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USE OF RENEWABLE ENERGY TO ENSURE THE THERMAL INDEPENDENCE FOR A LIVING BUILDING USING SOLAR HYBRID SYSTEMS

BY

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Abstract. Making solar hybrid systems and their integration within existing buildings or new buildings require financial efforts and special materials, such as attention to these systems is not accidental.

This comparative study of a classic system and one proposed applicable to the residential buildings, is a step in the design phase and planning for such systems in order to achieve the ultimate goal: economic increase and energy efficiency.

The aim is to achieve a unified analysis of solar hybrid system, the application actually achieved in a residential building. The comparison is even more necessary and more difficult because the solar hybrid systems are complex technical systems, the multiplicity of performance evaluation criteria often leads to the need for a global criterion (economic).

Key words: heat pump; solar energy; solar collector; efficiency; cost.

1. Introduction

Improving energy efficiency of industrial processes and residential, stands – largely – by introducing the secondary circuit energy resources and develop simultaneously occurring processes of this type.

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Heat pumps are part of installations using these resources contributing substantially to a better management of energy needed to supply heat required for various processes but, especially, for preparation of hot air, respectively, hot water or heating.

The need to implement these devices in buildings is closely related to domestic and international application of the legislation.

We conclude that the heat pump is an alternative that should be considered, seriously, assuming construction of residential or social-cultural but there may be a solution for replacement of heating or air conditioning in buildings existing.

2. Heat Pump: Working Principle, Use

The heat pump is a thermal machine that takes a quantity of heat from a low temperature source and gives the heat to a higher temperature source, by this effect the heat pump consuming energy. This energy consumption can be of varied nature: mechanical, electrical, thermal, solar, etc.

Principle of operation of heat pump was set back in 1852 by William Thomson (Lord Kelvin). This principle is identical to that of refrigeration, except that the cycle of operation of heat pump is located above the temperature of the environment.

Fig. 1 presents, in a schematic mode, the operating principle for a thermal machine.

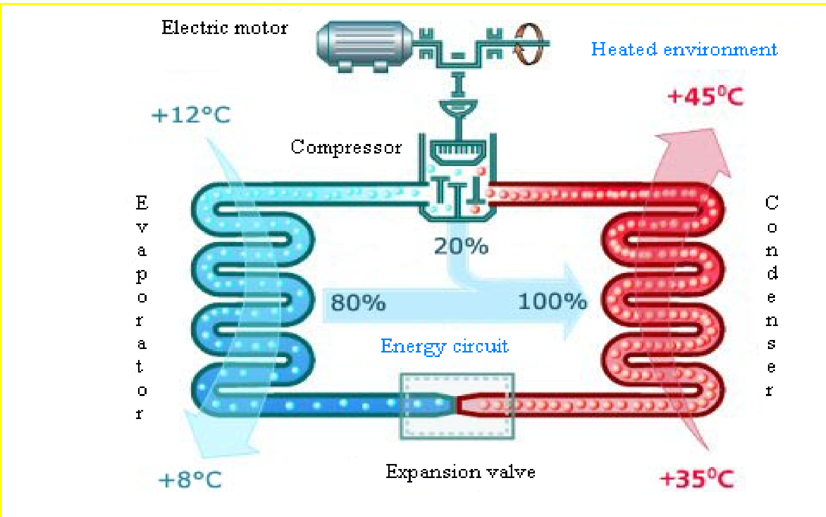

Fig. 1 – Heat pump's principle of operation.

Them get about three quarters of the energy required for heating from the environment and the rest uses electricity as energy drive as shown in Fig. 2

(typically providing starter motor to train the compressor heat pump a quantity of electricity of 1 kWh it will deliver about 3 kWh heat).

