Case study-
RES scheme for Coada lacului – Bulz village, Bihor county, Romania

1. Introduction

Electrical power production from renewable energy sources represents an attractive option for supplying off grid consumers. This solution is justified in many situations both technically and economically, because of environment protection constraints.
Demonstrative programmes and projects from all over the world share a common purpose: to demonstrate the viability of the energetic and technologic solutions and also the economical feasibility in the general context of sustainable development.
Romania has an important solar and wind energy potential. Also, there are a large number of sites, isolated households, holiday houses, archeological sites, etc. situated in zones with difficult access and away from the electrical power distribution network.
The use of renewable energy sources, generally, especially of solar and wind power, represents, in many cases, an promissing solution.
One of these sites is situated in Bulz, Bihor County.
There is here a tourist zone – Coada Lacului, which has a large number of holiday houses (above 350 houses) which are not connected to the network.
Local Council from Bulz had manifested its interest to supply these houses with electrical power using clean technologies for environment protection.
As a result, it was appreciated that the best solution is to use some adequate autonomous renewable systems (solar/wind) which consist of, in general, photovoltaic generators, wind generators, individual or both types in hybrid connection.
A hybrid PV/Wind system (REPS – Renewable Electric Power System) of 1,3 kW was achieved in the Coada Lacului /Bulz site which supplies a holiday house.
The selection of this house was based on the following premises:

- favorable orientation of the house (the roof) for the optimal reception of the solar radiation
- the approach from the middle line of the corridor formed by the hills from this zone where is a higher wind energy potential
- logistic supply by the owner to make a promoting demo center for information dissemination

The project was achieved with an external support, in partnership between Local Council Bulz (having ENERO as major partner), ICEMENERG and Southwest Windpower Inc.
The installation is operating from November 2001 for functioning in experimental exploitation.

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2. System description

2.1 The site :

- Location: Coada Lacului – Bulz village /Bihor county, Romania
- Latitude: 46,7º N
- Longitude: 23,9º E
- Altitude: 640 m

2.2 Solar wind energy potential.

2.2.1 Annual average solar radiation in horizontal plan: 980 kWh/m^2

The values of the daily average solar radiation from the site varies between 5-6 Wh/m^2 in the warm season and 0,6 – 1,2 kWh/m^2 in cold season.

2.2.2 Multiannual average wind speed: 3,4 m/s

Monthly average speed is between 3,1 m/s and 4,9 m/s.

It must be point out the quasicomplementary feature of these two renewable sources – sun and wind.

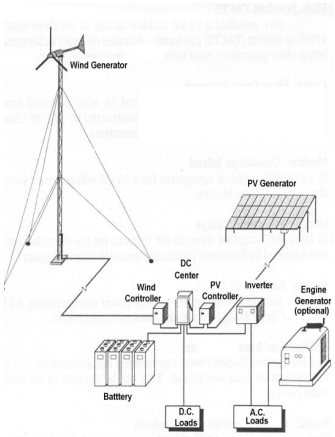
For this reason, the accomplishing solution of a hybrid REPS system is justified from a system structure optimization point of view and exploiting of this.

2.2.3 Nominal wind specific power: 75 W/m^2

2.3 Consumption data

Holiday house endowment with electrical receivers was made having the following premises:

a) To assure that Coada Lacului/Bulz is representative for PV/Wind applications
b) The achievement of the main utilities is by the real consumption regime (in accordance with the owner)
c) Using some energy efficient receivers
d) The achievement of energy saving with results on the system parameters (including the costs)



The electrical receivers include:

- Lightning (inside) : 130 W
- Lightning (outside) : 100 W
- Radio + TV : 100 W
- Power tools : 200 W
- Refrigerator/Boiler : 200 W

From the load curves and the simultaneity indexes it results an daily average consumption - type of 2,6 kWh.

2.4 Technical description

The general electrical layout and hybrid PV/Wind system structure, with a nominal power of 1,3 kW, is presented in Figure 1.

As it is show in this figure, the complete system includes:

- Wind generator
- PV generator
- Wind controller
- PV controller
- Battery
- Inverter
- DC Center
- DC Loads
- AC Loads

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- Engine Generator (optional)

This system can supply a load in d.c. (12 V) and / or in a. c. (220V/50 Hz).
Figure 2 represents a general view of the 1,3 kW hybrid PV/Wind demonstrative installation from Coada Lacului/Bulz.

2.4.1 Wind Generator

Figure 3 presents a photo image of the Wind generator.

