The Application of Ground Source Heat Pump in China

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Development History

• In 1980s, some research institution started doing research on GSHP.

• In 1990s, Some Scholars/engineers went to America, Sweden, Germany, Canada, etc. to study the technology of GSHP.

• In 1996, the first generation of FUERDA geothermal central air conditioning unit was installed in 2 residential buildings with the floor area of 50,000 m², in Liaoyang, LiaoNing province.

• In 1997, China-US started technology cooperation in energy efficiency, GSHP was one of the most important field, 3 demonstrations.

• From the beginning of the 21st century, China started to show this technology with large pilot projects, especially in Beijing, Shandong.
Brief introduction

（1）Development history

• In 2001, Beijing Ever Source Science & Technology Development Co., Ltd., invented “Single-Well Recharge Technology” UWHP system

• In 2005, the GSHP technology industry was considered as one of the 10 new advanced technologies by Ministry of Construction


• In 2006, Ministry of Finance and Ministry of Construction set special financial subsidies for the GSHP pilot projects over the nationwide

• In 2007, MOC started GSHP demo city.
(2) Market penetration

- The investigation of ground source heat pump in China shows that from the perspective of areas in current projects, the projects with the floor area above 50,000 m² account for about 16%, the projects with the floor area between 10,000 m² and 50,000 m² account for 42%, while those below 10,000 m² account for 42%. The future growing of GSHP potential is promising.
Brief introduction

(2) Market penetration

- The application area of underground water HP accounts for 45% in the total market;
- Ground-coupled HP accounts about 35%;
- Surface water HP accounts about 20%. 

![Diagram showing market penetration percentages for different types of heat pump systems. The categories and percentages are as follows: underground water HP 45%, ground-coupled HP 35%, surface water HP 20%.]
Brief introduction

(3) the technical area and application

- **Underground water HP system**
  - Started from 1995, Study and import the products from Europe and the United States,
  - Strengthen the international collaboration, Develop demonstration projects
  - with the most widely application
  - the biggest single project floor area reached 186,000 m²
  - According to an investigation done by CABR, the application of Underground water GSHP system focused on Beijing, Liaoning Province, Hebei Province and Shandong Province
Brief introduction

(3) the technical area and application in building of GSHP

- **Ground-coupled HP**
  - It grows fast and the biggest single project floor area reached 160,000㎡
  - An investigation showed that the application of GSHP focused on Beijing, Hubei and Jiangsu Province

- **Surface water HP**
  - it is used in the region where is abound in water or other advantage conditions
  - It has the largest city level demonstration project,

- **Industry waste water HP**
  - for the district heating of northern part of China
  - with large scale
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Relative Policies and Standards

State Law

• 《People’s Republic of China Renewable Energy Law》 1, Jan., 2006:
  Renewable energy: wind energy, solar energy, water energy, biomass energy, geothermal energy, Ocean energy, etc.

• 《Building Energy Saving Management Regulations》: The state encourage the application of solar energy and geothermal energy in the new buildings and the retrofit buildings

• In 2004, National Development and Reform Commission issued the first documentation 《National Energy efficiency, mid-long term planning》: push the application of renewable energy in building, such as solar energy, geothermal energy, etc.

• In Aug. 2006, The State Council issued 《Strengthening the energy efficiency work》: Develop widely renewable energy such as wind energy, solar energy, biomass energy, geothermal energy, water energy, etc.
《China National program response to Climate Change》: Support the development and application of wind energy, solar energy, geothermal energy, ocean energy, etc. especially the geothermal and ocean energy. Spread the technology of space heating and hot water supplying with geothermal energy.
• The Ministry of Construction and the Ministry of Finance jointly issued the 《Opinions on Promoting Application of Renewable Energy in Buildings》，《The Tentative Management method of Renewable Energy Development Special Fund》 and 《The Assessment method of the renewable energy demonstration projects》. Clearly support the promotion of the utilization of renewable energy in buildings. Provides special subsides to the pilot projects.
Policy

There are 8 key areas in 《Opinions on Promoting Application of Renewable Energy in Buildings》, four of which are GSHP:

- in the area where is rich in groundwater and surface water, using water source heat pump for heating and cooling.
- Using sea water GSHP system for heating and cooling in the coastal areas
- Using Ground-coupled GSHP technology for heating and cooling
- Using sewage GSHP for heating and cooling

Relative Policy and Standards

In Oct. 2006, Shenyang City government issued 《Implementation work Guidance on boosting the construction and application of GSHP》, reach 18 million m² GSHP in 2007.
Standards and codes

• 《Technical code for ground source heat pump system》 GB50366-2005
• 《Water-source heat pump》 GB/T19409-2003
• 《Design and Construction on the cool/heat source station of GSHP》（Atlas 06R115）

— Apply to new construction, renovation and expansion of the industrial and residential buildings

《Design Atlas on water-source heat pump》
— Engineering drawings have been applied and tested in practice, relatively close to reality
Relative Policy and Standards

Technical/Engineer Books

- 2004, 《Design of WLHP Air conditioning system》
- 2006, 《Design and Application of GSHPs》
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The R&D work

- Research on the suitability (adaptability) of GSHP technology
- Evaluation method for the impact on the environment
- Design method of optimizing GSHPs for energy efficiency
- Develop testing technology of GSHPs
  - detection technology for the formation of borehole
  - detection technology for the physical properties of the soil
  - detection technology for the system operation properties
The R&D work

• Application technology research on Ground-coupled HP
  — research on the underground heat exchanger
  — research on the buried underground backfill material

• Underground water HP
  — research on the inject technology of underground water source heat pump

• Sea water, sewage water HP
  — develop heat exchange equipment which is anti-clog and anti-corrosion.

