Study and performance of solar domestic water heating system (SDWHS)

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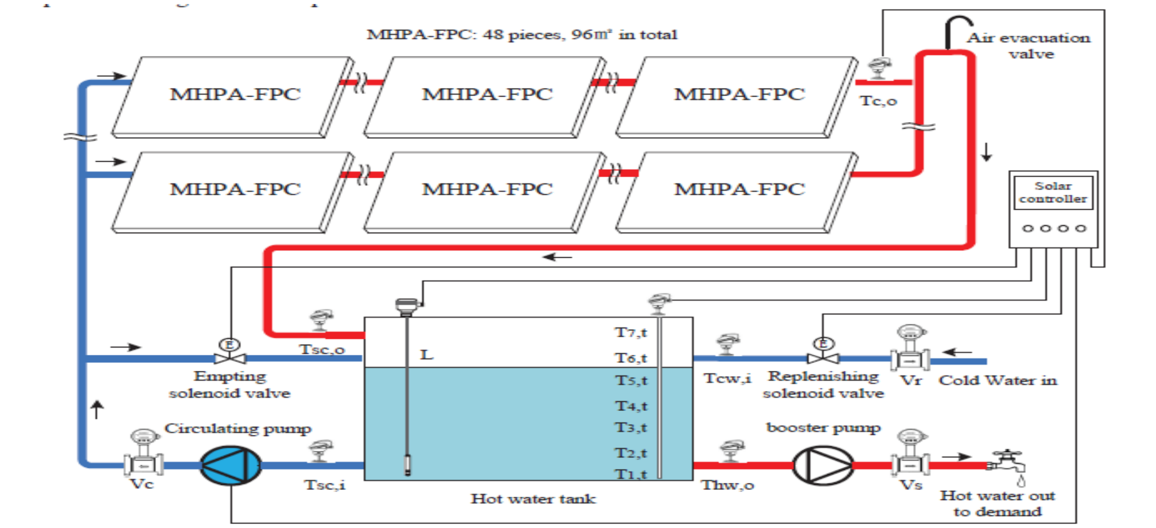
Abstract- **Solar domestic water heating systems (SDWHS) are widely used in China, with an installed collector area of more than 330million square meters by the end of 2014. In this study, we explored cost-optimal renewable-based district heat production systems and potentials to integratesolar heating systems in such systems under different contexts. A project has been conducted on an indirect natural circulation solar water heating system which is hung on a simulated balconywall in Lianyungang City in the east of China. The daily system efficiency could reach 62% with large solar irradiation and small temperature between the collectors' temperature and the ambient temperature. Experiments on SDWHS have been performed on the platform as well as on the ground,respectively. It has been found that the relative difference of the daily thermal efficiency measured by the two methods is lowerthan 3%.**

I. INTRODUCTION

The urban environment resides more than 50 % of the world's population. It is desirable to employ distributed sustainable energy technologies in order to supply its energy needs and to lower the impact on the environment [1]. Electricity and district heat (DH) production based on renewable resources is normally given priorityin many European member states, especially the Nordic countries [2]. Solar water heating systems (SWHSs) are widely applied in both domestic and commercial sectors. With huge amount of solar irradiation of about 50×10^{15} MJ received each year[3].China has become one of the top countries in the world in using solar energy. Study on the performance of SWHS has profound significances and broad market prospects, especially in China.The reduction of the energy consumption is one the main actual challenges. Energy management of building heating regulation systems – especially in buildings with a high proportion of active as well as passive solar energy– requires new approaches. These buildings are equipped with latest technologies such as solar panels, geothermal heat poles, heat pump etc.In fact, the goals of primary energy use and CO2 emission reduction in Europe can be achieved at a lower cost with district heating [4]. In this study, we explored cost-optimal renewable-based DH production systems and potentials to integrate solar heating systems in such systems under different contexts of wood fuel price. We investigated under what conditions a solar heating system become cost-efficient to integrate and theconsequences of this integration in a small-scale DH production system in the south of Sweden.[5].



