



ASIA CLEAN ENERGY FORUM 2023

Navigating toward a Carbon-Neutral Future through Clean Energy Solutions

13–16 June





ASIA CLEAN ENERGY FORUM 2023

Navigating toward a Carbon-Neutral Future through Clean Energy Solutions

13–16 June








*Affordable Rural Distributed Clean Heating – Case Study from Shanxi Low-carbon
and Inclusive Rural Development Project*

Shu Tan

Consultant, EASI

Asian Development Bank

-  Project Overview
-  Exiting Conditions and Challenges for Rural Heating
-  Improved Clean Heating Solutions
-  Cost savings and Reduction on Coal Use and Pollutants Emission
-  Value addition from ADB



Impact

The project is aligned with the impact that high-quality and green development and carbon dioxide (CO₂) emission peaking before 2030 in Shanxi Province and Yellow River Economic Corridor (YREC) achieved

Outcome

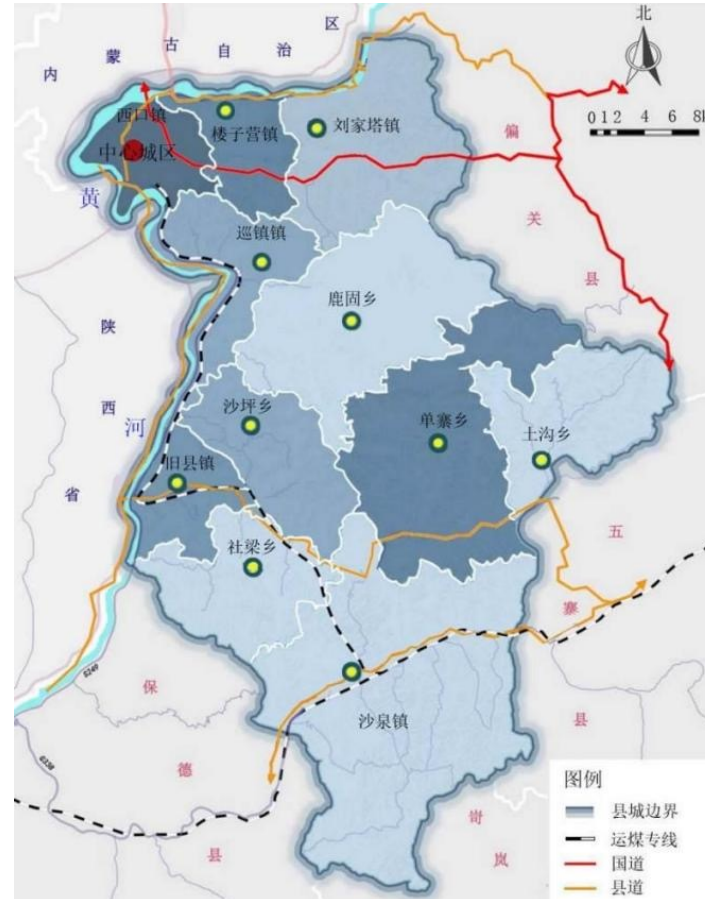
Low carbon, climate resilient, environmentally sustainable, socially inclusive public services improved in Shanxi Province

Output

1. Institutional capacity for decarbonization, inclusive development, and private sector engagement enhanced
2. Green, climate resilient, and inclusive urban-rural facilities enhanced (project investment component)
3. Green and inclusive financing mechanism operated (FI component)

Background for Rural Distributed Clean Heating Component

- **Project Location:** Xun Zhen Town, Hequ County, Shanxi Province, China
- **Project Scope:** 1,600 residential houses and 14 commercial houses in 14 administrative villages



Longitude: 110°53'3 " -- 113°58 'east;
Latitude: 38°6' 5" -- 39°40 'north.

Existing Conditions of Rural Buildings in Hequ County

Typical rural houses in Hequ County



Three rooms with large space



Large single room
(similar to three rooms)



U-shape



Courtyard

- **Large** building area, large single room, heating area around 50-100m²
- **Poor insulation**
- Rural resident pay more attention to building appearance than building energy efficiency

Number of floors: 1 or 2 floors, single building mainly;

Common layout: as pictures above;

Number of rooms: 5-8 rooms;

Functions: bedroom, living room, kitchen, bathroom, storage room, etc.

