



Solar Ark



Desert Research Station Attached housing (AH) Division



Southeast University (SEU)



XinJiang University (XJ)

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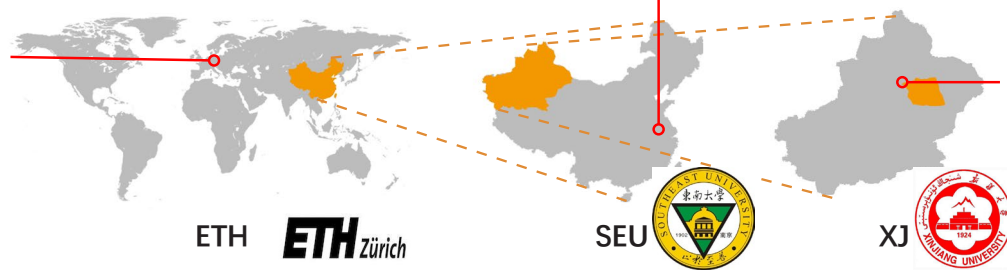
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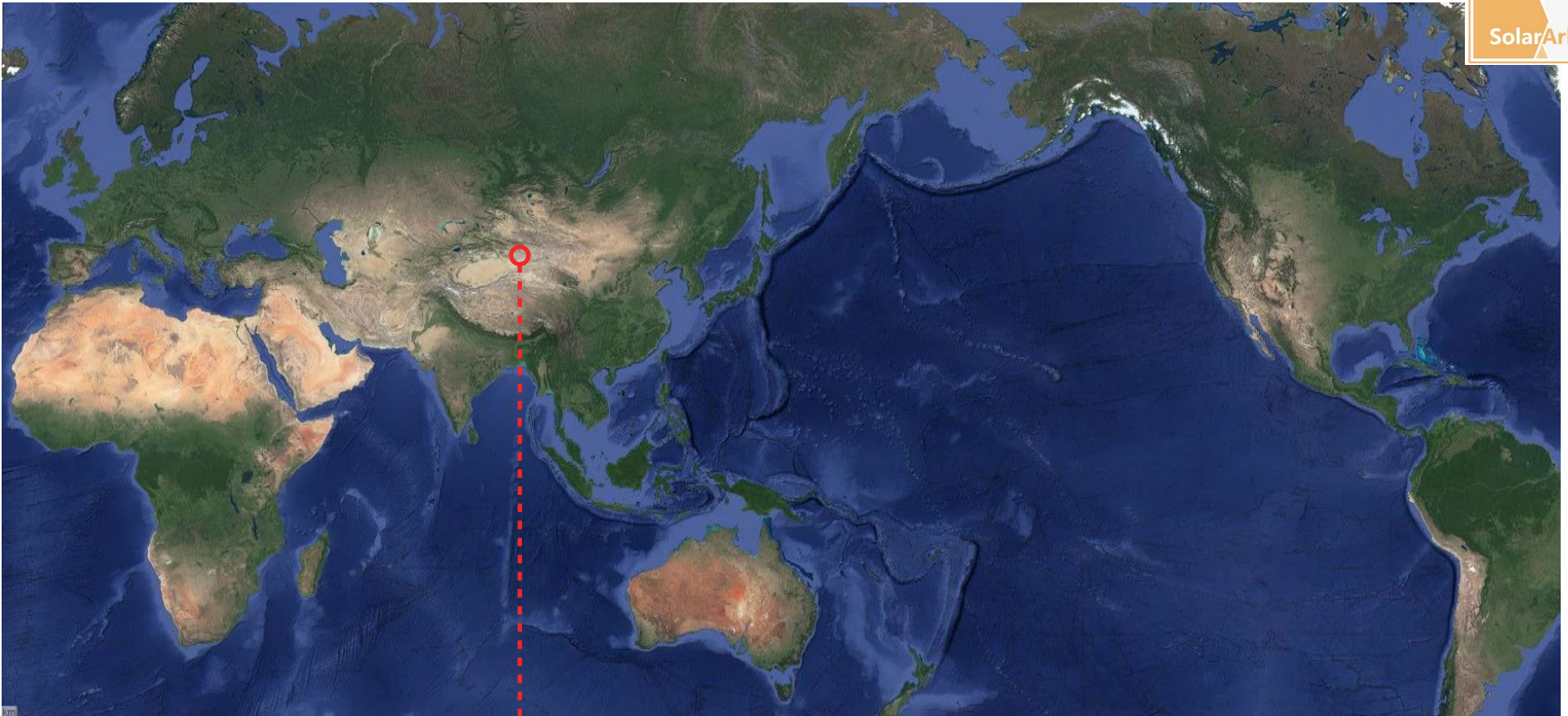


SEU: Wang Wei

We love every inch of earth, every creature, every grain of sand, every dance of life

01 Project progress report





Tuyuq

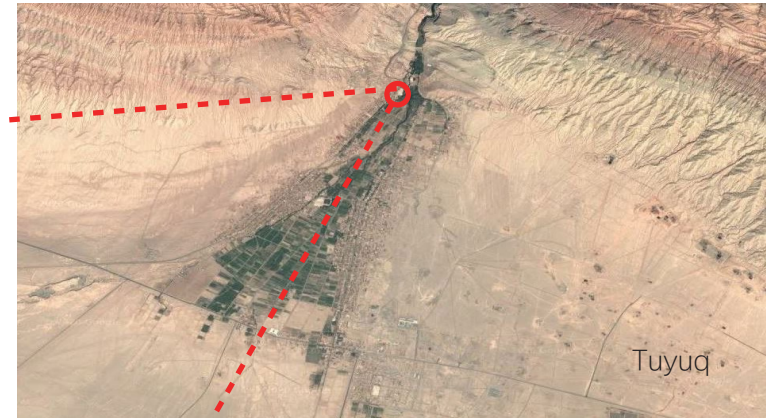
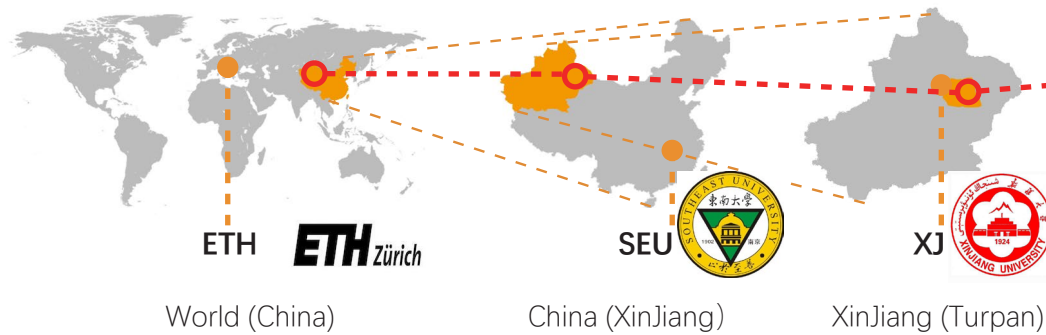
Desertification has been called "the cancer of the earth". It threatens the survival and development of two thirds of the world's countries and regions and one fifth of its population.

At present, the global desertification area has reached 36 million square kilometers, accounting for a quarter of the earth's land area. What's more, the desertification area is expanding at a rate of 50,000 to 70,000 square kilometers per year.

The site is located in Tuyuq area, the most serious desertification area in China, which is located in the geographical center of Asia and Europe. The farthest place in the world from the ocean, has the second largest desert in the world-the Taklamakan.

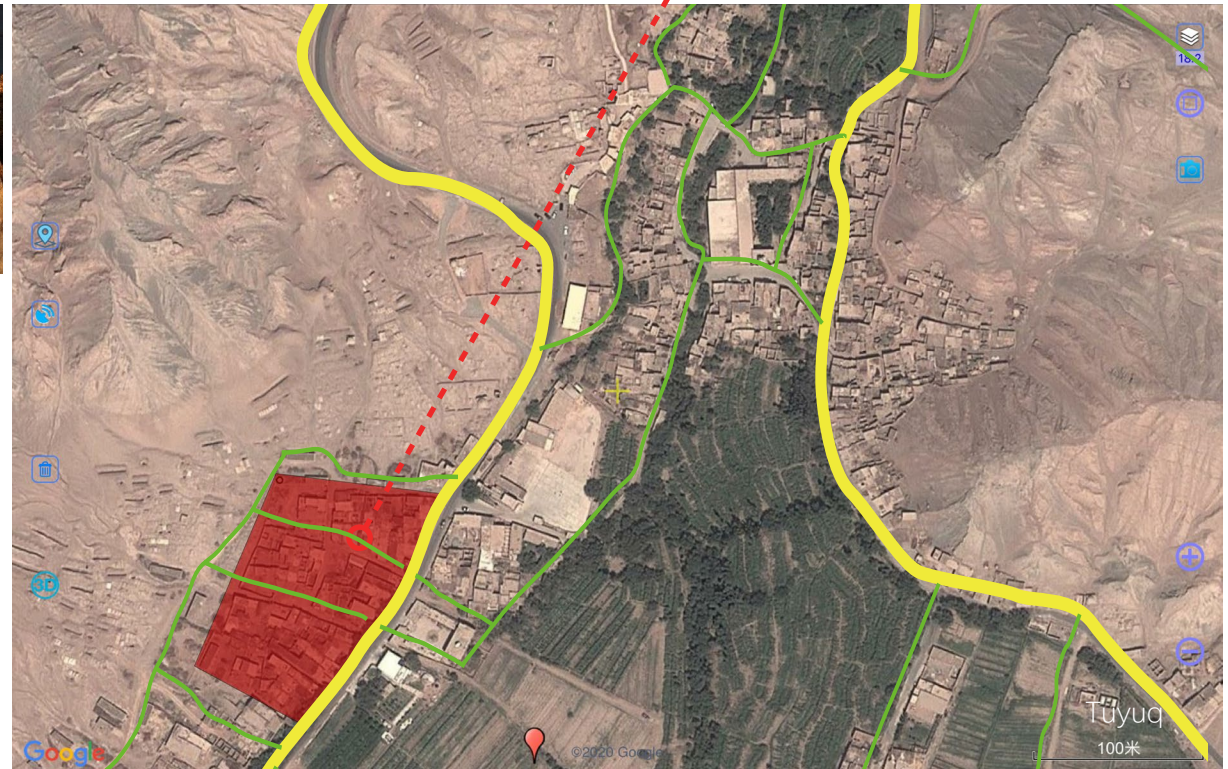
Solar Ark is a high performance building adapted to desert conditions, set up as a research station house to combat desertification. Inspired by the crescent dunes formed by wind erosion, Solar Ark can grow. The building brings people the hope of life by creating the desert into an oasis through a variety of desert technologies, similar to Noah's Ark for salvation.

Location



Community summary

- Population: 3048 people
- Nationalities: Uyghur, Han
- Number of residential units: 1461 households
- Mosque: 1
- Museum: 1
- Visitor reception center: 1
- Race: Uyghur
- Living environment: desert, oasis
- Travel: car, motorcycle, horse, camel
- Historical and cultural city, with a history of thousands of years, is the intersection of Eastern and Western civilization
- Main attractions:
Tuyoq Grand Canyon; Tuyoq Qianfo Cave;
Vomiting ditch



Site

Main road

Branch road





Tourism



Desert photovoltaic power generation



Drilling for oil



Playing children



Frosty in winter



Wind eroded dunes



Eagle



Camel



Antelope

Project Highlights

- Optimal shading angle design
- Uyghur regional architecture design
- Industry optimization and upgrading
- Turn the desert into an oasis
- Industrial assembly design
- Frame component design
- High-Strength Buildings Resisting Sandstorms and Earthquakes
- Design and application of energy-saving windows
- Upgrading of local rammed earth wall
- Best energy match
- Ventilation lighting simulation
- Efficient operation design
- Financial plan



Folk houses in Xinjiang Features

1) Inward spatial form.

Xinjiang is sunny in summer, with a hot climate but large temperature differences.

According to the lighting characteristics, the building's planar layout strives to be compact, with the most windows facing the inner courtyard, and the outer periphery being heavy windows to reduce the sunlight reflection on the ground.

2) Create shadow space.

Because the intensity of solar radiation is very large, far beyond the normal needs and patience of people, the shadows under strong light have become a space for people to live on.

① Utilizing grape stands:

② Gun gallery (a semi-open space built along the inner courtyard of the inner courtyard); the inner courtyard enclosed by the gun gallery and the cymbal plus the air tower constitutes a space called Arab-Iwan by Arabs.

3) Transfer space for warm winters and cool summers.

The climatic temperature difference is large, the summer is hot and the winter is cold, and the shifting lifestyle adapts to the climate.

In the south and south of the house in winter, the space is low, which is conducive to thermal insulation: in the summer, the house faces north, is in the shadow all day long, and the space is large.

There are ventilation windows to cool down at night. The transfer space is also manifested in the use of the roof as a space for cooling at night.

Project Data

- Location: Tuyuq, Turpan, Xinjiang Uygur, CHINA
- Climate Zone: Cold B based on GB50176-2016 (similar to IECC 5B)
- Area of single-family building: 229.45 m² (2470 sq ft)
- Area of single-family plot: 270 m² (2906 sq ft)
- Area of building: 1835.6 m² / 8 Units (21920 sq ft / 8 Units)
- Area of plot: 2160 m² / 8 Units (23248 sq ft / 8 Units)
- 3 BR, 3 BA, 3 stories
- HERS Index: 48 (without PV), -47 (with PV)
- Estimated Monthly Utility Cost: 77 \$ (without PV), -53 \$ (with PV)

Technical Specifications

- Envelope: R20 foundation, R22.4 wall, R50 roof
- Windows: U-value 0.086, SHGC 0.35
- HVAC Type: VRV Air-conditioning System
- HVAC Specs: SEER 20, HSPF 10.5
- Ventilation: Energy Recovery Ventilation (ERV)
- Renewable Systems: 20.56kw PV Array / Unit

Design Strategy

This design aims to provide a solution strategy for extreme desert climate conditions and an example of sustainable architecture in desert areas, to develop desert cities and the full use of desert resources, and to adopt a variety of building techniques to avoid the adverse effects of desert climate.

Specific innovations include:

- desert architecture assembly design
- lighting design for desert buildings
- water resource collection system design
- design of temperature regulation system for desert buildings
- ventilation design for desert buildings
- desert sand control system and landscape design
- new desert building materials
- oasis generation

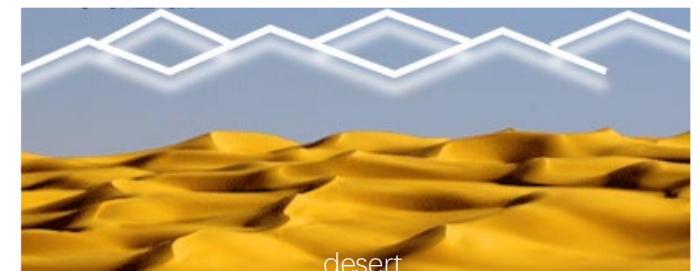
Logo



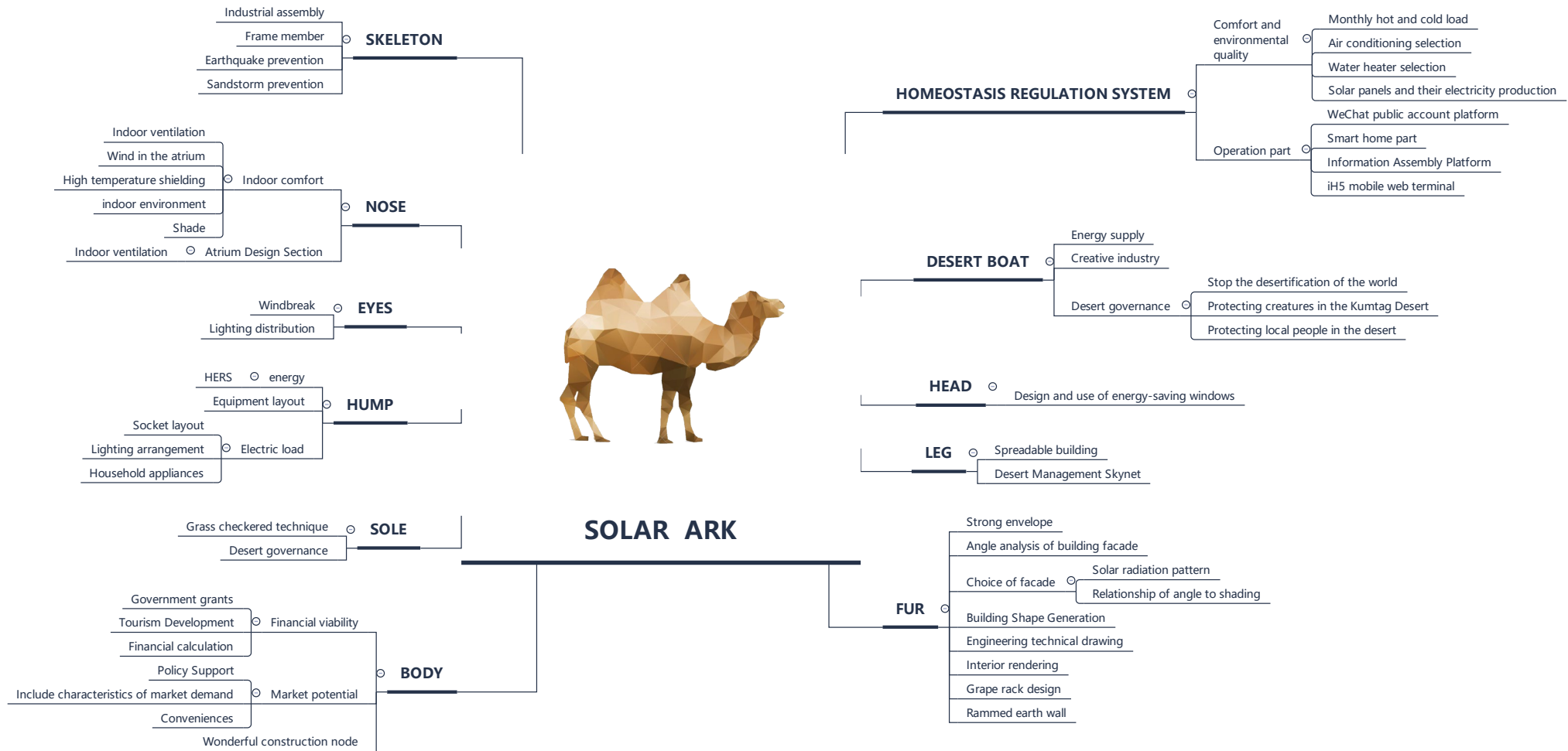
Extract the natural texture of the desert as the architectural Logo.



logo design



desert



Musicology, Religion, Anthropology, Nature, All-encompassing, The farthest civilization in the world from the ocean

02 Desert targeted decathlon







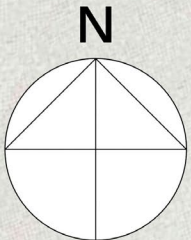


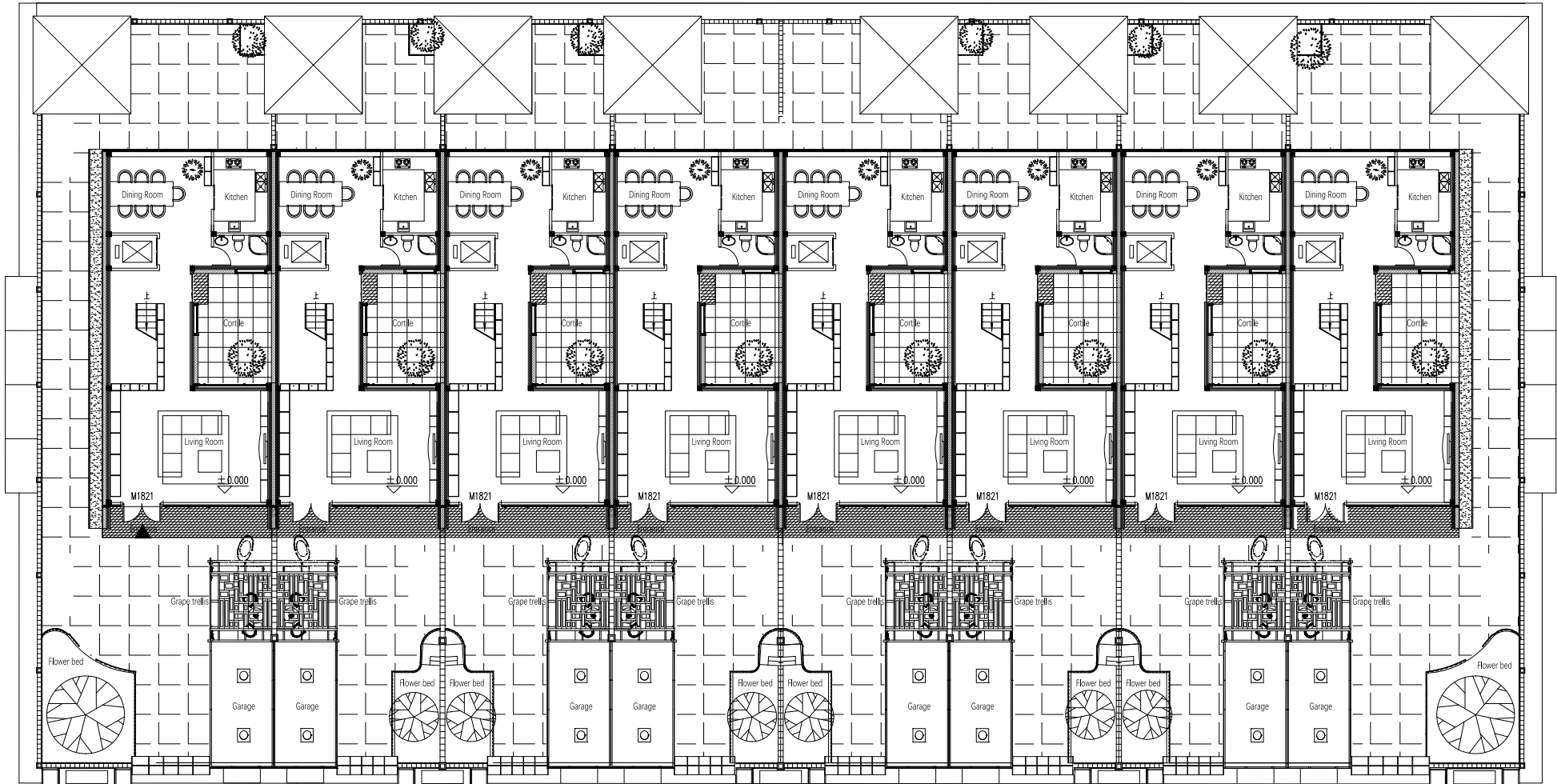
Technical-economic Indices

Total Site Area: 12135 m² (130620 sq ft)
 Total Floor Area: 3668 m² (39482 sq ft)
 Area of single-family building: 229.45 m² (2470 sq ft)
 Area of single-family plot: 270 m² (2906 sq ft)
 Plot Ratio: 0.12
 Site coverage Intensity: 30.2%
 Green Ratio: 41.2%
 Parking Space for Vehicles: 29

Site Plan:

A. Attached House
 B. Service Center
 C. Apartments
 D. Public Parking
 E. Private Parking
 F. Playground Area





Attached Housing

Total Floor Area: 1834 m² (19741.01sq ft)


Area of single-family building: 229.45 m² (2470sq ft)

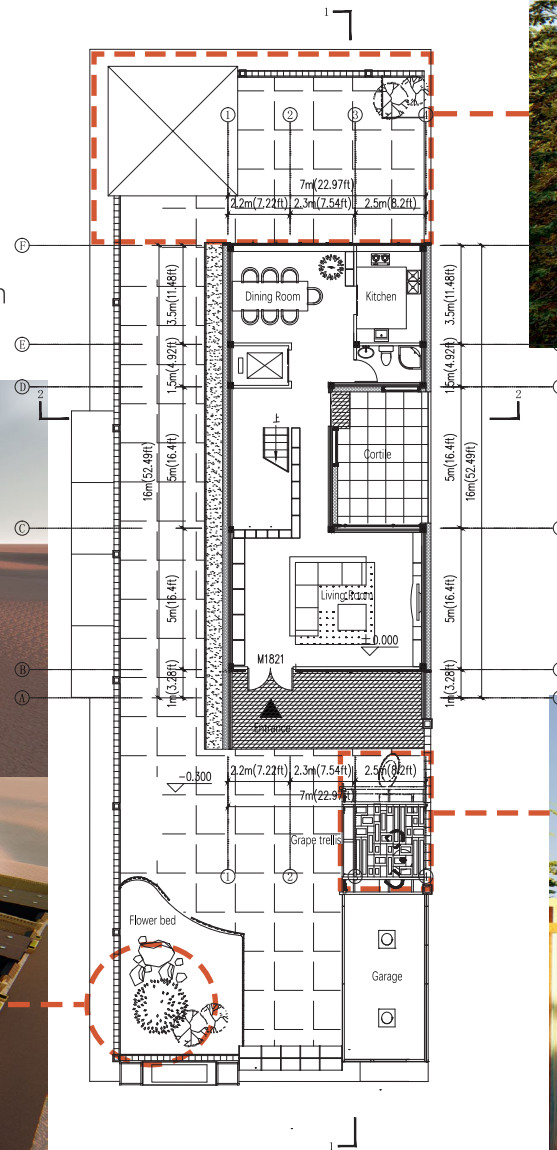
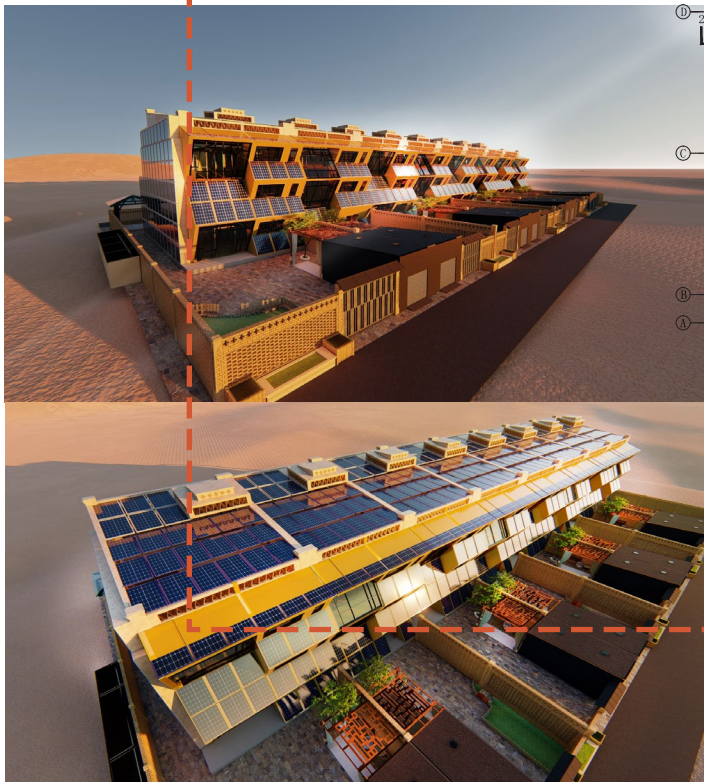
Area of single-family plot: 270 m² (2906sq ft)

Tree Species Selection

Poplar and mulberry are the original local trees

 Poplar has a good effect on resisting sandstorm.

 The luxuriant branches and leaves of mulberry can provide shade.



Grape Trellis

Meet the local people 's living habits

Outdoor barbecue

Land of cool weather



Building Facade

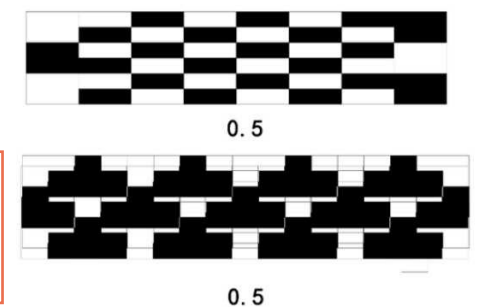
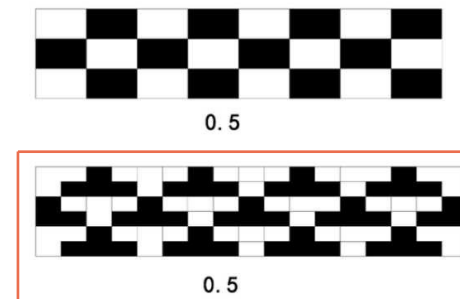
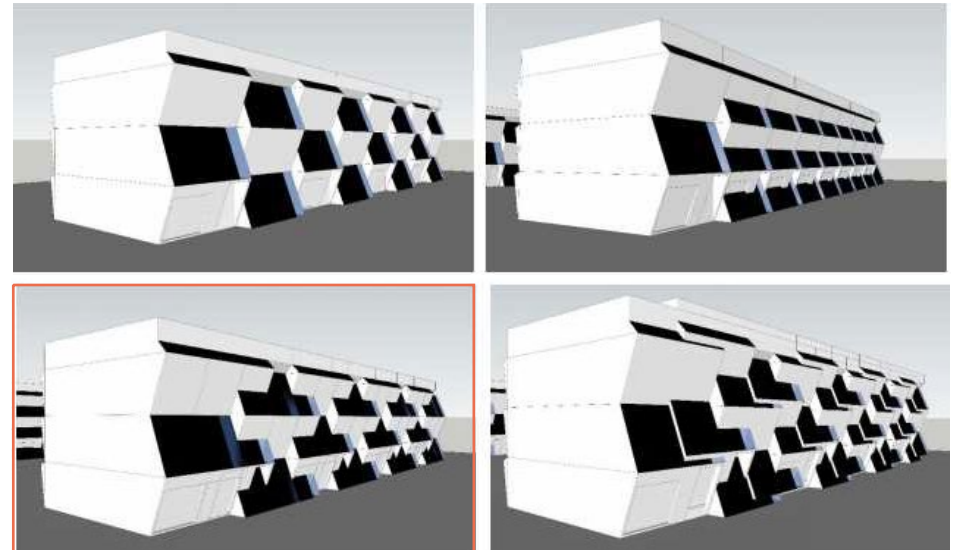
Extract natural texture of desert as building facade.



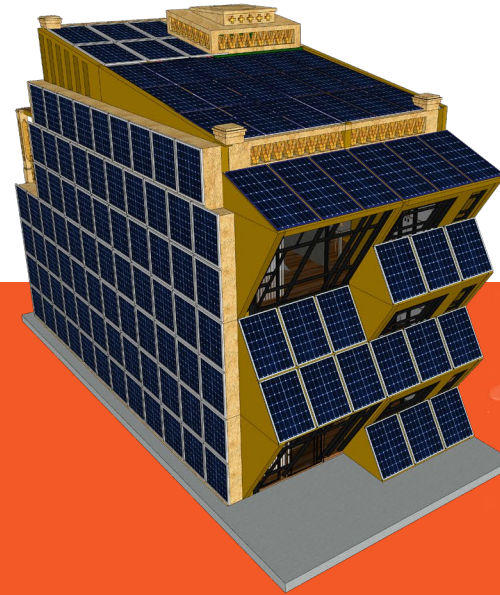
Building Facade Design

Under the premise that the area ratio of window to wall is 50%, the best window opening form shall be selected.

