Study Regarding the Possibility of Use the Alternative High Efficiency Systems for Increasing Energy Performance in Suburban Areas

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Abstract. Energy efficiency is often characterized as the most valuable form of energy, since it reduces costs and the negative impact on the environment associated with energy consumption, but also the dependence on energy imports. The highest potential for increasing energy efficiency in Romania is found in the heating of buildings, in the transformation of primary energy resources into electricity. In Romania, 86% of the built area is represented by residential buildings. From the 8.1 million housing units, single-family homes are dominant, accounting for 61% of these. The article aims to highlight the importance of investments in rural areas in order to increase energy efficiency. The energy from renewable sources is not adequately considered in the rural development programming exercise. The energy efficiency measures provide medium-term gain opportunities and long, by promoting saving solutions by reducing production and consumption costs, reducing the environmental impact and at the same time ensuring the promotion of economic and social development. The results of this study show the possibility of developing the “what-if” analysis, which can help the decision makers to choose the best adaptation strategy. In order to be able to make the best investment decisions in equipment and choose the right energy sources, consumers need access to the alternative energy sources (especially in rural areas) and quality information on the options they have and to financing opportunities. Soon, it will be necessary to support the cogeneration systems based on biomass and biogas in semi-urban areas, with the centralized distribution of the thermal agent.

1. Introduction
The Romanian energy strategy for the period 2007-2020, approved by HG no. 1069/2007, has as a general objective “to satisfy the energy needs in present but also in the medium and long term, at a lower price, suitable for a modern market economy and a standard of civilized life in compliance with the principles of sustainable development.

Romania has a variety of renewable energy resources: biomass, hydropower, and geothermal potential, respectively for wind, solar and photovoltaic energy. They are distributed throughout the country and will be able to be exploited on a larger scale as the technology performance-price ratio will improve. Biomass retains its central role in heating rural households, but in more efficient and less polluting forms [1-3]. High efficiency cogeneration continued to play an important role, through
planned investments integrated with the modernization and resizing of centralized heating systems with a thermal agent, with investments in new industrial units, respectively with programs to increase the energy efficiency of the houses [4-7]. According to the Romanian Energy Strategy 2016-2030, with the perspective of the year 2050, almost 90% of the houses from rural areas and 45% at the national level mainly use firewood for heating. The houses are usually only partially heated in stoves with incomplete combustion, the comfort level being low and the cost high. For Romanian, improving the quality of life for the rural residents must be a strategic priority by providing quality energy services. Soon, it will be necessary to support the co-generation systems based on biomass and biogas in semi-urban areas, with a centralized distribution of the thermal agent. These supports will be done through dedicated policies, efficient and less polluting installations. Until 2030, most rural households should have access to alternative sources of heating, and homes will be more energy efficient. The development of distributed systems to produce electricity (photovoltaic and wind), doubled by storage capacities, will take place especially in the semi-urban environment and will favour heating with air-to-ground heat pumps and cooking in electric ovens. Thermal solar panels will be an accessible solution for water heating [8], [9].

2. Case study

Several neighbouring villages with Timisoara city have undergone significant development in recent years. The villages have reached the suburbs of the municipality due to the development of facilities, utilities and infrastructure, joining territorial of the city. Other villages have also undergone significant development, the most correct being framed in a peri-urban area located in the second plan compared to the municipality of Timisoara, also borrowing specific urban characteristics.

The article aims to highlight the importance of investments in rural areas to increase energy efficiency. About half of the Romanian households use wood as their main source of heating, and progress in ensuring access to alternative fuels for heating is slow, especially in the rural area. In order to be able to make the best investment decisions in equipment and choose the right energy sources, consumers need access to alternative energy sources (especially in rural areas) and quality information on the options they have and to financing opportunities. Mostly heating based on electricity in Romania has the potential especially in the individual dwellings in the semi-urban environment and the one rural, where the investment in air-to-ground heat pumps with high energy efficiency can be economically justified. In the medium and long term, economically efficient solutions must be applied for the modernization of the heating systems in the rural area and for increasing the energy efficiency of the houses. It is essential to ensure the sources of their funding programs, especially for households affected by energy poverty [1-3].

In the case study, the situation of a residential neighbourhood with 20 houses under p + 1 regime with an average area of 150 square meters was analysed, and the total area was 3000 square meters. In order to choose the most economically technically correct solution, having, as a result, an air-conditioned, comfortable space and minimum operating costs, from the point of view of the heating installations, three possible scenarios were analysed.

These being:

I. Construction of the building with energy-efficient material, which proposes a classic heating system with condensing gas boiler and a classic heating system with radiators.

