Solar Ark

Desert Research Station Attached housing - AH - Division

Southeast University (SEU)  XinJiang University (XJ)  ETH Zurich (ETH)
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We love every inch of earth, every creature, every grain of sand, every dance of life

01 Project progress report
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.
Project Summary

Location

World (China)  China (XinJiang)  XinJiang (Turpan)

Tuyuq

Community summary

- Population: 3048 people
- Nationalities: Uygur, 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:
  - Tuuq Grand Canyon
  - Tuyuq Qianfo Cave
  - Vomiting ditch
Design Constraints Description

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.
Introduction  |  Project Summary  |  Tuyuq  |  Design Constraints Description  |  Regional architecture design  |  Design Goals

**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 ㎡ (2470 sq ft)
- Area of single-family plot: 270 ㎡ (2906 sq ft)
- Area of building: 1835.6 ㎡ /8 Units (21920 sq ft/8 Units)
- Area of plot: 2160 ㎡ /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

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

**Logo**

SolarArk

logo design

blowout dune

desert
Introduction | Project Summary | Tuyuq | Design Constraints Description | Regional architecture design | Design Goals
Musicology, Religion, History, 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 Plane

Attached Housing

Total Floor Area: 1834 m² (19741.01 sq ft)
Area of single-family building: 229.45 m² (2470 sq ft)
Area of single-family plot: 270 m² (2906 sq 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
Architectural Plane

First-story building plane
Area: 88.5m² (952.60sq ft)

Two-story building plane
Area: 73.45m² (790.60sq ft)
Three-story building plane
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
Architectural Profile

Profile 1-1

Profile 2-2
Three-level corridor and inner courtyard

Living room and inner courtyard

Three-story building plane
Area: 67.5m² (726.56sq ft)

Two-story building plane
Area: 73.45m² (790.60sq ft)

First-story building plane
Area: 88.5m² (952.60sq ft)

Rammed earth wall

Shared wall between two households
Building structure

South elevation structural section

- 15mm (0.59in) Solid wood floor surface
- 20mm (0.79in) Gypsum board cushion
- 100mm (3.94in) EPS polystyrene board
- 50mm (1.97in) Metal keel structure interlayer
- 50mm (1.97in) air interlayer
- 80mm (3.15in) Gypsum ceiling board

Construction node A
Building structure

South elevation structural section

Construction node B

8mm (0.31 in) Solar thin film power panel
35mm (1.38 in) Metal fixing bracket
2mm (0.08 in) Acrylate waterproof coating
5mm (0.2 in) Polyester foam cushion
1mm (0.04) Aluminum foil
50mm (1.97 in) EPS Polystyrene board
100mm (3.94 in) Structural interlayer
15mm (0.59) Gypsum Veneer
Building structure

North elevation structural section

Construction node C

- 10mm (0.39in) Ceramic decorative panel
- 130mm×280mm (5.12in×11in) Timber lintel
- 20mm (0.79in) Gypsum backing plate
- 150mm×150mm, δ=10mm (5.9in×5.9in, δ=0.39) steel beam
- 25mm (0.98in) Wood cushion
- 50mm×100mm, δ=44mm (1.97in×3.94in, δ=0.16) Metal keel
Building structure

South elevation structural section

- 8mm Solar thin film power panel
- 35mm (1.38in) Metal fixing bracket
- 20mm (0.79in) Polyester foam mat
- 10mm (0.39in) Rubber cushion
- 1mm (0.04in) Acrylate waterproof coating
- 10mm (0.39in) Wood Cushion
- 50mm (1.67in) Structural interlayer
- Roof truss, with 40mm×40mm, δ=4mm square steel pipe
  (1.57in×1.57in, δ=0.16in)

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 %.

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.

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

- Nominal Dimensions of Wall Blocks: 1500mm × 500mm × 700mm
- Thermal Conductivity of Modified Rammed Earth Wall: 0.823 W/m·K
- Thermal Conductivity of Straw Insulation: 0.043 W/m·K

Clay Quarry Near Site
Prefabricated Blocks for Walls
A large number of waste straw sources
Prefabricated straw insulation Board

Mixed Mortar Protective Soil Layer t=20mm
Modified Rammed Earth t=500mm
Air Interlayer t=50mm
Straw Insulation Layer t=130mm
Polyurethane Vapor Barrier Membrane t=1.5mm
OSB Board t=15mm
Filling between precast blocks with mixed mortar
Socket Plane

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)
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)
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)
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)

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.
Frame member

Application publication number: CN104499567A
Authorization announcement number: CN204370562U

(Scan the code to watch)
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.

