On the implementation of a micro hydropower plant on Gersa river, Bistrita, Romania

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Abstract: *This paper presents a feasibility study regarding the exploitation of micro hydropower potential from Gersa River; district Bistrita-Nasaud. It analysis the area from the view of electrical generation potential and estimates the best solutions for implementing of a micro hydropower plant. The network serves to supply electrical energy to the consumers that exist in that area and offering them electro energetic independence.*
With EDSA software, the parameters of the network are determined before and after the connection of the plant.
According to technical and economical criteria's the optimal solution is choosen.
Keywords: *small hydropower plant, power generation, Gersa river.*

I. INTRODUCTION

The basic principle of hydropower is that if water can be piped from a certain level to a lower level, then the resulting water pressure can be used to do work. [1]

The main advantages of hydropower are:

- hydropower is a very clean source of energy,
- it does not consume but only uses the water, after use it is available for other purposes,
- the conversion of the potential energy of water into mechanical energy is a technology with a high efficiency,
- power is usually continuously available on demand,
- given a reasonable head, it is a concentrated energy source,
- the energy available is predictable,
- no fuel and limited maintenance are required, so running costs are low (compared with diesel power)
- in many cases imports are displaced to the benefit of the local economy,
- It is a long-lasting and robust technology; systems can last for 50 years or more without major new investments. [3]

The objective of this paper is to promote the production of electrical energy from renewable sources, to provide electro energy independence to the referred area and simulate with accuracy the parameters (active power, reactive power, power magnitude and power factor) of the network and the economical impact on the social structure of the population.

II. TYPES OF HYDROPOWER PLANTS

Name	Description
Large	all installations with an installed capacity of more than 1000 kW (according to some definitions more than 10,000 kW)
Small	general term for installations smaller than 1000 kW (or < 10,000 kW). Also used for installations in the range between 500 and 1000 kW.
Mini	capacity between 100 and 500 kW
Micro	hydropower installations with a power output less than 100 kW (or less then 1000 kW)

Table 1. Classification of hydropower plants

III. MICRO HYDROPOWER PLANTS

The context of small hydropower can be described as follows:

- decentralized, small demand for power (small industries, farms, households and rural communities),
- distribution network with low voltages (eventually sub-regional grid),
- owned by a individual, co-operative or community with semi-skilled workers,
- short planning horizons and construction periods with the use of local available materials and skills,
- depending on generated power it can have a substantial impact on local standards of living (bigger than only the supplied power),
- as only some information is available about the potential power often not more then 40 % of the potential is used. [3]

IV. CASE OF STUDY

Location: Rebrisoara
District: Bistrita-Nasaud
River: Gersa

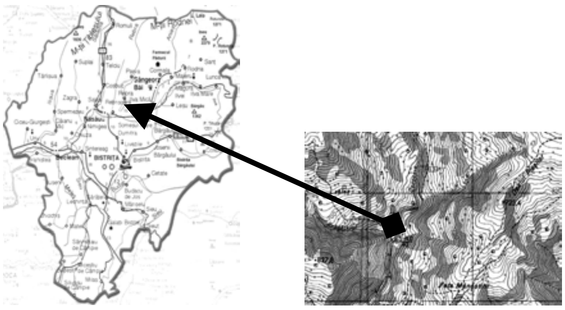

Figure.1. Location of the micro hydropower plant.

The reasons of choosing this place are:

- Small demand of electrical energy

The area is populated –so there is home demand of energy- and there are small industries –such as milk factories, lumber mill, and many other industries according to the region's values.

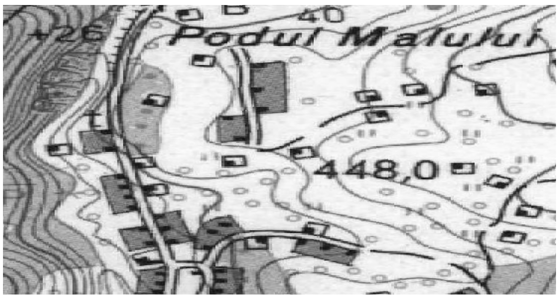

Figure 2. Demographic structure of the area

- The flow of the river is enough (although isn't not constant during the year)so that the placement of a SPP won't affect the water supply

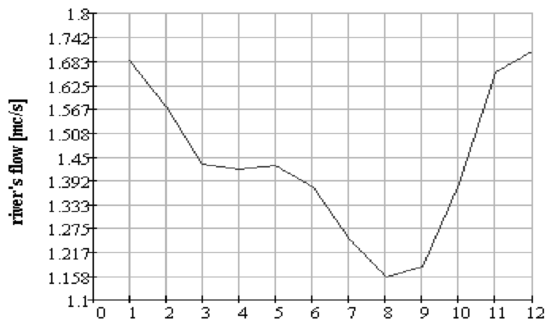

Figure 3. Variation of the flow during the year

We choose the lowest flow D=1.15 m^3/s.

- The net head is read from the level curves realized in Dimap software, and in our particular case, the net head is 40m on a 400 m distance.