The east-west direction of the building guarantees the simplicity of the facade while ensuring the self-shading



Indoor Atrium



Bulk stretch

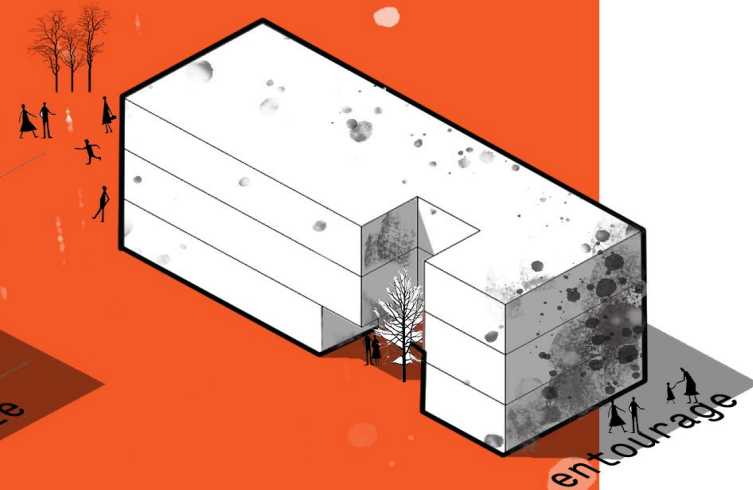
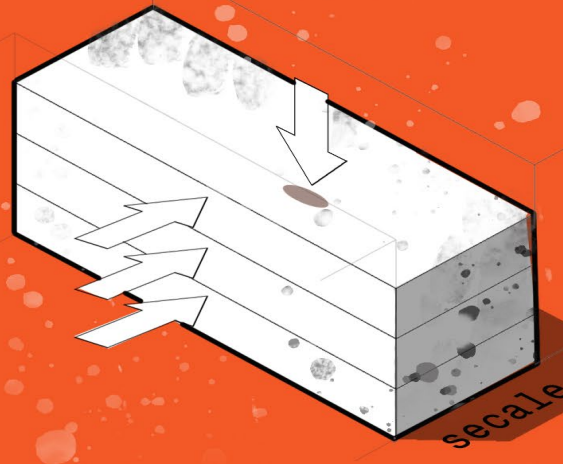
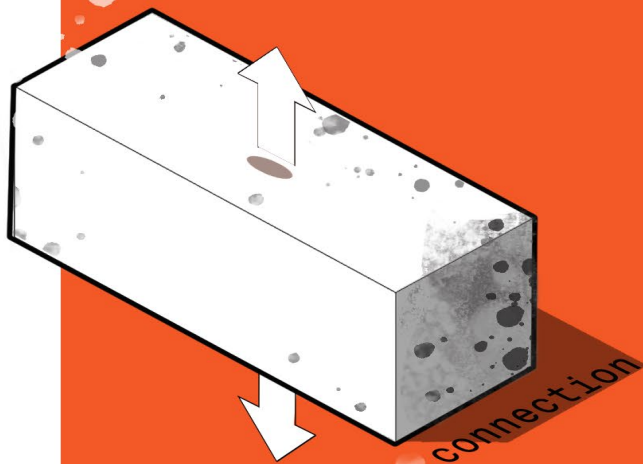
Three floors of building

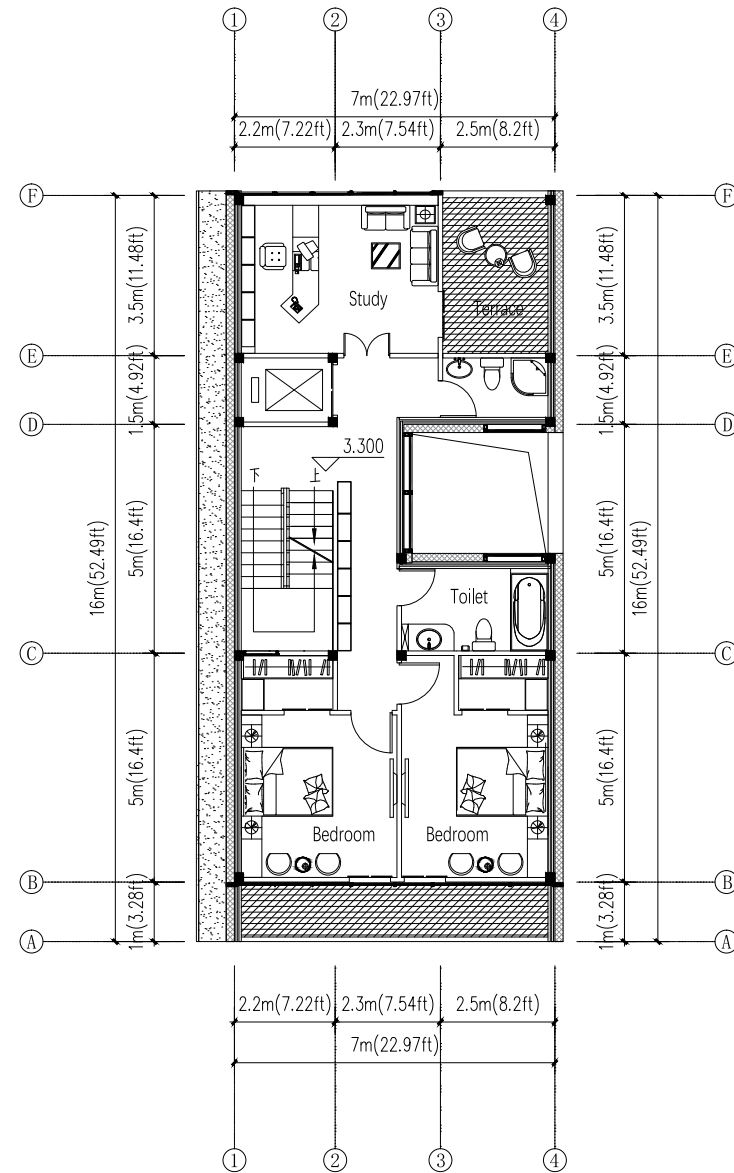
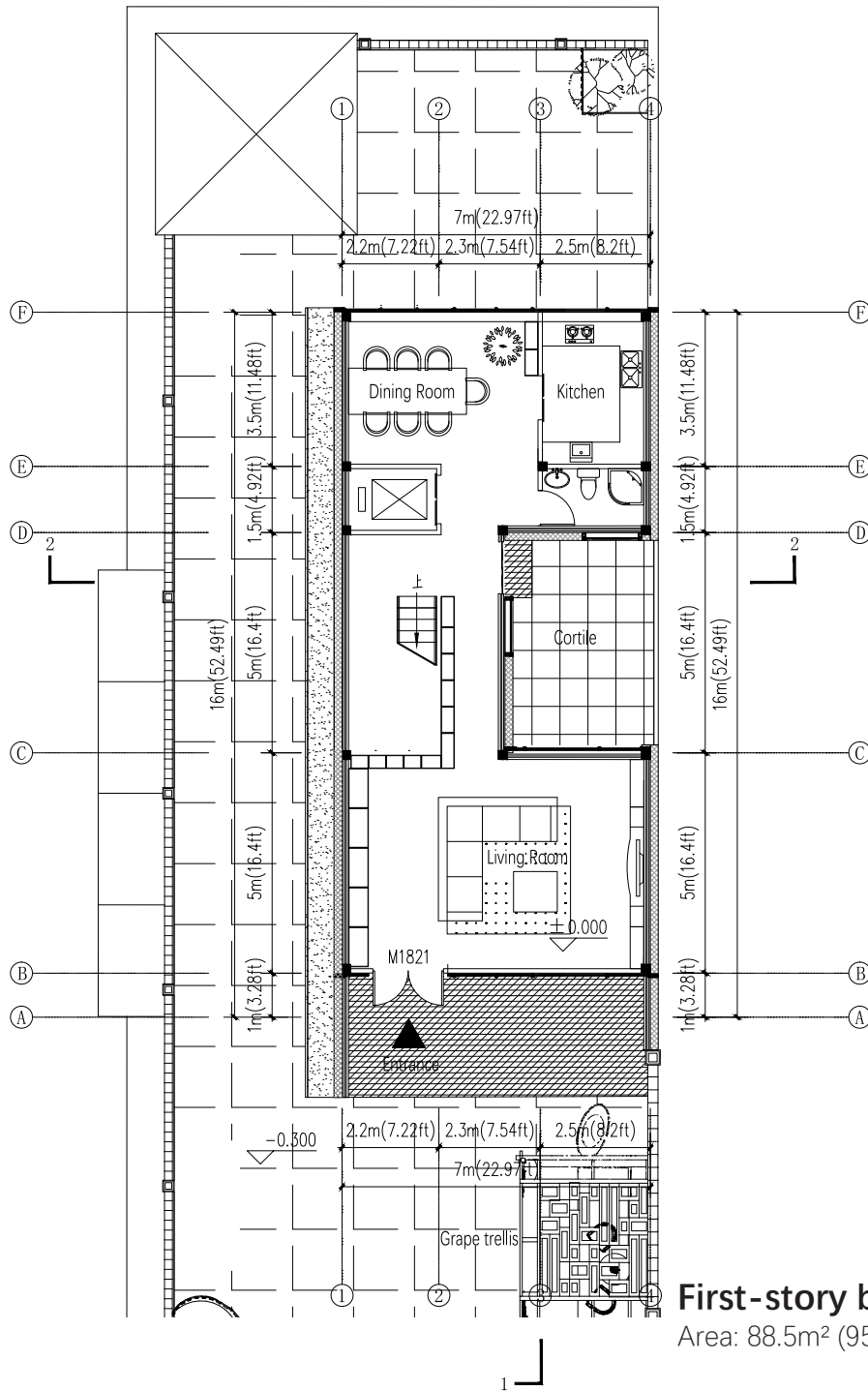
Block pressing

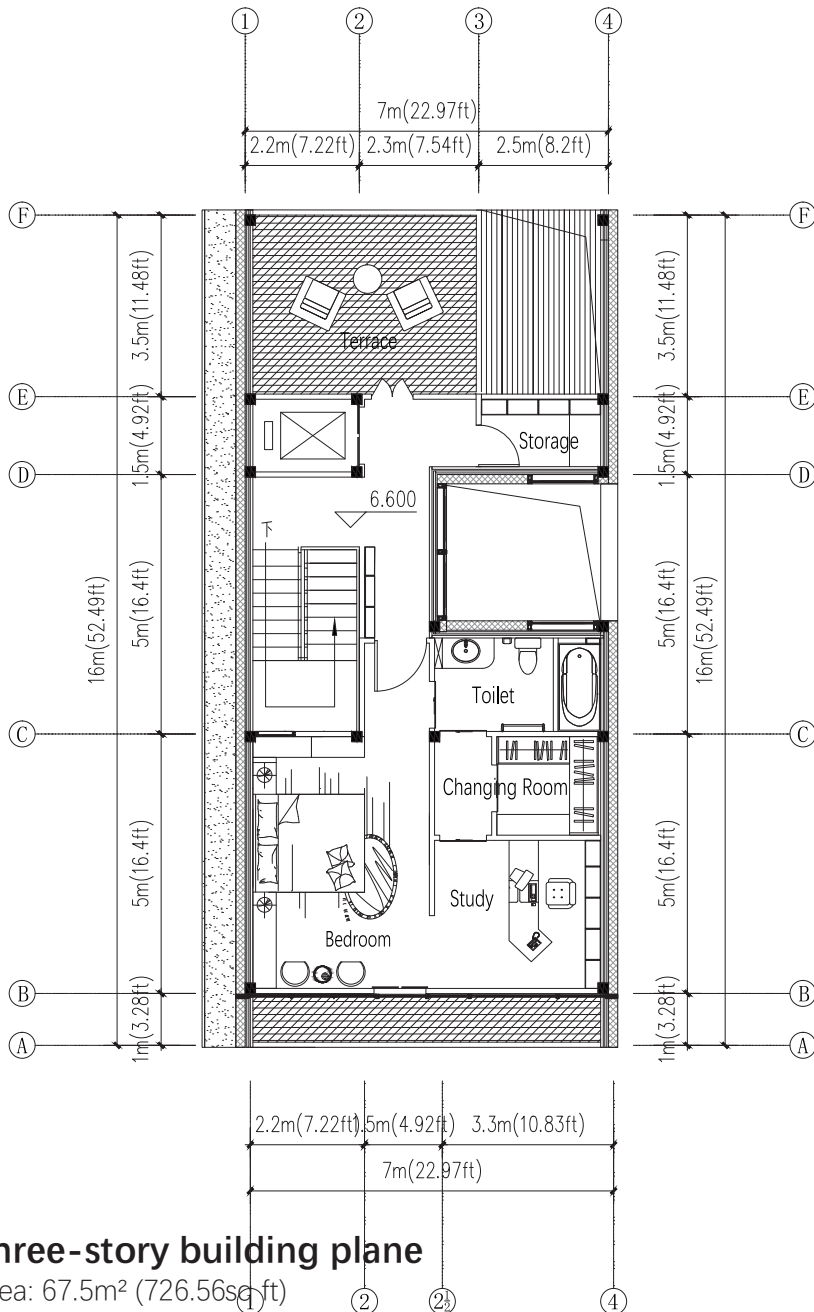
Enhance the spatial connection of each layer

Using atrium

Natural ventilation with atrium
Indoor spaces

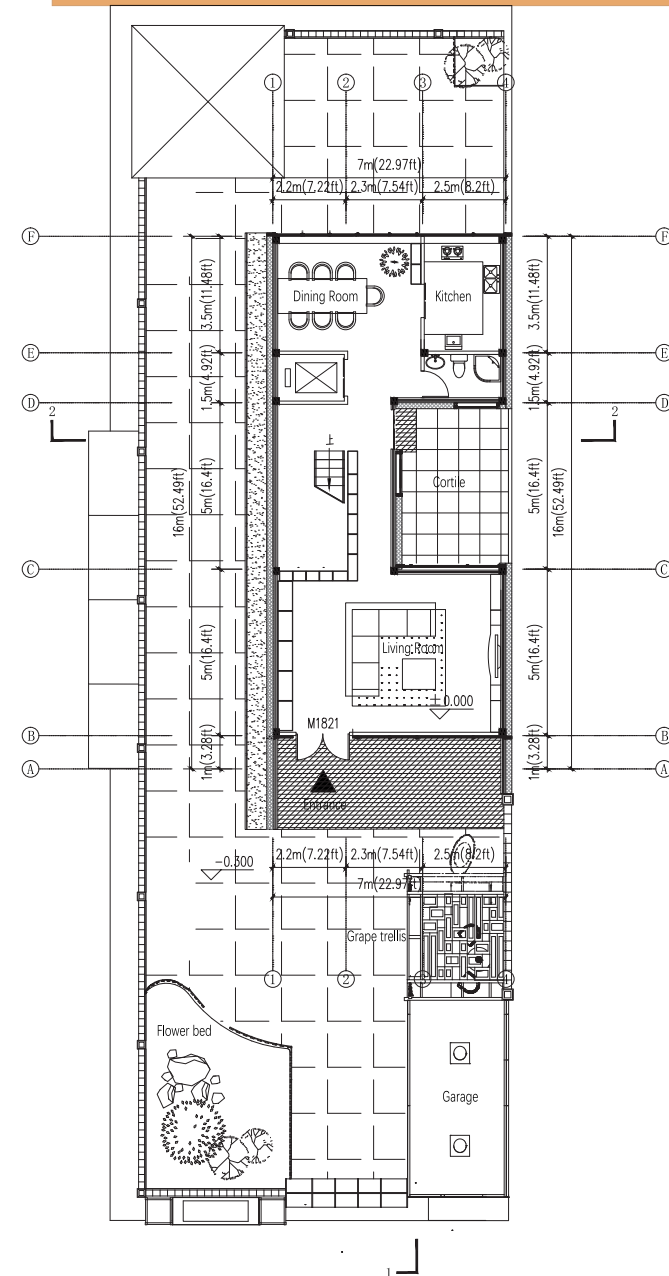






Three-story building plan

Area: 67.5m² (726.56sq ft)



Area of single-family building

229.45 m² (2470sq ft)

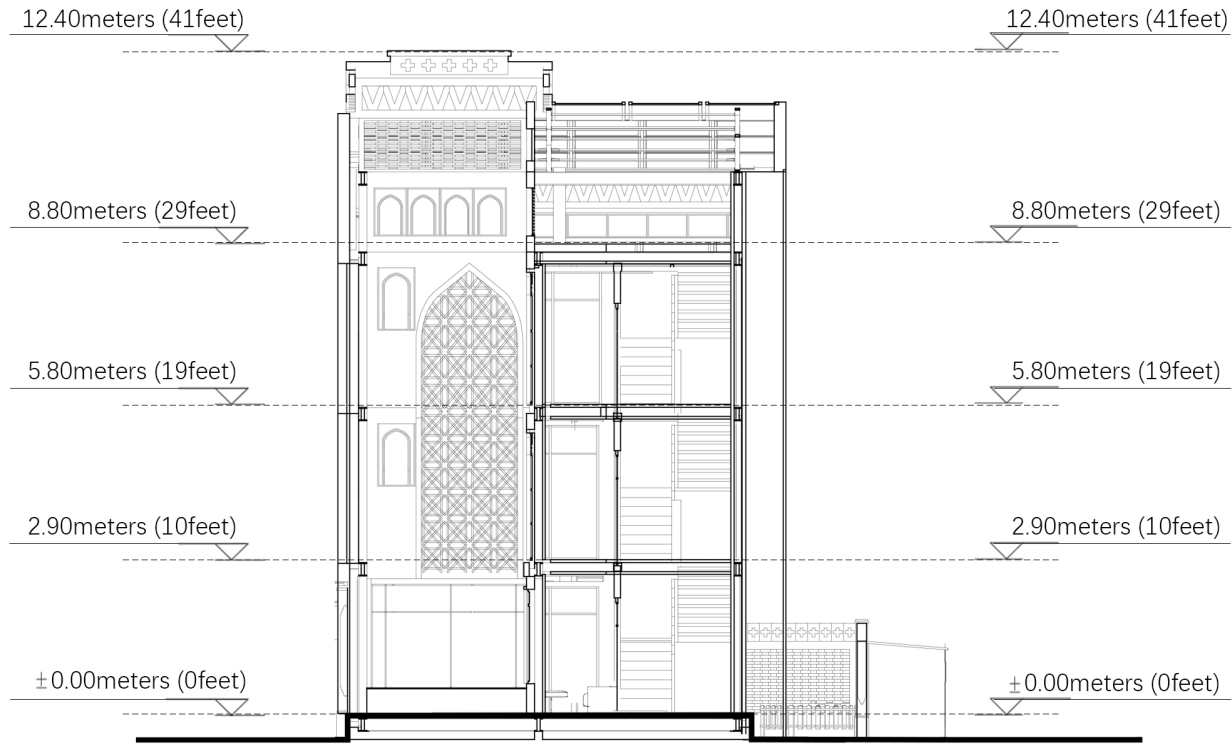
Area of single-family plot

270 m² (2906sq ft)

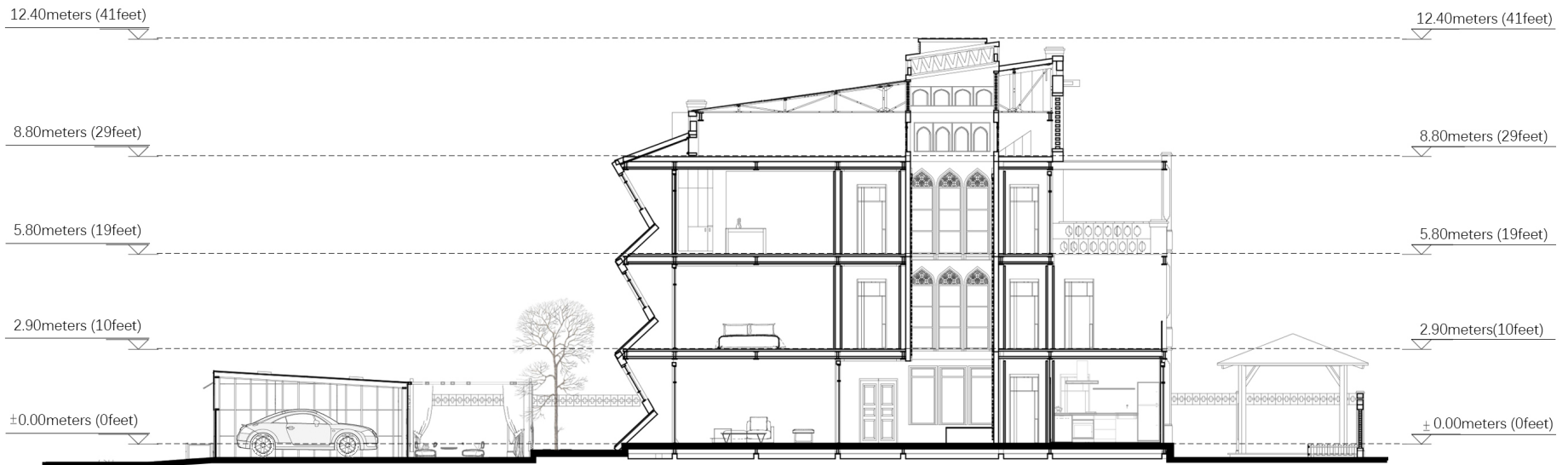


Architectural South facade

Architectural North facade



Profile 2-2

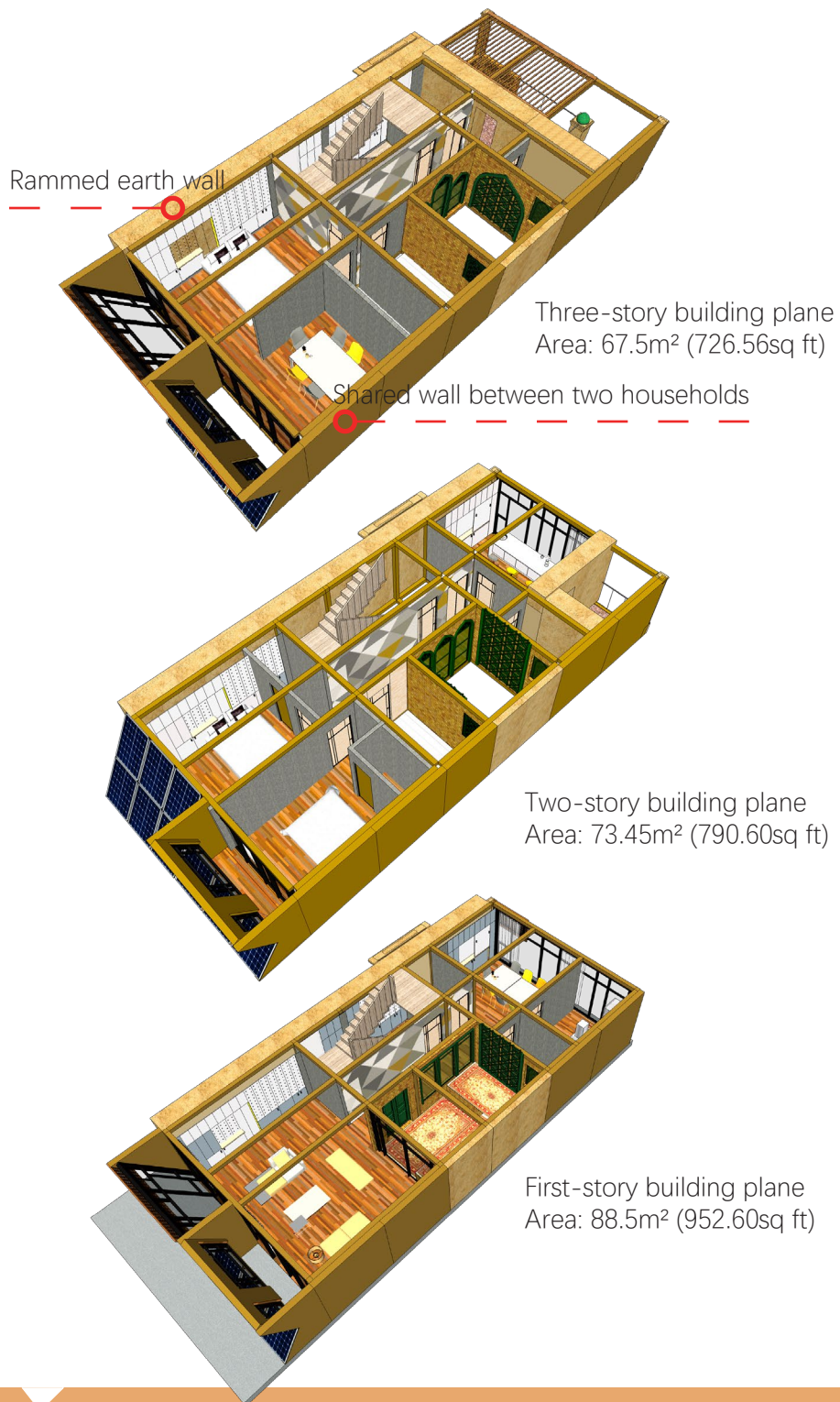


Profile 1-1



Profile 1-1

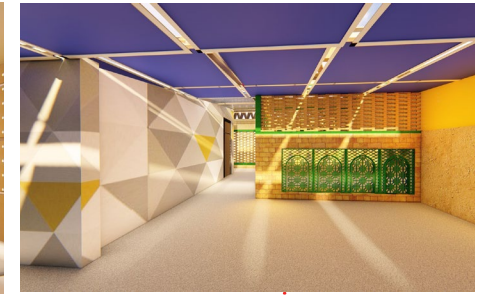
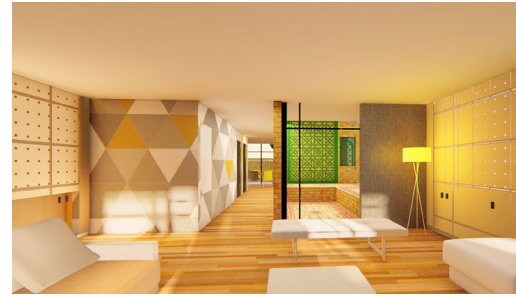
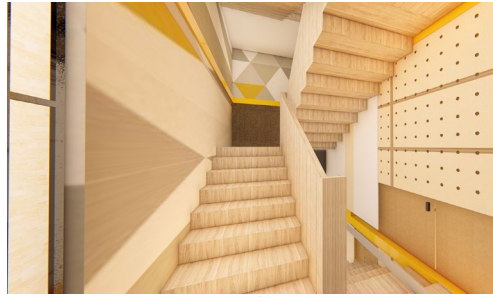
Profile 2-2



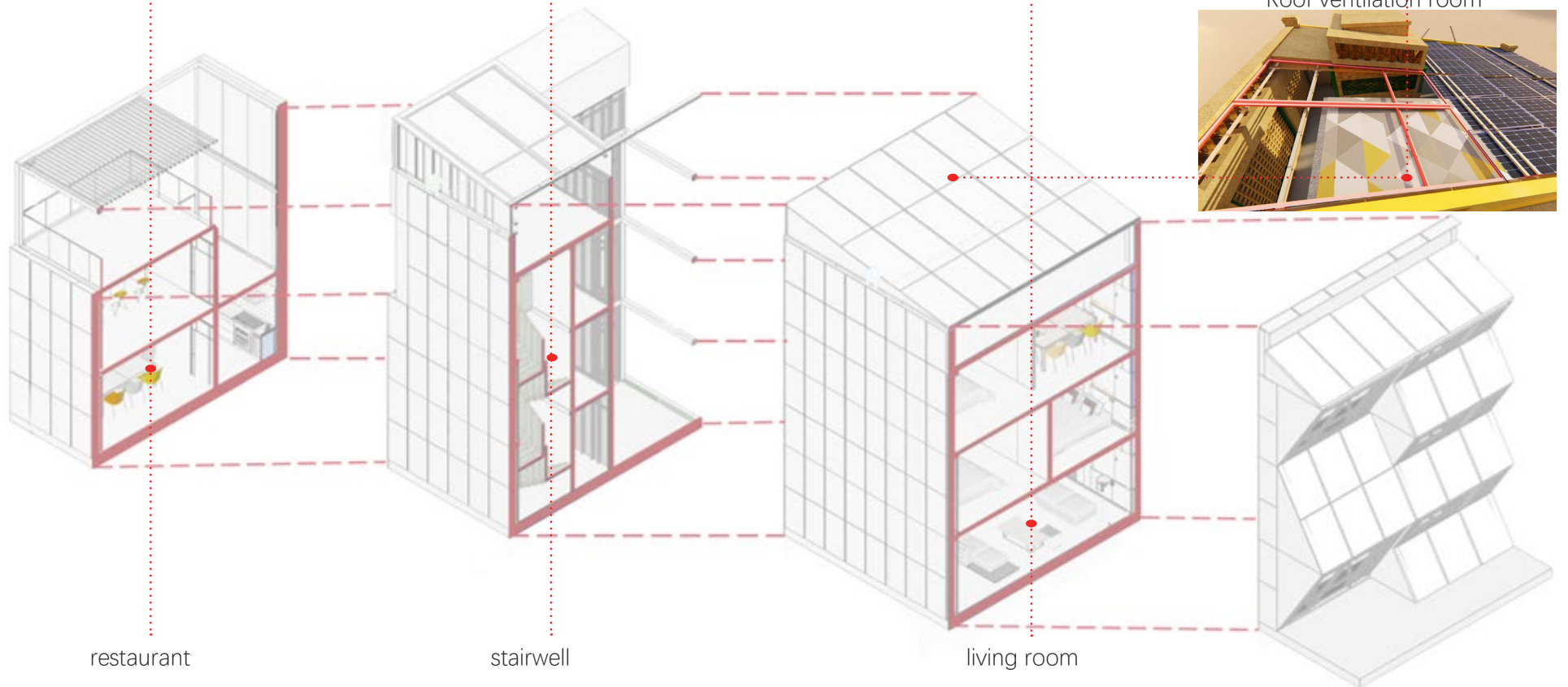
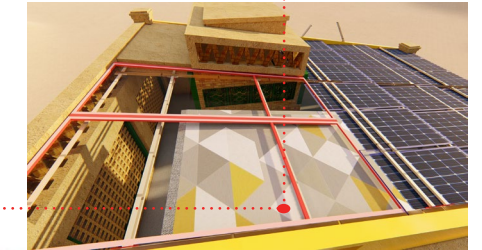
Living room and inner courtyard



