Advanced School of Architecture / ASA Director Pierre-Alain Croset

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

### Masterclass Paolo Cascone tutor Maddalena Laddaga

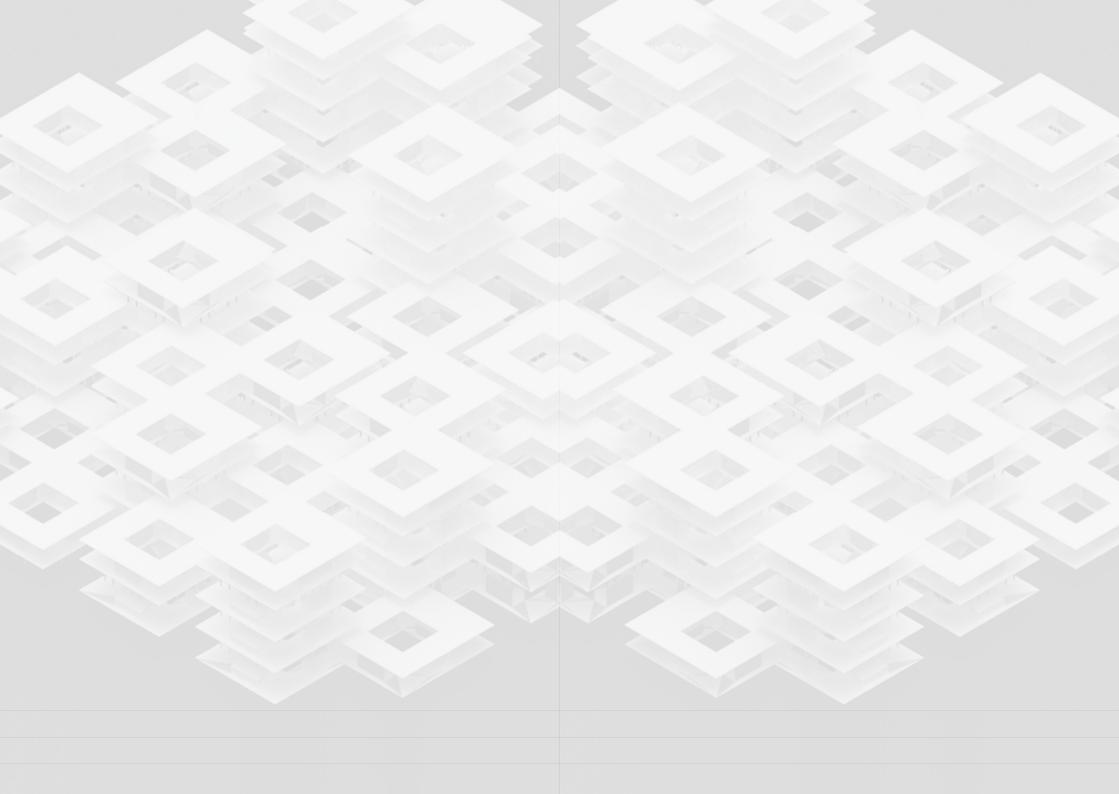
with the contribution of Prof. Maximiliano Romero Università luav di Venezia

ASA STUDENTS: NOORA KHALED ALI EBRAHIM HUSAIN ALHASHIMI CARLOS DAVID ARCOS JÁCOME 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 JOW STUDENTS: AGATHE ALEXANDRE METTE PEDERSEN EDOARDO RIPAMONTI ROFAYDA SALEM



POLITECNICO MILANO 1863





# 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







## **Case Studies**

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### ASA - Advanced School of Architecture Masterclass Paolo Cascone 2022

# 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.

### ASA - Advanced School of Architecture Masterclass Paolo Cascone 2022

# 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.

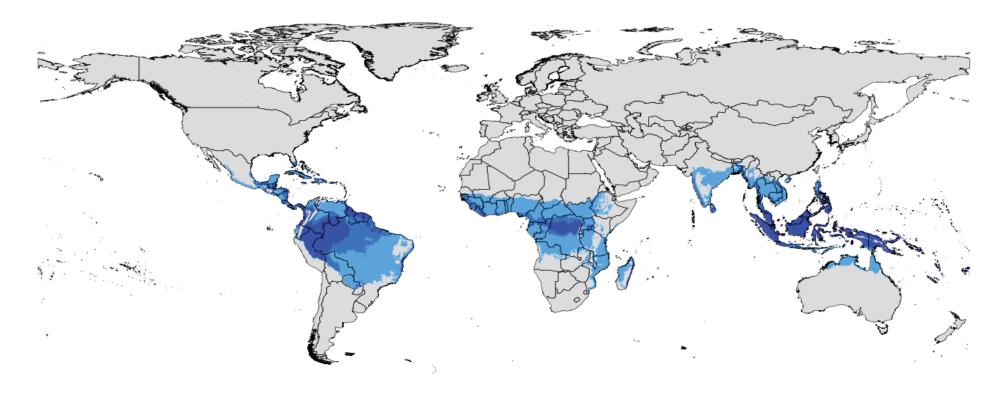
The most detailed part of the design concerns the panel system, that is imagined as breathable and adaptable skin wrapping itself around the skeleton of the living units. The system, inspired by tradition Jaali screens commonly found in the southern regions of India, is therefore a skin protecting from 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. composition of wood The panel consists a skin system, inspiration malleable and flexible taking from typical weaved palm frond cladding used in vernacular tropical housing.

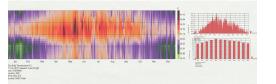
The housing unit is thus configured as a protected core, a sort of heart of the house, entirely covered by the climatically and energetically performing skin. The result of the housing

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

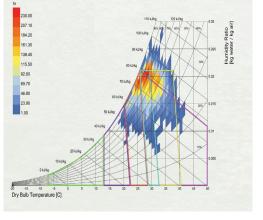




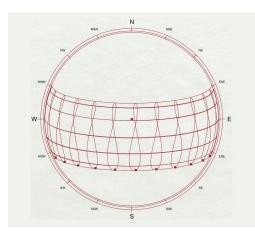
Dry Bulb Temperature - Chennai



Sun Path - Chennai



Psychometric Chart - Chennai



Sun Path - Chennai

Season Wind Rose - Chennai

### climate

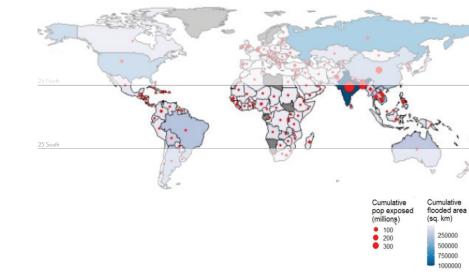
materials

social scenario

off-grid strategy

building component

house unit





Flood event in Chennai - 2015





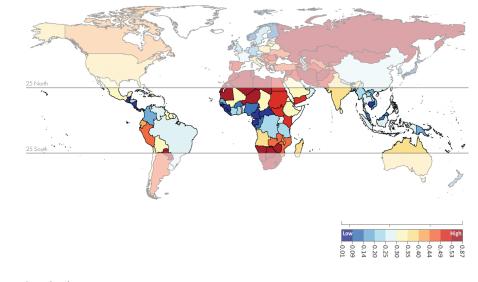
15

Population exposed to flood risk map

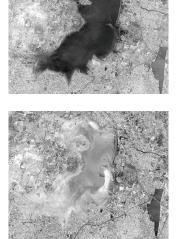
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FLOOD







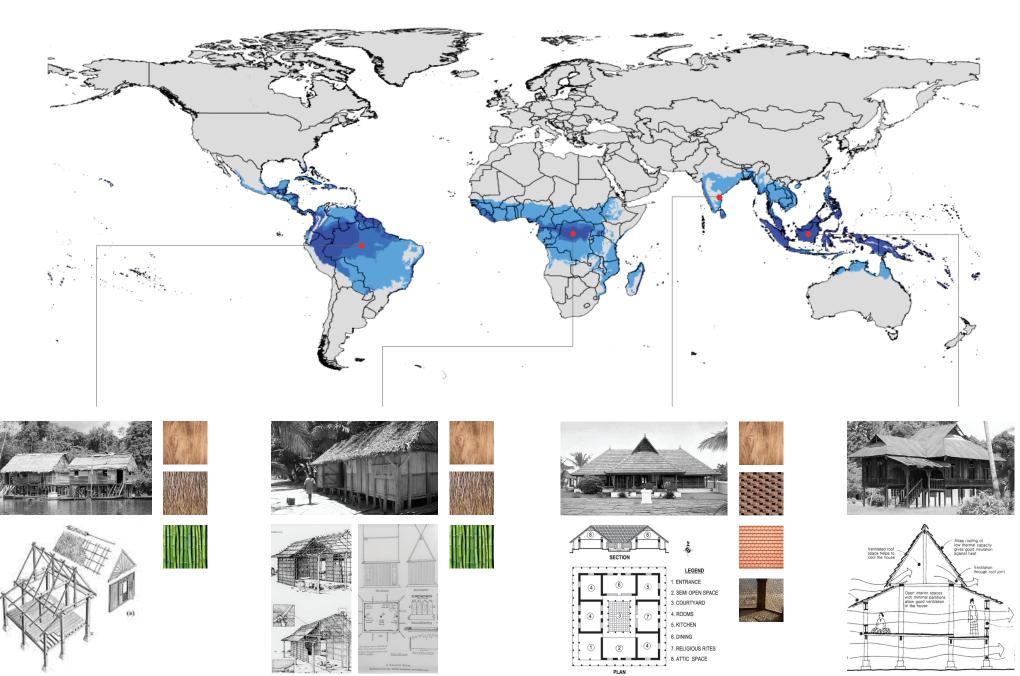
Drought risk map

### climate

materials

off-grid strategy

building component



materials

social scenario



### 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





### 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 oviad 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



### 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

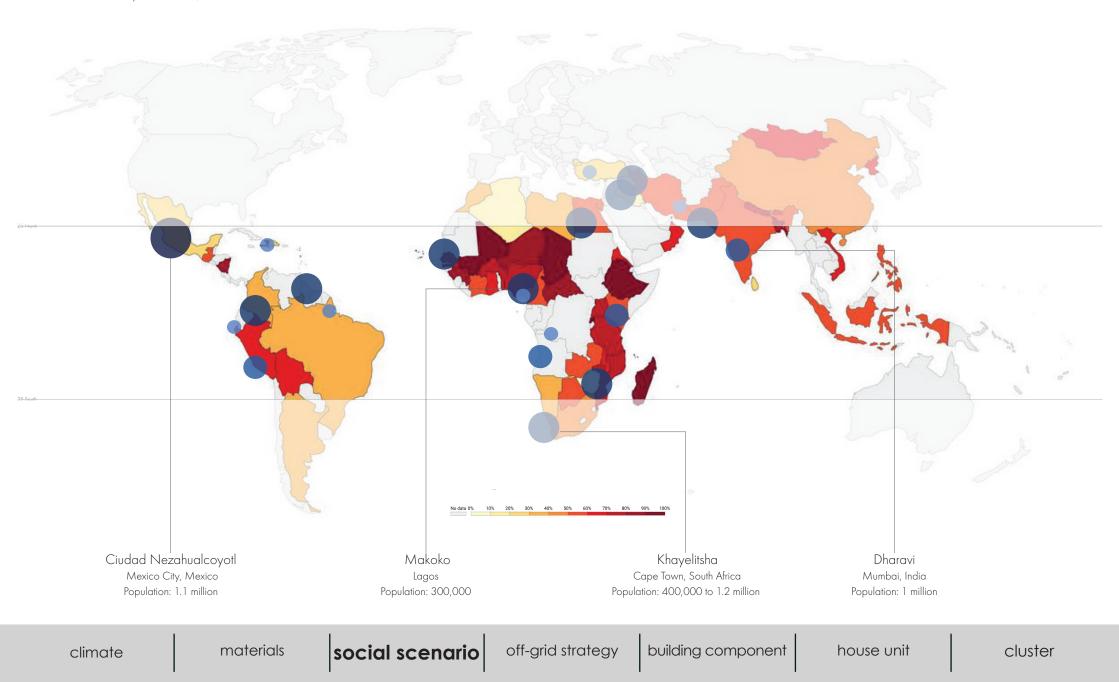
### WOOD JAALI

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

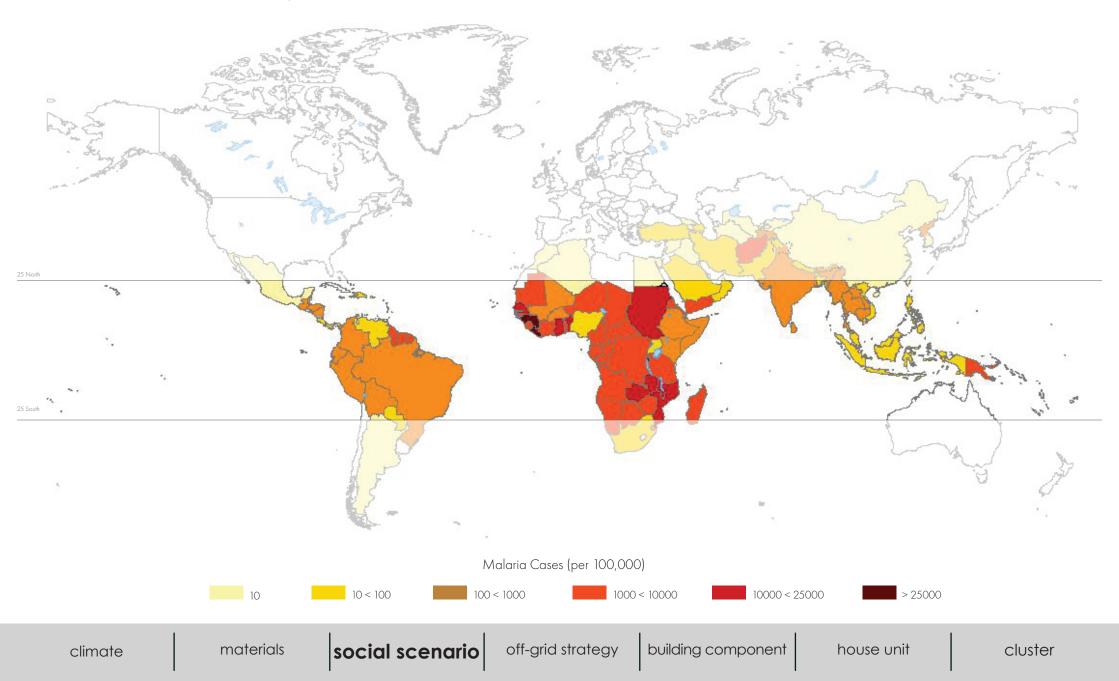
### DATA

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



### DATA

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

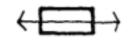


### ORIENTATION

- $\stackrel{( \square)}{\longleftrightarrow}$
- E-W direction in order to minimize areas exposed to solar radiation

Unit

• Staggered position to create wind channels







### DETACHMENT FROM THE GROUND

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



### NATURAL VENTILATION

• Garantee easy passage of air and cross ventilation

Unit

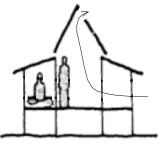
• Avoid the use of cooling electic systems



Panel







### ACCENTUATE PITCHED ROOF

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

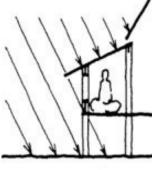
Unit







25



### OVERHANGS and LOW EXPOSED VERTICAL SURFACES

- Protection to rain
- Good shadow from solar radiations







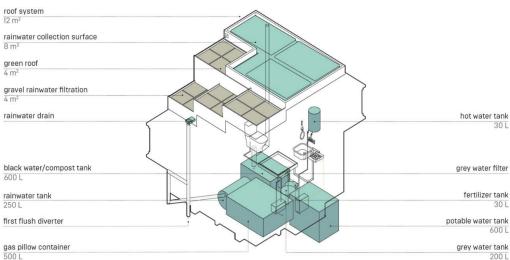


Unit

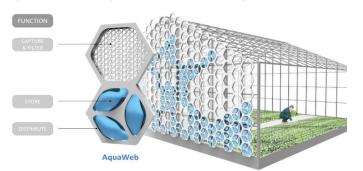


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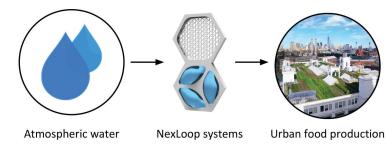
### WATER SYSTEM REFERENCE



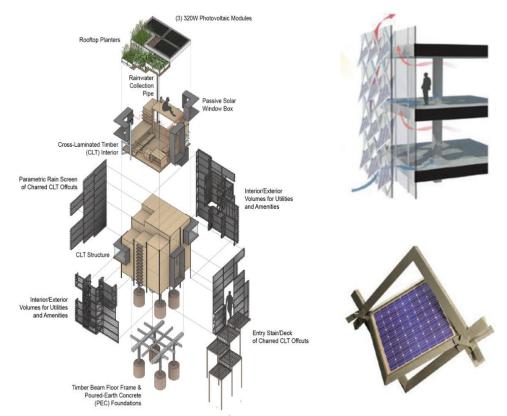
"Gallery of the Voxel Quarantine Cabin / Valldaura Labs - 28." ArchDaily. Accessed November 28, 2022. https://www.archdaily.



