CASE STUDY: SOLUTIONS FOR POWERING UP A ROMANIAN ISOLATED TOURISTIC SITE

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A community has specific needs when it comes to electricity and heat. Each site has its own particular characteristics and each proposed solution has certain efficiency. The paper analyses different solutions for electricity and heat supply of a tourist area. This site is located in a mountain area and several variables (like average number of people that are present there, different existing facilities, buildings, etc.) have been considered. The tourist complex will include a 3000sqm hotel, a restaurant for 300 people and in a different location a 2000sqm hotel and a restaurant for 200 people. The proposed solutions should provide a constant energy supply.

Keywords: *Renewable energy, Energy efficiencys, Cogeneration, Wind turbines, Photovoltaic, Biomass.*

1. Introduction

The studied area has a great touristic potential, considering the mountainous area, with tourist resorts of national interest and in the future of international interest.

The population is highly interested in this tourist component that will complete the range of the activities in the area and the perspective of the socio-economic development.

The project regarding the development of renewable and heat production energy sources by exploiting some ecological, renewable resources [1], is in line with the energetic trends [2] [3] and the conservation of environmental factors [4].

In the paperwork, there were presented solutions for production in cogeneration of electricity and heat energy and solutions for the use of renewable resources and clean technologies.

The project is important, necessary and appropriate because:

- ✓ the energy is generated from cogeneration using renewable energy resources

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- ✓ it has a positive impact on the environment and contribute to the achievement of the goals regarding the energy produced from renewable resources
- ✓ it supports the activities that give an extra quality to the alternatives regarding the education and spending time outdoors

The area is on montaneous, between 1400-1450 m in altitude.

The access from the locality to the studied area is made on a forest road, road that can be used only during the period from May to November, the rest of the year being covered with snow.

At present, there are no environmental issues. Due to the tourism development of the area, the activities that will be developed should be clean and should not affect the environmental factors: water, air and soil.

Inside the touristic complex, a certain number of the built buildings should be supplied with thermal energy for heating and for preparation of the hot water.

2. Case study

2.1. Site analysis

The entire solution is based upon following prerequisites. The site is located in a difficult accessed area. The site consists in two locations that need to be provided both with power and thermal energy. The closest connection with the National Power Grid is located at a distance of 20 km thus underground cable siting is difficult to accomplish. First location is at an altitude of 1600 m. At this site a 2000sqm hotel is located which has a 200 places restaurant. A second location is placed at an altitude of 1800 m. At this location a 3000sqm hotel is located which comprises a 300 places restaurant. As stated before the location is intended mainly for tourist use and at both analyzed sites, specific recreational and leisure equipment will be installed.

These sites have certain particularities. The average wind speed is about 4m/s (minimum average value during a one year period). The wind speed tends to increase with altitude. The site has an important natural open space that can be used. Namely, for the site located at the altitude of 1600m approximately 1000sqm can be used and for the site located at the altitude of 1800m approximately 5000sqm can be used.

2.2. Proposed solutions

The analysis has been conducted considering solutions for both thermal and electrical energy supply.

Necessary **heat** for both sites.

As stated above the objective consists in two buildings that need to be heated and need to be supplied with hot water at two different locations. When computing the heat necessary for these two locations, national and international regulations were taken into consideration. Also as input data, the volume and destination for the buildings were also considered. The beneficiary wants to install in the touristic complex the following:

- For the site at 1600m altitude: a four store hotel with a 2000sqm gross surface and a 200 places restaurant;
- For the site at 1800m altitude: a five store hotel with a 3000sqm gross surface and a 300 places restaurant.

According to provided information and following national and international regulations, following hourly consumption for thermal energy have been obtained. They are presented in Table 1.

Table 1.

Hourly consumption for thermal energy

Hourly consumption for thermal energy		**For the building at 1800 m altitude**			**For the building at 1600 m altitude**		
		Hotel 3000 m^2	**Restaurant 300 seats**	**Total**	**Hotel 2000 m^2**	**Restaurant 200 seats**	**Total**
For heating	kW_{th}	315	25	340	215	15	230
For domestic hot water	kW_{th}	125	45	170	95	35	130
Total amount of thermal energy	$\mathbf{kW_{th}}$	440	70	**510**	310	50	**360**

For the site at 1800m altitude it is necessary a CHP (Combined Heat and Power) source. This will be done with the help of a bio-diesel fuelled heat engine. The heat engine is designed to provide 200 kWh of electric power needed for different equipments. This CHP equipment will also provide with thermal energy pumped into a 90/70°C hot water circuit with the help of het recovered from flue gas and group's circuits. THE CHP power plant can provide a maximum of 387 kW_{th} /hour thermal energy. This value is closer to the one needed for the site at 1800m altitude thus a second thermal power source is needed.

