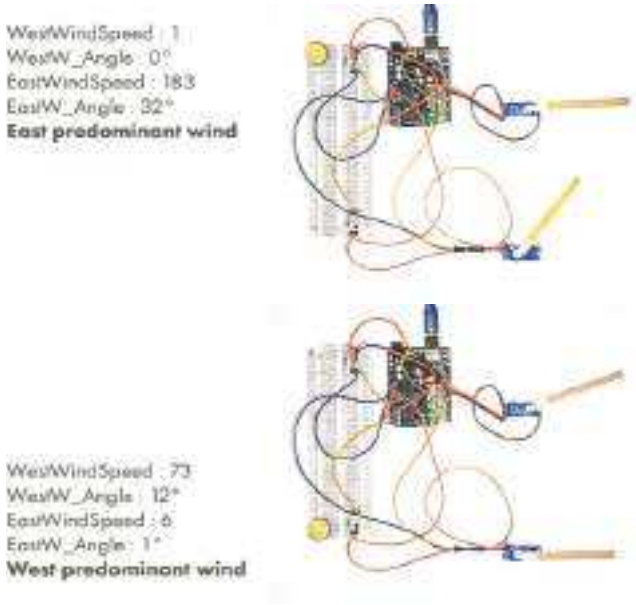
PVC Sheeting

Mosquito net

FLOWCHART




ELEMENTAL MOVEMENT




ARDUINO CODE

```
#include <Servo.h>
int sensorValueA;
int sensorValueB;
int mapValueA;
int mapValueB;
Servo WindPA, WindPB;
void setup() {
  pinMode(A0, INPUT);
  pinMode(A5, INPUT);
  pinMode(2, OUTPUT);
  pinMode(7, OUTPUT);
  Serial.begin(9600);
  WindPA.attach(2);
  WindPB.attach(7);
}
void loop() {
  sensorValueA = analogRead(A0);
  Serial.print("WestWindSpeed : ");
  Serial.println(sensorValueA);
  Serial.print("WestW_Angle : ");
  Serial.println(mapValueA);
  mapValueA = map(sensorValueA, 0, 1023, 0, 180);

  sensorValueB = analogRead(A5);
  Serial.print("EastWindSpeed : ");
  Serial.println(sensorValueB);
  Serial.print("EastW_Angle : ");
  Serial.println(mapValueB);
  mapValueB = map(sensorValueB, 0, 1023, 0, 180);
    if(sensorValueA>sensorValueB){
    Serial.println("West predominant wind");
    WindPA.write(mapValueA);
    WindPB.write(0);
  } else {
    Serial.println("East predominant wind");
    WindPB.write(mapValueB);
    WindPA.write(0);
   delay(100);
```

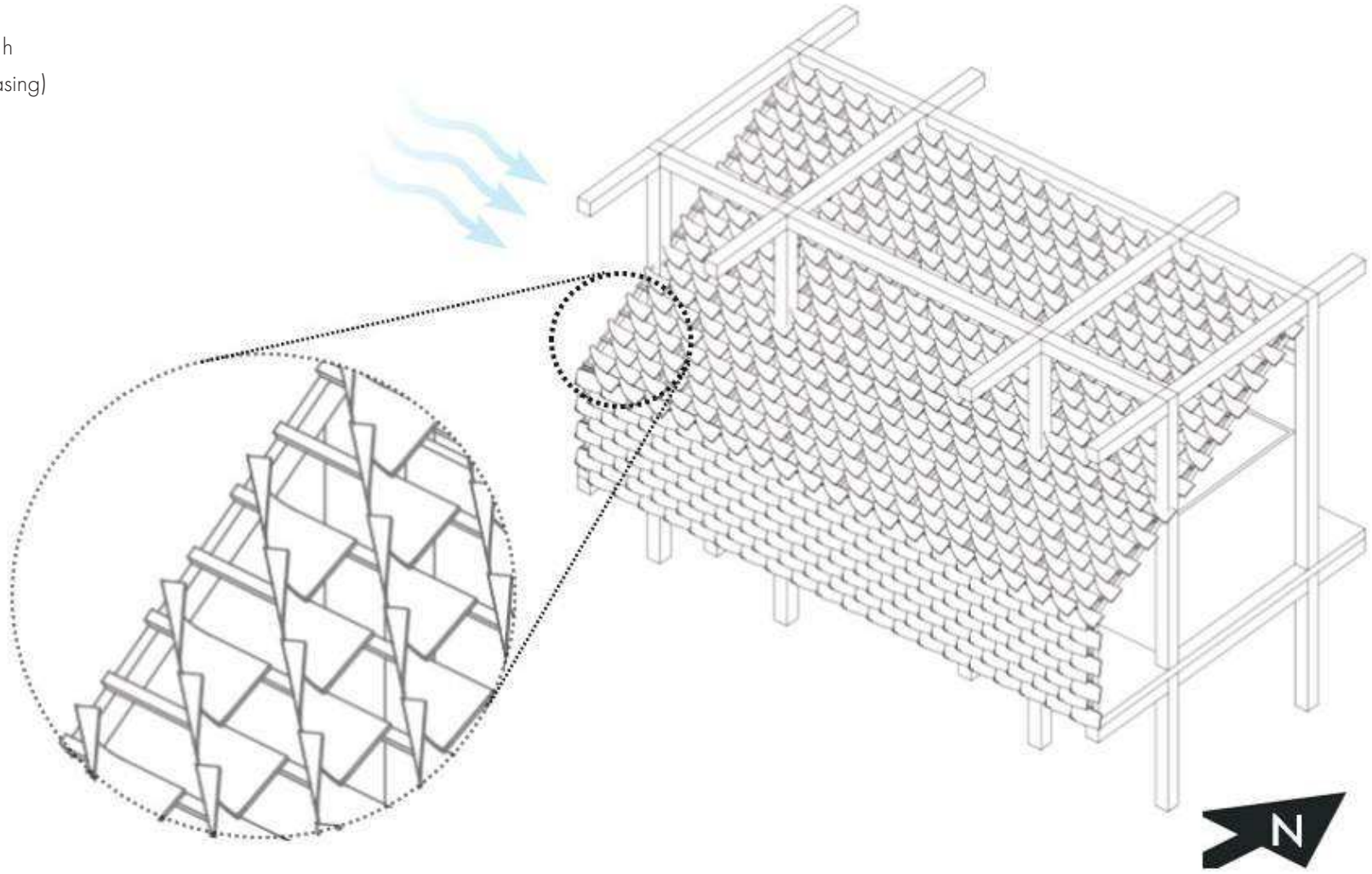
CLIMATIC CONDITION EXAMPLE:

Rain.- No

Wind direction.- West

Wind speed.- 25Km / h

(Increasing and decreasing)

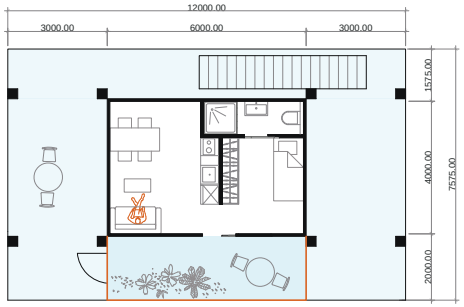


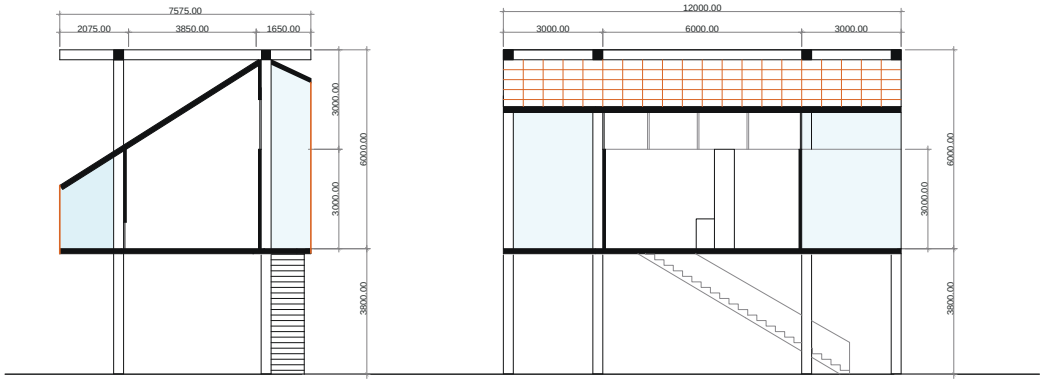

Panel performance

Facade performance

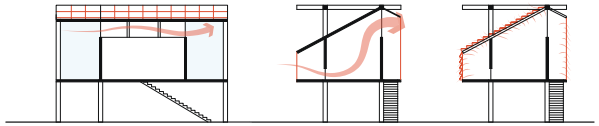
USERS:

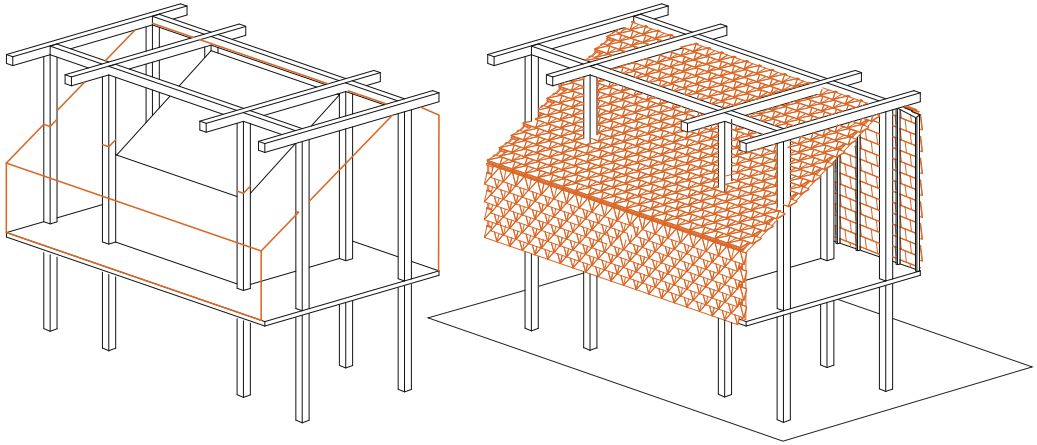
SIZE: 24 sqm



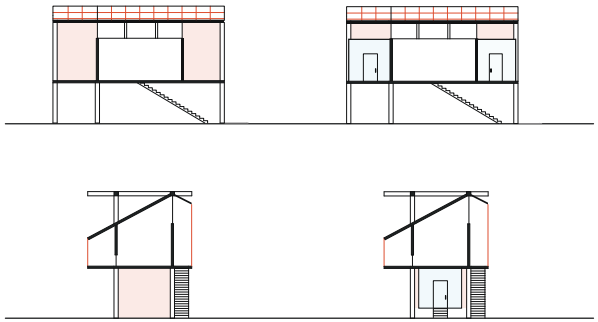




Natural ventilation
STRATEGY





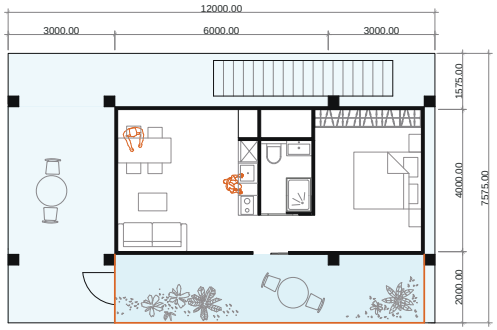
Incremental housing
STRATEGY

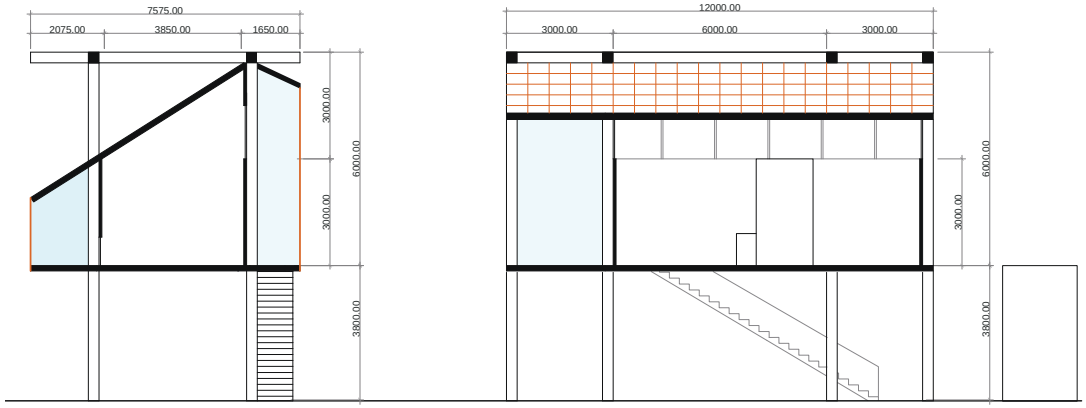


USERS:

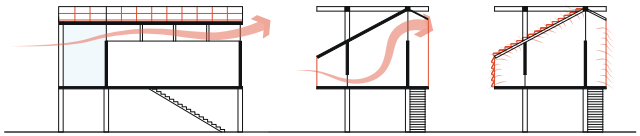
SIZE: 36 sqm

NEEDS
Energy: 1714 kW/h
Water: 270 l/day
Space: 19 sqm

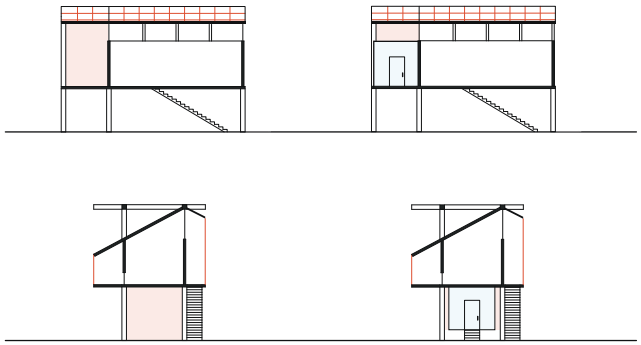


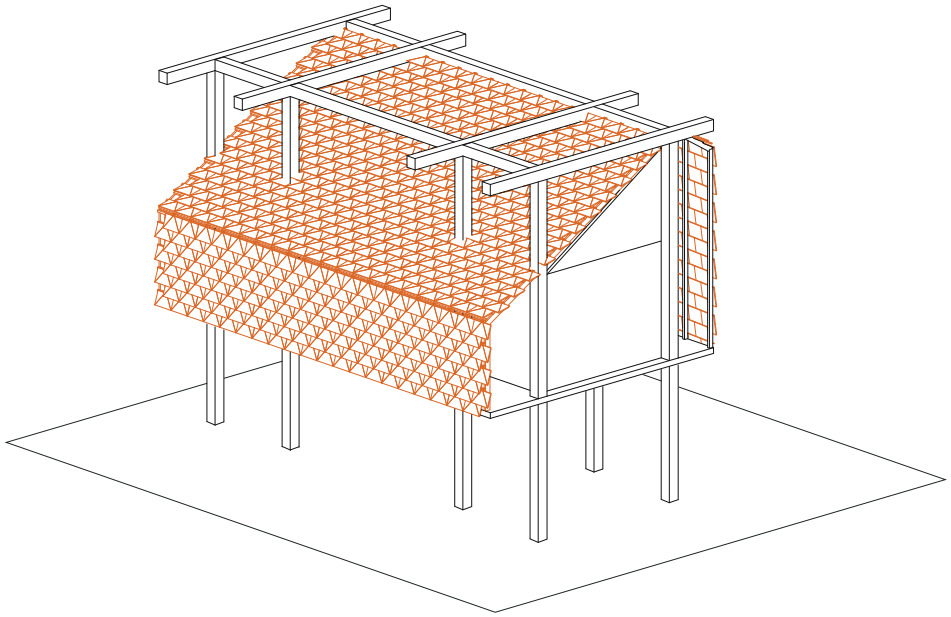




Natural ventilation
STRATEGY



Incremental housing
STRATEGY

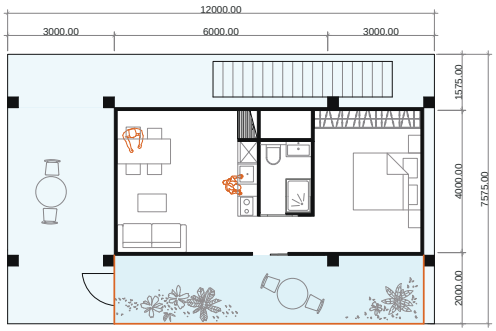


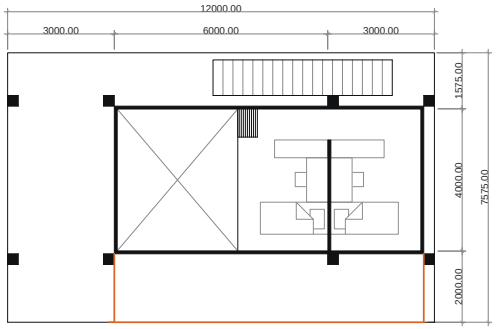


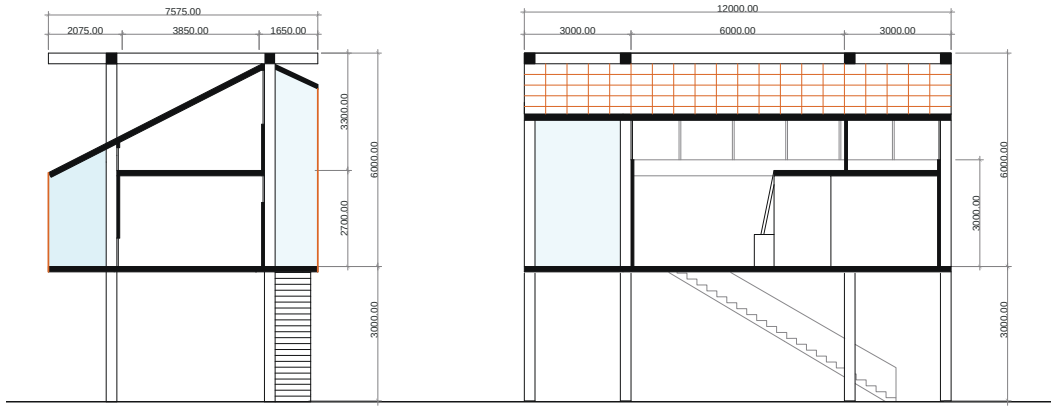
USERS:

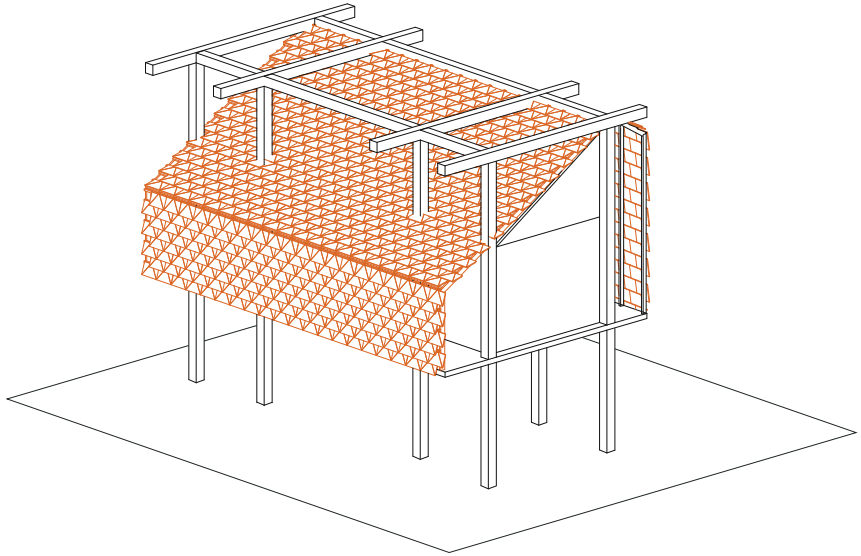
SIZE: 60 sqm

NEEDS
Energy: 3428 kW/h
Water: 540 l/day
Space: 38 sqm

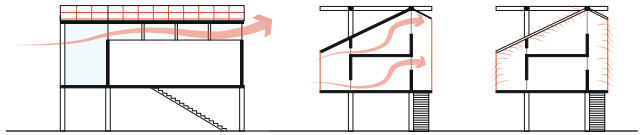


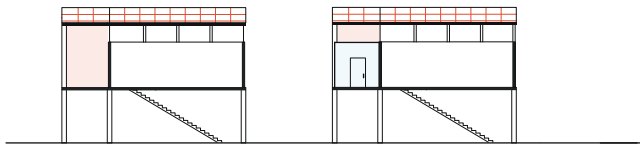



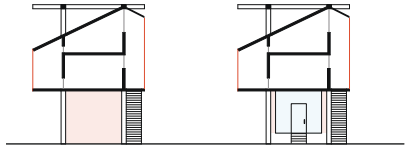



Natural ventilation
STRATEGY



Incremental housing
STRATEGY

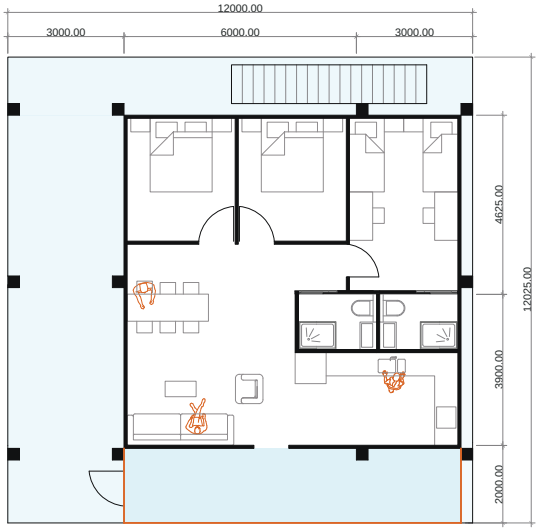


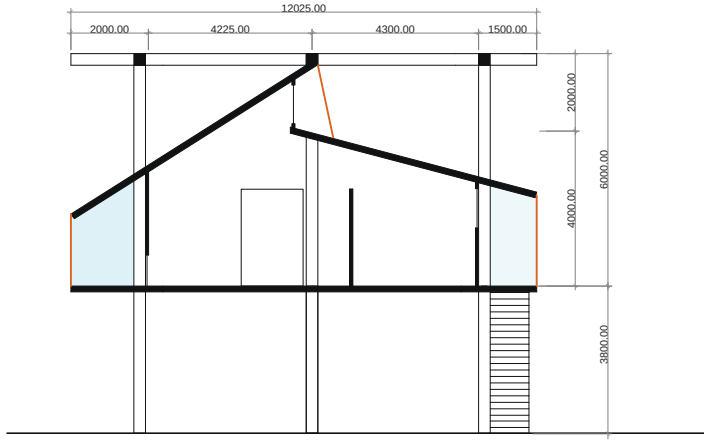


USERS:

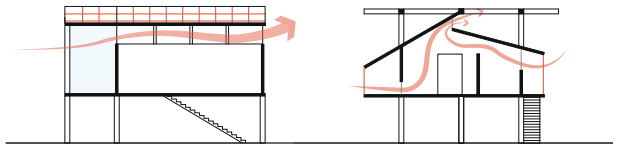
SIZE: 77 sqm

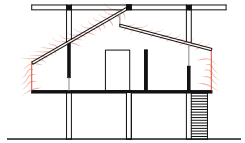
**NEEDS**
Energy: 5142 kW/h
Water: 810 l/day
Space: 57 sqm

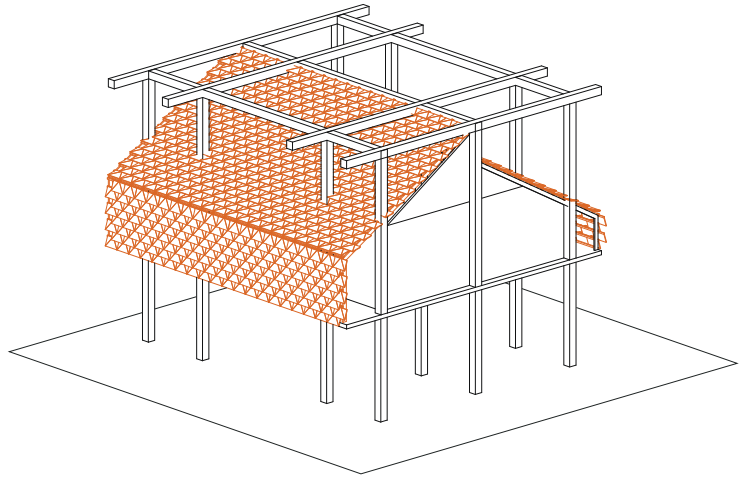


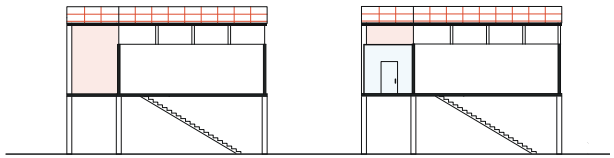

Natural ventilation
STRATEGY

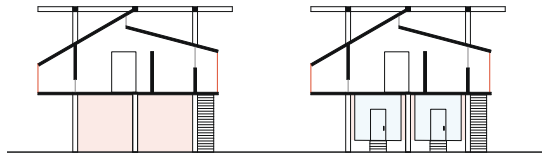


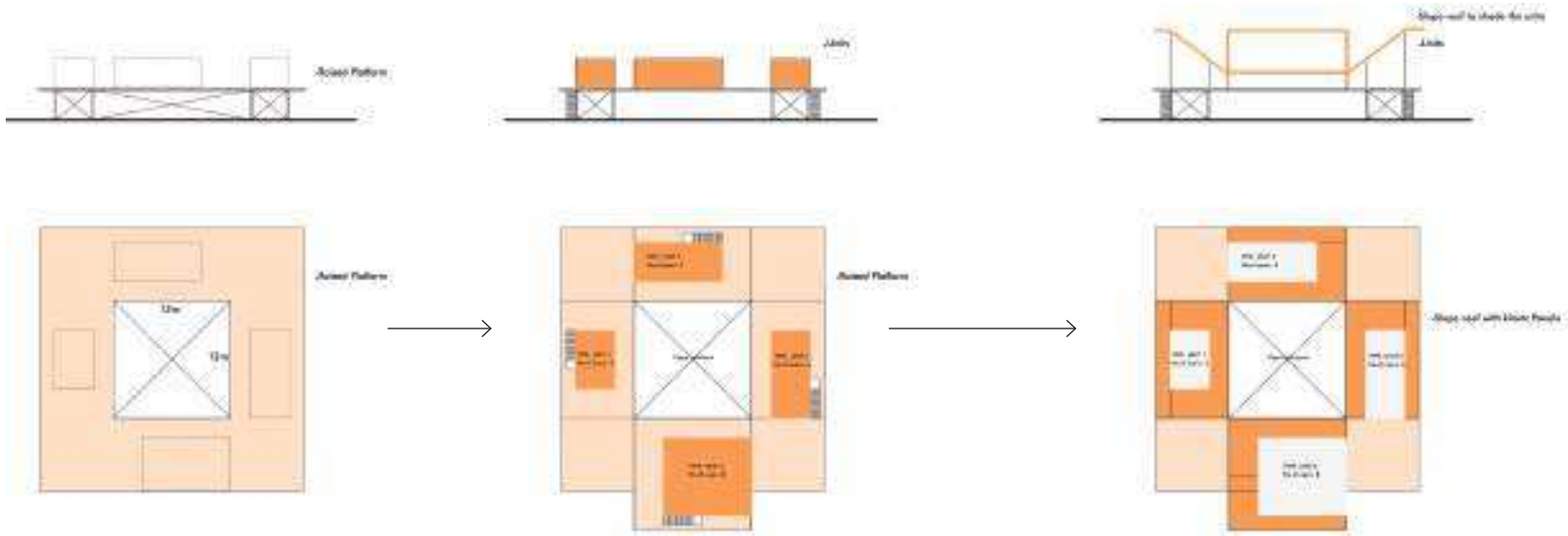




Incremental housing
STRATEGY



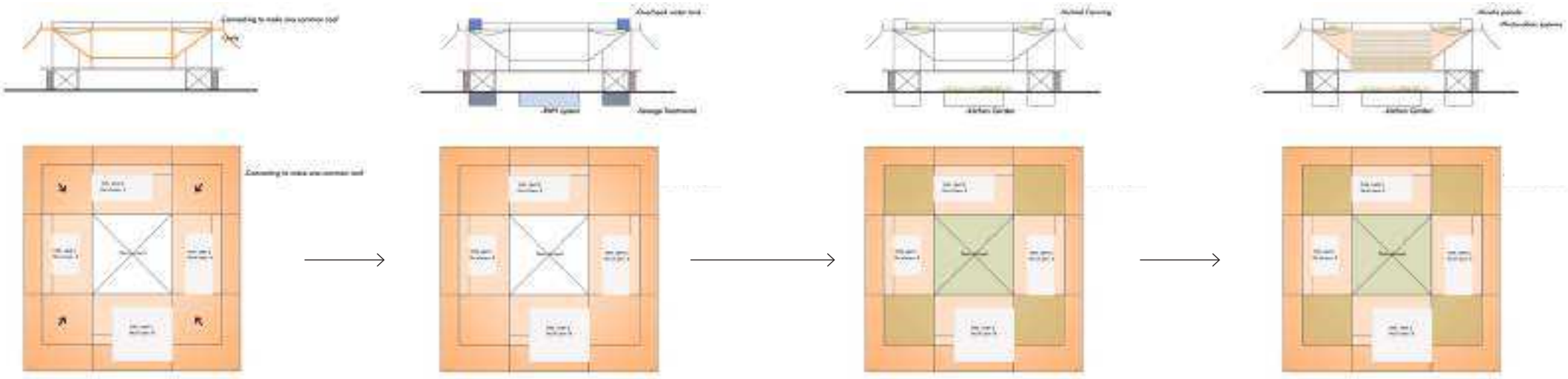




Basic structure

Units configuration

Skin roof



Common roof

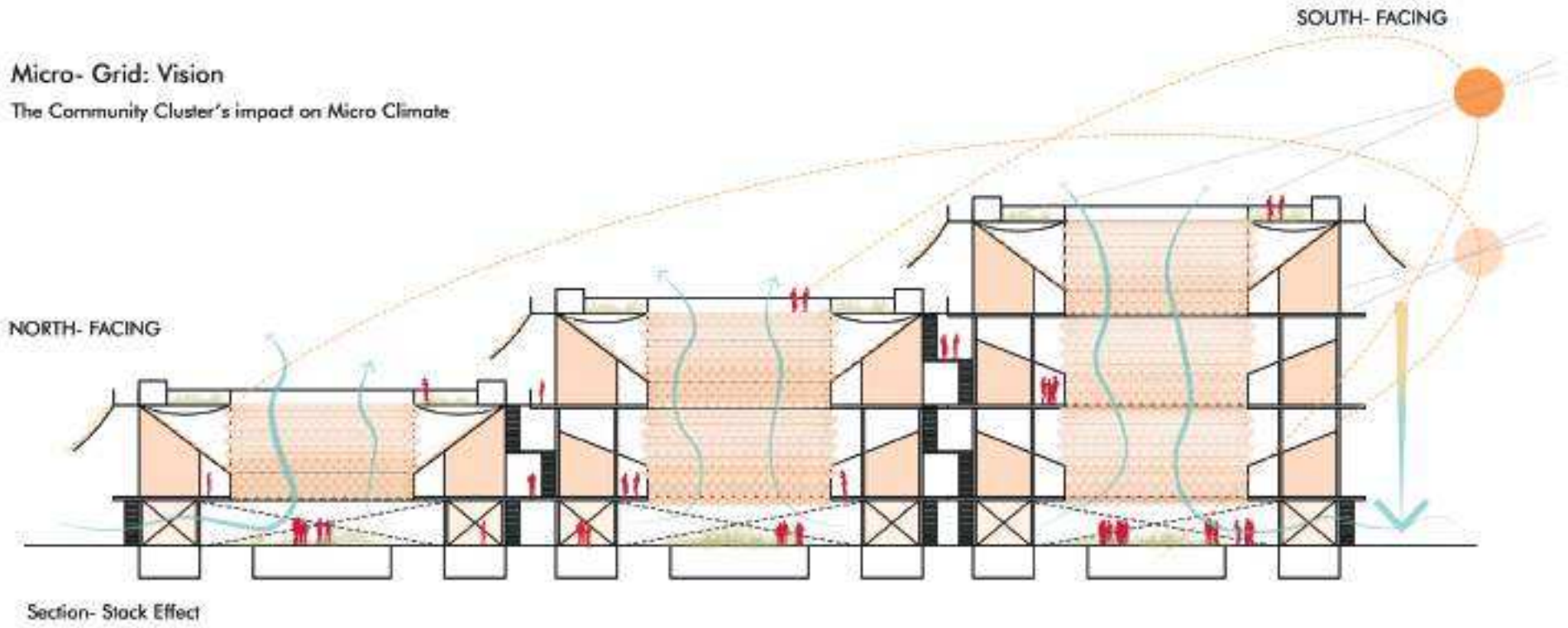
Water strategy

Vertical farming strategy

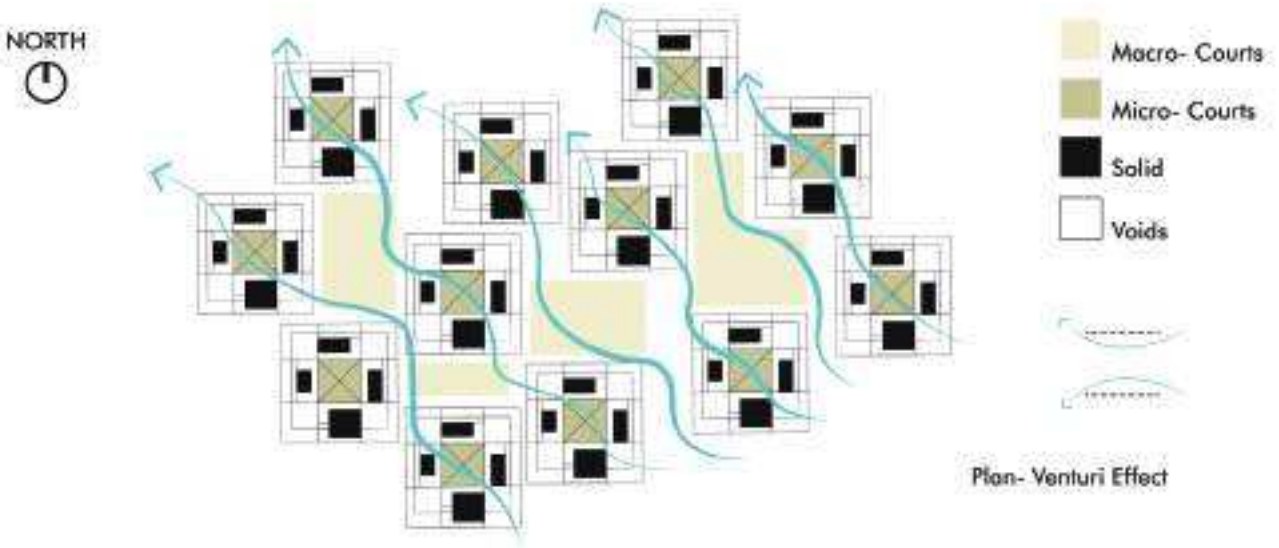
Final configuration

## Micro- Grid: Vision

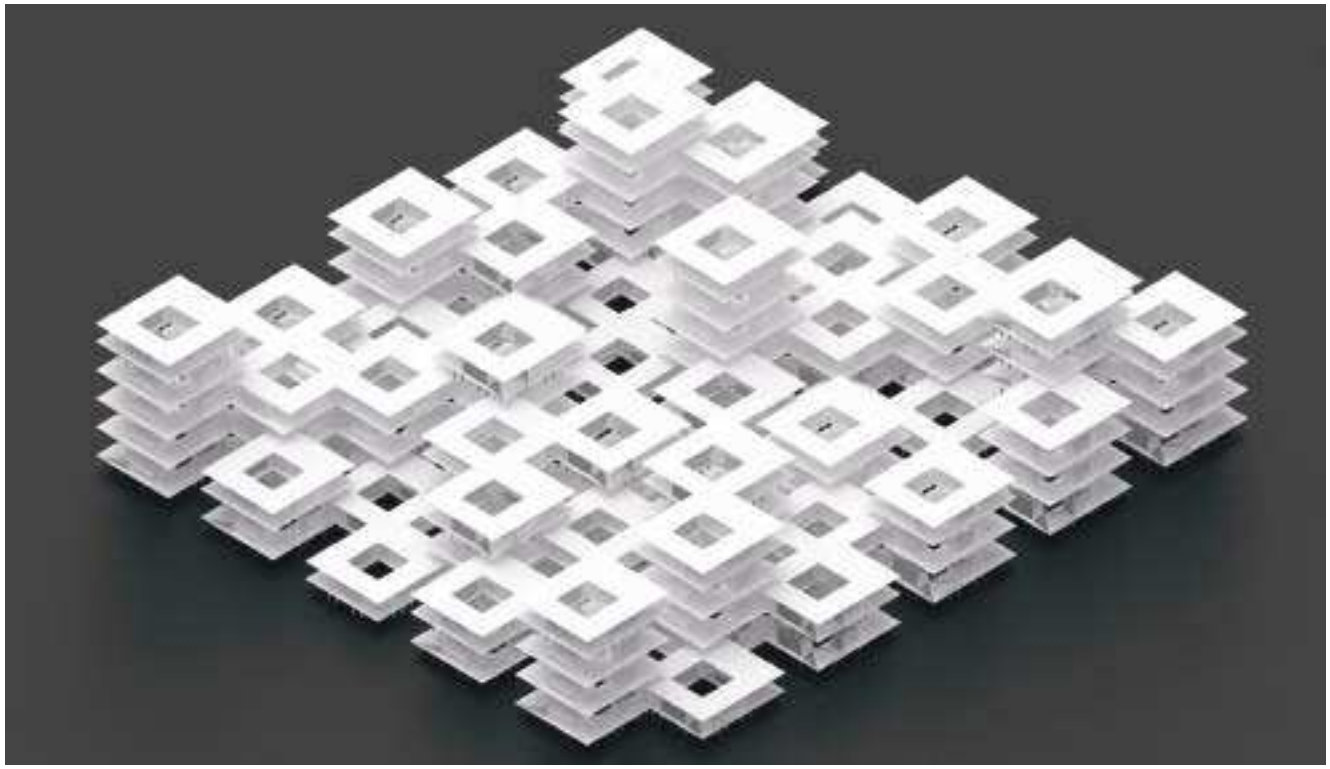
The Community Cluster's impact on Micro Climate