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

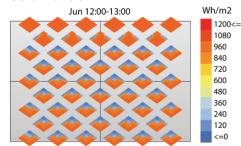


"Gallery of the Voxel Quarantine Cabin / Valldaura Labs - 28." ArchDaily. Accessed November 28, 2022. https://www.archdaily. com/958366/the-voxel-quarantine-cabin-valldaura-labs/60493f6ef91 c811380000286-the-voxel-quarantine-cabin-valldaura-labs-axo.

### Energy Collection



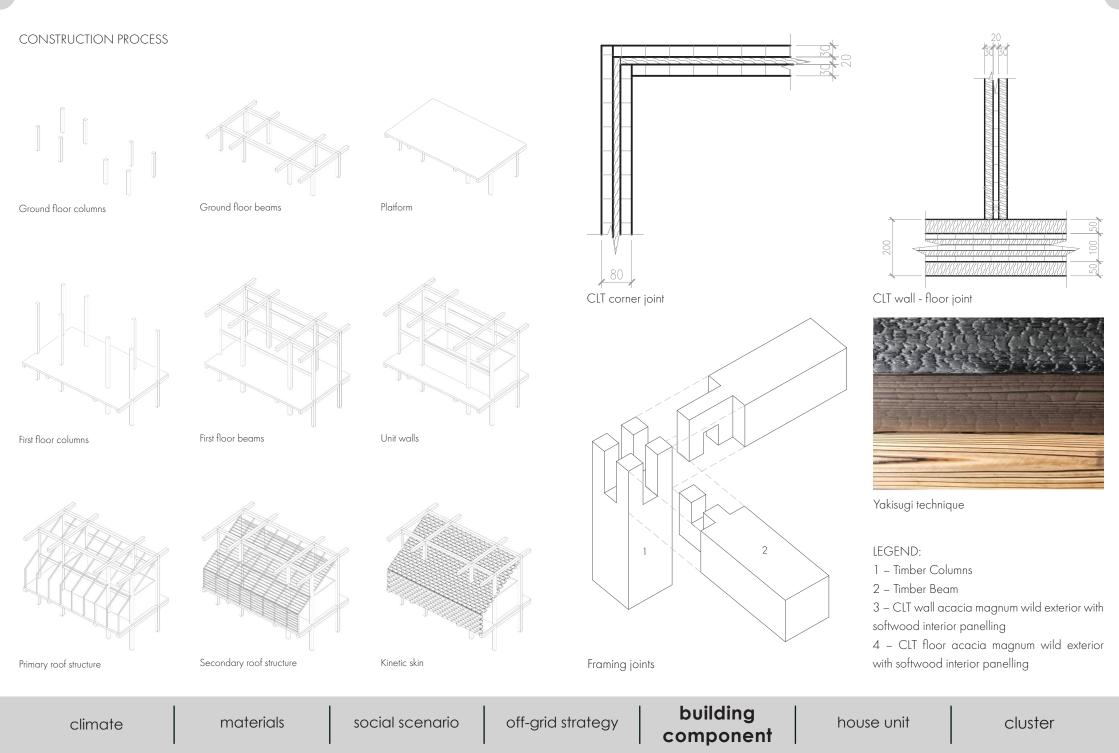
### Solar Panels

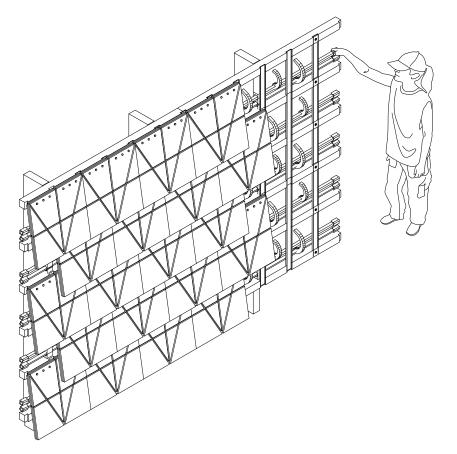


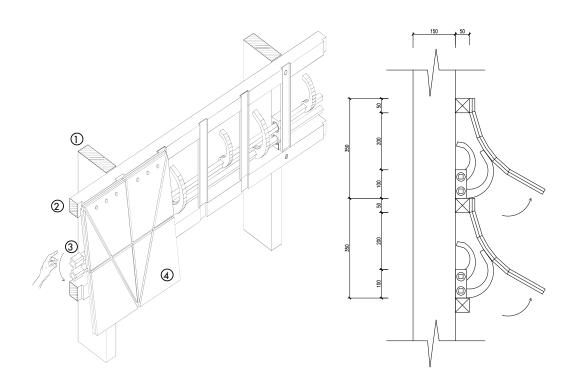
"Adaptive Solar Facade Prototype at the House of Natural Resources at ..." Accessed November 28, 2022. https://www.researchgate. net/figure/a-Adaptive-solar-facade-prototype-at-the-House-of-Natural-Resources-at-the-ETH-Zurich\_fig10\_311922852.

social scenario

house unit







### PANEL CLADDING AXO

### 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



PANEL CAM SYSTEM

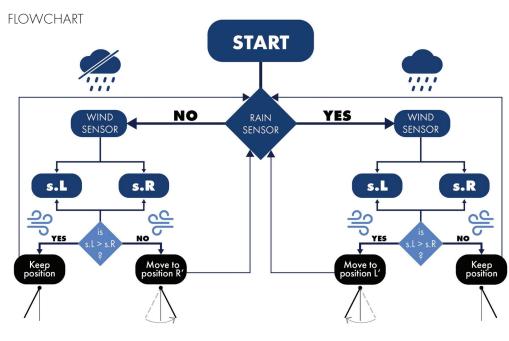






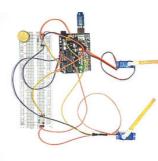




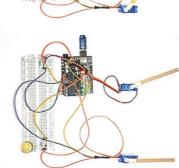


### ELEMENTAL MOVEMENT

WestWindSpeed : 1 WestW\_Angle : 0° EastWindSpeed : 183 EastW\_Angle : 32° **East predominant wind** 



WestWindSpeed : 73 WestW\_Angle : 12° EastWindSpeed : 6 EastW\_Angle : 1° West predominant wind