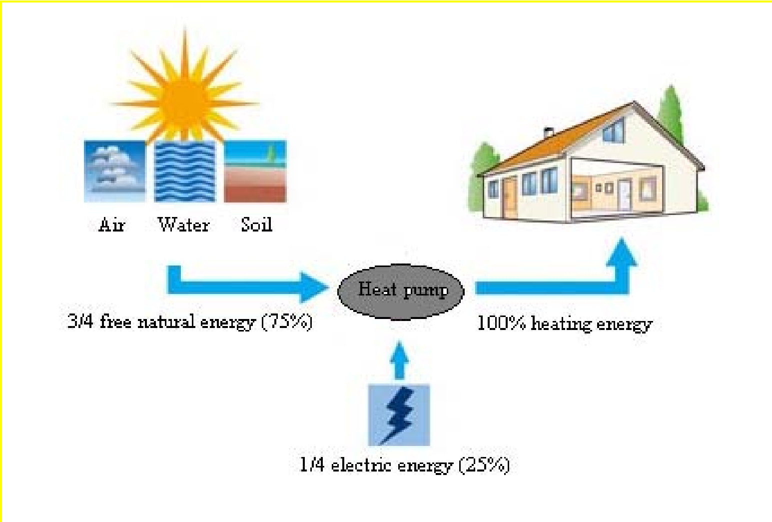

Fig. 2 – Renewable energy of a heat pump

Therefore, a mechanism that pumps heat from a low temperature environment to a high temperature, using the external power, may be particularly attractive to heat a building as a part of heat is taken “free” in the environment using a smaller amount of energy “conventional”, and heat from the outside is renewable under the combined action of sun, wind and rainfall.

By swap the roles of evaporator with condenser through a vein four-way will get a reversible heat pump, that is a machine used for air conditioning heat in summer.

It can be said that heat pumps – as energy conversion systems – is a smart way to transfer heat to the environment existing inside or outside the home.

These machines can provide thermal heat typically to temperatures of about 120°C.

For space heating, the heating must be delivered at temperatures below 90°C, which means that heat pumps can provide energy to heat for cover the entire range of temperatures encountered in heating, energy accounts for about 26% of total primary energy consumption.

Thermal analysis equipment must, also, be able to compete with those facilities that can simultaneously produce both electricity and thermal systems that currently are economically competitive, but the major disadvantage is represented by the fact that this one can not recover heat from the environment; the heat pump technology providing the premises necessary to efficiently use solar energy stored in water, soil and air as environmental heat.

3. Hybrid Systems Analysis Methodology to Ensure Thermal Independence

Analysis of technical performance, economic and financial hybrid system to ensure the heat independence for single-family housing was performed using the computer program RETScreen.

To obtain weather data and solar radiation (Fig. 3) the proposed system was located in Iaşi city, which corresponds to the IIIth temperatures zone.

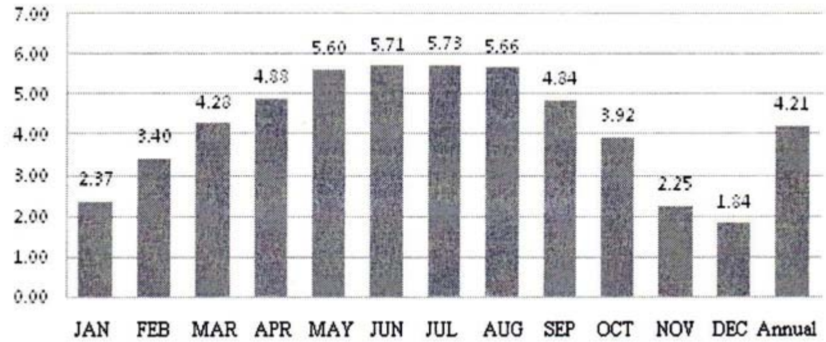

Fig. 3 – Daily solar radiation, tilted in the city Iaşi.

Hot water requirements according to STAS 1478-90 is of 60 L/person/ day with a running time of seven days per week and average heat demand is of 99 W/m (IIIth temperature zone).

The cost of natural gas in the year 2011 is of 0.036 €/kWh and the electricity cost is of 0.074 €/kWh in the same year.

To highlight the performance of the proposed scheme has made a comparative analysis between the reference case (natural gas central heating) and the proposed event (heat pump and solar thermal panels).

For reference case it's used a natural gas central heating with an efficiency of 80%.

For the proposed case a heat pump type soil–water with 350% efficiency and flat solar collectors with a fixed inclination of 45° and a conversion efficiency of 72% are used.

4. Case Study – Economic and Financial Analysis of Hybrid System, Heat Pump and Solar Heat Panels

In principle, block diagram of a hybrid plant for preparation heating and hot water has the following structure (Fig. 4):

a) Production subsystem, composed of solar collector, heat pump, the primary agent network, associated valves and equipment that ensure the smooth circulation of the primary agent.

b) Transport subsystem, composed of distribution networks and equipment to ensure smooth flow of the primary agent.

c) Subsystem for use composed of radiant floor, radiator, and fan equipment for hot water (mixing batteries).