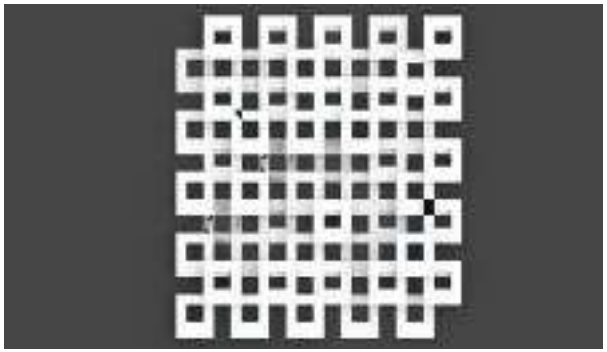

Section- Stack Effect



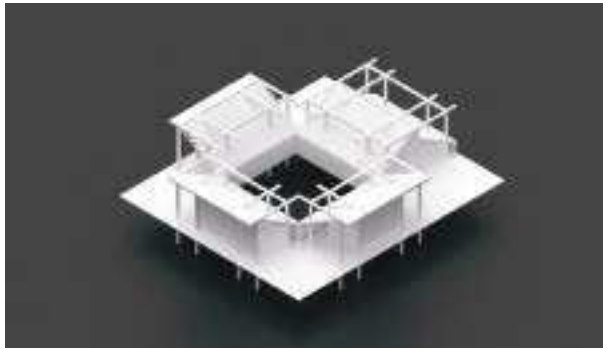

Plan- Venturi Effect



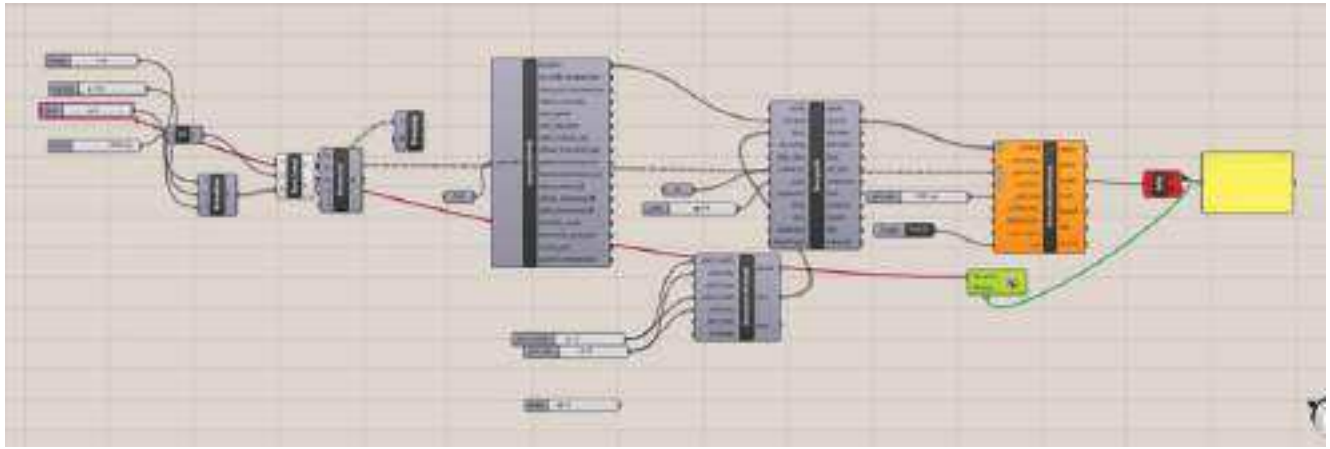
Cluster configuration



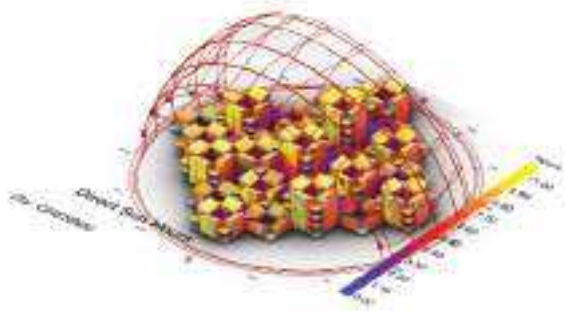
Cluster top view



Cluster unit



Grassopher script



Cluster sun hour analysis

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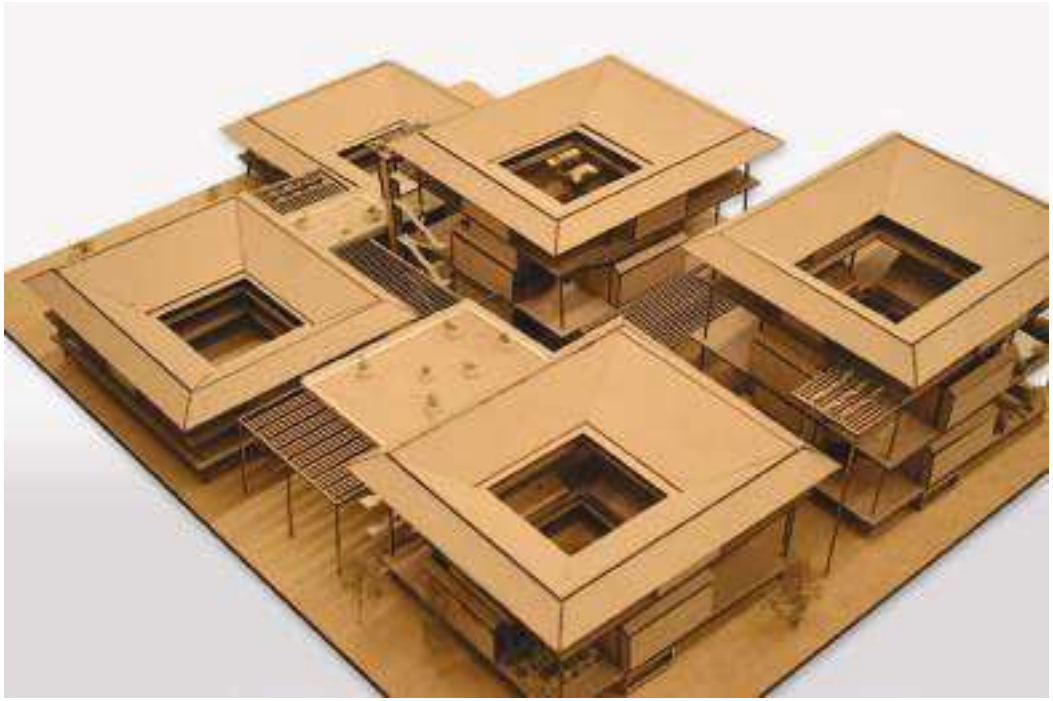

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# OFF-GRID COMMUNITIES
# eco-digital construction for sustainable living

## CONTINENTAL CLIMATE
## Lublin - Poland

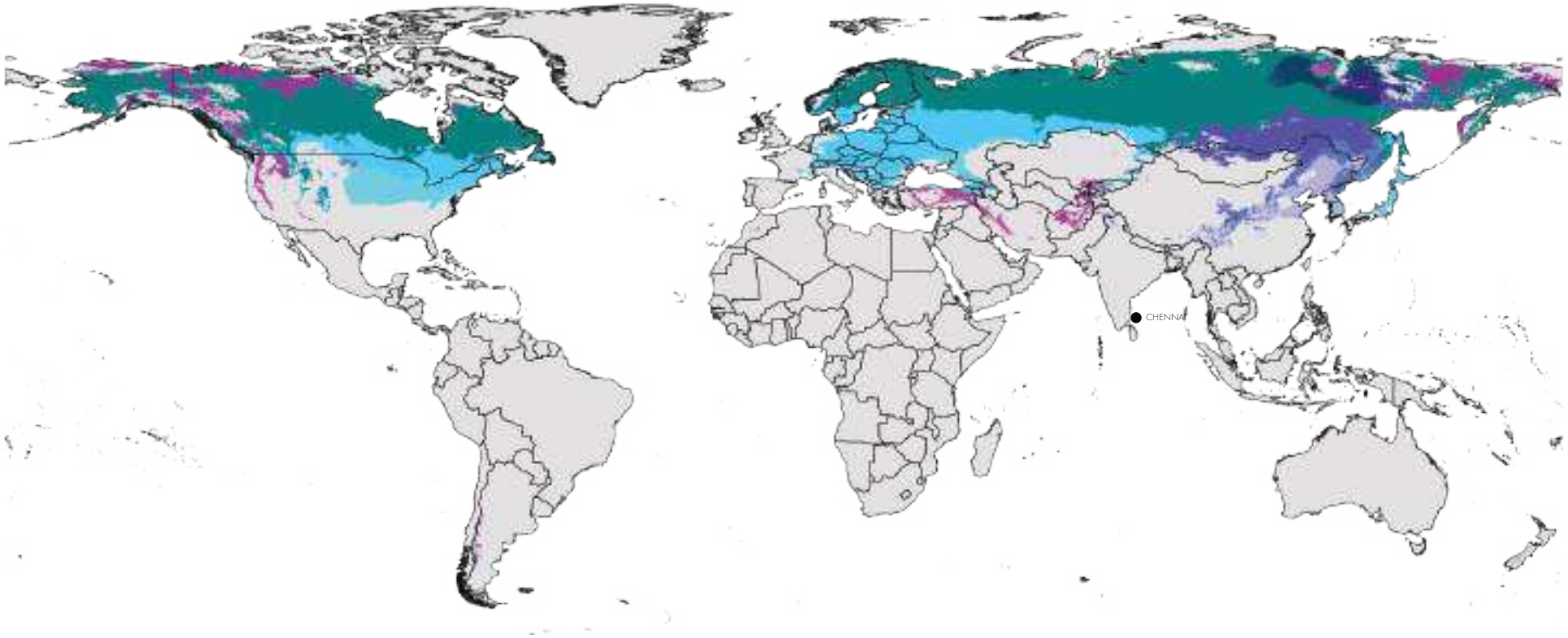
Lublin is the ninth-largest city in Poland and the second-largest city of historical Lesser Poland. It is the capital and the center of Lublin Voivodeship with a population of 336,339. Lublin has a humid continental climate with cold, damp winters and warm summers .In continental climates, precipitation tends to be moderate in amount, concentrated mostly in the warmer months. A portion of the annual precipitation falls as snowfall, and snow often remains on the ground for more than a month. Summers in continental climates can feature thunderstorms and frequent hot temperatures; Places with continental climates are as a rule are either far from any moderating effect of oceans or are so situated that prevailing winds tend to head offshore. Such regions get quite warm in the summer, achieving temperatures characteristic of tropical climates but are colder than any other climates of similar latitude in the winter.

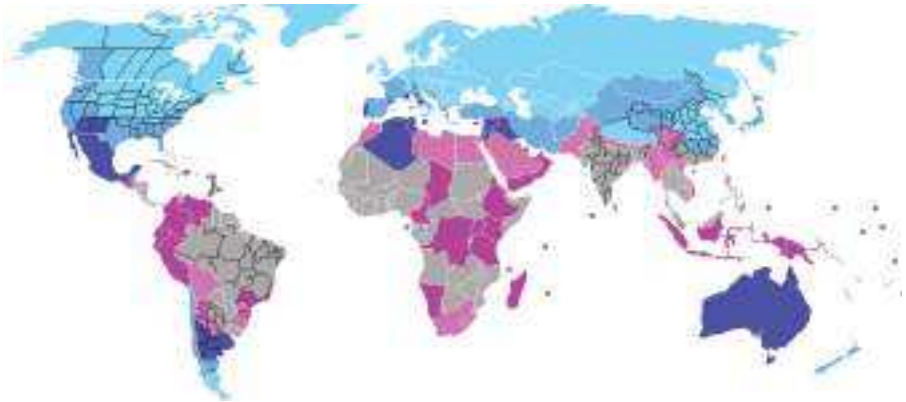
The plurality of climate characteristics determin that the panel system need to deal with both the hot summer and cold winter, to provide suffient insulation in winter and ventilation in summer. Therefore the panel has a operational double-skin with double openning. The size of the openning on the winter layer is sunlight condition to maximize the sunlight intake and reduce the heat loss. The thickness of panel is determined by rediation and varies among the location of the house. During summer the outer layer will be lift up to create shadow and allow the wind to come into the house. During the winter, out layer will cover the facade with extra insulation to reduce the heat loss.

The housing unit is the result of the simulations according to different parameters. Due to the climatic conditions, it is essential for the individual apartments to be as compact as possible while providing the necessary comfort conditions for the residents. Therefore, the origin unit type A, hosts two people in a space of 36 sq.m. with a grid of 6 m by 6m. All other housing units are developed according to this proportion with the addition of one or more bays of 3 meters. The different units are then combined into a single house unit the roof of which changes according to the sun angle, orientation and light availability in the spaces.

The main driver around the arrangement of the cluster is the annual exposure to sunlight. The main aim behind the layout is to position the units in a way which ensures maximum sun light and as result optimal energy collection throughout the year. Each village would comprise a series of buildings with attached greenhouses, creating spaces where families can grow fruit and vegetables, farm aquaponics or recycle waste products. They would also integrate sustainable energy technologies, producing all their own electricity. The ambition behind the project is to facilitate the development of off-grid, integrated and resilient neighborhoods that power and feed self-reliant families around the world.

**ASA STUDENTS:** DAVIDE FRANCESCO AVESANI · DENIS KAPITANOV · ZIRONG SONG
MILENA SHARKOVA · MONA NHEILI · MARCO STRINGHETTI



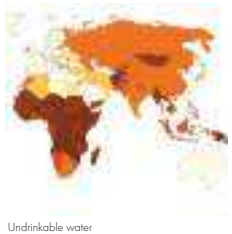
Sub-climatic zones within the climate zone;

- Snow below 1000m over sea level
- Snow only above 1000m over sea level
- Maysnow below 1000m over sea level but rarely

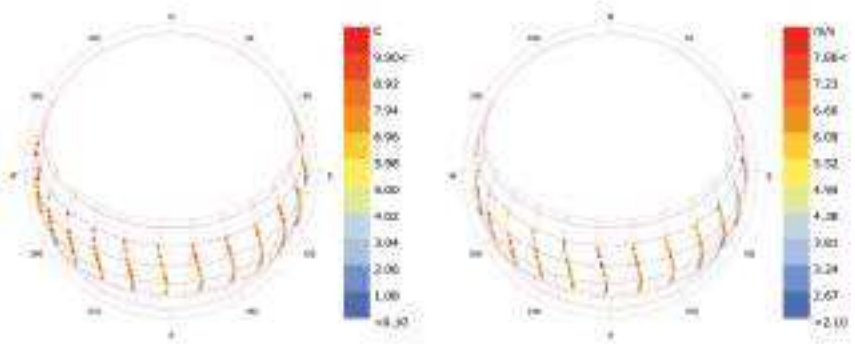
Main Influx of Refugees

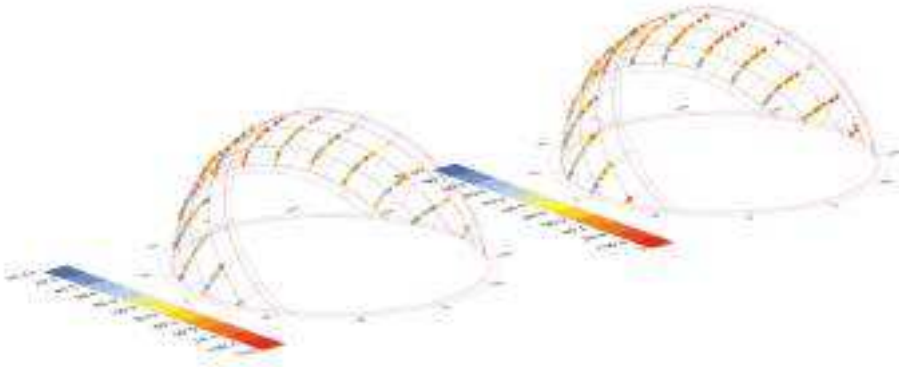

CLIMATE CHANGE

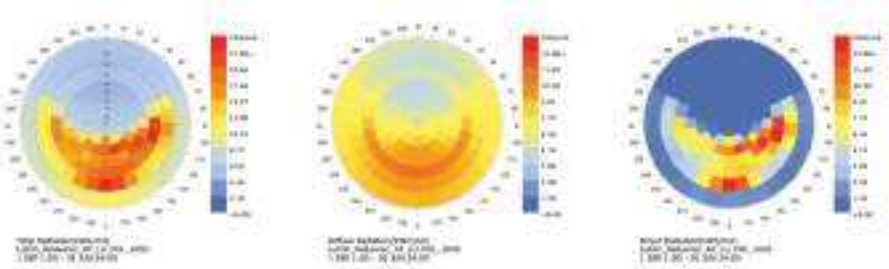

AIR POLLUTION

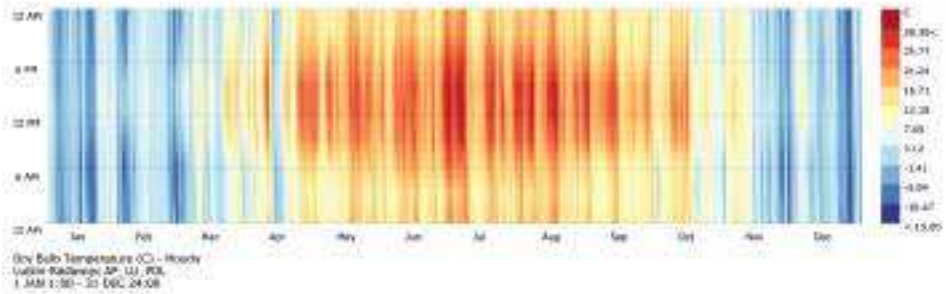


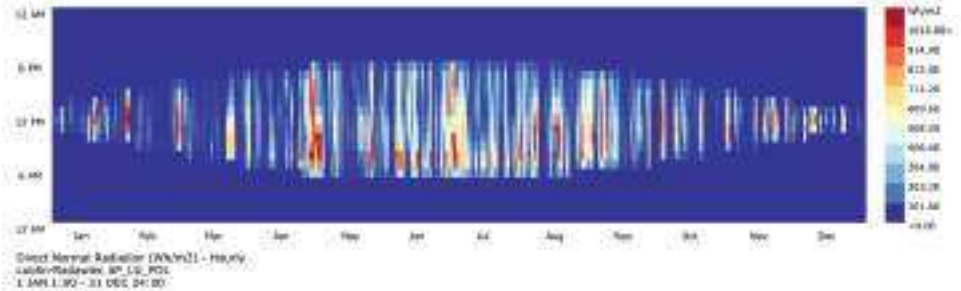

WATER POLLUTION

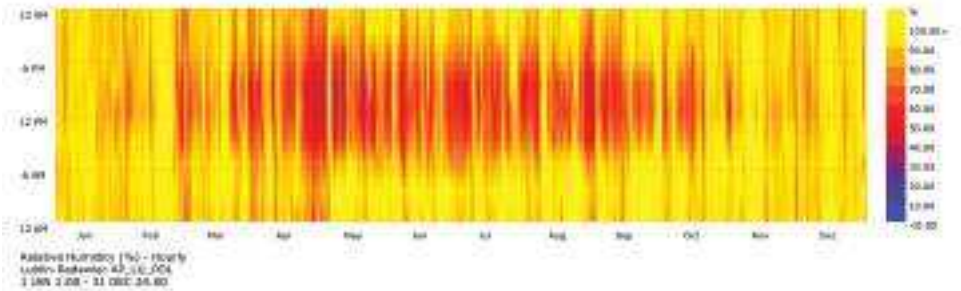




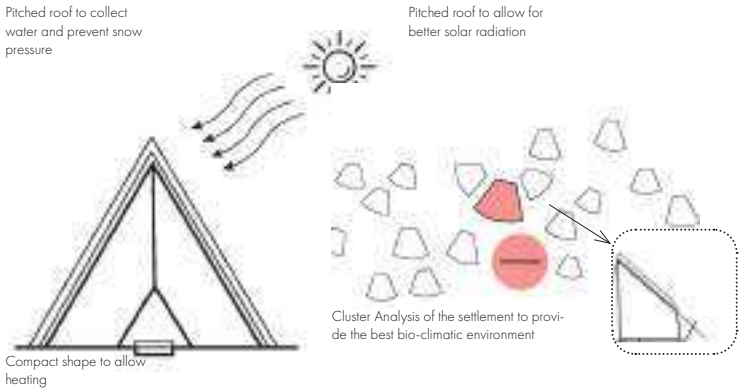


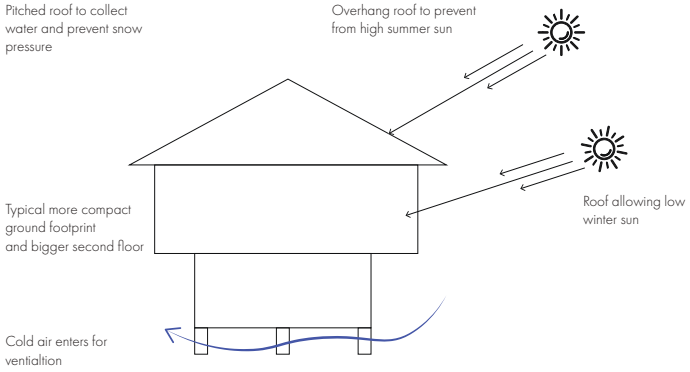


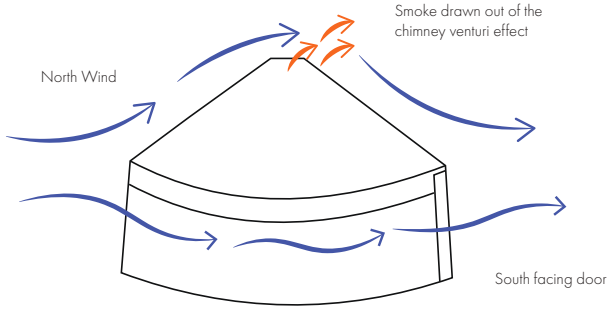




# ANALYSIS




## VERNACULAR

Lepenski Vir Neolithic Vernacular Houses

Traditional Scandinavian House

Traditional Yurt from Jazakhstan

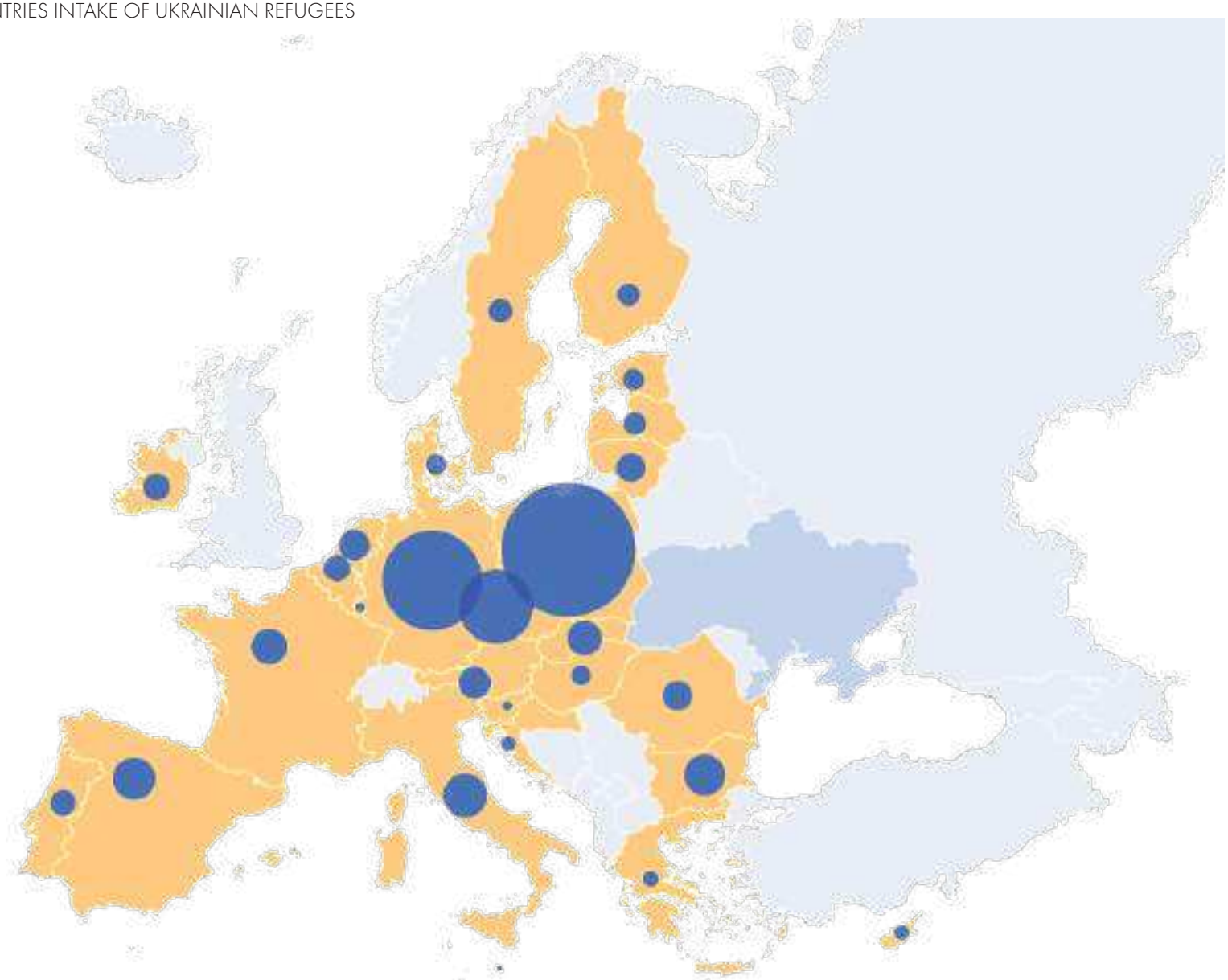
## CONTEMPORARY EXAMPLES

Dekleva Gregoric-Chimney House

Glenn Murcutt Marika-Alderton House

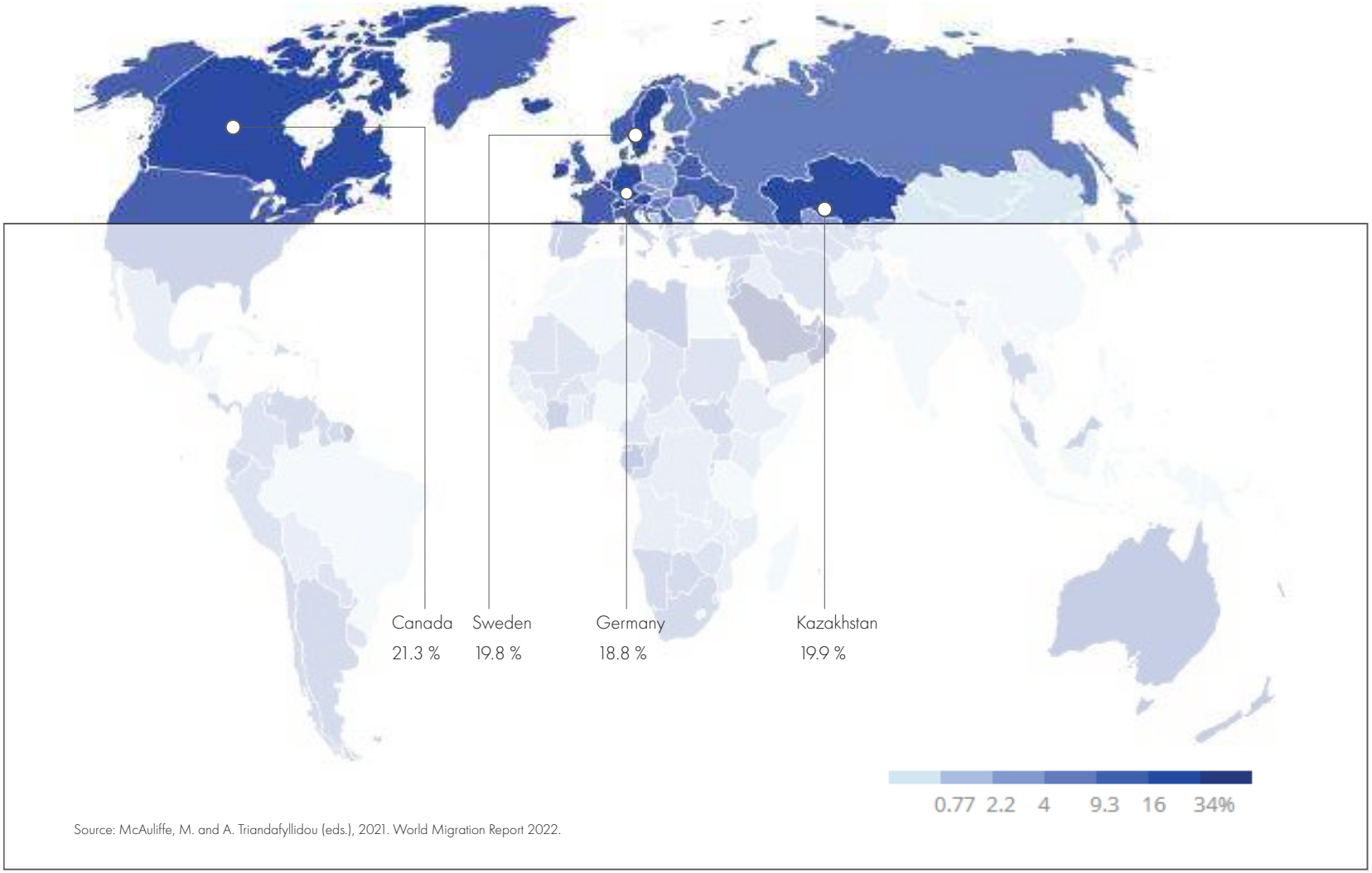
Gray Organschi Architecture-Ecological Living Module

EU COUNTRIES INTAKE OF UKRAINIAN REFUGEES



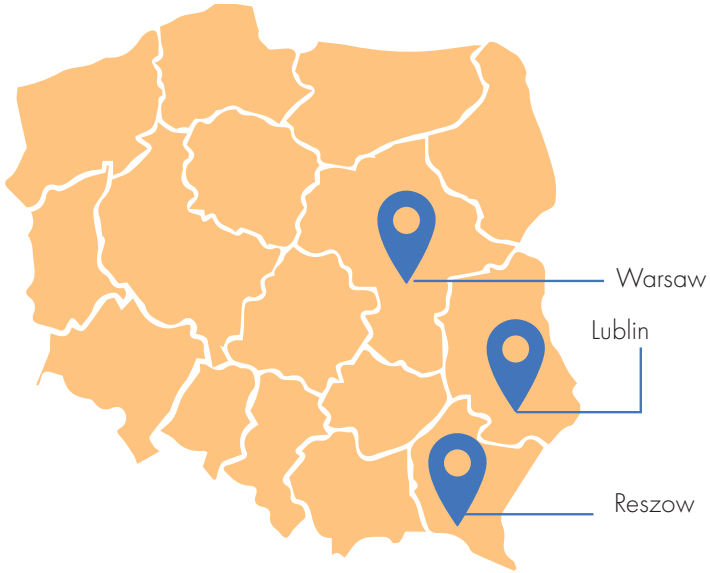
Source: McAuliffe, M. and A. Triandafyllidou (eds.), 2021. World Migration Report 2022.

SHARE OF INTERNATIONAL MIGRANTS IN EACH COUNTRY

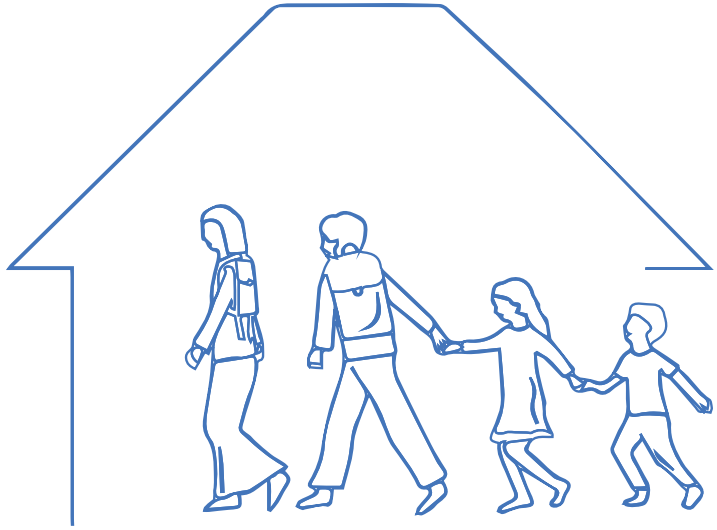



Source: McAuliffe, M. and A. Triandafyllidou (eds.), 2021. World Migration Report 2022.

