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House Hold Power Generation Using Rain Water

[1,]B. Phani Kanth, [2,]Ashwani, [3,]Sanjeev Sharma
[1,2,]M.tech Clean Technology Student, Amity University Jaipur, Rajasthan-302001.
[3,] Asst.Prof. Dept of Mechanical Automation & Clean Technology, Amity University Jaipur, Rajasthan-302001
[1,2,3,]Department of Mechanical, Automation & Clean Technology
Amity University Rajasthan, NH-11C, 36 KM Stone, Jaipur-Delhi, National Highway
Jaipur-302001 (Rajasthan)

Abstract

Energy is integral to virtually every aspect of life. It is hard to imagine life without it. Yet many of our most serious threats to clean air, clean water and healthy eco systems stem from human energy use. Currently, most energy is produced from coal, oil, natural gas and uranium. These energy sources pollute our air and water, damage the earth's climate, destroy fragile eco-system and endanger human health. A large amount of energy we generate is wasted, raising energy costs and harming the environment. We can meet our energy needs while protecting human wealth, our climate and other natural systems. The solution is a rapid transition to energy efficiency and use of clean, renewable energy such as the sun, hydro and wind. Renewable energy sources are abundant and inexhaustible. They do not use fuel, so fuel costs and price fluctuations are not an issue. This paper highlights the House hold power generation using small hydro power projects in India with its own resources and also through private investment.

Keywords: 1.Small scale Hydro power- 2.Renewable Energy-3.Potential Energy(P.E) -4.Rain Water-5.Kinetic Energy(K.E)

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1. INTRODUCTION

Hydroelectric Power Is A Major Source Of Electricity In India. In 2012 Around 21.53% Of The Electricity In India Was Generated Using Hydroelectric Power. This Electricity Is Typically Generated By Large Scale Dam Projects That Block Rivers And Pass Water Over Turbines. In This Fashion, The Amount Of Electricity That Can Be Generated Ranges From A Few Kilowatts To Hundreds Of Megawatts. The Streams And Rivers Effectively Funnel The Amount Of Rainfall Covering A Huge Land Area Into A Concentrated Flow With Enough Kinetic And Potential Energy To Justify Large Infrastructure Projects To Power A Large Number Of Households. India Is Blessed With Immense Amount Of Hydro-Electric Potential And Ranks 5th In Terms Of Exploitable Hydro-Potential On Global Scenario. The Present
As On 30-06-2011 Is Approximately 37,367.4 MW Per Year. [1-3]

2. HYDRO ELECTRIC POWER

Electricity generated by harnessing the energy in falling water. A non-depleting source of energy, hydroelectric power provides approximately 5% of the world's primary energy needs. The theoretical power of a hydro source is the product of the weight of water passing the unit time and the vertical height through which it falls, under average flow conditions. Dams serve to trap supplies and ensure continuity of flow while increasing the head of water available to drive the turbines. A small volume of water through high head equal to a large volume through a low head. The development of turbines has vastly increased the potential for exploiting hydro electricity. Turbines and generator both have efficiencies of over 90%. Therefore a modern hydro electric station can convert over 80% of energy inherent in water into electricity. In contrast, fossil fuelled power stations operate with large energy losses.[10-13]

3. THE TECHNOLOGY

Hydro power is produced when a flow of water, either from a reservoir or a river, is channeled through a turbine connected to an electricity generator. The amount of power generated depends on the rate of flow and the volume of water available, provided via the hydraulic Head – the vertical distance from the reservoir or river to the turbine. World hydro power capacity has reached about 700GW, generating about one fifth of the world's total electricity production. Most of this is from large scale scheme of more than about 10-15MW. However, many of these large scale schemes were developed a number of year ago, and the potential for identifying new large scale schemes is now more limited, not only because there are fewer commercially attractive sites still available, but also because of environmental constraints. Instead, smaller schemes of less than about 10-15MW now offer a greater opportunity for providing reliable, flexible and cost competitive power source with minimal environmental impacts.

