Technical and economic feasibility of Pico hydro power plants integrated to Green buildings

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Abstract: This paper describes a study on Economic consideration and feasibility of Pico Hydro Power plant near the Green Building. Pico hydro (micro-hydro) is the cheapest way to power a building or a small community. The price per watt-hour is far economic than photovoltaic cells and even less than wind. The resource is much more site-specific than solar. But if we are able to get enough head (height between source and hydro turbine) and enough flow, then we can go for Pico hydro power plant. Head and flow are two important components in the hydro power formula. A high head system with a very small flow can give the same amount of power as a low head system with a very large flow. This project is therefore focused on hydro power generation using the consuming water in the green building.

Key Words: Pico, homer, hydro, renewable.

1. INTRODUCTION

Electricity is one of the most used forms of energy nowadays. To meet the required increasing demand of electricity we need to tap every possible resource that we have. Hydro power is one of the renewable sources of energy and it can be easily to meet the required demand. Here, we need to study the importance of Pico hydro power plant, which can produce power up to 10 kW or more continuously.

Pico hydro power uses the potential of water to generate electricity. It brings us low cost generation of electricity without polluting the air and water. Hydro power is very useful technology, where people have to obtain energy from falling of water. It is still in the practice and obtain electricity from potential of water and it is in small scale and some time in large scale to feed an entire city.

The water flow from height has the potential energy that is fallen on the turbine and the turbine is connected with the generator via shaft. The water fallen on the turbine with the high pressure to make it rotate. The generator attached to the turbine convert mechanical energy into electrical energy. Pico hydropower system is relatively small power source that can be access by the individual person to install in their houses to remove the dependency of grid supply.

Hydropower plant is classified as a large, medium, small, Pico, and micro according to generation capacity of installed system. The electrical power is measured in watt (W), kilowatt (KW) or megawatt (MW). Pico hydro is considered as small hydro power plant which can produce power up to 10 kW.

The Hybrid Optimization Model for
Electric Renewable (HOMER) software is used to study the process of power production with its various constraints and its economic importance in the green building. HOMER software helps us to get the optimized generation of electricity and its feasibility with other renewable sources of energy like wind energy and solar power that can be used in the green building.

2. Advantages of Pico hydro power plant:

- It has a longer life span that can be up to 25 years.
- It is economical and does not require much investment.
- Requires very less maintenance.
- It uses renewable source of energy.
- Design is simple and does not require any or less infrastructure.

3. Power Estimation

In general, the feasibility of the proposed Pico-hydro System is based on the following potential

3.1input and output power equation:

$P_{in} = H * Q * g$

$P_{out} = H * Q * g * \eta$

Where,

Pin = Input power (Hydro power)

Pout = Output power (Generator output)

H = Water Head (meter)

Q = Rate of water flow (liter/second)

g = gravity (9.81 m/s2)

η = efficiency

The above power equation governs the rate of power production in Pico hydro power plant. Where Pin is the power input to the plant and Pout is the power that is produced from it. It is clear from the above equation that power produced from the plant depends on the rate of water flow and water head. The higher will be the Q that is flow of water, production of power will also be higher. Power production is also directly proportional to the head or the vertical distance of reservoir to the generator. And η is the efficiency of the plant.

η is given as Pout/Pin.

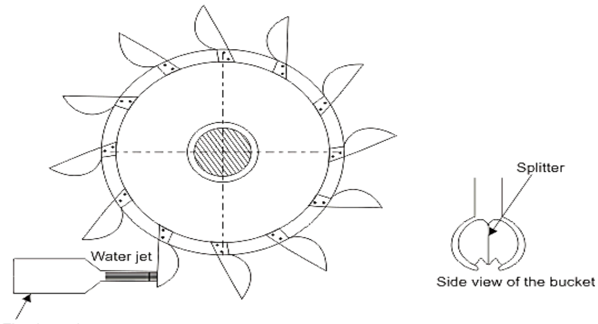
The water pressure determines the net head of the system in which the energy is converted to mechanical form by rotation of turbine. This mechanical energy is fed to the generator which converts it to electrical form.

4. Components of Pico hydro power plant:

4.1 Pen stock

Pen stock is a narrow pipe like structure that connects reservoir to the turbine. Heavy water flows from the reservoir to the turbine through the pen stock. Due to the force of water the turbine blade rotates which further rotates the shaft at a high speed which is connected to the generator, which produces the electrical power.