CITIES IN POLAND INTAKE OF UKRAINIAN REFUGEES

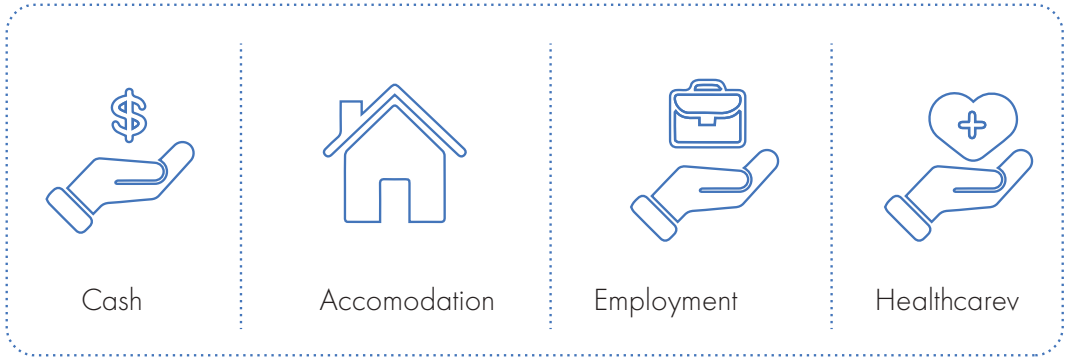


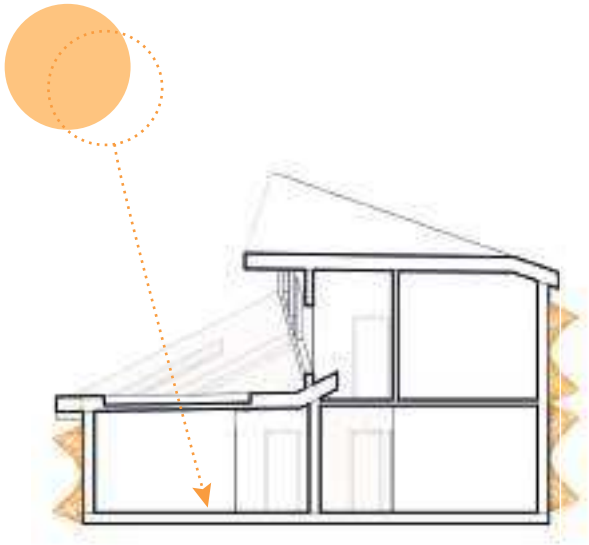

Main cities in Poland with the most refugees



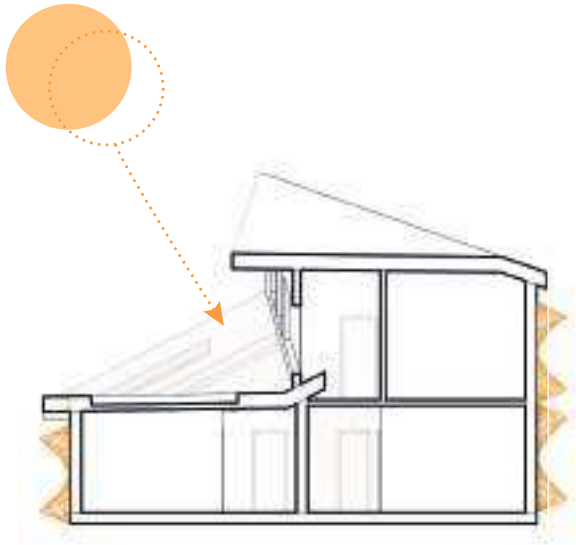
Top reasons for staying: Safety, Family ties, Temporary protection

ESSENTIAL NEEDS OF UKRAINIAN REFUGEES IN POLAND

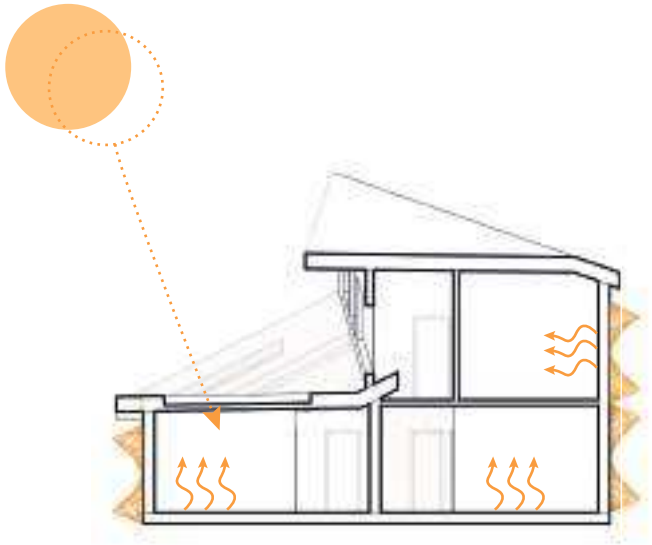




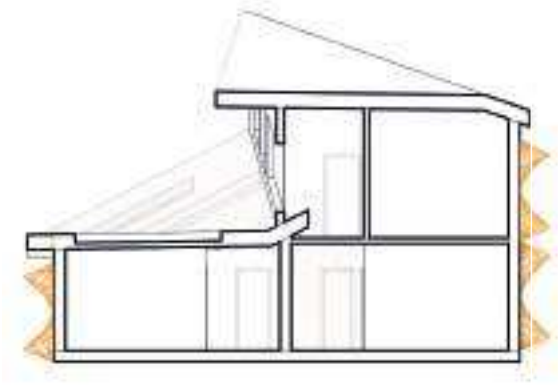
Daylight optimization of all units
in order to reduce electricity consumption



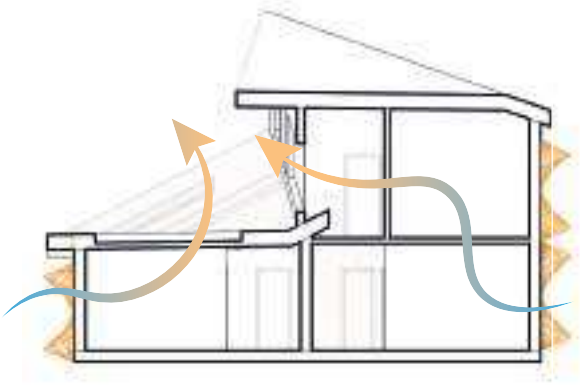
PV panels for generating energy for the residents



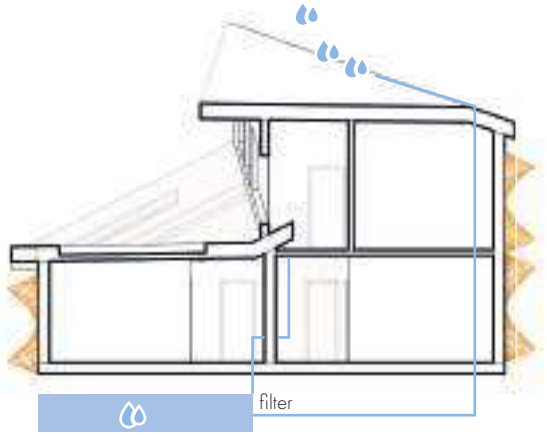
Thermal mass keeps cool in the summer and warm in the winter



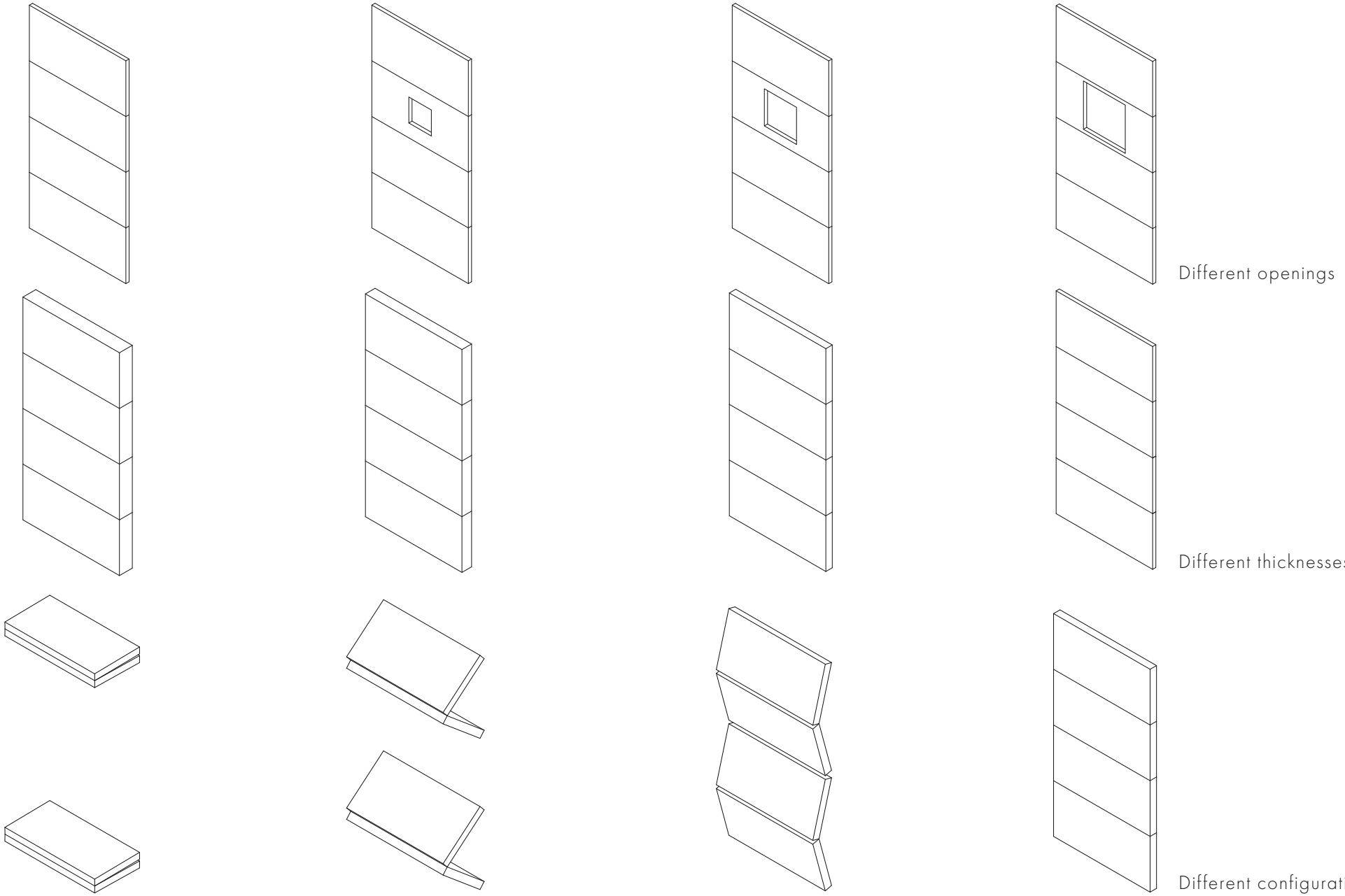
Sustainable, pre-fabricated materials like CLT minimize construction carbon footprint



Natural cross ventilation reduces the needs for mechanical ventilation




Water collection to use for grey waters and plant watering

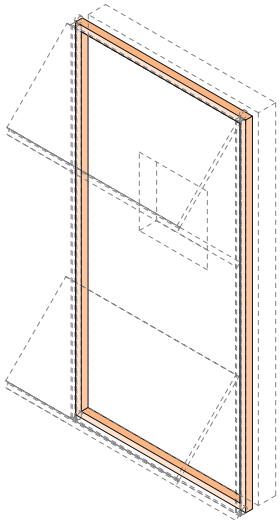


Different openings

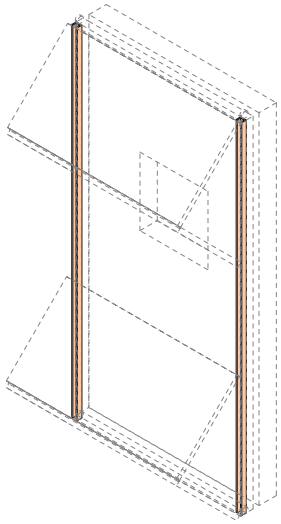
Different thicknesses

Different configurations

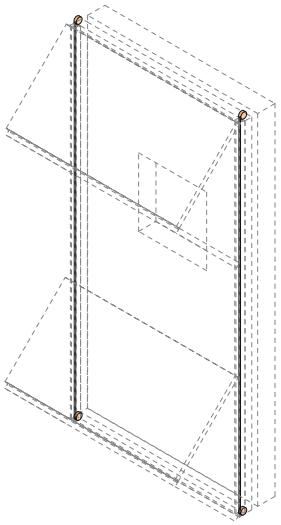
## MOVING PANEL



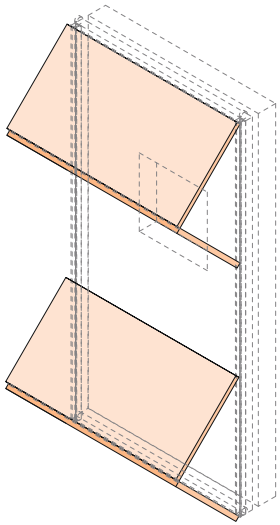
Structural part



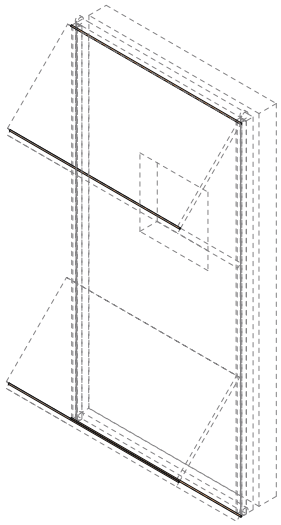
U-shape profiles



Wires and Motors

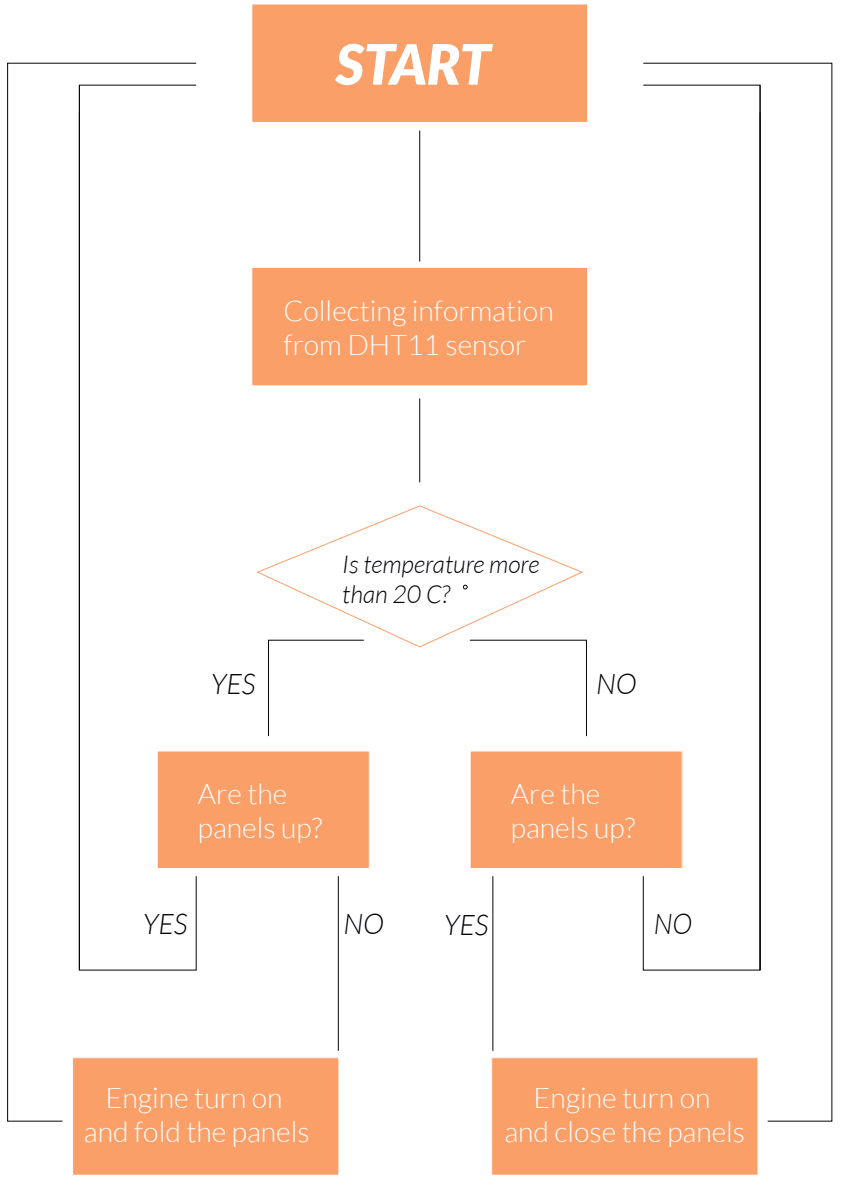


Panels

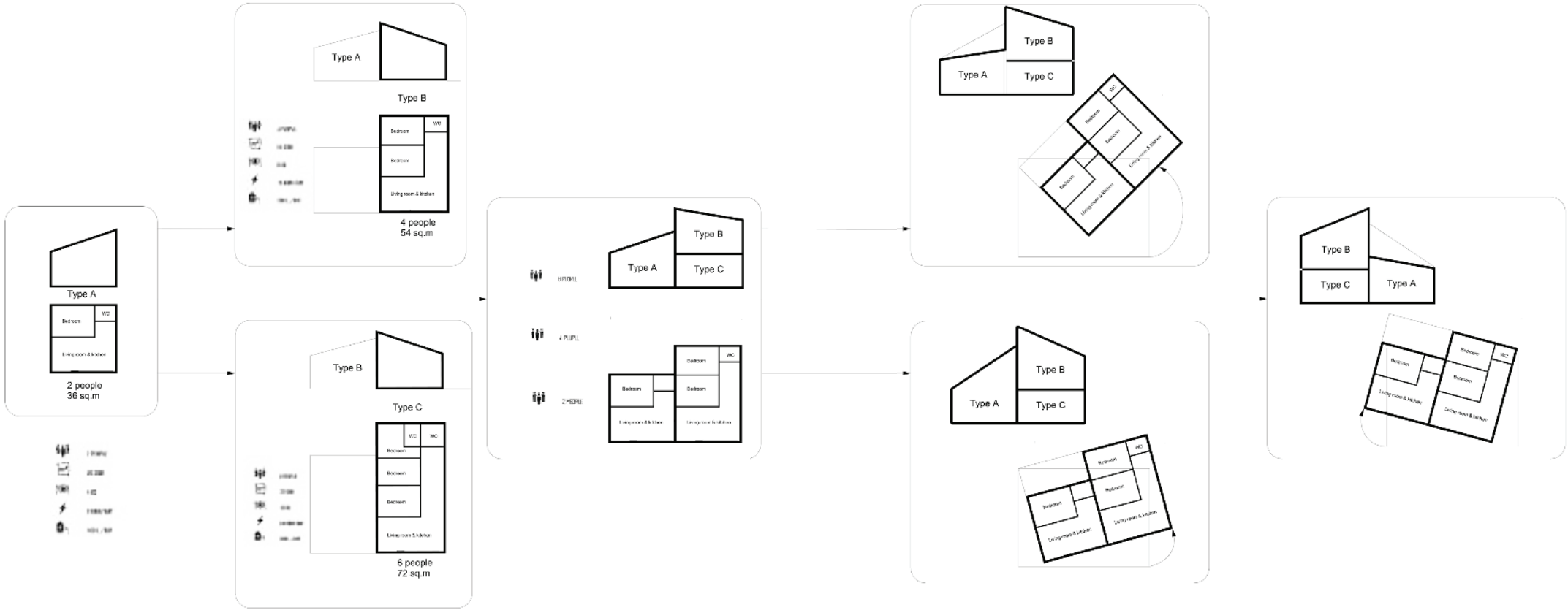


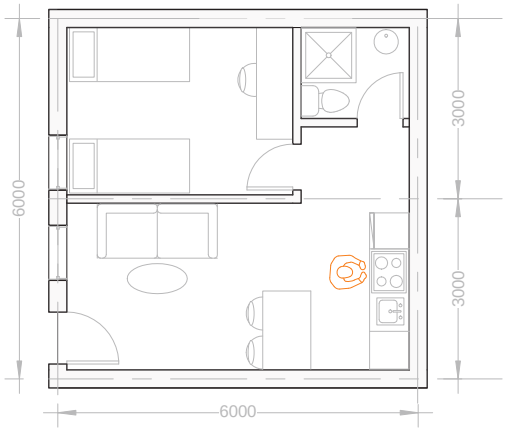
Pivot

## FLOWCHART

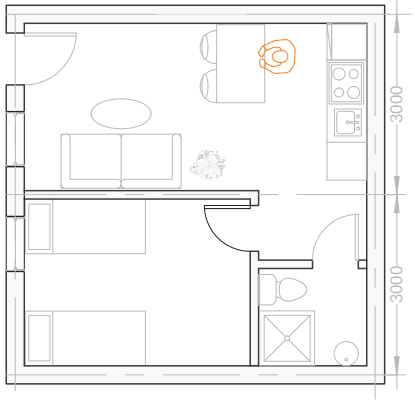


TYPOLOGIES

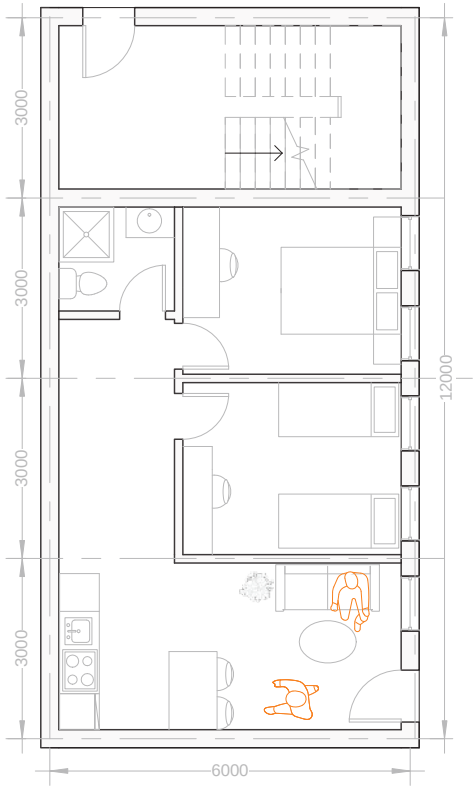

Type A
2 people
36 sq.m
Type A
Type B
4 people
54 sq.m
Type B
Type C
6 people
72 sq.m
Type A
Type B
Type C
Type A
Type B
Type C
Type B
Type C
Type A



