Large Scale Solar AC System Project

China Singyes Solar Technologies Holding Ltd.

Green Building Research Center

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1. Brief introduction of Singyes Solar
1. 1 Singyes Solar-Leading a low carbon economy in china

- Founded in 1990; listed in HK stock market in 2009
- More than 2000 engineers, corporation income >5 billion in 2014
1.2 Singyes Solar Manufactory Plant in Hunan

The world’s largest rooftop solar power station (20.8 MW) & 480KW Solar AC System built in Singyes Hunan Plant in 2012.
2. Working Principle of Singyes Solar AC System
2.1 Project overview

Location: Xiangtan · Hunan.
Average annual temp. is about 17°C
Average annual solar radiation : 4030 MJ/m².

Detail information of solar AC system:

<table>
<thead>
<tr>
<th>Type</th>
<th>AC Area</th>
<th>Cooling load</th>
<th>Heating load</th>
<th>Hot water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exhibition Hall</td>
<td>4,700 m²</td>
<td>480 kW</td>
<td>390 kW</td>
<td>/</td>
</tr>
<tr>
<td>Office Rooms</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Restaurants</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Dormitory</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>30T/day</td>
</tr>
</tbody>
</table>
2.2 Singyes Solar AC System’s Working Principle

Evacuated-tube solar collectors

- Hot water tank
- Absorption chiller 1
- Absorption chiller 2
- Cooling tower

Heating mode

- User Water tank
- AC terminals

Cooling Mode
### 2.3 Components of Singyes Solar AC System:

① **Heat pipe evacuated-tube solar collectors**

<table>
<thead>
<tr>
<th>Specifications of the solar collectors</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working temperature</td>
<td>50~90°C</td>
</tr>
<tr>
<td>Installation area</td>
<td>1,600 m²</td>
</tr>
<tr>
<td></td>
<td>256</td>
</tr>
</tbody>
</table>

Evacuated-tube solar collectors
2.3 Components of Singyes Solar AC System:

② Two LiBr Absorption chillers

<table>
<thead>
<tr>
<th>Cooling Capacity of Absorption Chiller</th>
<th>Auxiliary energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Libr Absorption chiller 1</td>
<td>230kW</td>
</tr>
<tr>
<td>Libr Absorption chiller 2</td>
<td>250kW</td>
</tr>
<tr>
<td></td>
<td>Natural gas</td>
</tr>
</tbody>
</table>

Absorption chiller 1

Absorption chiller 2
2.3 Components of Singyes Solar AC System:
③ Monitoring and control devices

Real-time monitoring system
2.3 Components of Singyes Solar AC System:  
④ Air terminal modules

- Embedded fan coils in exhibition hall
- Embedded fan coils in restaurants

Air terminals in the office
3. Performance of Singyes Solar AC System
3.1 Performance Data Analysis:

(1) Solar Irradiance VS. Driven Hot Water Temp.

Temperature of driven hot water is directly proportional to solar irradiance with delay.
3.1 Performance Data Analysis:

(2) Chiller’s Cooling Output VS. Driven Hot Water Temp.

The chiller’s output increased dramatically when the driven hot water temp. > 70°C.
3.1 Performance Data Analysis:

(3) Chiller’s Efficiency VS. Driven Hot Water Temp.

The average efficiency of the chiller is about 0.6 in the typical summer day.
### 3.2 Singyes Solar AC System Running Cost
(Compared with the conventional system)

<table>
<thead>
<tr>
<th>Seasons\Running cost (¥)</th>
<th>Singyes Solar AC system</th>
<th>Conventional system</th>
<th>Cost Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summer</strong> (150 days) : 480 kw cooling load</td>
<td>121,300</td>
<td>199,400</td>
<td>78,100</td>
</tr>
<tr>
<td><strong>Winter</strong> (120 days) : 390 kW heating load</td>
<td>82,200</td>
<td>105,700</td>
<td>23,500</td>
</tr>
<tr>
<td><strong>Spring and Autumn</strong> (90 days) : hot water 30T/day</td>
<td>40,000</td>
<td>122,500</td>
<td>82,500</td>
</tr>
<tr>
<td><strong>Annual cost</strong></td>
<td>243,500</td>
<td>427,600</td>
<td>184,100</td>
</tr>
</tbody>
</table>

The annual cost Y

![Bar graph showing cost comparisons between Singyes Solar AC System and Conventional system](image)
3.3 Performance Conclusions

- **Chiller efficiency** (driven hot water temp):
  The chiller have a higher efficiency when driven hot water temp. >70 °C.

- **Effective factor** (solar radiation):
  Building a larger hot water storage tank may decrease the effective factor of solar radiation, which can make the system working more stable.

- **Auxiliary energy** (natural gas):
  Increasing the solar collectors’ area may decrease the gas consumption and the running cost.
3.4 Advantages of the Solar AC System

- **Environmental friendly:**
  Non-freon system, decrease the Greenhouse effect

- **Low running cost:**
  Can supply heating in winter, supply cooling in summer, supply the hot water in the other seasons by mostly using the solar energy.

- **Good seasonal adaptability:**
  Cooling and heating capacity of the system is directly proportional to the solar radiation
3.5 Limitations for promotion of the Solar AC System

- High initial investment:
  long payback period

- Limited building installation areas for the solar collectors:
  higher running cost

- Low absorption chiller’s running efficiency:
  can not fulfill the user’s cooling and heating load
4. Prospects for Solar AC Development
Prospects for the Solar AC System Development

- High efficiency solar collectors;
- High efficiency chillers in low driven temperature;
- Low cost phase change material for energy storage.
The End
Thank you!