Three-level corridor and inner courtyard



Roof ventilation room



restaurant

stairwell

living room



living room



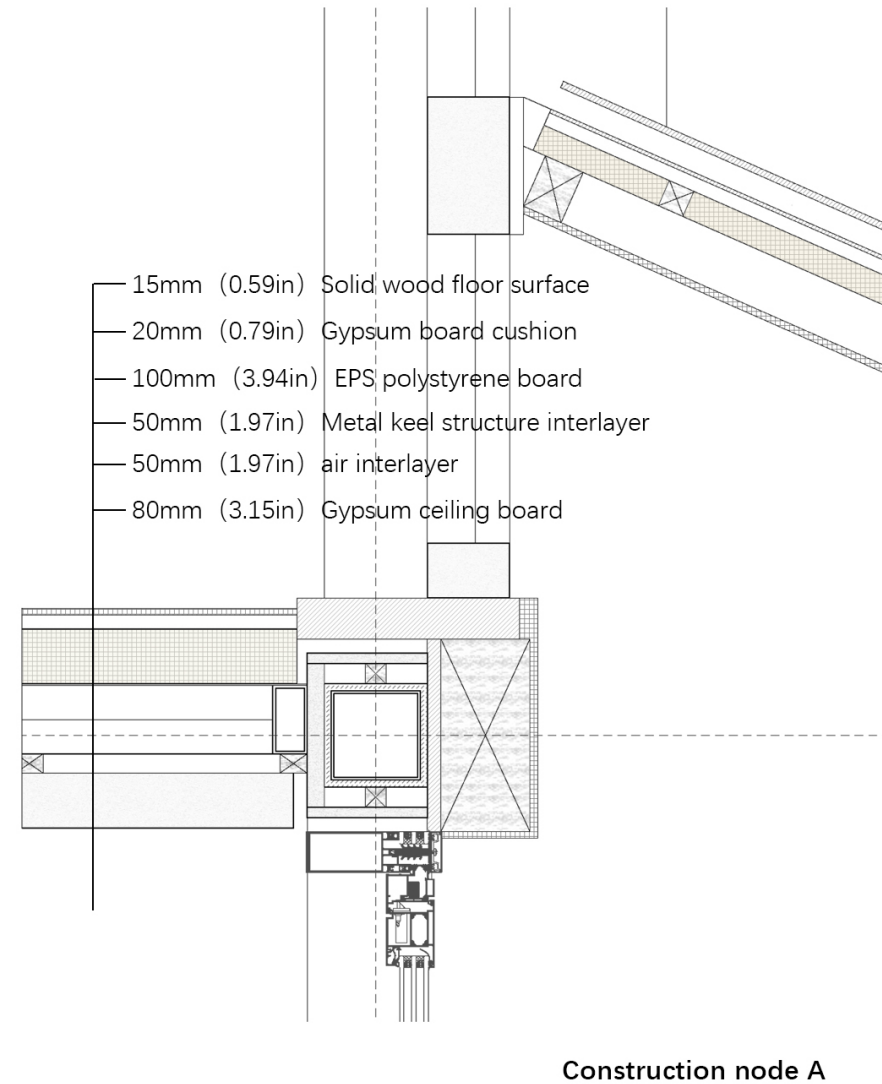
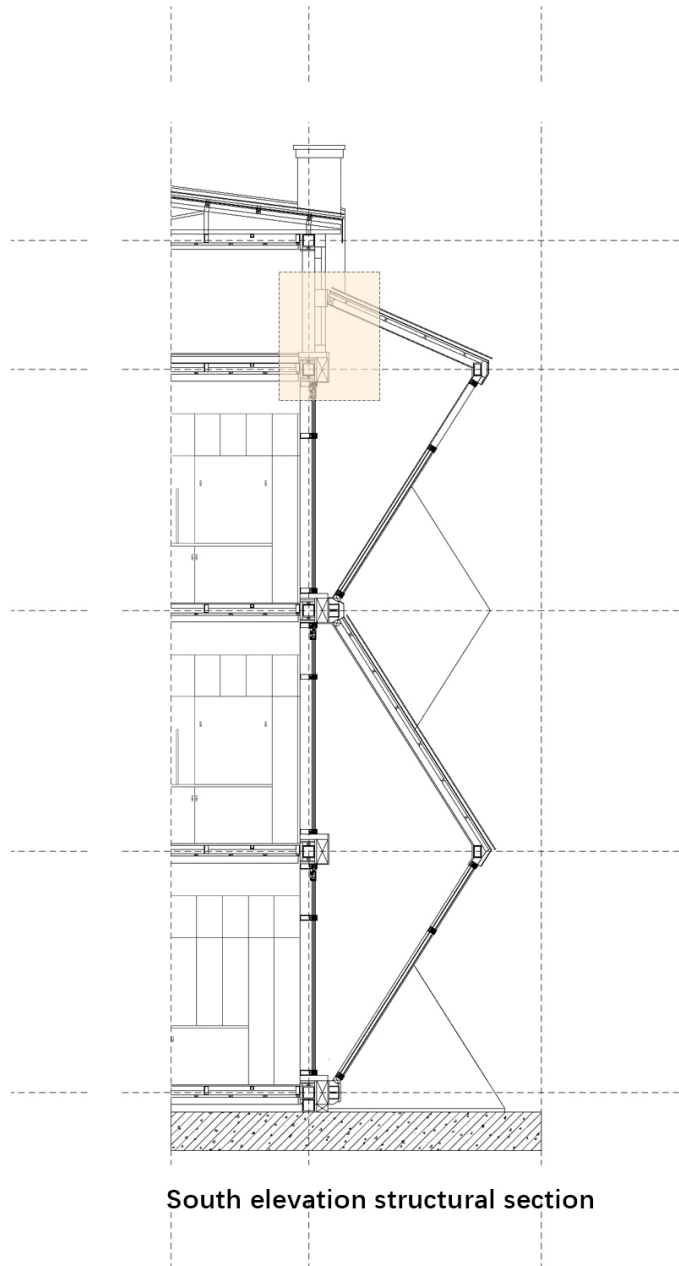
study

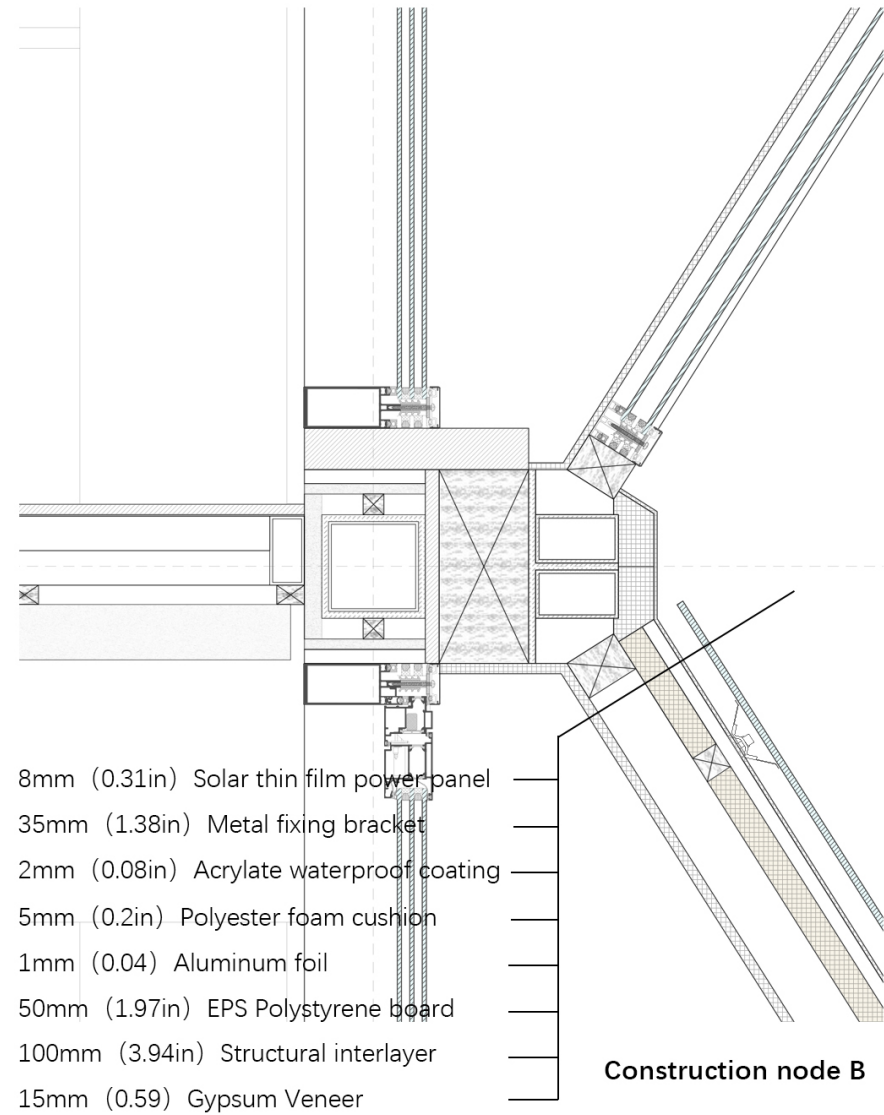
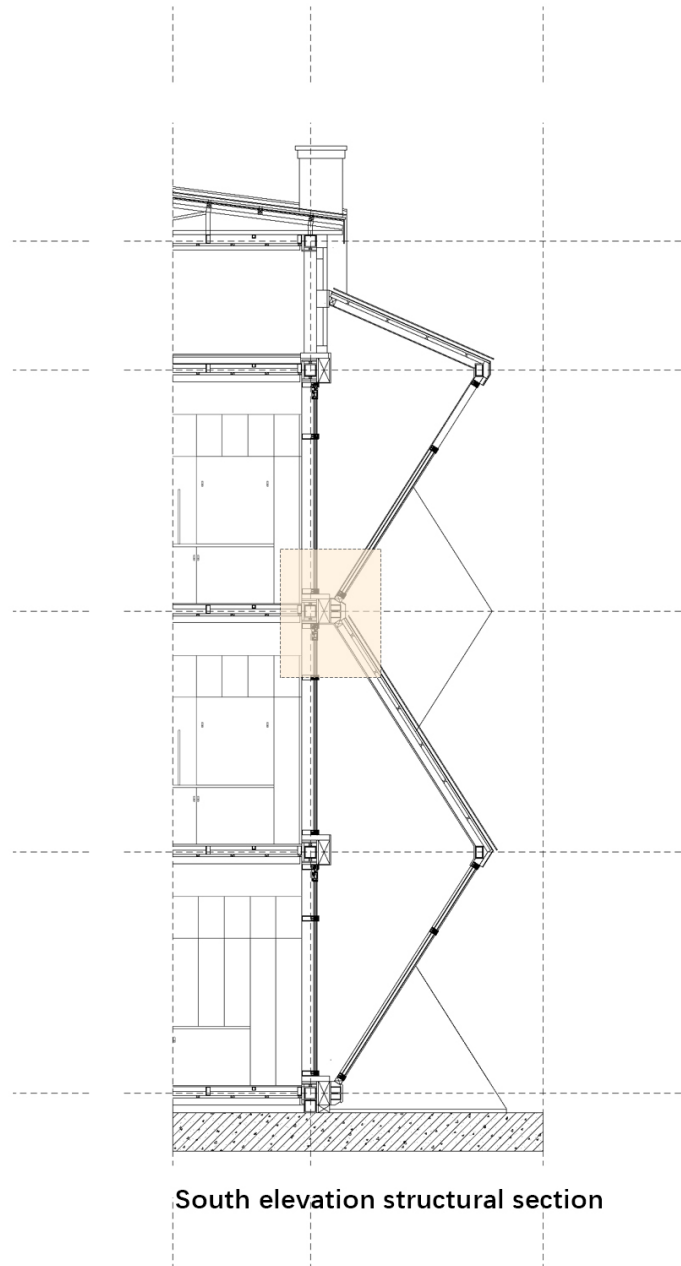


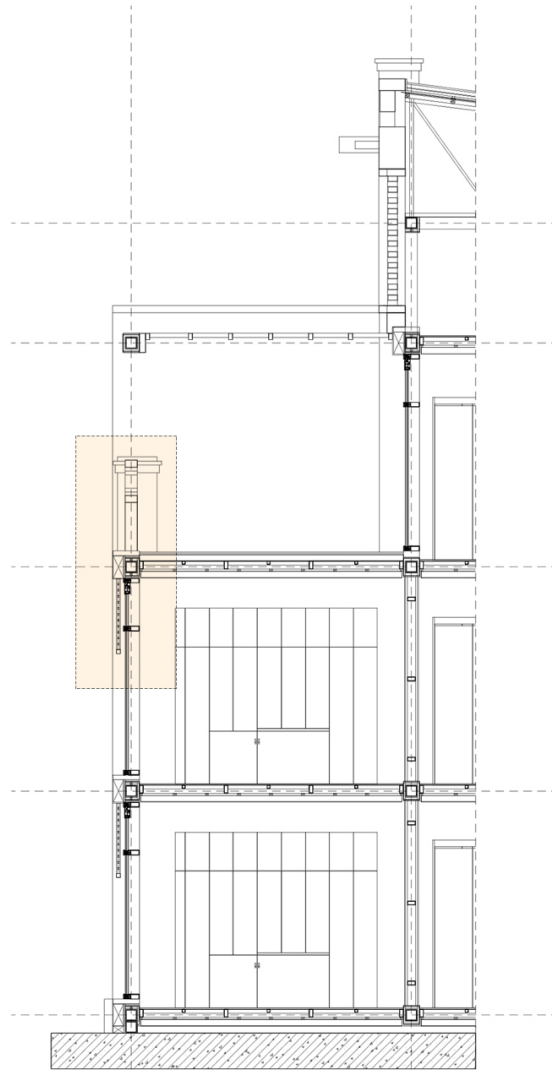
bedroom



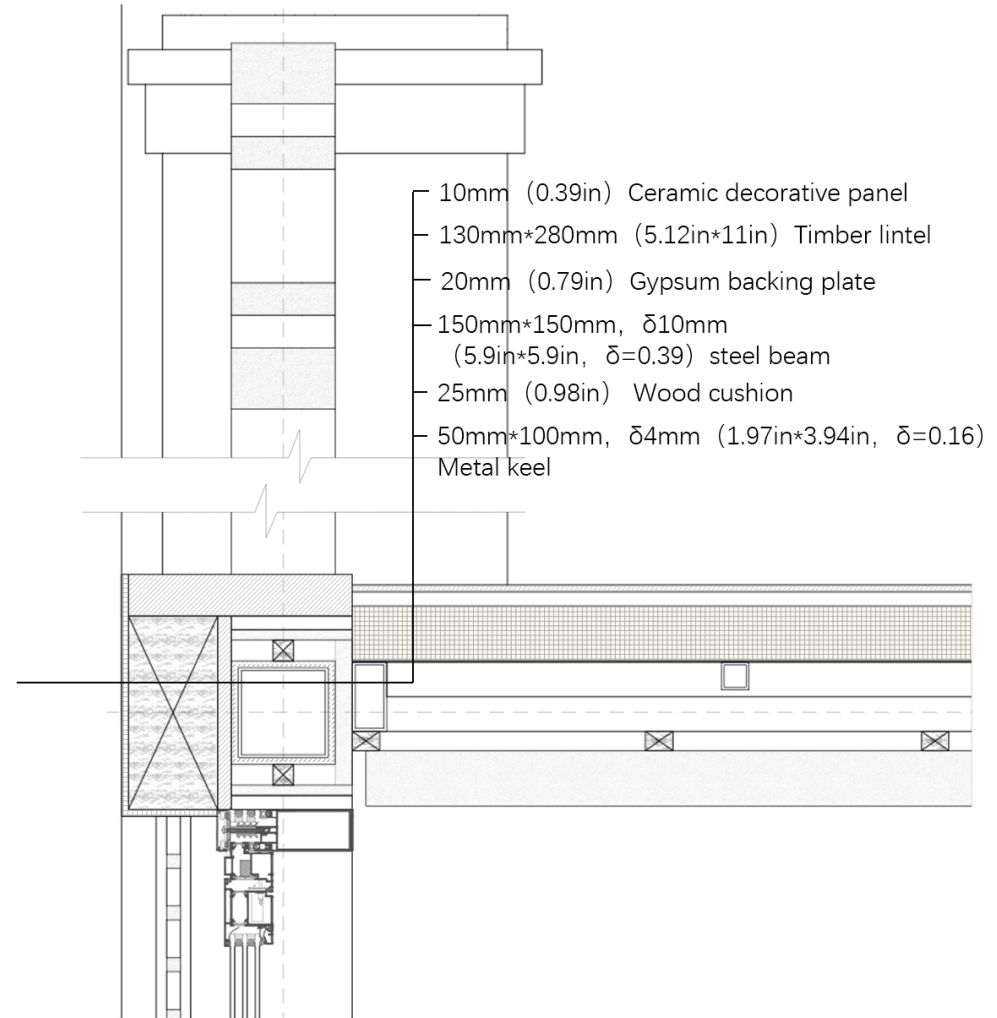
corridor



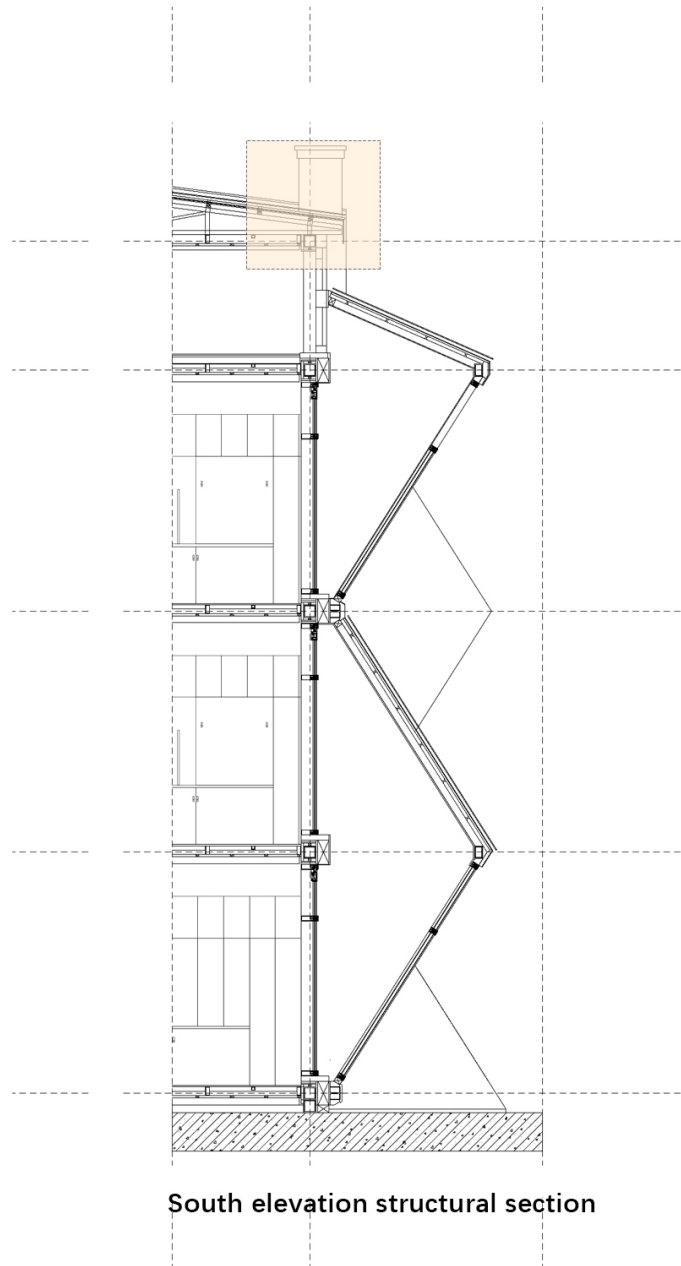




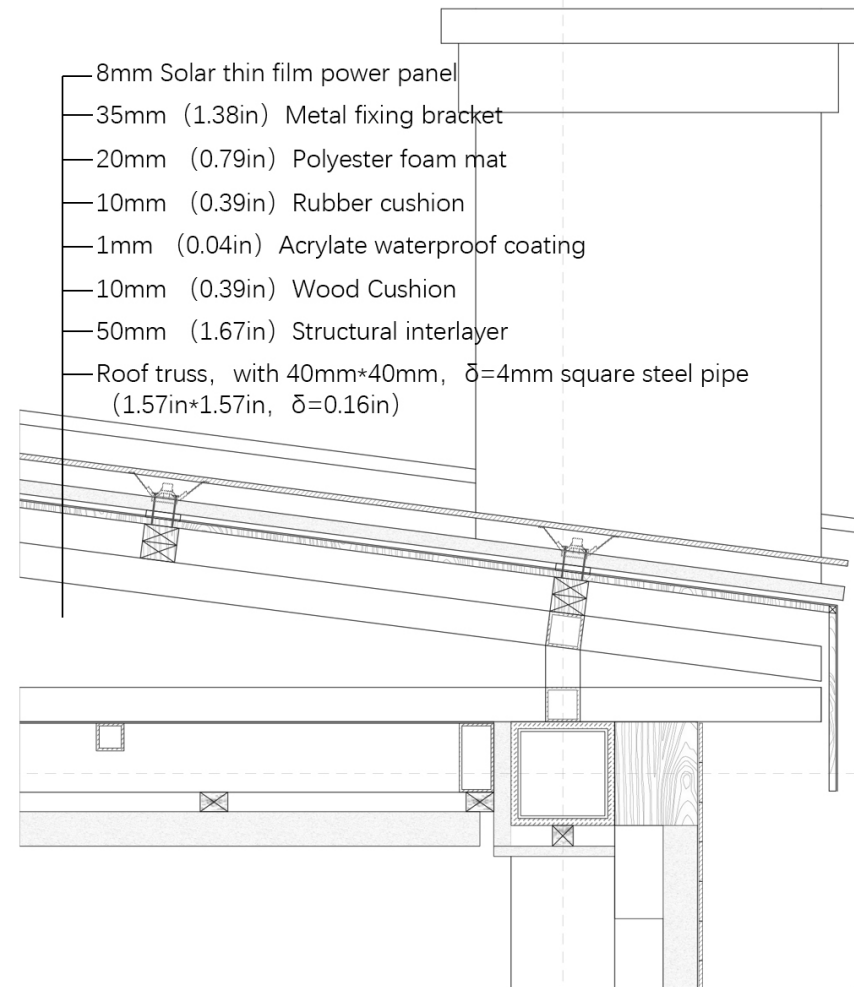
North elevation structural section



Construction node C



South elevation structural section



Construction node D

Modified Rammed Earth Wall + Straw Utilization

Background

Rammed earth building is one of the characteristics of traditional houses in Turpan, but the traditional rammed earth technology has many problems such as poor durability. Locally, cotton is the main cash crop. But when cotton is mature, the remaining straw is not well used. Burning straw will bring huge environmental pollution.

Technology

We hope to apply the knowledge of modern architectural technology and science, and learn from successful cases in the world to make full use of local suitable building materials. The research on houses in this area shows that the modified rammed earth wall has good heat preservation and insulation performance and material durability. The optimal formula is the apparent density of the material 1.9 g / cm^3 , and the cement content 7 wt %.



Clay Quarry Near Site



Prefabricated Blocks for Walls

Adopting prefabricated construction technology, which can reduce on-site manual work and improve construction efficiency.

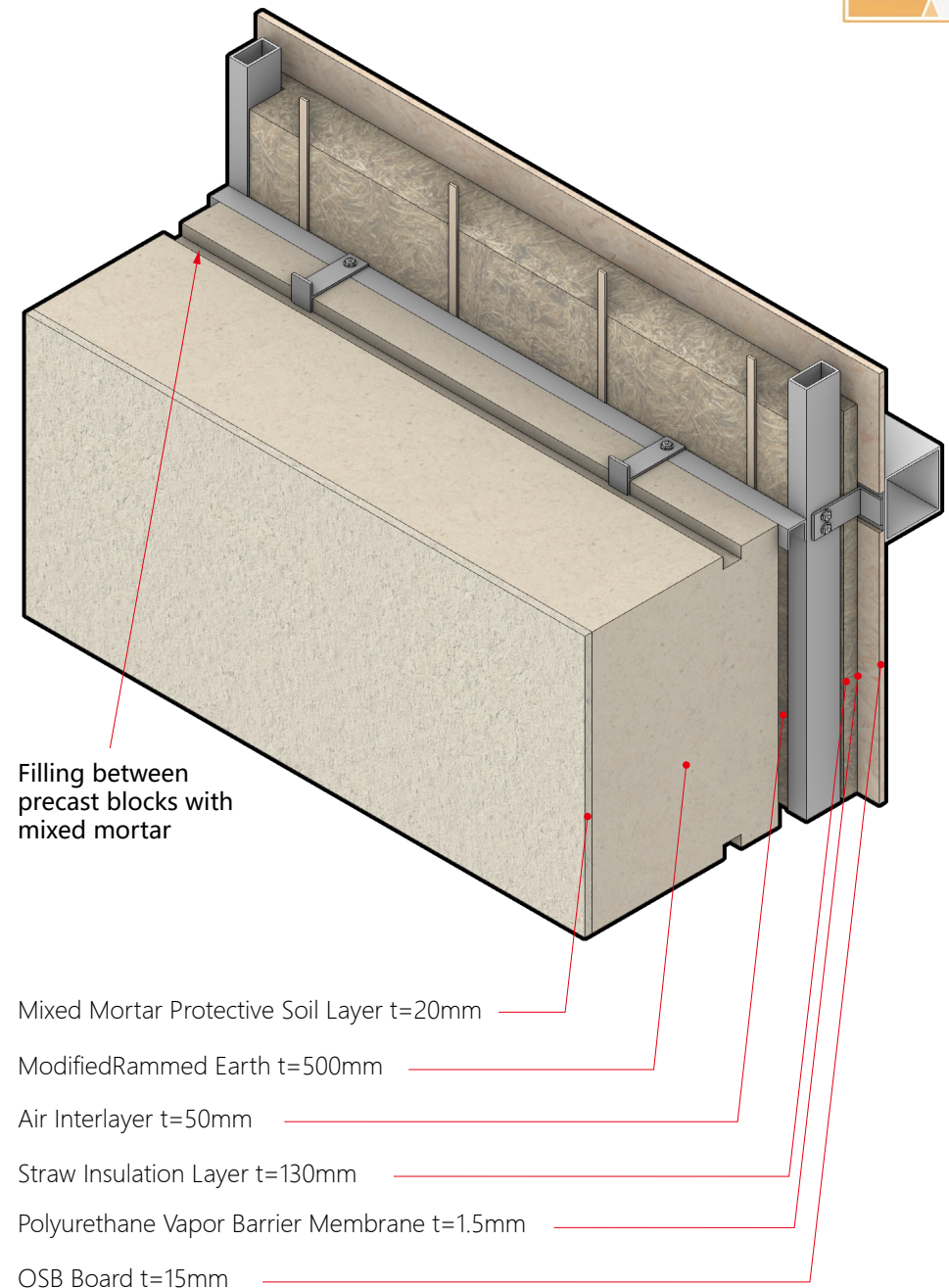
- Nominal Dimensions of Wall Blocks: $1500\text{mm} \times 500\text{mm} \times 700\text{mm}$
- Thermal Conductivity of Modified Rammed Earth Wall: $0.823 \text{ W/m}\cdot\text{K}$
- Thermal Conductivity of Straw Insulation: $0.043 \text{ W/m}\cdot\text{K}$

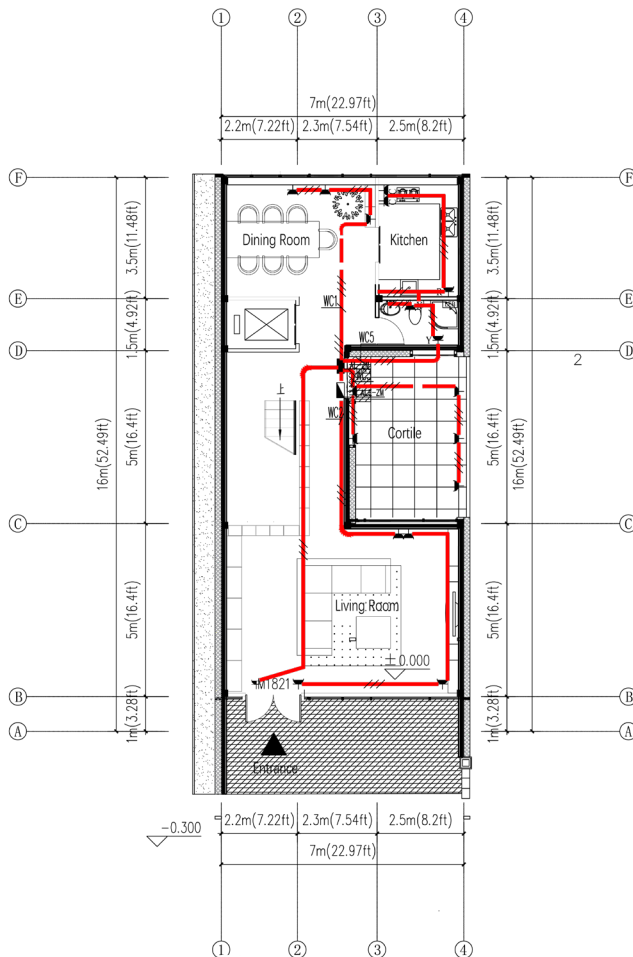


A large number of waste straw sources

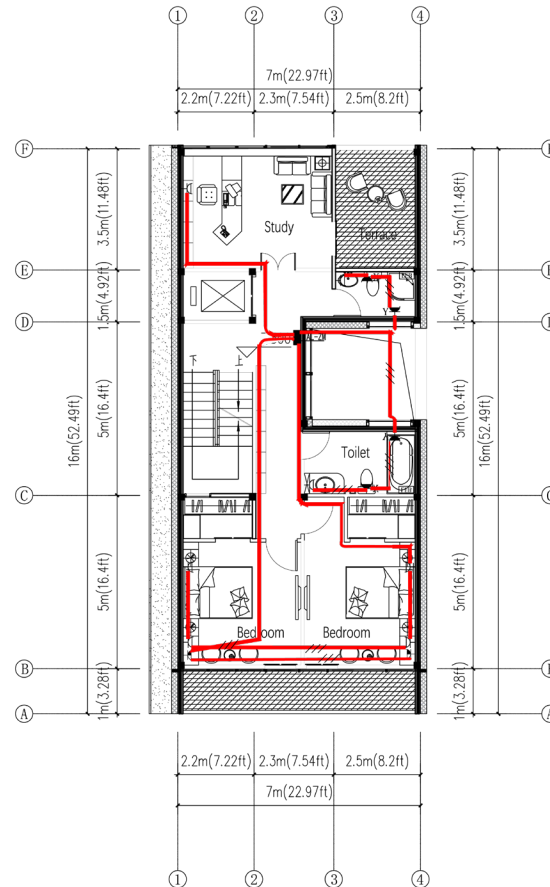


Prefabricated straw insulation Board

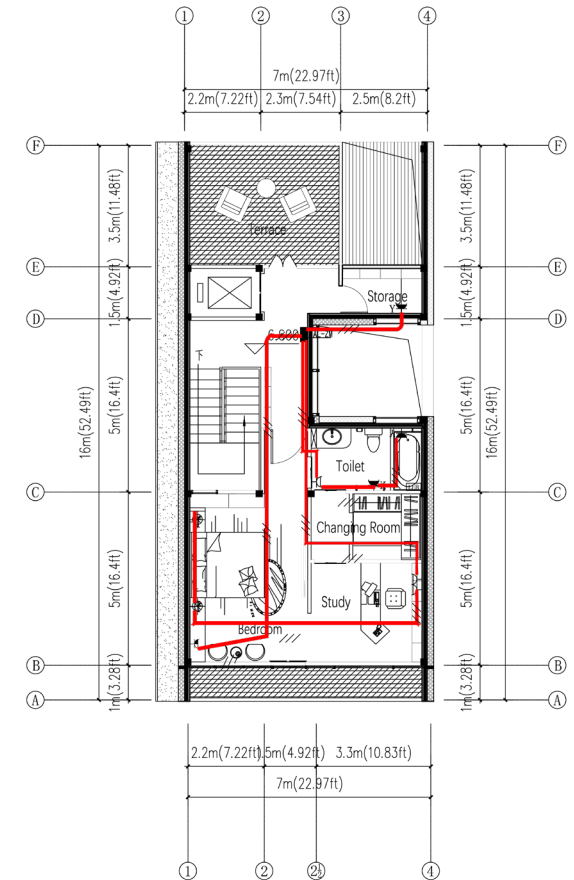




First floor socket plane
Area: 88.5m² (952.60sq ft)