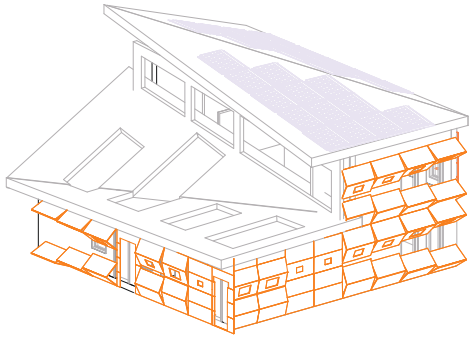

Two-person unit | Configuration 1

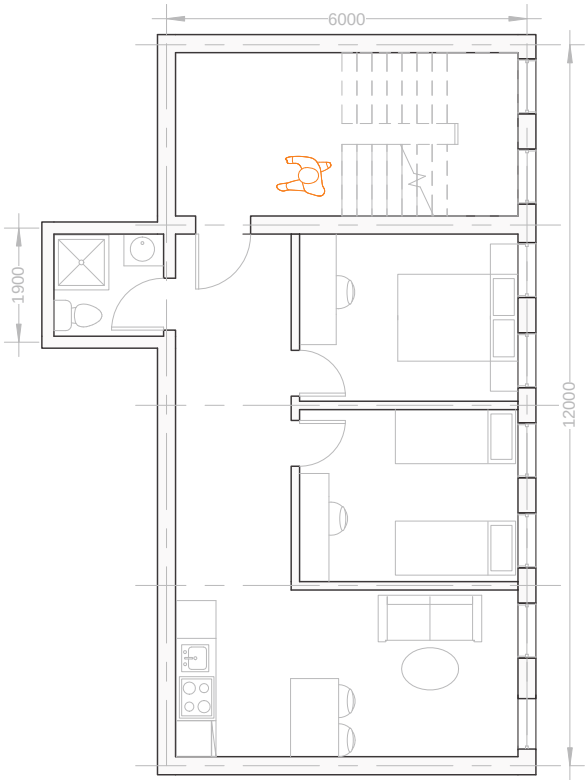



Two-person unit | Configuration 2

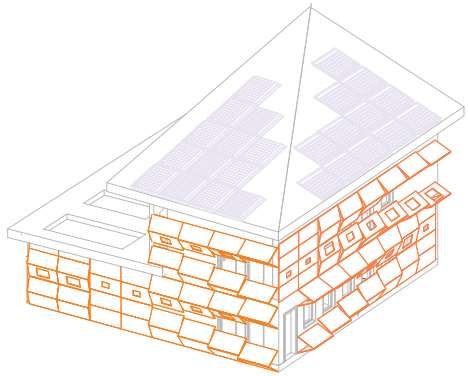


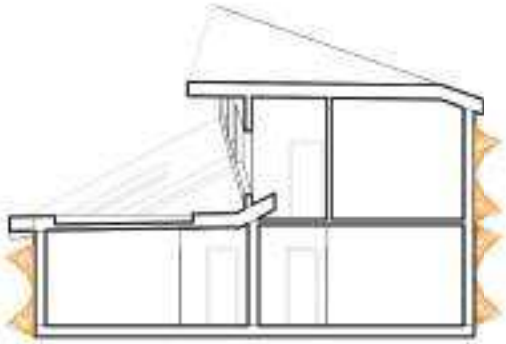

Three/Four-person unit | Configuration 1



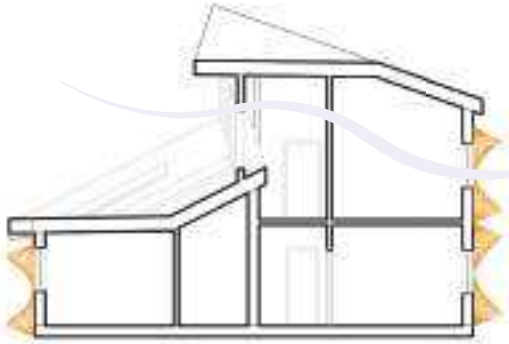



Three/Four-person unit | Configuration 2

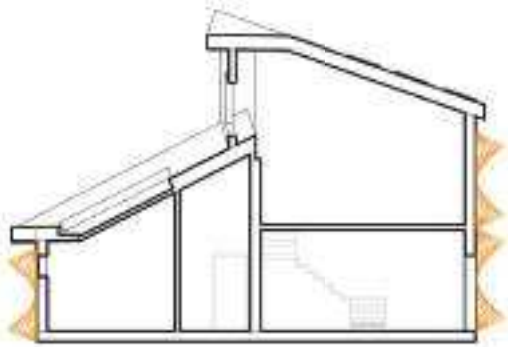




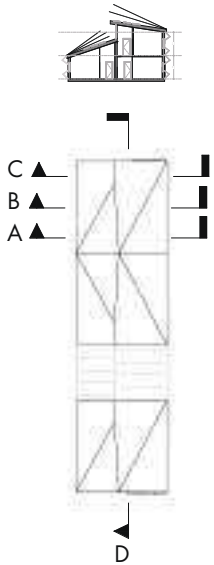
Section A

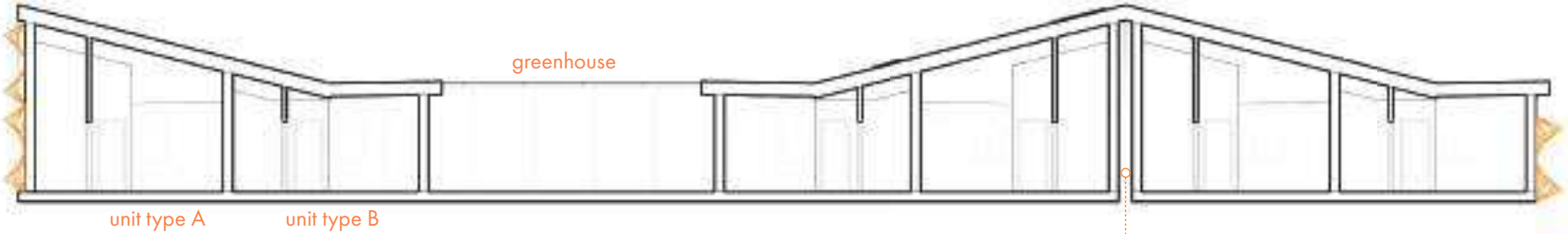


Section B

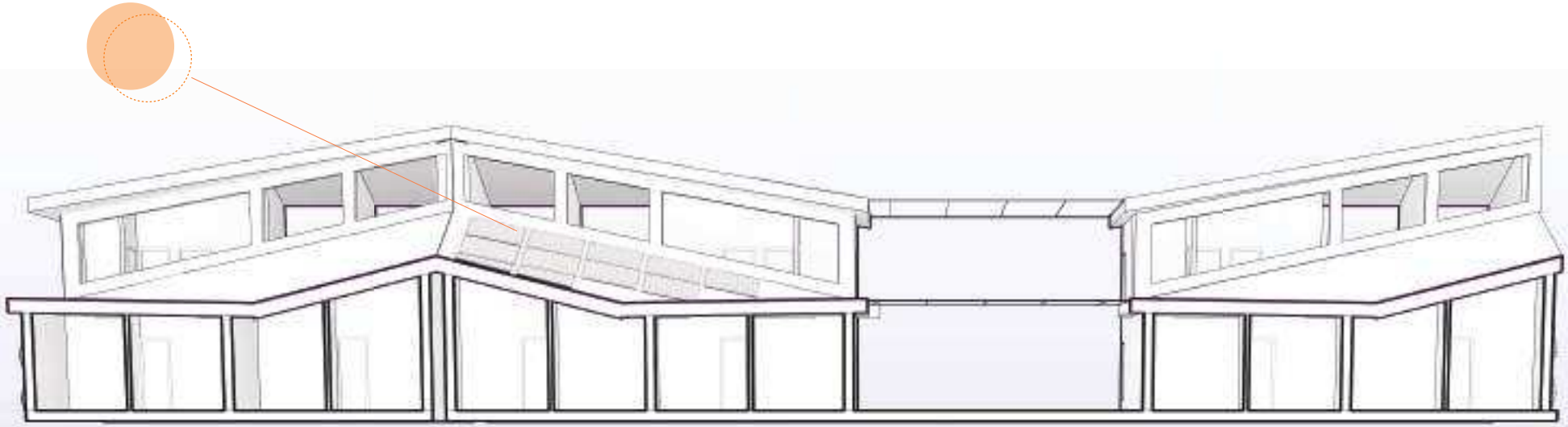


Section C



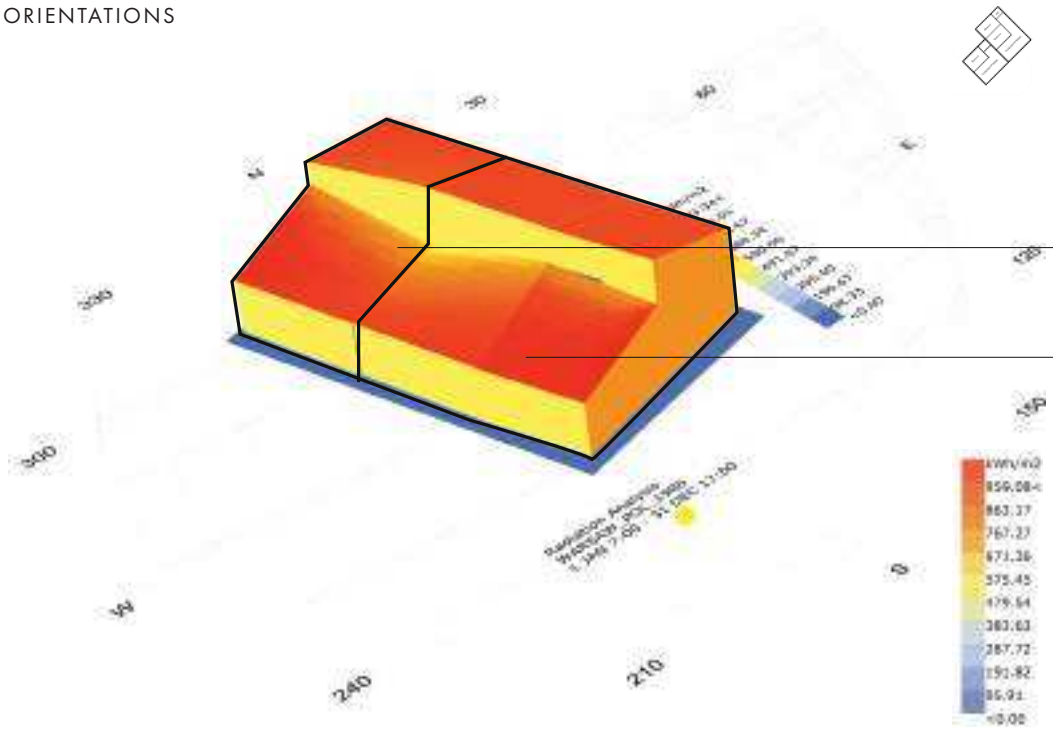



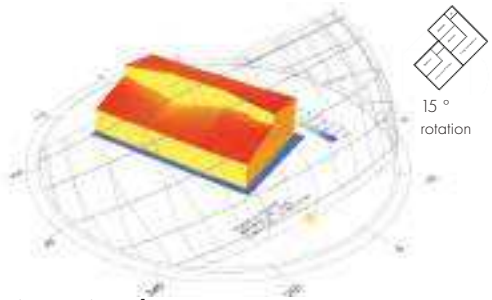

Section D



Perespective Section

ORIENTATIONS





15 °
rotation

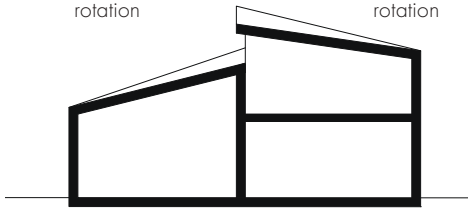
Orientation 1

30 °
rotation

Orientation 2

15-20 °
rotation

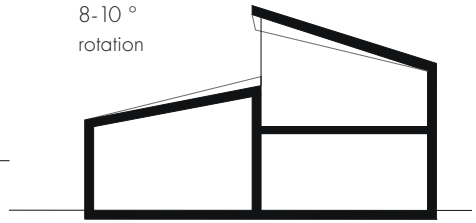
8-15 °
rotation



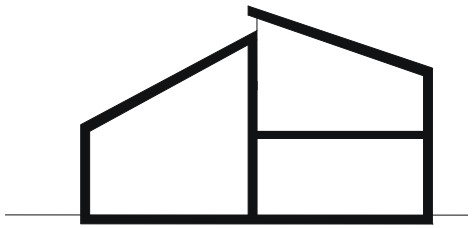
Unit C+B

20-25 °
rotation

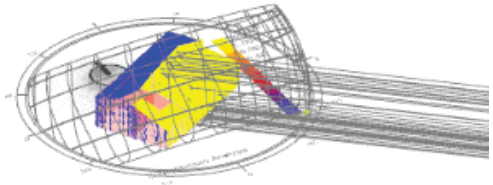
8-10 °
rotation



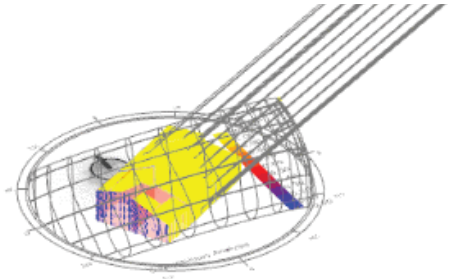
Unit A+B



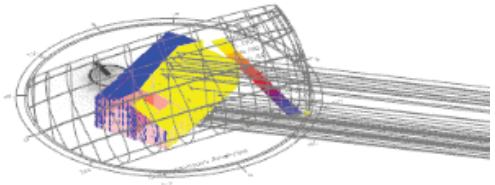
Non-residential unit



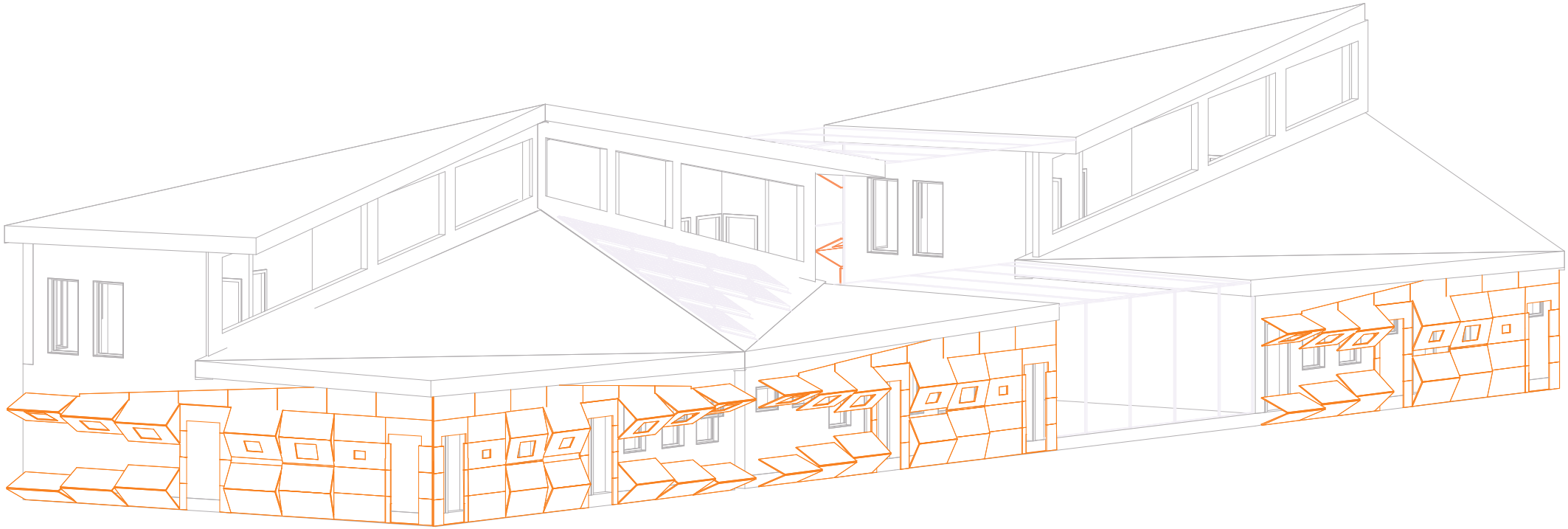
Winter Solstice



Sumer Solstice



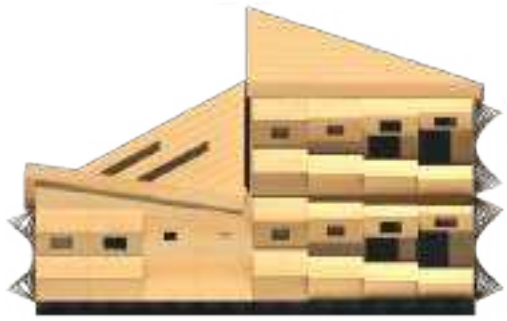
Spring Equinox



Roof change according to the different parameters and cluster configuration

Render 1

Render 2

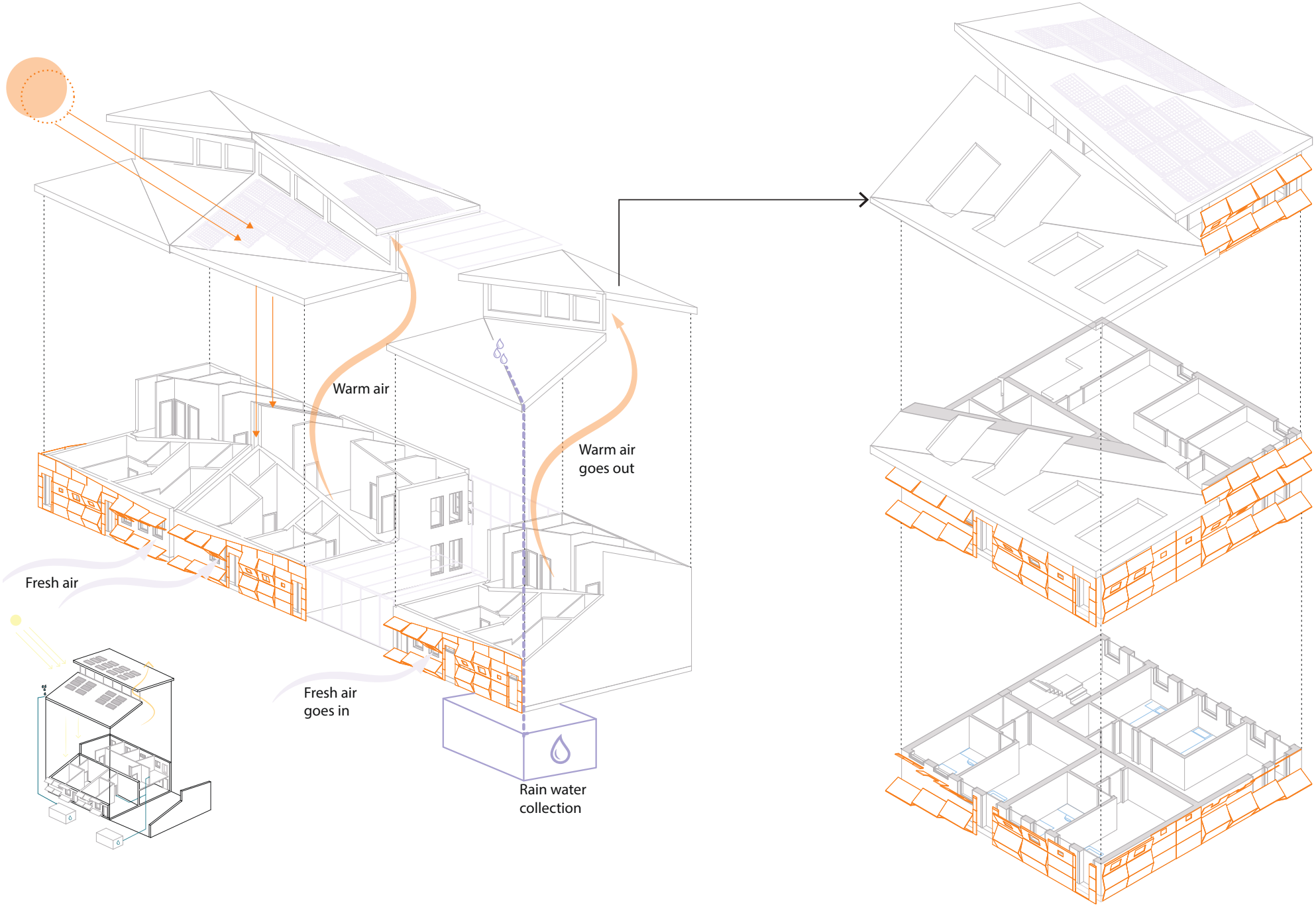


Elevation 1

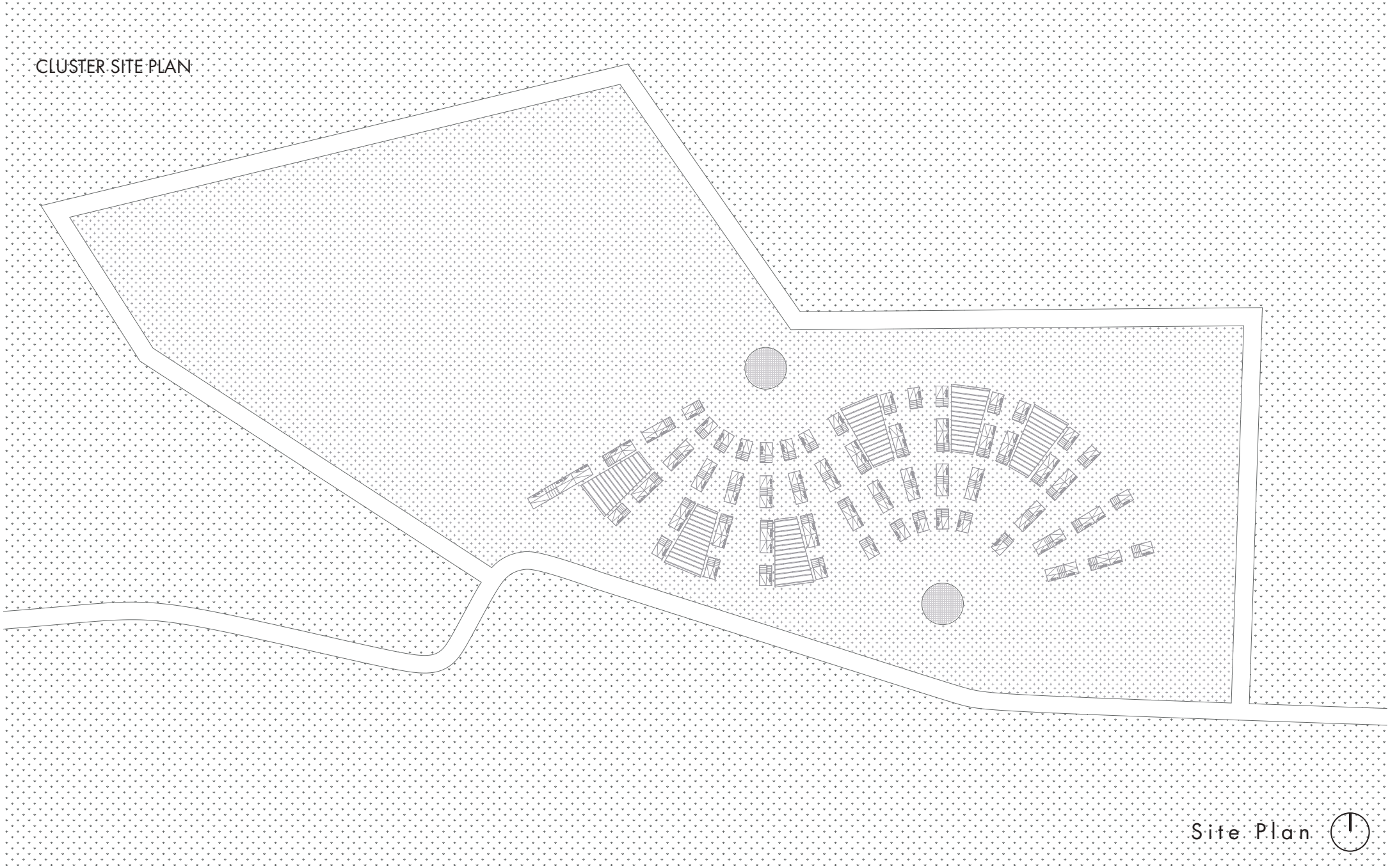
Elevation 2

Elevation 3

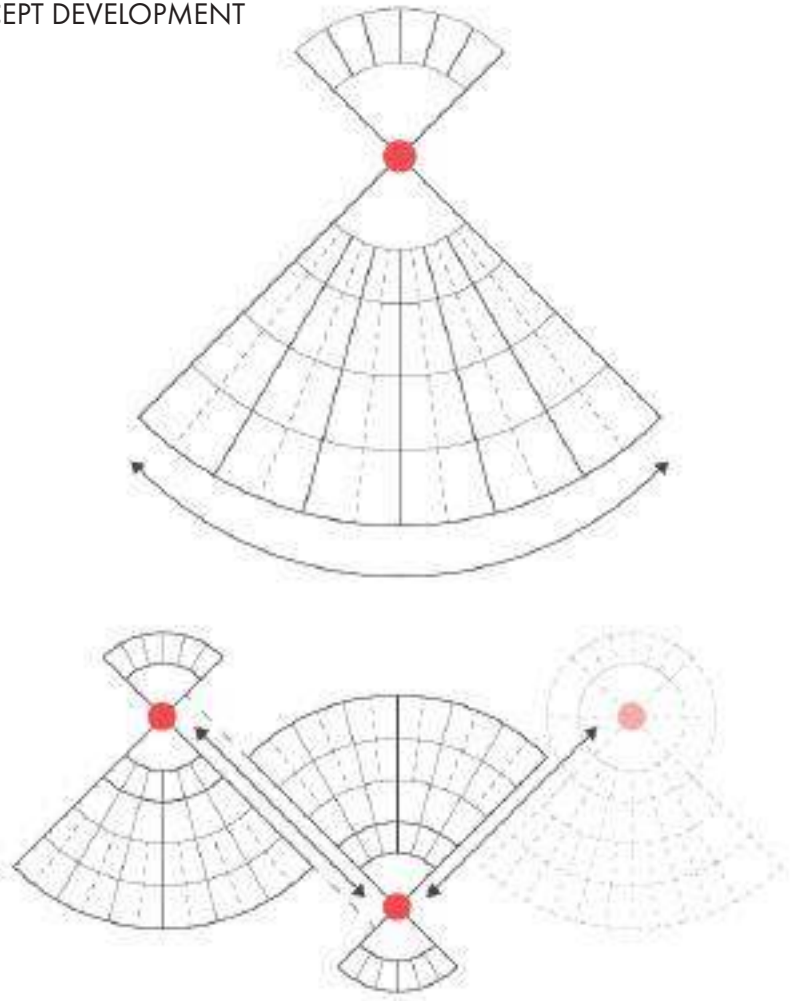
Elevation 4


Warm air
Warm air goes out
Fresh air
Fresh air goes in
Rain water collection

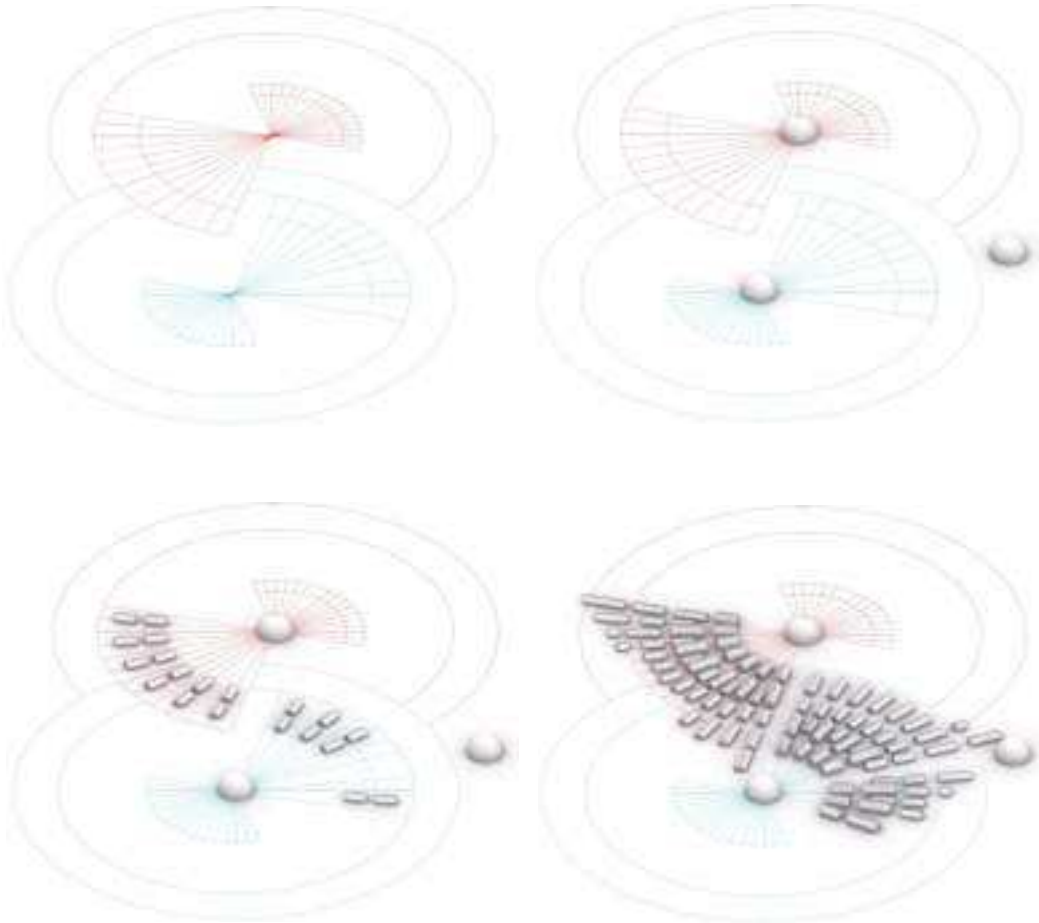
CLUSTER SITE PLAN



## CONCEPT DEVELOPMENT

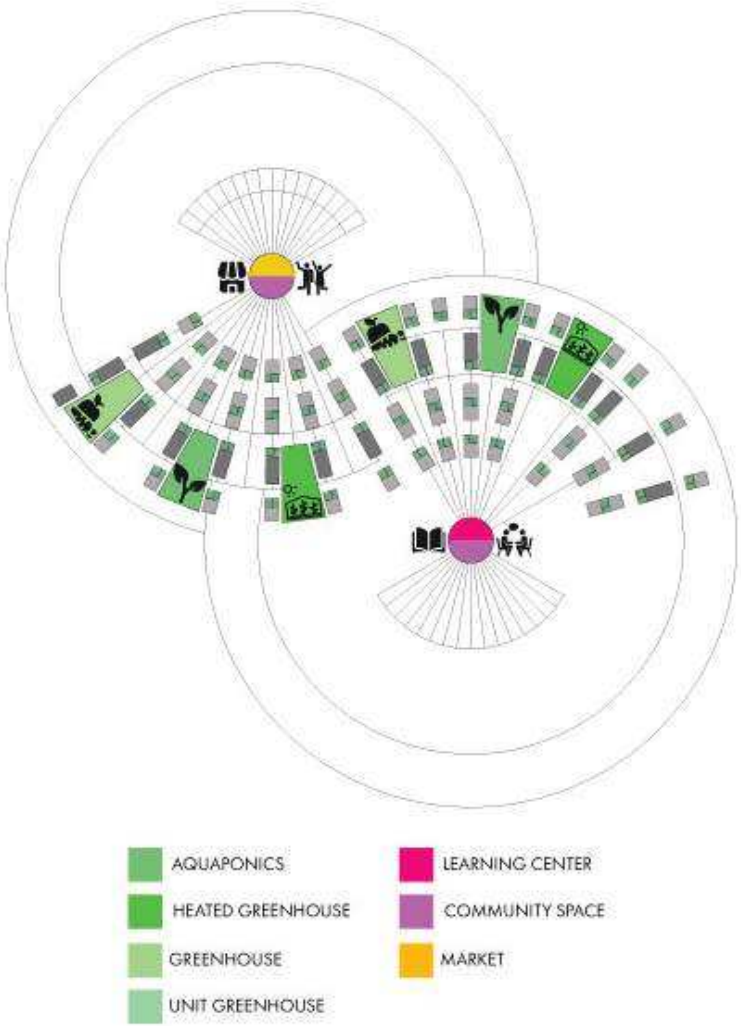


Cluster strategy

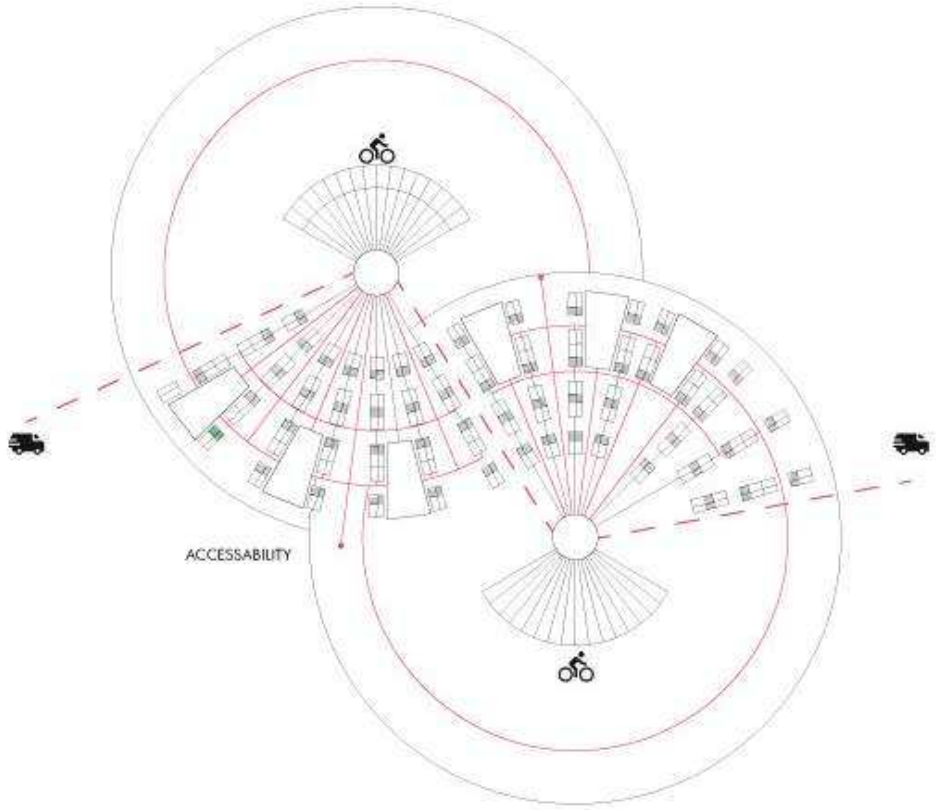


Concept Development in four stages

## PROGRAM AND ACCESIBILITY



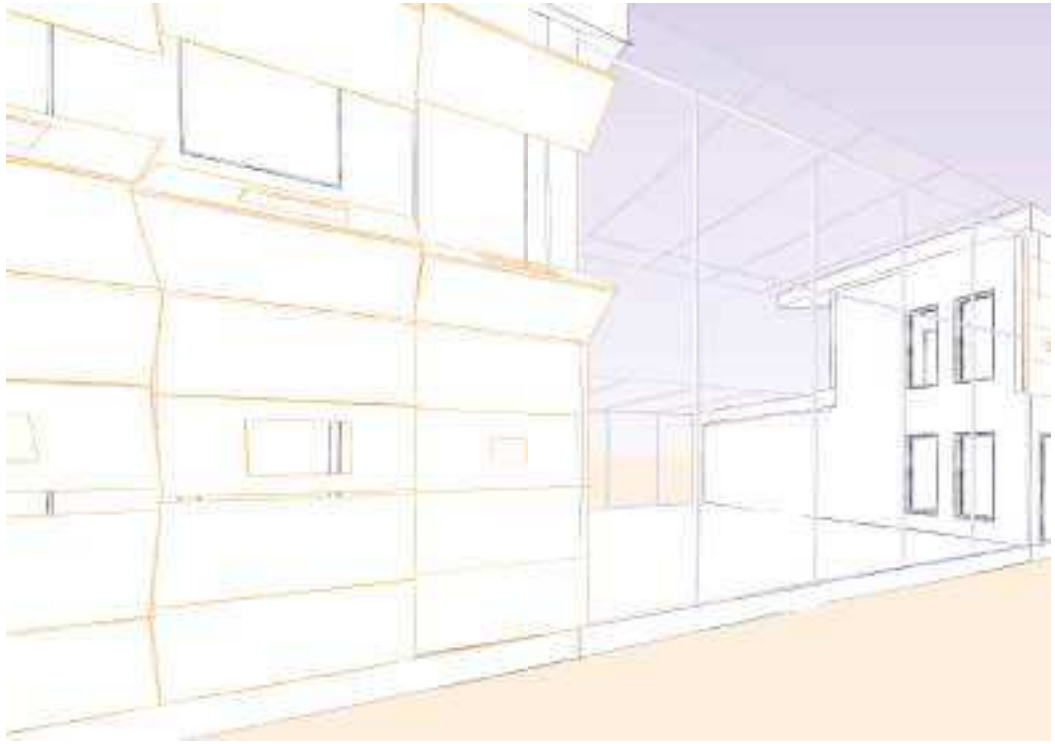

Program distribution




Cluster Accessability

CLUSTER COLLAGE

Section collage



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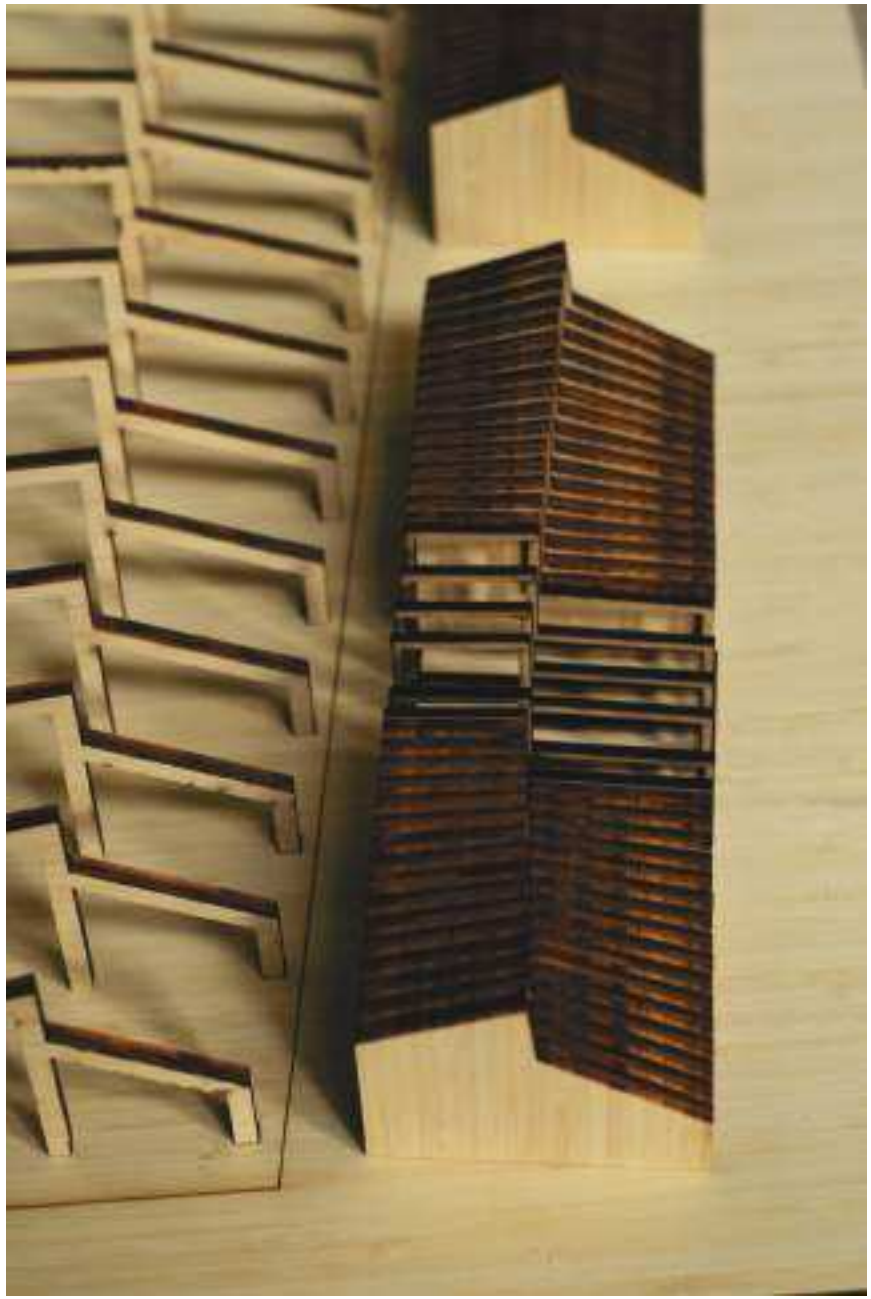


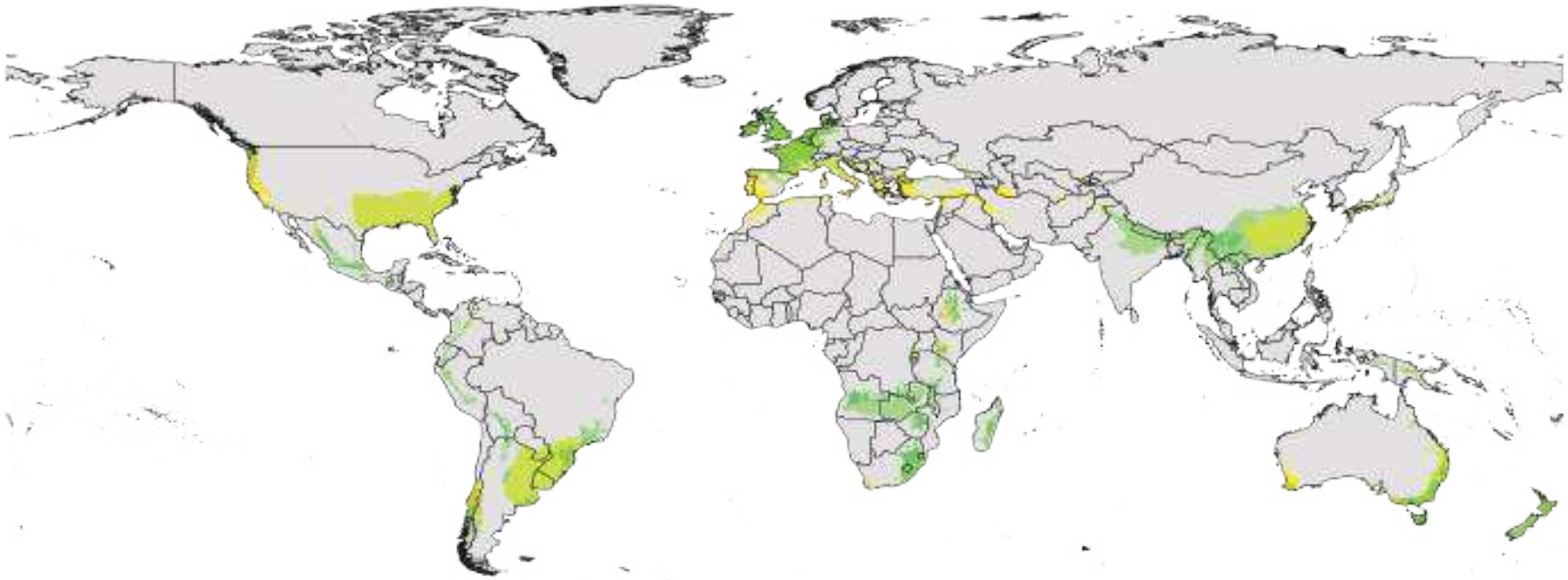
# OFF-GRID COMMUNITIES
# eco-digital construction for sustainable living

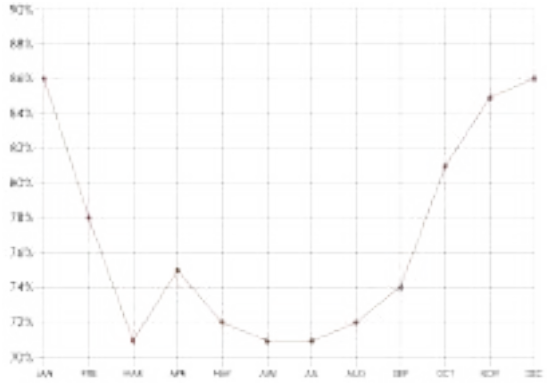
## TEMPERATE CLIMATE
## Milan - Italy

Milan is a metropolitan city in northern Italy characterized by a temperate climate. Selecting Milan as a climatic zone to study means investigating its increasing humidity and irregular rainfall. How do these characteristics influence the design of housing in Milan? Previously, housing typologies such as the urban farm of the Cascina has proved how a society can function autonomously through a clean and efficient relationship between the earth and its architecture. However recently, Milan has experienced a phenomenal demand of student housing that has been only met by increasing prices of properties to an unaffordable extent.

This proposal introduces an intervention that combines a passive environmental solution and a mass-produced technique of fabrication of elements of architecture to create a sustainable and dynamic mode of living in a city such as Milan. From the individual panel design, a rotating turbine is attached at certain instances and is activated by the force of wind and acts as a catalyst to generate power for the photovoltaic cells on the roof to function and supply heating for the building. Simultaneously, this system acts as the cooling mechanism for the building, its public spaces, and its inhabitants.
Combining several panels together creates 4 types of housing units that accommodate different users. The method of joinery - slit joinery technique - is designed to be user-friendly and easily mantled and dismantled. Thus, housing units can adapt to the need of the user in terms of varying demand of internal and external space. To ensure that a housing unit can maintain its livelihood as well as contribute to a more environmentally friendly impact on the entire building system, green production spaces are introduced.
The different types of clusters are assembled to form micro communities on different floors. Eventually, these floors form towers of varying heights, and in parallel, the towers are joined together by bridges of units serving public functions. Other technical facilities are embedded inside this complex, such as rainwater collection systems.
In terms of the ground floor, it belongs to the city. A porous and free ground floor that is designed around varying topographies and water features can be accessible by all. In this sense, the system is complete.

**ASA STUDENTS:** SARA IBRAHIM · ALICE MILONI · NEHIR ÖZDEMIR
SELIN YAVUZ · ANDREA DI TOMMASO · GABRIELE LICCIARDI



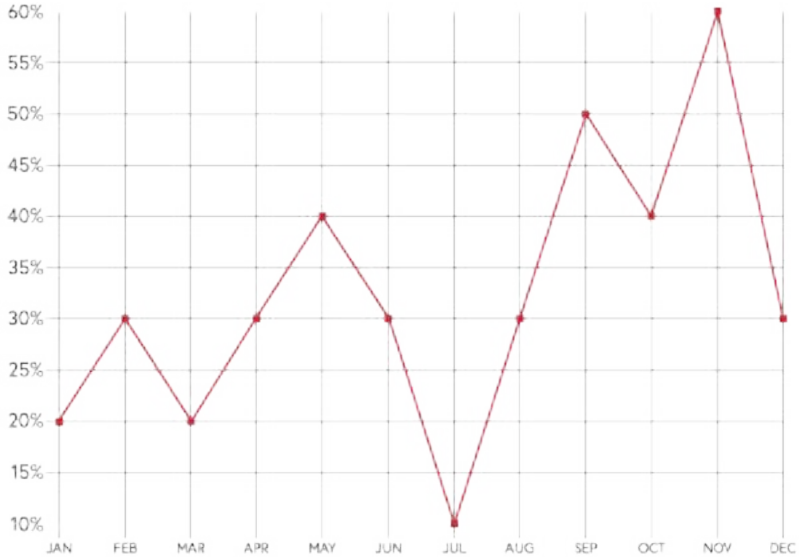


Average Relative Humidity - Milan

Consecutive Days Without Precipitation - Milan

Temperature Anomaly - Milan

Rainfall indicators based on monthly data collection in Milan.
The length of rainless periods can also lead to significant impacts in urban areas with regard to the functionality of certain components, including, for example, water supply.




Intense precipitation
number of days with very heavy precipitation [20 mm or more].


Consecutive days without precipitation
monthly average percentage of the maximum number of consecutive days without rain [i.e. with less than 1 mm of rain].with less than 1 mm of rain].


Maximum monthly precipitation
the maximum amount of precipitation in one day.

## SPRUCE (Air Dry)

**Density (kg/m3):** 390
**Specific gravity (12% m.c.):** 0.36
**Hardness (N):** Side: 1880
End: 2470
**MOE (Mpa):** 9930
**MOR (Mpa):** 62.7
**Compression parallel (Mpa):** 36.9
**Compression perpendicular (Mpa):** 3.45
**Shear (Mpa):** 6.79
**Cleavage (N/mm width):** 38.7
**Shrinkage:** Radial (Oven Dry): 3.2%
Tangential (Oven Dry): 6.9%
Volumetric (Oven Dry): 11.3 %
Volumetric (Air dry): 6.8 %
**Shaping**: Good shaping quality.
**Sawing**: Easy to work with both hand and power tools.
**Screwing:** Very good resistance to splitting.
**Natural decay resistance:** Non-resistant to heartwood decay.

## DOUGLAS FIR (Air Dry)

**Density (kg/m3):** 487
**Specific gravity (12% m.c.):** 0.45
**Hardness (N):** Side: 2990
End: 4020
**MOE (Mpa):** 13500
**MOR (Mpa):** 88.6
**Compression parallel (Mpa):** 50.1
**Compression perpendicular (Mpa):** 6.01
**Shear (Mpa):** 9.53
**Cleavage (N/mm width):** 38.9
**Shrinkage:** Radial (Oven Dry): 4.8%
Tangential (Oven Dry): 7.4%
Volumetric (Oven Dry): 1.9%
Volumetric (Air dry): 7.0%
**Shaping**: Excellent shaping quality
**Sawing**: Easy to work with both hand and power tools.
**Screwing:** Very good holding. Excellent resistance to splitting.
**Natural decay resistance:** Should not be used in applications with prolonged ground contact without treatment.

## EUROPEAN LARCH (Air Dry)

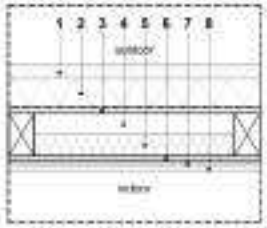
**Density (kg/m3):** 600
**Specific gravity (12% m.c.):** 0.55
**Hardness (N):** Side: 4210
End: 5670
**MOE (Mpa):** 14300
**MOR (Mpa):** 107.0
**Compression parallel (Mpa):** 60.9
**Compression perpendicular (Mpa):** 7.31
**Shear (Mpa):** 9.25
**Cleavage (N/mm width):** 48.0
**Shrinkage:** Radial (Oven Dry): 5.1%
Tangential (Oven Dry): 8.9%
Volumetric (Oven Dry): 14.0 %
Volumetric (Air dry): 8.0 %
**Shaping**: Good shaping quality.
**Sawing**: Easy to work with tools.
**Screwing:** Good. Tends to split in nailing. Excellent holding once nailed. Surpasses Douglas-fir.
**Natural decay resistance:** Should not be used in applications with prolonged ground contact.

