Feasibility Study of Household Solar Photovoltaic Heating

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ABSTRACT: *Solar energy is a kind of natural and clean energy which will play an important role in the future of human society.The components of household solar photovoltaic heating include: battery board, battery, controller, battery, DC, AC inverter,the power control box, electric heating heating system. Calculating the laboratory thermal load and with the ability of heat load of laboratory and solar photovoltaic equipment, then get the number of solar panels.*
**Keywords:** *Solar heating，Photovoltaic power generation*

I.   PREFACE

Long coal dominated energy structure of our country and the single energy consumption pattern has brought serious environmental pollution. With the rapid development of economy and the continuous growth of energy demand, the greenhouse gas emissions caused by fossil fuel combustion have caused more and more pressure on the environment. In the face of the current fossil energy consumption and serious environmental crisis,it is urgent to adjust the energy structure. In the new energy, solar energy has the absolute advantage, the solar thermal utilization has been rapidly developed and widely used in our country, mainly in the use of solar heating and domestic hot water. This is China's earliest development and large-scale renewable energy industry. Now the solar water heater our country has 125 million square meters, the number of the world accounted for about 70% [1] . But the use of solar thermal is only a very small, and not limited to the use of heat. We should expand the application fields, such as solar energy into electrical energy by electric energy into various forms of energy or power needs of human beings. At present, the internationally recognized methods of thermal utilization of solar are energy utilization, power utilization, solar battery, photochemical utilization and fuel utilization.[2]

1. Principle of solar heating system
A household solar system components including panels, battery, controller, battery, DC, AC inverter, power control box and a water storage heat circulation system composed of several [3] .

The specific structure as shown in Figure 1.
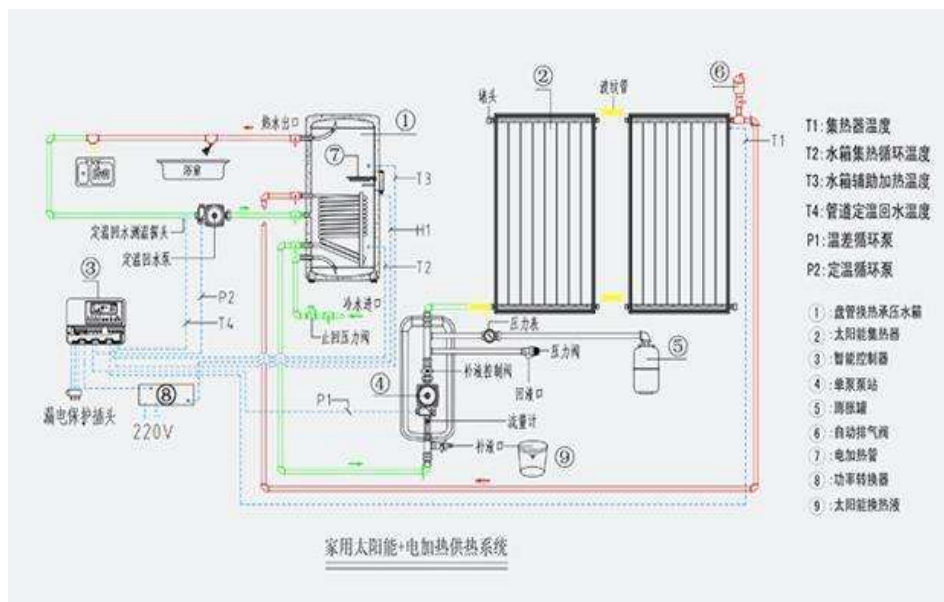
Figure 1   household solar heating system
The solar panel is the core part of the solar photovoltaic system. The function of the solar panel is

to convert the solar energy into electric energy, and then output the direct current to the battery. The solar panel is one of the most important parts in the solar photovoltaic system,and the conversion rate is determined and the service life of solar cell is an important factor use value. Usually designed in accordance with the relevant IEC standard requirements, using 36 or 72 pieces of polycrystalline silicon solar cells are connected in series to form a component of 12V and 24V of various types. The module can be used for a variety of household photovoltaic systems, stand-alone photovoltaic power plants and grid connected photovoltaic power plants. [4]

The battery is used high (more than 16.5%) of the solar chip package, to ensure that the solar panels generate enough power.The solar controller is composed of a dedicated processor CPU, electronic components, display, switching power tube and other components. The battery (Storage Battery) is a equipment that make chemical energy into electricity directly, which according to the rechargeable battery recharging design, achieved by reversible chemical reaction.It refers to the lead-acid battery, it is a cell and belonging to the two battery. Its working principle: when charging the external power for the regeneration of internal active substances, the energy stored as chemical energy, and discharging again the output of chemical energy into electrical energy when needed, such as commonly used in mobile phone batteries. DC inverter, AC inverter is the device for converting DC into AC . Due to the solar battery and storage battery are the direct current and the DC load is AC load.By using inverter equipment, DC solar generated electricity or battery DC into AC load release if needed. Continuous and sufficient electricity can be used for the electric heating system operation. The working principle diagram of electric heating system is shown in Figure 2.
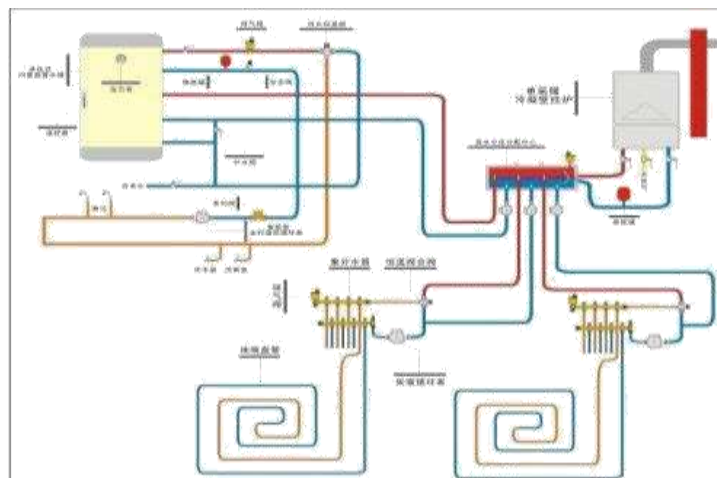