- Nominal power : 900 W
- Wind turbine: three blades, horizontal ax
- Rotor diameter: 2,1 m
- Electric generator: asynchronous, with permanent magnets
- Output nominal voltage (with rectifier) : 12 V
- Model: Whisper H 40

The wind turbine is located on a pole that is anchored in four points, with ten meters high.

2.4.2 PV Generator

A general view of PV generator it is shown in Figure 3.
Technical data:

- Peak power: 423 W (AM 1,5; 1000W/m^2 ; 25º C)
- Structure: 8 solar modules Siemens M55 type (parallel connexion)

Solar modules are located on the holiday house roof, having an orientation to South and under an inclination angle about of 47º .
The PV generator connection to the controller is achieved by a junction box which includes 8 blocking diodes (for solar modules protection).

2.4.3 Controller

In the general layout of REPS from Figure 1 are indicating two controller blocks, for each generator (wind, PV).
In the Coada Lacului project, this two blocks are included in a single functional unit, with regulator/controller role to charge the battery.
Figure 5 is o photo image from electric devices room: controller unit (situated on top, on the wall), inverter unit and batteries.

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Technical data:
- Operating voltage: 12 V (regulated in step of 24 V, 48 V)
- Wind/PV Generator current : 120 A/80A
- Maximum load: 2000W
- Capabilities: to indicate PV/Wind generators and batteries voltages/currents
- Model : EZ WIRE 120/200

2.4.4 Distribution block
This unit includes the system connections/distribution general table and protection devices (automated and fusible fuses).

2.4.5 Inverter
The inverter unit (see Figure 5) electrical power supply in a.c. at the network parameters, 220 V/50 Hz.
Technical data :
- Nominal power : 1000 W
- Input: 12 V / max. 120 A
- Wave form: modified sinus

2.4.6 Battery
This subsystem (see Figure 5) assures electrical power storage for demands in unfavorable periods: covered days, night, calm days, etc.
Battery sizing was made for 3 consecutive unfavorable days.
Project technical data:
- Nominal voltage: 12 V
- Storage capacity: 600 Ah (7,2 kWh)
- Configuration: 4 batteries x 150 Ah

In the first stage of the experimental exploitation the system had a 300 Ah (2 X 150 Ah) battery.

2.4.7 Engine generator (optional)
For supplying with electrical power in unpredicted situations (supplementary load, much longer unfavorable periods then it was predicted, etc.) the system could be equipped with an engine generator (with fuel or diesel oil) which can give power at the necessary parameters: 12 Vdc and 220 Vac. The project has as purpose that the level of using the engine generator to be under 10 % from the total consumer necessary power.

3. Production/consumption balance
The predicted energy data were established from solar/wind energy potential data, function parameters of the equipment and consumption curves for this application, , in project, regarding the production/consumption balance.
Table 1 presents the electrical power monthly distributions:
- produced by the PV generator
- produced by the Wind generator
- produced by the hybrid PV/Wind generator

Also here are shown the annual and daily average values for the electrical power production and consumption (project).

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Table 1

Monthly, annual, daily average production/consumption balance (project)

Month	PV [Kwh]	Wind [Kwh]	PV/Wind [Kwh]	Consumption [Kwh]
January	11	90	101	85
February	14	76	90	88
Mars	25	138	163	87
April	45	52	97	80
May	62	90	152	82
June	72	38	110	71
July	70	38	108	70
August	64	33	97	70
September	45	63	108	75
October	28	57	85	78
November	12	76	88	80
December	10	86	96	82
Annual	458	837	1295	948
Daily average	1,25	2,29	3,54	2,60

4. Economical aspects

The cost of this equipment is about 5800 EURO (4380 EURO/kW).
Even if this value represents a serious investment effort in the first stage, the economical viability of using this renewables systems can be determined for many punctual situations, especially by the:

- network connecting cost (estimated about 25000 EURO/km)
- necessity to make some specific works in complex terrain
- environment costs

Under this conditions, on the system lifetime (estimated on 25 years) and a repaying rate of 7 %, the produced power cost by a typical installation (like the Coada Lacului project) is estimated to 0,4 – 0,8 EURO / kWh.

5. Conclusions

The Coada Lacului/Bulz, Bihor County, Romania project represents a successful demonstration. The 1,3 kW hybrid PV/Wind system is in the long monitoring phase, which has as objective to validate the solutions, and also to establish the operational/maintenance specific conditions of the system in order to increase the technical and economical performances for further applications.

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