## CHESNUT (Air Dry)

**Density (kg/m3):** 590
**Specific gravity (12% m.c.):** 0.50
**Hardness (N):** 3010
**MOE (Gpa):** 8.61
**MOR (Mpa):** 71.4
**Compression parallel (Mpa):** 50.1
**Compression perpendicular (Mpa):** 6.01
**Shrinkage:** Radial (Oven Dry): 4.2%
Tangential (Oven Dry): 6.9%
Volumetric (Oven Dry): 12.6%
**Sawing**: Easy to work with both hand and power tools.
**Screwing:** Splits easily, so care must be taken in nailing and screwing the wood.
**Natural decay resistance:** Rated as durable to very durable, though susceptible to insect attack.

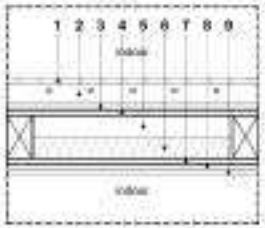
## HORIZONTAL STANDARD ELEMENTS

### FL-R 01



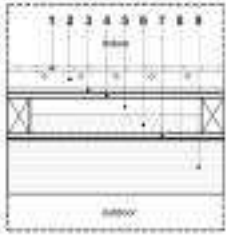
| | Dimension | Material |
|---|---|---|
| 1 | 60 mm | Roof finishing |
| 2 | 125 mm | Insulation in slope |
| 3 | 25 mm | OSB vertical panel |
| 4 | 100 mm | Air cavity |
| 5 | 100 mm | Mineral wall |
| 6 | 25 mm | OSB vertical panel |
| 7 | 15 mm | Air cavity |
| 8 | 20 mm | Interior finishing |

### FL-R 02



| | Dimension | Material |
|---|---|---|
| 1 | 20 mm | Interior finishing |
| 2 | 60 mm | Floating screed |
| 3 | 30 mm | Sound insulation |
| 4 | 25 mm | OSB vertical panel |
| 5 | 100 mm | Air cavity |
| 6 | 100 mm | Mineral wall |
| 7 | 25 mm | OSB vertical panel |
| 8 | 15 mm | Air cavity |
| 9 | 20 mm | Interior finishing |

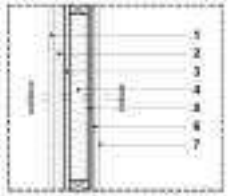
### WA-R 03



| | Dimension | Material |
|---|---|---|
| 1 | 20 mm | Interior finishing |
| 2 | 60 mm | Floating screed |
| 3 | 30 mm | Sound insulation |
| 4 | 25 mm | OSB vertical panel |
| 5 | 100 mm | Air cavity |
| 6 | 100 mm | Mineral wall |
| 7 | 25 mm | OSB vertical panel |
| 8 | | Membrane |
| 9 | 300 mm | Wood beam |

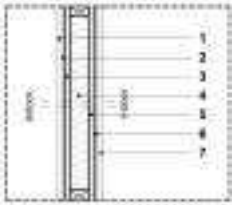
## VERTICAL STANDARD ELEMENTS

### WA-R 01



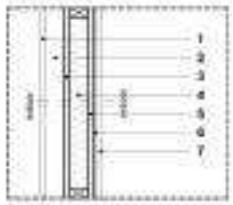
| | Dimension | Material |
|---|---|---|
| 1 | 25 mm | External wooden facade |
| 2 | 60 mm | Thermal insulation |
| 3 | 25 mm | OSB vertical panel |
| 4 | 108 mm | Mineral wall |
| 5 | 25 mm | OSB vertical panel |
| 6 | 15 mm | Air cavity |
| 7 | 20 mm | Interior finishing |

### WA-R 02



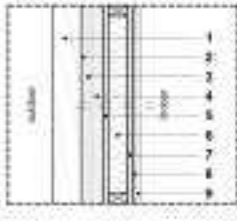
| | Dimension | Material |
|---|---|---|
| 1 | 20 mm | Interior finishing |
| 2 | 15 mm | Air cavity |
| 3 | 25 mm | OSB vertical panel |
| 4 | 100 mm | Mineral wall |
| 5 | 25 mm | OSB vertical panel |
| 6 | 15 mm | Air cavity |
| 7 | 20 mm | Interior finishing |

### WA-R 03



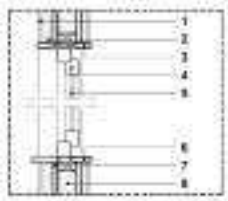
| | Dimension | Material |
|---|---|---|
| 1 | 20 mm | Interior finishing |
| 2 | 100 mm | Installation cavity |
| 3 | 25 mm | OSB vertical panel |
| 4 | 100 mm | Mineral wall |
| 5 | 25 mm | OSB vertical panel |
| 6 | 15 mm | Air cavity |
| 7 | 20 mm | Interior finishing |

### WA-R 04



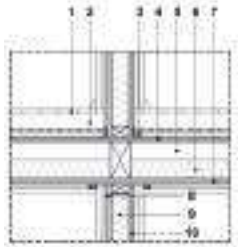
| | Dimension | Material | Product |
|---|---|---|---|
| 1 | x mm | Shading device - wooden brise-soleil | |
| 2 | 25 mm | Air cavity | |
| 2 | 25 mm | External wooden facade | |
| 3 | 60 mm | Thermal insulation | |
| 4 | 25 mm | OSB vertical panel | |
| 5 | 250 mm | Mineral wall | |
| 6 | 25 mm | OSB vertical panel | |
| 6 | 15 mm | Air cavity | |
| 7 | 20 mm | Interior finishing | |

## JOINTS



Exterior wall - Window

| | | |
|---|---|---|
| 1 | 25 mm | External facade - wood |
| 2 | 60 mm | External thermal insulation |
| 3 | | Windowsill |
| 4 | 20 mm | Window frame |
| 5 | 10 mm | Glass |
| 6 | | Fenestration |
| 7 | 20 mm | Plaster panel |
| 8 | 108 mm | Insulation |



Slab - interior partition

| | | |
|---|---|---|
| 1 | 25 mm | Floor finishing |
| 2 | 60 mm | Floating screed |
| 3 | 30 mm | Sand insulation |
| 4 | 20 mm | Plaster panel |
| 5 | 108 mm | Air cavity |
| 6 | 108 mm | Insulation |
| 7 | 20 mm | Plaster panel |
| 8 | 20 mm | Plaster panel |
| 9 | 108 mm | Insulation |
| 10 | 20 mm | Plaster panel |

## USERS AND MINIMUM SPATIAL DIMENSIONS (according to Italian law)

### STUDENT

single bedroom ≥ 11,0 m²
(1 bed + 1 study place)

double bedroom ≥ 16,0 m²
(2 beds + 2 study places)

toilet ≥ 3,0 m²

living space ≥ 14,0 m²
(private or shared)

kitchenette ≥ 5,0 m²
kitchen ≥ 9,0 m²

### EMPLOYEE

single ≥ 9,0 m²

double ≥ 14,0 m²

toilet ≥ 3,0 m²

≥ 14,0 m²

kitchenette ≥ 5,0 m²
kitchen ≥ 9,0 m²

### SELF EMPLOYED

single ≥ 9,0 m²

double ≥ 14,0 m²

toilet ≥ 3,0 m²

≥ 14,0 m²

kitchenette ≥ 5,0 m²
kitchen ≥ 9,0 m²

working space ≥ 7,0 m²

### COUPLE

single ≥ 9,0 m²

double ≥ 14,0 m²

toilet ≥ 3,0 m²

≥ 14,0 m²

kitchenette ≥ 5,0 m²
kitchen ≥ 9,0 m²

### COUPLE + CHILD

single ≥ 9,0 m²

double ≥ 14,0 m²

toilet ≥ 3,0 m²

≥ 14,0 m²

kitchenette ≥ 5,0 m²
kitchen ≥ 9,0 m²

### COUPLE + CHILDREN

single ≥ 9,0 m²

double ≥ 14,0 m²

toilet ≥ 3,0 m²

≥ 14,0 m²

kitchenette ≥ 5,0 m²
kitchen ≥ 9,0 m²

## CONSUMPTION OF ENERGY, WATER AND FOOD

energy: 2,5 kWh/day
920 kWh/year

- washing machine
- dishwasher
- refrigerator
- freezer
- 1 computer
- television

water: 50-240 lt/day
→average 150 lt/day

food (fruit and vegetables):
440 gr/day
160 kg/year

energy: 4,5 kWh/day
1650 kWh/year

- washing machine
- dishwasher
- refrigerator
- freezer
- +1 computer
- television

water: 100-480 lt/day
→average 300 lt/day

food (fruit and vegetables):
880 gr/day
320 kg/year

energy: 6,5 kWh/day
2400 kWh/year

- washing machine
- dishwasher
- refrigerator
- freezer
- +2 computer
- television

water: 150-720 lt/day
→average 450 lt/day

food (fruit and vegetables):
1320 gr/day
480 kg/year

energy: 8,2 kWh/day
3000 kWh/year

- washing machine
- dishwasher
- refrigerator
- freezer
- +2 computer
- television

water: 200-960 lt/day
→average 600 lt/day

food (fruit and vegetables):
1760 gr/day
640 kg/year

### HOW HARD WAS IT TO FIND HOUSING IN MILAN AS A STUDENT?

"the worst place to find apartment"

Milan is the worst place I have ever come across in searching for an apartment

"the hardest task"

Hardest experience of my life

Probably one of the hardest tasks I had to do , very demanding in terms of both time and money

"rents are crazy high"

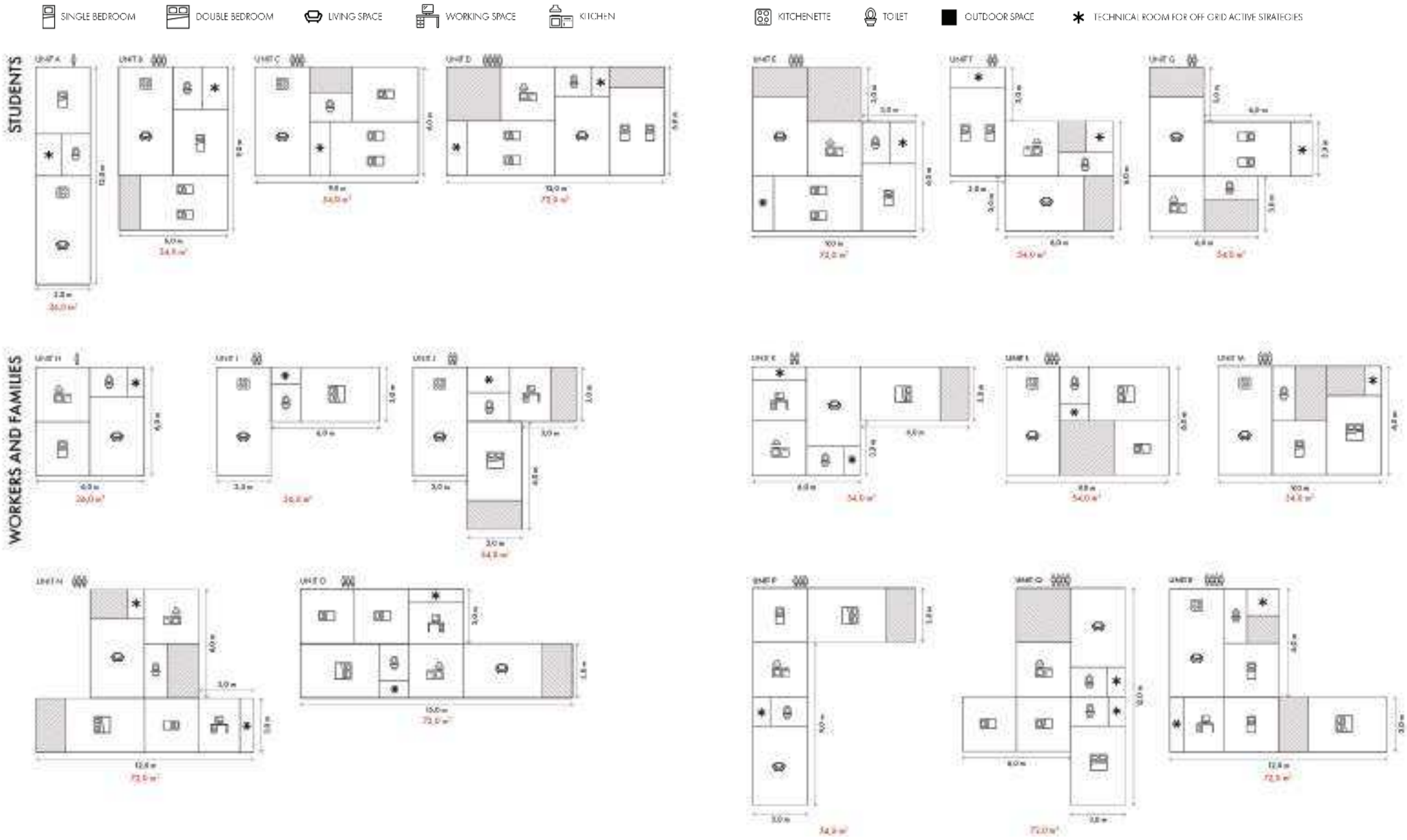
Last year, I arranged it online without seeing the apartment, it wasn't so hard but it was actually not very convenient because I couldn't see the place in real life. This year it was difficult to find a convenient place for an acceptable price, rents were already crazy high and now they are even higher.

"Time consuming, very expensive and really hard"

Probably the hardest experience that happened during my stay in Milan. Time consuming, very expensive and really hard

STUDENTS

WORKERS AND FAMILIES



***Renewable energy***

use of solar panels

air, water & heat pumps

***Water and sanitation***

greywater recycling

use of rainwater

water storage

hydropanels

***Food self production***

solar greenhouses

green roofs

vegetable gardens

livestock

***Waste management***

waste seperation

sale of waste

compost wc systems

\+

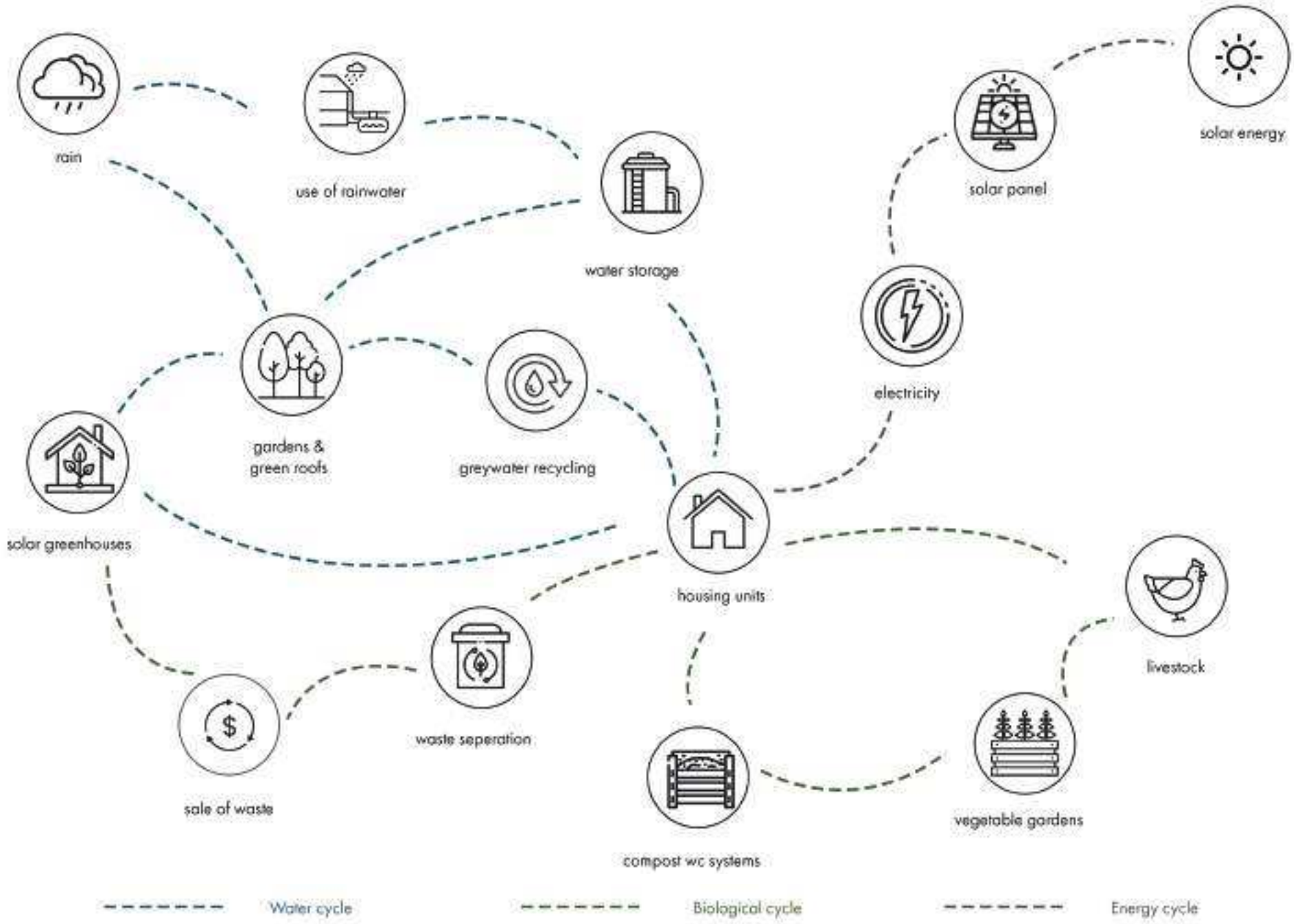
***Minimizing consumption & CO2 emission***

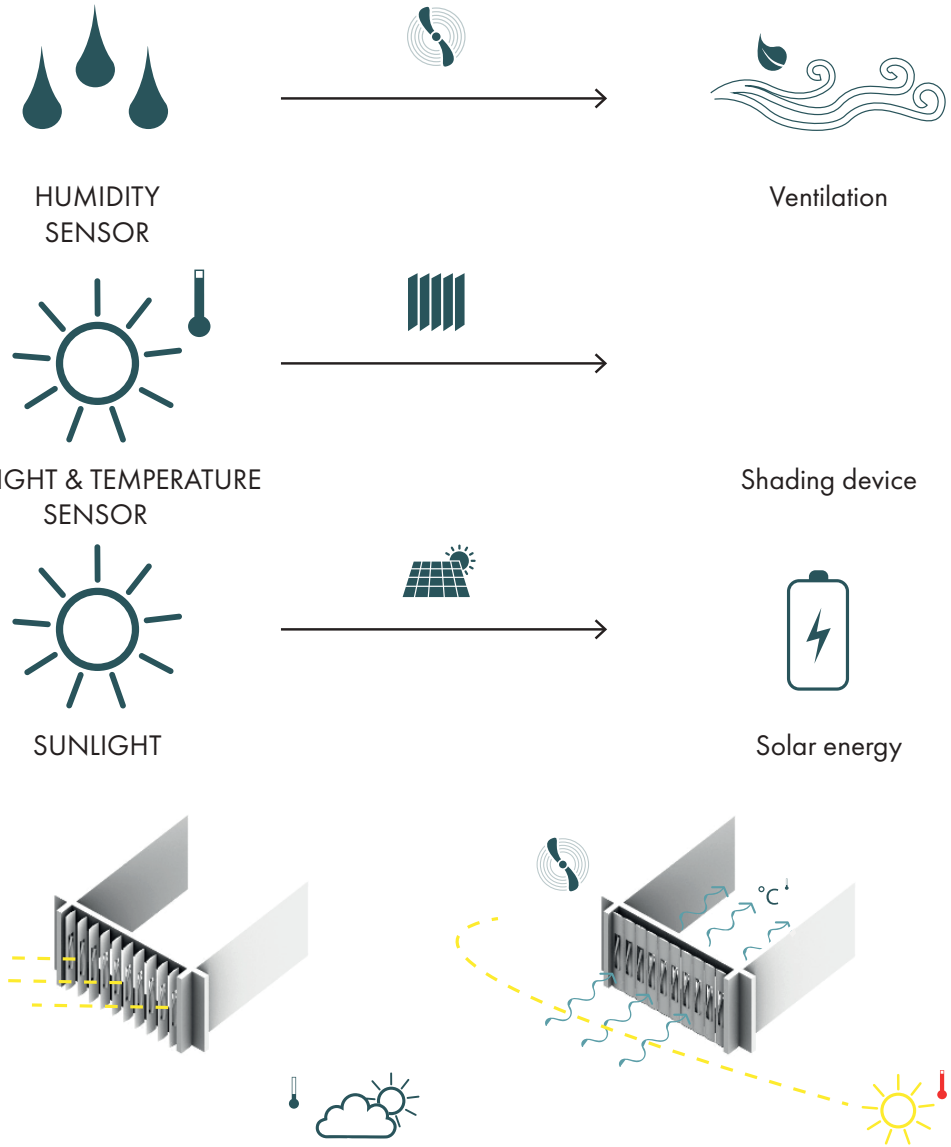
*cycling stations*

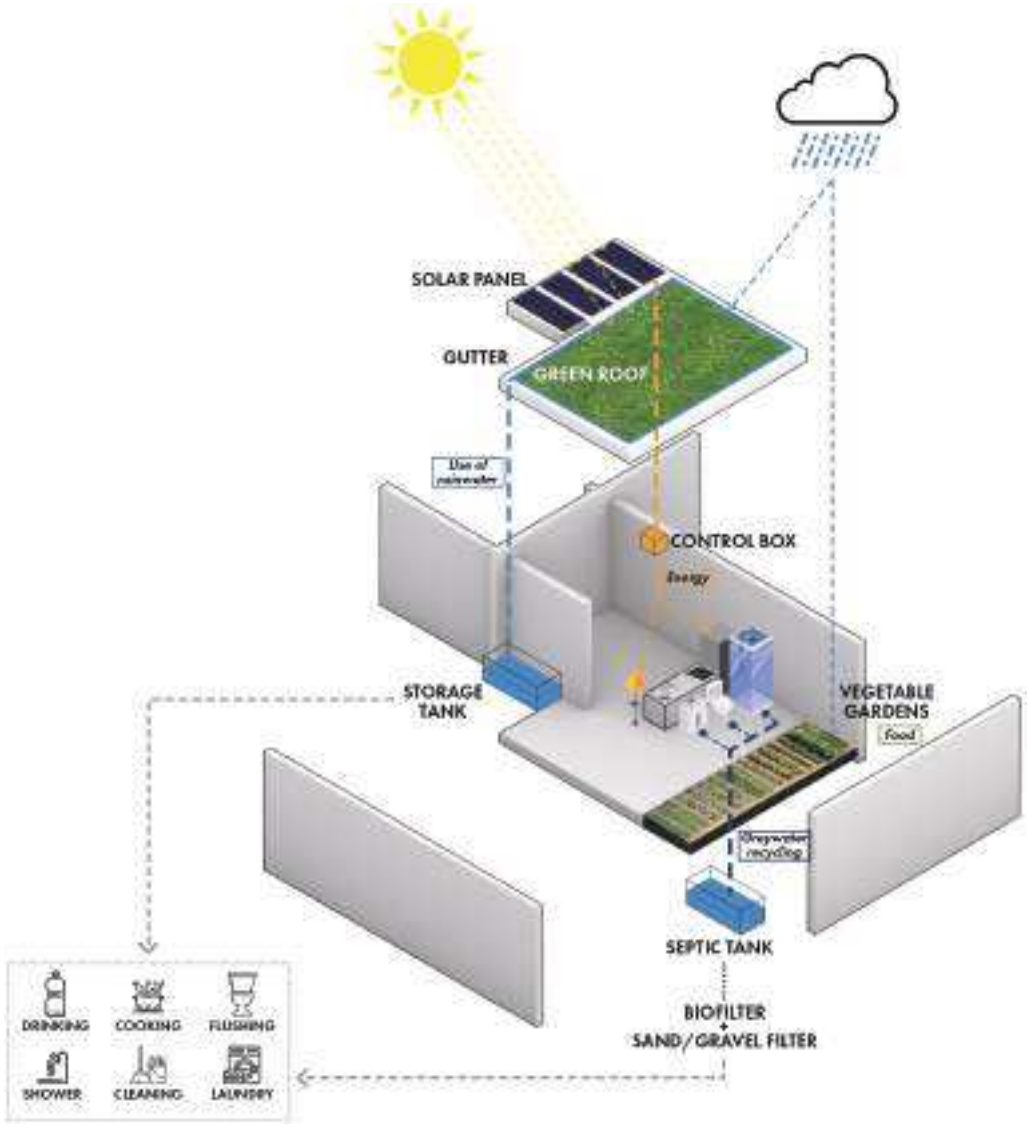
*electric car sharing*

*prefabricated panels*

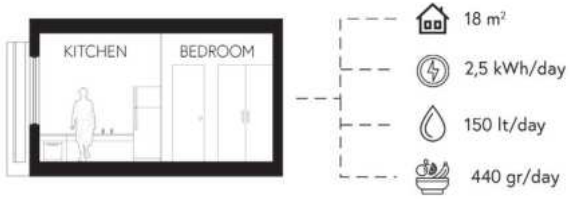
*panel storage*

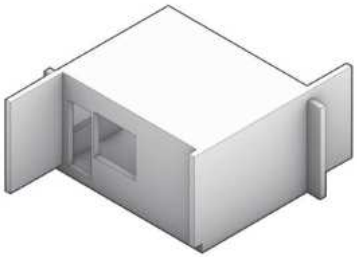

rain
use of rainwater
water storage
solar panel
solar energy
electricity
gardens &
green roofs
greywater recycling
solar greenhouses
housing units
livestock
waste seperation
sale of waste
compost wc systems
vegetable gardens
Water cycle
Biological cycle
Energy cycle

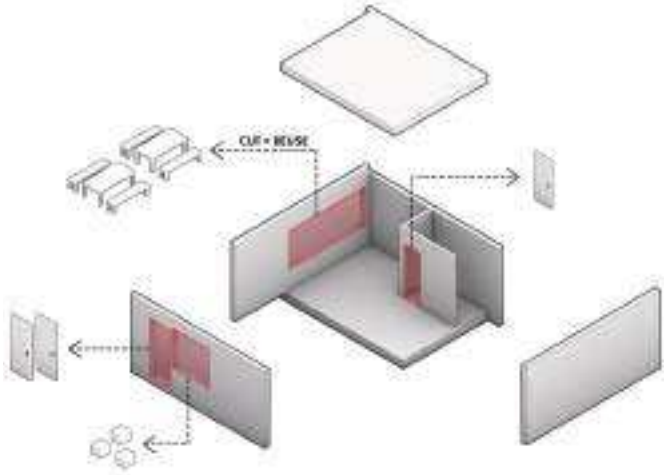

HUMIDITY SENSOR
Ventilation
SUNLIGHT & TEMPERATURE SENSOR
Shading device
SUNLIGHT
Solar energy


SOLAR PANEL
GUTTER
GREEN ROOF
CONTROL BOX
STORAGE TANK
VEGETABLE GARDENS
SEPTIC TANK
BIOFILTER
SAND / GRAVEL FILTER
DRINKING
COOKING
FLUSHING
SHOWER
CLEANING
LAUNDRY