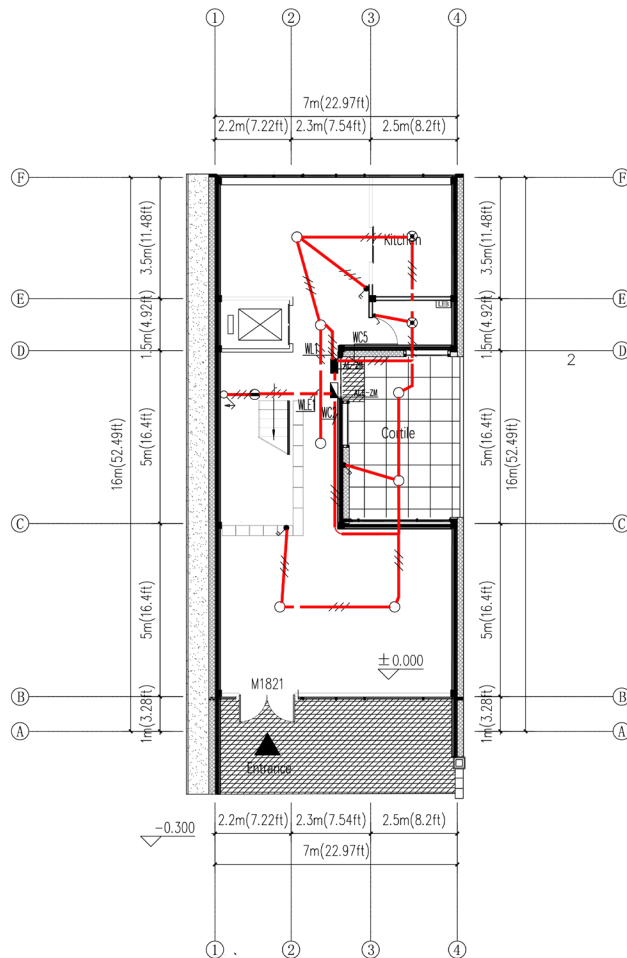


Second floor socket plane
Area: 73.45m² (790.60sq ft)



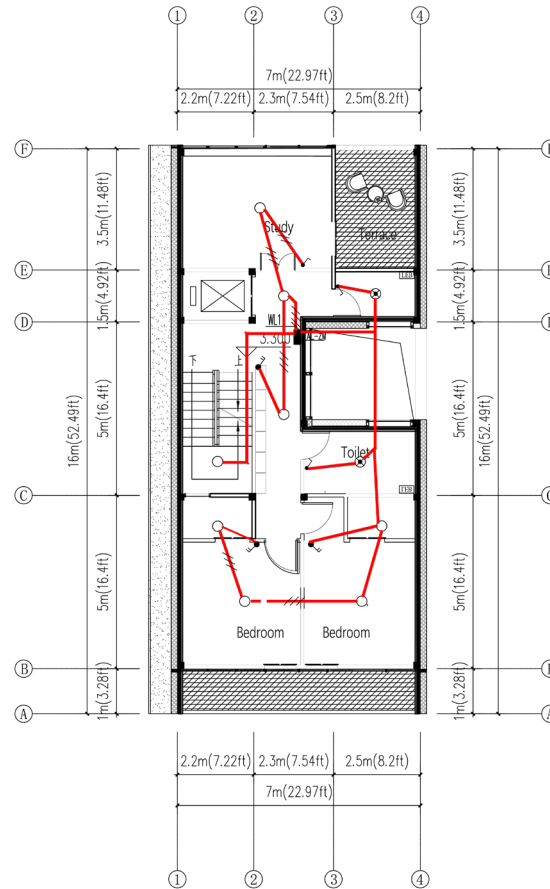
Third floor socket plane
Area: 67.5m² (726.56sq ft)

	Common Grade Three household grade two safety type socket
	Safety type switch socket for single phase air conditioner
	Reserved position
	Distribution box for normal lighting (concealed)
	Double Power Distribution Box (free load)
	Single-link single-controlled dark switch
	Double-connected single-controlled dark switch
	Acousto-optic dimmer switch
	Waterproof dustproof lamp (Energy Saving Lamp)
	Local equipotential connection terminal box



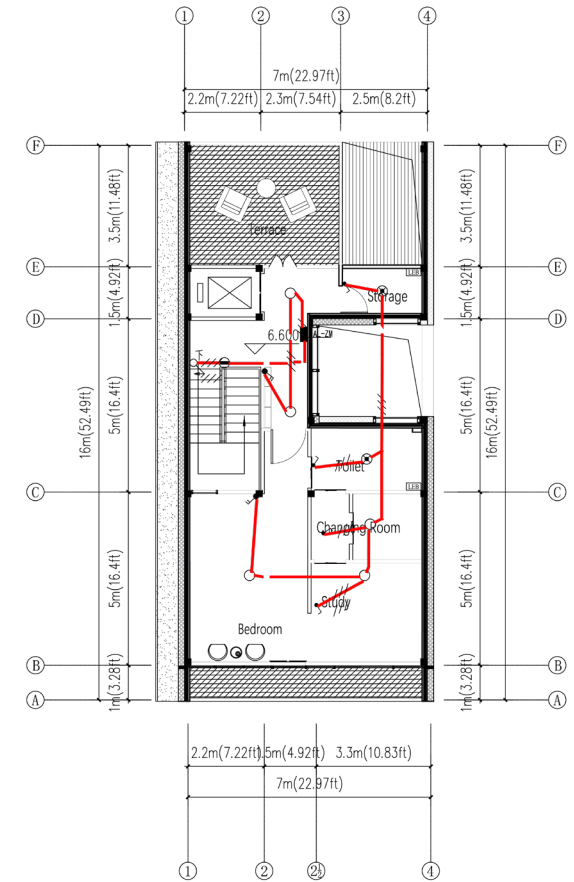
First floor lighting plane

Area: 88.5m² (952.60sq ft)



Second floor lighting plane

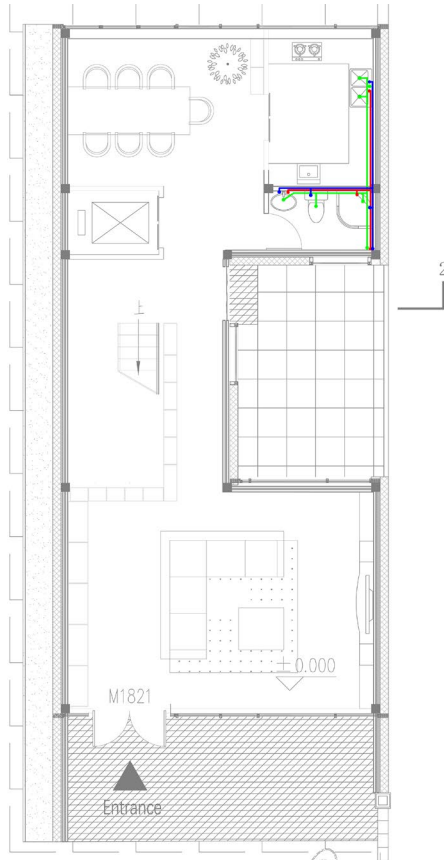
Area: 73.45m² (790.60sq ft)



Third floor lighting plane

Area: 67.5m² (726.56sq ft)

	Common Grade Three household grade two safety type socket
	Safety type switch socket for single phase air conditioner
	Reserved position
	Distribution box for normal lighting (concealed)
	Double Power Distribution Box (free load)
	Single-link single-controlled dark switch
	Double-connected single-controlled dark switch
	Acousto-optic dimmer switch
	Waterproof dustproof lamp (Energy Saving Lamp)
	Local equipotential connection terminal box



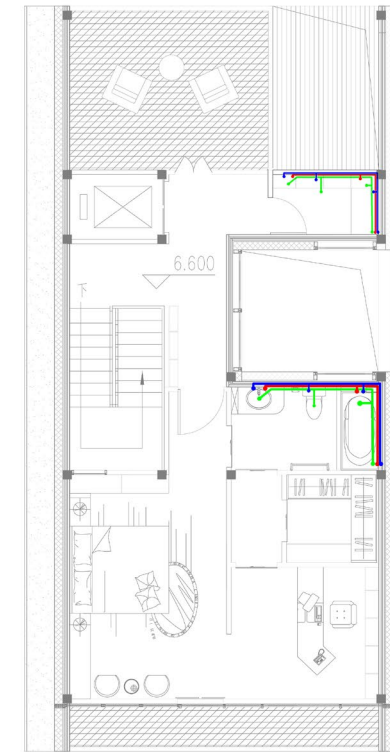
First floor Water supply and drainage plane

Area: 88.5m² (952.60sq ft)



Second floor Water supply and drainage plane

Area: 73.45m² (790.60sq ft)



Third floor Water supply and drainage plane

Area: 67.5m² (726.56sq ft)

— Cold water pipe

— hot water pipe

— drain pipe

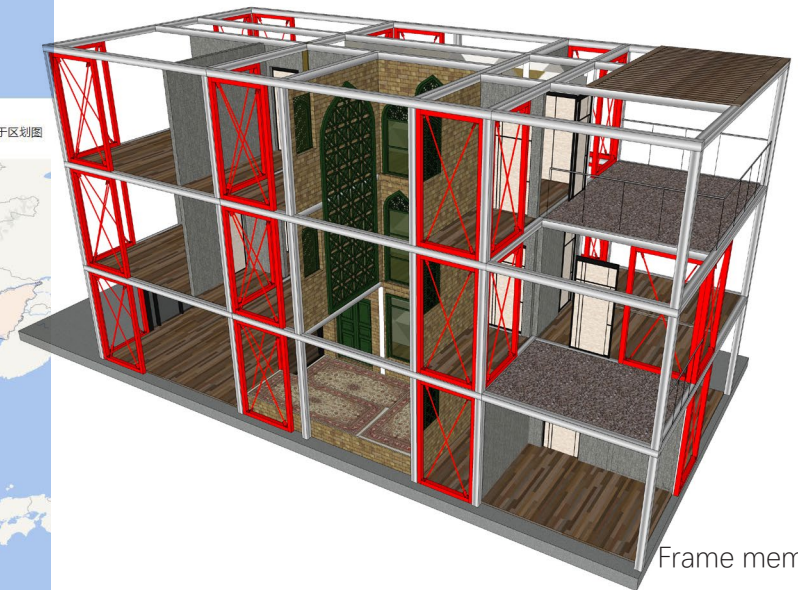


Tulugou Township (Shanshan County, Turpan, Xinjiang Uygur Autonomous Region, China)

The Tuyugou area is located in central Xinjiang, on the plate seismic zone between the Indian Ocean plate and the Eurasian plate.

Affected by the North-South Tianshan earthquake zone, there have been many strong earthquakes in history, and the region has the tectonic conditions for destructive earthquakes.

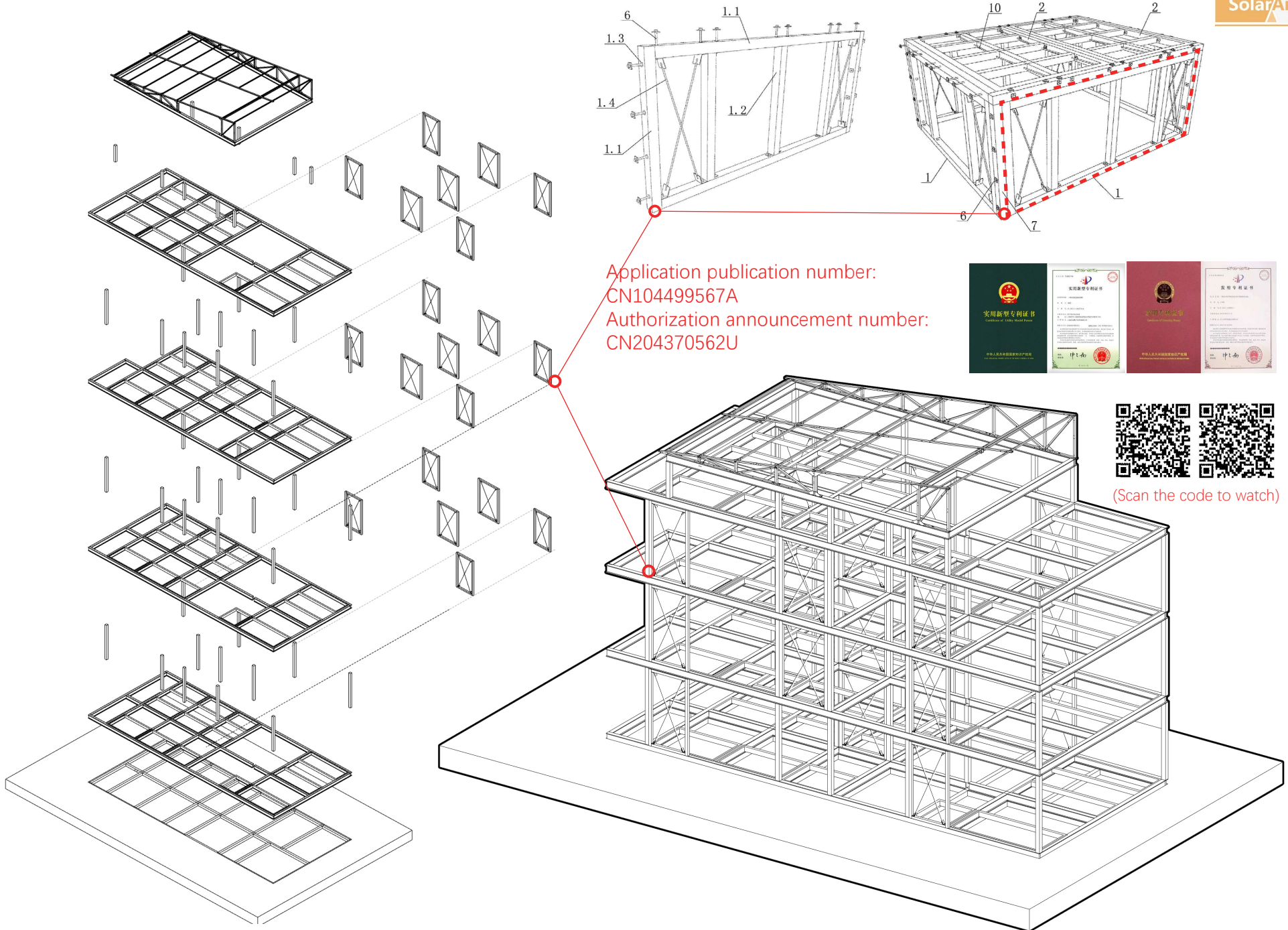
Peak ground acceleration: 0.10 (g)



Frame member



The frame member is a patented product developed by us for structural instability in earthquakes. Its strengthening effect on the structure has been demonstrated through many actual projects. It has the characteristics of light weight, high strength and good stability.



Seismic Analysis

According to GB50011-2010, the seismic character of the Turpo is

Seismic intensity: 7

Design basic acceleration of ground motion: 0.1g

Max influence factor: 0.08

Characteristic ground period: 0.4s

Damping ratio: 5%

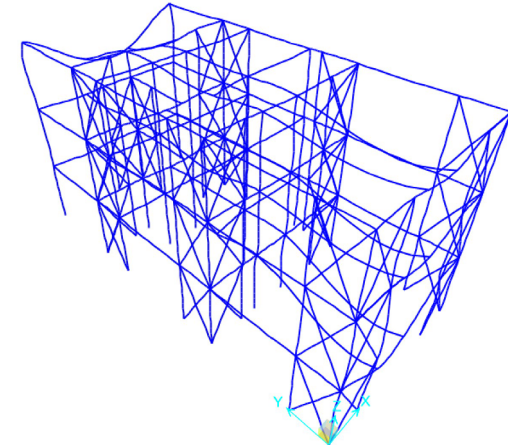
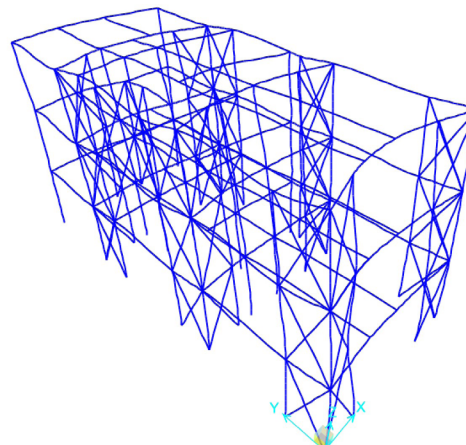
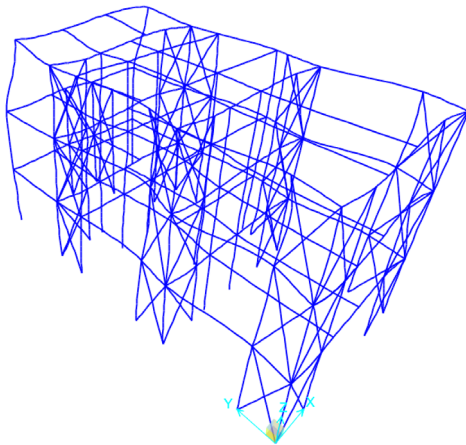
The above parameters were used as input parameters in SAP2000 for seismic analysis.

The seismic analysis was carried out in both directions.

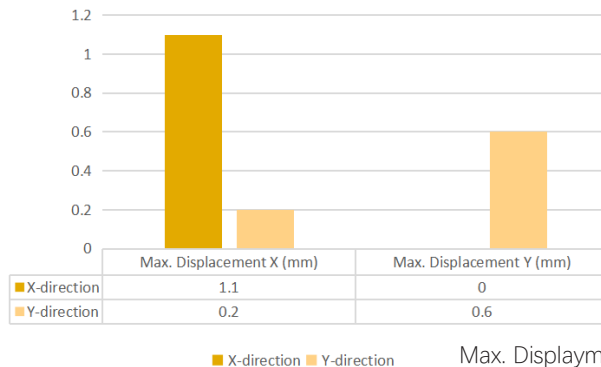
The following deformed shaped are under seismic action, dead load and live load.

Seismic Analysis calculation book (click to open):

<https://drive.google.com/file/d/1AQxGHYHXfqDI4QnGj0QXszMZH299NpNb/view?usp=sharing>

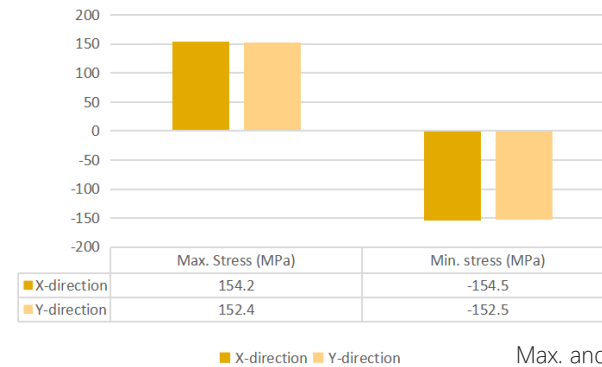


Deformed Shape under the Earthquake Action in x-direction



Deformed Shape under the Earthquake Action in y-direction

Deformed Shape under the Earthquake Action in x- and y-direction



conclusion: The results indicated that the requirement of the maximal stress and maximal displacement under seismic action are fulfilled.

Grass squares against sandstorms



Due to its unique geographical environment, northwestern China is an area where sandstorms frequently occur. Tuyuq's proximity to the Kumtag Desert is also one of the sources of sandstorms.

Local people use grass grids as wind walls to respond to desert invasions. Grass grid sand barriers are a method of windbreaking and sand fixation and water conservation. They use wheat straw, straw, reeds and other materials to form a grid shape in the desert.

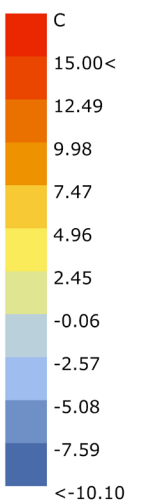
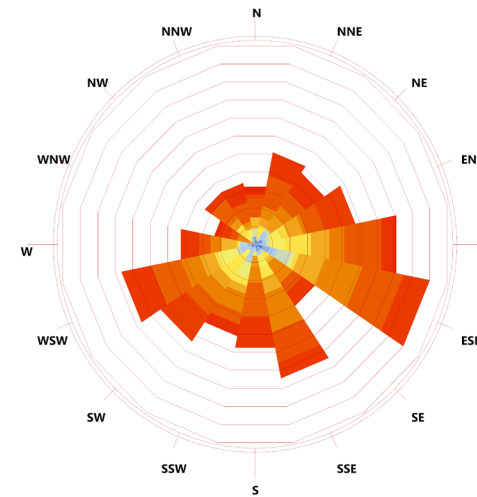
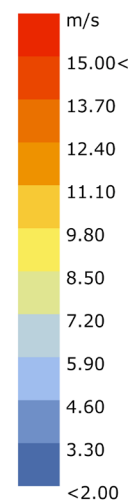
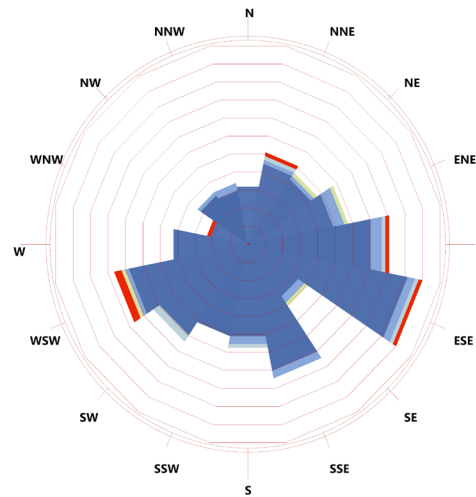
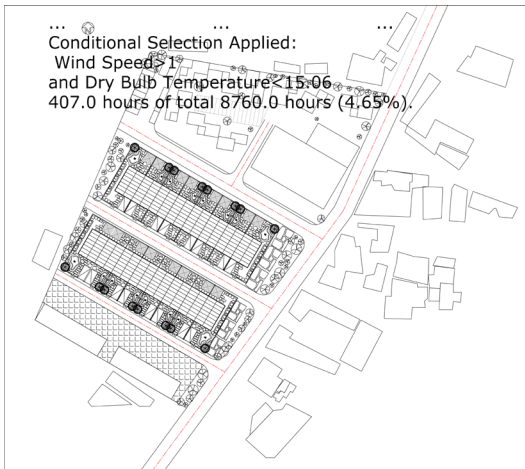
The first is to make the ground rough and reduce wind force to reduce wind erosion.

Another can trap water, such as rain, and increase the moisture content of the sand layer, which is conducive to the survival of sand-fixing plants.

Wind-Rose (Tuyuq, Turpan, Xinjiang Uygur, China)

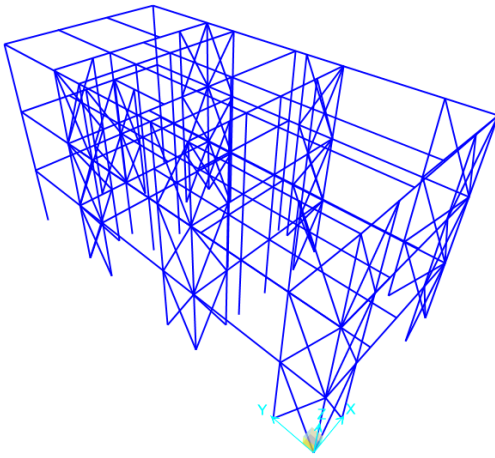
Wind-Rose
Turpan_Xinjiang_CHN
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Dry Bulb Temperature (C)
Calm for 0.00% of the time = 0 hours.
Each closed polyline shows frequency of 0.1%, = 4 hours.

Conditional Selection Applied:
Wind Speed > 1 m/s
and Dry Bulb Temperature < 15.06
407.0 hours of total 8760.0 hours (4.65%).

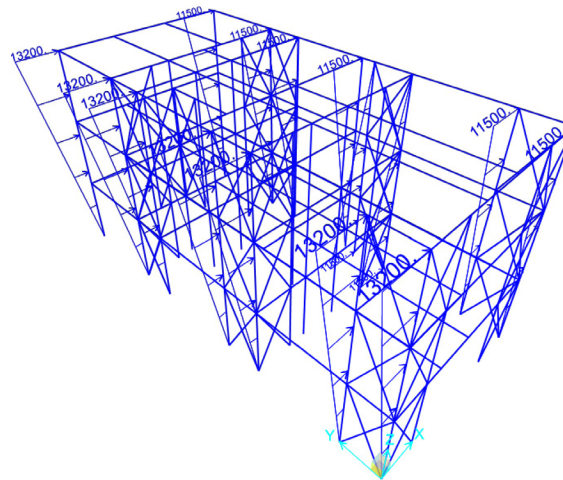


Wind Load Analysis

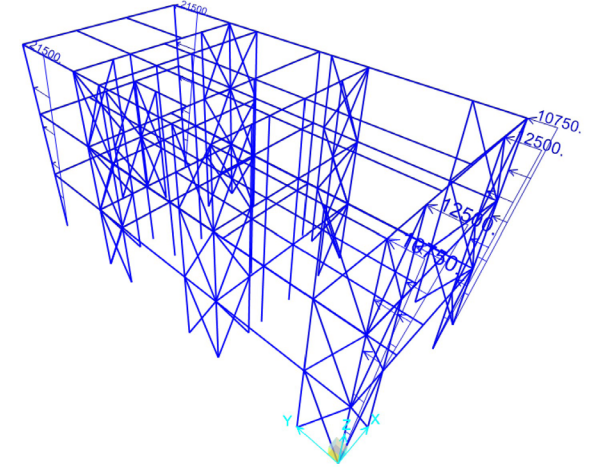
Undeformed shape in SAP2000



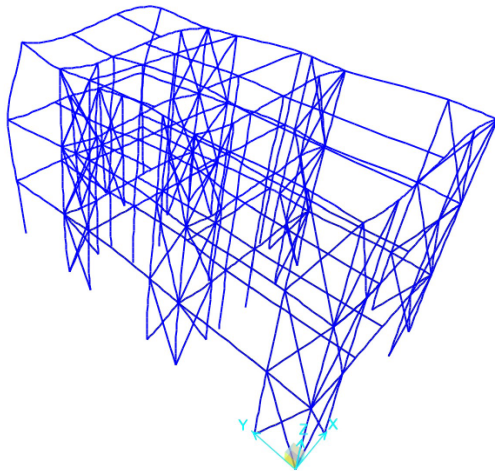
Wind load in x-direction



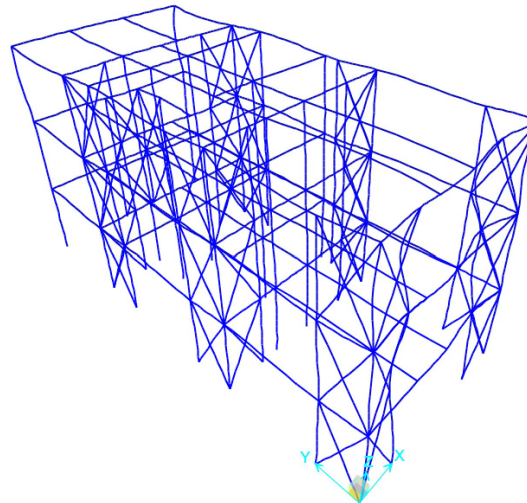
Wind load in y-direction



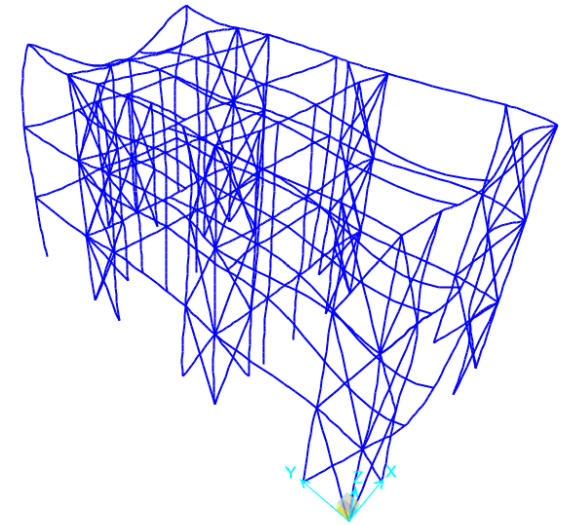
Deformed shape under wind load in x -direction



Deformed shape under wind load in y-direction



Deformed shape



Conclusion:

Empirical calculations show that the structure meets the strong winds of sandstorms.