### 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);
1
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");
```

Serial.println("East predominant w
WindPB.write(mapValueB);
WindPA.write(0);
delay(100);

### climate

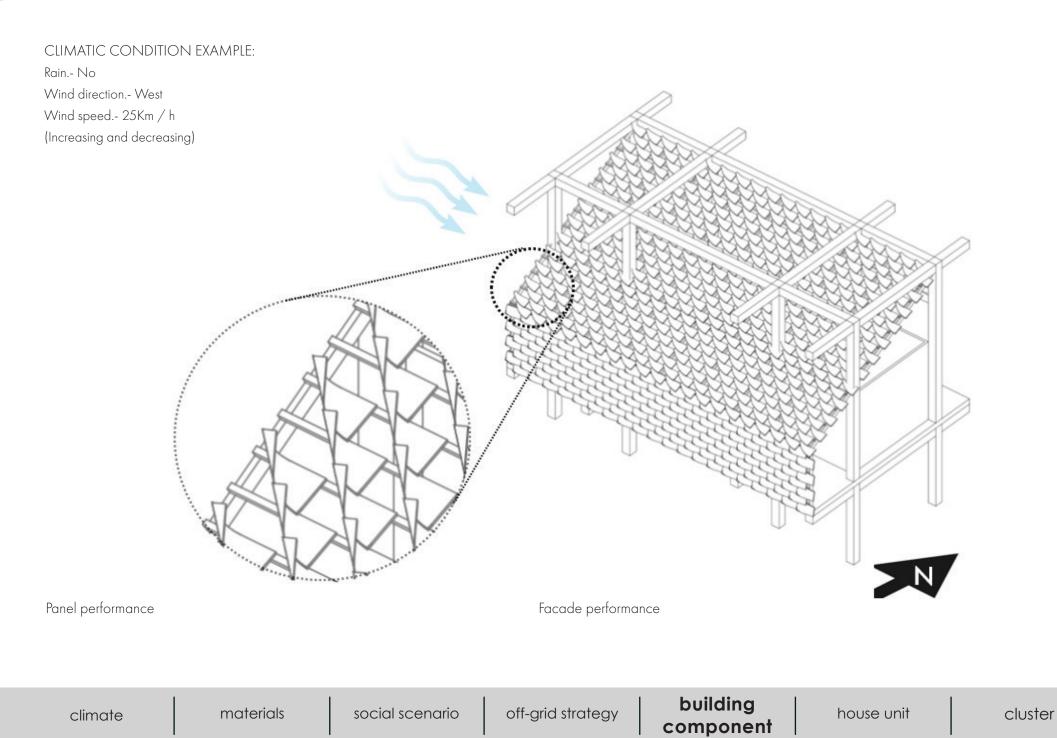
materials

social scenario

off-grid strategy

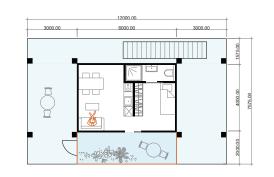
<sup>gy</sup> | building | component

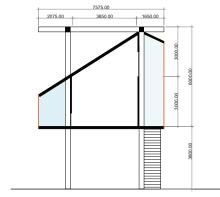
house unit

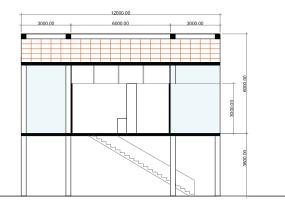




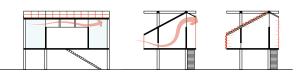
SIZE: 24 sqm







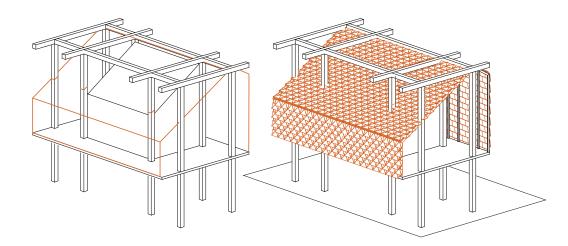
### Natural ventilation STRATEGY



Incremental housing STRATEGY





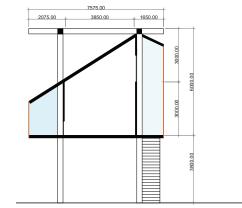


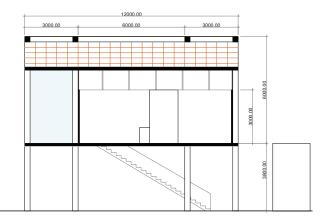


SIZE: 36 sqm

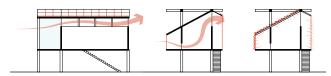
NEEDS Energy: 1714 kW/h Water: 270 l/day Space: 19 sqm



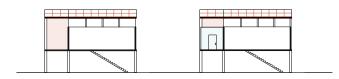




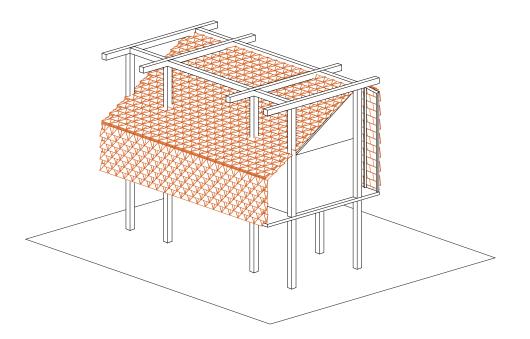
### Natural ventilation STRATEGY



Incremental housing STRATEGY







climate

materials

social scenario

off-grid strategy

building component

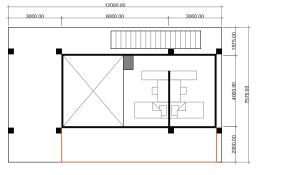
house unit



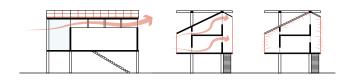
SIZE: 60 sqm

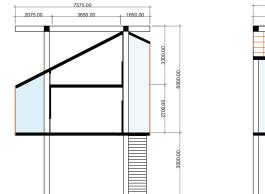
NEEDS Energy: 3428 kW/h Water: 540 l/day Space: 38 sqm

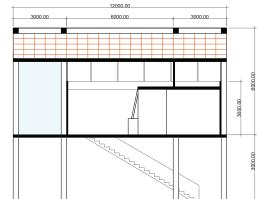


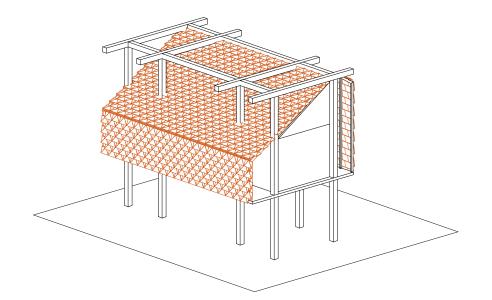


Natural ventilation STRATEGY



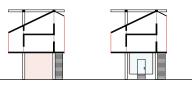






Incremental housing STRATEGY







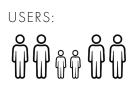
materials

social scenario

off-grid strategy

y building component

onent house unit

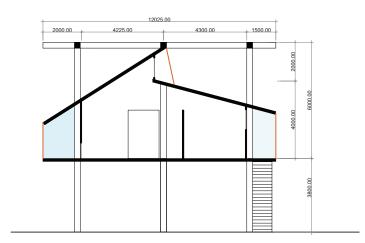


SIZE: 77 sqm

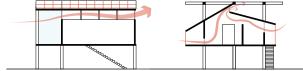
NEEDS

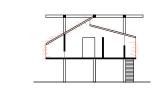
Energy: 5142 kW/h Water: 810 l/day Space: 57 sqm

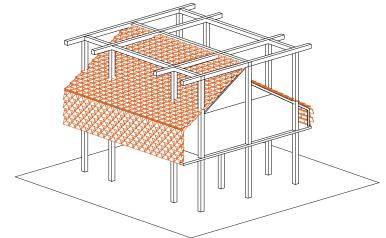






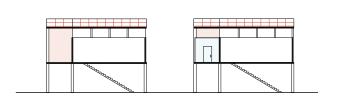


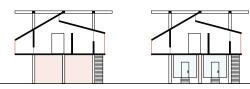




Incremental housing STRATEGY

climate





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· .

materials

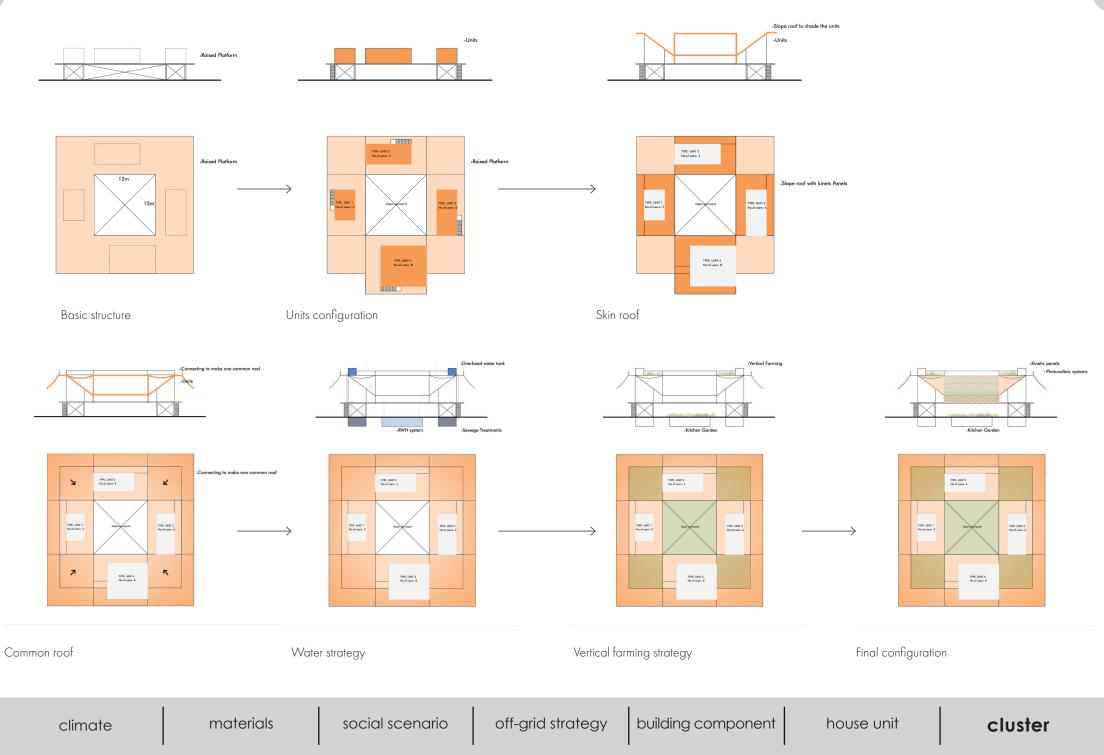
social scenario

off-grid strategy

building component

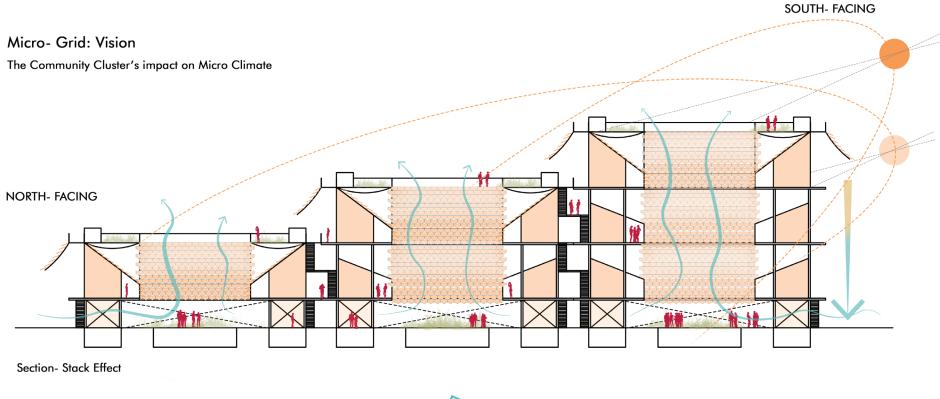
omponent house unit

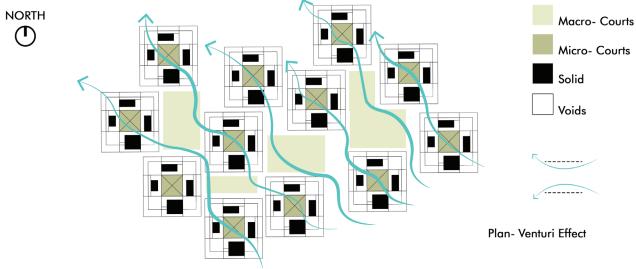
### 44 Advanced School of Architecture | Off-Grid Communities

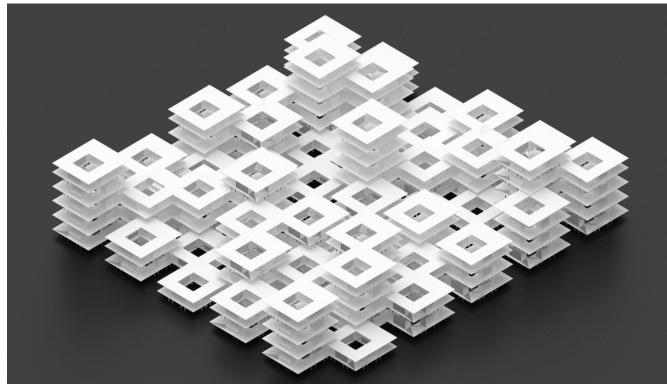


materials

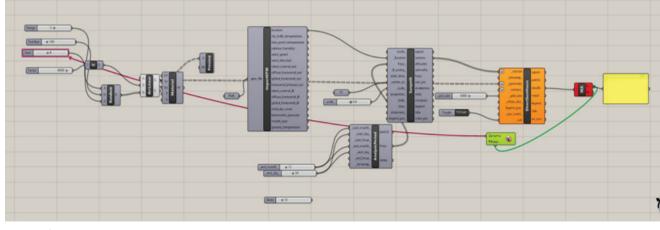
climate





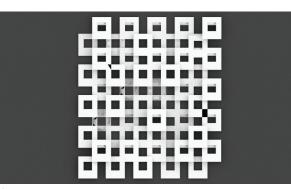


Cluster configuration

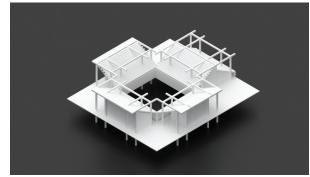


Grassopher script

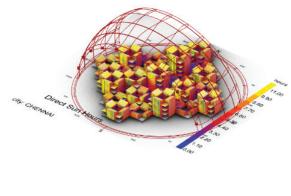
climate



Cluster top view



Cluster unit



Cluster sun hour analysis

49



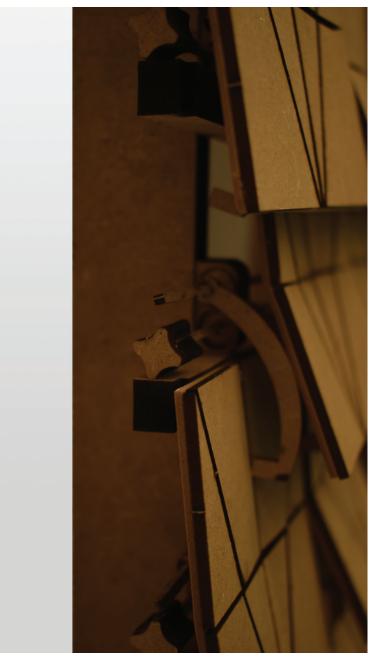








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### ASA - Advanced School of Architecture Masterclass Paolo Cascone 2022

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

### CONTINENTAL CLIMATE Lublin - Poland

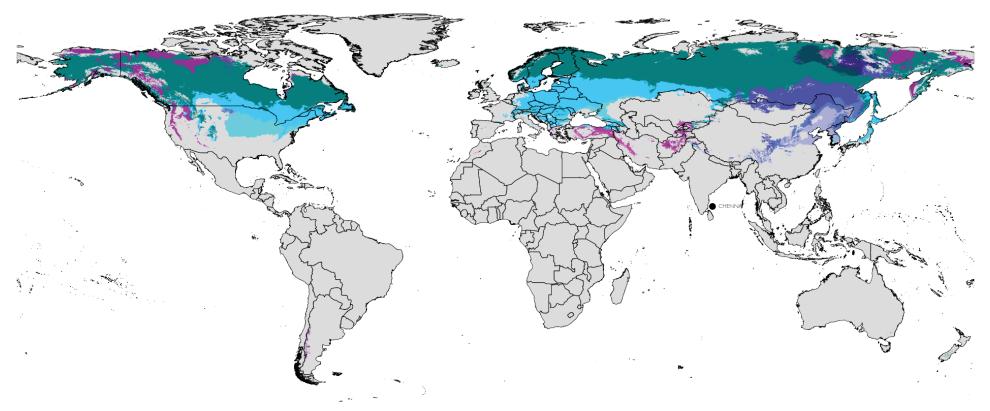
Lublin is the ninth-largest city in Poland and the second-largest city of historical Lesser Poland. It is the capital and the center of Lublin Voivodeship with a population of 336,339. Lublin has a humid continental climate with cold, damp winters and warm summers .In continental climates, precipitation 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.

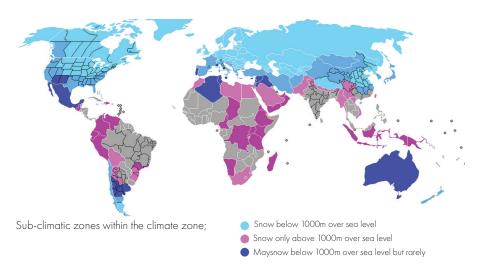
The plurality of climate characteristics determin that the panel system need to deal with both the hot summer and cold winter, to provide suffient insulation in winter and ventilation in summer. Therefore the panel has a operational double-skin with double openning. The size of the openning on the winter 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.