Existing Conditions for rural heating in Hequ County

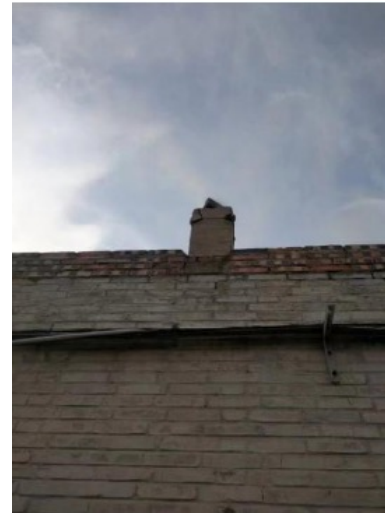
Current heating situation



Coal-fired furnace



Coal-fired furnace



Chimney



Raw coal

- Mainly coal-fired furnace
- **Serious environmental pollution** inside and outside the house
- **Difficult to control** heating equipment, **ineffective heating** facilities
- Traditional heating equipment, **complex and frequent** manual operation, **safety risks**
- The fire or radiator is the end of the heat dissipation, uneven heat dissipation
- **Low** indoor heating comfortableness

Initial Proposal of Clean Heating by Hequ County

- **Modified heat source only**
- **Heat source :**
Air source air-to-water heat pump replaces the original small coal-fired furnace



Schematic diagram of heating system of air source air-to-water heat pump

Serial number	Item	Detailed information
1	Number of renovation units	498
2	Air source heat pump	Heat production 10.8kW; Heating power 6.0kW
3	Water circulation pump	G=5t/h;H=25m;N=0.4kW
4	Heat storage tank	0.5m ³

Initial Proposal of Clean Heating by Hequ County

Potential problems:



- **High initial investment:** CNY 41,800 yuan per household
- **High heating operation cost:** The average heating electricity bill for each household is 3,460 yuan/year, which is too high for the farmers, and the government needs to bear the operation subsidy for a long time



- **High failure rate:** water-type heating system is complex, difficult to meet the intermittent heating needs of farmers with a high risk of pipeline freezing



- **Power/grid capacity increase demand:** The rated power of the air source heat pump is 6 horsepower. Each household needs to increase the power/grid capacity to about 10kW to ensure the normal start-up of the heat pump. High burden to the existing 220V voltage rural grid

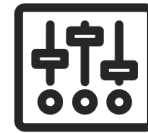


- Under low winter outdoor temperature conditions, it is difficult to guarantee the heating capacity and effect

Introduced Technical Innovations through ADB's Technical Due Diligence



➤ Improved internal insulation



➤ Easy to use/ user friendly



➤ Tailored heating schemes



➤ Clean and green



➤ Lower cost in procurement and operation

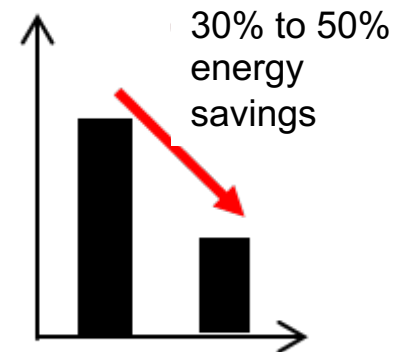
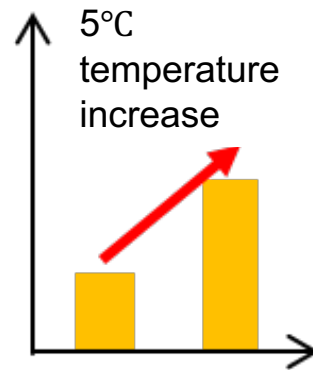