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

Max. Displayment in x- and y-direction
Max. and Min. Stress in x- and y-direction

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

Seismic Analysis calculation book (click to open):
https://drive.google.com/file/d/1AQxGHYHfDqDI4QnGjOQXszMZ H299NpNb/view?usp=sharing
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 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/1AQxGHYH-KfL4QnGj0QXszMZ99NhN/view?usp=sharing
Climate

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

Dry Bulb Temperature

Relative Humidity

Global Horizontal Radiation

Wind Rose
**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**  
- Total 38.1  
- Total 26.5  

**Renewable Energy**  
- PV 38.1  

**Rated Software:** REM/Rate - v16.0.1  

**HERS INDEX**  
- More Energy  
- Existing Homes  
- Reference Home  
- 100  
- Less Energy  

**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.

**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)  
- 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)  
- National Program Requirements ENERGY STAR Certified Homes, Version 3 (Rev. 10)

**Code for Renewable energy Design**  
- DOE Zero Energy Ready Home National Program Requirements (Rev.07)  
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.

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.
Pv Panel Tilt Design

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.

**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$) /kWh
Unit Price of Photovoltaic Panel: 700¥ (100$)

**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 - A

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

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<th>AC Energy (kWh)</th>
<th>Value ($)</th>
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### SYSTEM - B

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

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### SYSTEM - C

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

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Pv System Calculation

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 × 427kWh = 10248 kWh (34.96 MMBtu), located on roof
SYSTEM - B: 21 × 460kWh × 0.65 = 6279 kWh (21.42 MMBtu), located on south elevation
SYSTEM - C: 73 × 149kWh = 10877 kWh (37.11 MMBtu), located on west elevation
In addition, the PV array located on east elevation is similar to SYSTEM - C:
73 × 149kWh = 10877 kWh (37.11 MMBtu)

Average annual energy generation per unit is:
10248 kWh + 6279 kWh + (13505 kWh + 10877 kWh) / 8 = 19574.75 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 × 12V × 200Ah × 3 = 28.8 kWh (98.26 MMBtu)

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:
28.8kWh × 0.7 × 0.95 = 19.15 kWh (65.34 MMBtu)

The actual charging capacity of the battery is:
28.8kWh × 0.7 / 0.95 = 21.22 kWh (72.40 MMBtu)

When PV panels fail to generate electricity in extreme cases, the energy in the battery can maintain the residential operation for about:
19.15kWh × 3.5 / 28.11kWh/day = 2.4 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.
Analysis of Indoor Temperature

Monthly Indoor Average Temperature

Atrium facade

Atrium ventilation

Upper atrium

Atrium

lower atrium
Analysis of Indoor Wind Environment

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

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

Pure hot-press ventilation (natural air extraction)

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

Winter Solstice (December 22)

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

Autumnal Equinox (September 23)

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

Summer Solstice (June 22)

Spring Equinox (March 21)
Relationship between annual sunshine hours and south-facing angle

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

**Conclusion:** The overall building has good daylighting.
Air-conditioning equipment

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

### Specifications
#### Cooling Non-Ducted
- Rated Capacity Btuh: 34,000
- Capacity Range Btuh: 6000-18000
- Rated Power Input W: 2,740
- SEER/EER: 20/12.50

#### Heating Non-Ducted
- Rated Heating Capacity 47°F Btuh/hr: 36,000
- Heating Capacity Range Btuh/hr: 8000-39000
- Rated Power Input W: 2,710
- HSPF: 10.50
- COP @ 5°F: 2.0
- Max. Heating Capacity 5°F Btuh/hr: 36,000
- Max. Heating Capacity -15°F Btuh/hr: 25,000

---

**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
Industry Analysis

The secondary industry

<table>
<thead>
<tr>
<th>Industry</th>
<th>Percentage</th>
<th>Number</th>
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<tbody>
<tr>
<td>Planting</td>
<td>18% (548)</td>
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<tr>
<td>Animal Husbandry</td>
<td>33% (1006)</td>
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<tr>
<td>Medical profession</td>
<td>1% (30)</td>
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<tr>
<td>Other</td>
<td>2% (61)</td>
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<tr>
<td>Tourism</td>
<td>39% (1188)</td>
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<tr>
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<td>3% (91)</td>
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<tr>
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<td>4% (122)</td>
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<td></td>
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</table>