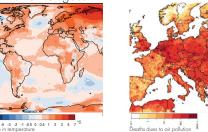
The main driver around the arrangement of the cluster is the annual exposure to sunlight. The main aim behind the layout is to position the units in a way which ensures maximum sun light and as result optimal energy collection throughout the year. Each village would comprise a series of buildings with 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

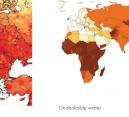




Main Influx of Refugees







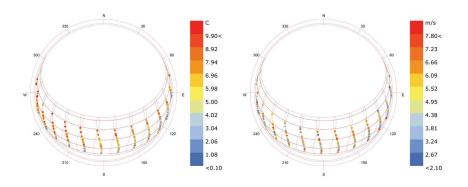


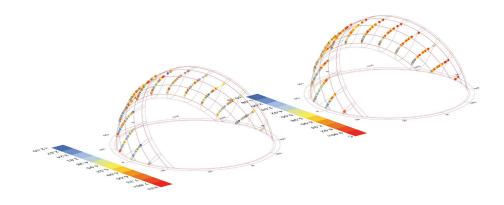
### climate

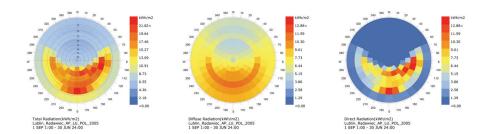
materials

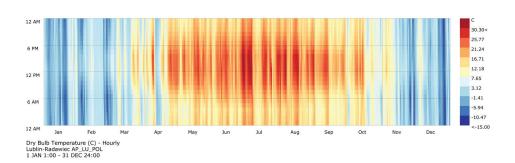
off-grid strategy

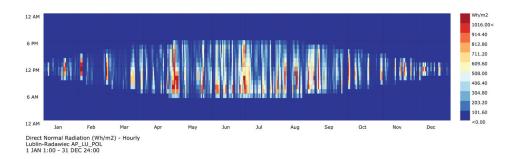
CLIMATE CHANGE

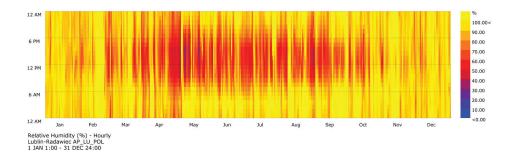












climate

materials

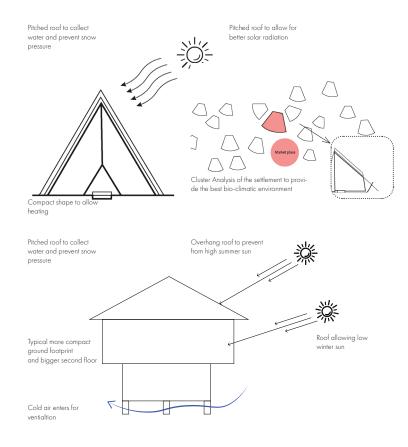
social scenario

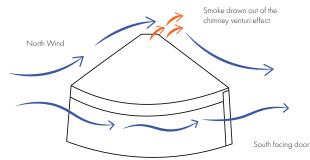
off-grid strategy

building component

house unit

### 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

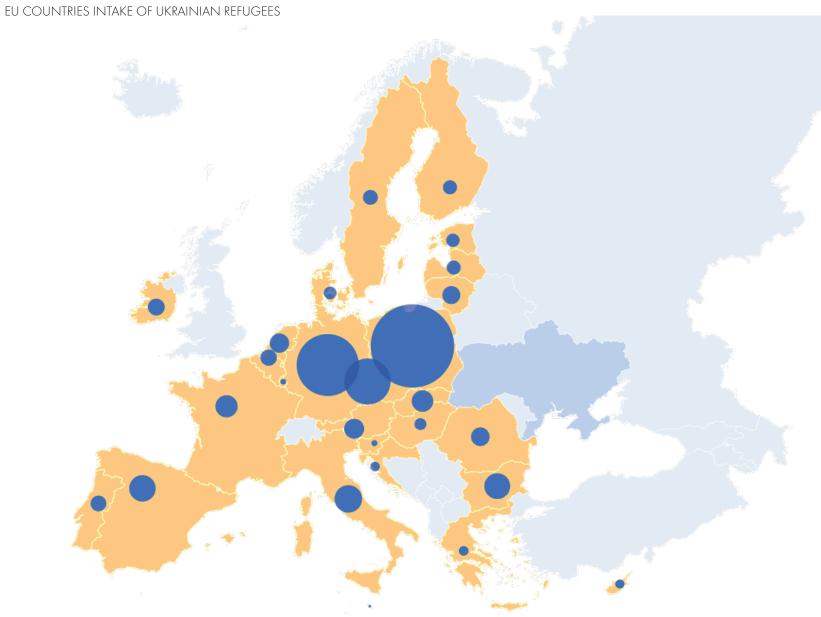
67

Cool air enters for ventilation climate

**materials** 

social scenario

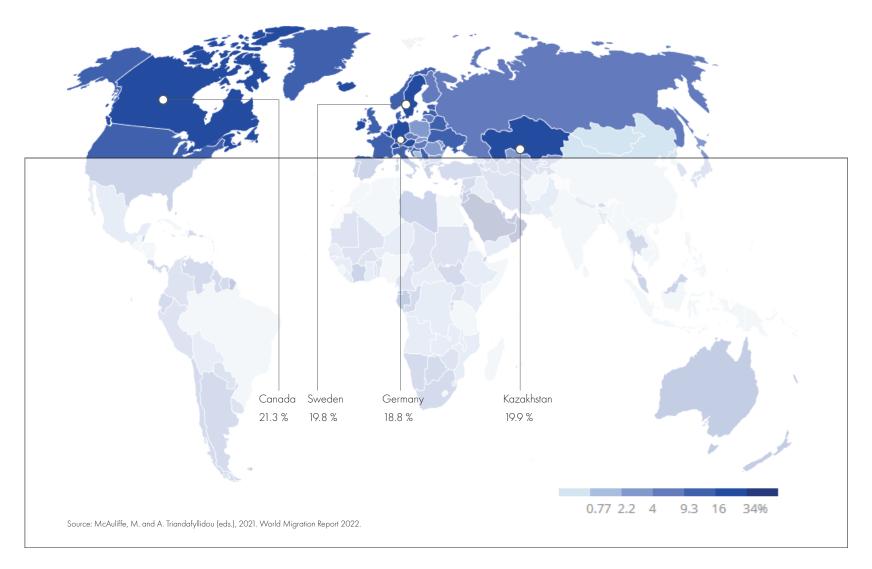
building component



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

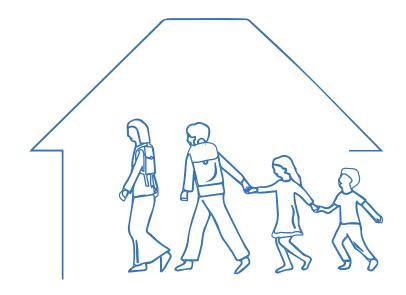
climate

### SHARE OF INTERNATIONAL MIGRANTS IN EACH COUNTRY





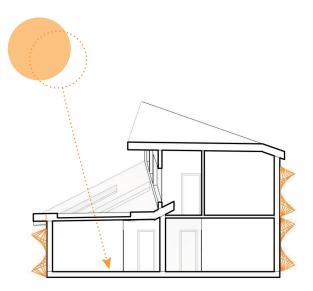




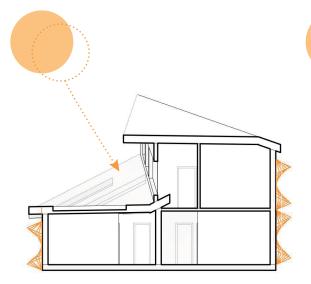
Top reasons for staying: Safety, Family ties, Temporary protection

### ESSENTIAL NEEDS OF UKRAINIAN REFUGEES IN POLAND

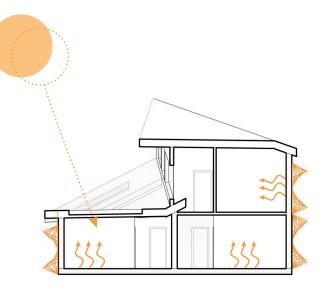




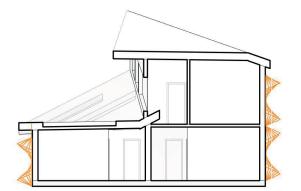
Daylight optimization of all units in order to reduce electricity consumption



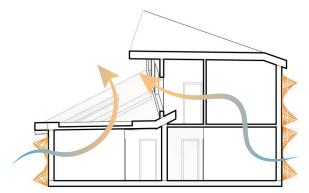
PV panels for generating energy for the residents



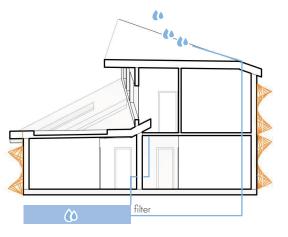
Thermal mass keeps cool in the summer and warm in the winter



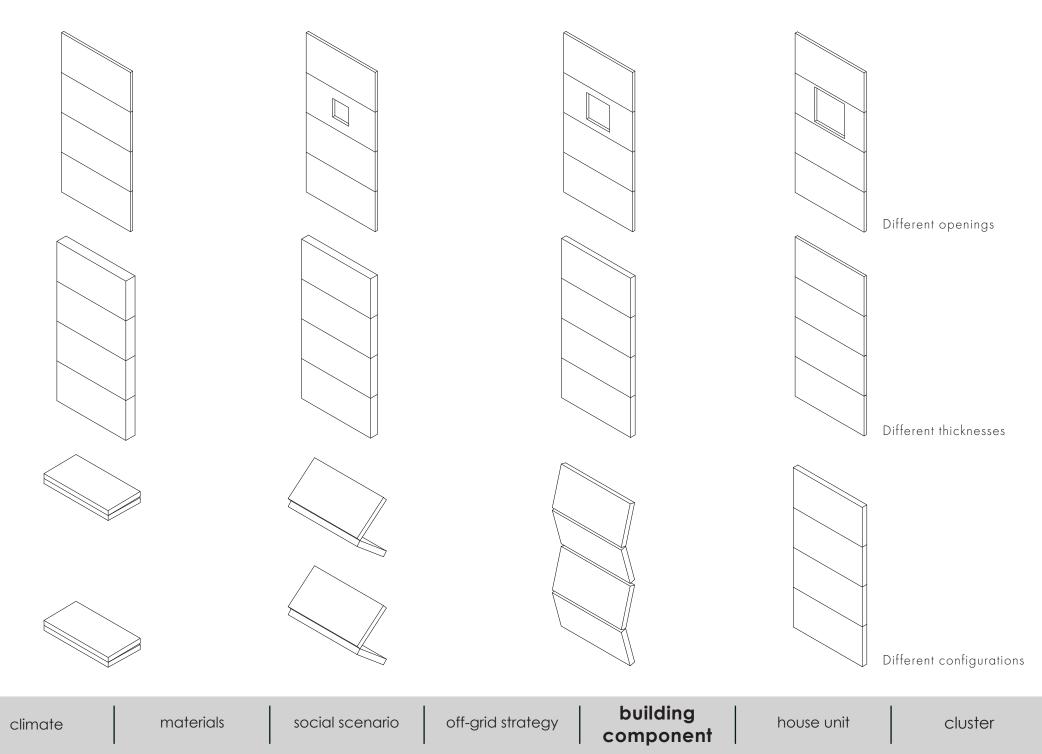
Sustainable, pre-fabricated materials like CLT minimize construction carbon footprint



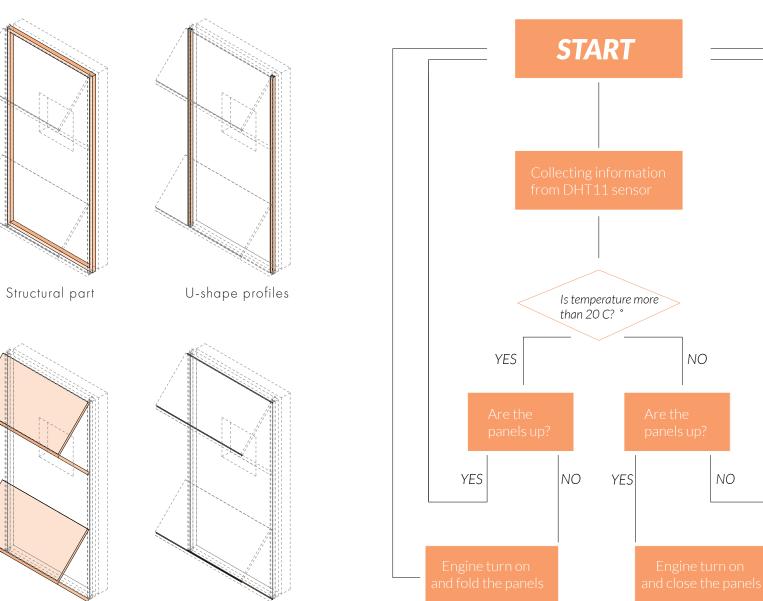
Natural cross ventilation reduces the needs for mechanical ventilation



Water collection to use for grey waters and plant watering



### MOVING PANEL



building

component

### Flowchart

Wires and Motors

climate

materials

social scenario

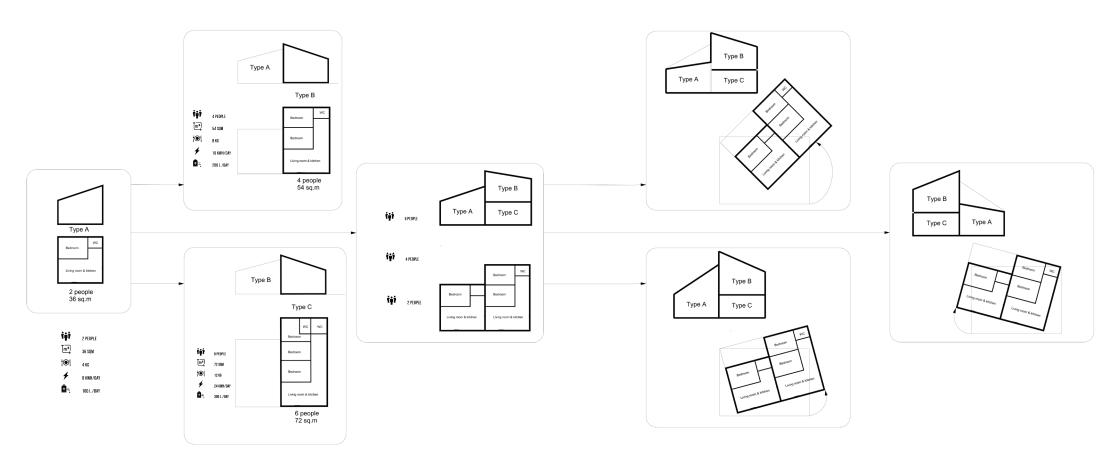
Pivot

off-grid strategy

house unit

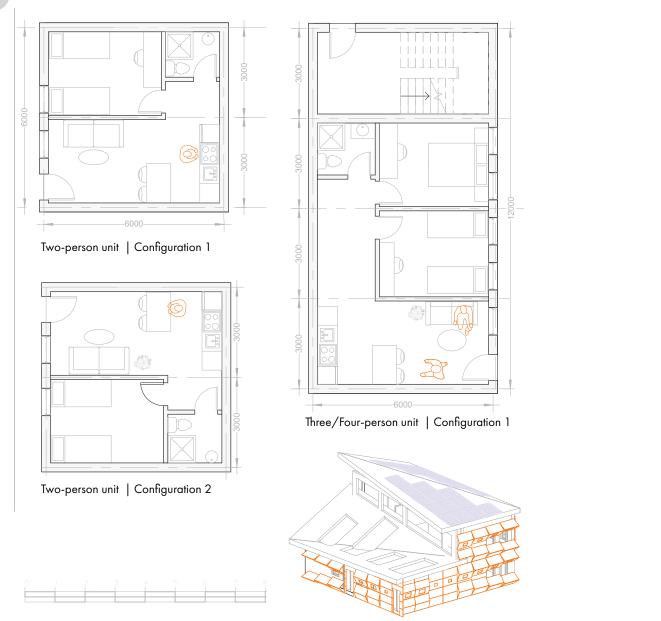
cluster

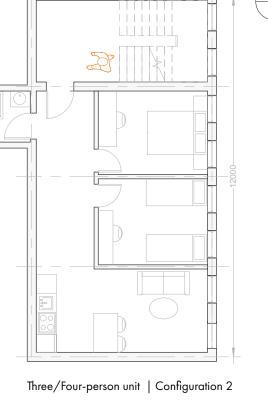
### TYPOLOGIES



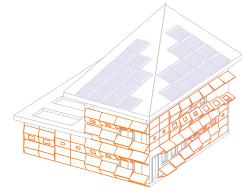


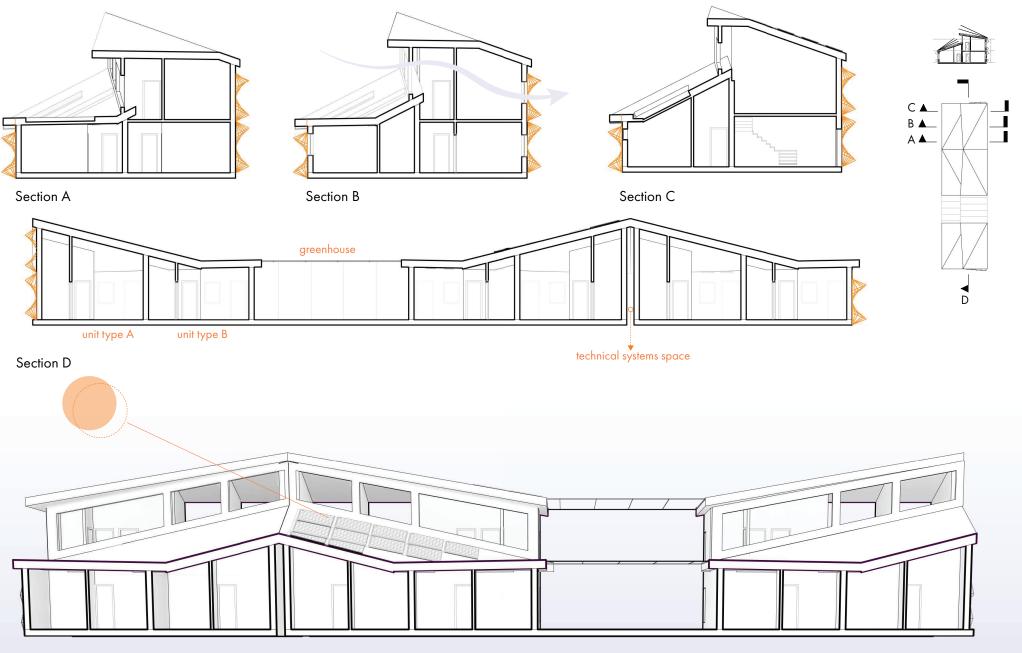
### 82 Advanced School of Architecture | Off-Grid Communities





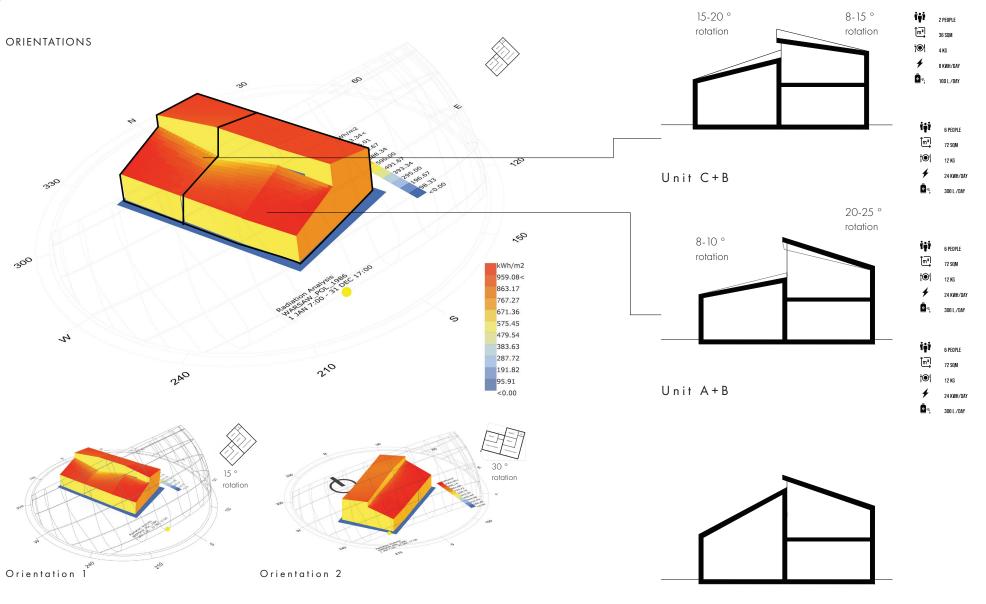
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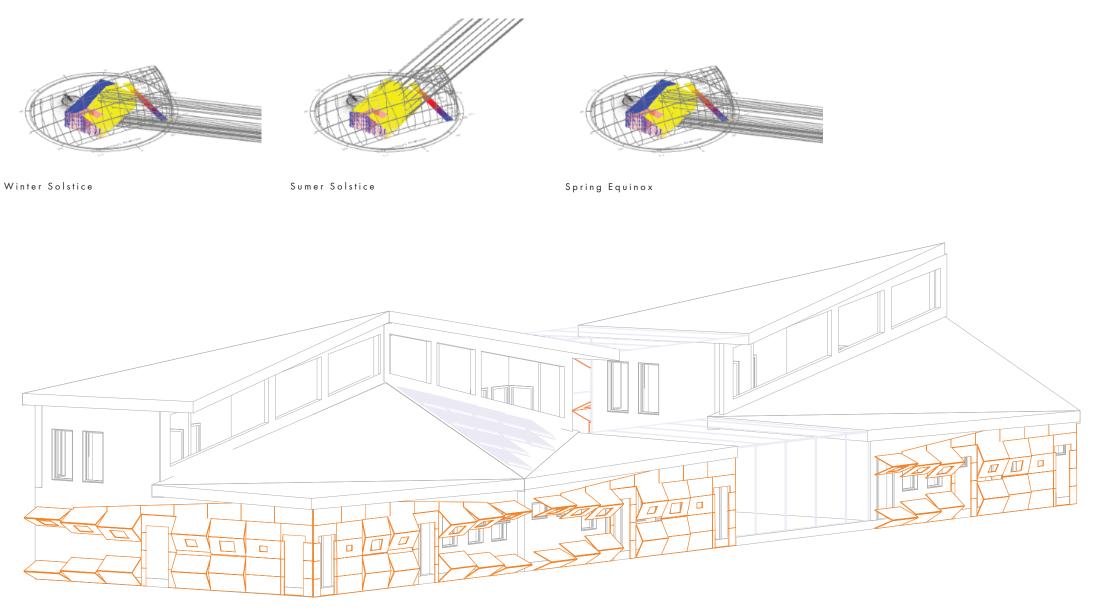
### Perespective Section

$\sim$	limate



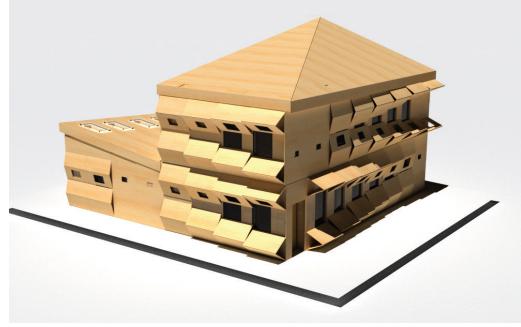


climate materials social scenario off-grid strategy build



Roof change according to the different parameters and cluster configuration

climate



Render 1



Render 2



Elevation 1

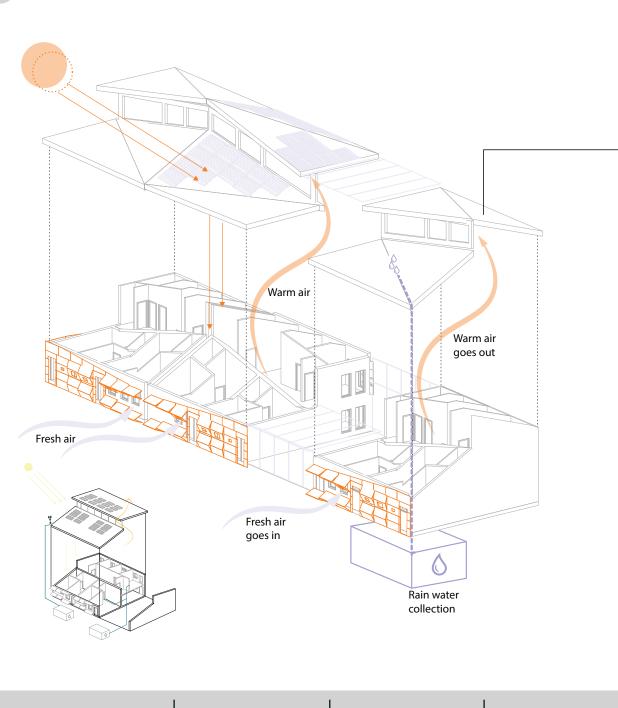
Elevation 2

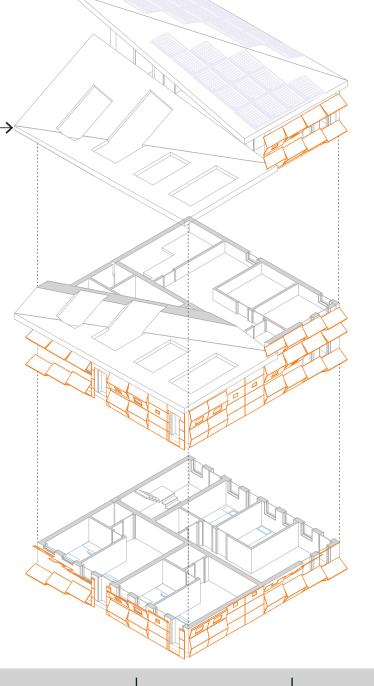


Elevation 3

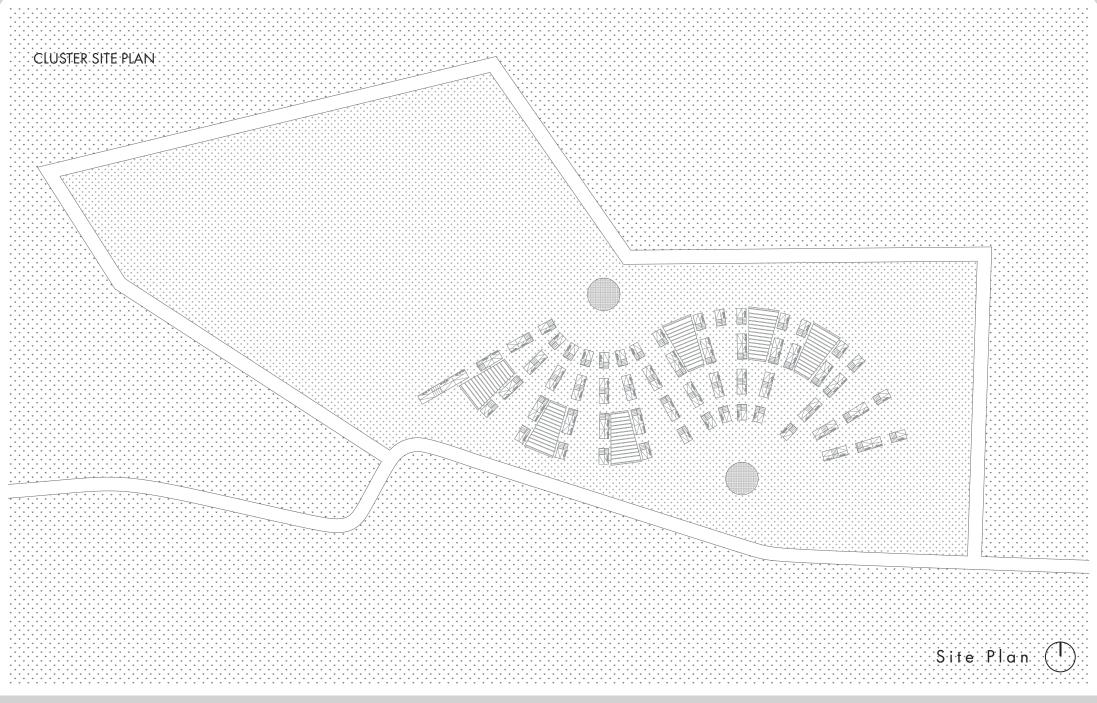


Elevation 4









climate

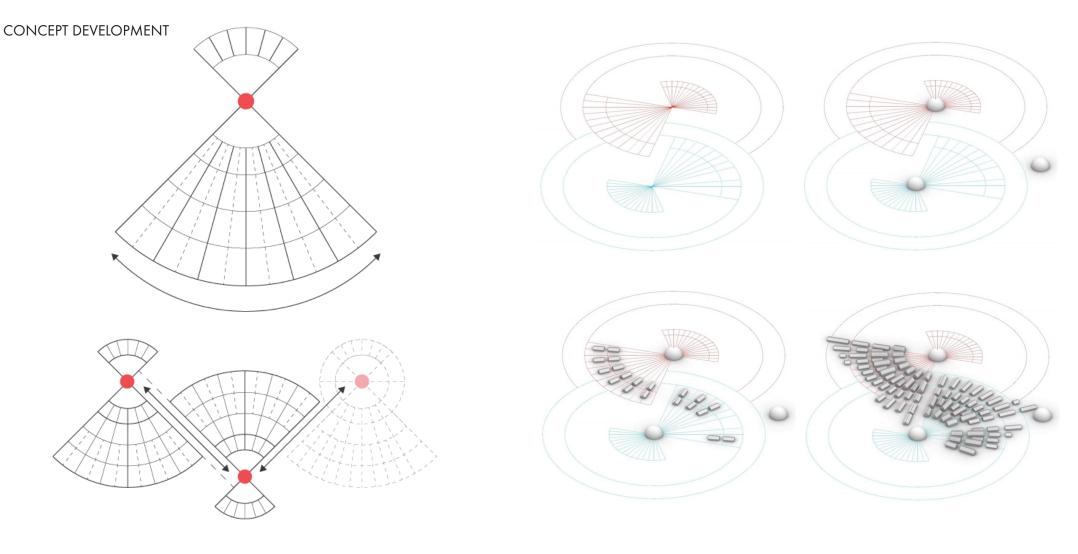
social scenario

off-grid strategy building

building component

house unit

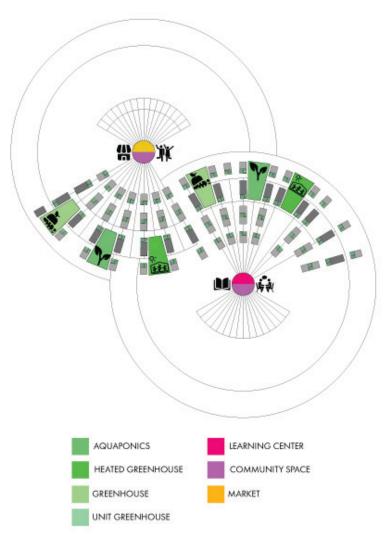
cluster



Cluster strategy

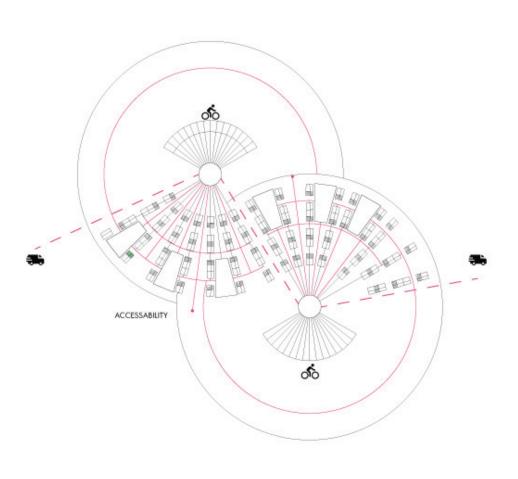