UNIT 1 - STUDENT

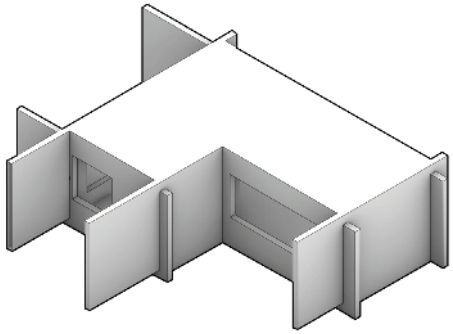



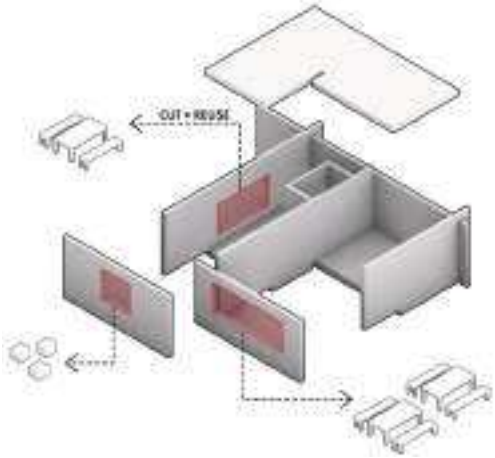





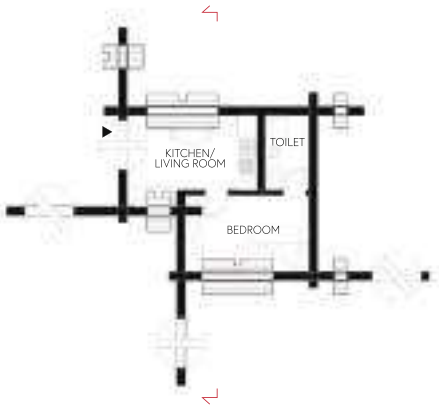

UNIT 2 - STUDENTS



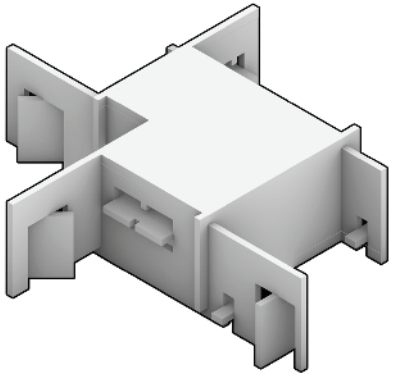


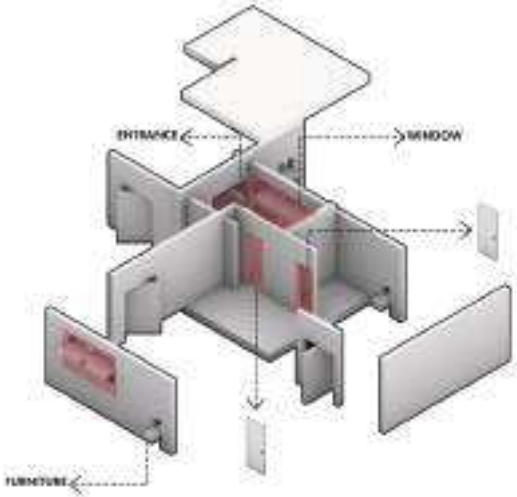


UNIT 3 - WORKER

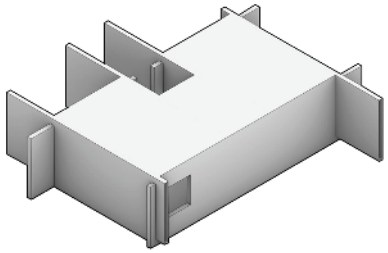


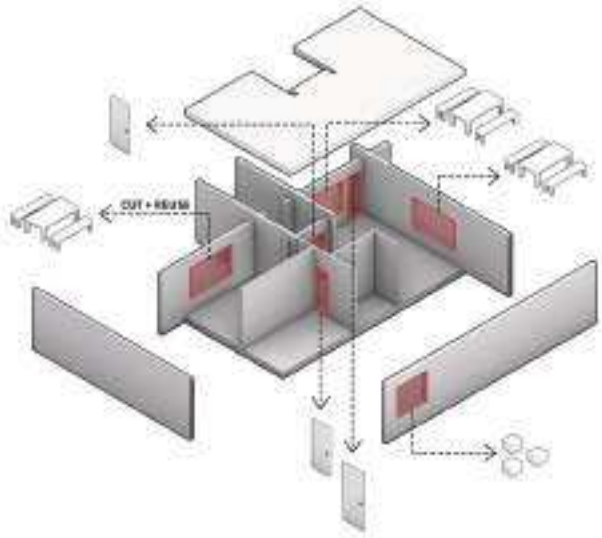


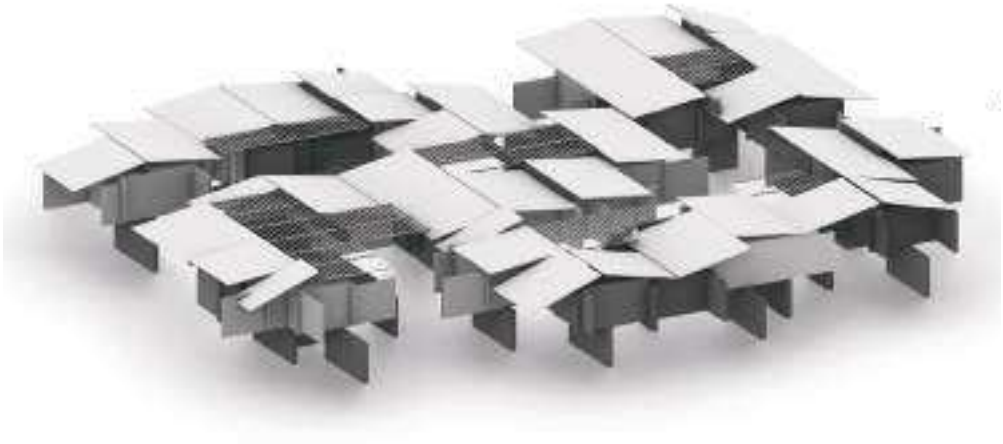





UNIT 4 - FAMILY

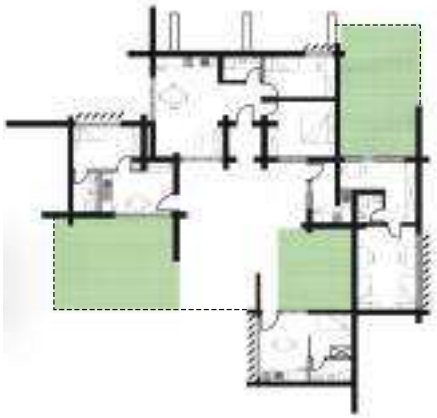




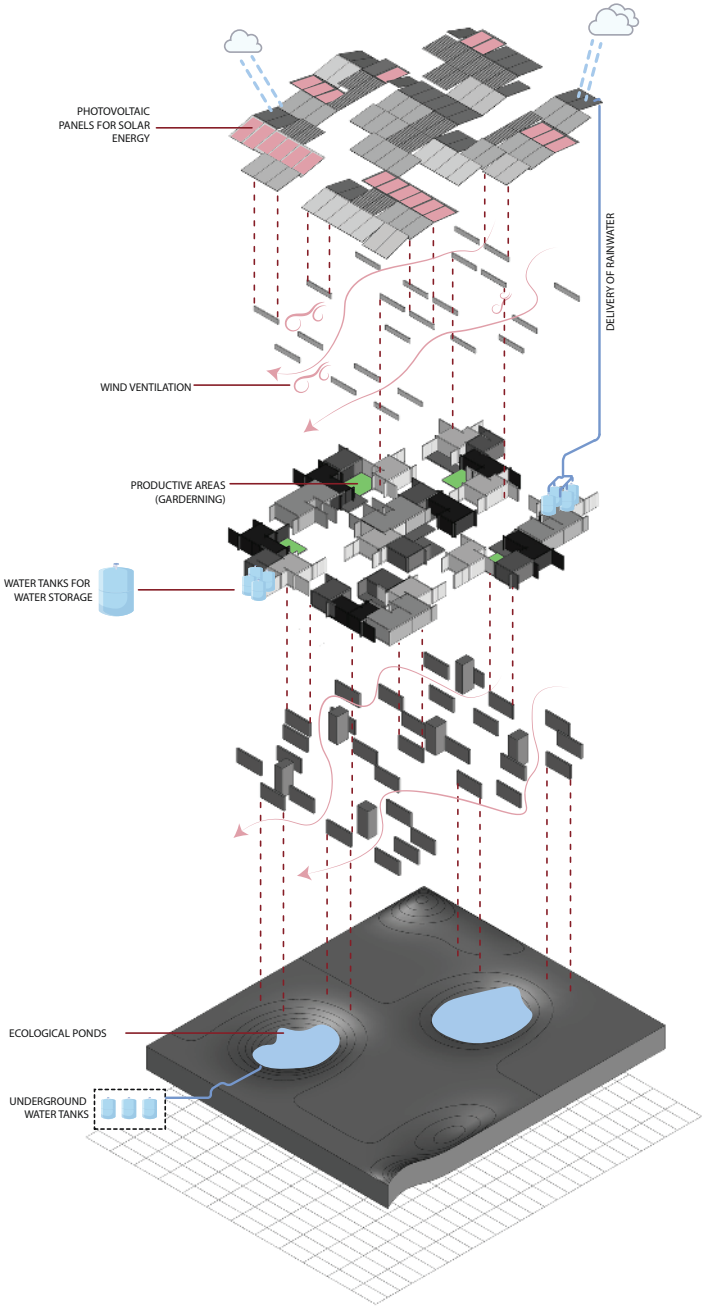
HORIZONTAL CONFIGURATION

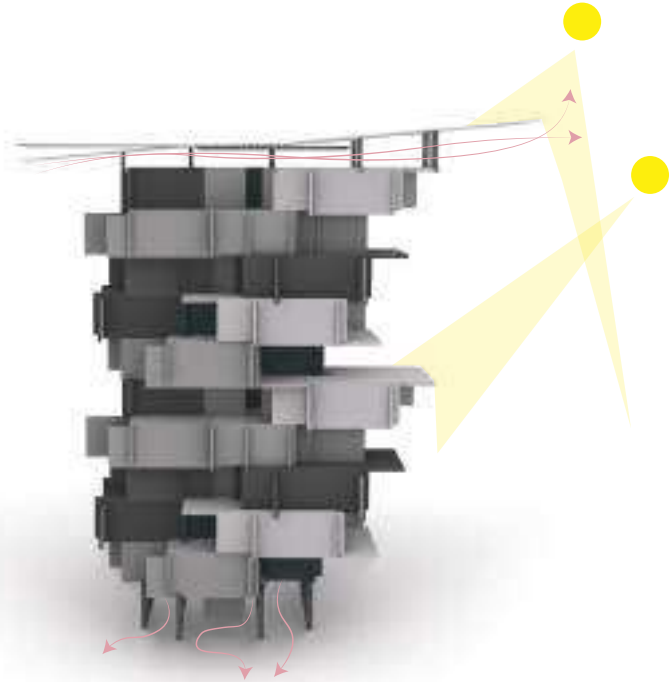
HORIZONTAL CONFIGURATION

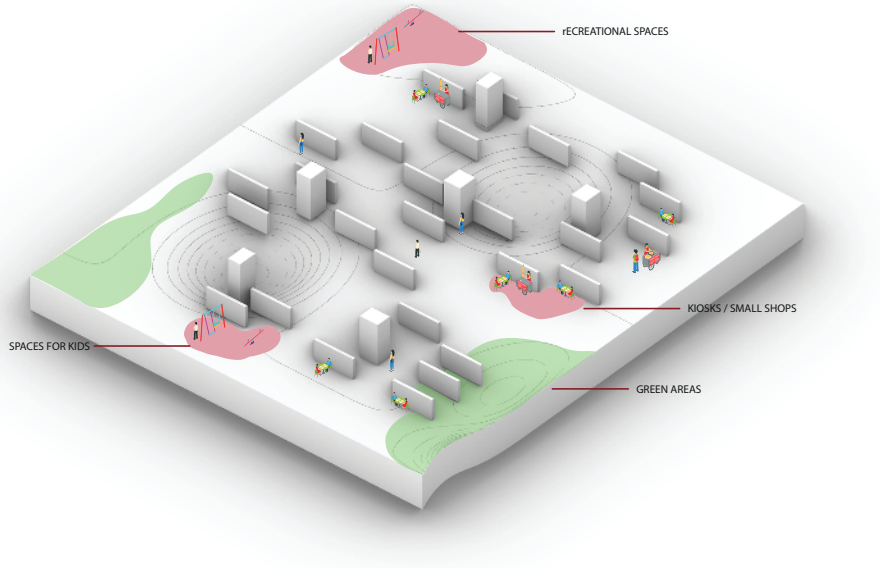


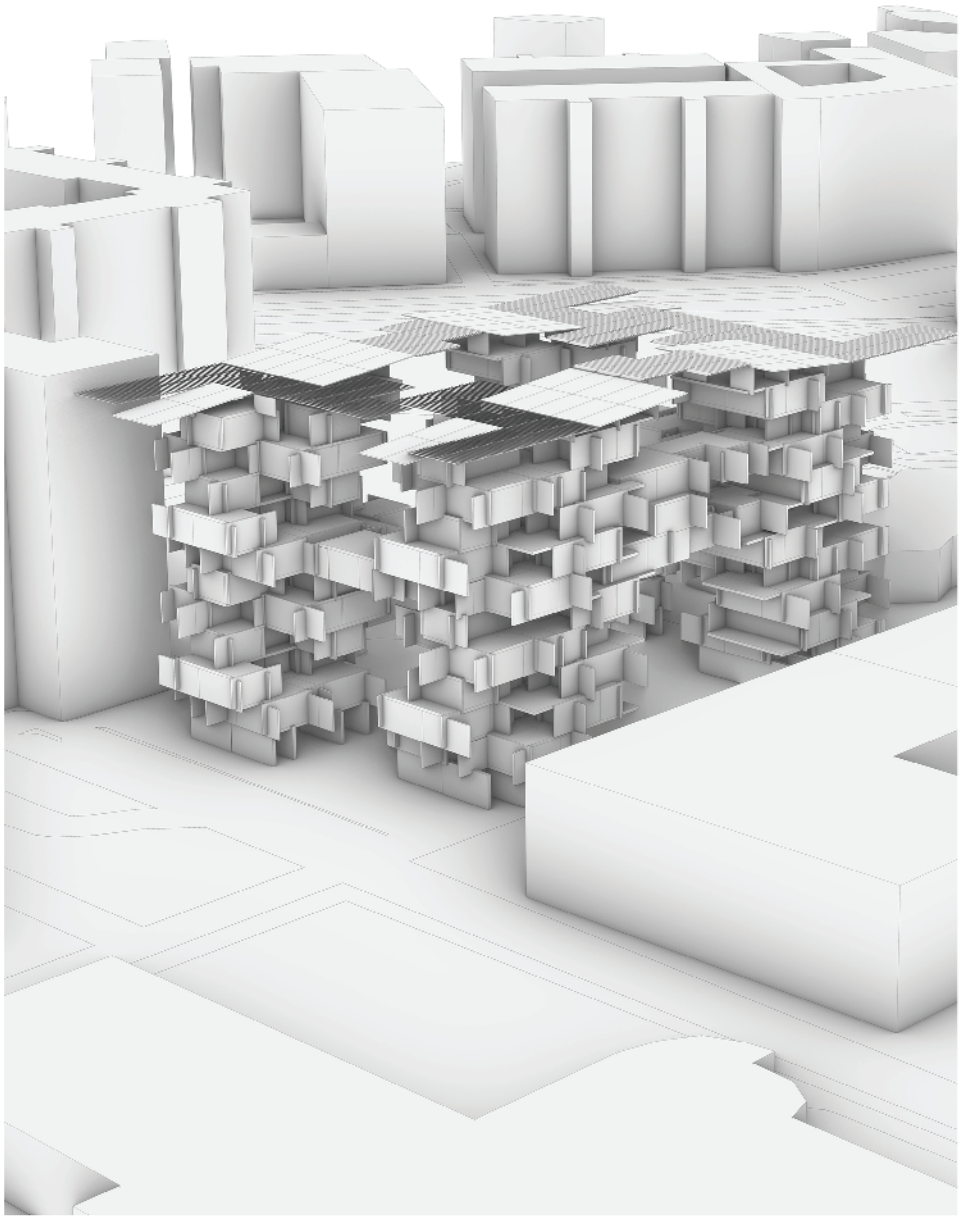
CLUSTER FLOOR PLAN 1/200

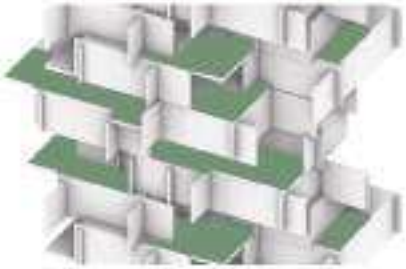
CLUSTER FLOOR PLAN 1/200


PHOTOVOLTAIC PANELS FOR SOLAR ENERGY
DELIVERY OF RAINWATER
WIND VENTILATION
PRODUCTIVE AREAS (GARDERNING)
WATER TANKS FOR WATER STORAGE
ECOLOGICAL PONDS
UNDERGROUND WATER TANKS




rECREATIONAL SPACES
KIOSKS / SMALL SHOPS
SPACES FOR KIDS
GREEN AREAS





**Referencing the idea of Cascina :**
Cascina is a characteristic type of a traditional agricultural settlement in Italy, consisting of buildings gathered around a large courtyard.

**Producing Food Collectively :**
Each one of the units uses the other unit's roof that is underneath as a vegetable garden for collective food production.

## Shared Spaces & Facilities :

GREEN TERRACES

BICYCLE SHARING

ELECTRIC CAR SHARING

CO-WORKING SPACES

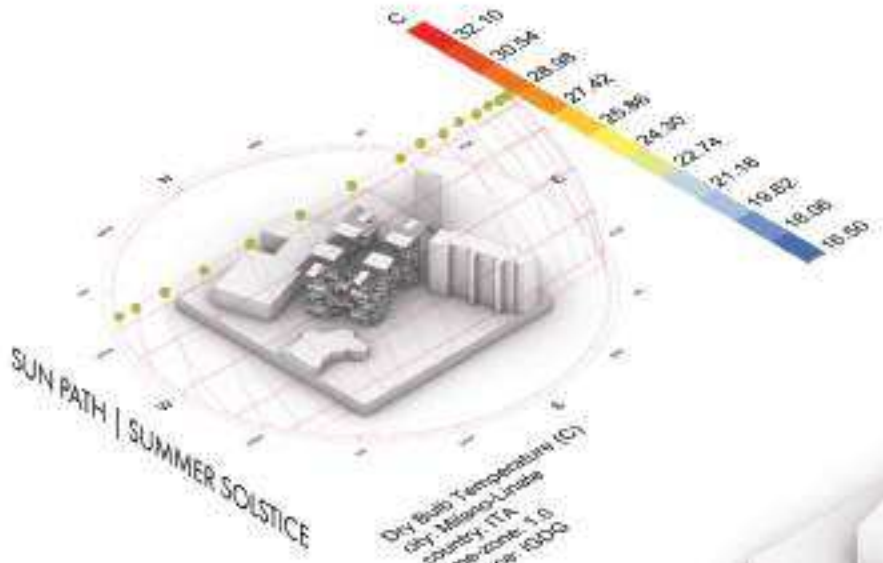
SMALL SHOPS

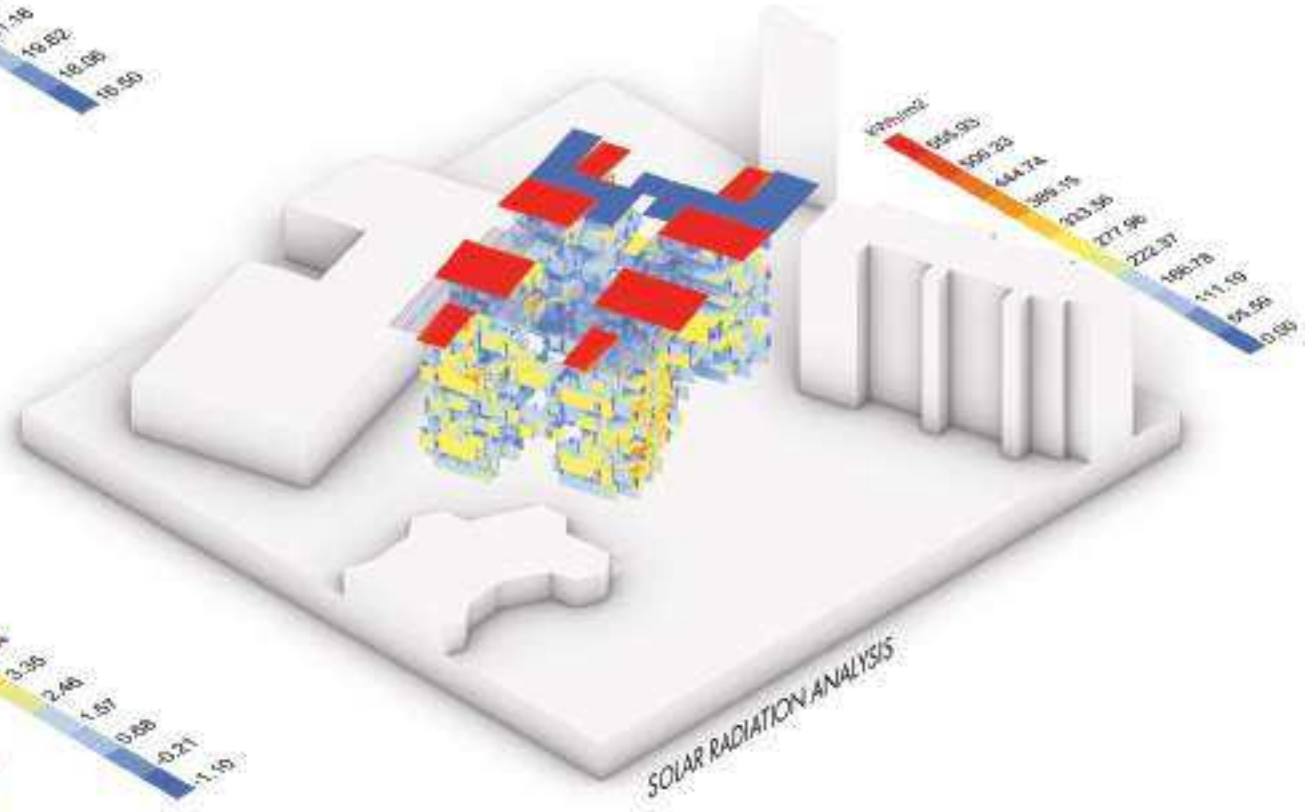
CHILD CARE / NURSERY

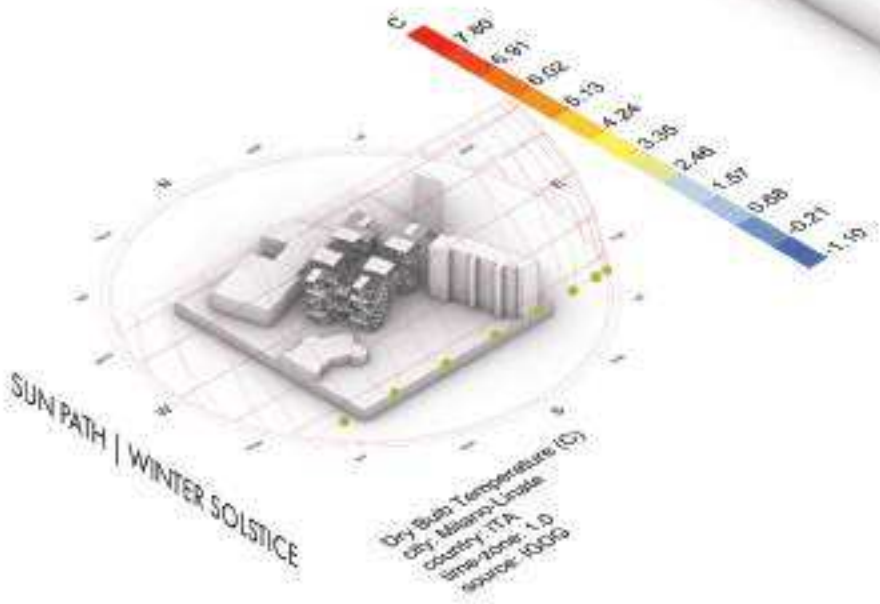
SHARED GYM

CO-LIVING ROOMS

CO-DINING SPACES


C
32.10
30.54
28.98
27.42
25.86
24.30
22.74
21.18
19.62
18.06
16.50
SUN PATH | SUMMER SOLSTICE
Dry Bulb Temperature (C)
city: Milano-Linate
country: ITA
time-zone: 1.0
source: IGDG


kWh/m2
SOLAR RADIATION ANALYSIS


C
7.80
6.91
6.02
5.13
4.24
3.35
2.46
1.57
0.68
-0.21
-1.10
SUN PATH | WINTER SOLSTICE
Dry Bulb Temperature (C)
city: Milano-Linate
country: ITA
time-zone: 1.0
source: IGDG

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# OFF-GRID COMMUNITIES
# eco-digital construction for sustainable living

## TEMPERATE CLIMATE
## London - England

One of the most popular cities in the world, London boasts an ever-growing population of almost 9 million residents, resulting in a lush diversity of people but a lack of sufficient housing. Existing Data from London reveals that the major attribute to the current housing crisis in London is the issue of affordability,whereby many residents are driven out of their homes due to increasing rent, whereby the rent is increasing because space to build new housing is scare. Housing has become a desired commodity due to its scarcity rather than a utilitarian right for all. Aside from climate, this is the key driver for the instigation of this project. Coupling this issue with an intensely interwoven existing urban fabric, the design of sustainable housing in London must consider the adaptation of existing typologies but for larger communities. In this regard, the terrace house was selected as a typology for its ability to provide both privacy and community and its easy insertion within London's current housing patterns, but this study aims to push the constraints of a typical terrace house to meet the needs of today and tomorrow.
The current climate in London includes mild winters and temperate summers, with consistent rainfall throughout the seasons and occasional sunshine. However, with the increase of summer temperatures, the climate of London is set to change, and future housing must consider an architecture that is adaptable to such unpredictability. Hence, this project proposal focuses on sustainability from a level of clustered massing all the way to façade details. On a unit level, each apartment is created based on selecting spaces from a catalogue of sections that correlate to family size and user demands to ensure that no space is wasted. The same sections are optimized parametrically to create sun-filled courtyards and to meet the direction of the sun for solar panels to be placed on the top level. On a detailed level, the paneling system is comprised of a double skin that rotates to ventilate in the summer and heat by solar gain in the winter. The automated motor detects directions of sun and wind in order to attract or deflect them, as wanted by the user.
Finally, on a communal level, the cluster reveals the full scope of the proposal whereby the original typology of a terrace neighbourhood transcends into a self-sufficient community through multi-story living, shared amenities and facilities, and an overall massing scheme that invites solar penetration to fertilize a shared vegetable garden in a safe, sheltered environment engulfed within the community.

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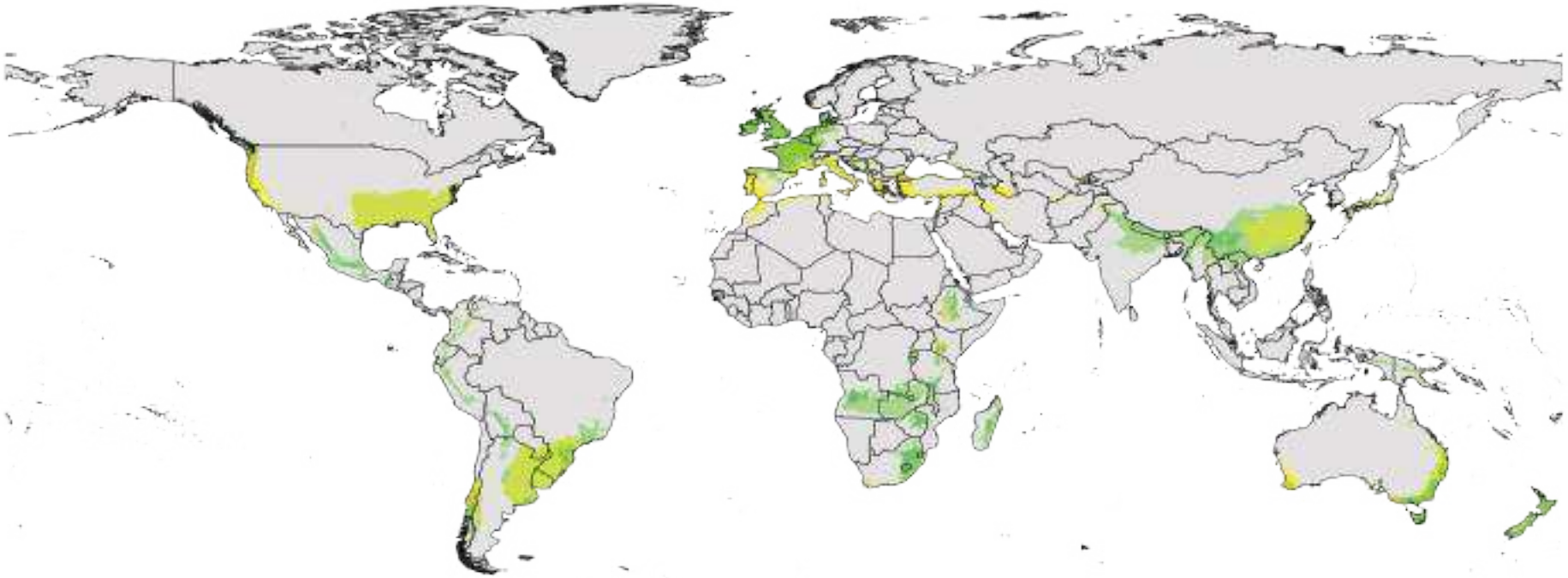
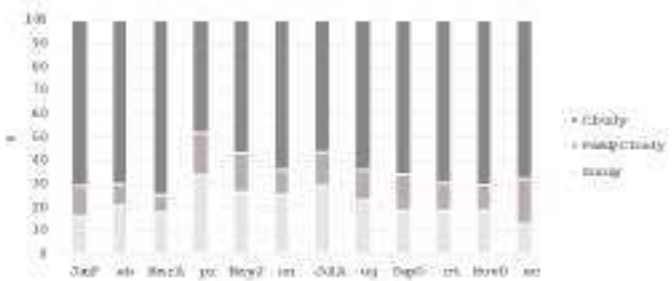
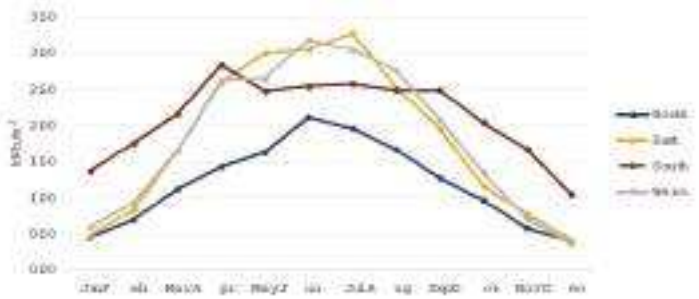
**UoW STUDENTS:** AGATHE ALEXANDRE · METTE PEDERSEN · EDOARDO RIPAMONTI · ROFAYDA SALEM



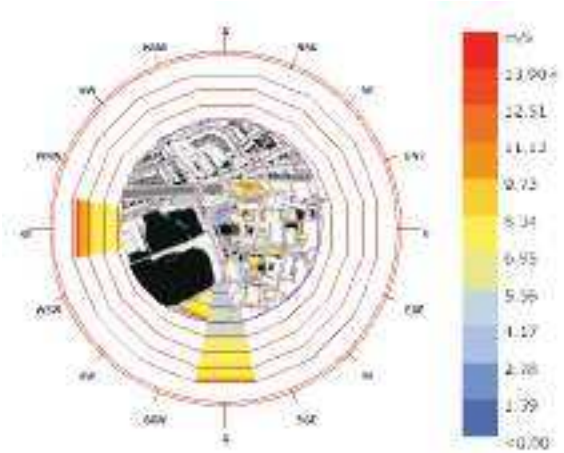


Frecuency of the sky type in London- meteonorn



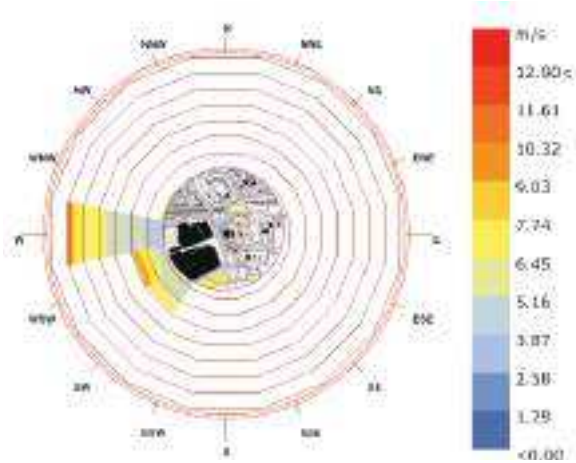
Monthly average global metric radiation- meteonorn

## Spring



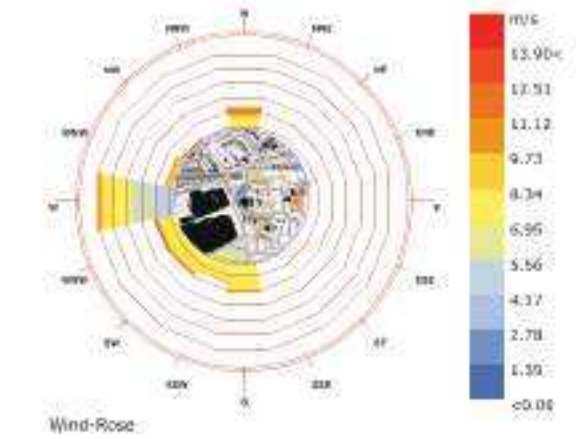
Wind-Rose
5100180 UK
1 Mar 1:00 - 28 May 24:00
Hourly Data: Wind Speed (m/s) Calm for 3.46% of the time = 74 hours. Each closed polyline shows frequency of 1.3%. = 28 hours.

## Summer



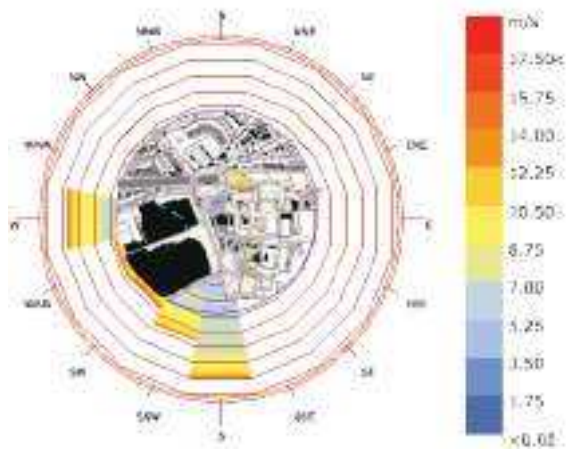
Wind-Rose
5100180 UK
1 Jun 1:00 - 28 Aug 24:00
Hourly Data: Wind Speed (m/s) Calm for 3.46% of the time = 74 hours. Each closed polyline shows frequency of 1.3%. = 28 hours.

## Autumn



Wind-Rose
5100180 UK
1 SEP 1:00 - 28 NOV 24:00
Hourly Data: Wind Speed (m/s) Calm for 3.46% of the time = 74 hours. Each closed polyline shows frequency of 1.3%. = 28 hours.

## Winter



Wind-Rose
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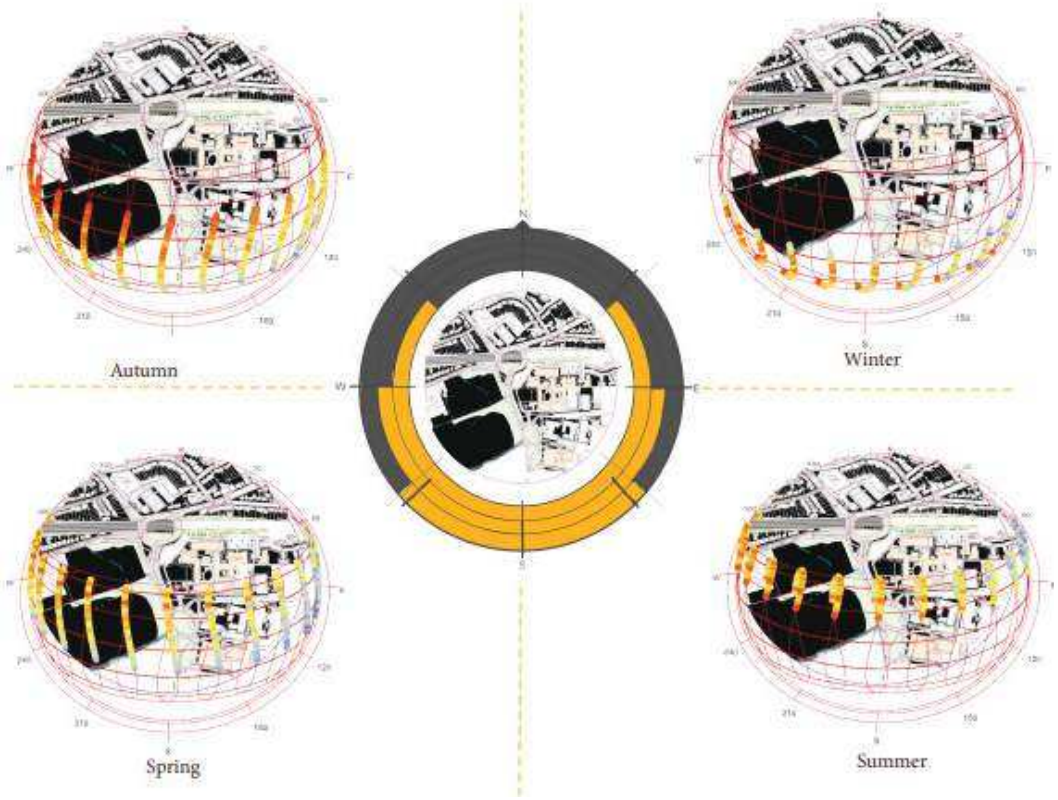
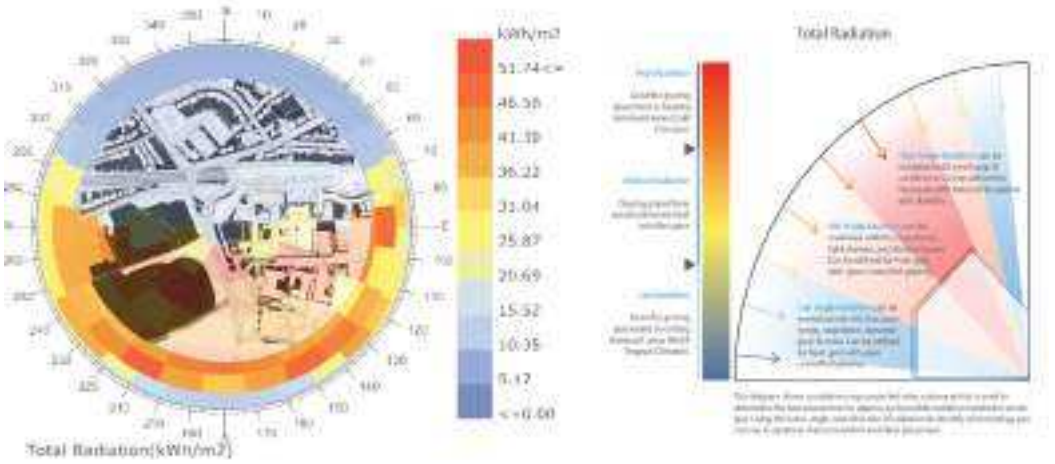
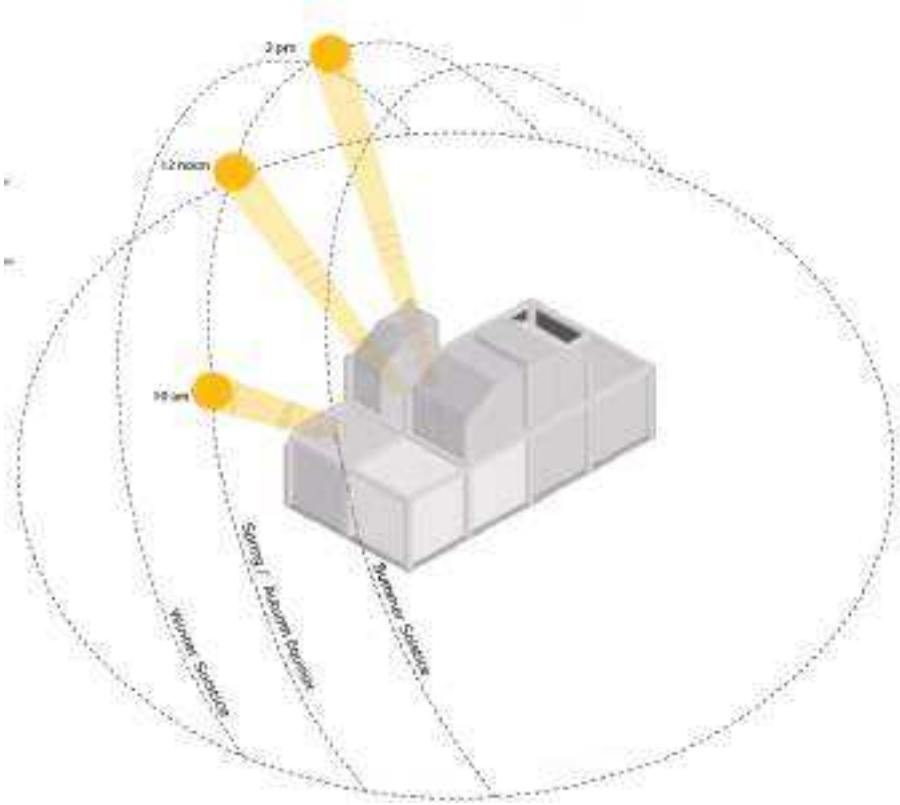


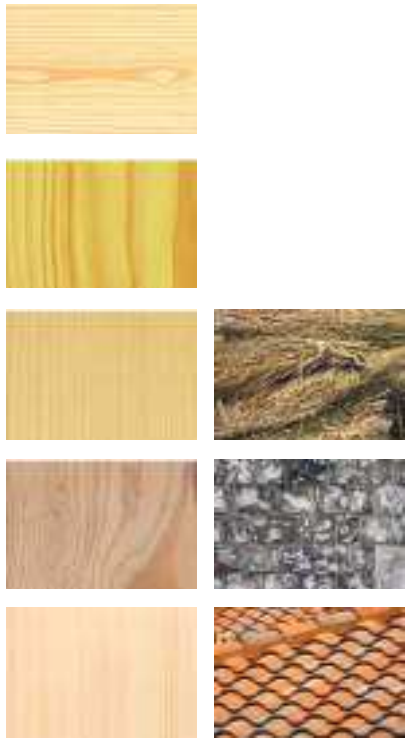




2 pm Sun paths of 24 solar terms

19 Winter Solstice


10 Summer Solstice

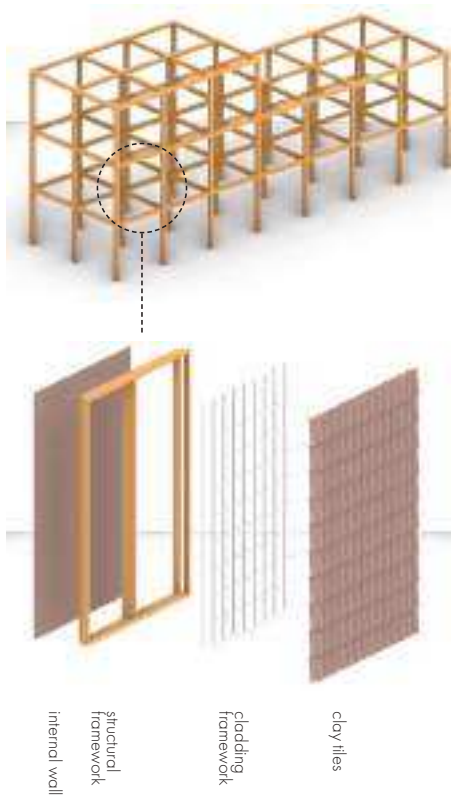





Over the same period, the UK roundwood production increased by nearly 80% from 6.5 million green tonnes in 1990 to 11.6 million tonnes in 2018. The UK is the world's second largest importer of wood after China, importing around £7.5bn-worth of timber annually. We currently grow only around 20% of our wood requirement.

While the upward trend in UK and global demand for wood is clear, the UK government's own forecasts show that supplies of home-grown wood will start to decline in the 2030s, meaning there will be less wood available in future than there is now.