➤ Easy access to fuel

Insulation Improvement and Building Retrofitting



CNY100 (USD 15) per square meter



Recommended Heating Solutions and Technologies



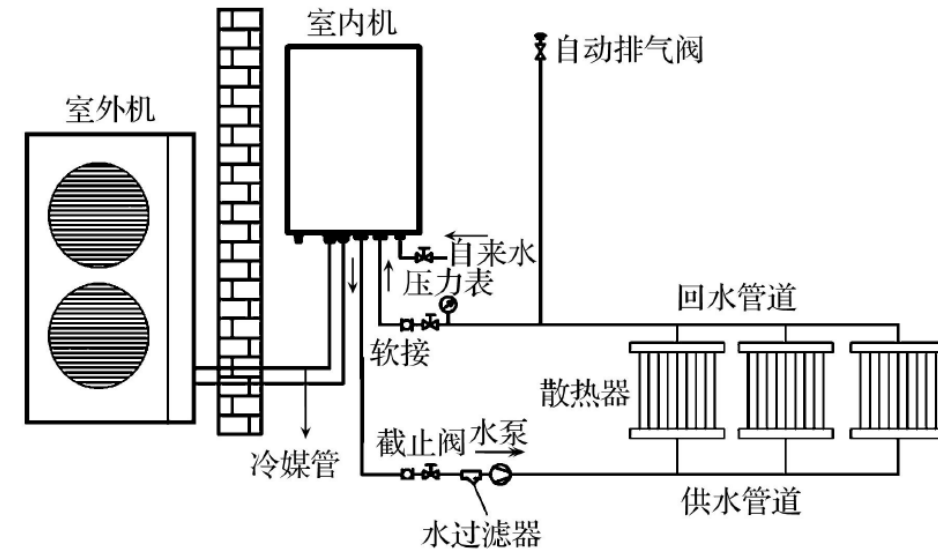
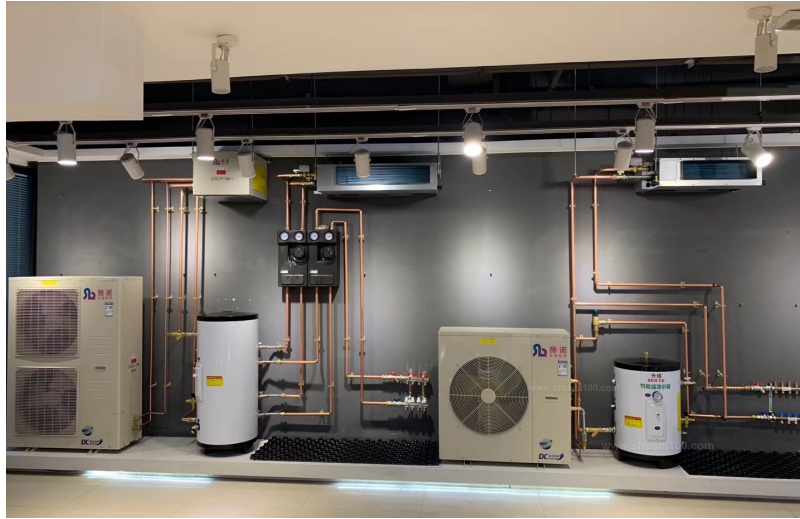
➤ Combination of heating solutions

- ❑ 800 households ---- intelligent biomass pellet heating furnace,
- ❑ 350 households ---- air source air-to-air heat pump
- ❑ 450 households ---- air source air-to-water heat pump
- ❑ 1,600 households ---- thermal insulation retrofitting
- ❑ 1 biomass pellet fuel processing plant with an annual output of 2,000-3,000 tons

➤ Improved efficiency :

The average total cost per household reduced to CNY 21,200 from CNY 41,800 in the original plan