Primary industry

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<td>Animal Husbandry</td>
<td>18% (548)</td>
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The service sector

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<tbody>
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</table>

Graph showing percentage distribution of industries and age groups.
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

rent
monthly household debt
operation and maintenance cost
monthly utility cost
proper tax
insurance

recent month
Overview of construction cost

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Foundation</td>
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<tr>
<td>Roofing</td>
<td>29%</td>
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<tr>
<td>Insulation</td>
<td>8%</td>
</tr>
<tr>
<td>MEP</td>
<td>14%</td>
</tr>
<tr>
<td>Window and door</td>
<td>6%</td>
</tr>
<tr>
<td>MEP</td>
<td>11%</td>
</tr>
<tr>
<td>Exterior finish</td>
<td>3%</td>
</tr>
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<tr>
<td>Other</td>
<td>8%</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost</th>
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<tbody>
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<td>Foundation</td>
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<tr>
<td>Roofing</td>
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<tr>
<td>Framing</td>
<td>$14000</td>
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<tr>
<td>Insulation</td>
<td>$3000</td>
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<tr>
<td>Exterior finish</td>
<td>$1000</td>
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<tr>
<td>Window and door</td>
<td>$1500</td>
</tr>
<tr>
<td>MEP</td>
<td>$5000</td>
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<tr>
<td>Interior finish</td>
<td>$6000</td>
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<tr>
<td>Photovoltaic</td>
<td>$5000</td>
</tr>
<tr>
<td>Other</td>
<td>$3000</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$52250</strong></td>
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</tbody>
</table>
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: %)

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

- In-Unit Laundry
- Big Kitchen
- Storage
- Extra
- Private
- Outdoor Entert
- Open Floor Plan
- Bath tub

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
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.
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)
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)
A Sand A World

We Are the 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

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

Wind Environment Simulation

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 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 checkered sand barrier: windbreak and sand fixation; water conservation
Thank you for your help from the beginning to the end.

04 Appendix
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
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=%2B2szOVtDHUJKWyH7zBbMQ%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.
Passive energy-saving window

- Wind tunnel
- Box for louvers and motors
- Axis of rotation
- Ventilation grid
- Gas sensor
- Motor fixing box
- The valve
- Single-glass
- Motor no. 6 rotating shaft
- Louver direction control shaft
- Louver direction control line
- Louver lifting shaft
- Louver line
- Shutter
- Axis, line, louver connection mode
- Rope and shaft fixed joint
- Louver axis of rotation
- Louver shaft
- The lifting louver rope only goes through the board
- Turn the louver rope and fasten it to the plate
- Secure with rope and weights

Cloud works | Group photo | Passive energy-saving window | Links and resources
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.

\[
\sin \frac{b}{L} = \sin \frac{L - b}{L} \\
\frac{b}{L} = \frac{L - b}{L} = \frac{L}{L} - 1 = 1 - \frac{b}{L} \\
\sin 90° = \frac{b}{L} \\
\frac{b}{L} = \sin 90° = 1 \\
L = 2 \pi R \times \frac{\sin 90°}{\sin \frac{b}{L}} \times \frac{b}{90°} \\
\text{The relation between the sun's altitude Angle and the motor's rotation Angle can be calculated by these three formulas.}
\]

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

CO₂ concentration < 0.04 → Turn the fan on
CO₂ concentration > 0.04 → Turn the fan off
Passive energy-saving window

Lifting louver shaft
A motor that controls the louver direction

Gas sensor

The valve no. 1
The valve no. 2

Shutter

The valve no. 3
The valve no. 4

Ventilation

Glass

Rotate the line
The line that enclosed sof

Ventilation network
Cloud course results:

Frame type patent:

Energy saving window patent:

iH-5:

Information Assembly Platform:

Calculation book:

Seismic Analysis calculation book (click to open):
https://drive.google.com/file/d/1AQxGHYHxqDI4QnGqQXszMZ/H299/NpN/view?usp=sharing

Gale Analysis calculation book (click to open):
https://drive.google.com/file/d/1AQxGHYHxqDI4QnGqQXszMZ/H299/NpN/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.