This amount of the thermal energy is provided by a thermal power plant equipped with four boilers for hot water using wood as fuel. Each boiler has a thermal output of 100 kW_{th} obtaining a total of 400 kW_{th} for the entire power plant.

According to existing legislation the boilers will have to be placed in a separate building, close to CHP power plant and will play the role of a backup for the Diesel group. The boilers themselves can provide 78% of the needed thermal load without the help of Diesel engine.

For the site at 1600m altitude the solution consists in the same Diesel engine providing in the same time heat and power for the building fueled with bio-diesel and with the characteristics at the same rate of the one found at 1800m altitude.

Additionally a second power plant with three boilers will be built each one using chip wood as fuel. Of course each one of the boilers will provide a thermal output of 100 $kW_{th\ thus}$ obtaining a total of 300 kW_{th} for the entire power.

Same as the power plant at the altitude of 1800m, the one located at 1600m of altitude will be placed in a separate building, close to the CHP power plant and will be a backup for this to ensure continuity in the supply of heat to consumers. The boilers themselves can provide 80% of the needed thermal load without the help of Diesel engine.

When choosing the Diesel groups (CHP plants) and thermal power plants, following inputs were considered:

- Diesel group must provide maximum power (200 kW) the entire period;
- The thermal energy will be provided mainly by the CHP power plant (considering that the diesel group will provide maximum electrical power all the time) and if needed, the boilers using wood chip will provide the rest of the heat that's to be used.
- The thermal power plant must provide at least 75% of the maximum heat needed (as seen for the first site) and about 80% of the maximum heat needed for the second site. This will have to be without the help of the Diesel engine. The maximum thermal load it is of 510 kW_{th} for the first site and of 360 kW_t for the site located at 1600m altitude. In addition to diesel CHP plant and to satisfy these demands regarding the necessary heat and additional thermal power plant has been added for each site. For the location at 1800m a thermal power plant consisting in four 100 kW_{th} boilers has been considered and for the location at 1600 m of altitude a thermal power plant consisting in three 100 kW_{th} boilers has been considered.

Necessary **electricity** for both sites.

In order to power up with electricity two hotel buildings, two ski slopes, recreation buildings and some functional premises following solution has been adopted: the electrical energy for these premises will be obtained using renewable resources in environmental friendly equipments.

As stated previously, the closest connection to the national power grid is at a distance of 20 km.

Using renewable resources for electricity production in a touristic site has its advantages:

- No pollution put out to the environment;
- Low operational costs;
- Low maintenance costs;
- CHP technologies are safe and reach their maturity ;
- Replacement parts for the power equipment are on a descending trend.

Tables 2 and 3 are presenting the power needed for both sites.

Table 2.

Main equipments that require electrical power for the site located at 1800m altitude.

Consumers	Pieces	In function/ stand by	Needed Power (kW)
Main feed pumps for hot water	2	1/1	10
Main bleed pumps	2	1/1	1.5
Fire extinguishing installation pumps	2	1/1	11.5
Main feed pumps for fresh water	2	1/1	10
Power needed for lighting	1	1	45
Power needed for electrical outlet	1	1	25
Equipments for kitchen and restaurant	2	1/1	10
Phones	1	1	0.5
Fire alarm, CCTV, Antitheft system	1	1	1
Lighting the ski slope	1	1	20
Powering up the chairlift	1	1	75
Exterior lighting	1	1	3
Recreation buildings	25	15/10	20
Utilities	2	1/1	5
Total needed power			**200kW**

Table 3.

Main equipments that require electrical power for the site located at 1800m altitude.