Heat Source 1 : Low Ambient Temperature Air-to-water Heat Pump

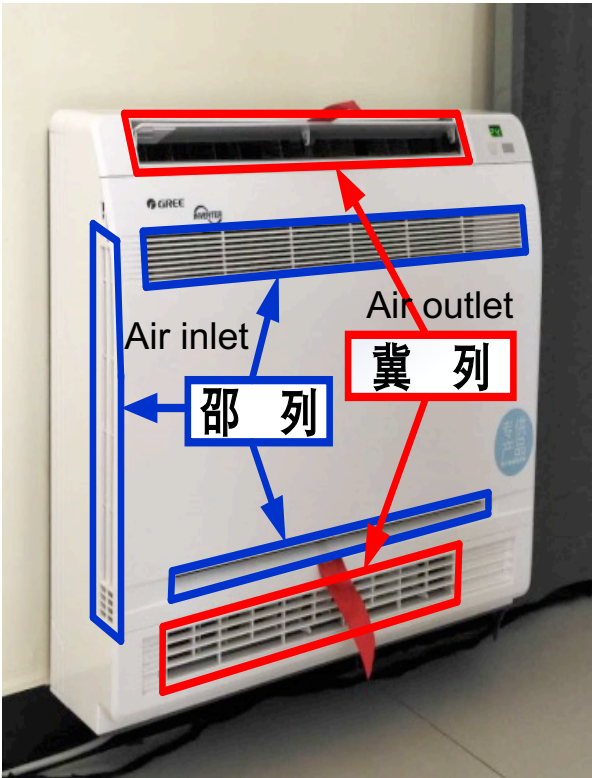


Schematic diagram of air source air-to-water heat pump heating system

- The air source air-to-water heat pump can be directly connected with the original coal-fired furnace heating pipeline and radiator system
- The system is relatively complex, the high initial investment for equipment, and the capacity of the grid needs to be increased
- Suitable for households with more heating rooms, continuous use and relatively good economic conditions

Heat Source 2 : Low Ambient Temperature Air-to-air Heat Pump

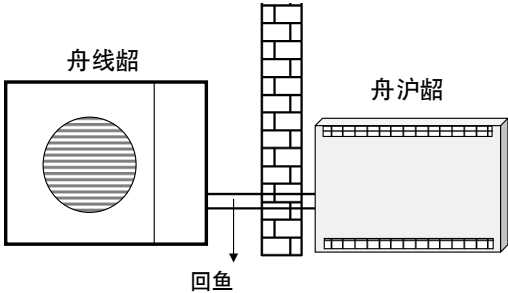
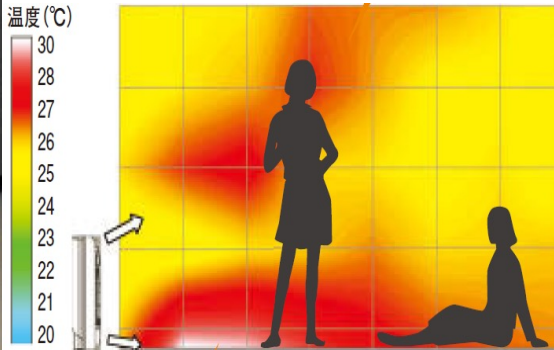
- Optimized heating air distribution with double hot air outlets for indoor unit
- Flexible start and stop, convenient temperature control, economic and energy saving
- Suitable for ultra-low temperature in winter, also for summer cooling



Upper outlet:
Human activity area,
Fast space heating
Lower outlet:
Warm the ankle area,
Underfloor heating



Applied in Uraanbaatar yurts



- Unit price: ~¥4500
- SEER≥3.0
- Grid power requirements (3~5kW)

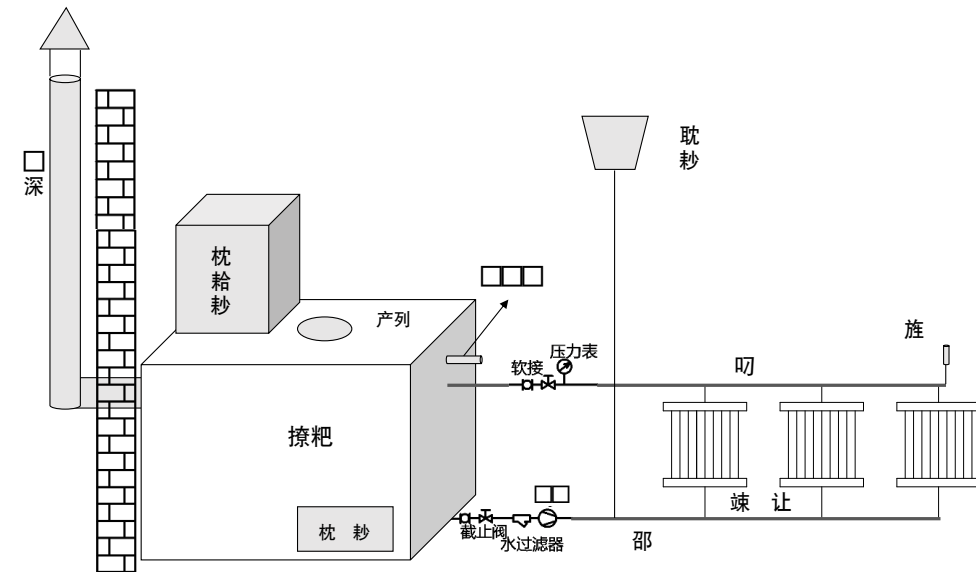
Heat source 3 : Intelligent Biomass Fuel Heating Furnace