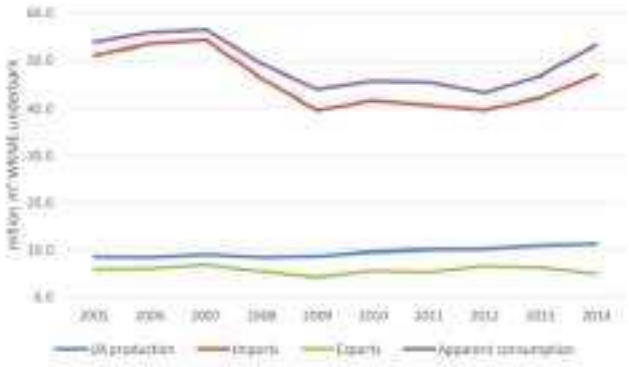
Initially, we considered that timber will be used for the framework of the building since the structure is easy to construct and can be prvefabricated off site. As for the cladding/panelling system in the building, we considered clay tile cladding as it is a local material and is non combustible.




| Source | Sawn softwood | Sawn hardwood | Plywood | Particle-board | Fibre-board | Pellets |
|---|---|---|---|---|---|---|
| per cent of total UK imports (volume) in each category | | | | | | |
| Sweden | 42 | 2 | 0 | 2 | 1 | 0 |
| Germany | 6 | 5 | 0 | 19 | 20 | 0 |
| Finland | 14 | 3 | 9 | 0 | 1 | 0 |
| Latvia | 16 | 6 | 2 | 16 | 7 | 11 |
| France | 0 | 11 | 2 | 17 | 1 | 0 |
| Netherlands | 1 | 4 | 0 | 0 | 0 | 0 |
| Italy | 0 | 10 | 1 | 2 | 0 | 0 |
| Ireland | 7 | 2 | 1 | 12 | 29 | 0 |
| Belgium | 1 | 1 | 1 | 13 | 9 | 0 |
| Austria | 1 | 1 | 0 | 1 | 0 | 0 |
| Spain | 0 | 0 | 1 | 4 | 13 | 0 |
| Poland | 1 | 2 | 1 | 5 | 5 | 0 |
| Estonia | 2 | 17 | 0 | 0 | 0 | 3 |
| Other EU-28 | 4 | 4 | 0 | 8 | 8 | 2 |
| **Total EU-28** | **94** | **67** | **18** | **99** | **94** | **17** |
| USA | 0 | 14 | 0 | 0 | 0 | 59 |
| Canada | 1 | 2 | 1 | 0 | 0 | 21 |
| China | 0 | 0 | 37 | 0 | 2 | 0 |
| Brazil | 0 | 0 | 18 | 0 | 0 | 1 |
| Russia | 5 | 1 | 8 | 0 | 1 | 12 |
| Malaysia | 0 | 3 | 7 | 0 | 0 | 0 |
| Cameroon | 0 | 5 | 0 | 0 | 0 | 0 |
| Other non-EU | 0 | 8 | 11 | 0 | 2 | 0 |
| **Total non-EU** | **6** | **33** | **82** | **1** | **6** | **83** |

**1.1 Overall UK Consumption of Wood Raw Material Equivalent**

The following table allows direct comparison between wood grown in the UK and the raw material equivalent of wood imports to the UK..

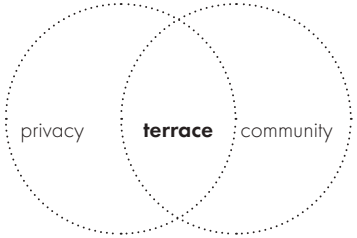


**The Terrace House**

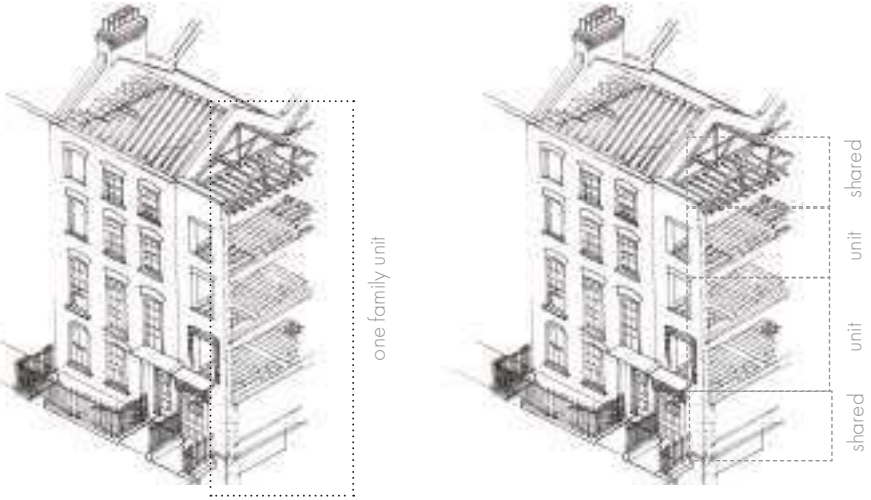
Most common in London

*"Terraces represent the perfect marriage between living in the city and enjoying a family home with a sense of community"*

-Rise Design Studio



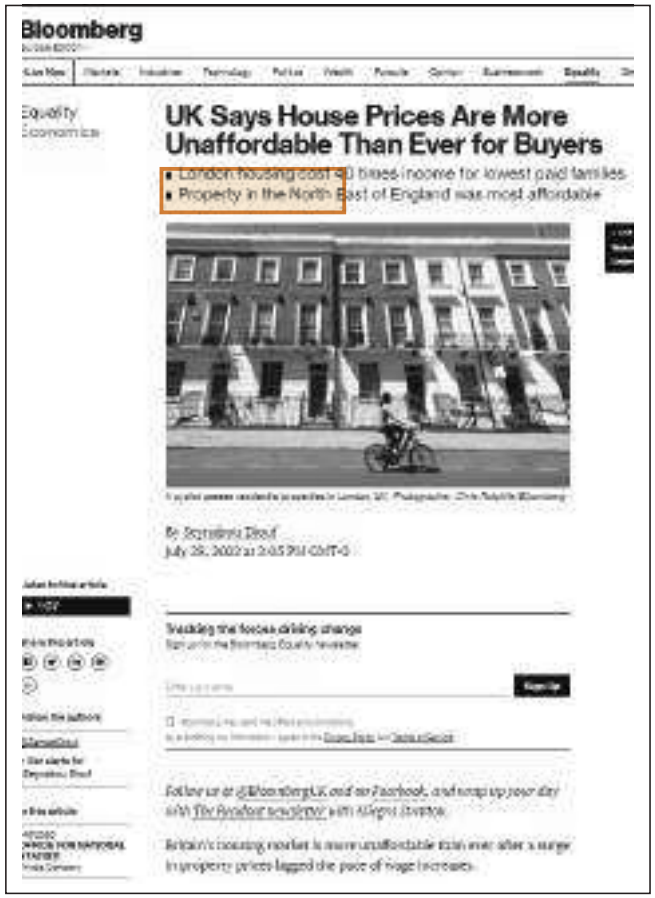


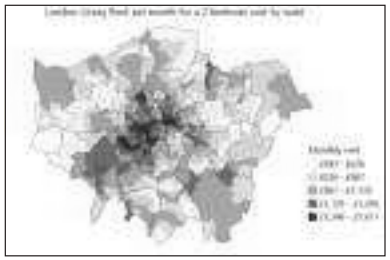


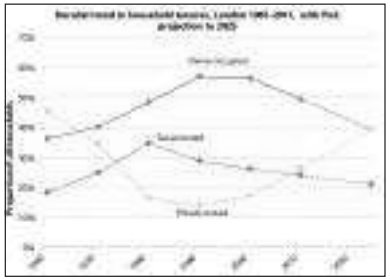

existing scenario ⇢ proposed redesign

Precedent: Peter Barber

*"Being pretty square in plan and stepping back at the rear to allow light and ventilation and private roof terraces instead of back gardens."*
Peter Barber Architects arranged the 30 two-bed houses and two one-bed homes on a series of pedestrian streets that were designed to open up the site and connect the homes to the existing estate.





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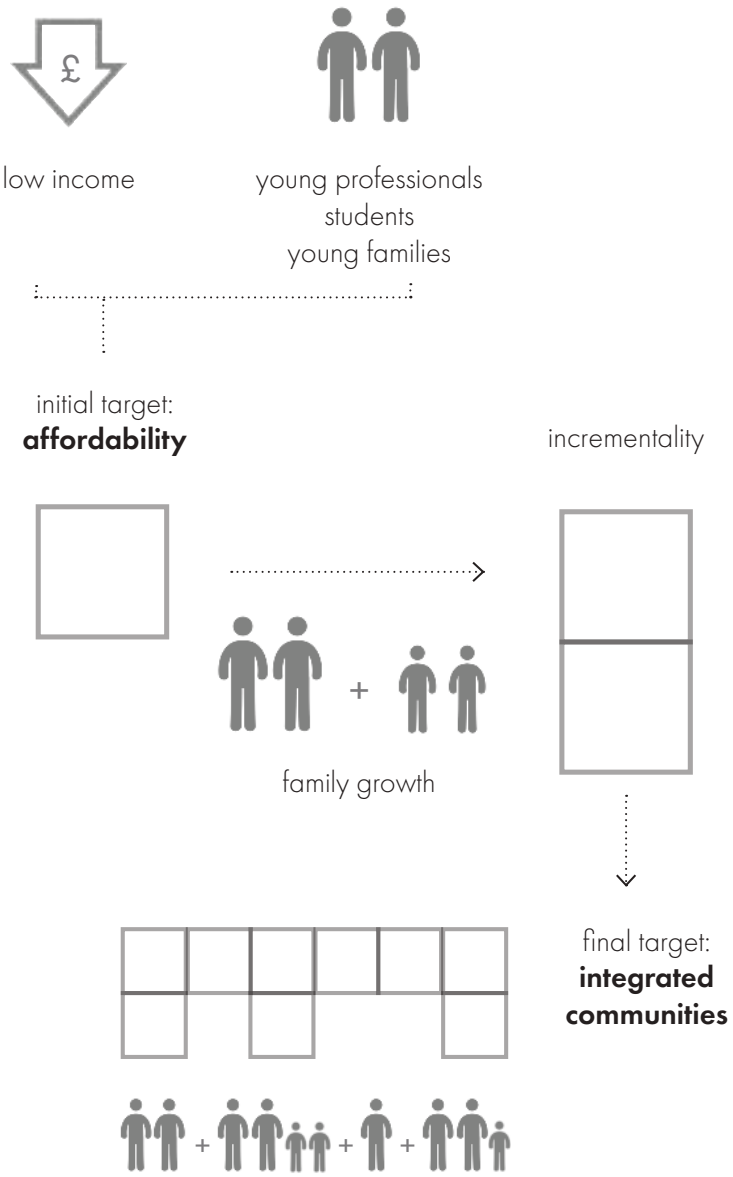
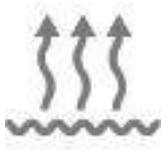


Photovoltaic system
Generators for storage

Rainwater collection
Thermosolar system
for hot water



Air-source heat pump
Tube network as a heat
source

Vertical farming
Hydroponics

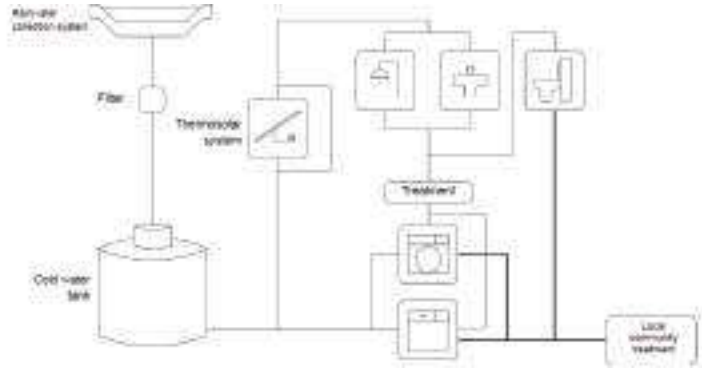
**Average Energy Use in the UK**

| | | |
|---|---|---|
| 1 Bed House | 4.9 - 6.5 KWh daily | Average amount of energy produced by a standard photovoltaic system |
| 2 Bed House | 6.8 - 8.2 KWh daily | |
| 3 Bed House | 8.2 KWh daily | |
| 4 Bed House | 9.5 KWh daily | 37 m - 350-850 KWh monthly |
| 5 Bed House | 11.7 KWh daily | 11.6-28.3 KWh daily |

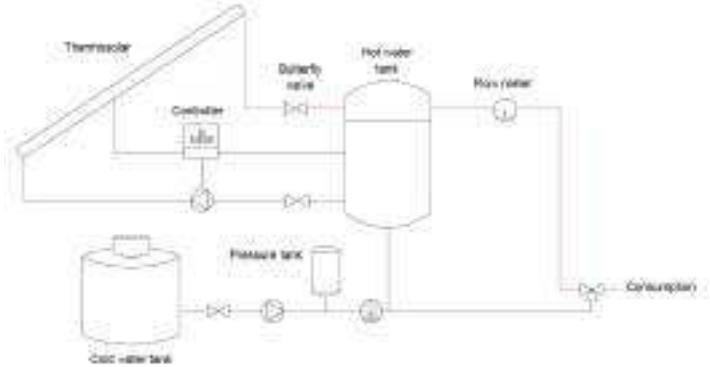
**Average Water Use in the UK**

| People | Average annual (m) | Average water use by various appliances | |
|---|---|---|---|
| 1 | 54 | Fill a bath | 115 l |
| 2 | 101 | Shower | 50 l |
| 3 | 134 | Washing machine | 55 l |
| 4 | 164 | Dishwasher | 15 l |
| 5 | 191 | Toilet flush | 6-10 |
| 6 | 216 | | |
| 7 | 239 | | |

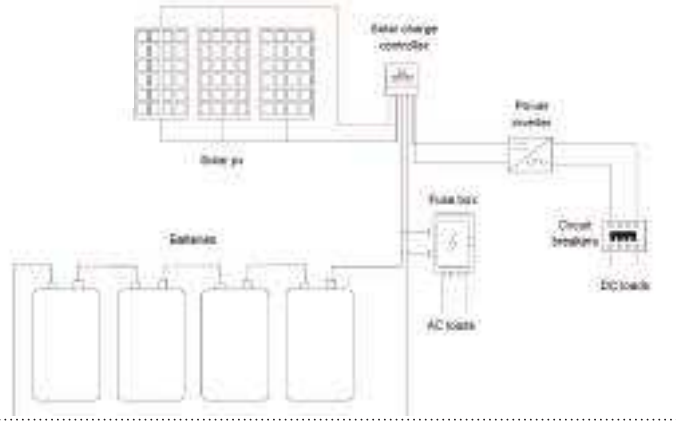
Water Reuse System



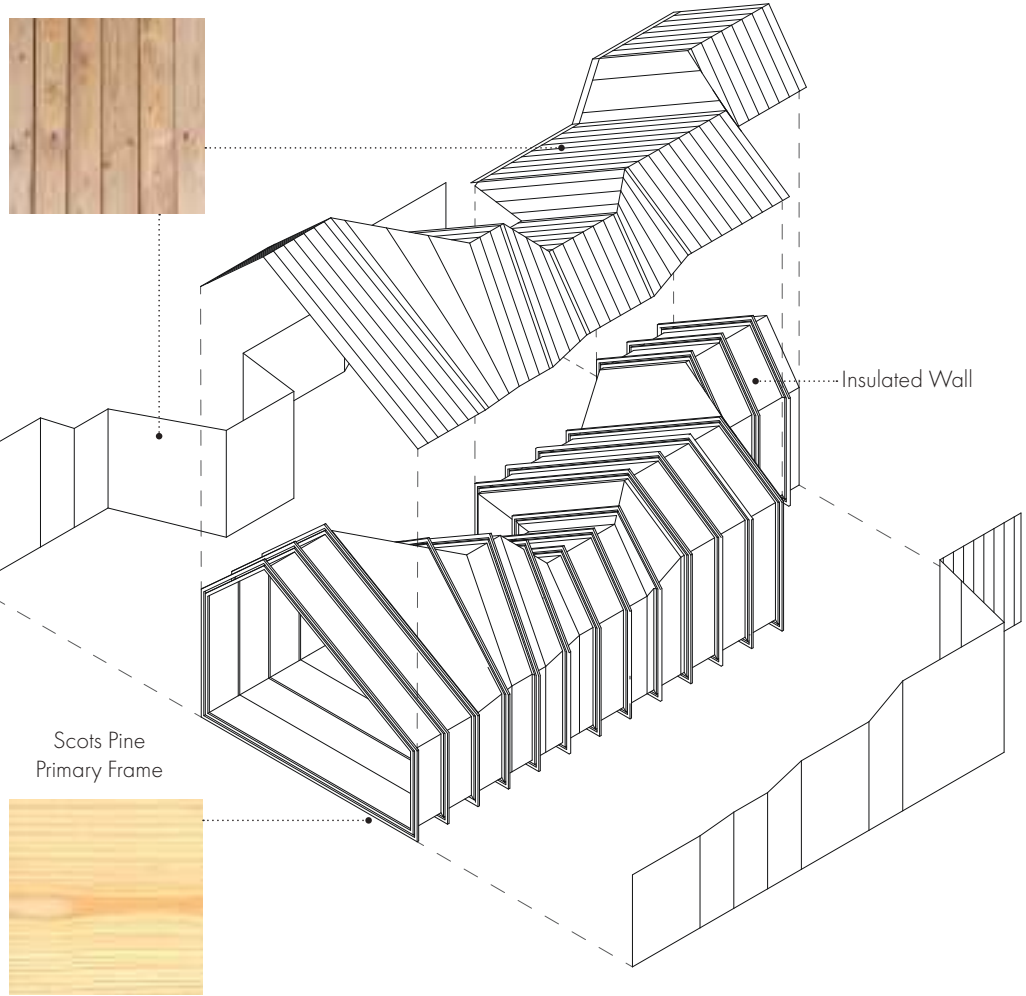
Hot Water Production



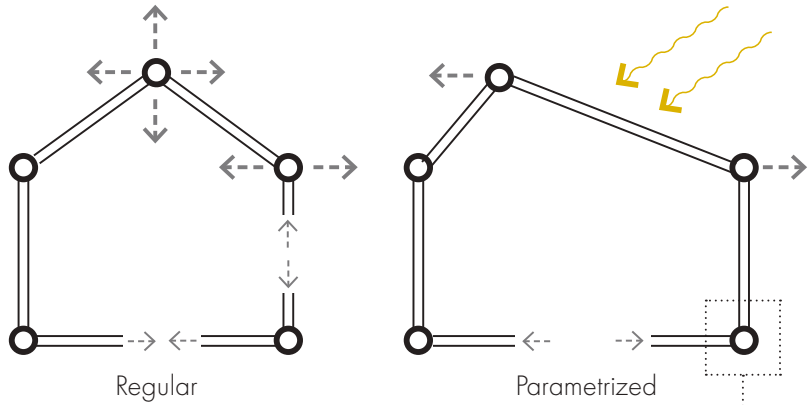

Off Grid Energy Production



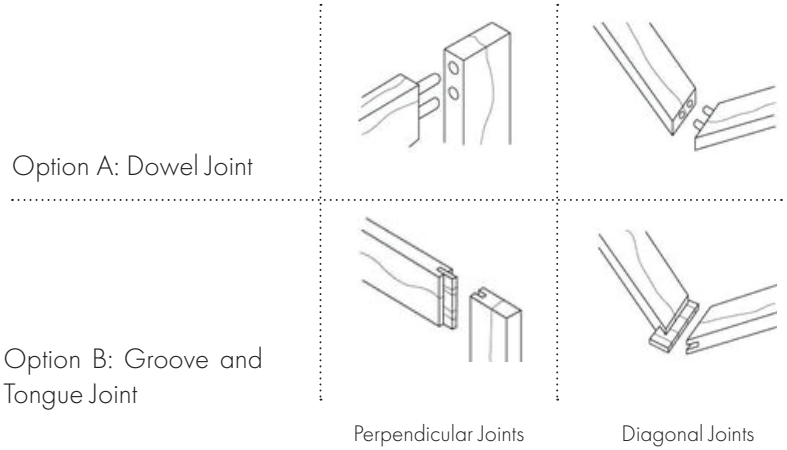
SIBERIAN LARCH
EXTERNAL PANELLING SYSTEM

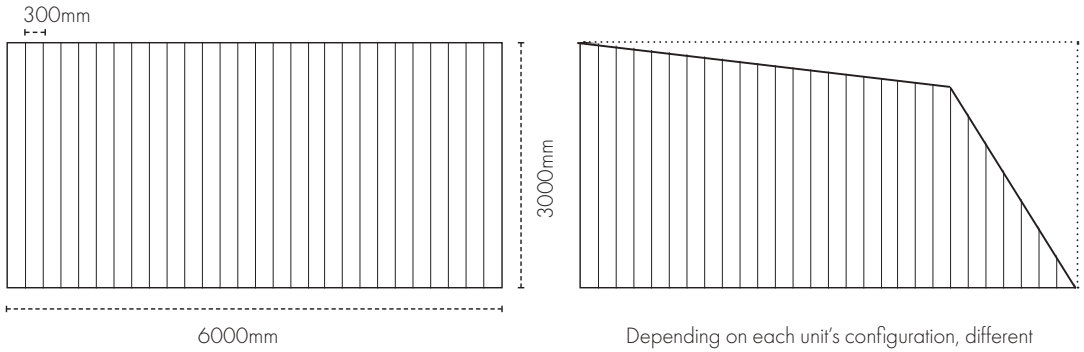



PRIMARY FRAME SYSTEM




The Primary Frame is based on a simple vernacular house structure, however, it is designed parametrically by creating adjustable vertices to adapt to the environmental surroundings of each unit.



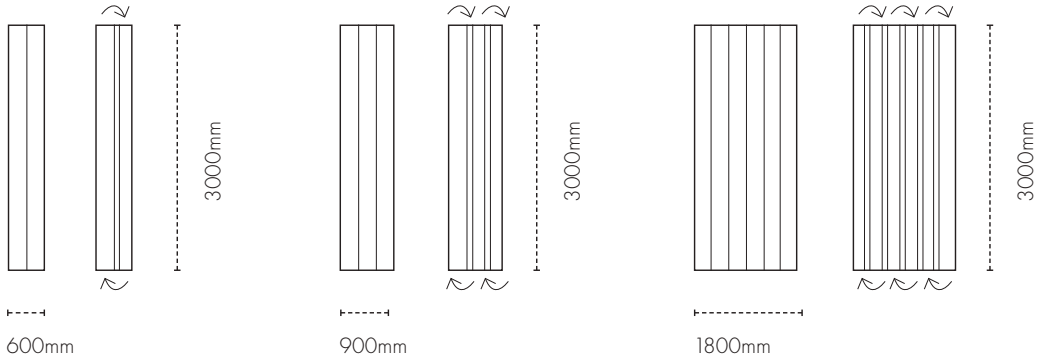



Solid Panel - Standard Size

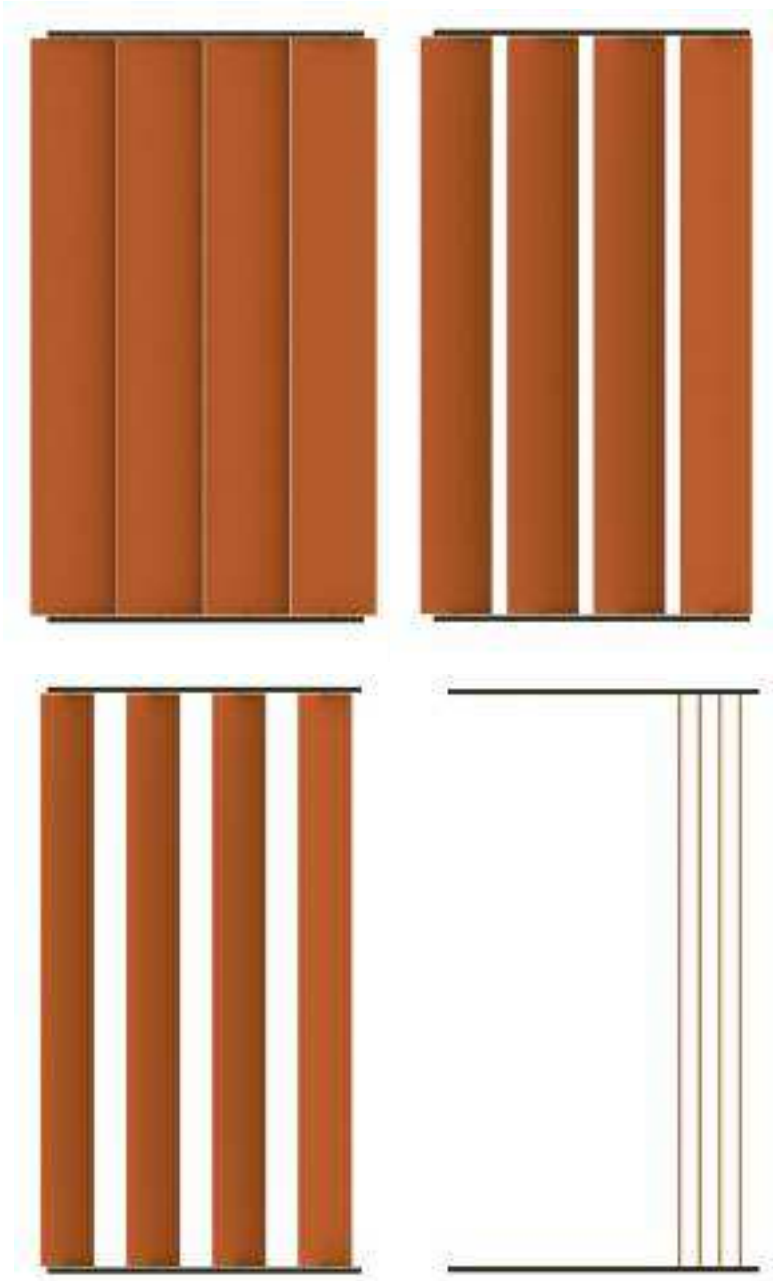


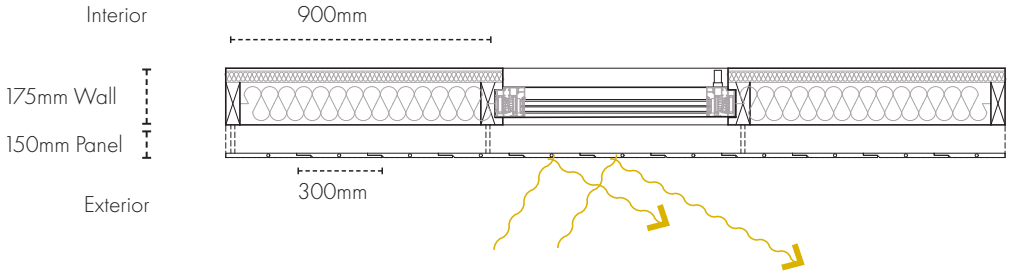
Depending on each unit's configuration, different panels can be extracted from grasshopper

Solid Panel - Prefabricated off site

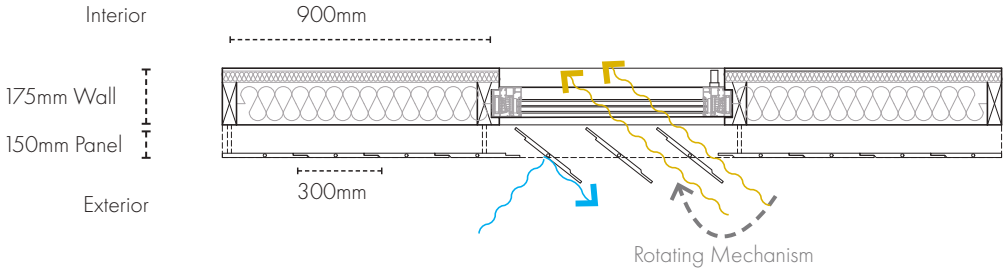



Openable Panels

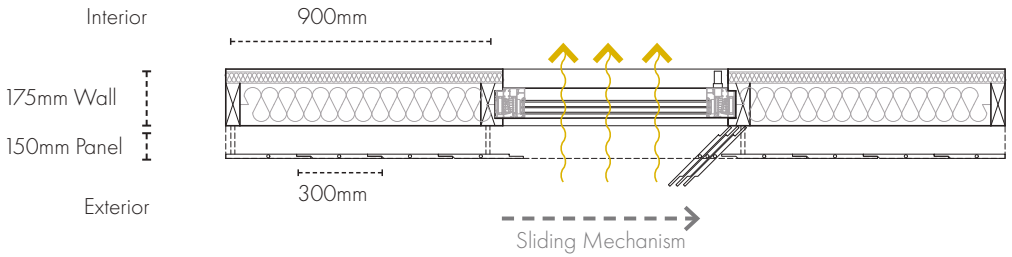





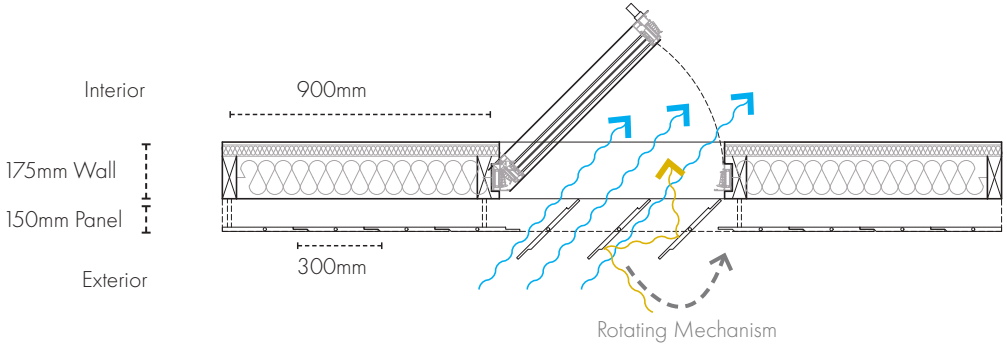

**Summer** - Fully Closed Panels with Closed Window



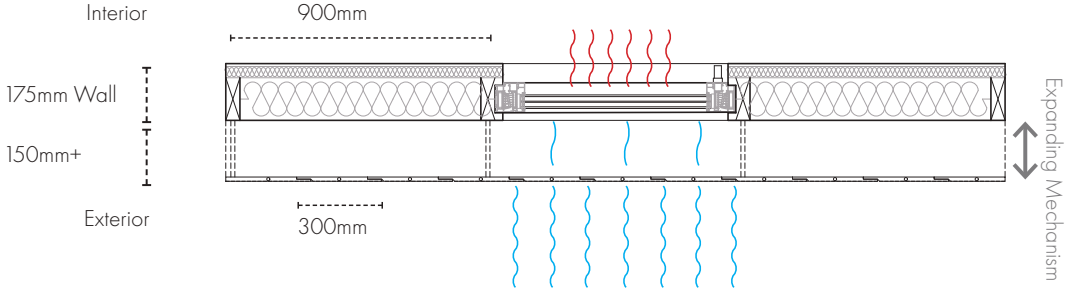

**Winter** - Semi Open Panels with Closed Window



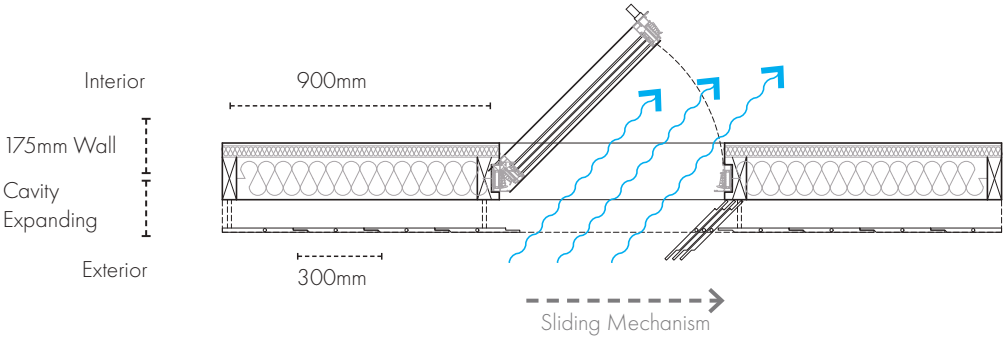

**Winter** - Fully Open Panels with Closed Window




**Summer** - Semi Open Panels with Open Window



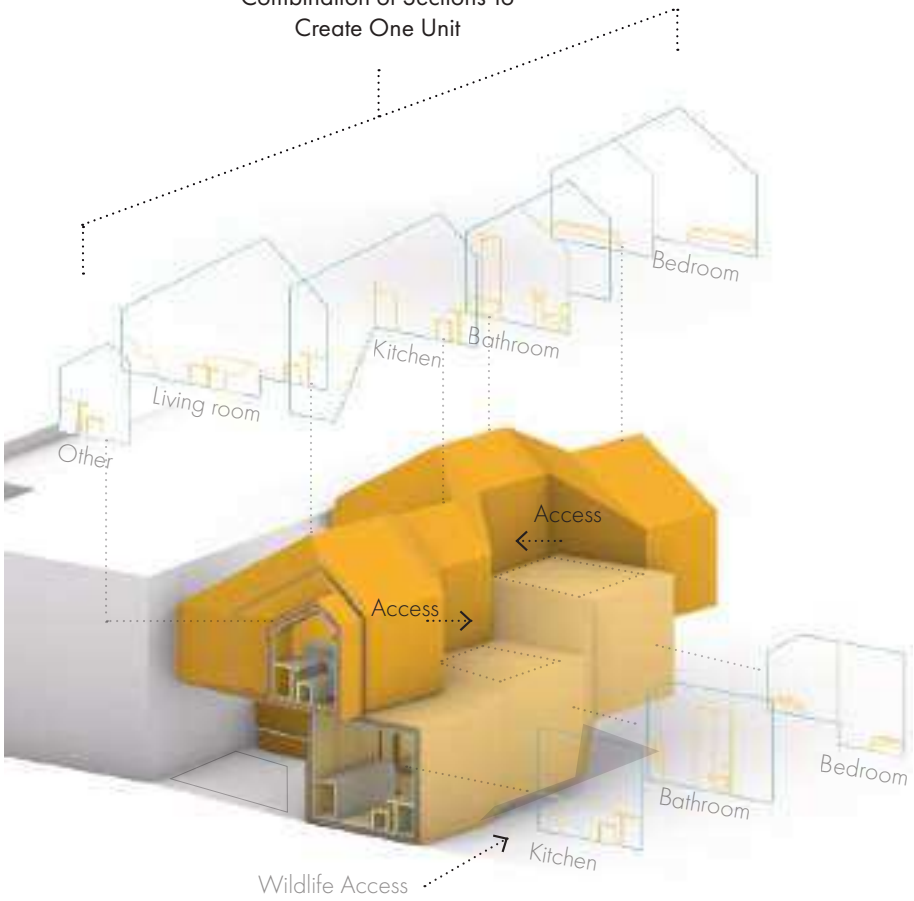

**Winter** -Expanding Cavity

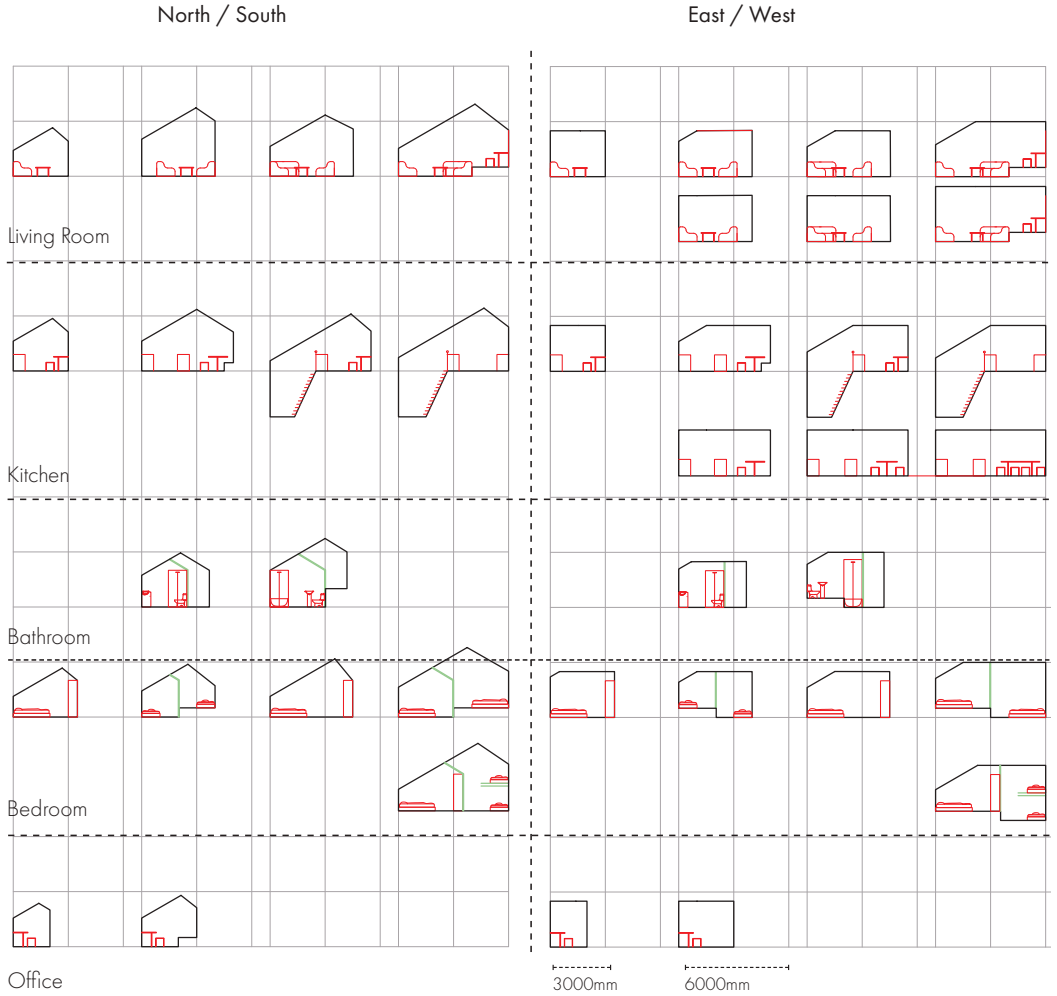



**Summer** - Open Panels with Open Window

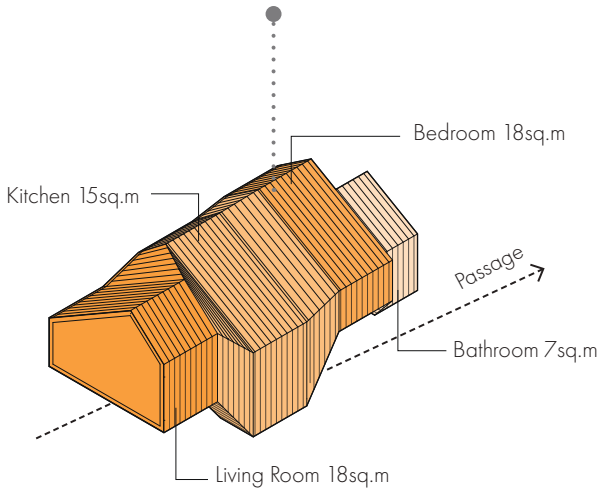
## MAIN IDEA
### Function by Section

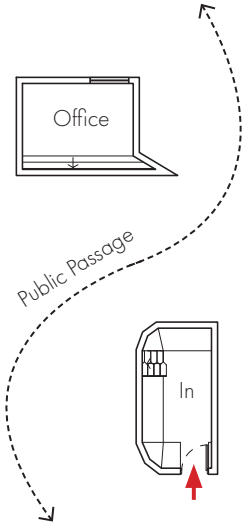
Combination of Sections To Create One Unit