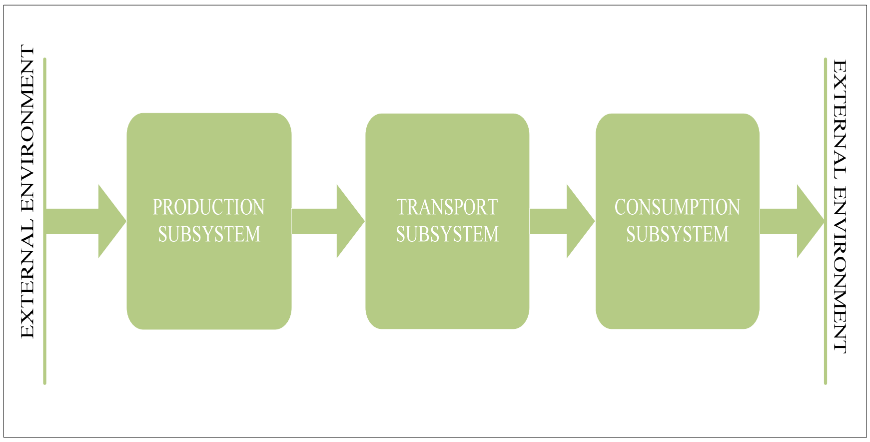

Fig. 4 – The system of hybrid installations for heat and hot water.

In the Figs. 5,…,13 are presented the main parameters for simulation of economic and financial performance of the proposed system (collectors planning and ground-water heat pump) compared with a reference system (natural gas central heating).

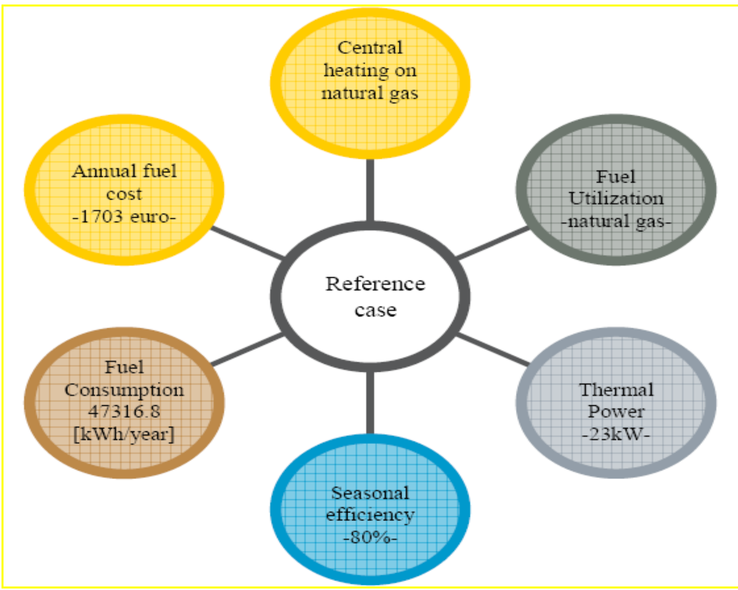

Fig. 5 – The main economic parameters of reference case.

The economic parameters are: a) fuel utilization; b) annual fuel cost; c) thermal power; d) fuel consumption; e) seasonal efficiency; f) solar fraction.

