. Micro hydro turbine generator (MHTG)

Electric Energy Generation by Extracting Potential Energy of Water Stored In Overhead Tank in Multi-storeyed Buildings

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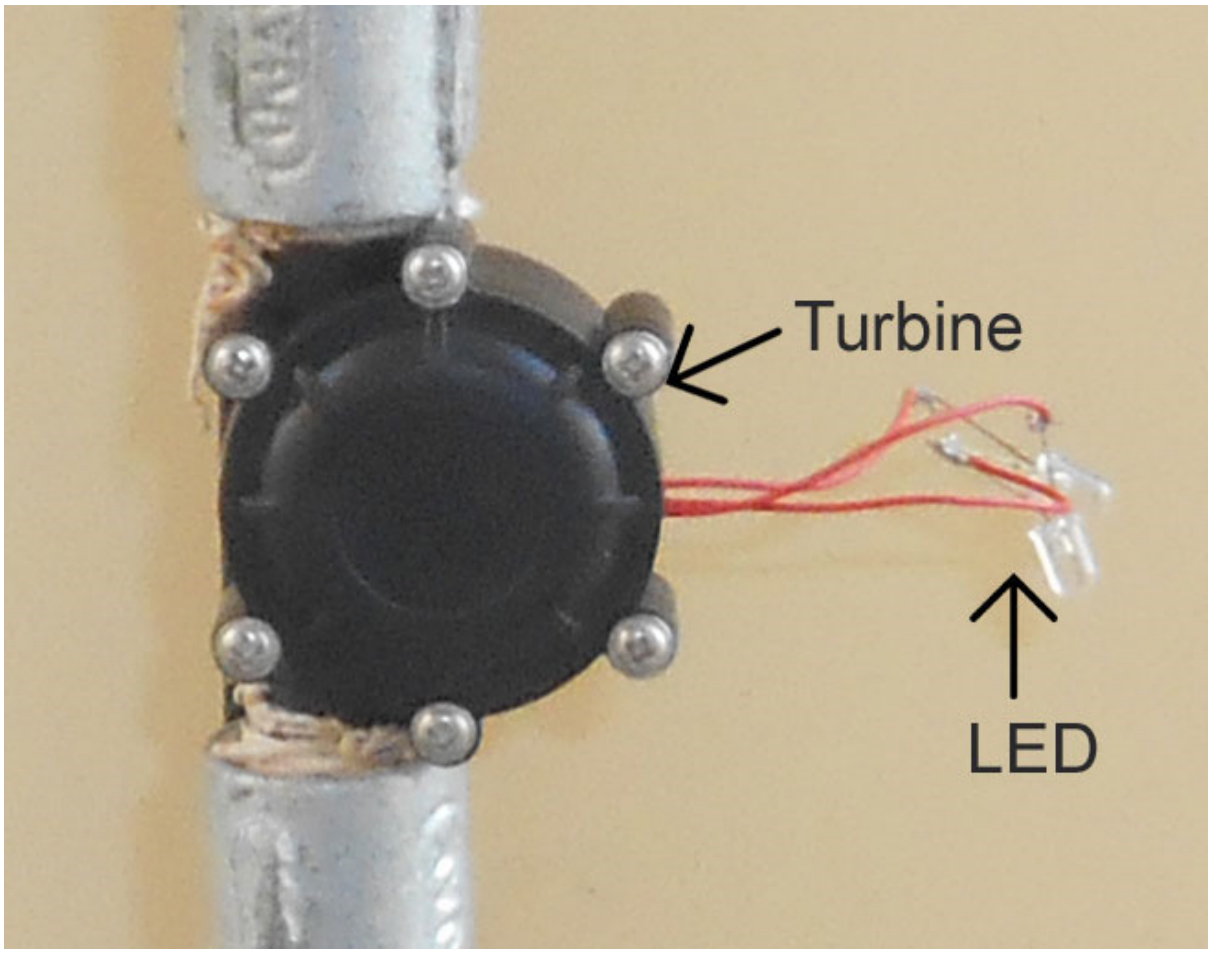
A micro hydro turbine generator (MHTG) converts potential energy stored in water tank held at height to kinetic energy, turning a turbine to produce electricity. Small scale hydro power ranges from a few hundred watts (possibly for use with batteries) for domestic schemes, to KW for commercial schemes.