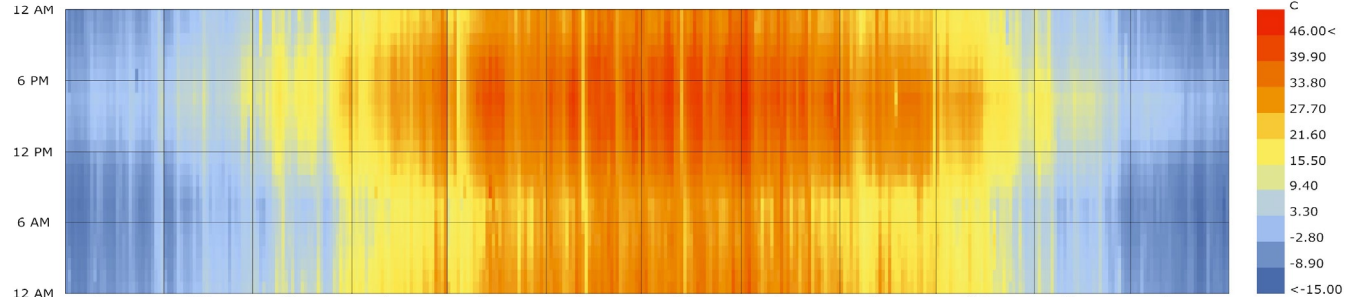
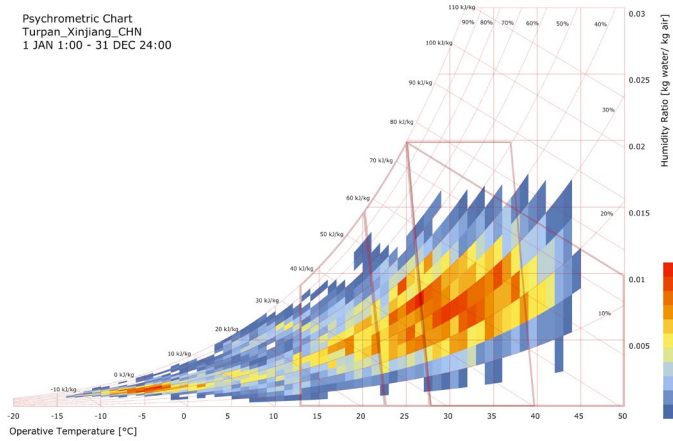
Gale Analysis calculation book (click to open):

<https://drive.google.com/file/d/1AQxGHYHXfqDI4QnGj0QXszMZH299NpNb/view?usp=sharing>

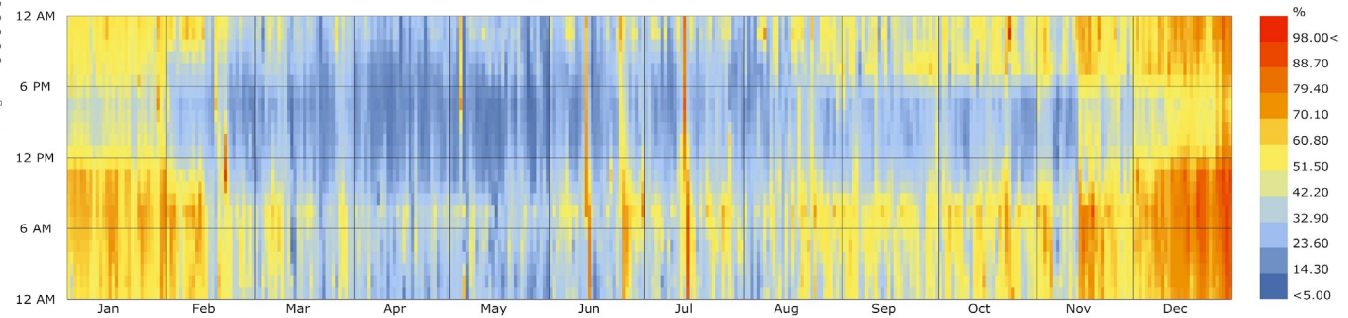
Psychrometric Chart (Tuyuq, Turpan, Xinjiang Uygur, China)

Dry Bulb Temperature

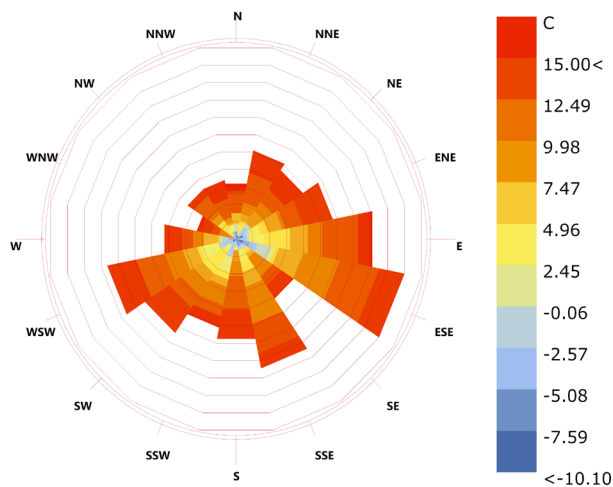
Psychrometric Chart
Turpan_Xinjiang_CHN
1 JAN 1:00 - 31 DEC 24:00



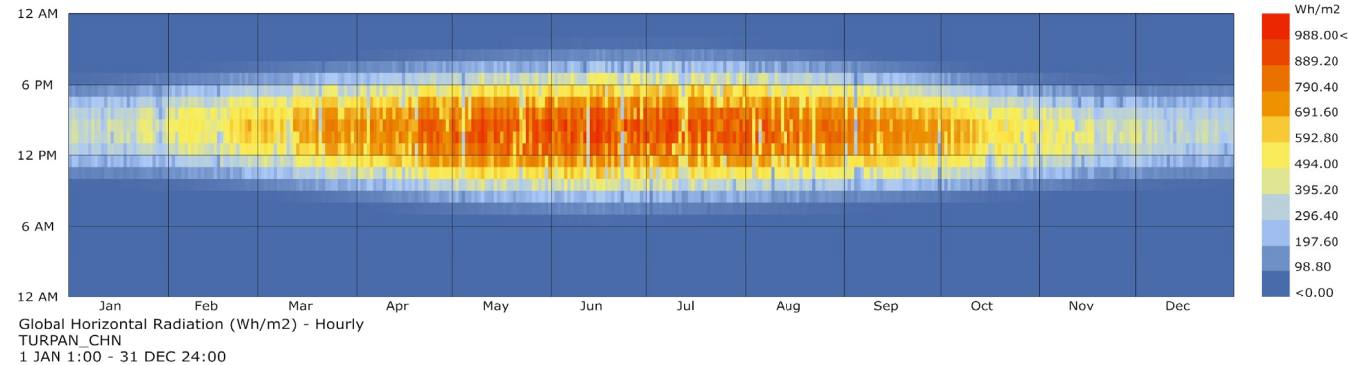
Relative Humidity



Wind Rose



Global Horizontal Radiation



DOE Zero Energy Ready Home Confirmation Summary

Climate Location: Tooele, UT

Condition Floor Area: 1754 ft²

Number of Bedrooms: 5

Rating Software: REM/Rate - v16.0.1

HERS index of The Target Home Using Size

Adjustment Factor: 52

Estimated Annual Energy Savings:

Electric 24899 Kwh \ Natural Gas 171 Therms

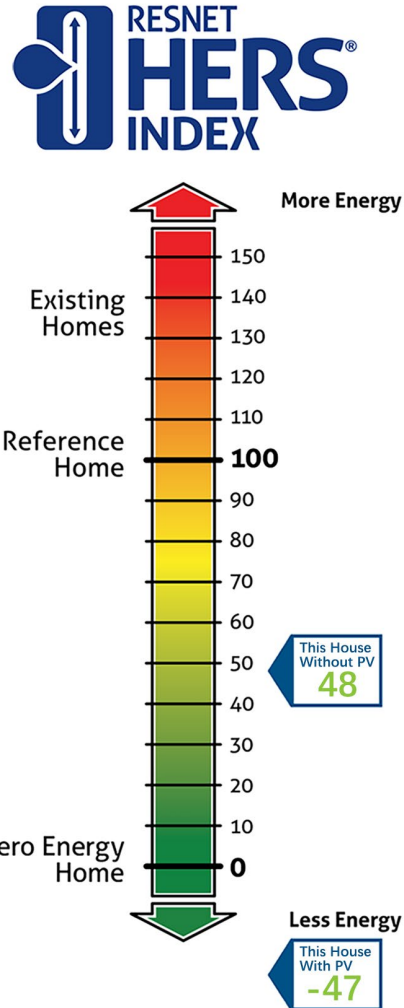
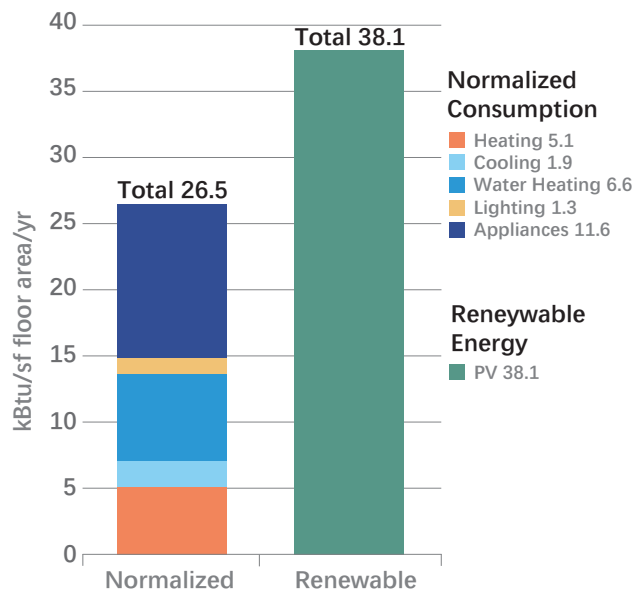
Annual load :

Heating 17.2 MMBtu/yr

Cooling 16.1 MMBtu/yr

Water Heating 9.4 MMBtu/yr

Building Performance Factor



Code for Architectural Design

- Residential Construction in Cold Regions of Xinjiang, XJJ/T073-2016
- Evaluation Standard for Greening Building, GB/T 50378-2019
- DOE Zero Energy Ready Home National Program Requirements (Rev.07)
- 2015 International Energy Conservation Code
- National Program Requirements ENERGY STAR Certified Homes, Version 3 (Rev. 10)

Code for HVAC Design

- Detailed Rules for The Implementation of Design Standards for Energy Efficiency of Residential Buildings in Severe Cold Areas of Xinjiang, XJJ001-2011
- Design Code for Heating Ventilation and Air Conditioning in Civil Buildings, GB50736-2012
- DOE Zero Energy Ready Home National Program Requirements (Rev.07)
- 2015 International Energy Conservation Code
- National Program Requirements ENERGY STAR Certified Homes, Version 3 (Rev. 10)

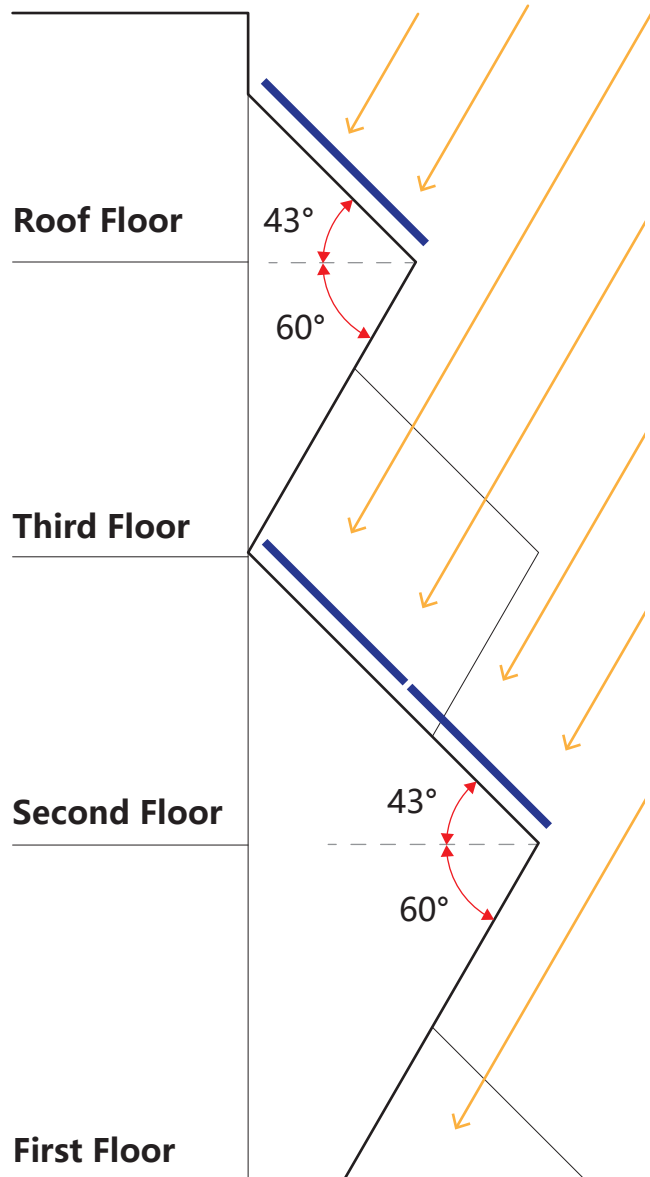
Code for Renewable energy Design

- Evaluation Criteria for Building Application Of Renewable Energy, GB/T 50801-2013
- DOE Zero Energy Ready Home National Program Requirements (Rev.07)
- 2015 International Energy Conservation Code

NOTE: In order to better match the DOE Zero Energy Ready Home National Program Requirements (Rev.07), we compared the climate database on the EnergyPlus website, and selected an American town (Wendover, Tooele Co., Utah) with similar climate to Turpan. Wendover is located in IECC CZs 5B, so we assume that the climate conditions of Solar Ark are similar to zone 5B.

Optimal angle solution

Combining the PV panel efficiency, the sand and snow in the desert area and the shadow shielding of the wavy facade, the optimal Angle of the solar panel is obtained.



FACTOR 01
PV Panel Efficiency

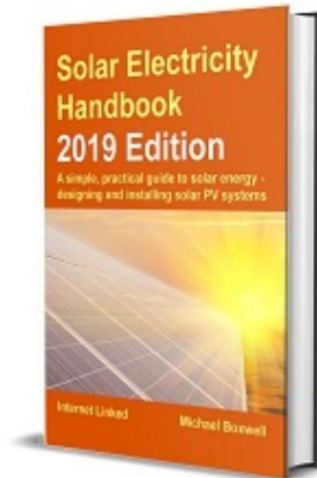


FACTOR 02
Blown Sand and
Snow








FACTOR 03
Building Self
Shading

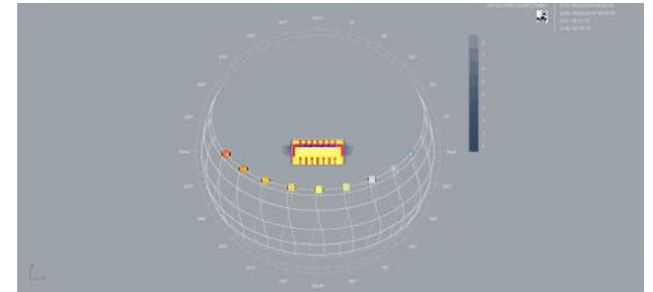
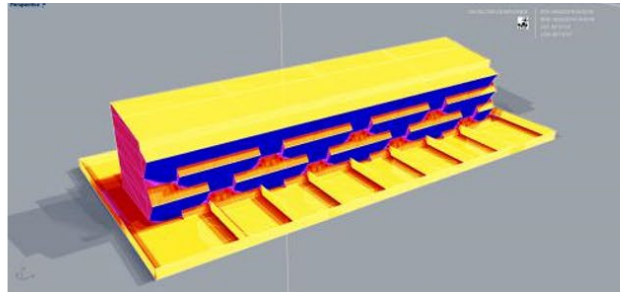
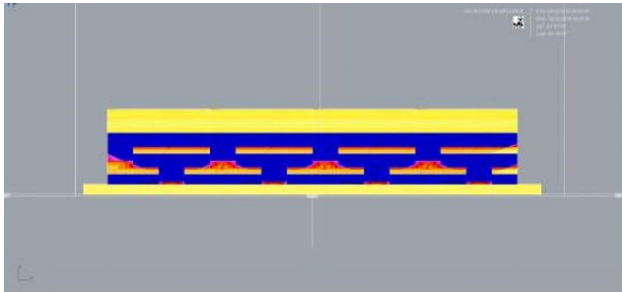
Pv Panel Tilt Design



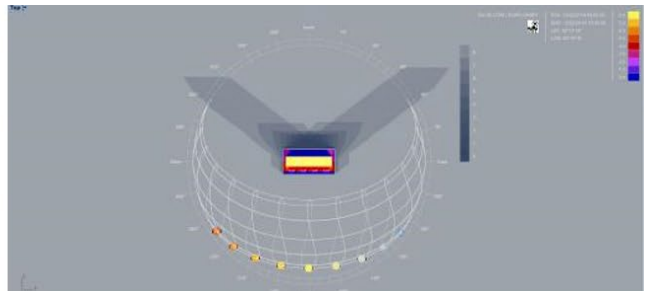
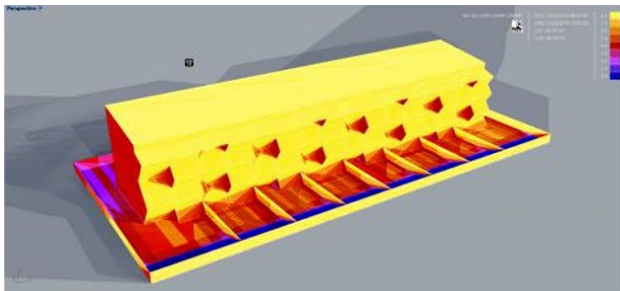
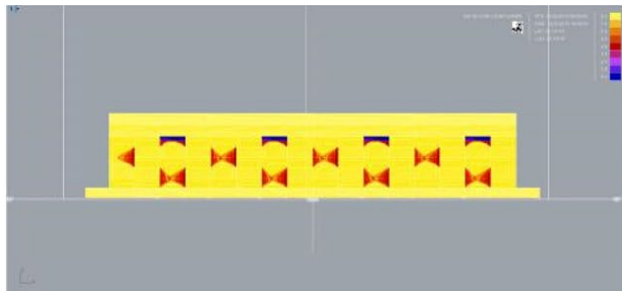
It is a computer generated report based on information entered on the Solar Project Analysis web page on the Solar Electricity Handbook website.

Solar Ark's environment is not suitable for all grid connected energy storage forms, which will bring great fluctuations to the local power system. Therefore, we give priority to the design of off grid system, and the tilt angle of PV panel should meet the maximum annual capacity,

Panel Tilt	Spring	Summer	Autumn	Winter
 Flat	4.63 kWh/m ² per day	6.20 kWh/m ² per day	4.80 kWh/m ² per day	2.10 kWh/m ² per day
 Upright	4.67 kWh/m ² per day	2.68 kWh/m ² per day	4.04 kWh/m ² per day	5.03 kWh/m ² per day
 47° angle Best average year-round performance	6.14 kWh/m ² per day	5.40 kWh/m ² per day	5.79 kWh/m ² per day	4.74 kWh/m ² per day
 63° angle Best Summer Setting	5.89 kWh/m ² per day	5.91 kWh/m ² per day	5.71 kWh/m ² per day	4.00 kWh/m ² per day
 31° angle Best Winter Setting	6.04 kWh/m ² per day	4.65 kWh/m ² per day	5.56 kWh/m ² per day	5.19 kWh/m ² per day



Simulation Time 01 - Summer Solstice



Simulation Time 02 - Winter Solstice

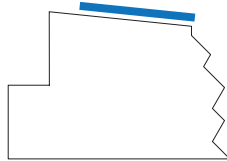
Conclusion

It can be seen that the undulating facade can achieve self-shading of the body on the summer solstice, while the maximum area of solar radiation can be obtained on the winter solstice.

- Use the NREL's PVwatts® calculator to calculate the PV cells in three different positions. And then, multiplying the calculated data by the corresponding number of photovoltaic panels is the total power generation of the PV array.
- It should be noted that the influence of the shadow of the building itself on the PV panel cannot be considered when the system B adopts this method. We use the software combination of Ladybug and Honeybee to simulate and modify.

SYSTEM - A

Array Tilt: 8.3°
 Array Azimuth: 210°
 Number of PV Panels: 24
 PV Peak Power Generation:
 24 × 250W = 6000W
 Number of Inverter: 1



Month	Solar Radiation (kWh / m ² / day)	AC Energy (kWh)	Value (\$)
January	2.20	19	2
February	3.32	25	2
March	4.53	37	3
April	5.74	43	4
May	6.69	51	4
June	6.88	49	4
July	6.76	50	4
August	6.15	45	4
September	5.28	39	3
October	3.94	31	3
November	2.61	21	2
December	1.99	17	1
Annual	4.67	427	\$ 36

Location

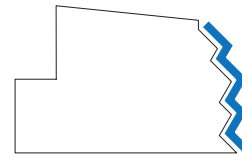
Weather Data Source: (INTL) TURPAN, CHINA 1.5 mi
 Latitude: 42.93° N
 Longitude: 89.2° E

Economics

Average Retail Electricity Rate: 0.59¥ (0.084\$) /kWh
 Unit Price of Photovoltaic Panel: 700¥ (100\$)

SYSTEM - B

Array Tilt: 43°
 Array Azimuth: 210°
 Number of PV Panels: 21
 PV Peak Power Generation:
 21 × 263W = 5523W
 Number of Inverter: 1



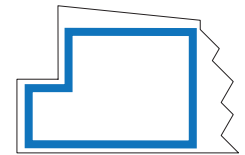
Month	Solar Radiation (kWh / m ² / day)	AC Energy (kWh)	Value (\$)
January	3.06	26	2
February	4.29	32	3
March	5.08	41	3
April	5.77	43	4
May	6.24	47	4
June	6.19	44	4
July	6.19	46	4
August	6.05	44	4
September	5.91	43	4
October	4.96	39	3
November	3.70	30	2
December	2.95	25	2
Annual	5.03	460	\$ 39

Pv System Specifications

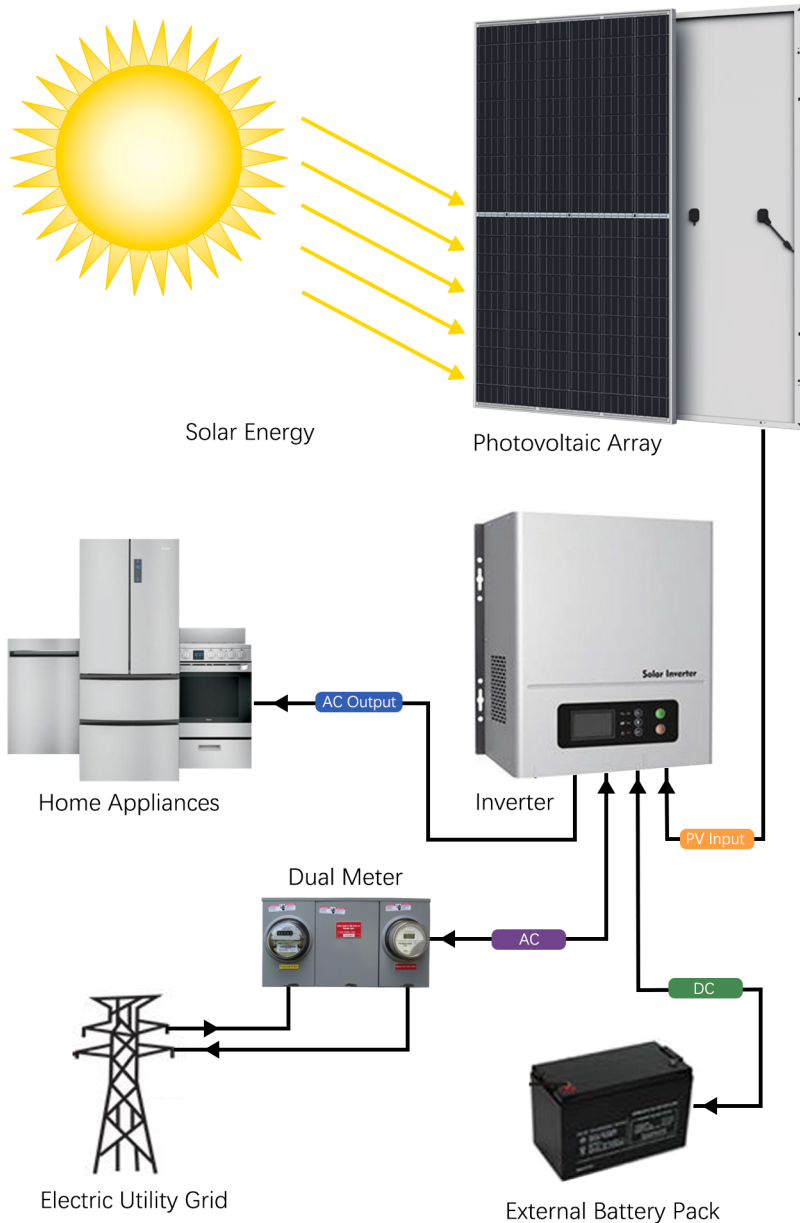
DC System Size: 0.325 kW
 Module Type: Premium
 Array Type: Fixed (roof mount)
 System Losses: 14.08%
 Inverter Efficiency: 97.5%
 Max. DC input power of Inverter: 7kW
 Inverter Nominal Output Power:
 6kW (back-up), 5kW (grid side)
 DC to AC Size Ratio: 1.3

SYSTEM - C

Array Tilt: 90°
 Array Azimuth: 300°
 Number of PV Panels: 73
 PV Peak Power Generation:
 73 × 173W = 12629W
 Number of Inverter: 3



Month	Solar Radiation (kWh / m ² / day)	AC Energy (kWh)	Value (\$)
January	0.93	8	1
February	1.52	12	1
March	1.81	15	1
April	2.48	19	2
May	2.99	23	2
June	3.20	24	2
July	3.03	23	2
August	2.63	20	2
September	2.19	16	1
October	1.50	12	1
November	0.90	7	1
December	0.71	6	1
Annual	1.99	185	\$ 17



Photovoltaic System Diagram

Pv Panel Specifications

Model: Trinasolar TSM-DE06H(II), single crystal panel
 Size: 35mm × 1700mm × 1000mm
 Efficiency: 19.7%
 Power: Rated 325W



Energy Generation Calculation

Total annual energy generation is :

SYSTEM - A: $24 \times 427\text{kWh} = 10248 \text{ kWh}$ (34.96 MMBtu), located on roof

SYSTEM - B: $21 \times 460\text{kWh} \times 0.65 = 6279 \text{ kWh}$ (21.42 MMBtu), located on south elevation

SYSTEM - C: $73 \times 185\text{kWh} = 13505 \text{ kWh}$ (46.08 MMBtu), located on west elevation

In addition, the PV array located on east elevation is similar to SYSTEM - C:
 $73 \times 149\text{kWh} = 10877 \text{ kWh}$ (37.11 MMBtu)

Average annual energy generation per unit is:

$10248\text{kWh} + 6279\text{kWh} + (13505\text{kWh} + 10877\text{kWh}) / 8 = 19574.75 \text{ kWh}$ (66.79 MMBtu)

Net Production Energy Calculation

According to the results of building energy consumption simulated and calculated in REM / Rate software, the electricity consumption of unit residence is 28.11 kWh (95.89 MBtu) per day, the energy consumption of unit residence is 37.34 kWh (127.40 MBtu) per day, and the average net production energy per unit is 16.30 kWh (55.62 MBtu) per day

Energy Storage Calculation

24 gel batteries of 12V and 200Ah are selected, each of which is divided into 4 batteries in series, and then 3 batteries are connected in parallel and put into the battery box to connect an inverter. So the battery capacity is:

$$4 \times 12\text{V} \times 200\text{Ah} \times 3 = 28.8 \text{ kWh} (98.26 \text{ MBtu})$$

In order to prolong the service life of the battery, 70% discharge depth and 95% discharge efficiency are set. The actual discharge capacity of the battery is:

$$28.8\text{kWh} \times 0.7 \times 0.95 = 19.15 \text{ kWh} (65.34 \text{ MBtu})$$

The actual charging capacity of the battery is:

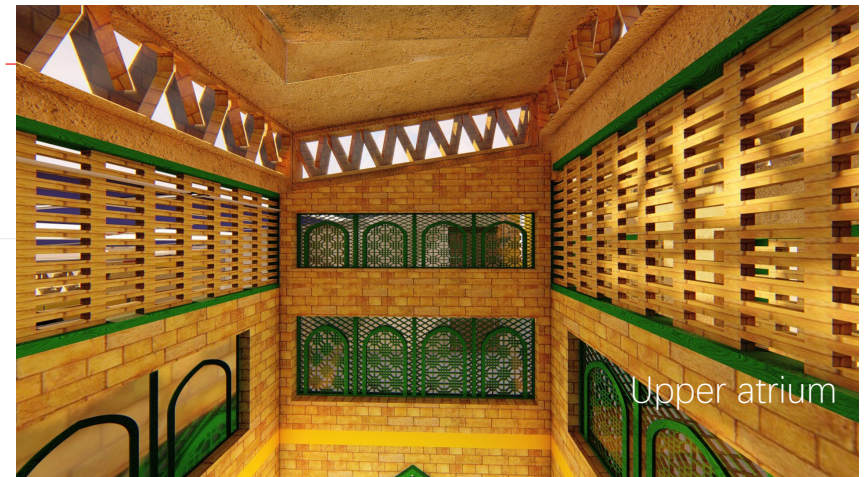
$$28.8\text{kWh} \times 0.7 / 0.95 = 21.22 \text{ kWh} (72.40 \text{ MBtu})$$

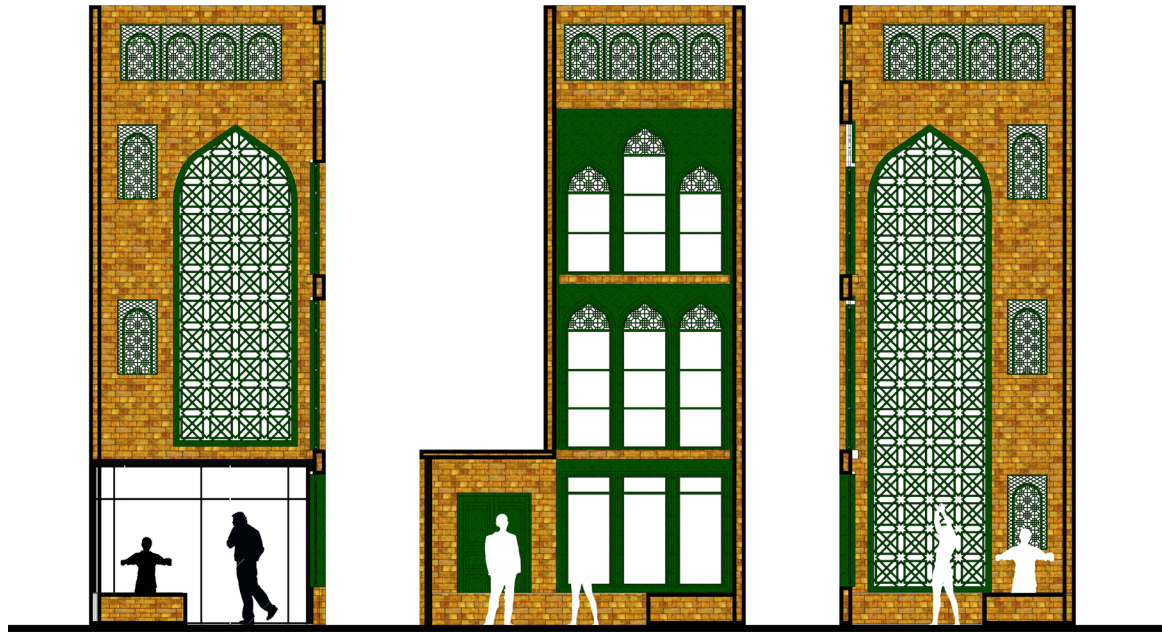
When PV panels fail to generate electricity in extreme cases, the energy in the battery can maintain the residential operation for about:

$$19.15\text{kWh} \times 3.5 / 28.11\text{kWh/day} = 2.4 \text{ days per unit}$$



Through the chimney effect of indoor ventilation, it can bring comfortable ventilation to the building. As the transition space, the atrium has no energy consumption load, but it brings ventilation and cool comfort in summer. In winter, the windows are closed to form a closed space, which can block the cold air.