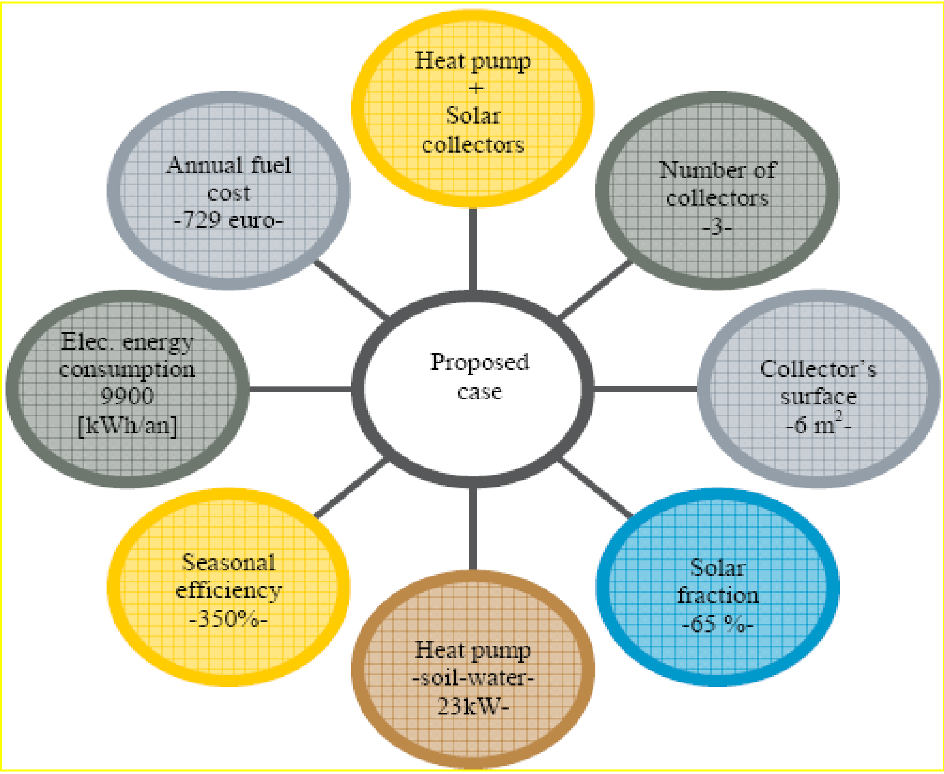

Fig. 6 – The main economic parameters of proposed case.

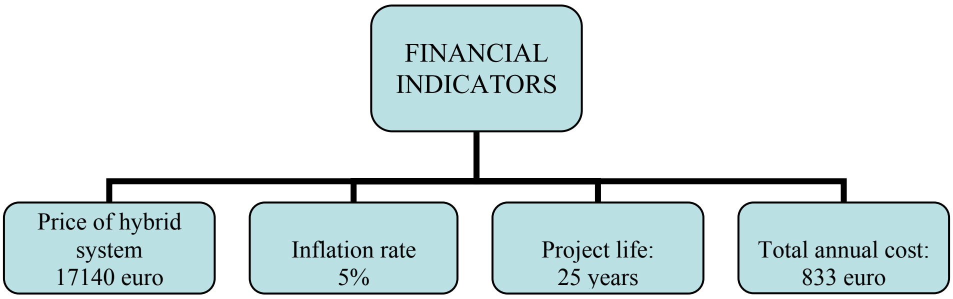

Fig. 7 –Financial indicators of the proposed case.

The Figs. 8,…,15 represent the financial indicators of the proposed system based on fuel value index.

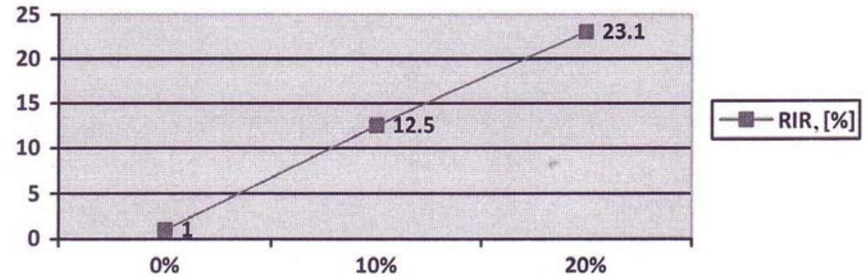

Fig. 8 –Internal rate of profitability of the investment.

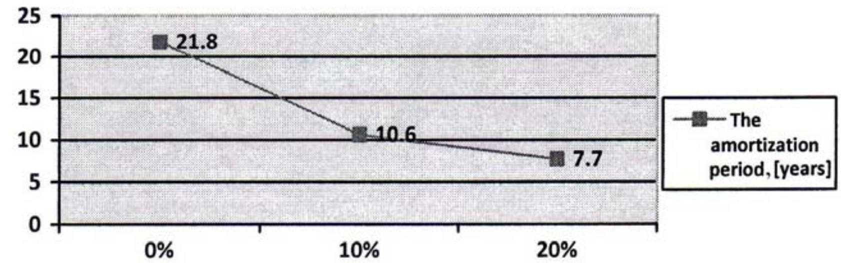

Fig. 9 –The amortization period of the investment.

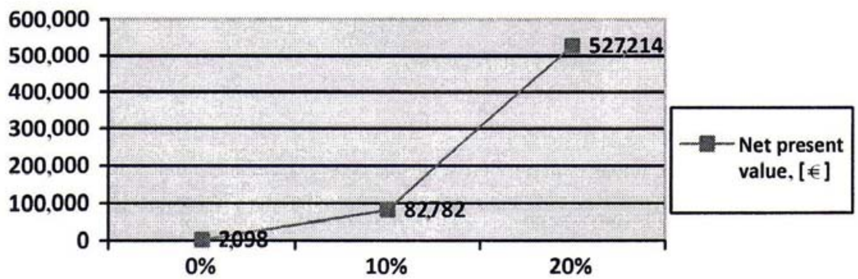

Fig. 10 –Net present value of the proposed case.