$T_{c,o}$ is water temperature at the collector outlet, ℃; $T_{sc,i}$ and $T_{sc,o}$ are water temperatures inlet and outlet to the solar collector array, ℃; $T_{cw,i}$ is cold water temperature, ℃; $T_{hw,o}$ is hot water supply temperature, ℃; V_c, V_r, V_s are water volume flow rate of circulation, cold water replenishment and hot water supplement, $m^3 \cdot h^{-1}$; L is water level, m; $T_{1,t}$-$T_{7,t}$ are water temperature at the different level of tank, ℃.

Fig.2. Schematic diagram of the SWHS

II. SOLAR WATER HEATING SYSTEM

The diagram of the solar water heating system is shown in Fig. . The flat plate collector absorbs the sun's rays and turns the rays into heat energy, heating working fluid in the circulation pipe. As the temperature of working fluid raises, the density decreases slightly, then the hot working fluid in the circulation pipes thermo siphons into the jacket and heats the water in the tank. After heat exchange, the cold working fluid flows back to the collector through the circulation pipe. With continuous thermo siphoning, the water in the tank will be heated
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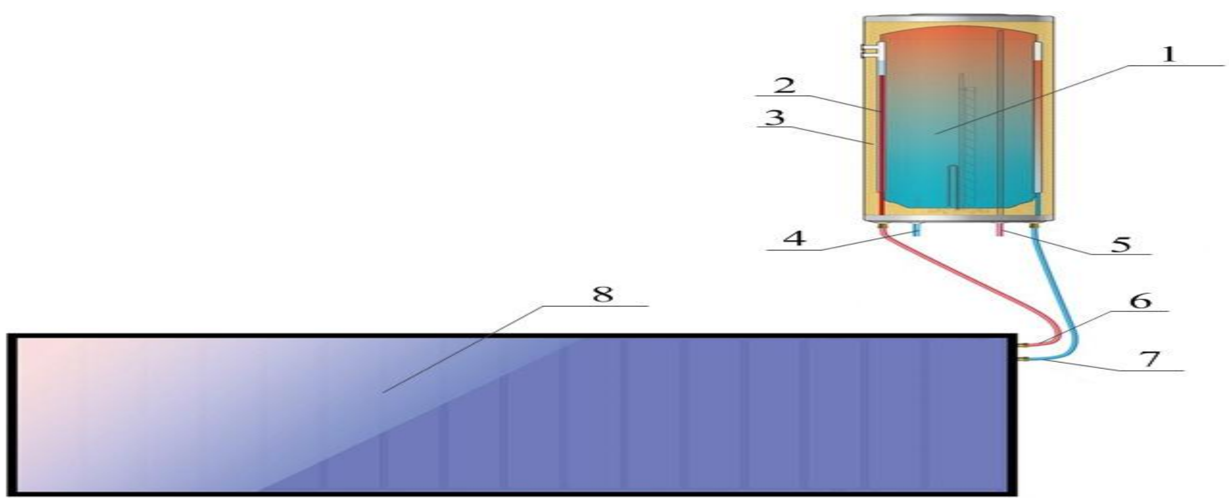


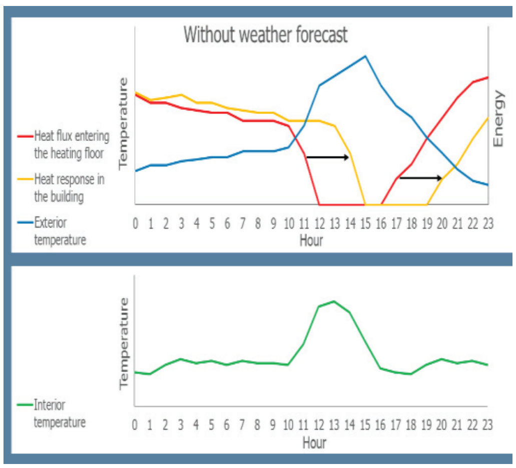
Fig:-system diagram

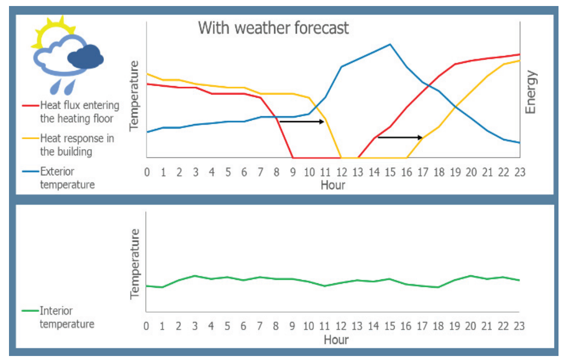
1. Water tank 2.Jacket of water tank 3.Polyurethane insulation layer 4.Inlet of water tank5. Outlet of water tank 6.Outlet of collector 7.Inlet of collector 8.Flat plate collector