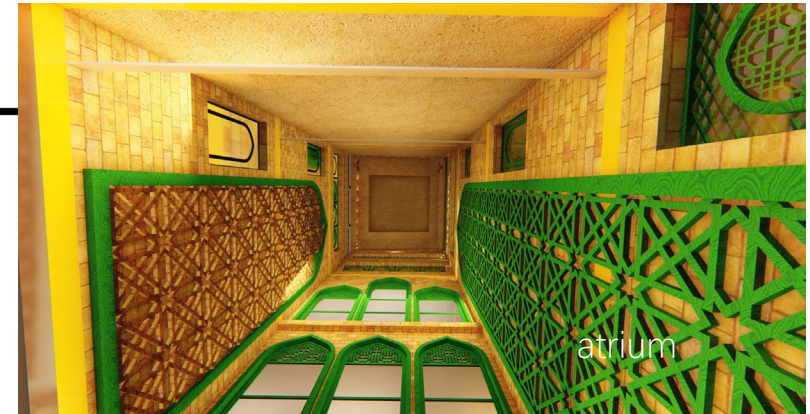
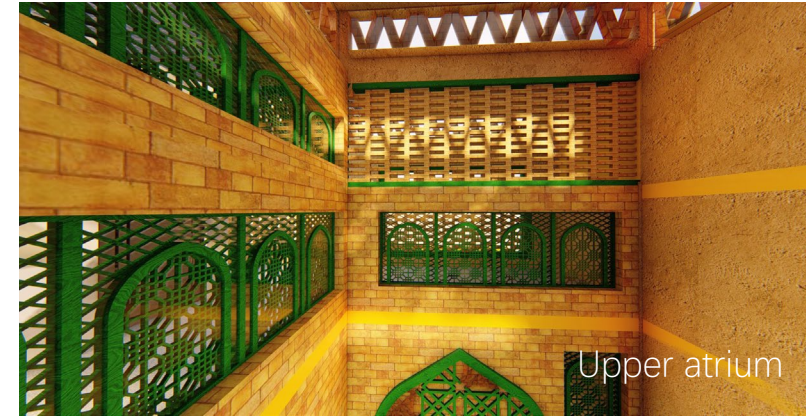
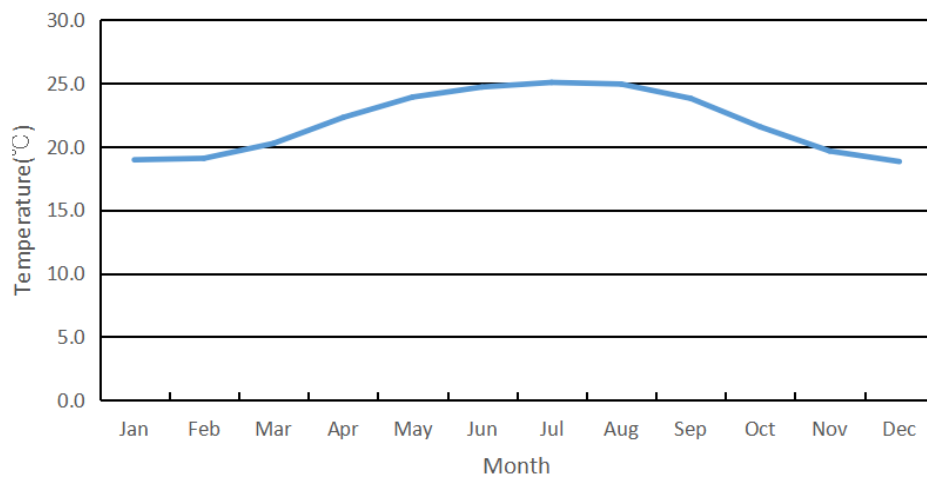




Atrium facade

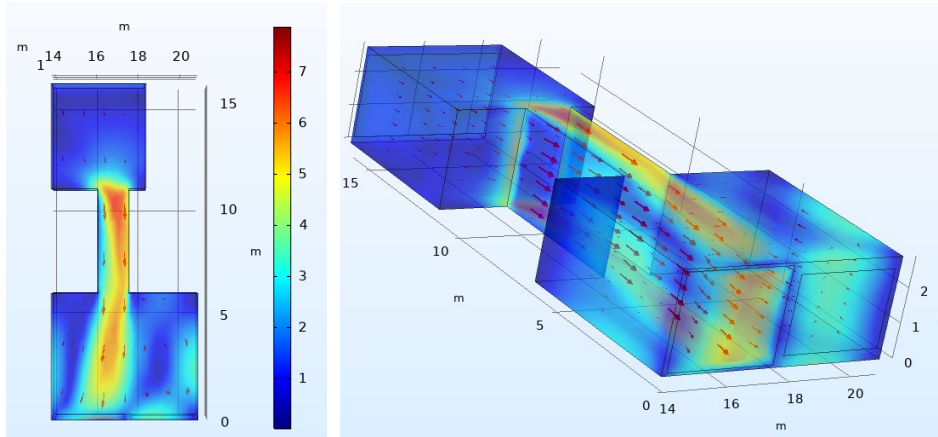
Analysis of Indoor Temperature

Monthly Indoor Average Temperature

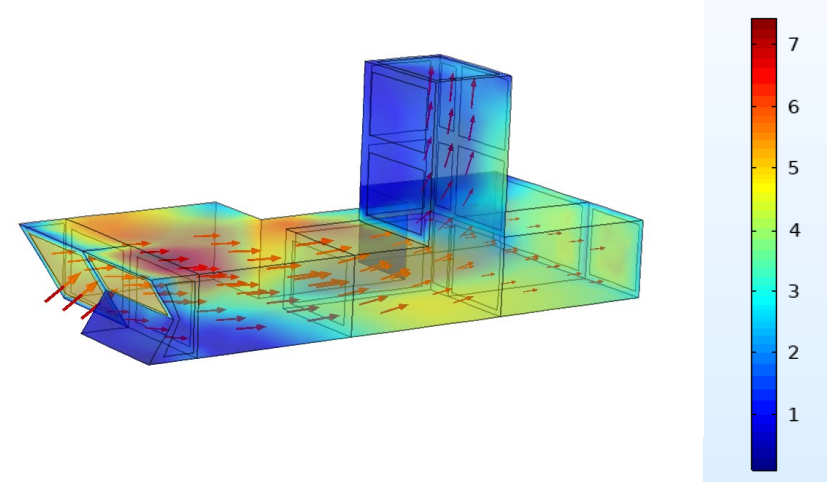


Analysis of Indoor Wind Environment

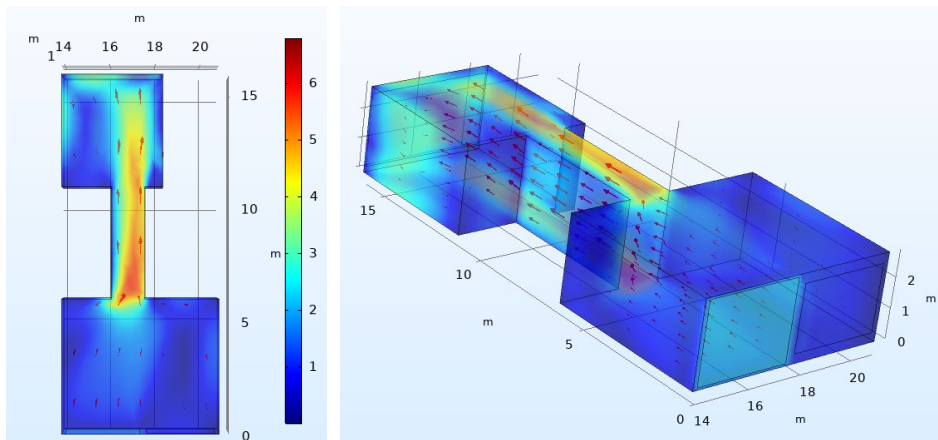
1st floor natural ventilation, wind north, wind speed 2.5m/s



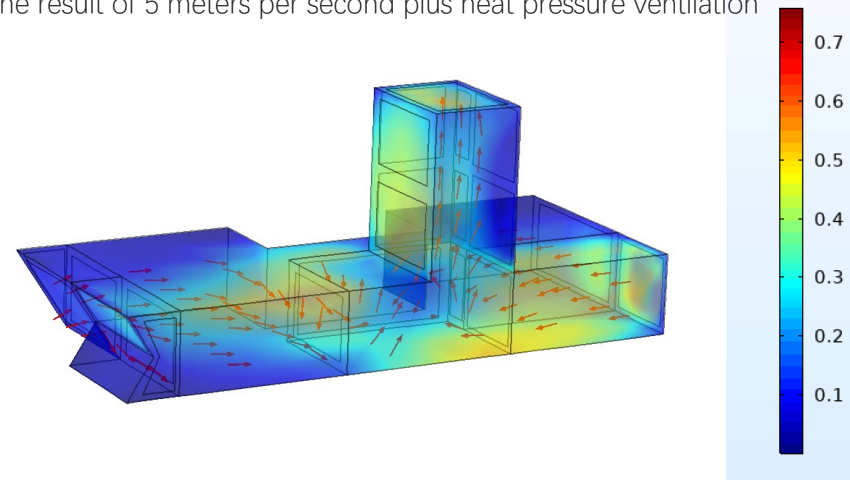
Pure hot-press ventilation (natural air extraction)



2nd floor natural ventilation, wind north, wind speed 2.5m/s



The result of 5 meters per second plus heat pressure ventilation



Conclusion:

the design of the atrium perfectly brings excellent indoor ventilation and a comfortable transition space that is warm in winter and cool in summer.

Lighting distribution

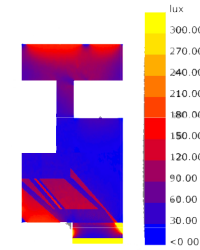
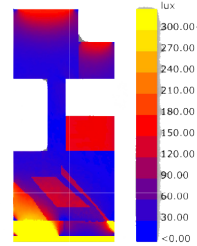
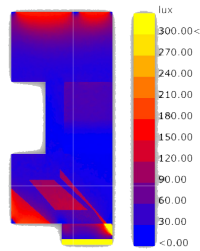


The first floor of the room is 0.75m (2.5ft) at 12 noon

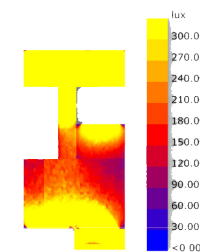
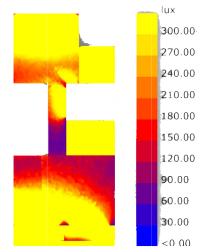
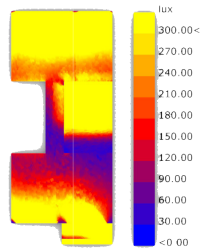
The second floor of the room is 0.75m (2.5ft) at 12 noon

The third floor of the room is 0.75m (2.5ft) at 12 noon

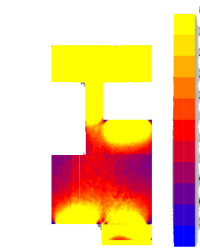
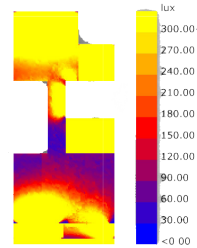
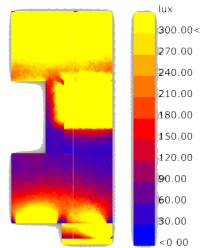
Winter Solstice
(December 22)



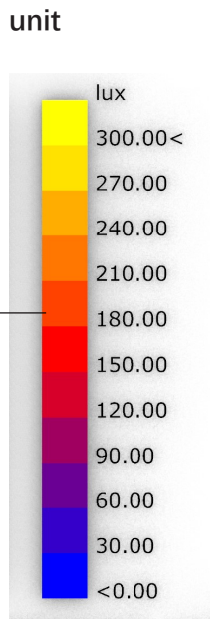
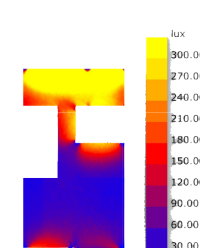
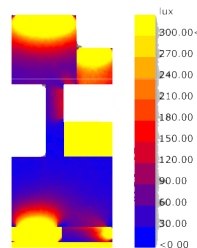
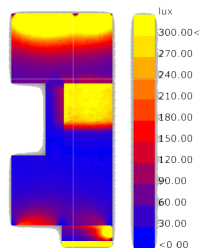
Autumnal Equinox
(September 23)



Summer Solstice
(June 22)

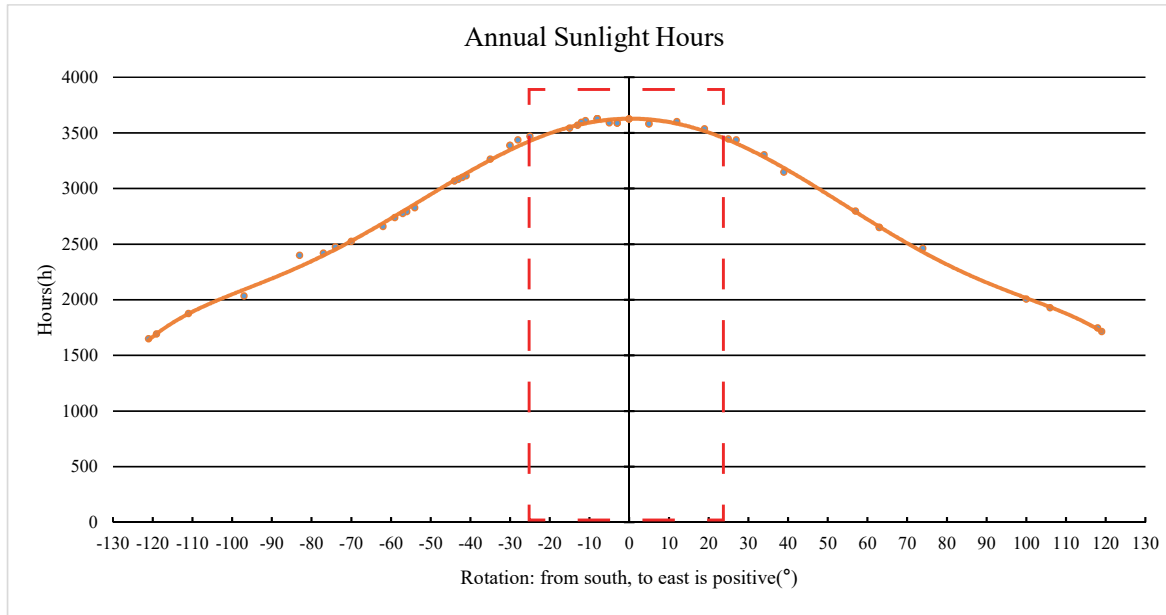


Spring Equinox
(March 21)

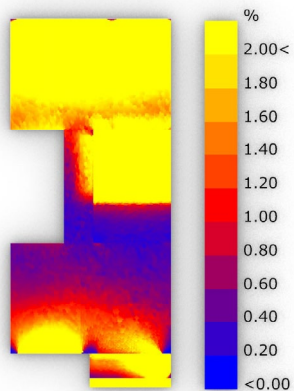


Relationship between annual sunshine hours and south-facing angle

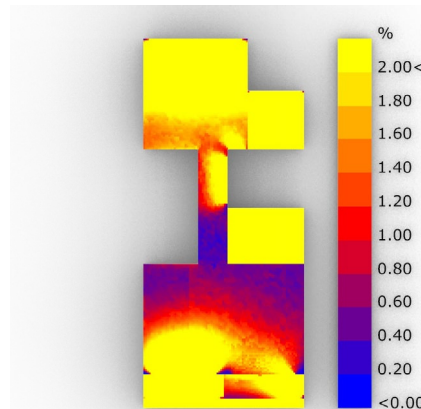
25 ° West



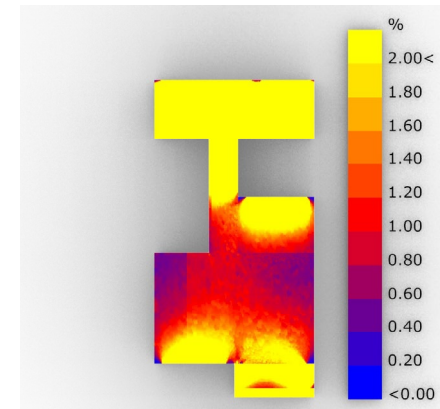
Conclusion: The hours of sunlight are affected little by the orientation and will not affect the lighting.



0.75m average daylighting coefficient above the second floor of the room



0.75m average daylighting coefficient above the first floor of the room



0.75m average daylighting coefficient above the third floor of the room

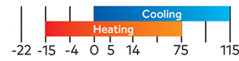
Conclusion: The overall building has good daylighting.



GE APPLIANCES
a Haier company



Operating Range (°F):



Arctic Series

Specifications

		4U36EH2VHA
Cooling Non-Ducted	Rated Capacity Btu/hr	34,000
	Capacity Range Btu/hr	6000-38000
	Rated Power Input W	2,740
	SEER/ EER	20 /12.50
Heating Non-Ducted	Rated Heating Capacity 47°F Btu/hr	36,000
	Heating Capacity Range Btu/hr	8000-39000
	Rated Power Input W	2,710
	HSPF	10.50
	COP @ 5°F	2.0
	Max. Heating Capacity 5°F Btu/hr	36,000
	Max. Heating Capacity -15°F Btu/hr	25,000



Ideal for colder regions, ensures fan will not blow cold air during heating mode startup



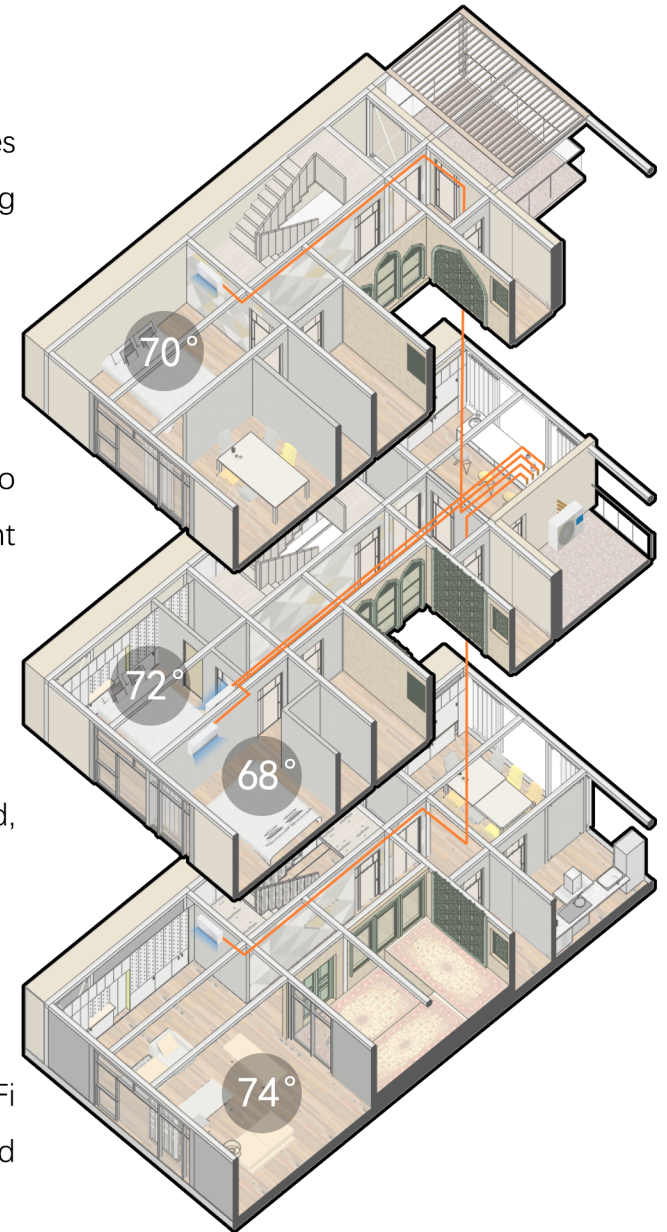
Separate control according to different room environment requirements



Changed quickly with the load, and has high comfort



Wall mount units feature WiFi accessory compatibility and achieve intelligent control



WATER HEATER

A.O. Smith G6-S7576NV
74-Gallon Tall 6-Year Limited Natural Gas Water Heater

Rated Storage Capacity: 71-Gallon
First Hour Rating: high, 125 gallons
Source: natural gas
Uniform Energy Factor: 0.60
Estimated Yearly Energy Use: 282 therms

- Ideal hot water delivery for households with 5+ people
- Electronic gas valve provides precise temperature control for optimum hot water delivery
- Self-diagnostic electronic gas control incorporates an LED status indicator that monitors and reports on system operational status
- Built-in safety system reduces the risk of accidental flammable vapor ignitions



REFRIGERATOR

Haier HRQ16N3BGS
16.4 Cu. Ft. Quad Door Refrigerator

Fresh Food Capacity: 11.1 cu ft
Freezer Capacity: 5.3 cu ft
Control Type: Electronic Touch
ENERGY STAR - rated
Estimated Yearly Electricity Use: 448 kWh

- Quick Cool and Quick Freeze Functions
- Sabbath Mode Functionality
- Providing An Affordable Built-In Look
- Dedicated High/Low Humidity Crisper
- 2 Full-Width, Tempered-Glass Shelves
- 6 Encapsulated Door Bins
- 2 Sliding Freezer Drawers



DISHWASHER

Haier QDT125SSLSS
18" Built-In Dishwasher

Number of Place Settings: up to 8
Wash System: 3-Level, standard
Estimated Yearly Electricity Use: 108 kWh

- PIRANHA Hard Food Disposer with Removable Filter
- Sanitize option (NSF Certified)
- ENERGY STAR - rated
- WiFi Capable



RANGE

Haier QGAS740RMSS
24" 2.9 Cu. Ft. Gas Free-Standing Range with Convection and Modular Backguard

Product Type: free-standing single oven
Fuel Type: Natural Gas (factory set)

- Perfect Match Over-The-Range Microwave
- Modular Backguard
- Quick and Easy Clean

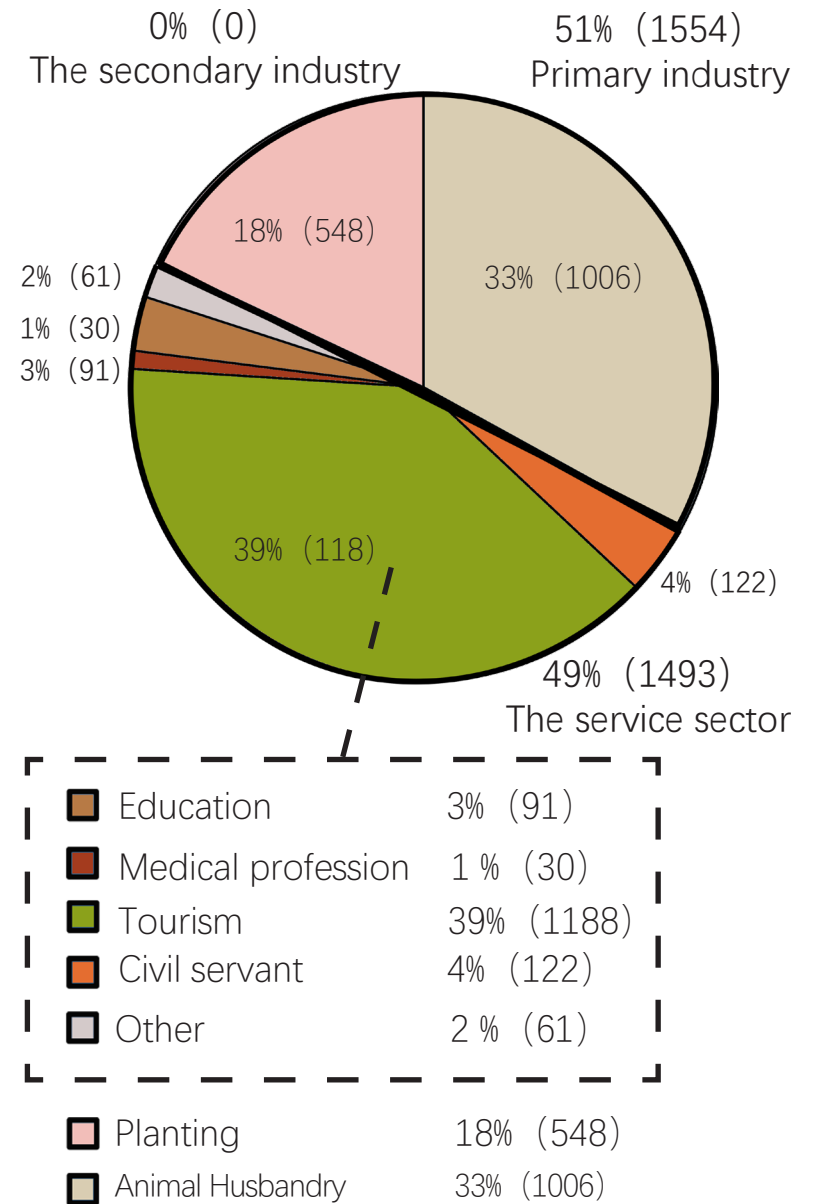
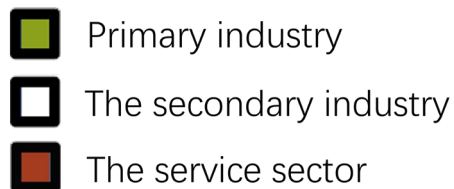
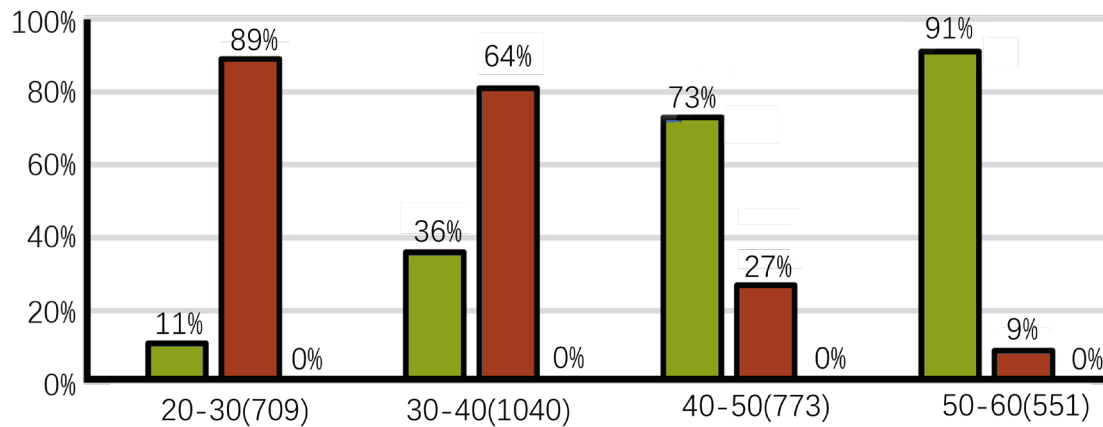


WASHER & DRYER

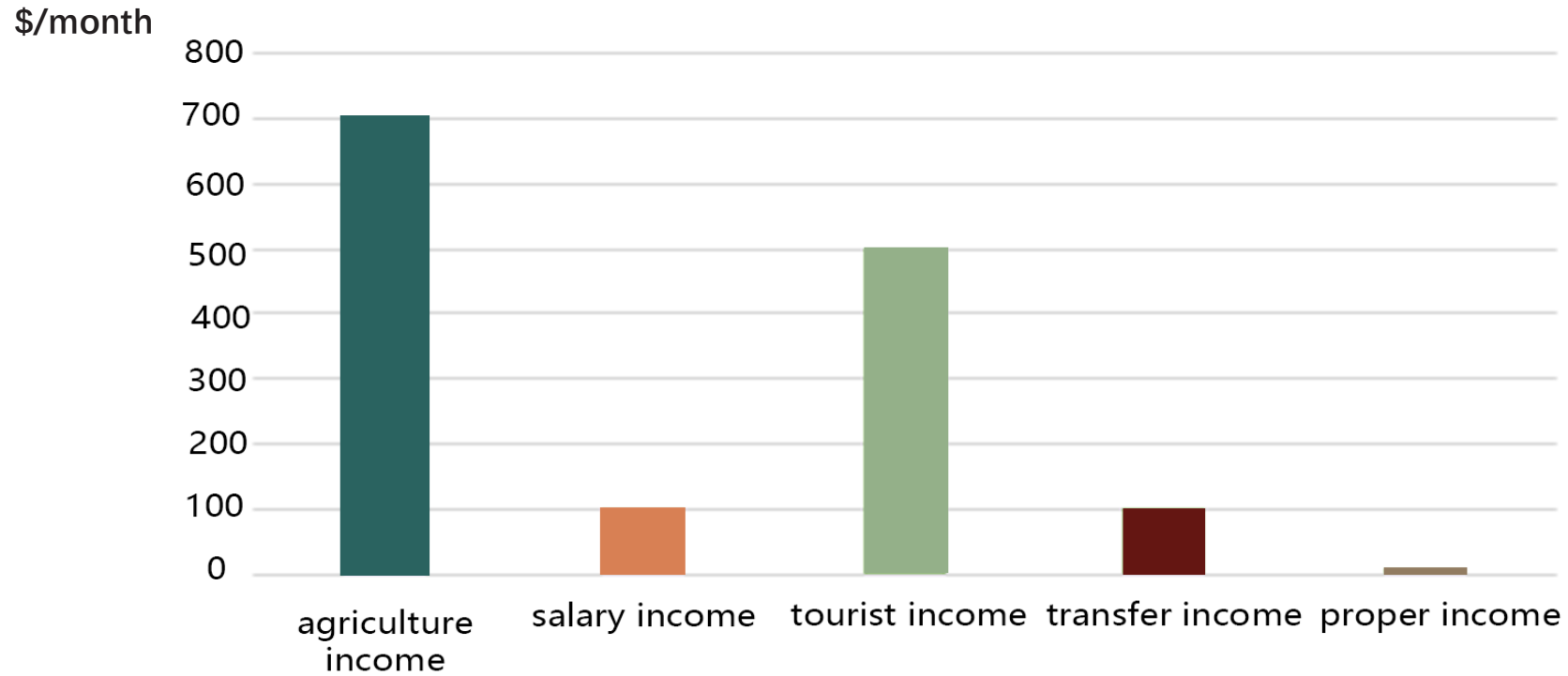
Haier Stackable Washer and Dryer
2.4 cu. ft. Smart Frontload Washer
4.1 cu.ft. Capacity Smart 24" Ventless Condenser Frontload Electric Dryer with Stainless Steel Basket

- Simple Control With Hundreds of Options
- WiFi Connected for Smart Home
- Stackable Laundry & Ventless Dryer for Small Spaces





Income analysis



The flaming mountain in xinjiang is the most famous scenic spot in turpan. Located at the northern margin of the turpan basin, north of the ancient silk road, it is mainly composed of red sand, conglomerate and mudstone from the Jurassic, cretaceous and tertiary periods of the Mesozoic era. Locals call it kiziletag, which means red mountain.



local incentive

※ District housing and construction office:

green building star standard subsidy

One-star: appropriate

two-stars: \$6.44 /square meter

three-stars: \$11.46/square meter

※ Municipal construction commission:

1. Municipal policies related to energy conservation and emission reduction or green residential industrial park will be met

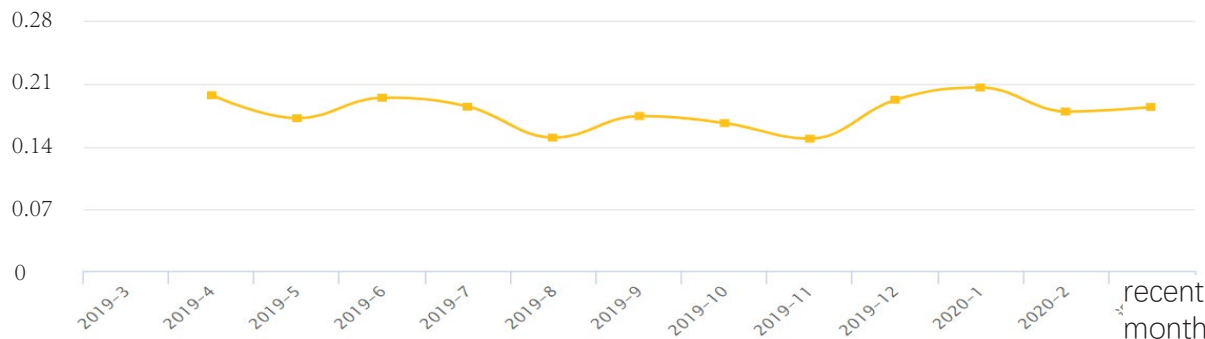
With the city matching fee reduction and exemption of the preferential policy for the total cost of 3%-6%.

2. To meet the national policies on energy conservation and emission reduction or green residential industrial park, 30% of the incremental cost of the building will be subsidized.