Although these small scale schemes currently contribute only about 3% to the total hydro power capacity, they are making an increasing contribution towards new and renewable energy installations in many regions of the world, especially in rural or remote regions where other conventional sources of power are less readily available. Small scale hydro power generation is now a well established technology. Small scale hydro power schemes are designed to offer power generation with high levels of availability over a long operating life. Civil engineering works (weirs, channels) can last for many years with suitable maintenance, and the mechanical and electrical lifetime of a hydro power plant can be upto 50 years. Small scale hydro schemes are characterised by relatively high initial capital outlay. However, these high initial costs are offset by the long life time of the scheme , its high reliability and availability, low running costs and the absence of annual fuel costs. Capital costs can often be reduced by making use of existing engineering structures or by refurbishing existing plant and equipment. The cost of generating power from small scale hydro schemes depends on the characteristics of the site, and in particular the height of the hydraulic head, such that the scheme's economic viability decreases as the head decreases. In certain locations, however, even very small hydro schemes can be developed to provide an economic source of power. House hold Hydroelectric Generation is the scheme of rainwater channels on the basement of buildings for carrying away water to turbines coupled to a generator that will convert the falling or running water into electricity with the water eventually flowing to tankers to be stockpiled and vacuum pumped back to the roof during non rainy days, instead of pipes carrying water to the sewage, with the excess stockpiled rainwater to be used to irrigate plants and gardens. Successfully proven with the appropriate architectural engineering design, house hold hydroelectric power will save the world from the potential of devastation or at least reduce human suffering. Which can be designed with a water cycle continuous loop, is a perpetual energy source that will meet the future of unlimited demands even with overpopulated developing countries in the billions? Normally, hydroelectricity depends on large natural water storage. Reservoirs upstream of dams or rivers flowing down from mountain tops where the water flow can be controlled to have constant water level to assure power provided for a populated community. With hydroelectric power generation from rooftops of buildings the Philippines, a country with an average rainfall of more than 80 inches or more than 2000 mm of rain each year, can have a perpetual energy source simply by designing a Rooftop Hydroelectric Power Generator emplaced in structures of high rises, schools, and homes providing the possibility of electricity in all the provinces with (barangays) villages of people currently living without power.

The individual buildings, depending on the square area of the rooftops and gravitational flow of the rainwater, will be classified as small to mini or micro hydro in capacity of providing the energyAn industrial Rain water hydroelectric power generation to provide electricity in metropolises, entire provinces, or new developments that can have the infrastructure of poles and wires will provide electricity in a world worried about Climate Change and Global Warming destruction with no worries of accidental flooding associated with existing hydroelectric power plants, but the idea of individual buildings can provided wireless electricity in a planned community and independent from the problems linked with power plants like during typhoon seasons of uprooted poles and dislodged wires. For the duration of dry seasons or non rainy days, vacuumed pumped from stockpiled rainwater in tankers on ground level can produce electricity even during high peak demands instead of a loop, but during tropical storms electricity will be naturally created from raindrops and gravity for an energy source provided by Mother Nature, every rainy day perpetually. [14-18]

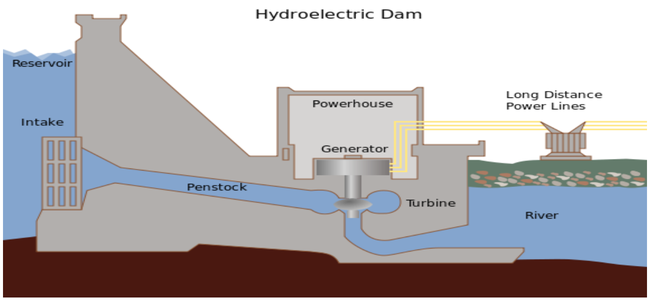
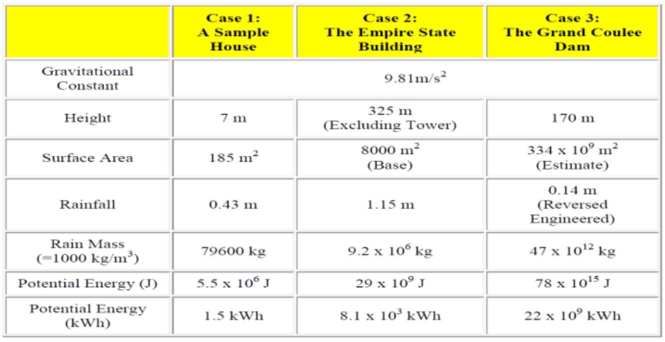


Figure 1: Process of Hydro Electric power Generation

4. POTENTIAL ENERGY OF WATER

Anybody of mass that has been raised above the Earth's surface has a potential energy relative to the same mass on the Earth's surface. As explained above, by running elevated water over a turbine, some of this potential energy can be converted into kinetic and electrical energy. In the water cycle, water evaporates via solar energy and gains potential energy that is then lost again when the water precipitates. This cycle of evaporation, rain, turbine, provides a mechanism for the conversion of solar into electrical energy. At best, the amount of electrical energy that can be generated is equal to the potential energy of the rain.This gravitational potential energy is simply equal to the product of mass, height, and gravitational constant (9.81 m/s2). For example, the potential energy of a cubic meter of water (1000kg) in a stratus cloud at 2000 m of elevation is about 20 MJ, or 5.5 kWh. This means that in a region where the average amount of rain is about 0.40 m, the total amount of rain potential energy lost over a 1 km2 plot of land is about 7.8 x 1012 J, 2.18 x 106 kWh, or enough energy for about 220 homes. Unfortunately, the vast majority of this energy is lost via friction with the air during the rain fall. The next section looks at the total amount of kinetic energy that is still present when the rain hits the ground. [4-6]