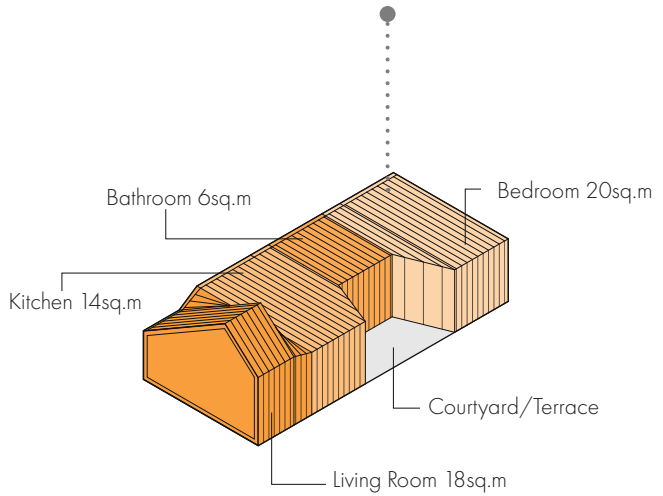
Pitched Roof Variation

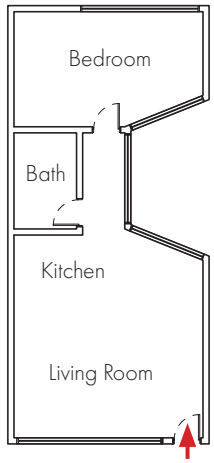


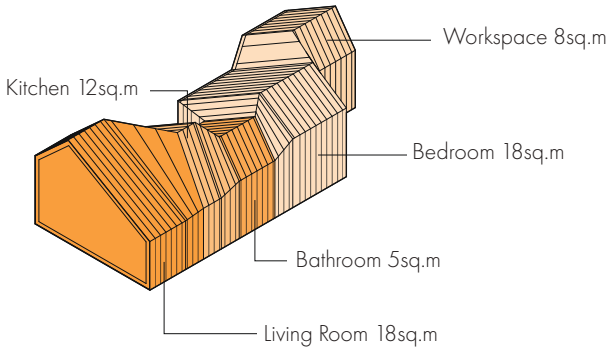

**1-2 Professionals** 58sq.m
Optimized for photovoltaics and rain collection
Underpassage for public access to backyard

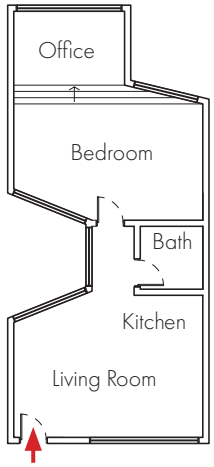
Flat Roof Variation



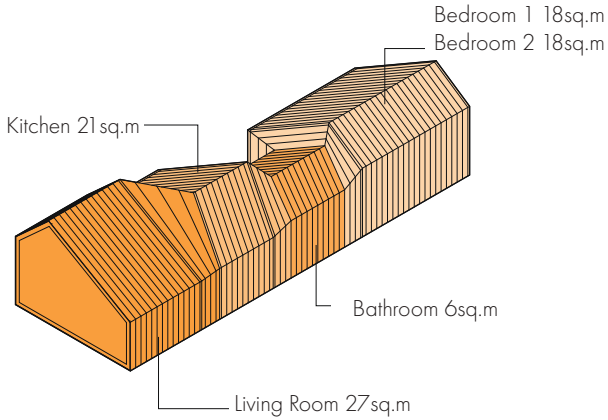



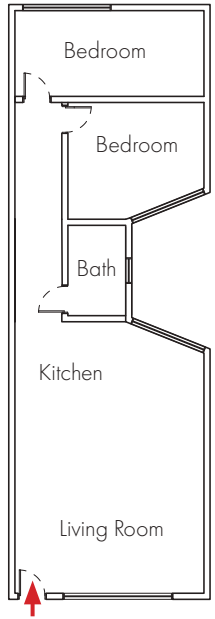

**1-2 Professionals** 60sq.m
Ground Floor Unit with Courtyard
Flat Roof for possibility of stacking above



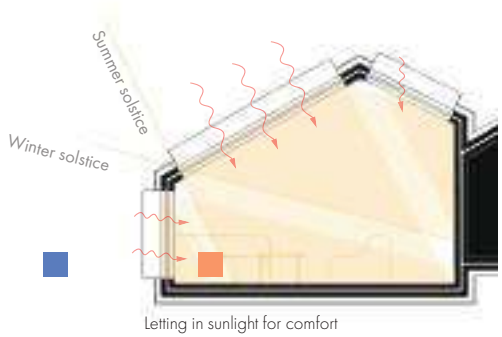




**1-2 Students** 64sq.m
Optimized for photovoltaics and rain collection

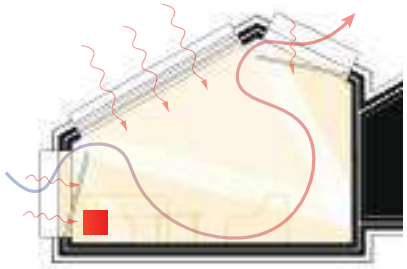


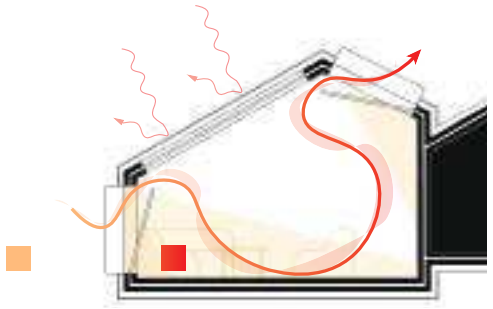

**Family of 3-4** 94sq.m
Optimized for photovoltaics and rain collection



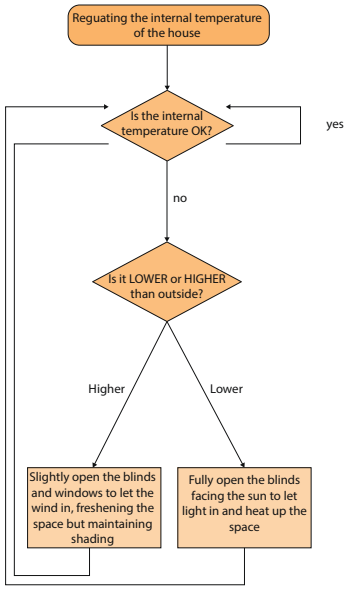

Letting in sunlight for comfort
Air pollution is okay
Closing windows not to loose heat
Opening all panels for added heat

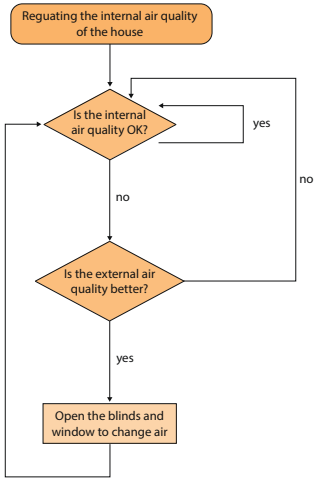


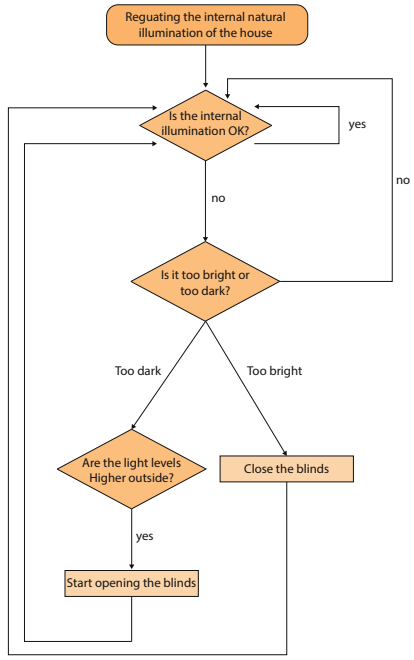
Letting in sunlight for comfort
Ventilate for air quality
Opening all panels for added heat

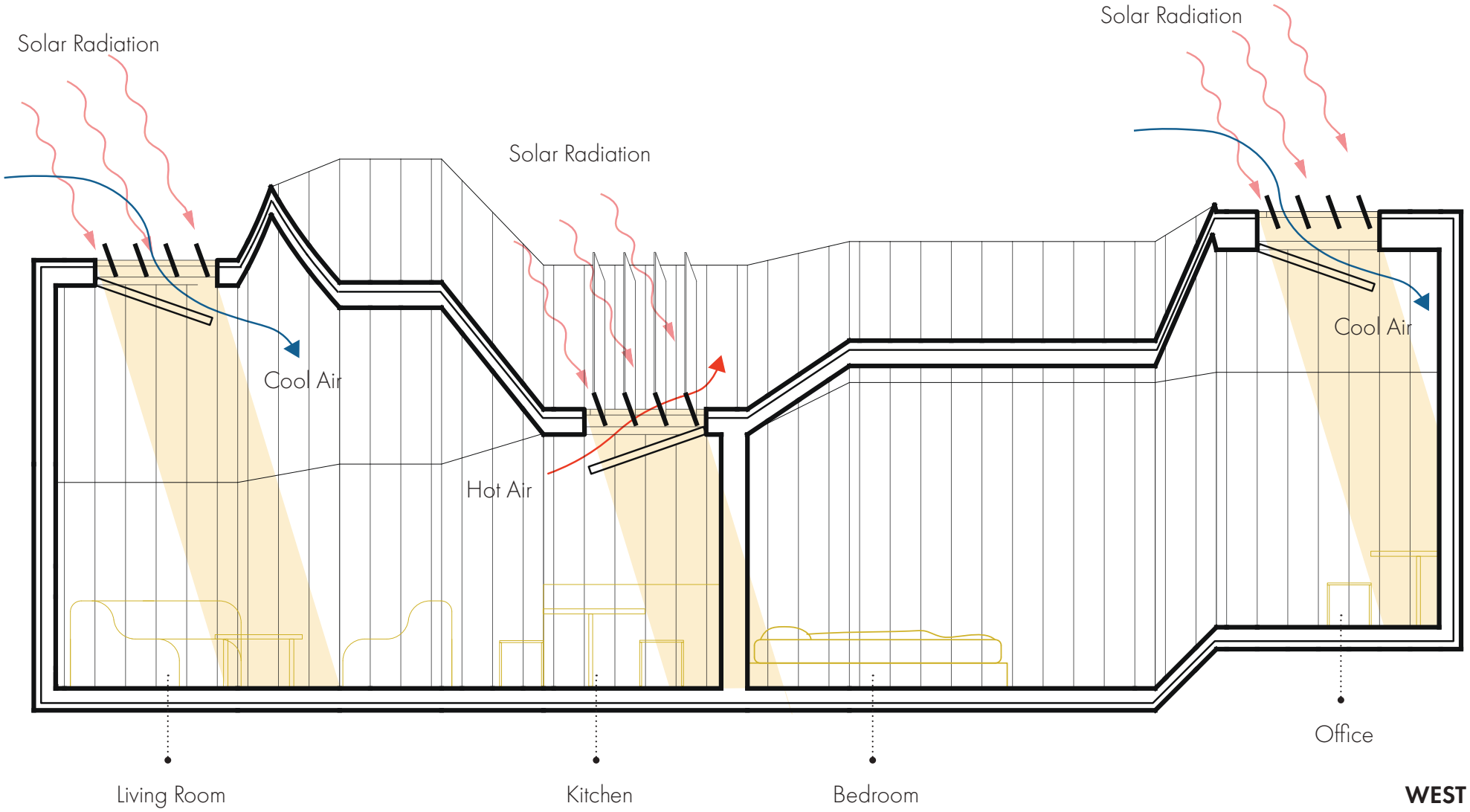


Letting in sunlight for comfort
Ventilation for air quality
Closing for direct sunlight to not gain heat
Ventilate to lower the temperature



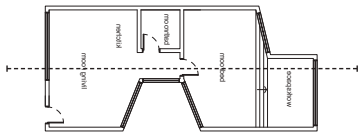




Solar Radiation
Solar Radiation
Solar Radiation
Cool Air
Cool Air
Hot Air
Living Room
Kitchen
Bedroom
Office

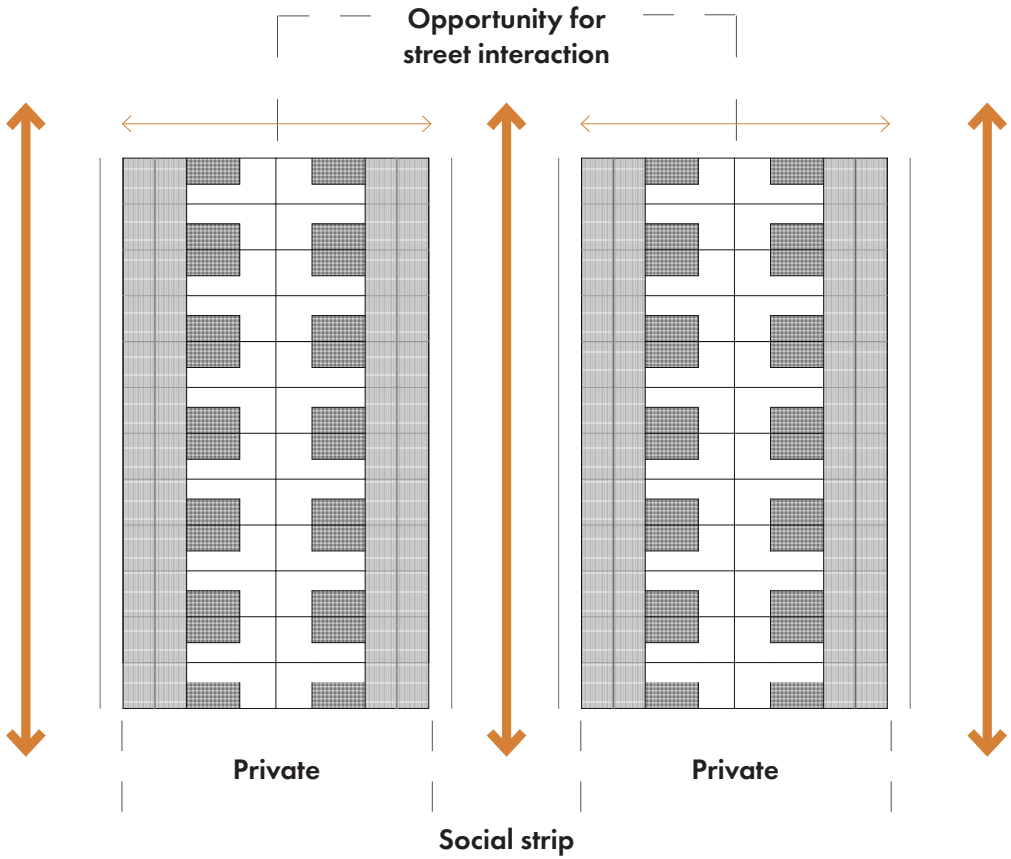
**EAST**

**WEST**



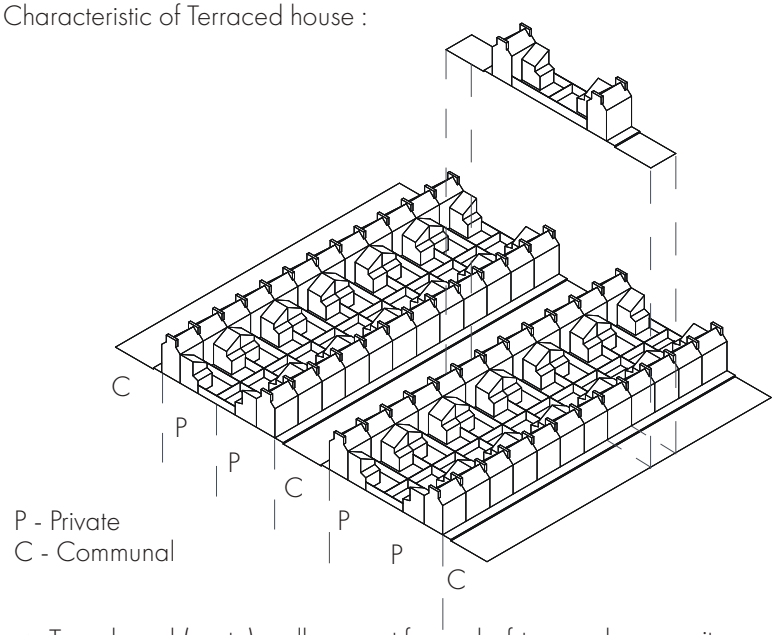
Terraced houses are the most common housing type in the UK. They often have uniform facades and have the same height, sharing side-walls with the houses on either side.

The terraced street is a street with two roe of terrace houses. The back-to-back terrace houses present a street block filled with terrace houses. Often the public facilities or community spaces such as allotments and parks being located in a separate area.




Long rows of terraced houses on rear infill sites, or that are perpendicular to the street on long and narrow sites, contribute little to the character and activity of a street.

Characteristic of Terraced house :

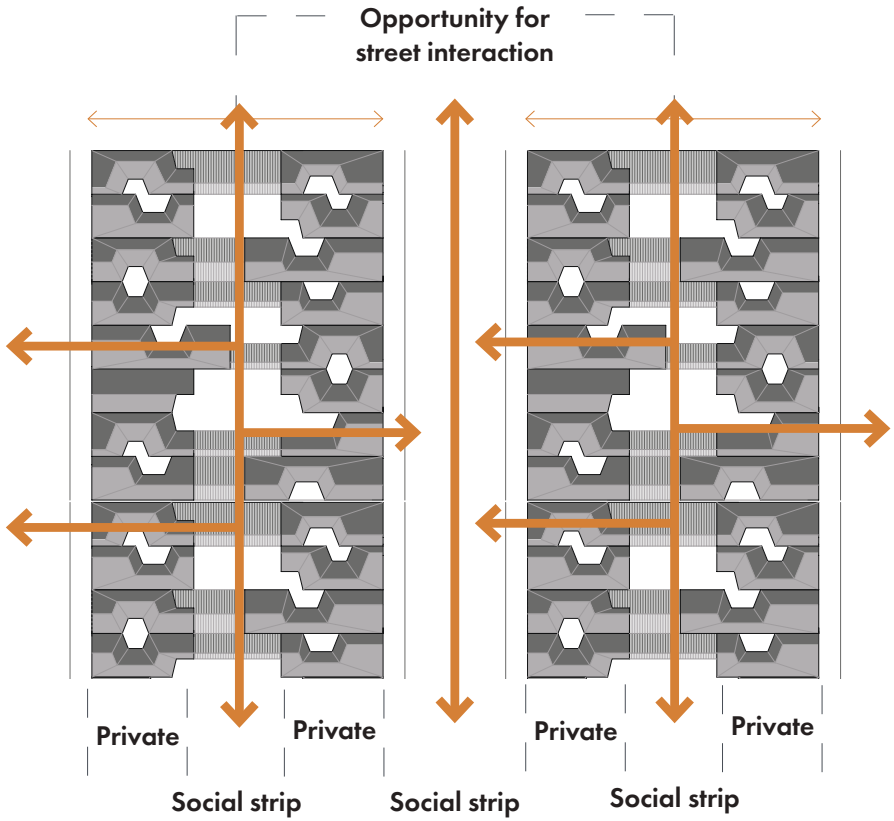



- Two shared (party) walls except for end-of-terrace house units
- Typically one to four storeys
- Individual front doors and pedestrian access to dwellings, directly off the street
- They can be converted into flats or remain as individual houses
- A private rear garden or patio and a front entrance area
- Consistency in front façade design, building line and skyline
- Clearly defined fronts and backs with fronts addressing public streets, spaces or accessways. Backs are contained to the rear, and are usually back-to-back in a perimeter block arrangement.

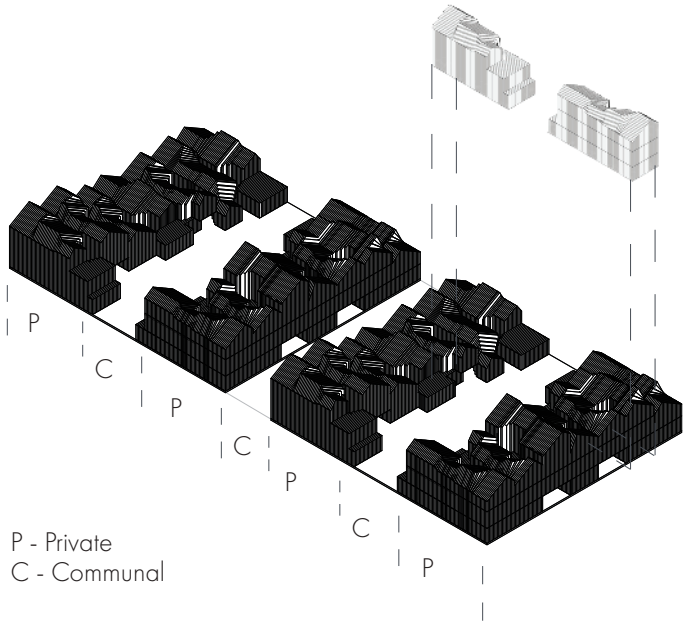
Street Revival

Street parties in London were and are still a common form of communal celebration for events such as the Golden Jubilee bringing the residents of the street together.

Designing compact systems alongside the existing neighborhood typology will allow the same streets to be repopulated but with more people to create a greater sense of community




Opening up the gardens to the community creates opportunities for public facilities or community spaces such as allotments and parks, that increases social interaction.




P - Private
C - Communal

Roof Level

Rain water harvesting

Solar Panel

Green roof

Envelope

Heating and cooling

Ventilation

Insulation

Triple glazing

Garden + Landscape

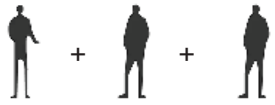
Community garden

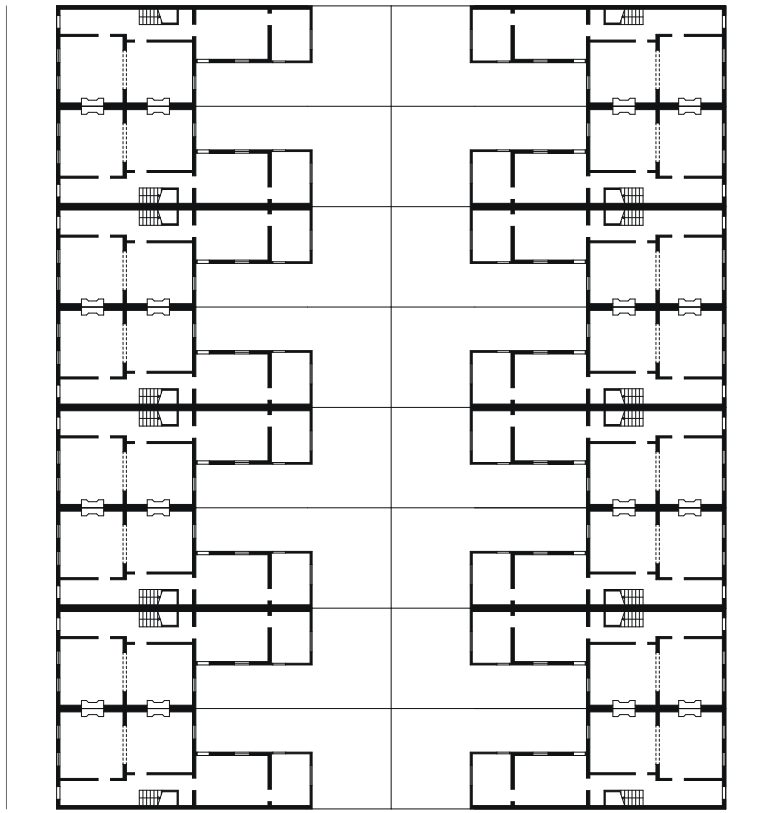
Community Allotment

Park / Play area

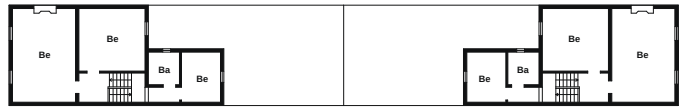
Social community

A typical 2 floor terraced house has 2/3 bedroom, typically allowing up to 6 people to occupy the house

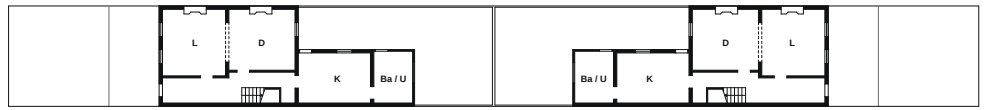
| Property use | Occupants | |
|---|---|---|
| | Example user type | Number |
| Single family home |  Couple | 2 |
| |  Family | 2 / 3 / 4 / 5 / 6 |
| Shared house Co-habitation |  Individual | 3 |
| |  Individual Couple | 4 |
| |  Couple Couple Couple | 5 |
| |  Couple Couple Couple | 6 |




**Back to Back Terraced House Strip**

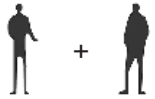



First Floor

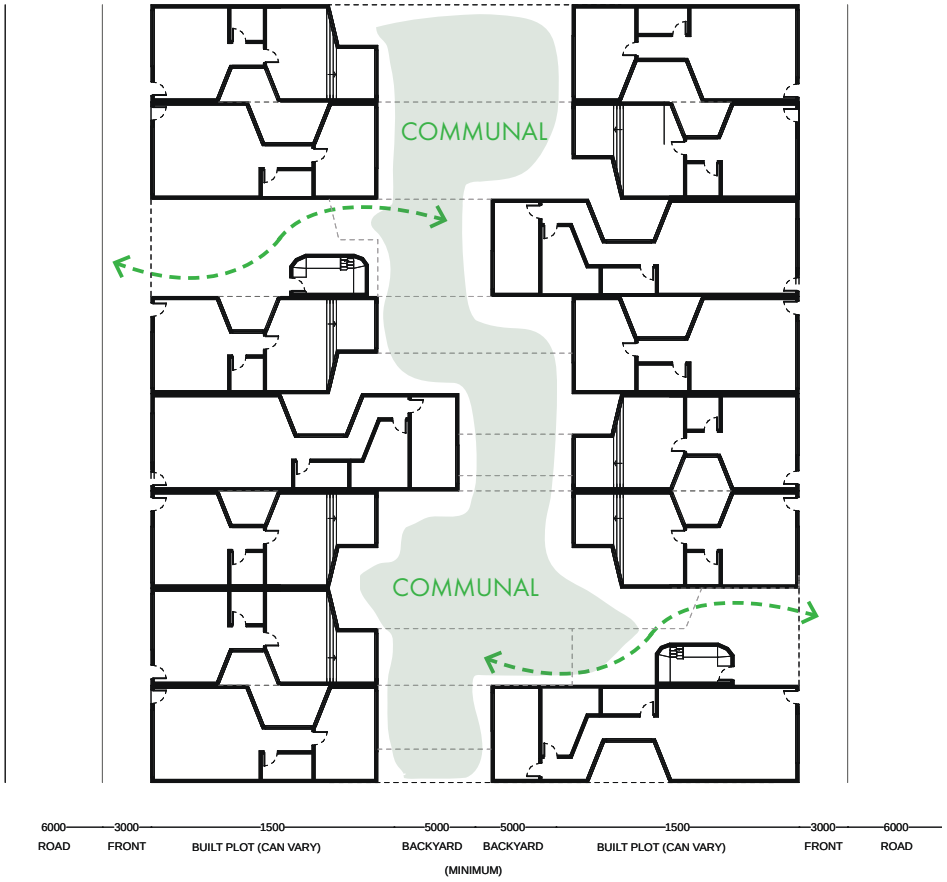



Ground Floor

The units can accommodate up to 2 bedroom, and with the initial typology of 2 floors it can accommodate up to 4 bedrooms within a cluster but with the possibility of increasing the density vertically.

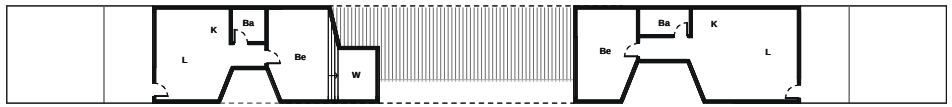
| Unit use | Occupants | |
|---|---|---|
| | Example user type | Number |
| Single family Unit |  Couple | 2 |
| |  Family | 2 / 3 / 4 |
| Shared house Co-habitation |  Individual | 2 |
| |  Individual Couple | 3 |
| |  Couple Couple | 4 |

Extended roofs connect some units to create shaded spaces as well as shelter from the rain. Additionally, depending on the material chosen some of the roofs could perform as a green house for the production of vegetation.




**Back to Back Terraced House Strip**

Strip type 1

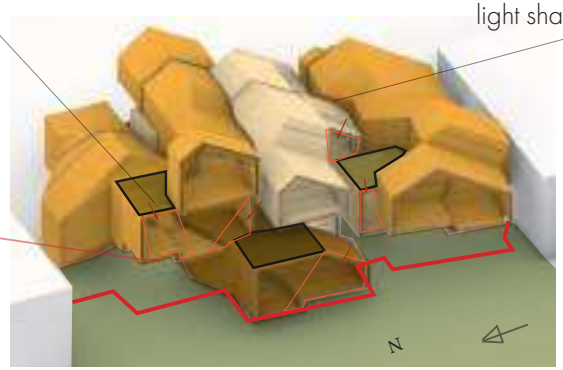



Strip type 2

Rooftops makes balconies or common spaces

Fluid arrangement gives space for air/ light shafts.

Staggered facade gives opurtunity to let light into lower units through facade or skylight




Cluster is staggered to optimise roof space

Roof area optimised towards the south

Roof pitches come together to collect water


- 1 Person/Couple
- Single parent and child
- Family of 3
- Family of 4

Roof inclination is 30* from the optimal solar radiation angle

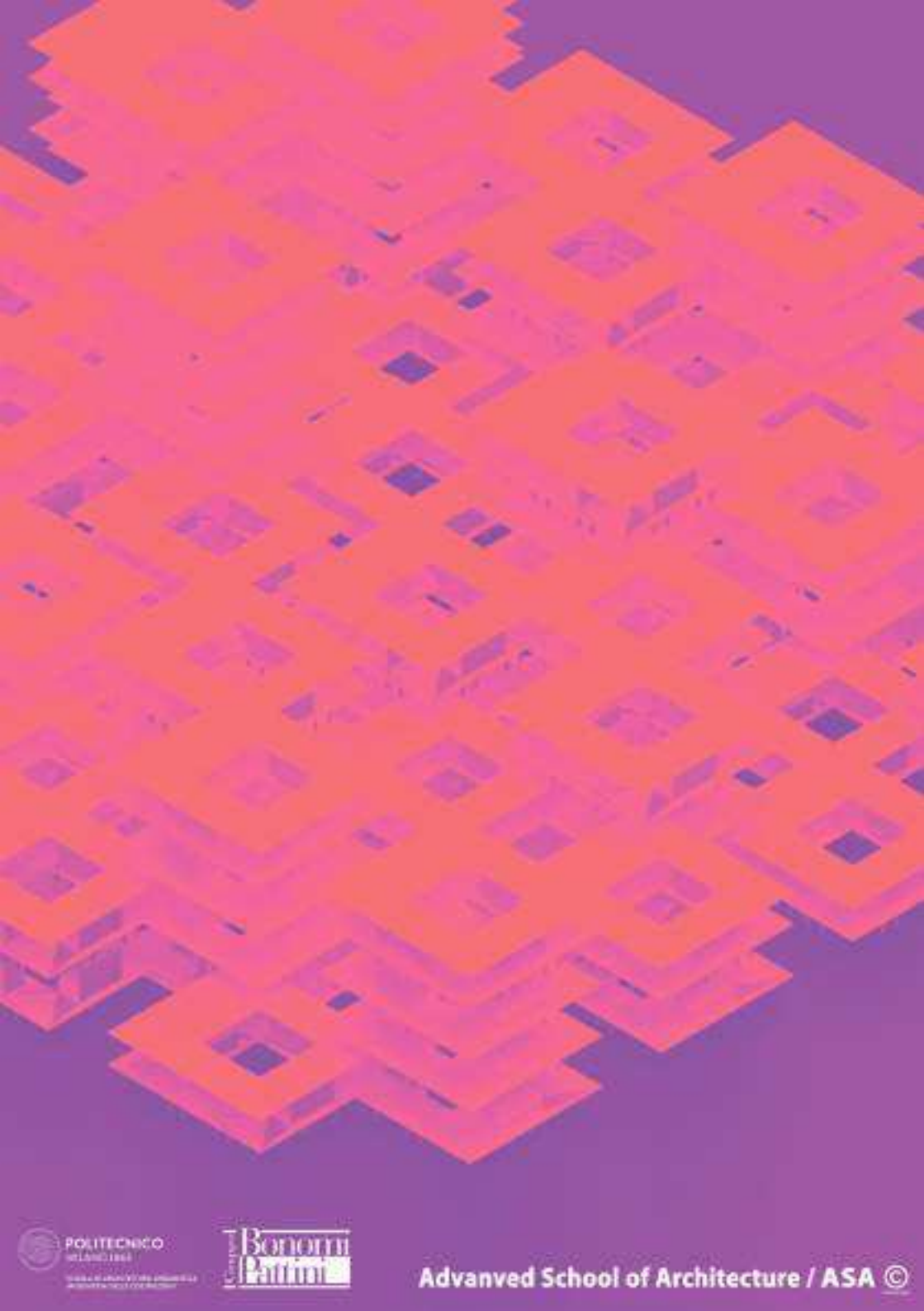
Void spaces gives opurtunity for vegetation

Holes in the structure allows passage from garden to street for foxes.

Larger plots gives opurtunity for vegetable gardens or barbeque spots

© Denis Kapitanov

© Denis Kapitanov



POLITECNICO MILANO 1863

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