4.2 Turbine

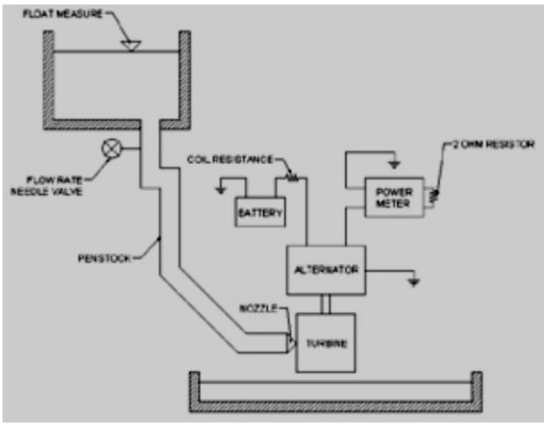


Turbine is a device that converts the potential energy of water to the mechanical energy which is converted to electrical energy with the help of generator.
The turbine rotates due to the force of water on its blade which rotates the shaft.
There are two types of turbines:
1. Reaction turbine
2. Impulse turbine

4.3 Generator:

Pico generator is used to convert the mechanical energy of the shaft to the electrical energy and has capacity to produce 10 KW of power.
Electrical power is given by the product of mechanical power and the generator efficiency.
3. Battery bank
The battery bank is used to store the surplus power produced during operation of the turbine.
The power produced may vary according to the flow of water.
If the flow of water is varying during the day , the power produced by the turbine may also vary. Therefore to maintain the continuous power supply battery bank along with an inverter and rectifier may be used.
4. Grid connected system
The Pico hydro power plant connected to the grid.

LAYOUT OF PICO HYDRO POWER PLANT

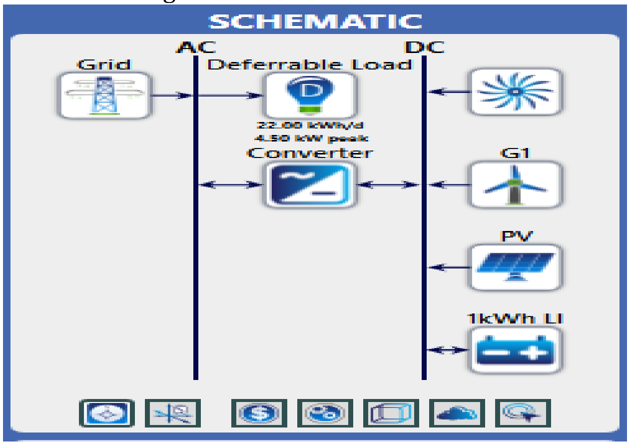


The layout of a common Pico hydro power plant is given by the above figure. The various components used in Pico hydro power plant are the reservoir, penstock, nozzle, turbine, alternator, battery and net meter. Reservoir is used to store the water and is supplied to the turbine through the pen stock through the vent. The flow of water is controlled with the help of valve. The turbine rotates due to force of water which due to which the turbine rotates.
The shaft of the generator or the alternator rotates as it is coupled with the turbine.
The system is connected to the battery bank to store power with the help of inverter. A power meter is connected to measure the power produced by the system.

5. FEASIBILITY OF PICO HYDRO POWER PLANT NEAR GREEN BUILDING AND SIMULATION

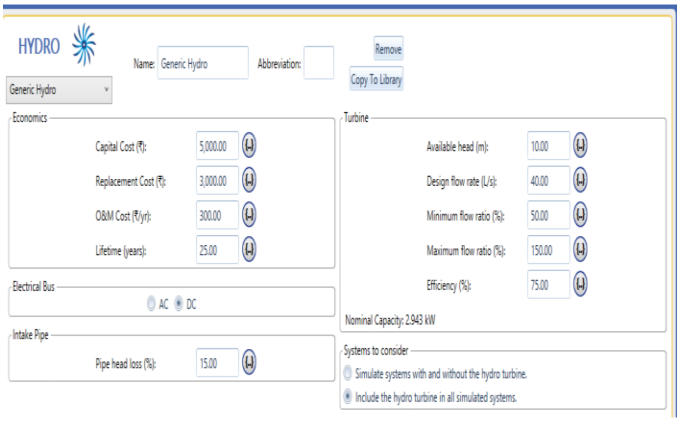
PICO-HYDRO SYSTEM PLANNING
This stage is the most critical stage in this research project as it determines the feasibility and achievability of the proposed Pico-hydro system. There are many factors that Determine the feasibility and achievability of the system. This

SIMULATION:
Schematic Diagram:

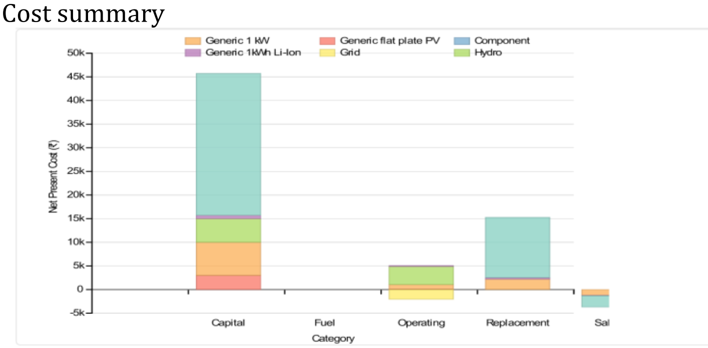


The above Diagram shows the connection of hydro power plant along with other sources of power in Green Building, which are solar power (PV cells), Wind turbine, Battery banks and the Grid.

2. Various costs included in the Pico hydro power plant:



Cost summary



Conclusion:

A Pico hydro power can be integrated to any buildings and its feasibility of power can be 100 W to 500 W and it can illuminate 5 to 6 LED bulbs and the cost of the system is also very less.

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