• Research on the evaluation parameter system for the application of GSHP

• Research on the evaluation method for the operating performance of GSHP
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**The Application**

**Underground water HP — Beijing Friendship hospital**

**AC. area:** 53,000 m²  
**Cooling load:** 4200 KW  
**Heating load:** 3800 KW  
**Well numbers:** six, three for charge wells, two for recharge wells, the other for desanding well  
150 cubic meter/hour /well.  
Depth: 81m  
Operation and Maintenance **costs** (heating): 16.9 RMB/㎡  
Operation and Maintenance **costs** (cooling): 10.14 RMB/㎡  
Completion: 2003.9
Floor area: 178,000 m²
Heating load: 15 MW
Cooling load: 16 MW
Well numbers: 8 for charging, eight for recharging, two for desanding wells.
Depth: 110 m
Total water quantity: 1170 m³/hour

The biggest underground water project in China
The Application

• Underground water HP — Beijing Haidian foreign language school

“Single recharge well”
AC area: 65308 m²
Heating load: 4717 kw
Cooling load: 4581 kw
Operation and Maintenance costs (heating): 19.39 RMB /m²
Ground-coupled HP

—Beijing Jiuahua Villa

Ground-coupled HP+ ice storage

AC area: 131,262 m²

Initial cost: 38 million RMB

Cooling load: 131,26KW

Heating load: 10,500KW

700 double-U exchangers,

100 meter deep
Ground-coupled HP
—Beijing Yongyou software center

Ground-coupled HP+ ice storage

- First stage floor area: 184,000 m²
- AC. area: 160,000 m²
- Total heating load: 13,391KW
- Total cooling load: 15,784KW
- Domestic hot water heat consumption an hour: 1,722KW
- Cost equivalent: 270 RMB/㎡
- 616 boreholes, 120m depth
- Diameter: 150mm
Ground-coupled HP – Nanjing LangShiYuan

- Total floor area: 220,000 m², 16 residential buildings are in use of GSHP for space heating and cooling, with cooling tower as auxiliary. There are two end forms: roof radiation system and replacement fresh air system, etc.

The B-1 district with 6 buildings was finished, the floor area is 68115.62 m²
- Cooling load: 2333.71kW
- Heating load: 1827.83kW
- 1187 boreholes with the depth of 60m

Largest Ground-coupled GSHP
The Application

Surface water HP (sea water)
- Qingdao Olympic surfing base

Media center

Media center floor area: 8138 m²
Heat load: 492 kW
Cooling load: 795 kW
Initial investment: 495.2 RMB/m²
Surface water HP (sea water)  
— Shandong Weihai Star

First viewing tower being built on the sea in the world

The lower part with 14 floors has a floor space of 25000 m², the upper part with 6 floors has a floor space of 4000 m²

Cooling load: 3050 KW

Heating load: 2670 KW

Sea side water temperature in summer 24/29°C,  
Sea side water temperature in winter: 2.3/0°C
Surface water HP
-Dalian Xinghai Convention and Exhibition Center

Total floor area: 257,800m²
Total cooling load: 24.48 MW
Total heating load: 19.56 MW
Initial investment: 351.6 RMB/m²

Sea side water temperature in summer
23/33°C,
Quantity: 3072 m³/h

Sea side water temperature in winter
3/0.5°C,
Quantity: 5130 m³/h
Sewage source heat pump—Beijing Olympic village

AC area: 393,000 m²
Initial investment: 117,000,000 RMB
Sewage treatment capacity:
400,000 t/day
Sewage temperature: Winter: 16-20°C; Summer: 20-25°C
Pipe length: 3KM
Cooling load: 32MW Heating load: 37MW
The Application

• **Surface water (Industry waste water) HP**
  – Daqing Ranghulu District

Total floor space: 3.2 million m²

Pipe length: 7KM

- Heating load: 192 MW,
- Hot water load: 28 MW.
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Five Zones:
- Severe Cold
- Cold
- Hot Summer & Cold Winter
- Temperate
- Hot Summer & Warm Winter
The features

• Due to its huge area, China was divided into 5 climatic zones from north to south. In north areas, our main attention is heating, while in south, cooling. An absolutely large part of China is in need of both heating and cooling.

— The coexistence of various kinds of GSHP was caused by the multiple climate zones in China. Accordingly, we should make use of renewable energy in buildings based on different location and climatic zones.
The features

• Guide by the technology, promoted by the industry, lead by the government, choose by the market

• Study the experiences in advanced countries integrated with our own situation, innovate and promote this GSHP technology

• Pilot projects----- demonstration with different types--- promotion

• With regard to underground water HP, the initial system investment is approximately 300-400 yuan/m²; as for ground- coupled HP system, The initial investment should be 350-450 yuan/m².

  — The initial investment is a bit more compared with the conventional single heating or cooling system, while the difference is slight compared to chiller unit together with district heating with boiler or gas boiler.

  — The initial investment is relatively low compared to developed countries.
Promote the sustainable development,
Build up the energy saving and environmental friendly society

Thanks