III. BUILDING HEATING NEEDS

New regulation is based on the building heating needs forecast. Calculated based on the weather forecast, the building heating needs for the next 48 hours are anticipated.

In a standard regulation of a heating system based on heat pump, the heat provided depends on the actual and previous exterior temperatures. Future exterior temperature aren't considered and, therefore, an increase of exterior temperature induces an increase of ambient temperature in the building leading to useless consumption of energy , see Fig. Thus, anticipation of building heating needs is a method to take into account the building inertia and to ensure a stable ambient temperature in the building. This method will allow to spare energy and avoid thus the waste energy. The potential of economy, using this method has been evaluated at about 10% [6].





IV. DESIGN CONCEPT

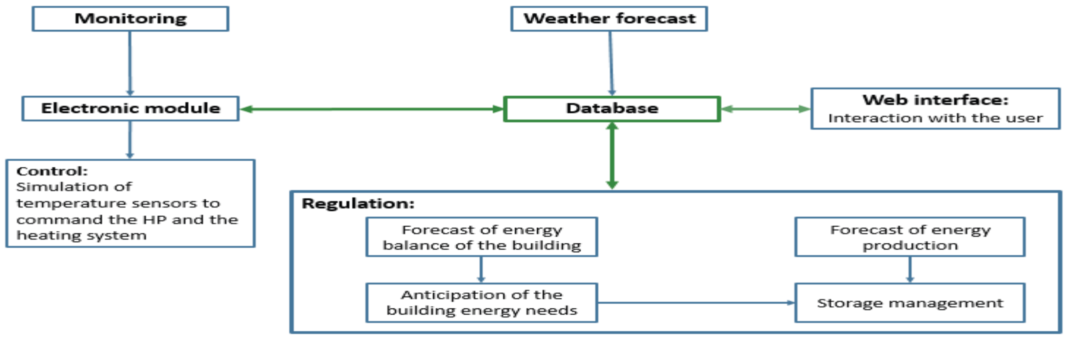
The system uses concentrating parabolic trough collectors that convert the sun's energy to thermal energy ,delivered as 175°C (347°F) pressurized hot water. This hot water is used to either generate (i) electricity from an Organic Rankine Cycle (ORC) power generator, (ii) chilled water of 12°C (54°F) from an absorption chiller or (iii) domestic hot water of 78°C (172 °F) directly from the solar collectors or through the condenser heat of ORC and chiller. The domestic hot water is delivered in parallel to a flat plate solar collector system which was designed as a secondary stand-alone system for research purposes.[5Jeremy P. Osborne Paul Kohlenbach, Uli Jakob, Johan Dreyer , Jamey Kim]

V. REGULATION'S STRATEGY

The regulation's strategy is built and developed on 4 main principles

1. Forecast of energy production,
2. Forecast of energy building needs,
3. Storage management,
4. The utili zation of the past monitored data to improve the future regulation,

improving thus the heating system, optimizing the solar energy use and storage and decreasing the dependency onthe grid. This approach is possible thanks to the monitoring of the facility and the weather forecast.[7].



VI. CONCLUSION

The total radiation received on the inclined surface of the solar water heating system hung on a balcony wall throughout the year was large and well balanced. The heat gain of the solar water heating system hung on a balcony wall was affected by the solar irradiance and the ambient temperature greatly.The heat gain and the average daily efficiency of solar water heating system hung on a balcony wall increased with the increase of ambient temperature.With the increase of ambient temperature, the temperature drop of the water tank t decreased, but the average loss factor of the hot water system changed little throughout the year.In addition, the influence of different slopes of the circulation pipes on the heat gain of solar water heatingsystem hung on a balcony wall was small.

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