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PICO HYDRO SYSTEM

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Abstract

The proposed system converts energy from moving water into electricity. It is a simple system which is driven by water. The prime mover of the system is interfaced to turbine which is in turn driven by water. The system consists of a permanent magnet based low rpm generator, turbine, Charger, Storage unit. The potential energy of the water is converted into mechanical energy by turbine which is in turn converted to electrical energy by generator. The proposed system enables any house old to drive lights, Television &Mixer (500 Watts) kind of loads.

Index items- Turbine, Generator, Controller, Battery Bank, Inverter and Load.

INTRODUCTION

Pico hydro is hydro power with a maximum electrical output of five kilowatts. Hydro power systems of this size benefit in terms of cost and simplicity from different approaches in the design, planning and installation than those which are applied to larger hydro power. Recent innovations in Pico hydro technology have made it an economic source of power even in some of the world's poorest and most inaccessible places. It is also a versatile power source. AC electricity can be produced enabling standard electrical appliances to be used and the electricity can be distributed to a whole village. Common examples of devices which can be powered by Pico hydro are light bulbs, radios, televisions, refrigerators and food processors. Mechanical power can be utilized with some designs. This is useful for direct drive of machinery such as workshop tools, grain mills and other agro-processing equipment.

The focus of this manual is the implementation of hydro technology for the electrification of small villages in hilly or mountainous regions. This constrains the scope of the designs to turbine and generator units which are suitable for medium to higher head sites (more than 20 meters) and AC generation as low voltage DC systems cannot easily convey electricity over more than a few

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meters. Many aspects of the Implementation methods described however, are common also to other designs including those suited to low head sites and to those which benefit individual consumers rather than small communities.

BASICS OF PICO HYDRO SYSTEM

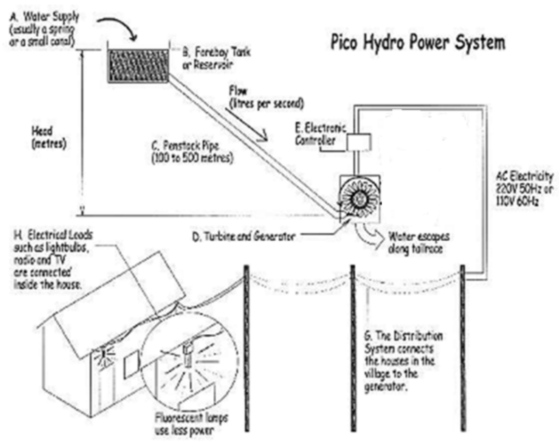

Figure shows the layout of a picohydro system.

Each of the components has been described in more detail below.

A. The source of water is a stream or sometimes an irrigation canal. Small amounts of water can also be diverted from larger flows such as rivers. Springs make excellent sources as they can often be depended on even in dry weather and are usually clean.

B. The water is fed into a fore bay tank. This is sometimes enlarged to form a small reservoir. A reservoir can be a useful energy store if the water available is insufficient in the dry season.

C. The water flows from the forebay tank or reservoir down a long pipe called the penstock. At the end of the penstock it comes out of a nozzle as a high-pressure jet.

D. The power in the jet, called hydraulic power or hydro power is transmitted to a turbine runner which changes it into mechanical power. The turbine runner has blades or buckets which cause it to rotate when they are struck by water.

E. An electronic controller is connected to the generator. This matches the electrical power that is produced, to the electrical loads that are connected. This is necessary to stop the voltage from going up and down.

F. The Distribution System connects the Electricity supply from the generator to the houses.

G. The Consumer Loads are usually connected inside houses. Electrical load is a general name which refers to any device which uses the electricity generated.

PLANNING A PICO HYDRO SYSTEM

A.Cost and availability:

Determine the head, flow, power output required, obtain the overall cost of turbine-generator & other products.

B. Power Estimate and Demand Survey:

Depending on the head& flow we have to estimate the power required for a particular area.

C. Sizing and costing:

Estimate the size of the generator & turbine to meet energy demand.

D.Village meeting:

Present the findings of the survey to the community at an open meeting to which local government staff and local development organizations should also be encouraged to attend.

E. Finalize power output:

Modify the original estimate of generator size based on accurate assessment of site hydraulic potential (available power in the stream).

F. Scheme layout:

Sketch scheme layout, using the site plan map as the basis. Write on lengths of penstock, any canals and each different section of the distribution system if one is required.

G. Organize finance and order materials:

Arrange finance based on supply contracts.

H. Installation and operator training.

I. Consumer training and commission scheme.

POWER

Power is measured in **Watts (W)** or **kilowatts (kW).** There are 1000 W in 1 kW. Pico HydroPower has a maximum electrical power output of5 kW. It is important to say which type of poweryou are referring to when discussing a hydropower project as there are three types and theywill all have a different value. The water power(or hydraulic power) will always be more than themechanical and electrical power. This is because,as the power is converted from one form toanother, some is lost at each stage as illustratedin Figure below.

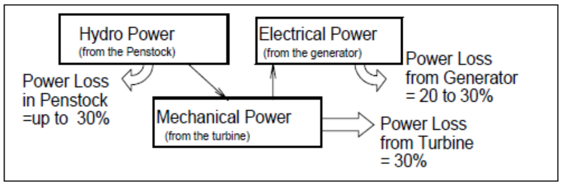

Figure shows that some power is lost at each stage during the conversion from a water jet to electricity

EFFICIENCY

Efficiency is the word used to describe how well the power is converted from one form to another.The system efficiency forelectricity generation using Pico hydro istypically between 40% and 50%.

