RENEWABLE ENERGY SYSTEMS FOR RURAL AREAS

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In the rural areas, especially those located far enough from infrastructure works (highways and national roads, electricity and gas networks, etc.), energy supply (both quantitatively and qualitatively) is poorer than the urban ones. The purpose of this paper is to analyse the use of renewable energy hybrid systems in order to increase the quality and the quantity of energy supplied to the rural settlements.

Keywords: rural areas, hybrid systems, renewable energy.

1. Introduction

In Romania there are about 4.200.000 households in urban area and 3.800.000 in rural area. According to the 2002 census data, the following communal services are provided to these 8.000.000 households.

Table 1

Household communal services in Romania[1]

Communal service	*Total [%]*	*Urban [%]*	*Rural [%]*
Current water supply:	70,6	95,7	42,8
- indoor	53,0	87,9	14,4
- outdoor	17,6	7,8	28,4
Hot water supply:	43,4	76,2	7,0
Electricity supply	97,1	99,2	94,7
District heating	30,6	57,9	0,5
Natural gas supply	40,5	70,7	7,0

It is easy to remark that countrymen are underprivileged in comparison with the townspeople regarding water, electricity and heating supplies. This affirmation is supported by the following arguments:

- In most cases, the designed supply capacities are lower than the demand, due to the further added consumers;
- During peek periods (especially in the cold season), the energy quality parameters (voltage and frequency for electricity, pressure and flow-rate for natural gas, supply rate for solid and liquid fuels) decrease

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dramatically because of the distance from the main network and the influence of weather condition.
- The maintenance activities are more difficult and extended on longer time periods;

The advantages of the renewable energy systems are [2]:
- The use of local energy resources that can be cheaper than the fossil fuels or free of charge (biomass, biogas, solar, wind and hydro energy);
- Local (decentralized) energy generation reduces or eliminates the transport and distribution looses.
- Renewable energy use has a lower impact on the environment than the classic technologies based on fossil fuels;

There are also disadvantages:
- The cost of the generated energy could be higher than the market one;
- The users (owners) of the equipments should have minimal operating skills;

2. Electricity systems

The hybrid system combines multiple sources to deliver non-intermittent electric power. The most common configuration of such system includes one or more units of renewable source generation (photovoltaic generator, wind, and, sometimes, hydro power generator), one or more unit of conventional generation (diesel), a storage system (mechanical, electrochemical or hydraulic), systems of power regulation (inverter, rectifiers, charge regulators), and, finally, a control and regulation system.

The actual tendency is planning hybrid systems where renewable sources and storage supply up to 80…90% of energy needs, having diesel only back-up function. Certainly, a so characterized plant needs higher investment cost and it can be suitable where electricity and/or fuel supply is expensive or unreliable.

In the hybrid systems for remote communities small sized wind turbines are used, with 1…20 kW nominal power, diameter of rotor of 2…10 m, height of tower being variable from 15…30 m. The total cost of wind plants of this kind installed can vary from 1.500…5.000 €/kW. The highest costs concern plants of smaller size.

There are places (such as protected natural reservations) where, even if there is an interesting wind source, medium and large aerogenerators can not be installed, because of small availability of space, or problems related to environment or grid. In these cases it can be convenient using low voltage grid connection of small sized machines.

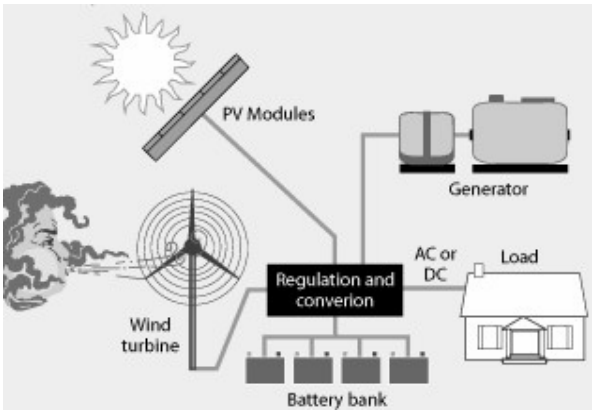

Fig. 1 Energy hybrid systems

Due to their capital cost 1,5…2 times higher than large sized wind plants, the cost of the produced energy is much higher (10…15 c€/kWh instead of 5…8 c€/kWh). Therefore, hardly the investment will result economically sustainable.

Wind turbines of nominal power up to 15…20 kW (rotor diameter up to 8…10 m) can also be installed near small residential users [3]. The advantage for the user can basically be an energy bill saving, which is equal to the energy consumption avoided thanks to the energy production through the aerogenerator.

In this case, the exceeding produced energy, in comparison with the own needs, can be sold to the energy distribution company through an agreement of energy sale, even if the price is much lower than the paid price by the user for the energy consumption from the grid.

If the wind plant is optimal sized for the user's energy consumption, and the wind source is sufficient, and considering the price paid by the users for the energy uses taken from the grid (in Romania generally the price paid around 12 c€/kWh for residential use), it is possible to find the investment cheap and profitable.

The so-called "net metering" technique (for wind power and photovoltaics) has been applied in Western Countries. In such operating mode, the use of reversible counters let use the grid as a "bank" of the exceeding produced energy of its own needs, in order to decrease the following consumption taken from the grid.

3. Heat systems

Regarding the heat supply, 98 % of the Romanian rural households are heated by stoves burning wood, coal or agricultural sub-products, with low efficiency

(40…60 %). The fuel is often unavailable or expensive, forcing the peasants to procure it by illegal means. Besides low efficiency, the old stoves can bring also local pollution with flue gases and particulate.

Here, in our opinion, essential is the efficient use of biomass (wild and crops) in special designed combustion apparatus.

Two different techniques may me analysed in comparison related to the scale factor. Let us analyse these two apparatus for a village with 750 households and 2.250 inhabitants:

a. *1 large biomass fuelled hot/water boiler* (around 5 MW), coupled with a hot water network
b. *750 biomass fuelled individual boilers* (18 kW) generating warm water.

Both installations are operating for the same average period of 5.500 hours and load factor of 85 %. The capital cost for all individual boilers is about 950.000 €, and for the large boiler the value is 750.000 €. The balancing parameter is here the thermal network length. If the capital cost of the network exceeds 200.000 €, then is more efficient to chose the distributed generation b. solution. If not, then the centralized generation a. solution is more suitable.

Remarks: The heat cost in variant a. is higher than those in variant b. due to the added manpower and the network energy losses. The large boiler also is an electricity consumer for internal services (moving grate, air ventilator, flue gas exhauster, pump, etc.). But the variant b. requires individual biomass and ash storage and a lot of operational works, decreasing the inhabitants' comfort.

4. Conclusion

The appropriate energy source will be selected those with higher potential and efficiency, minimal capital and operational costs and better comfort.

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