Concept Development in four stages

### PROGRAM AND ACCESIBILITY



materials

social scenario



Program distribution

climate

Cluster Accessability

off-grid strategy

building component house unit

cluster

CLUSTER COLLAGE



Section collage

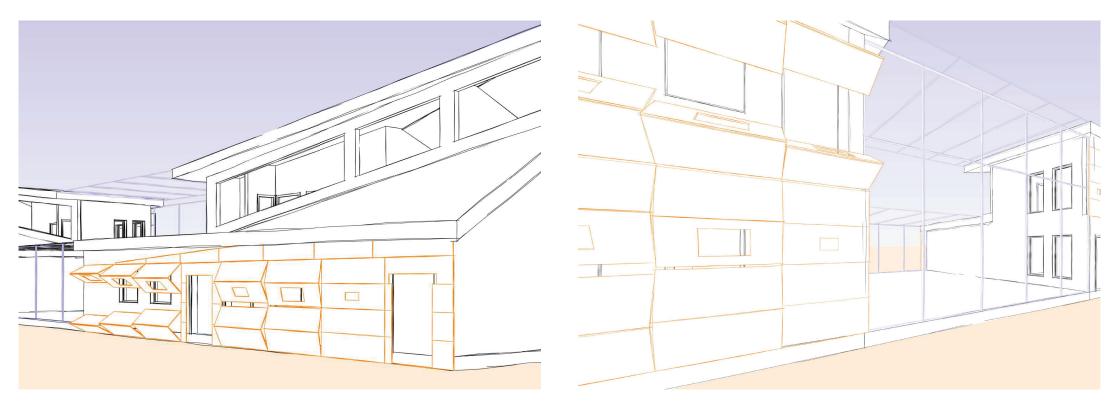
climate

d strategy building

building component

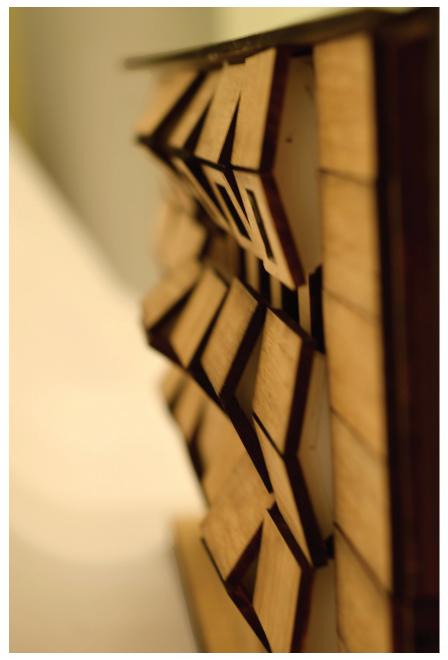
house unit

cluster





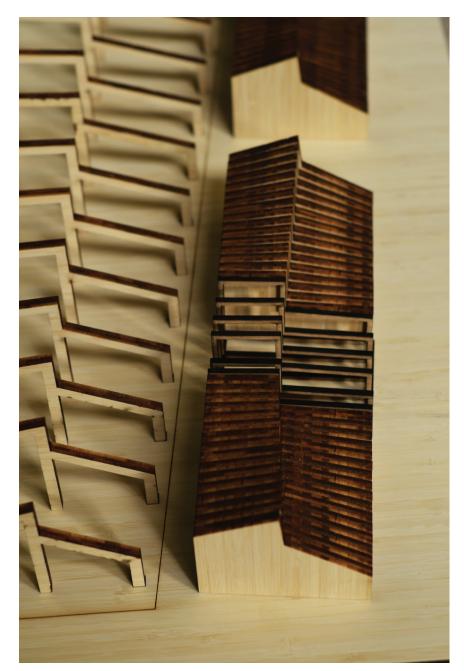
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# ASA - Advanced School of Architecture Masterclass Paolo Cascone 2022

# 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.

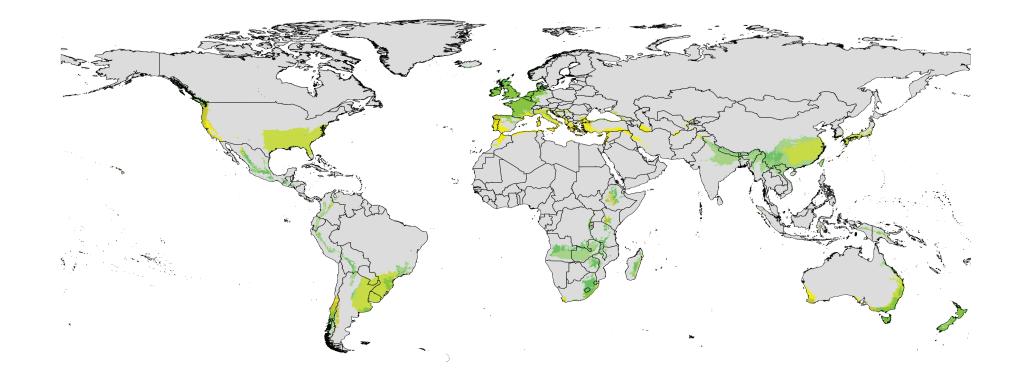
This proposal introduces an intervention that combines a passive environmental solution and a mass-produced technique of fabrication of elements of architecture to create a sustainable and dynamic mode of living in a city such as Milan. From the individual panel design, a rotating turbine is attached 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.

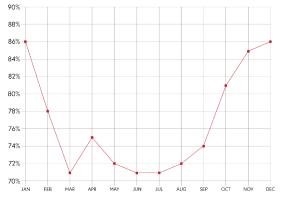
Combining several panels together creates 4 types of housing units that accommodate different users. The method of joinery - slit joinery technique - is designed to be user-friendly and easily mantled and dismantled. Thus, housing units can adapt to the need of the user in terms of varying demand of 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

# climate

materials

1.0

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].

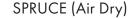
Maximum monthly precipitation the maximum amount of precipitation in one day.



# climate

materials





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): 7.4% 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.

115

### 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.

enario 🛛 c

off-grid strategy

building component

house unit

1

2

3

4

5

6

7

8

9

2

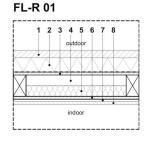
3

4

5

9

### HORIZONTAL STANDARD ELEMENTS



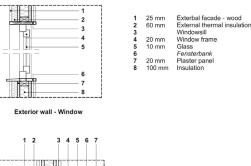
	Dimension	Material
1	60 mm	Roof finishing
2	125 mm	Insulation in slope
3	25 mm	OSB vertical panel
4	100 mm	Air cavity
5	100 mm	Mineral woll
6	25 mm	OSB vertical panel
7	15 mm	Air cavity
8	20 mm	Interior finishing

#### VERTICAL STANDARD ELEMENTS

4

WA-R 01

### JOINTS

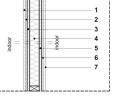


FL-R 02

	indoor			
· · ·	0	0	0	
				X
	indoor			777

#### Dimension Material 20 mm Interior finishing Floating screed 90 mm Sound insulation 30 mm 25 mm OSB vertical panel 100 mm Air cavity 100 mm Mineral woll 25 mm OSB vertical panel 15 mm Air cavity Interior finishing 20 mm

WA-R 02



#### Dimension Material

Dimension

25 mm

100 mm

15 mm

1

2 60 mm

3 25 mm

4

5 25 mm

6

7 20 mm Material

External wooden facade

Thermal insulation OSB vertical panel

OSB vertical panel

Air cavity Interior finishing

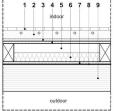
Mineral woll

1	20 mm	Interior finishing
2	15 mm	Air cavity
3	25 mm	OSB vertical panel
4	100 mm	Mineral woll
5	25 mm	OSB vertical panel
6	15 mm	Air cavity
7	20 mm	Interior finishing
		0

Material

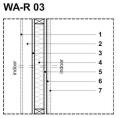
1234567			
	1 2 3 4 5 6 7 8 9 10	25 mm 90 mm 20 mm 100 mm 20 mm 20 mm 20 mm 100 mm 20 mm	Floor finishing Floating screed Sond insulation Plaster panel Air cavity Insulation Plaster panel Plaster panel Insulation Plaster panel

Slab - Interior partition



#### Material Dimension Interior finishing Floating screed 20 mm 90 mm 30 mm 25 mm 100 mm Air cavity Mineral woll 100 mm 25 mm

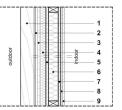