Figure 2 Electric heating system working principle diagram

2. Economic benefits of solar heating system

Thermal load analysis of heating system According to the characteristics of heating load of retaining structure of test room is calculated, including the basic consumption of the retaining structure, infiltration heat loss and cold air heat invasion.[5]

2.1. Design and calculation of heating load

The experimental room of the total construction area is about $40m^2$ and with an area of $34m^2$, mainly including indoor office furniture, lockers and other facilities. During the winter, in order to maintain the indoor air at a certain temperature, we need heating equipment to meet the heating of the heating room. The heat load of the heating system design refers to the design of the outdoor temperature. The heat in the unit time within the building supply heating system is based on the basic design of the heating system. According to the design of heat load, including heat retaining structure, infiltration heat loss and cold air intrusion into consumption.

2.2. The basic structure of the heat consumption

Calculation of retaining structure for Q' basic consumption

In type:

$$Q' = KF(t_n - t'_w)\alpha \quad W \qquad (1)$$

K -- the thermal conductivity of the envelope structure, W/ (m²·°C);

F -- the heat transfer area of building envelope(m²);

t_n -- winter indoor temperature (°C)

t'_w -- heating outdoor temperature(°C);

α -- temperature difference correction factor;

According to the selection of the design,we can design outdoor heating temperature as -2 degrees Celsius and the indoor temperature as 20 degrees Celsius.

According to equation (1) of the heating load calculation of each envelope, we can get the test room envelope, Q = 1292.04W. Affected by some meteorological conditions, the actual consumption of enclosure structure needs to be corrected.The main orientation correction of wind heat consumption, heat consumption and real high additional heat loss can be calculated from experimental. Envelope of a room after correction of the total heat Q_1' equals 1186.94 W.

2.3. Infiltration heat loss

Due to the effect of wind pressure and hot pressing, the outdoor air gap through the closed door and window, entering the room and is heated back to the outdoors. In this process, the cold wind will take away part of the heat. Therefore, the cold air consumed from the outdoor temperature heating to room temperature heat, which is called the air infiltration. According to the experimental research object, the calculation of cold air infiltration should be this.

Infiltration heat loss:

$$Q_2' = 0.278 V \rho_w c_p (t_n - t'_w) \qquad (2)$$

V -- the total air volume into the room through the door gap m³/h;

c_p -- cold air specific heat capacity at constant pressure kJ/ (kg ·°C);

ρ_w --outdoor temperature air density, kg/m^3;

To determine the total amount of air into the interior of the door, by type (3) is calculated, i.e.

$$V = Lln \qquad (3)$$

Formula: L - the amount of air penetration per door window into the room, m³/(m·h);

L --the length of the external doors and windows(m);

N --the correction coefficient for the penetration of cold air;

Into the look-up table and calculated data, get the air infiltration

$Q_2' = 55 \quad W$.

2.4. Cold air invasion of consumption

Open cold air indoor after absorbing indoor heat and increase its temperature after leaving the room away,which is called cold invasive heat consumption. The cold invasive energy consumption calculation accords with the type (4)

$$Q_3' = N Q_{1 \cdot j \cdot m}' \quad W \qquad (4)$$

Type

N -- the outer air invasion of the additional rate(%);

$Q_{1 \cdot j \cdot m}'$ -- the basic consumption outside the door, W. Because no room door, so there is no need to consider the cold wind heat invasion.

Thus, $Q_3' = 0$, total consumption of test room.

$$Q' = Q_1' + Q_2' + Q_3' \approx 1786 + 55.38 = 1242.32w \qquad (5)$$

Heating period of 24 hours of uninterrupted heating, the heating period of daily electricity consumption

$$1.24 kW \cdot h \times 24 = 29.8 kW \cdot h \qquad (6)$$

2.5. Solar array
Determining the number of solar cells based on the thermal load Solar panels with power of 310W
Assume that the effective daily illumination time is 7 hours and the efficiency is about 90%

$$29.8 \div (7 \times 0.310 \times 0.9) = 15 \qquad (7)$$

Taking into account the domestic solar photovoltaic panels in the domestic Chinese installed in the apartment building is difficult to implement, but it can be implemented in a private villa and village square. General household solar photovoltaic power generation in Shanghai is more than 5kW grid connected photovoltaic power generation system, the number of solar panels at least more than 18.Meet the needs of a long time in a room heating, and there will be residual incorporated into the national grid.

There will be 7 per watt to 10 yuan expenditure during initial installation. Photovoltaic power generation proceeds mainly by power occupied power over the Internet state subsidies to local subsidies, according to state subsidies 0.42 yuan / kWh to prevail in Shanghai area as an example, the system is equal to the per kilowatt, it can be used free oneself electricity and we can get a government subsidy of 0.82 yuan. Of course, different subsidies over. In this way, the cost recovery period of about 4-5 years. The cost of photovoltaic power generation is also related to the quality of PV modules, we do not advocate the purchase of low quality components.According to statistics, the use of low quality products will affect the use of the entire system life and maintenance cost, directly affects the cost recovery period.

II. CONCLUSION

Household photovoltaic power generation system market is still very broad, but limited by the current policy is not complete, the market environment is depressed, the cost is too high, there is no large-scale development.

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