ABSTRACT

Overhead tank on buildings stores water for everyday use. Energy can be extracted from flowing water when it is supplied to apartments. A micro hydro turbine generator (MHTG) may be fitted in water pipe line to convert potential energy of water into electrical energy. Paper describes techno-economic feasibility of the concept. The literature survey carried indicates that, no such micro turbine- generator set is available in market which exactly matches the application. Electrical energy generation for 20 storied building is estimated on per day and per year basis. It is shown that, energy generated is not just sufficient to power staircase lighting of the building, but also in addition conserve substantial part of energy required for lifting water.



Apart from conserving energy, it is a big Clean Development Mechanism (CDM) project generating valuable Certified Emission Reductions (CERs) for the Delhi Government.

INTRODUCTION

Demand for energy is increasing day by day with growing industrialization. There is need to tap all possible sources of energy whatever small in quantity they may be. Conventional energy sources such as coal, oils are going to last for few decades. The world is looking towards non-conventional energy sources as only hope for survival. Research is going on for the further development of solar, wind, biomass, micro hydro and other renewable energy technologies. *One more advantage of renewable energy sources is that they are not concentrated at one place. Transmission and distribution losses are getting reduced considerably by use of such distributed sources of energy.* Domestic energy needs are partially fulfilled by products such as solar water heating systems and domestic wind mills. One more source of energy still remained untapped and that is the potential energy available with water stored in overhead tank on the buildings. Overhead storage tanks on buildings are used to store water for daily use. Energy can be extracted from water, by micro hydro turbine generator set when it flows down from tank to apartments. It can be stored in battery when water flows and stored energy in battery can be used to power say staircase lighting and some other domestic appliances through inverter. Considering total number of buildings all over the world, millions of MWh of energy can be generated by this new non-conventional source of energy.

TECHNICAL ANALYSYS

The minimum available water head for energy generation is around three metres for single storied building with addition of three metres for every added floor. The minimum water discharge produced by partial opening of a water tap is found to be fraction of a litre per second by measurements taken. Micro hydro turbine-generator sets can be made which can produce power with water discharge as low as 0.18 litres/second and those with water head

as low 2 metres^2. Literature survey carried out so far, indicate that micro hydro turbines are not available in markets, which exactly match this application. The water use is not continuous and so the discharge. That's why energy is required to be stored in battery. One micro hydro turbine-generator set to be commissioned on each floor. The Head availability ranges from 3 metres to 60 metres for 20 storied building.

ENERGY AVAILIBILITY IN 20 STORIED BUILDING

Assumptions made

1. There are five flats per wing per floor.
2. The number of persons per flat is four.
3. 80 % of water is being used in morning 4 hours3. This figure will be useful to find average water discharge.
4. One MHTG set is to be installed per floor.

Energy Estimation

For twenty storied building, water head available with generator at ground floor H =60 metres with floor height of 3 metres. Water consumption of 150 litres per capita per day 4 , with 4 persons per family and 5 flats per floor, total water consumption per floor, per wing is equal to

Water consumption =150 x 4 x 5 = 3000 litres.

With 80% of water used in morning 4 hours

Average discharge per floor in litres/second, Q = 3000 x 0.8 ÷ 4x 3600

= 0.167 litres/second = 0.167×10^{-3} m^3 /s

Available water power is given by

$P_a = 1000 \times g \times Q \times H$ Watts

Discharge will last for time t = 3000/0.167 = 17964.07 seconds

Energy available with water is given by $E_a = P_a \times t$ Joules

Assuming overall efficiency MHTG set including losses in pipes to be of 50% (water to wire), electrical energy output from generator is = $P_a \times t \times 0.5$ Joules.

Electrical Energy availability per day in KWh = $P_a \times t \times 0.5$ J/3.6 MJ

The values of Head available, water power, Electrical energy per day, electrical energy per year and cost of energy@ Rs. 3/- per KWh, are tabulated below for each floor in

Table 1: Energy & cost for 19th to 11th floor

Floor No	Water Head in metres	Water power per P_a watts	Electric energy per day KWh	Electric energy per year KWh	Cost of energy in Rs.
19	3	4.91	0.0122	4.453	13.36
18	6	9.83	0.0245	8.942	26.83
17	9	14.74	0.0367	13.395	40.18
16	12	19.66	0.049	17.885	53.65
15	15	24.57	0.0613	22.374	67.12
14	18	29.49	0.0735	26.827	80.48
13	21	34.40	0.0858	31.317	93.95
12	24	39.32	0.0981	35.806	107.42
11	27	44.23	0.110	40.15	120.45

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Energy generated per day from 19th floor to 11th floor = 0.551 KWh.
Energy generated per year = 201.15 KWh.
Cost of energy per year @ Rs.4 per KWh = Rs. 804.60

Table 2: Energy & Cost for 10th to Ground Floor.