	Case 1: A Sample House	**Case 2: The Empire State Building**	**Case 3: The Grand Coulee Dam**
Gravitational Constant	$9.81 m/s^2$		
Height	7 m	325 m (Excluding Tower)	170 m
Surface Area	$185\ m^2$	$8000\ m^2$ (Base)	$334 \times 10^9\ m^2$ (Estimate)
Rainfall	0.43 m	1.15 m	0.14 m (Reversed Engineered)
Rain Mass ($=1000\ kg/m^3$)	79600 kg	9.2×10^6 kg	47×10^{12} kg
Potential Energy (J)	5.5×10^6 J	29×10^9 J	78×10^{15} J
Potential Energy (kWh)	1.5 kWh	8.1×10^3 kWh	22×10^9 kWh

Table 1: Examples of the potential energy of rain on the roof of two buildings and into the Columbia River Basin

In order to account for the total amount of amount of potential energy that practically be used, assume that the rain is funneled (via home gutters) and then stored into a tank located about roof level, say, 7 m off the ground. The total amount of potential energy of the rain water in the tank would be equal to about 70 kJ per cubic meter of water. As an example, if the total roof space were about 185 m2 (2000 sq feet), the amount of potential energy would be 130 kJ (0.036 kWh) per cm of rain. In a college town where the amount of rain is only about 43 cm/year, this amounts to only about 1.5k Wh. Even in the rainiest place on earth the amount of energy generated would be 48kWh. [7] In order to capture enough rain for a years worth of energy, the amount of surface area at 7 m and exposed to 100 cm of rain per year would need to be about 515000 m2. This assumes a perfectly efficient generator, which does not exist. Instead of relying entirely on rainfall to fill the tank of water on top of the house, a home owner could have a similarly sized tank (or pool) at ground level and build a mechanism catching water that rises due to evaporation. This would be the same conversion of solar thermal energy into electricity as explained above. The average amount of water that can be evaporated per unit of surface varies, with a peak of 404 cm in Death Valley and a value of about 182 cm in the San Francisco area. If the evaporation was taking place from a pool of the same size as the roof tank (185 m2 to a tank 7 m high) above, the total amount of energy harvested would be about 6.42 kWhr at Stanford and 14.3 kWr in Death Valley. Again, not nearly enough to power a home. Finally, another (obviously horrible) idea is to fill the potential energy tank on top of house via a garden hose. Since the homeowner does not directly run/pay for the water pump, this would not be a net electricity loss when looked at from the home's perspective. Assuming a garden hose can output 6 gallons per minute (456 x $10-6 m3/s) onto the rooftop, the total amount of power generated is about 31W. Running this hose for an hour would generate about $0.003 worth of electricity while consuming 360 gallons, or about $1, of water (approximately 2000x more expensive).Studying the total amount of rainfall on an entire river valley, yields vastly different results. For example, the size of the River basin is about 668 x 109 m2. Making (my own) estimate that half of this land drains upstream of the Nagarjuna Sagar Dam, this means that the exposed surface area for rain collection is about 334 x 109 m2. The Nagarjuna Sagar Dam itself is about 170 m high and generates 21 x 109 kWh per year. This means that, on average, 14 cm of rain that falls in the upper basin needs to reach the dam in order to provide it with enough potential energy (assuming perfect conversion) to generate its electricity. As a final limit, if all the rain that fell in the United States (an area of 9.62 x 1012 m2 and depth of 76.2 cm) was passed over a structure the height of the dam, a total of 3.4 x 1012 kWh could be produced. While this number is still only 80% of the total electrical production, it is worth mentioning that the hydroelectric production is already at 21.5% of this number.

5. RAIN KINETIC ENERGY

As shown above, trapping rain, storing it, and running it past a turbine is one mechanism of converting the energy of rainfall into electricity. Another option that can be used in tandem is to capture the kinetic energy of the rain directly. This can be done using piezoelectricity, where crystals convert mechanical motion into electricity. Again making the unrealistic assumption of perfect conversion, the amount of kinetic energy in a object is half the mass times the velocity squared. The velocity of rain is limited by air resistance and typically has a maximum of around 8 m/s [4]. Doing the calculation, the amount of kinetic energy falling on a 185 m2 roof is about 59.2 kJ (0.016 kWh) per cm of rain. This is only about 1.6 kWh of energy per year in an area that receives a meter of rain per year. As an unrealizable limit, the total amount of rain kinetic energy over the USA is about 65 billion kWh (a quarter of the total energy use). There are practical applications that arise from this effect, however. Recent research has demonstrated how this effect can power small sensors that use only a little amount of energy and are inconvenient to power by other means. [7-9]

6. CONCLUSION

This article shows basic calculations and estimates for the amount of energy that could potentially be harvested from rain. In moderate scales, there is little potential for energy generation using either the potential or kinetic energy of falling water. In the gigantic scale, however, where nature has carved out a large basin to catch rainfall, dams and turbines can be installed to produce significant amounts of electricity. On small sensors, the kinetic energy of rain can provide enough energy in order to sustain operation. Overall, using precipitation to generate electricity can be used situationally to compliment other technologies, but is not an end solution.

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