Example 1: Calculate the hydraulic power in a small stream

The Hydraulic Power in a stream can be calculated when the Head and the Flow have been measured. The formula to calculate Hydraulic Power is as follows:

Power = Head (m) **x Flow** (l/s) **x9.81**

What is the Power in a stream if the head is 60m and the flow is 10 l/s?

Power = 60 x 10 x 9.81

= **5886** watts (**W**) or **5.9** kilowatts (**kW**)

Example 2 Calculate (i) the net head, (ii) the useful mechanical power and (iii) the electrical power which could be generated from the stream described in Example 1

Use the following assumptions: 25% of the head is lost as friction in the penstock, the turbine is 65% efficient and the generator is 80% efficient?

(i) Calculate the net head

If 25% of the head is lost as friction in the pipe the head loss is 0.25 x 60 = 15m. If 15m are lost then the useful head (or **net** head) is:

= 60 - 15 = **45 m**

The net hydraulic power available at the turbine is now less than the hydraulic power using the total (gross) head:

Power = Net Head x Flow x 9.81

= 45 x 10 x 9.81

= 4414 W

(ii) Calculate the mechanical power

If the turbine is 65% efficient the mechanical power produced will be:

Power (Mechanical)

=net hydraulic power x turbine efficiency

= 4414 x 0.65

= 2870 W

(iii) Calculate the useful electrical

Power

If the generator is 80% efficient, then the electrical power available for lighting and other purposes is:

Power (Electrical)

=mechanical power xgenerator efficiency

= 2870 x 0.8

= **2295 W** or **2.3 kW**

MARKET SURVEY

On a global scale, a very substantial market exists in developing countries for Pico hydro systems (up to 5 kW). There are several reasons for the existence of this market.

(i) Often, small communities are without electricity even in countries with extensive grid electrification. Despite the high demand for electrification, grid connection of small communities remains unattractive to utilities due to the relatively low power consumption.

(ii) Only small water flows are required for Pico hydro so there are numerous suitable sites. A small stream or spring often provides enough water.

(iii) Pico hydro equipment is small and compact. The component parts can be easily transported into remote and inaccessible regions.

(iv) Local manufacture is possible. The design principles and fabrication processes can be easily learned. This keeps some equipment costs in proportion with local wages.

(v) The number of houses connected to each scheme is small, typically under 100 households. It is therefore easier to raise the required capital and to manage maintenance and revenue collection.

(vi) Carefully designed Pico hydro schemes have a lower cost per kilowatt than solar or wind power. Diesel generator systems, although initially cheaper, have a higher cost per kilowatt over their lifetime because of the associated fuel costs.

SPECIFICATIONS

SOURCE: Water source.

TURBINE: Pelton turbine.

GENERATOR: Permanent Magnet based low rpm generator.

CONTROLLER: To maintain constant voltage and frequency.

BATTERY: To store the energy in the dc format.

INVERTER: To convert dc quantity to ac quantity.

LOAD: Incandescent bulb, CFL’s, T.V.

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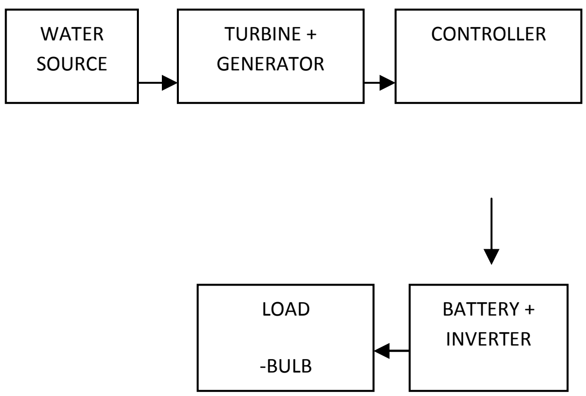
BLOCK DIAGEAM OF PICO HYDRO SYSTEM WITH STORAGE OPTON.



ADVANTAGES

(i) Improved lighting for studies.

(ii) Better air quality because no kerosene lamps.

(iii) Less money spent on batteries.

(iv) Eco-friendly: Non-conventional energy.

(v)Indigenous and home grown technology.

(vi) Local business opportunity.

APPLICATIONS

(i) Lighting:

Rural Electrification,

Health Care,

Domestic etc.

(ii) Agricultural: Drip Irrigation.

(iii) Educational Institutions.

CONCLUSION

This system is to help encourage more widespread adoption of Pico-hydro technology. A manual for manufacturers, "The Pico Power Pack – Fabrication and Assembly Instructions" aims to stimulate local production of recommended designs and therefore help to reduce the problems of availability which exist in many countries. The "Starting a Business Using Water Power" guide encourages applications for income generation and community benefit using Pico hydro. In particular, proven examples of successful commercial applications are described. By encouraging local entrepreneurs to use Pico hydro as the source of power for a business, the technology can be more readily financed even in areas where development loans or subsidies are not available to rural people.

Finally, this project is aimed at everyone with an interest in Pico hydro or rural Electrification. It is particularly intended for those who are thinking about this technology for the first time. It seeks to inspire sufficient confidence to encourage local implementation by "first-time" hydro engineers. With this in mind, criticisms from readers would be welcomed to allow the guidelines and procedures to be refined and updated in the light of further experience.

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