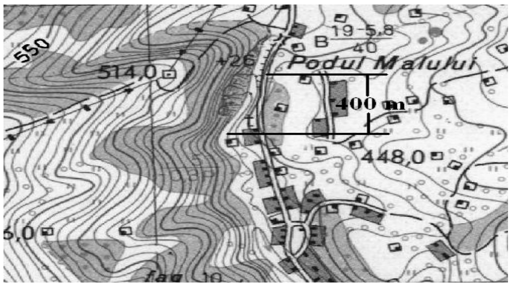

Figure 4. Determine the net head

Having these two variables determined: the flow and the head, we can proceed to choosing the civil constructions that need to be done and the electrical and mechanical equipment for the SPP.
According to the design of a SPP (see fig.5)

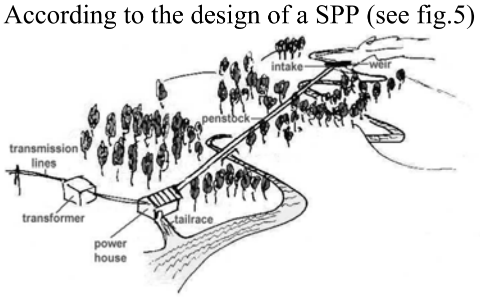

Figure 5. Design of a SPP

The civil constructions are:

- The weir

We choose the weir with Coanda screen for the intake, because isn't the most suitable for this situation:
-it is positioned on the course of the river,
-it permits the free pass of the fishes and the water organisms,
-screening capacities of 0.09-0.14 m3/s per meter of weir length,
-small height (up to 2 m),[1]

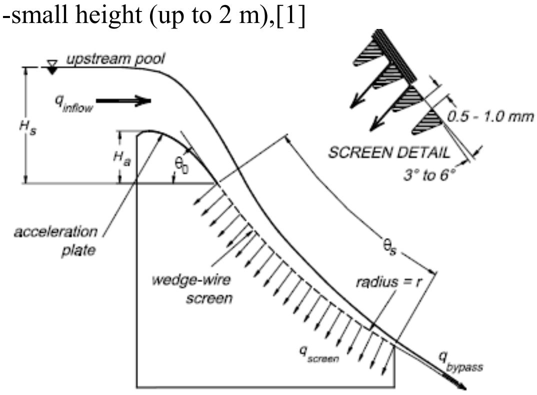

Figure 6. Design of the weir with Coanda screen

- The penstock

The pipe which conveys water under pressure from the fore bay tank or straight from the weir to the turbine.

Figure 7. The penstock

Diameter, d=0.71m
Length, L=400m
Material, GRP (glass reinforced plastic)

- The tailrace

It can be made out of wood, wood being the most economical solution in the area and having in the same time good material qualities.

The electrical and mechanical equipment:

- The turbine:

According to the determined parameters (head and the speed of the water) we choose the appropriate turbine:

Type of turbine		Range of speed [rpm]	Range of head [m]
Kaplan	L	350-500	30-40
	M	501-750	10-30
	F	751-1100	≤ 10
Francis	L	50-150	110-300
	M	151-251	50-110
	F	251-450	≤ 50
Pelton	L	2-15	1000-1300
	M	16-25	700-1000
	F	26-50	100-700
Banki-Michell		30-200	5-100

Table 2. Different types of turbines

In our case: Kaplan turbine is the most suitable.
Its main advantages are:
-acceptance of flow and head variation is high
-it has a high efficient turbine 93% (comparing to Turgo turbines witch efficiency is 85%) [1]

- The generator:

We'll use an asynchronous generator because of his multiple advantages:
-asynchronous generators are cheap (comparing to the synchronous generators),
-are used in stable grids where their output is an insignificant proportion of the power system load
-their efficiency is between 95-97 %,
-they draw their excitation current from the grid absorbing reactive energy by their own magnetism,
-adding a bank of capacitors can compensate for the absorbed reactive energy. [3]

V. SIMULATION

The simulation was realized in EDSA (Energy Distribution System Analysis) software.[2],[4]

According to our porpoise we simulate the previous network existing in the area, and recorded the parameters.

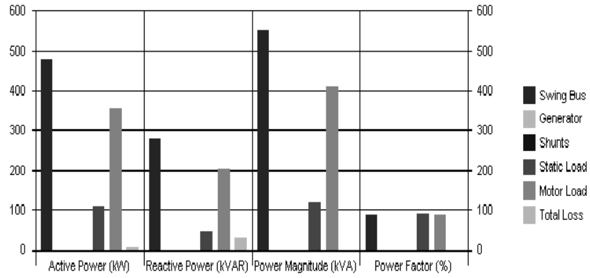

Figure 8. The parameters of existing network

And the parameters after connecting the SPP:

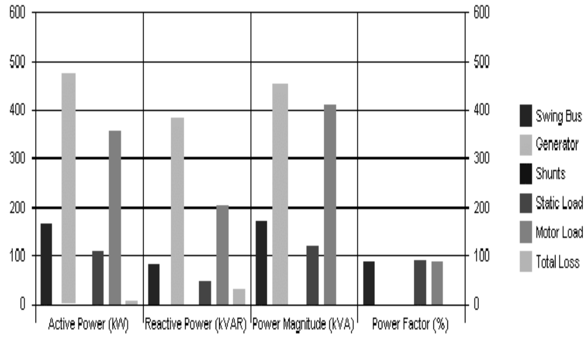

Figure 9. The parameters of the network after connecting the SPP

Comparing these two different cases, we can observe the decreasing of consumed active power from the grid and using a bank of capacitors we can keep constant the absorption of reactive power.

VI. CONCLUSIONS

Using SPP we contribute to the reduction of global emissions, producing green energy, by non polluting means.
It raises the economical development of a region, by using the local materials and local work forces.
It's a long term investment, SPP being considered viable for more than 50 years.

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