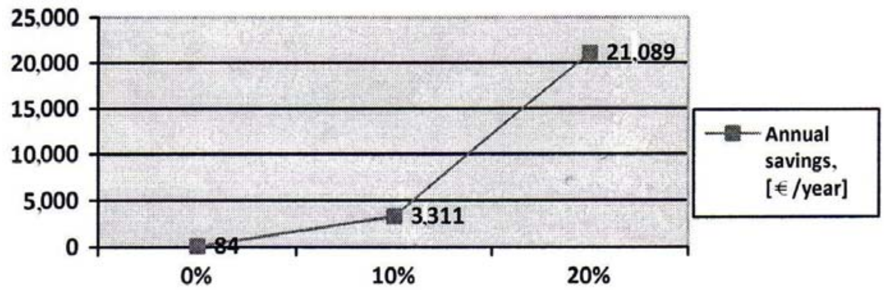

Fig. 11 –The annual savings achieved by proposed case.

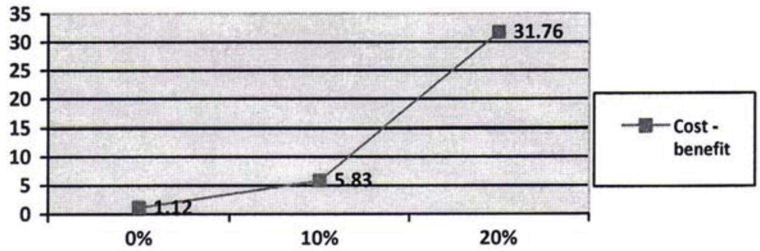

Fig. 12 – Cost – benefit of the investment

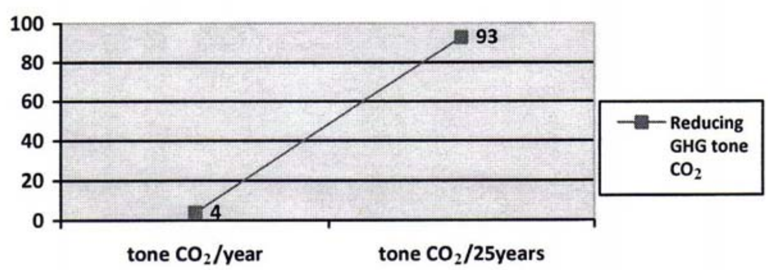

Fig. 13 – The greenhouse gas reductions achieved from the use of proposed case.

5. Conclusions

The present study presents a comparative economic and financial analysis between a hybrid solar system (heat pump and thermal solar panels) and a classical system (natural gas heating central) to provide thermal energy independence.

Using the proposed system ground-water heat pump and solar thermal panels, brings several advantages namely

a) Annual savings depending on the amount of fuel used for indexing the reference case.

b) Reduced conventional fuel during the cold season.

c) Payback periods between 7 and 22 years depending on the amount of fuel used for indexing the reference case.

d) Reduce greenhouse gas emissions.

In pursuit of new technologies designed to solve energy problems, different solutions of energy production are badly needed to meet global demand in a way which does not affect the development of future generations.

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UTILIZAREA ENERGIILOR REGENERABILE PENTRU ASIGURAREA INDEPENDENȚEI TERMICE A UNEI CLĂDIRI DE LOCUIT FOLOSIND SISTEME SOLARE HIBRIDE

(Rezumat)

Realizarea sistemelor solare hibride şi integrarea lor în cadrul clădirilor existente sau a clădirilor noi necesită eforturi financiare şi materiale deosebite, astfel că atenția acordată acestor sisteme nu este deloc întâmplătoare.

Prezentul studiu comparativ dintre un sistem clasic şi unul propus, aplicabile la nivelul clădirilor de locuit, reprezintă o etapa în faza de concepere şi proiectare a unor astfel de sisteme, în vederea atingerii scopului final – creşterea eficienței economice şi energetice.

Scopul propus este acela de a realiza o analiză unitară a sistemului solar hibrid, aplicația realizându-se în mod concret în cazul unei clădiri de locuit. Comparația este cu atât mai necesară, dar şi mai dificilă, deoarece sistemele solar hibride reprezintă sisteme tehnice complexe, pentru care multiplicitatea criteriilor de evaluare a performanțelor conduce adesea la necesitatea elaborării unui criteriu global (economic).