Floor No	Water Head in metres	Water power per P_a watts	Electric energy per day KWh	Electric energy per year KWh	Cost of energy in Rs.
10	30	49.15	0.1226	44.75	134.25
9	33	54.06	0.1348	49.20	147.60
8	36	58.98	0.1594	53.69	161.07
7	39	63.89	0.049	58.18	164.54
6	42	68.80	0.1716	62.63	187.89
5	45	73.72	0.1839	67.12	201.36
4	48	78.64	0.1962	71.61	214.83
3	51	83. 55	0.2084	76.07	228.21
2	54	88.47	0.2207	80.55	241.65
1	57	93.38	0.2330	85.04	255.12
GF	60	98.29	0.2452	89.50	268.50

Energy generated per day from 10th floor to Ground floor = 2.024 KWh
Energy generated per year = 738.97 KWh.
Cost of energy per year @ Rs 4 per KWh = Rs.2955.88

Total energy generation for 20 storied building per year = 940.12 KWh.
Total revenue of energy generation per year = Rs. 3760.48

SUITABLE TURBINE
The turbine is required to be fitted in the pipeline. When all water taps are closed, water will be filled up in the turbine. So impulse type turbines will not be suitable for this application. Reaction turbines will be suitable in this case.



Specifications for Reaction turbines generator
Minimum Discharge = 0.18 litres/s with minimum required head = 30 m
Electrical power output = 25 watts

With discharge = 1.5 litres/s, power o/p = 250 watts at head = 30 m

Energy generation for floor having head of 30 m, by Reaction turbines Generator
Water utilization = 3000 litres per floor
For discharge Q = 0.18 litres/s, discharge time t = 3000 litres/0.18litres = 16666.66 sec.
Electrical energy = power x time = 25x16666.66 = 416666.5 J
Energy in KWh/day = 416666.5/3.6MJ = 0.1157 KWh
Energy/year = 0.1157 x 365 = 42.245 KWh
Energy revenue @ Rs. 3 per KWh/ year = 42.245 x 3 = Rs. 126.73

ENERGY STORAGE IN BATTERY
As the use of water and hence water discharge is not continuous, energy generated is required to be stored in battery. 12 V or 24 V batteries can be used. CFL lamps can be powered directly from batteries. For this purpose inverter circuits used in emergency lanterns which operate on 12 V dc supply will be most appropriate. For other loads inverters are to be used to convert 12 V/ 24 V dc into mains voltage.

ECONOMIC ANALYSYS
As mentioned earlier MHTG sets are not available in markets which exactly suit this application. So capital cost of MHTG sets is not known. Under this constraint, it can be analysed in the following way.

“If interest obtainable on investment made in capital cost is equal to or less than cost of energy generated, then energy generation will be economically feasible; considering environmental benefits.”

RESULTS
Total energy generated per year for 20 storied building will be 940.12 KWh.
Cost of energy for 20 storied building will be Rs. 2820.36 @ Rs. 3 per KWh.
Sum of energy generated for 19tth to 11tth per day will be 0.551 KWh.
Sum of energy generated for 19th to 11th per year will be 201.15 KWh.
Cost of energy generated for 19th to 11 h per year will be Rs. 603.45 @ Rs. 3 per KWh.
Sum of energy generated for 10th to ground floor per day will be 2.024 KWh.
Sum of energy generated for 10th to ground floor per year will be 738.97 KWh.
Cost of energy generated for 10 h to ground floor per year will be Rs. 2216.91

CONCLUSIONS
Theoretical value of energy generated for 20 storied building per year is 940.12 KWh.
The concept is technically feasible. Micro hydro turbine generator set is required to be designed and fabricated for this application. CERs are extra revenue for the Government.