Consumers	Pieces	In function/ stand by	Needed Power (kW)
Main feed pumps for hot water	1		
Main bleed pumps	2	1/1	10
Fire extinguishing installation pumps	2	1/1	1.5
Main feed pumps for fresh water	1	1	40
Power needed for lighting	1	1	21
Power needed for electrical outlet	2	1/1	11.5
Equipments for kitchen and restaurant	2	1/1	10

Consumers	Pieces	In function/ stand by	Needed Power (kW)
Phones	1	1	0.5
Fire alarm, CCTV, Antitheft system	1	1	1
Lighting the ski slope	1	1	30
Powering up the chairlift	1	1	3
Exterior lighting	50	30/20	50
Recreation buildings	2	1/1	10
Utilities	2	1/1	5
Total needed power			**162 kW**

Recommended configuration for electricity supply. For the situation presented above following solution has been proposed: 150 kW_e installed in 5 wind mills each of 30 kW and 300 kW in photovoltaic panels these representing the solution for both sites.

Power sources (both thermal and electrical) adopted for the analyzed sites are summarized in table 4.

Table 4.

Main characteristic for power sources

For electrical power	Obtained power	**For thermal power**	Obtained power
	kW		**kW**
1. Five wind mills each of 30 kw; 2. Photovoltaic panels	150 300	CHP represented by a Diesel engine	2x250

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6. Conclusions

For the case of electrical supply (at 0,4 kV) for machinery and related consumers of the objective, there has been provided a flexible scheme with three supply sources:

- Diesel engine groups;
- Wind mills;
- Photovoltaic cells.

When evaluating the economical aspects, there should be considered the following aspects:

- The lifetime is satisfactory;
- Capital depreciation of the investment ;
- Benefits;
- Establishment cost.

From the experience of the developed countries can be drawn the following conclusions:

- The deployment and starting costs are high, for example for the big investment projects (aggregates with big wind mills), the deployment costs are around 3millions Euro/MW installed;
- Although the amount seems large, please note that the investment would be amortized in about 7÷10 years, a reasonable term for an energy field investment, this without considering the "externalized" costs. If these would also be considered, the wind energy would be the cheapest.
- The investment is technically and economically profitable when using a hybrid solution (energy obtained by photovoltaic cells and aero generators).

Generally, for the investments in the energy area, there has to be considered the efficiency of the investment effort, in a certain context, for operating indices (productions/consumes) obtained from sizing he technical solution. Thus:

- Identify, evaluate and compare both the costs and the incomes from the operating new infrastructure – updated net revenue (UNR)
- Evaluate the investment recovery degree – internal efficiency rate (IER) and investment recovery time (IRT)
- Recommend the sensitive parameters of the project

In the case of the present paper, the subject of the analyzed investment cannot be treated separately, being part of a project with an important contribution to:

- The development of the tourism in the area, through the building of a tourist complex, mainly for winter sports (ski slopes and accommodation facilities);
- Limiting the migration of the active population, especially youngs, through the involvement in touristic and related activities.

Moreover, from technical point of view, for the success of the investment, it is very important that the energy (electrical and thermal) supply solution would facilitate the energy management process, mainly in the phases of:

- ✓ Cogeneration energy production (thermal and electrical) in best technical conditions, with minimum environmental impact, due to the conditions imposed by the energy infrastructure in the area location;
- ✓ Energy supply (thermal and electrical) in safe and continuity conditions.

Considering the fact that the insurance of the energy sources was proven in technically and economically optimal conditions, it is very important that the basis for the decision to initiate the project include all the components:

- ✓ Diversification of the choice for spending time outdoors and recreation;
- ✓ Creating a considerable number of accommodations with increased comfort conditions;
- ✓ Contribution to creating greater green energy production by using the renewable energy sources;
- ✓ Decrease of the dependence of the classical cogeneration sources on the imported fuel;
- ✓ Compared with the conventional operating systems, contributes significantly to reducing the environmental impact, especially in a mountain area, considering the fact that the mountain tourism is promoted as a priority;
- ✓ Creating new jobs and business opportunities.

The closest city has an important touristic, natural and anthropic, but little known at national and European level. Promoting the investment „Energy supply of the touristic complex" is determined by the business promoting as well as the sustainable economical development of the area

The feasibility study pursued the development of a technical solution that would mainly comply:

- ➢ The technical conditions, through the energy supply of the touristic complex , with facilities for winter sports, as well as the neighbouring housing, considering:
  - o The production using the renewable energy sources, with impact on the preservation and environment protection, as well as reducing the green-house effect gases
  - o Safe energy supply, especially continuous supply at competitive prices al local level.

The socio-economic conditions, by the fact that it creates the premises for building the touristic complex, enabling the ski potential in the area and, in extension, of the touristic one complies with nowadays development strategies [5] for isolated sites.

R E F E R E N C E S

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