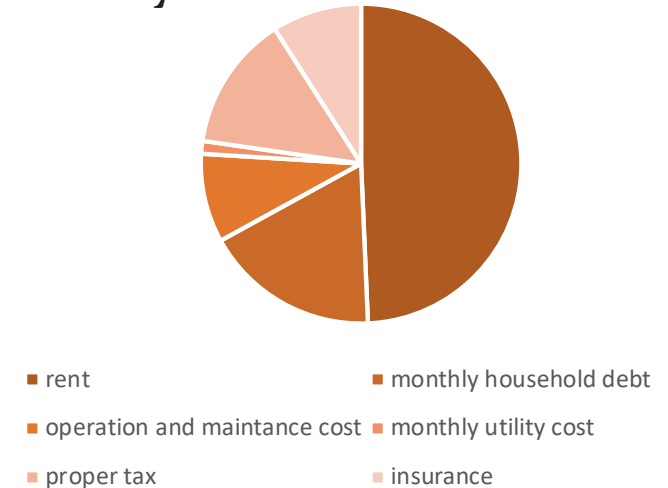
Rental cost

average rent

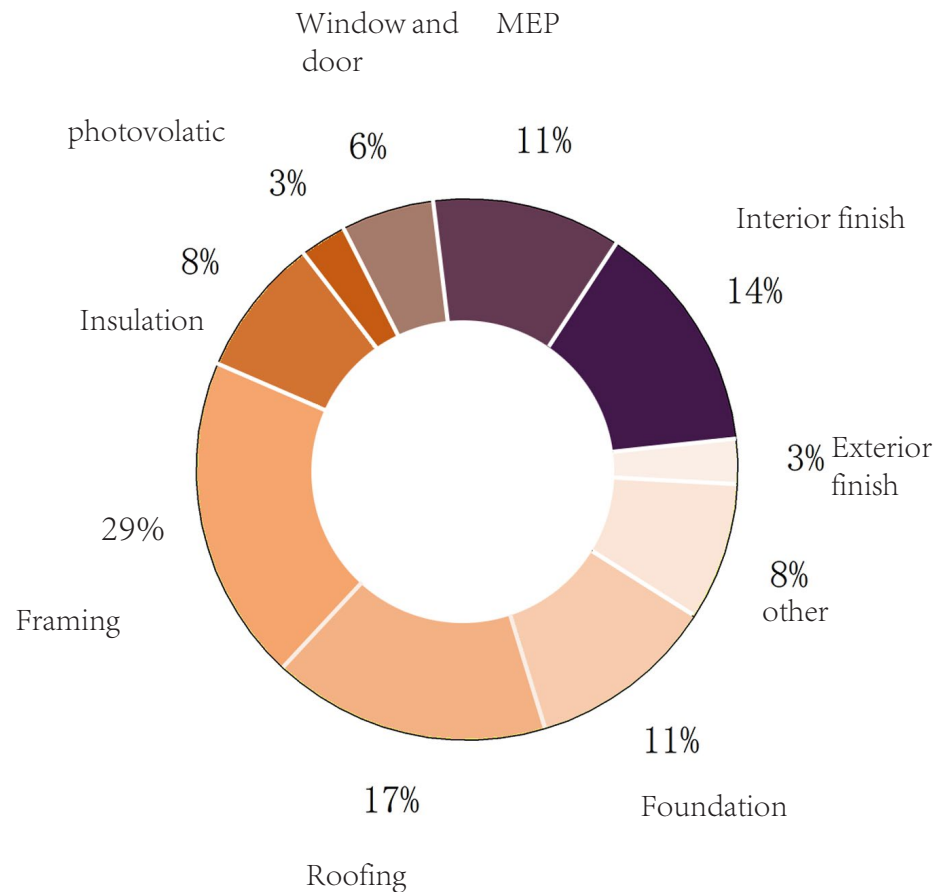
\$/sq.ft/monthly



monthly cost



Overview of construction cost

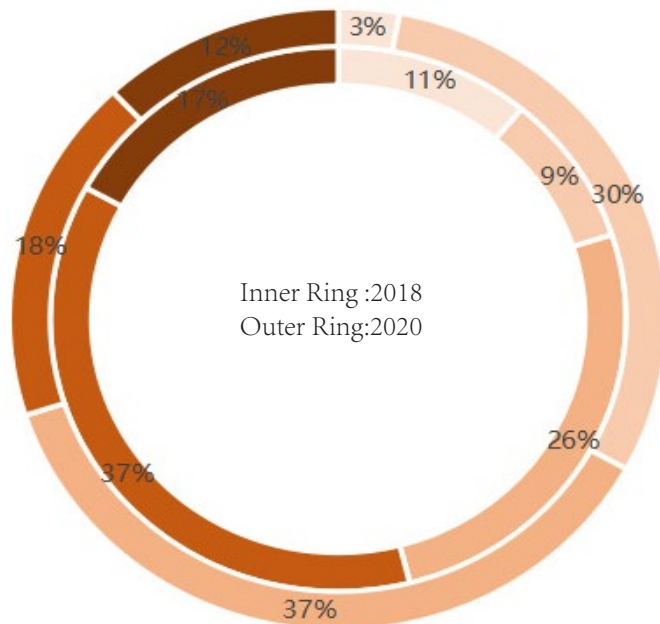


	COST
Foundation	\$5000
Roofing	\$8750
Framing	\$14000
Insulation	\$3000
Exterior finish	\$1000
Window and door	\$1500
MEP	\$5000
Interior finish	\$6000
Photovoltaic	\$5000
other	\$3000
total	\$52250

Policy Support

With the rapid development of China's construction industry, the energy consumption of buildings has also risen sharply, and huge energy consumption has become a burden on the national economy. Therefore, the development of building energy efficiency and green buildings is imperative.

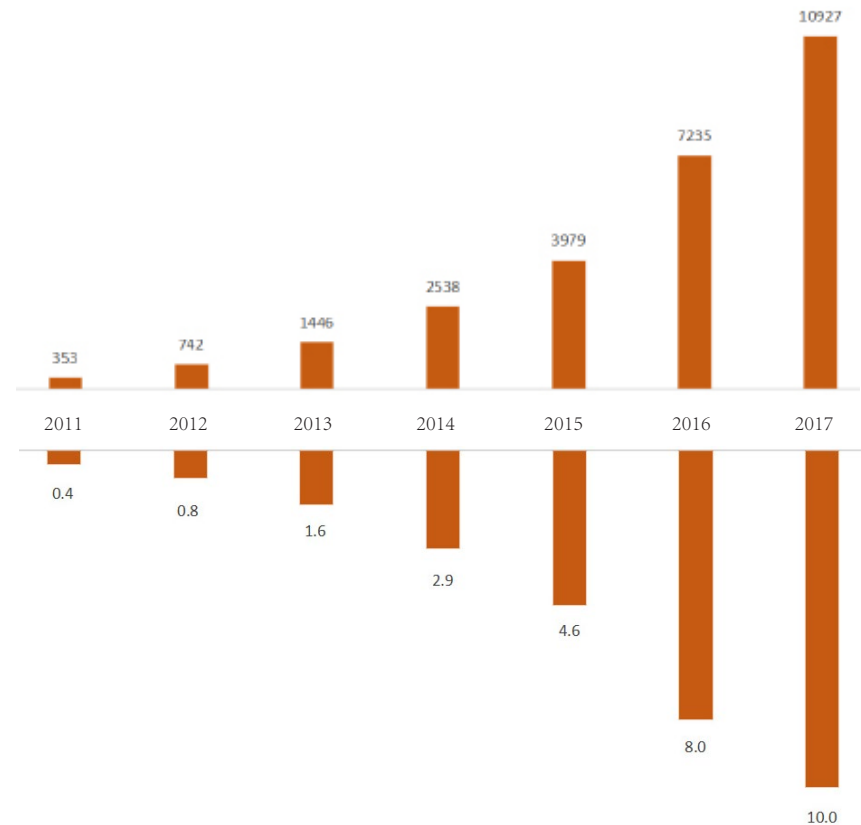
China's Green Buildings in 2018 and 2020 (unit: %)



- In Development
- Green Building Projects Account For More Than 60%
- Green Building Projects Account For 31% -60%
- Green Building Projects Account For 16% -30%
- Green Building Projects Account For 1% -15%

Development of China's Green Buildings Projects from 2011 to 2017

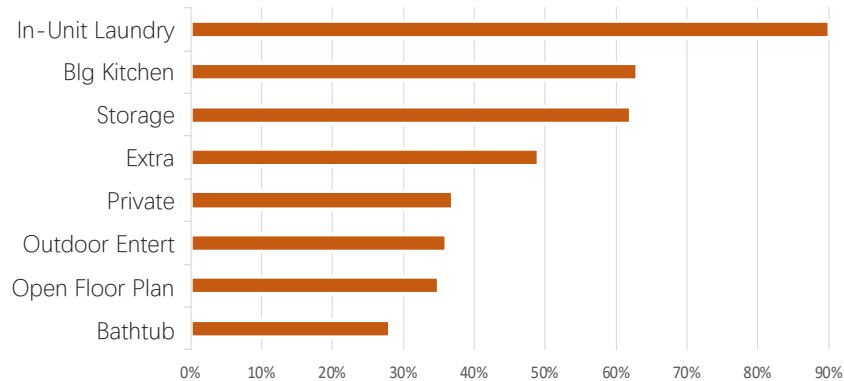
Projects with National Green Building Evaluation (price)



National Green Building Area (100 Million Square Meters)

Universal Design

Survey on Must-have Features



Must-have Features

- Private Garden Space
- Sufficient bathrooms
- Few hallways in house
- Big kitchen
- Plenty of storage space
- In-Unit Laundry
- Outdoor Entertainment Space

Sun Space

- South side rooms (bedrooms, living room)
- Inner courtyard for indoor lighting
- North-facing balcony on the third floor

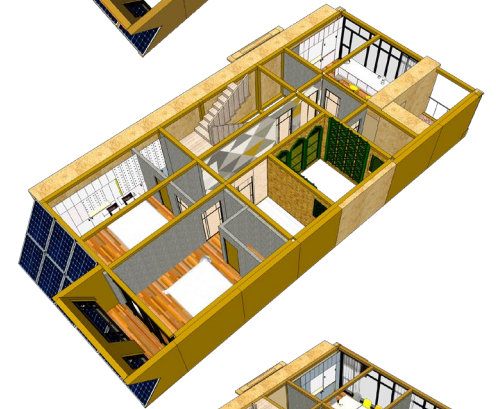
Universal Design Principles:

- 3 foot doors
- 5 foot turning diameter
- Clear lines of sight

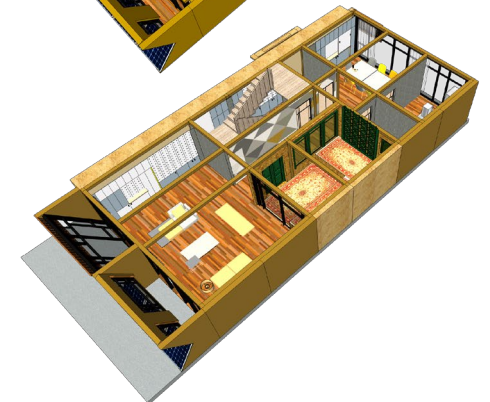
The Third Floor Plan



The Second Floor Plan

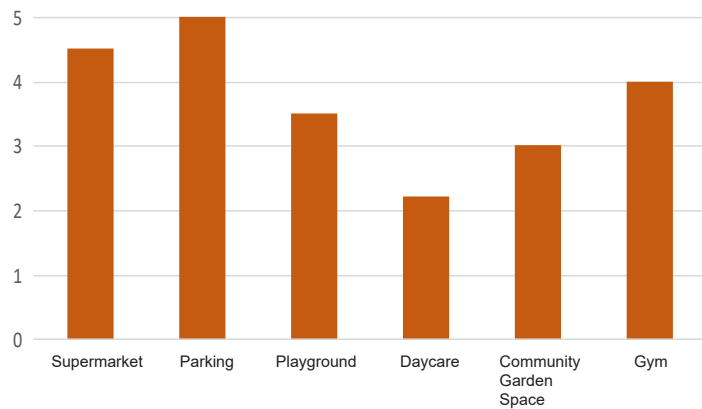


The First Floor Plan



Amenities

Importance of Local Amenities



Site Development Note:

- A.attached housing
- B.service center
(including supermarket, restaurant and gym)
- C.apartments
- D.public parking
- E.private parking
- F.community garden space
- G.playground area

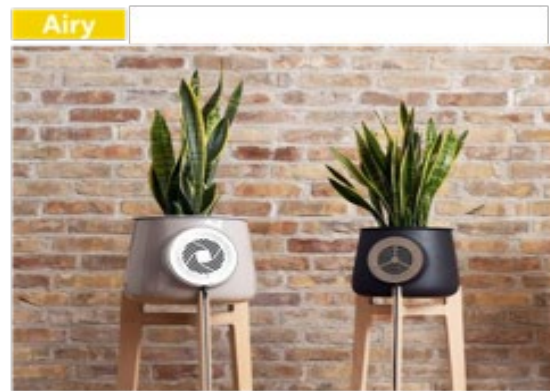


Smart Home System

Smart homes provide a convenient way to integrate all the complex functions and operations of a building into one platform. The building's smart home system can maintain the daily operation of the building. The mobile smart home information platform can be used to conveniently and quickly operate all functions and devices.



High-precision home air quality monitor



Pot green plant air purification round basin



Intelligent whiteboard system Smartmaker



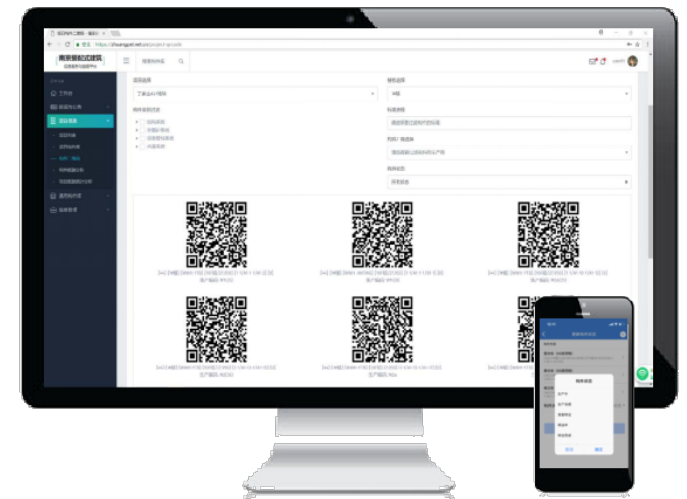
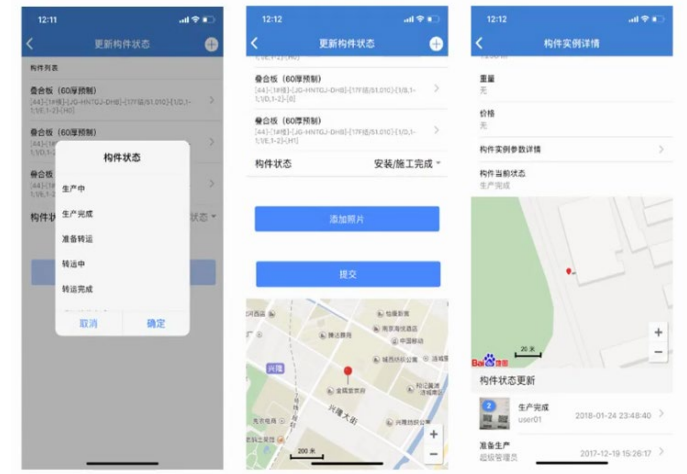
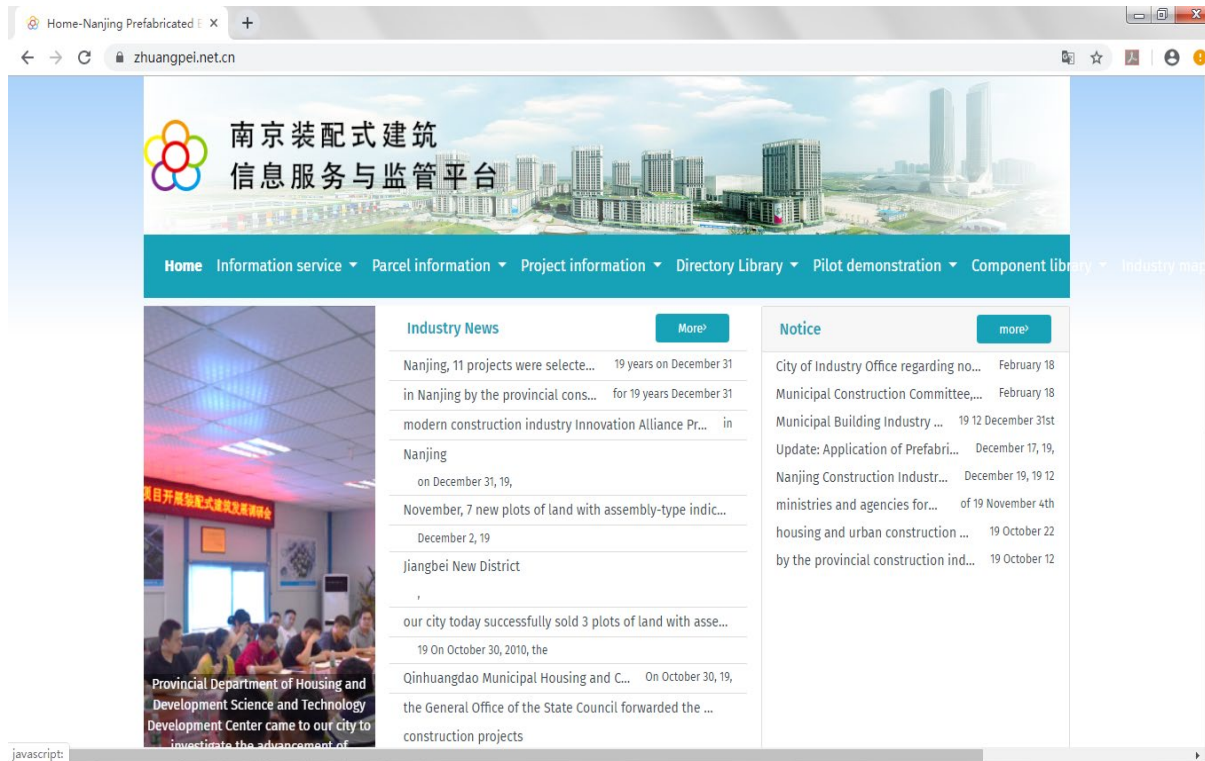
Dein Weg ins Smart Home

Jetzt iHaus App herunterladen, Produkte verbinden und los geht's!

Download on the App Store

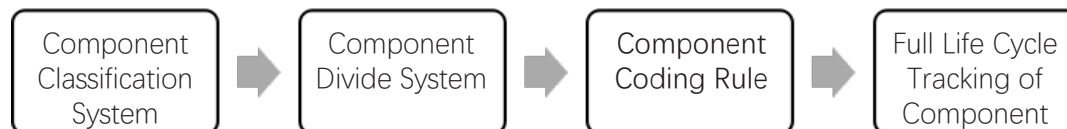
GET IT ON Google Play

Assembly Building Information Management Platform



Tracking Technology of Building Information Management Platform

1. The whole process of component information tracking, monitoring and tracing is realized through the Internet of things technology.
2. Track and feedback the process and status of BIM generated components through mobile applications.



Website link: <https://www.zhuangpei.net.cn/>
(Click to jump to web page)

Assembly Building Information Management Platform

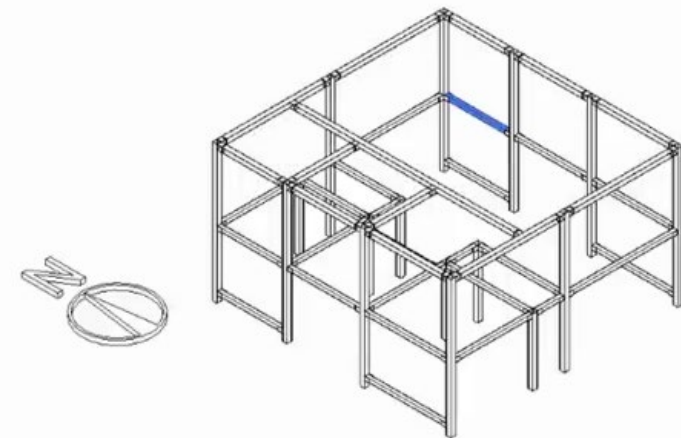


Building component information monitoring database can conveniently locate component life cycle information through mobile phone scanning QR code.

Through this system, the real-time monitoring of the whole life cycle of components from production, transportation, installation, use, maintenance and demolition can be realized.



Website link: <https://www.zhuangpei.net.cn/>
(Scan the upper QR code, the lower information will appear, we need to use our internal software permissions)



[89]-[C-HOUSE]-[JG-GJGGJ-GL]-[2F/2.425]-[C,3;D,4]-[H0V1]
生产编码: JGL03-2780(25)
当前状态: 无状态

Passive Energy-saving Window

1. This window is a patent project developed by ourselves.
2. Passive energy-saving windows apply the principle of Trumbo wall to windows, use glass to absorb the long-wave reflection of the short-wave and the greenhouse effect to achieve the purpose of heat insulation and heating in winter, and active shutters in the summer for sunshade.
3. The glass cavity of the window uses the change in temperature of the sun to generate heat pressure, and combines sensors and smart homes to achieve linkage control. According to different temperatures and carbon dioxide concentrations, four air currents are formed to achieve the purpose of energy saving.

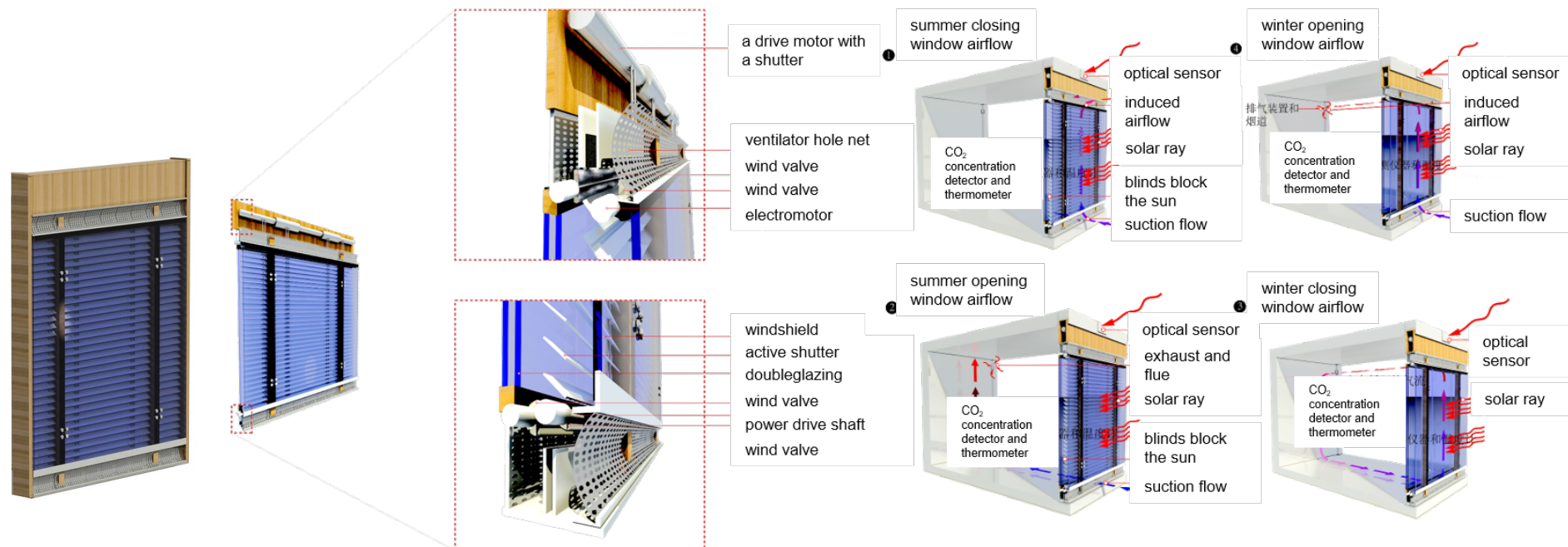
(Details of the device structure are shown in the appendix)



(Scan the code to watch)

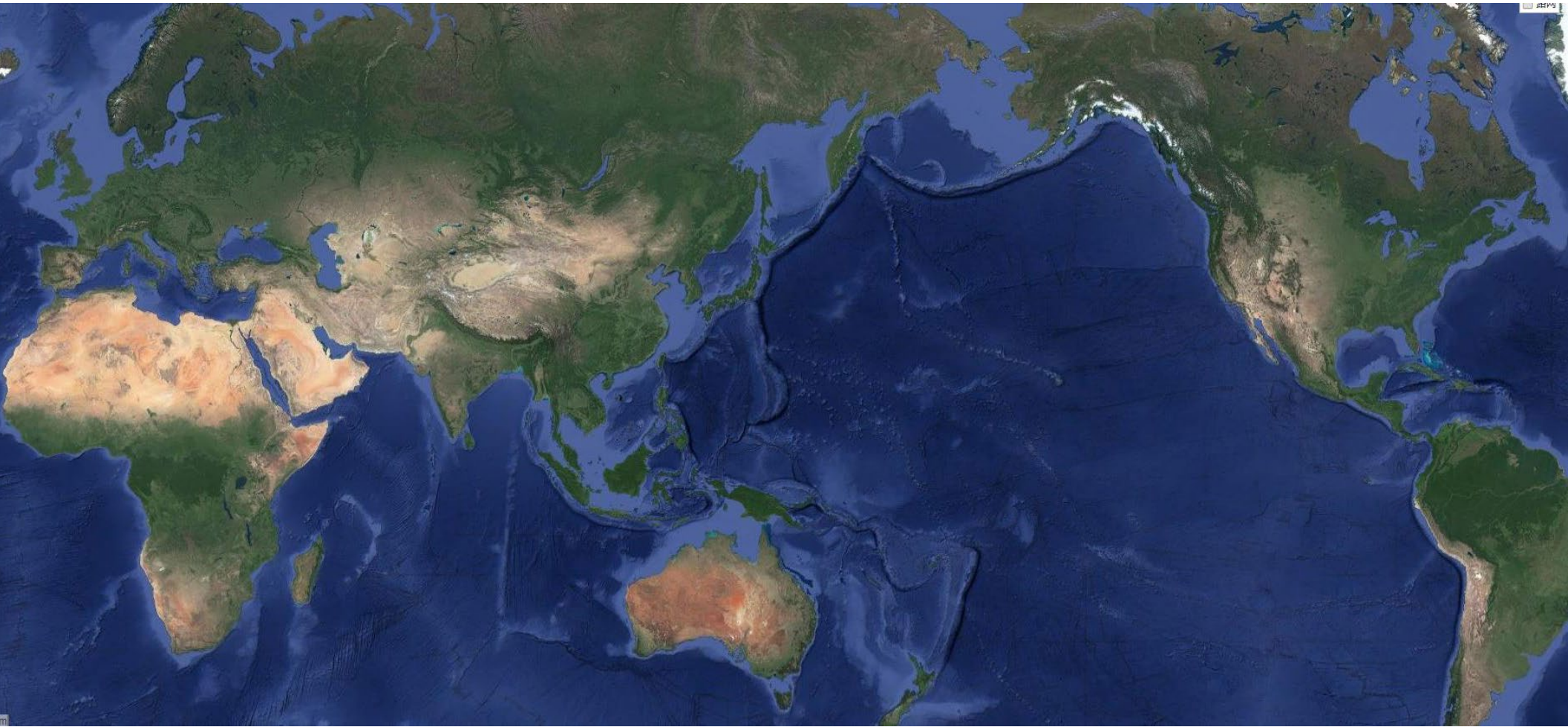


Invention patent application publication number : CN107313703A
Utility model authorization publication number: CN207315167U



We Are the World

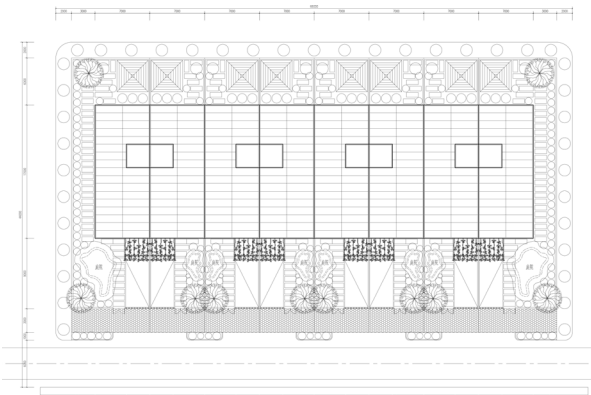
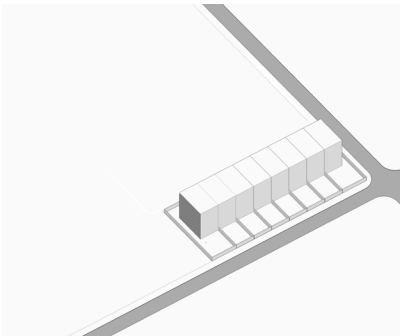
03 A Sand A World



Desertification has been called "the cancer of the earth". It threatens the survival and development of two thirds of the world's countries and regions and one fifth of its population.

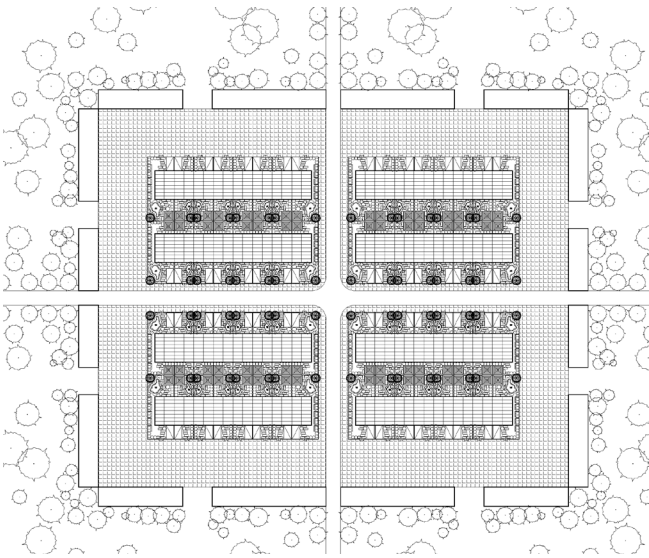
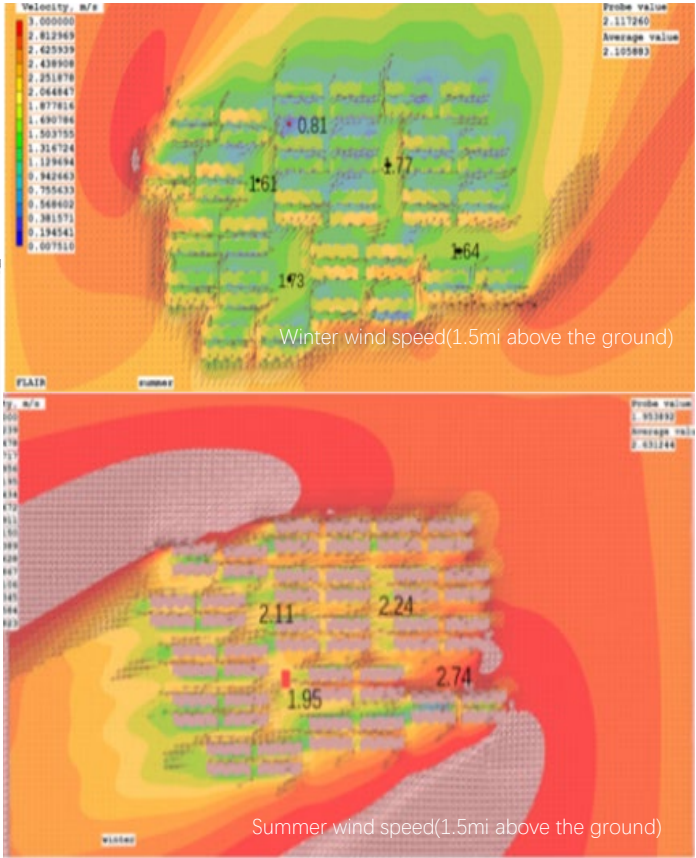
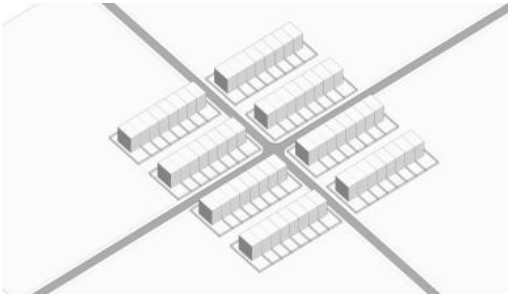
At present, the global desertification area has reached 36 million square kilometers, accounting for a quarter of the earth's land area. What's more, the desertification area is expanding at a rate of 50,000 to 70,000 square kilometers per year.