II. The construction of the building with energy efficient material, which proposes a classic heating system with system heating on wood and a classic heating system with radiators.

III. Construction of the building with energy efficient material, which proposes a heating / cooling system with air-water heat pumps and a ventilation system with heat recovery.
In the first scenario, heating system with gas condensing is proposed for central heating, with high energy efficiency, automated operation and electronic control, to produce hot water at 95 degrees Celsius / 3 bar, designed with the gas operation. Although it is one of the most efficient heating systems on gas fuel, it cannot fulfill all the comfort requests of the buildings, and additional equipment is needed for cooling and ventilating the spaces.

In the second scenario, a system of co-generation on biomass by pyrolysis or co-generation on liquefied gas with a mixture of oxy-hydrogen gas (HHO) is proposed (ecological variant). This solution generates enough electrical and thermic energy for the complete coverage of the annual consumption. It has the advantage that it can achieve maximum efficiency for heating / hot water (AMC) and electricity, as well as air quality, for example:

a) It is possible to heat the spaces and to prepare the domestic hot water with the help of the co-generation group and the accumulation system.

b) During the cold season, both electric and thermic energy can be used, and during the summer only domestic hot water and electricity.

c) During the summer the thermic energy cannot be used. The disadvantage, in this case, is that there is no need for heat and the equipment must be switched off, in which case I cannot use electricity anymore.

In scenario 3, from the point of view of the solutions and of the interior installations, a heating / cooling / ventilation system is proposed with heat recovery in air, with ceiling fans with 4-way discharge, heat recovers with a minimum of 95% efficiency.

The investment would consist of:

- 6 pcs - 28.8-31 kWt air-water heat pump systems with direct condensation in the accumulation systems. The temperature achieved in these accumulation systems is, in the upper area 85C, in the middle zone 60C, and in the lower area 30C-45C with management and monitoring via the Internet: 5kWp photovoltaic system for partial / total coverage of consumption.

- 2 pcs - thermodynamic solar system (4kWt air-water heat pump) 500L with two serpentines, with direct discharge into the accumulation system. The temperature achieved in this accumulation system is, 55C-60C.

- 1 pcs - hot water station.

![Figure 1](image-url)  
**Figure 1.** Monthly operating costs in EURO without VAT, for heating and domestic hot water preparation.
Following the analysis of the 3 scenarios it can be seen in figure 1 that on the same heating surface, the monthly operating costs are different, depending on the equipment used. The heating surface is about 3000 sqm, plus the costs regarding the preparation of domestic hot water. Also, it can be observed that the classic heating system has the highest operating cost, the co-generation system because it produces two energies at the same consumption and becomes more profitable; Heating system with gas condensing and 30-50% HHO operation, Heat pump powered by the National Energy System (SEN) have operating costs near and heat pump powered by the photovoltaic system has operating costs zero.

From the amortization point of view, in figure 2 the amortization of the investment in comparison with the fossil fuel systems is realized approximately in 5 years. The heat pump powered by the Photovoltaic system will be amortization in about 7 years due to the high value of the investment in the photovoltaic system. As you can see the classical heating system, regardless of its performance compared to the heat pump systems, they are never amortization, generating permanent costs.

![Figure 2. Comparison of amortization according to the operating costs](image)

![Figure 3. Amortization of co-generation equipment, 50kWe-100kW](image)
The calculation of the amortization of the co-generation according to the energy produced and delivered (consumed), was done with several 6000 operating hours, a minimum number of operating hours. As can be seen in figure 3, the amortization of this equipment can be done in about 3.5 years, considering the costs of maintaining the cogeneration group.

3. Conclusions
In order to achieve a long-term strategy for the extensive renovation of the real estate fund, an incentive framework for policies and regulation is needed, and the availability of public and private financing in energy efficiency. Energy efficiency measures provide medium-term gain opportunities and long, by promoting saving solutions by reducing production and consumption costs, reducing the environmental impact and, at the same time, ensuring the promotion of economic and social development. Energy from renewable sources is not adequately considered in the rural development programming exercise. Therefore, the investments in energy from renewable sources should also be for the benefit of rural areas. The energy and economic analyses presented above highlight the performances of the different rehabilitation solutions. In the final analysis and decision regarding the adoption of certain solutions and packages in order to reduce the energy consumption, it should be taken into account that the specific price of the thermal energy will increase in the coming years,- so that the investment recovery time will be reduced accordingly. The beneficiaries of the renewable energy projects can recover some of the investment costs by selling the energy produced at preferential prices or at the market price or they can improve the economic performance of their operations.

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