- **Application:** Suitable for distributed heating
- **Advantages:** Different types of furnaces can be adopted to the number of heating rooms and fuel type



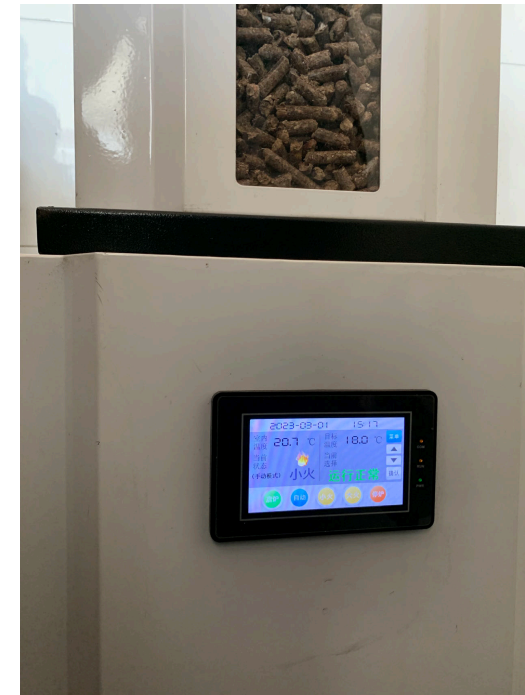
Heating and cooking furnace (hot water type)

Suitable for houses with more rooms



- **One-click operation**
- **Automatic feeding, intelligent fire control**
- **Remote monitoring**

Heat source 3 : Intelligent Biomass Fuel Heating Furnace



Innovative Business Model : Rural Cooperatives for Biomass Fuel Processing and Production

- **Business model:** Government support + cooperatives by farmers
- **Operation mode:** 3 tons of straw for 1 ton of fuel or pay 400 yuan/ton processing fee
- **Benefits:** improve the income of the local farmers + reduce the cost for coal purchasing + reduce the pollution by straw burning



Pilot Distributed Biomass Pellet Plant

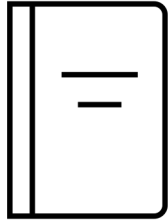
Cost Analysis

Serial number	Specific scheme	Energy type	Energy price	Energy consumption	Annual heating costs CNY	Cost saving CNY
1	Intelligent biomass pellet heating furnace	Biomass pellet	700yuan/t	4 t	2800	400
2	Air source air-to-water heat pump	Electricity	Peak price: 0.5070 yuan/kWh; Valley price: 0.2862 yuan/kWh	7429 kWh	2947	253
3	Air source air-to-air heat pump	Electricity		2999 kWh	1189	2011
4	Scattered coal furnace	Raw coal	800yuan/t	4 t	3200	-

- Average household coal consumption reduction: 4 tce/a
- Replacement scale: 1600 households
- Total coal reduction: 6,400 tce.

Emission Reduction

Number	Object (Unit)	Reduced amount
1	Scattered coal (t/a)	6400
2	SO ₂ (kg/a)	5280
3	NO _x (kg/a)	9600
4	PM (kg/a)	90000
5	VOCs (kg/a)	24000



Developing Evaluation and Technical Guidelines on Rural Clean Heating





THANK YOU!