Passive Quantitative Evaluation

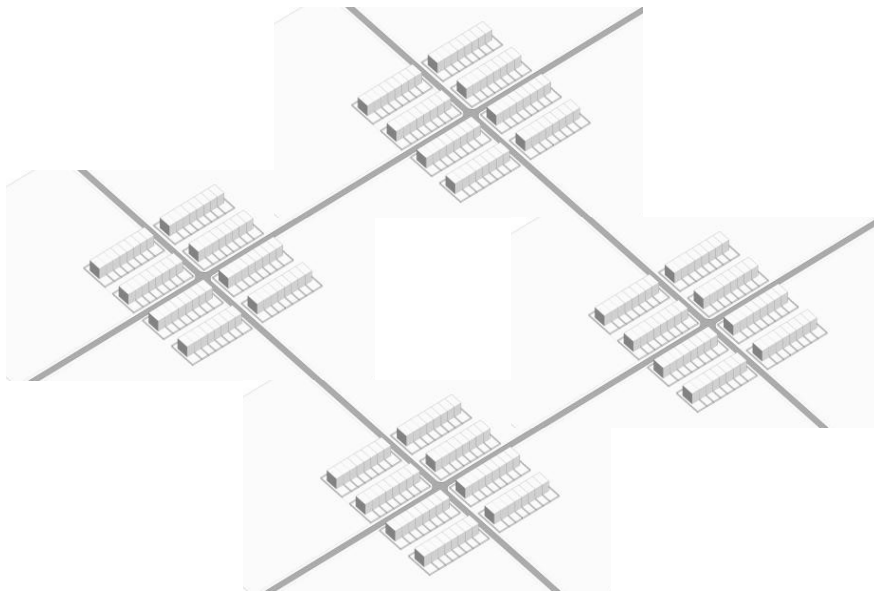


Wind Environment Simulation

According to the residential building standards and combined with the software simulation, the building spacing was determined to be 14.4m.

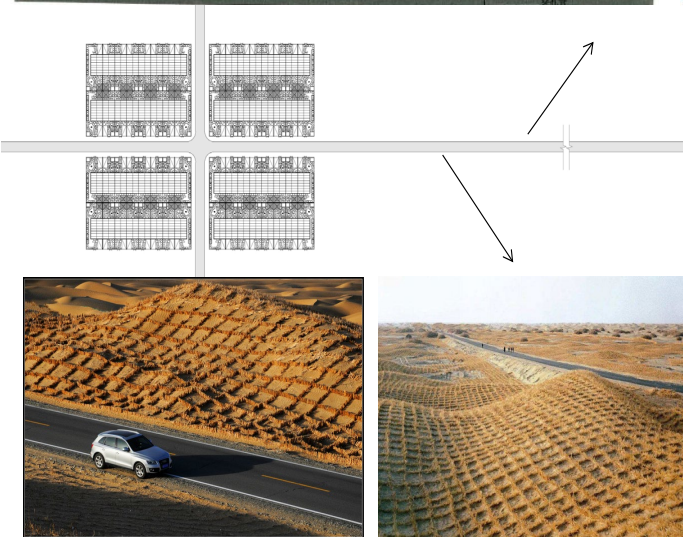
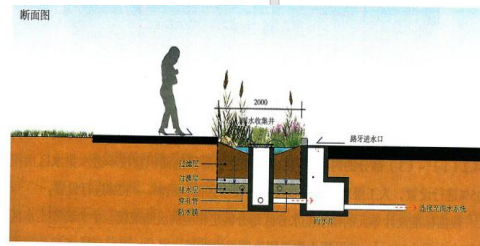
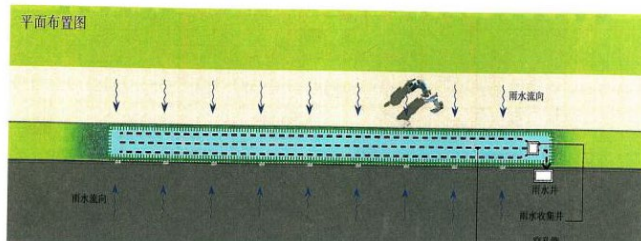


Buildings grow from the best angle of natural ventilation.



Grass squares are set between buildings, in which seeds sprout with the help of organic matter to turn the desert into an oasis.

The Use Of Grass Squares

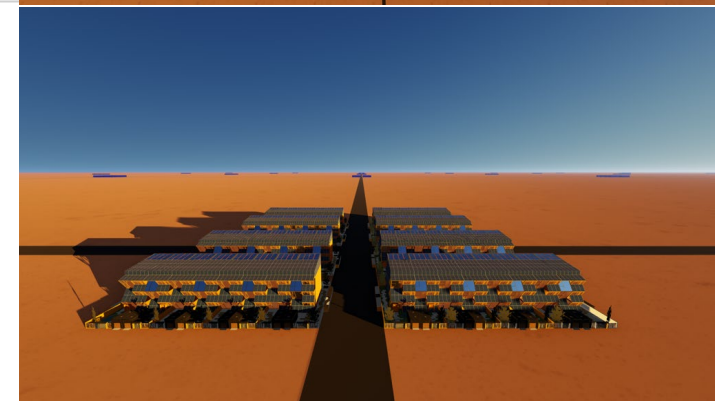
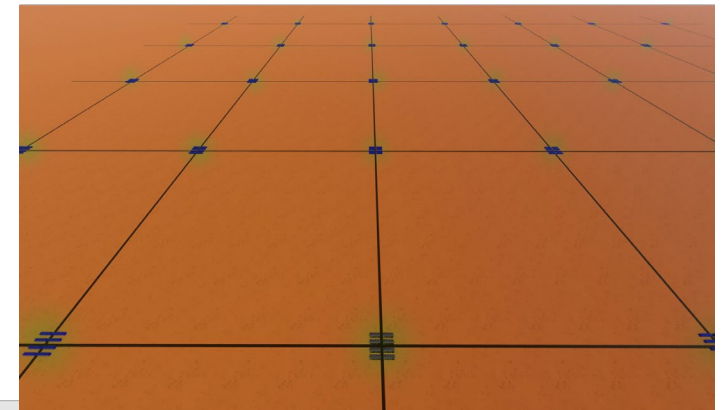


The role of grass squares

1. Improvement of soil
2. Wind and sand fixation
3. Moisturize with solid water
4. Protective effect



Architecture combined with grass grid and grows in the desert



Grass checked sand barrier: windbreak and sand fixation; water conservation









Thank you for your help from the beginning to the end

04 Appendix



Building Network Information Platform Operation



Click on the link to jump: <https://mp.weixin.qq.com/s/HswuXQF5bMFZhVsLb1E9-w>

With the development of the times, the way of expression and operation of the building has also changed greatly. Many modern innovative technologies have been adopted in the building, and the operation has been promoted through a variety of network information platforms. People can easily access building information whether on computer or mobile phone.



The official account of WeChat
public school, Southeast
University

Propaganda and promotion
of buildings through various
information channels

Design results completed on
January 10, 2020

Solar Decathlon Design Challenge | 2019年东南大学建筑学院研究生建筑设计课程

中大院 1月22日

2020国际太阳能十项全能建筑设计竞赛

2020 Solar Decathlon Design Challenge

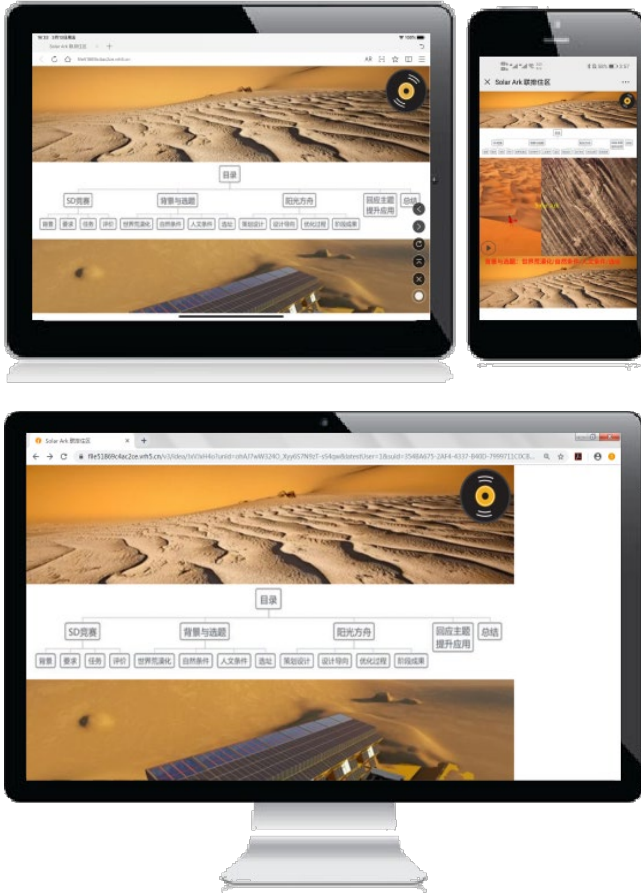
2019年东南大学建筑学院研究生建筑设计课程



国际太阳能十项全能竞赛（Solar Decathlon，简称SD）被誉为太阳能和绿色建筑行业的“奥运会”，竞赛由美国能源部发起，借助世界顶尖研发、设计团队的技术与创意，每个参赛团队需要将太阳能、节能与建筑设计以一体化的新方式紧密结合，设计、建造并运行一座功能完善、舒适、宜居、具有可持续性的太阳能住宅。竞赛期间，太阳能住宅的所有运行能量完全由太阳能设备供给。目前在全球范围内已有美国、中国、欧洲、中东、非洲、拉美六大组委会。

The International Solar Decathlon competition (SD) is known as the "Olympic Games" of solar energy and green building industry. The competition is sponsored by the U.S. Department of energy. With the technology and creativity of the world's top R & D and design teams, each team needs to closely integrate solar energy, energy conservation and architectural design in a new integrated way, design, build and operate one Solar energy residence with perfect function, comfortable, livable and sustainable. During the competition, all the operating energy of the solar house is completely supplied by the solar equipment. At present, there are six organizing committees in the world, namely, the United States, China, Europe, the Middle East, Africa and Latin America.

Assembly Building Information Management Platform



Animation demonstration Propaganda and promotion of buildings through various information channels

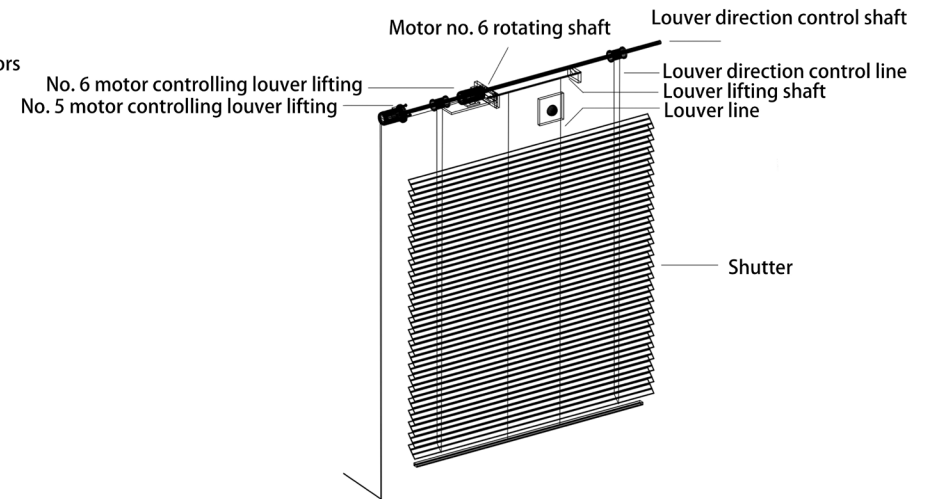
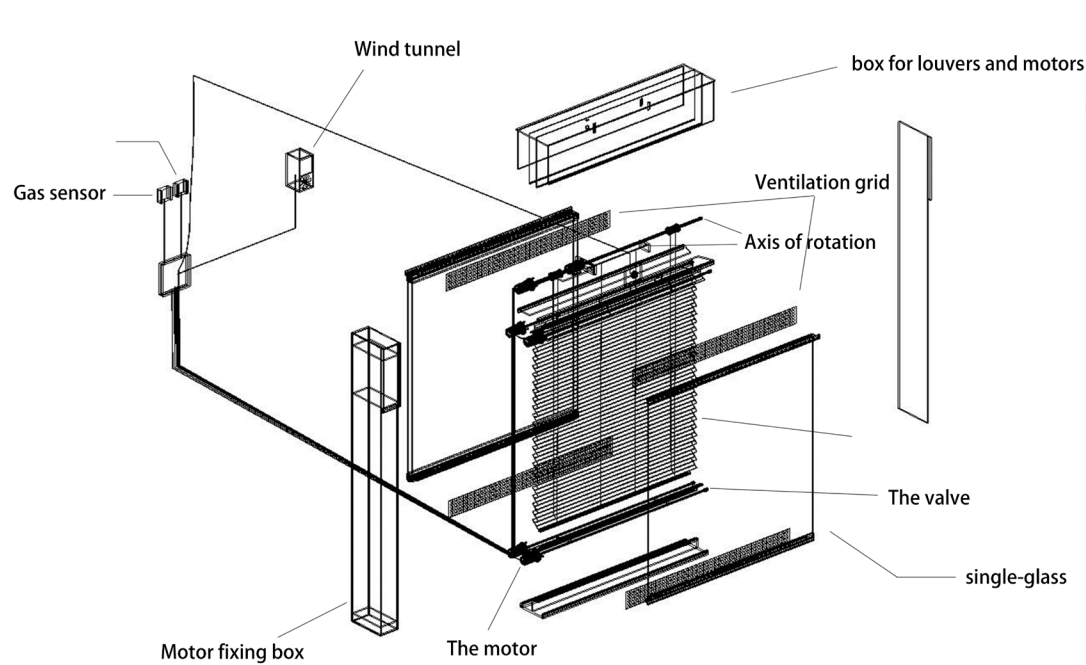
iH5 mobile web: <https://file51869c4ac2ce.vrh5.cn/v3/idea/JxVJxH4o>

Building animation: <https://v.qq.com/x/page/a3055nupton.html?vuid24=%2B2szOVtDHUJKiVyH7zBbMQ%3D%3D&pt>

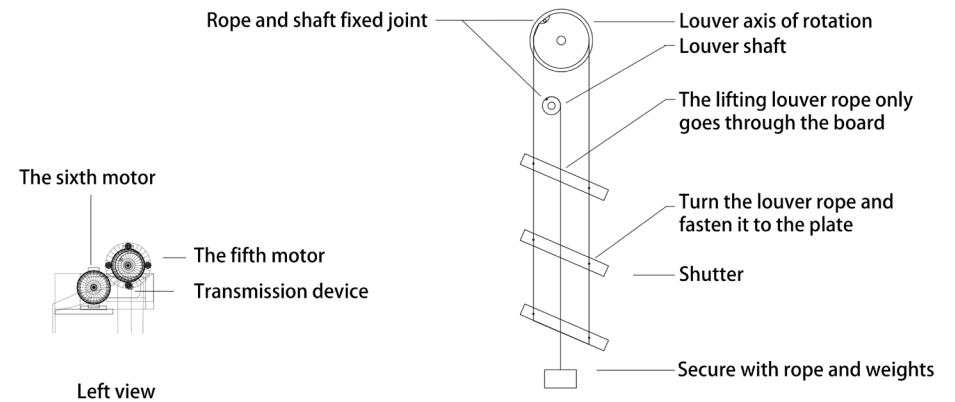
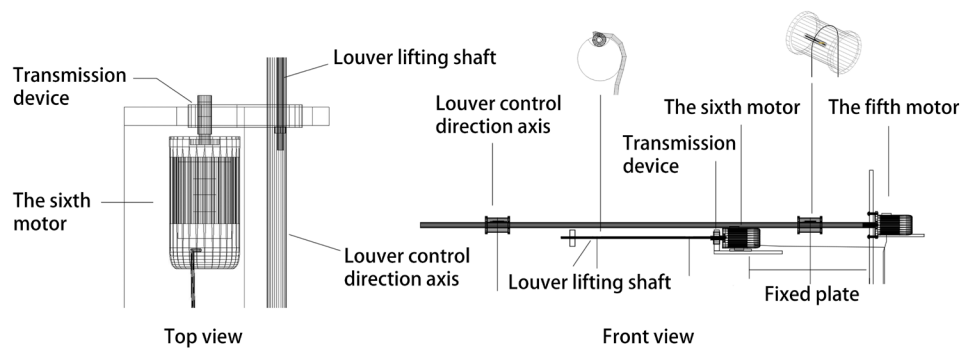


We have realized the cloud text display without drawings and documents in the form of H5, which can be obtained on any electronic device at any time and any place with only one account, thus bringing solar Ark will go to the market and attract the market's attention to solar energy buildings, so that more people can understand the International Solar Decathlon competition, share solar energy knowledge with more people, and promote sustainable energy development in the future.

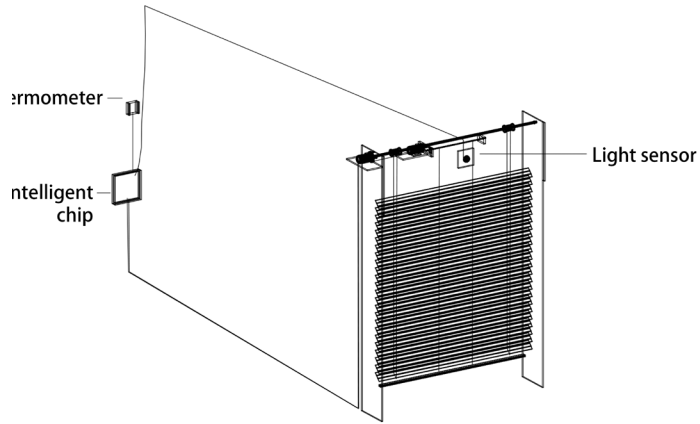




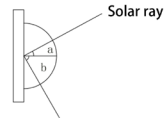
Axis, line, louver connection mode



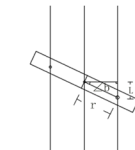
Louver control system



The basic principle of light sensor turning louver
The control louver rotating chip is loaded with the solar height Angle change data of sunrise and sunset of the sun throughout the year



The louver from the horizontal Angle B is the supplementary intersection of the sun's rays and the horizontal Angle A, so $A+B=90$



Louver rotation Angle

$\sin \angle b = L/r$
If you can see that the arc of the axis of rotation is equal to the vertical distance from the fixed end of the louver to the midpoint, so...

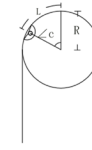
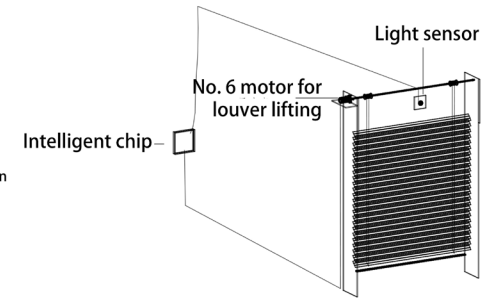
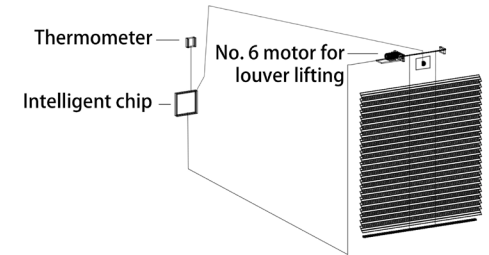


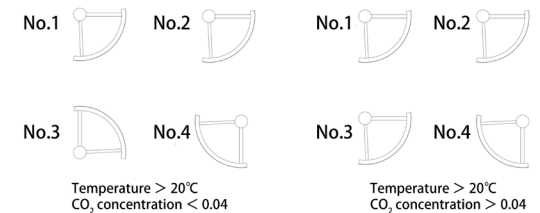
Diagram of louver axis

$L=2\pi R \times \angle C/360^\circ$
 $\sin \angle b = L/r$
 $\angle a + \angle b = 90^\circ$
The relation between the sun's altitude Angle and the motor's rotation Angle can be calculated by these three formulas

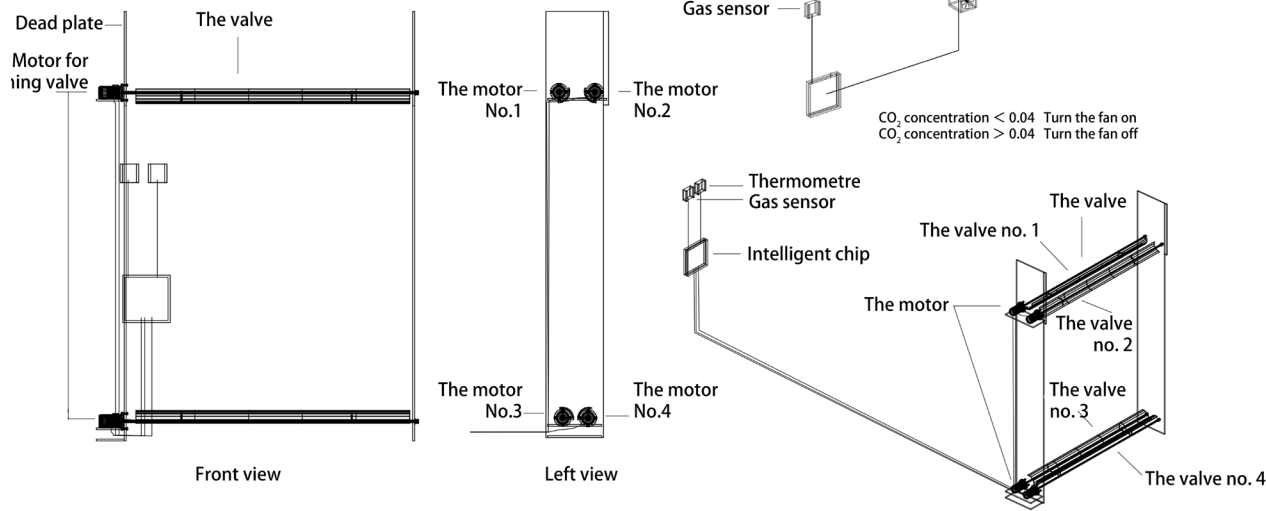
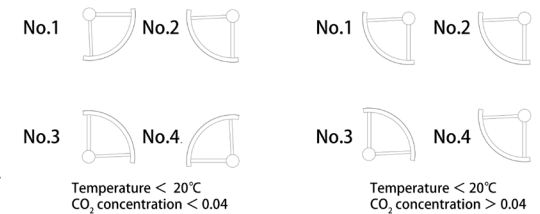


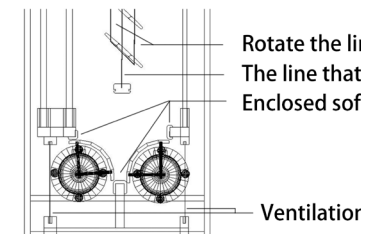
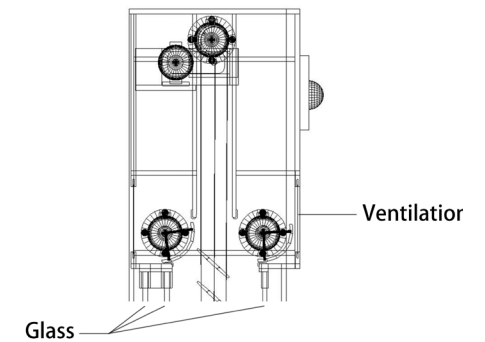
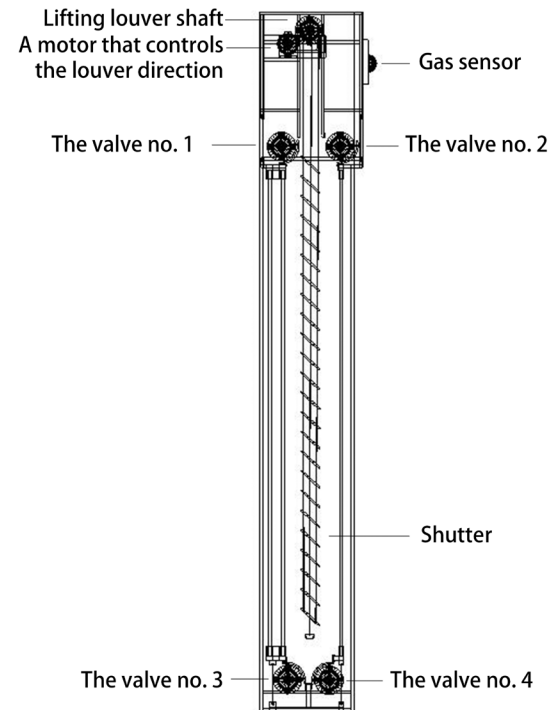
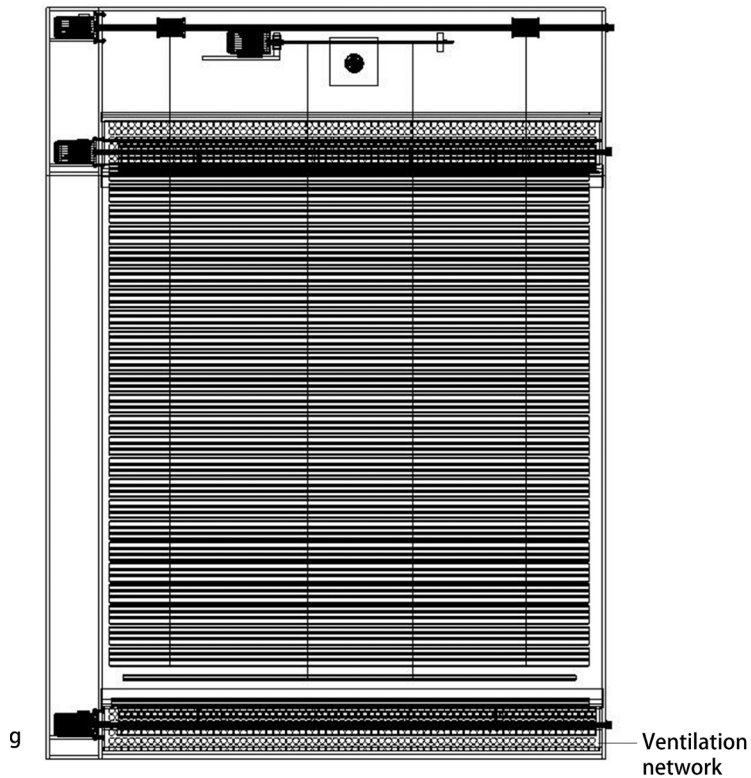
The greater the solar height Angle, the smaller the clockwise rotation of the motor

Left view of valve under different conditions



Left view of valve under different conditions



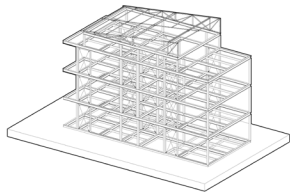


Cloud course results:



Click on the link to jump: <https://mp.weixin.qq.com/s/HswuXQF5bMFZhVsLb1E9-w>

Frame type patent:



(Scan the code to watch)

Application publication number: CN104499567A

Authorization announcement number: CN204370562U



Energy saving window patent:



(Scan the code to watch)



Invention patent application publication number : CN107313703A
Utility model authorization publication number: CN207315167U

All links and resources



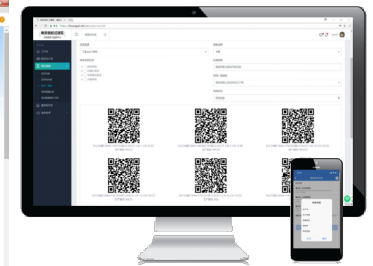
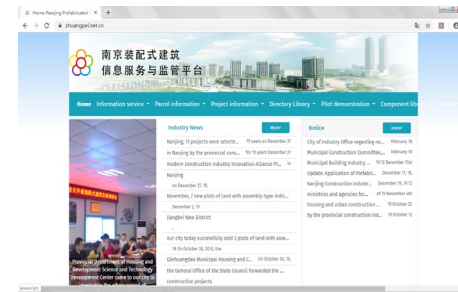
iH-5:



iH5 mobile web: <https://file51869c4ac2ce.vrh5.cn/v3/idea/JxVJxH4o>

Building animation: https://v.qq.com/x/page/a3055nupton.html?vuid24=%2B2szOVtDHUJkiVyH7zBbMQ%3D%3D&ptag=2_7.8.8.20569_copy

Information Assembly Platform:



Website link: <https://www.zhuangpei.net.cn/>
(Click to jump to web page)

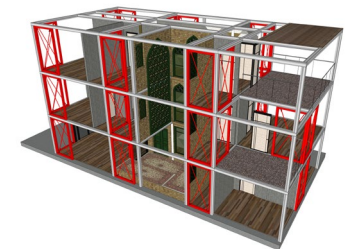
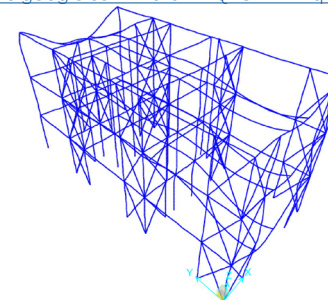
Calculation book:

Seismic Analysis calculation book (click to open):

<https://drive.google.com/file/d/1AQxGHYHxfqDI4QnGj0QXszMZH299NpNb/view?usp=sharing>

Gale Analysis calculation book (click to open):

<https://drive.google.com/file/d/1AQxGHYHxfqDI4QnGj0QXszMZH299NpNb/view?usp=sharing>



Hanikzi

Hanikzi was born into a Uyghur family in Xinjiang. Its name in Uighur means the best among young women. Her graceful dancing posture is as flowing and elegant as the desert. It can be said that she feels like a fairy, and such exquisite beauties are rare in real life. She fully reflects the traditional art of the ancient Western Regions from her dance. She is, in a sense, the cultural spokesperson of Xinjiang.



Southeast University (SEU)



XinJiang University (XJ)

ETH Zürich

ETH Zurich(ETH)