Sound insulation OSB vertical panel OSB vertical panel Membrane 300 mm Wood beam



#### 20 mm Interior finishing 2 100 mm Installation cavity OSB vertical panel 25 mm 3 100 mm Mineral woll 4 5 25 mm OSB vertical panel 6 15 mm Air cavity Interior finishing 7 20 mm

Dimension

WA-R 04



Dimension	Material Product
x mm	Shading device - wooden brise soleil
25 mm	Air cavity
25 mm	External wooden facade
60 mm	Thermal Insulation
25 mm	OSB vertical panel
200 mm	Mineral woll
25 mm	OSB vertical panel
15 mm	Air cavity
20 mm	Interior finishing

2

2

5 6

6

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

STUDENT



single bedroom ≥ 11,0 m<sup>2</sup> (1 bed + 1 study place)

double bedroom ≥ 16,0 m<sup>2</sup> (2 beds + 2 study places)

toilet  $\geq 3.0 \text{ m}^2$ 

living space  $\geq 14,0 \text{ m}^2$ (private or shared)

kitchenette  $\geq 5.0 \text{ m}^2$ kitchen  $\geq 9.0 \text{ m}^2$ 

**EMPLOYEE** О

ſŪ single  $\geq 9.0 \text{ m}^2$ 

double  $\geq 14.0 \text{ m}^2$ 

toilet  $\geq 3.0 \text{ m}^2$ 

≥ 14,0 m<sup>2</sup>

kitchenette  $\geq 5.0 \text{ m}^2$ kitchen  $\geq 9.0 \text{ m}^2$ 

SELF EMPLOYED



single  $\geq 9.0 \text{ m}^2$ 

double  $\geq 14.0 \text{ m}^2$ 

toilet  $\geq$  3,0 m<sup>2</sup>  $\geq 14.0 \text{ m}^2$ 

kitchenette  $\geq 5.0 \text{ m}^2$ kitchen  $\geq 9.0 \text{ m}^2$ 

working space  $\geq 70 \text{ m}^2$ 



single  $\geq 9,0 \text{ m}^2$ 

double  $\geq 14.0 \text{ m}^2$ 

toilet  $\geq$  3,0 m<sup>2</sup>

 $\geq 14.0 \text{ m}^2$ 

kitchenette  $\geq 5.0 \text{ m}^2$ 

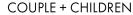
kitchen  $\geq 9.0 \text{ m}^2$ 

COUPLE + CHILD



single  $\geq 9,0 \text{ m}^2$ 

kitchen  $\geq 9.0 \text{ m}^2$ 





single  $\geq$  9,0 m<sup>2</sup>

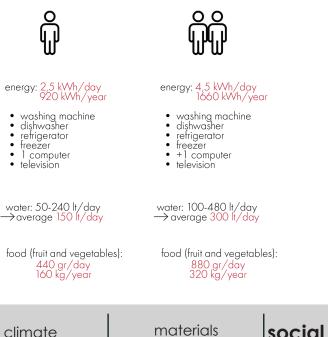
double  $\geq 14.0 \text{ m}^2$ 

toilet  $\geq$  3,0 m<sup>2</sup>

 $\geq$  14,0 m<sup>2</sup>

kitchenette  $\geq 5.0 \text{ m}^2$ kitchen  $\geq 9.0 \text{ m}^2$ 

### CONSUMPTION OF ENERGY, WATER AND FOOD





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

- washing machinedişhwasher
- refrigerator freezer
- +2 computer
- television

water: 150-720 lt/day  $\rightarrow$ average 450 lt/day

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



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

- washing machinedişhwasher
- refrigerator
- freezer
- +2 computer
- television

water: 200-960 lt/day  $\rightarrow$  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!

119

off-grid strategy social scenario

0000



kitchenette  $\geq 5.0 \text{ m}^2$ 

 $\geq 14.0 \text{ m}^2$ 

double  $\geq 14.0 \text{ m}^2$ toilet  $\geq$  3,0 m<sup>2</sup>



climate



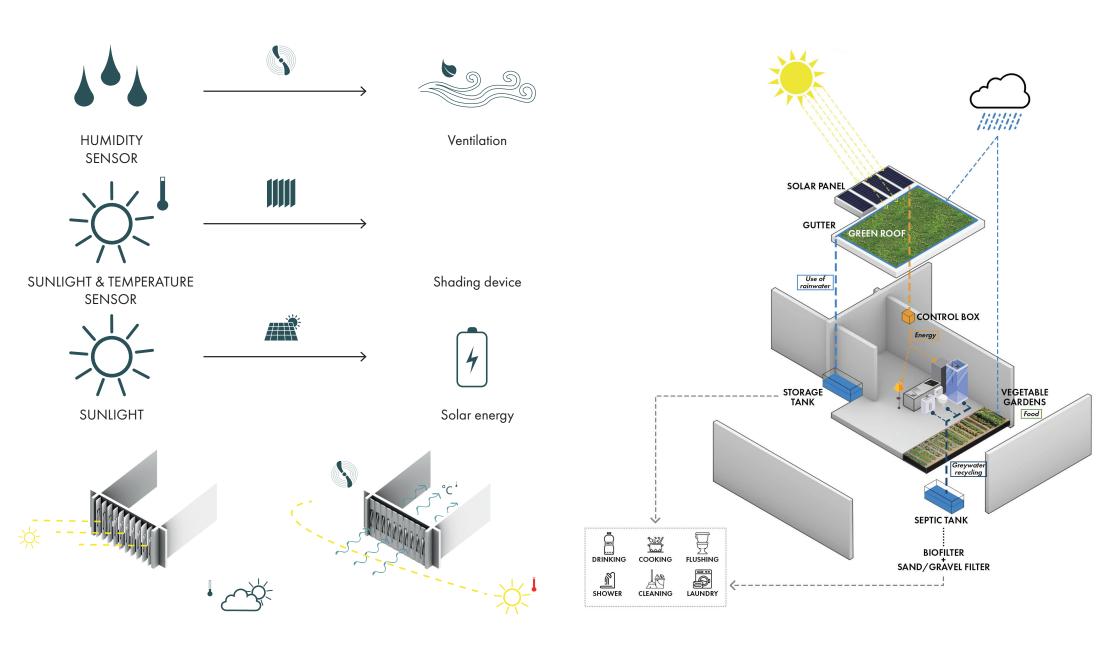


social scenario

component house unit

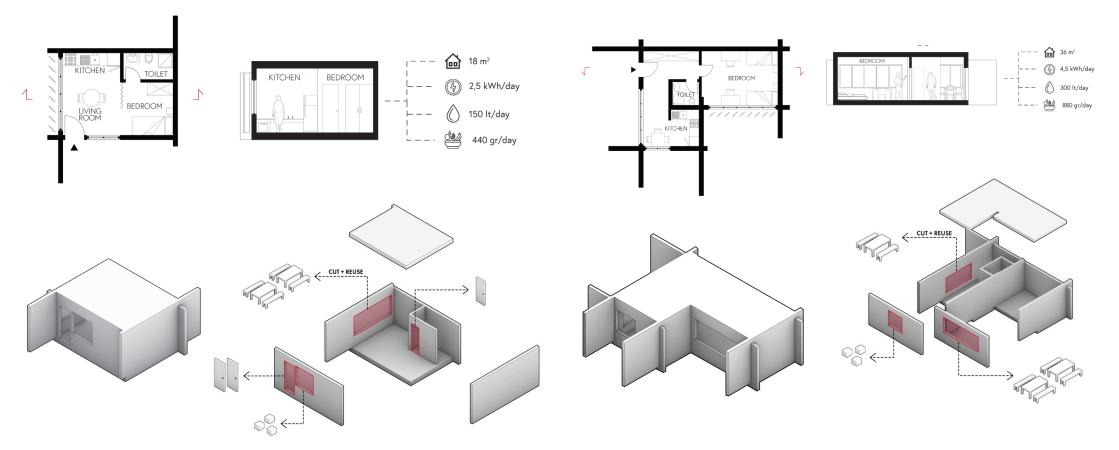
cluster



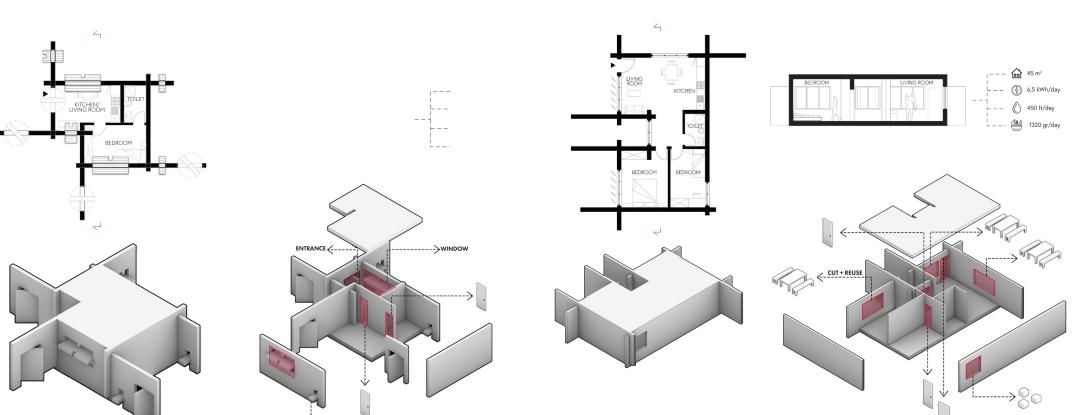


climate materials social scenario off-grid strategy **building** house unit cluster

### UNIT 1 - STUDENT



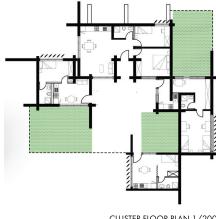
UNIT 2 - STUDENTS



UNIT 4 - FAMILY

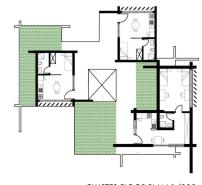
UNIT 3 - WORKER

HORIZONTAL CONFIGURATION



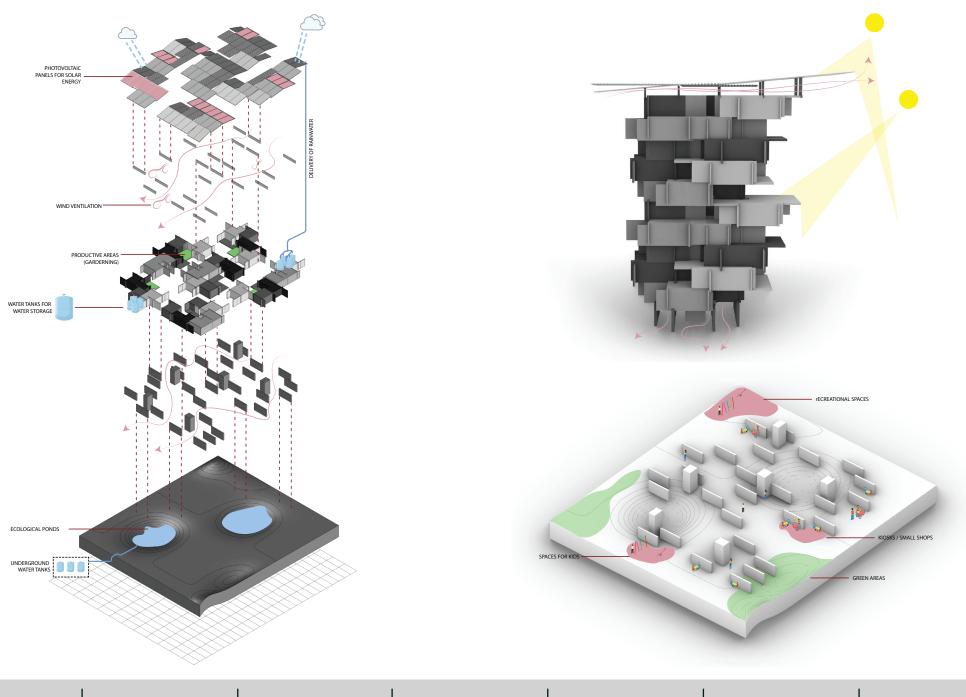
CLUSTER FLOOR PLAN 1/200

HORIZONTAL CONFIGURATION



CLUSTER FLOOR PLAN 1/200

climate

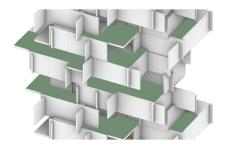






Referencing the idea of Cascina : Cascina is a characteristic type of a traditional agricultural settlement in Italy, consisting of buildings gathered around a large courtyard.

### Shared Spaces & Facilities :



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.







GREEN TERRACES

**BICYCLE SHARING** 

ELECTRIC CAR SHARING







SMALL SHOPS

CHILD CARE / NURSERY



SHARED GYM

CO-WORKING SPACES

**CO-LIVING ROOMS** 



**CO-DINING SPACES** 

climate

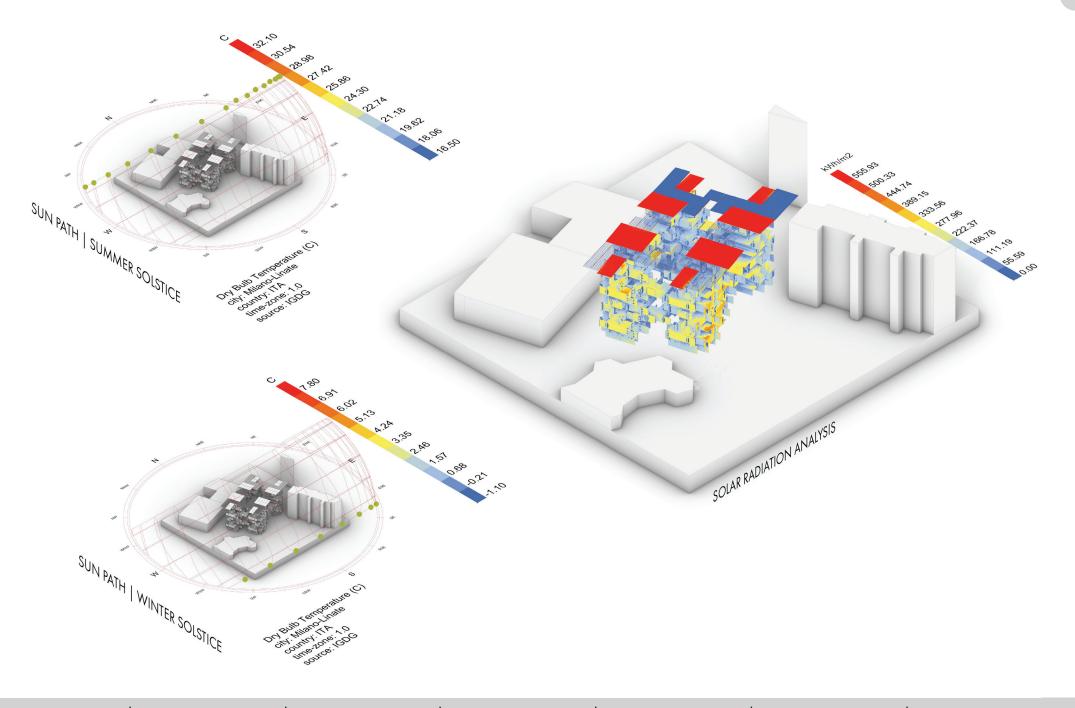
off-grid strategy

building component

house unit

cluster



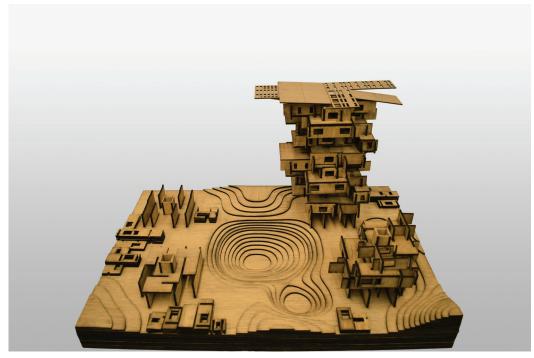




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## ASA - Advanced School of Architecture Masterclass Paolo Cascone 2022

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

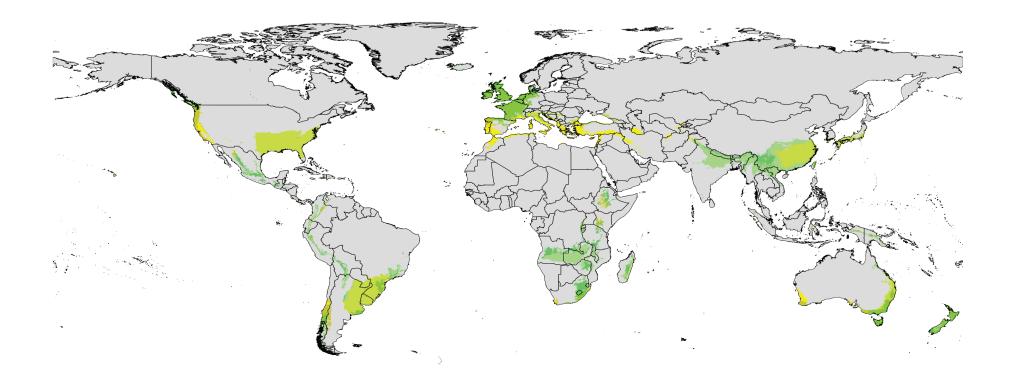
# TEMPERATE CLIMATE London - England

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 afford-ability, 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.

**ASA STUDENTS:** NOORA KHALED ALI EBRAHIM HUSAIN ALHASHIMI · EMILY MARIE SHIGA **Uow Students:** Agathe Alexandre · Mette Pedersen · Edoardo Ripamonti · Rofayda Salem





# climate

materials

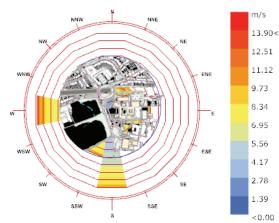
social scenario

o off-gr

off-grid strategy

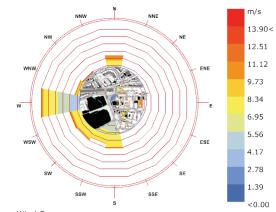
building component

#### Spring



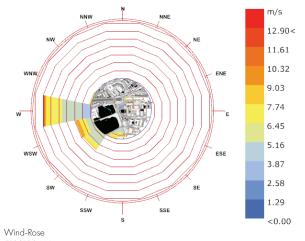
Wind-Rose 5100180 UK 1 Mar 1:00 - 28 May 24:00 Hourly Data: Wind Speed (m/s) Calm for 3.46% of the time = 74 hours. Each closed polyline shows frequency of 1.3%. = 28 hours.

#### Autumn



Wind-Rose 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.

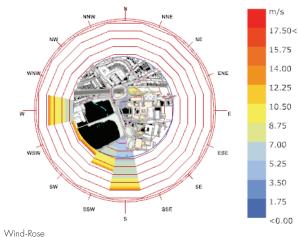
#### Summer



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.

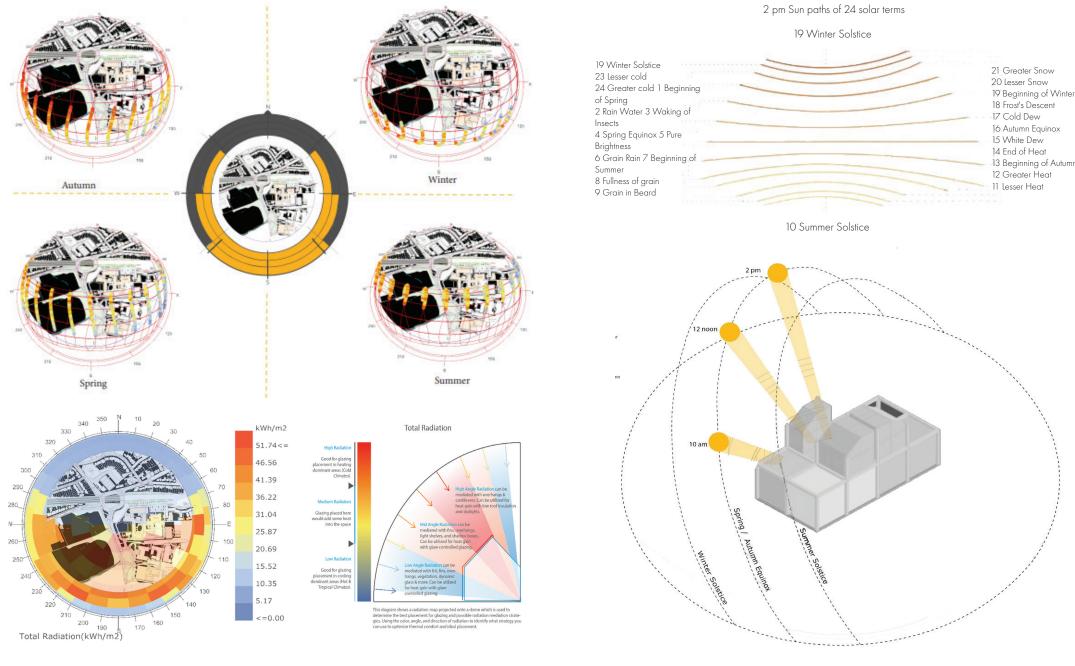
Winter



5100180 UK

1 Dec 1:00 - 28 Feb 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.



climate

**materials** 

social scenario

off-grid strategy

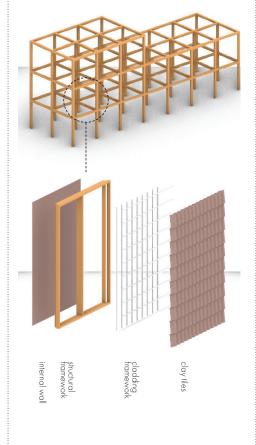


European Import Local to UK

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.

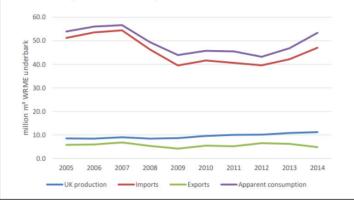
Initially, we considered that timber will be used for the framework of the building since the structure is easy to construct and can be prvefabricated off site. As for the cladding/panelling system in the building, we considered clay tile cladding as it is a local material and is non combustible.



Source	Sawn softwood	Sawn hardwood	Plywood	Particle- board	Fibre- board	Pellets
per cent of total l	JK imports (v	olume) in eac	h 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.



#### climate

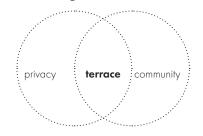


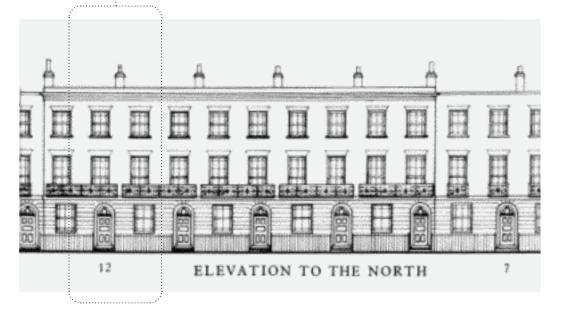
#### The Terrace House

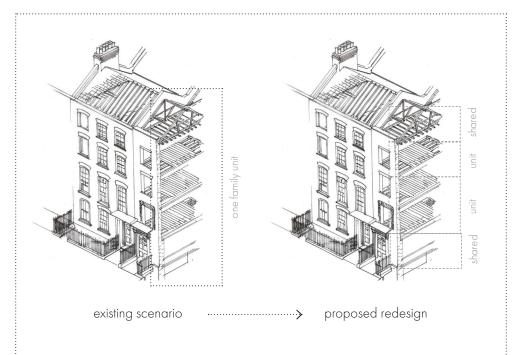
Most common in London

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

#### -Rise Design Studio







#### 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.

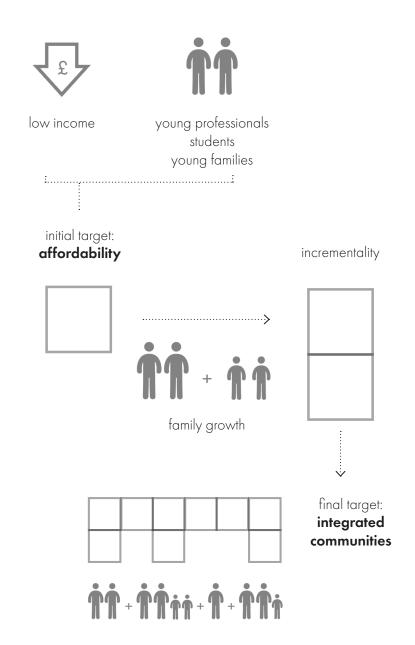


social scenario

off-grid strategy



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. This is the key driver for the instigation of this project.



climate

social scenario

off-grid strategy

building component

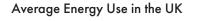




Photovoltaic system Generators for storage Rainwater collection Thermosolar system for hot water

Air-source heat pump Ve Tube network as a heat H source

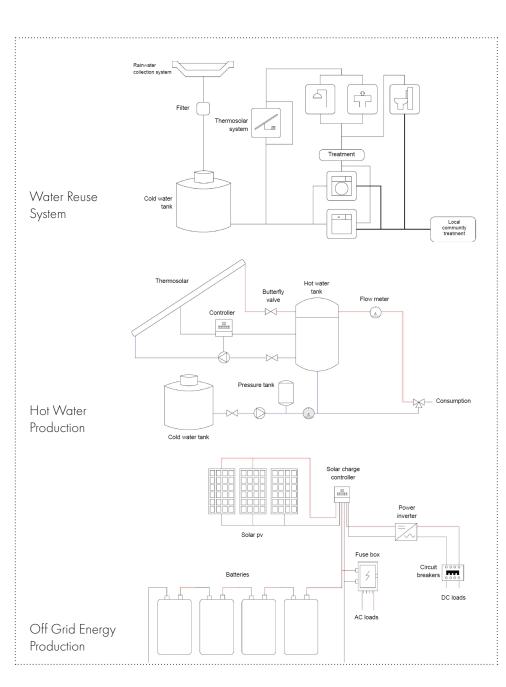
Vertical farming Hydroponics



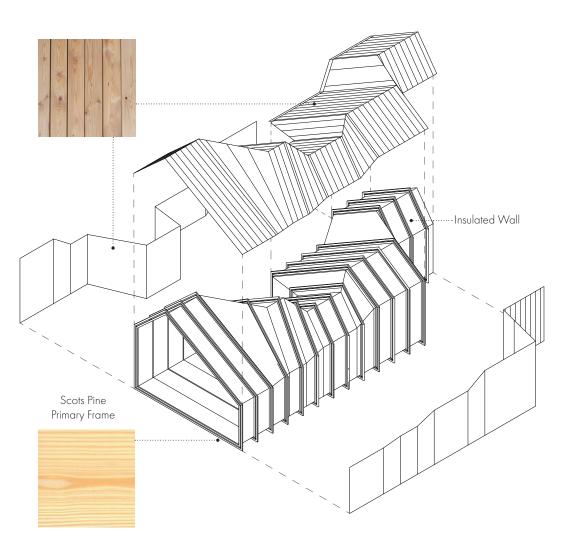
1 Bed House 2 Bed House 3 Bed House	4.9 - 6.5 KWh daily 6.8 - 8.2 KWh daily 8.2 KWh daily	Average amount of energy produced by a standard photovoltaic system
4 Bed House	9.5 KWh daily	37 m - 350-850 KWh monthly
5 Bed House	11.7 KWh daily	11.6-28.3 KWh daily

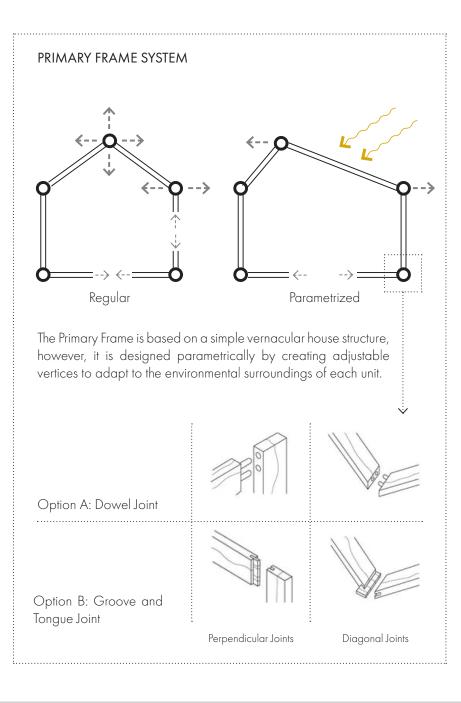
#### Average Water Use in the UK

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

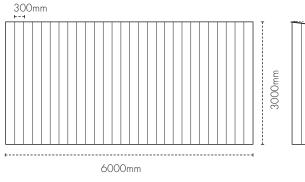


## SIBERIAN LARCH EXTERNAL PANELLING SYSTEM

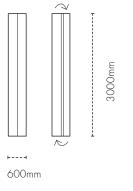


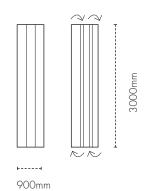


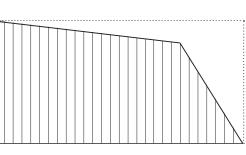
climate



Solid Panel - Standard Size

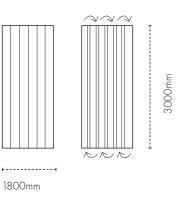






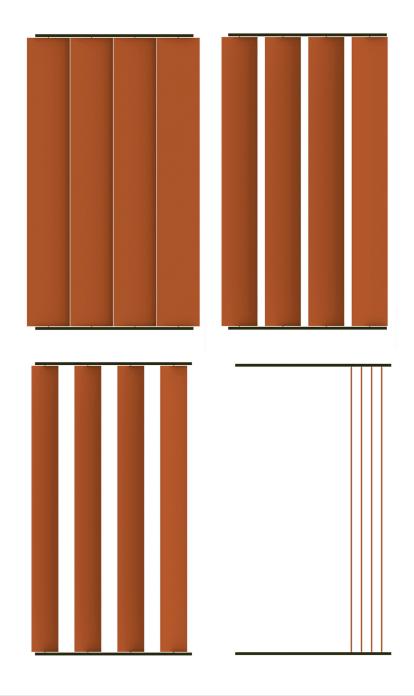
Depending on each unit's configuration, different panels can be extracted from grasshopper

Solid Panel - Prefabricated off site









materials

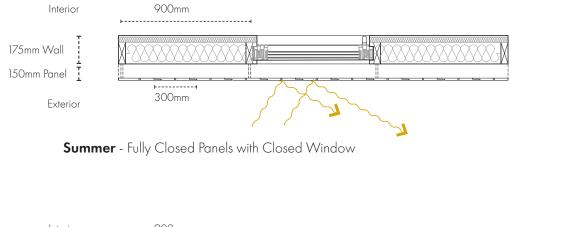
social scenario

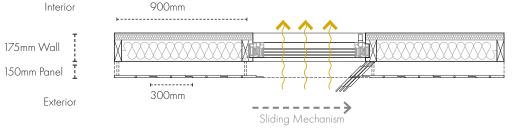
off-grid strategy

ategy

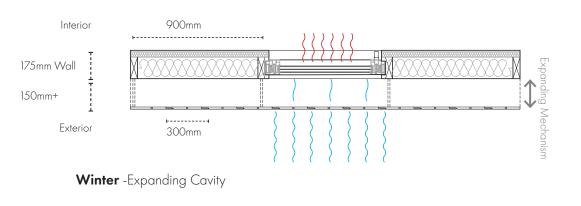
building component

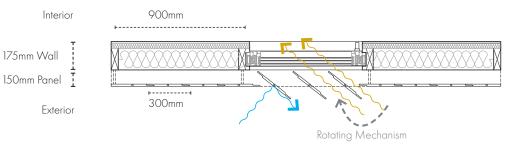
house unit



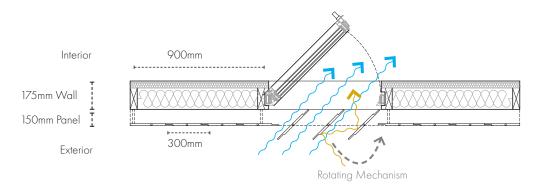




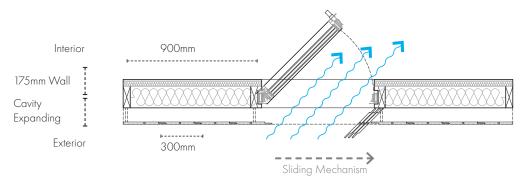




Winter - Semi Open Panels with Closed Window

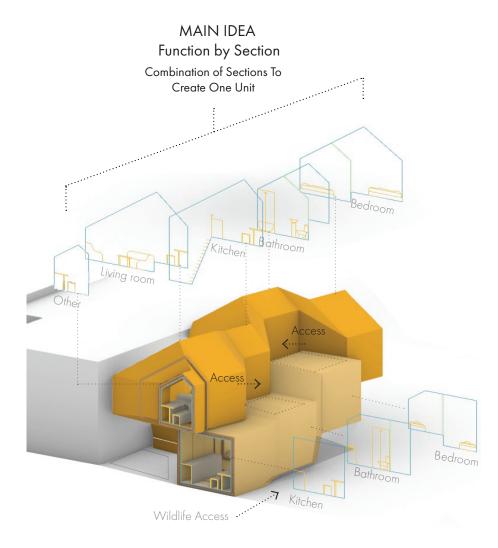


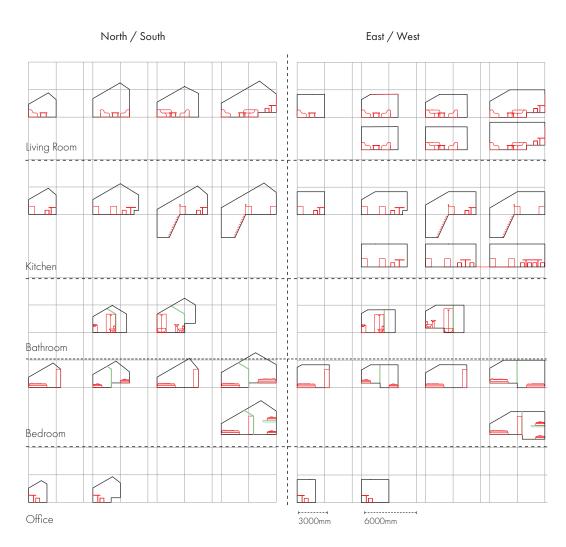
Summer - Semi Open Panels with Open Window





climate	materials	social scenario	off-grid strategy	building component	house unit	cluster
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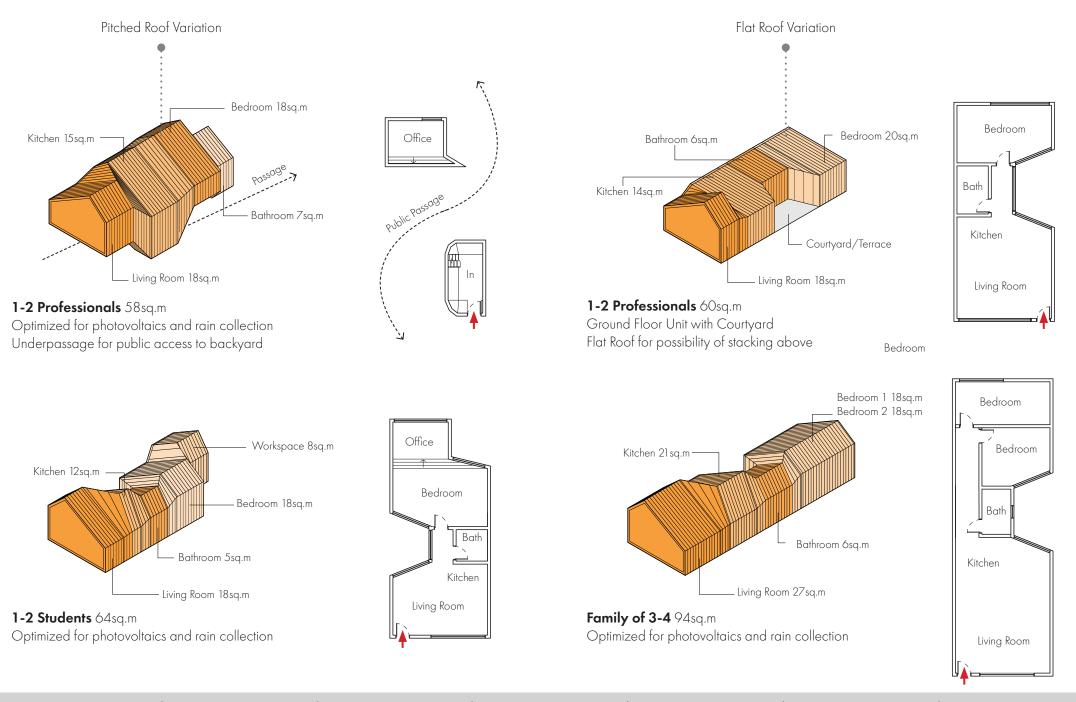




materials

climate

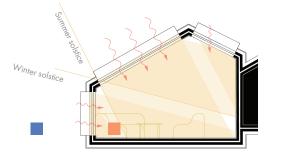
social scenario



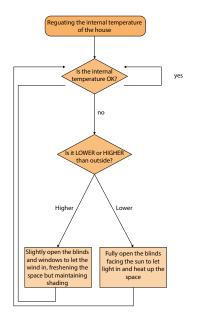
off-grid strategy

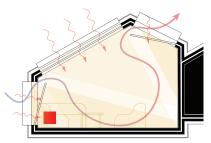
building component

169

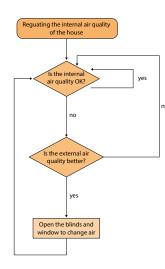


Letting in sunlight for comfort Air pollution is okay Closing windows not to loose heat Opening all panels for added heat



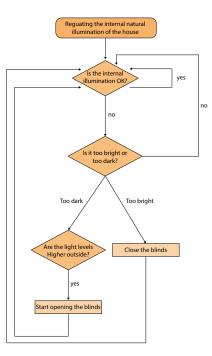


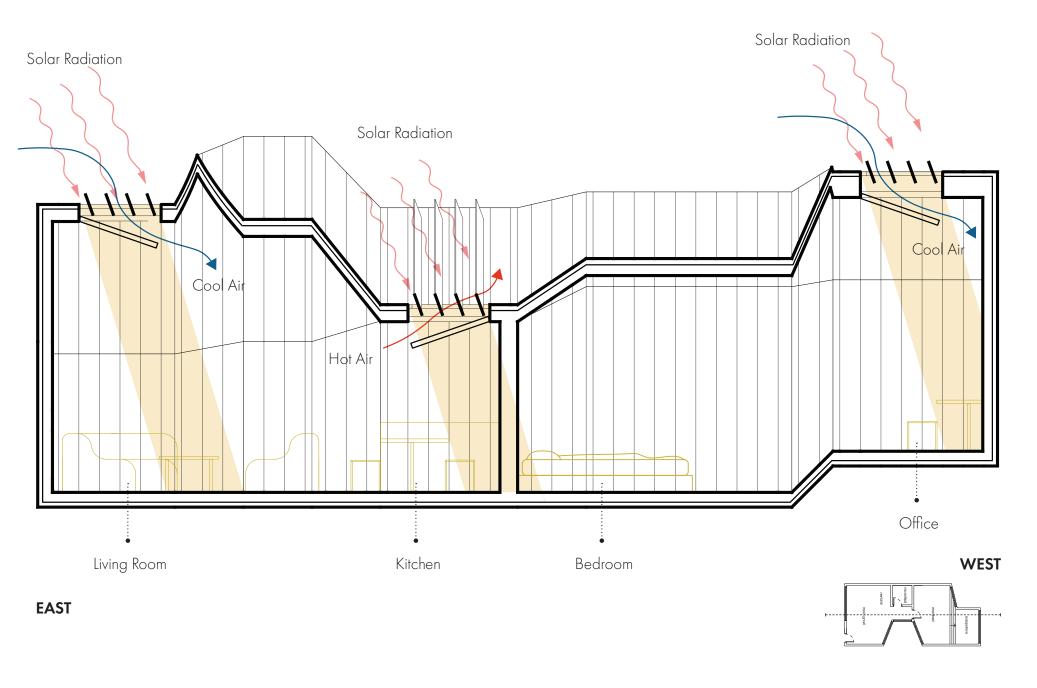
Letting in sunlight for comfort Ventilate for air quality Opening all panels for added heat





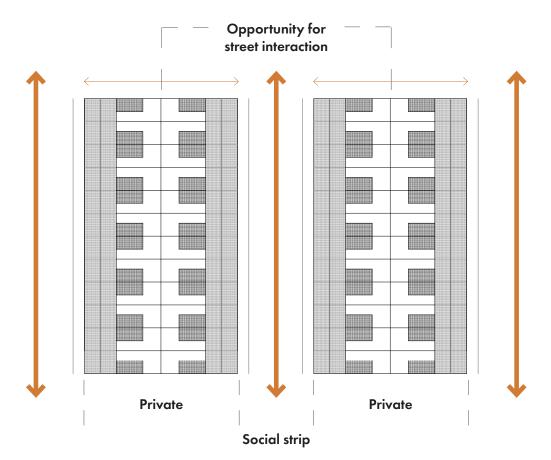
Letting in sunlight for comfort Ventilation for air quality Closing for direct sunlight to not gain heat Ventilate to lower the temperature



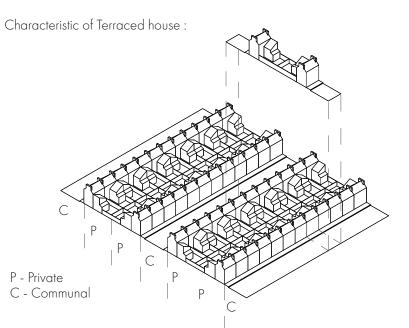


Terraced houses are the most common housing type in the UK. They often have uniform facades and have the same height, sharing side-walls with the houses on either side.

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.



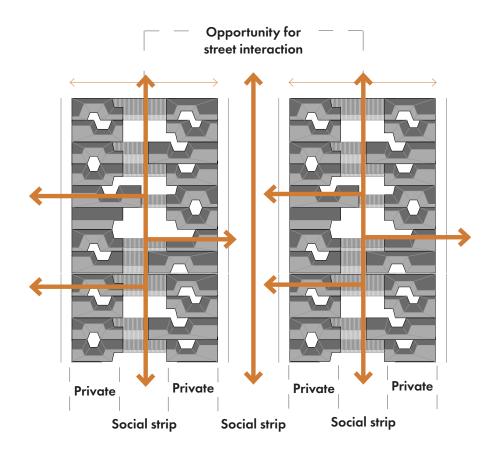
- Two shared (party) walls except for end-of-terrace house units
- Typically one to four storeys
- Individual front doors and pedestrian access to dwellings, directly off the street
- They can be converted into flats or remain as individual houses
- A private rear garden or patio and a front entrance area
- Consistency in front facade 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-toback in a perimeter block arrangement.

Street Revival

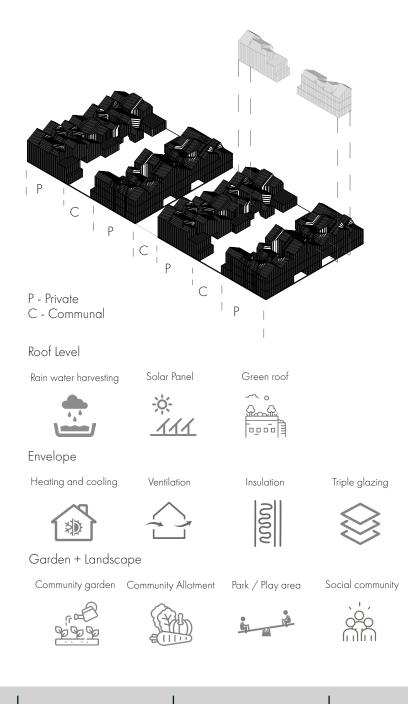


Street parties in London were and are still a common form of communal celebration for events such as the Golden Jubilee bringing the residents of the street together.

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.



climate

social scenario

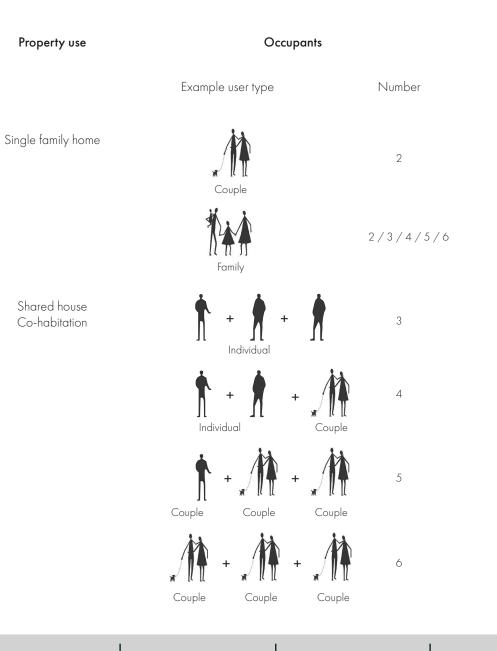
off-grid strategy

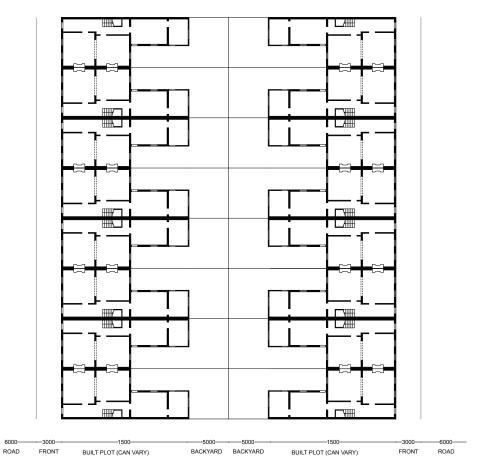
building component

house unit

### 178 Advanced School of Architecture | Off-Grid Communities

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





#### Back to Back Terraced House Strip

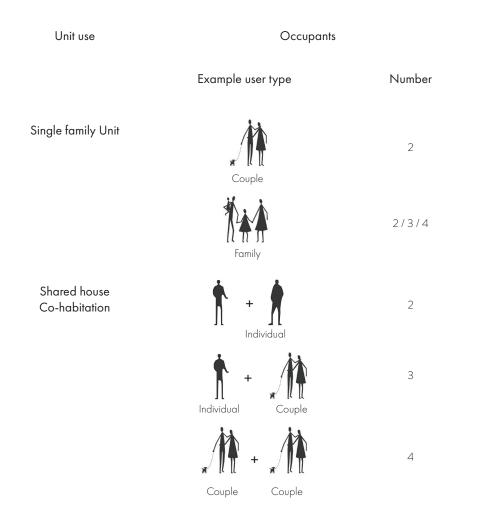


First Floor

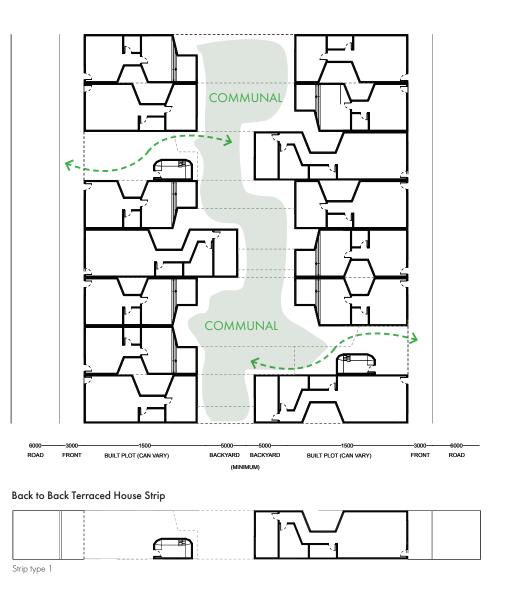


Ground Floor

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.



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.

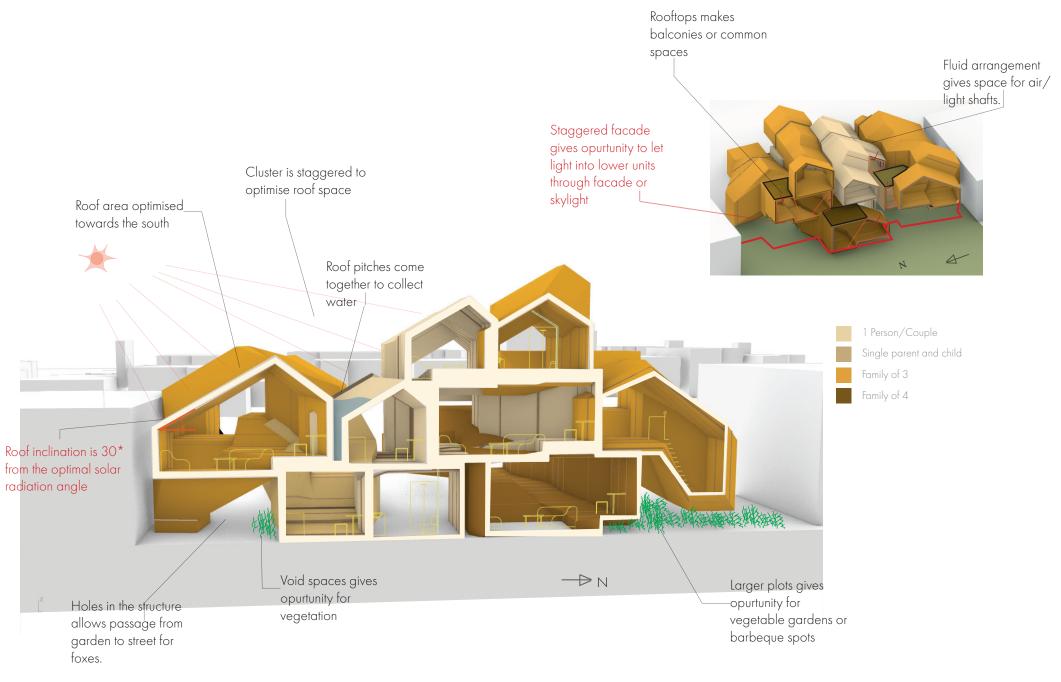




Strip type 2

building component

house unit



climate





off-grid strategy

trategy building c

building component

house unit



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