Rain water harvesting integrated with Energy efficient pumping: A Case study analysis

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Abstract - *Rainwater harvesting (RWH) and pumping of water are interrelated with both technologies. If efficient and proper design of pumping system is not implemented; the water pumping cannot be done in a proper way. RWH will likely see heightened importance as a water security measure with energy efficient pumping design.*

In this Paper, an analysis has been done about the chances of rain water harvesting related to better energy efficient pumping system in GIET campus. The final report of the project will gives complete information about the Rain water harvesting with technical parameters and also in terms of savings in electrical power consumption.

Key Words: Rain water harvesting, Energy efficient pumping, Green buildings, Phytoremediation.

1. INTRODUCTION:

In the present scenario in the world main problem is water. The wastage of water is more in the present era than water conservation. So to get the fresh water one best ever method is rain water harvesting as rain water is ultimate source of fresh water. Other water source contain small amount of mineral and salt. Since rain water contains no chlorine, As it is not regulated by municipal water restriction so in drought periods it can protect landscaping, garden ponds, and swimming pools investment. Due to rain water eroded foundations, overflowing sewers, water pollution and soil erosion occurs so by collecting rain water we can eliminate these problems with expensive storm water control. Rain water harvesting generally adopted the technology of surface runoff harvesting and roof top harvesting.

Again the waste water that is released from daily work of us which is also of bad smell can also be treated and made useful for our daily use. Waste water treatment can be done by primary filtration, secondary treatment, sedimentation, water filter, carbon filtration for carbon removal and sand filtration for municipal waste water. To decrease the cost of rainwater harvesting and make more economical and eco-friendly another method came into picture called Phytoremediation process.

The term Phytoremediation (phyto=plant and remediation=correct evil) is relatively new, coined in 1991. This is most economical and can be done by the help of plants only. Phytoremediation is an emerging technology that uses various plants to degrade, extract, contain, or immobilize contaminants from soil and water. Plants mainly used are halophytes and the plants used must be salt tolerant like, tamarix smyrnensis etc. The Phytoremediation process requires two stages of plants contamination clearing pond and polishing pond and a pump to provide water to the plants. The fresh and contamination free, bad smell free water come out from the polishing pond. This method is economical and eco-friendly with more advantages than conventional way. So in this method plants and a small pump are requiring for water treatment. This process can be done with a very less cost and can be a way of providing fresh water and also using it with air tunneling system the temperature of a house can be decreased to a level reducing the cost of air-conditioners.

So these processes help in providing fresh useful water for a house or a community with the advantages of air conditioner in less cost. So these methods are now helpful among the latest generations.

2. IMPLEMENTATION OF RAIN WATER HARVESTING:

Rain water harvesting can be implemented by the stepwise procedure. The rain water can be collected by tiled roof or roof sheeted with mild steel called roof catchment. These types of roofs preferred as they are easy for cleaning and the asbestos roofs should be avoided. Rain water collected in the guttering placed around the eaves of building. The guttering water transferred to the downpipe which is connected to the storage tank. Downpipe must provide the prevention from bird droppings, vegetable waste, and dust etc. Sometimes a special filter arrangement is done to provide protection to downpipe from ingredients. The run off capacity of a roof is proportional to quantity of rain fall and area of the roof. For one millimeter of rain a square meter of roof area will yield one liter of water (ignoring losses). Capacity of storage tank based upon several design criteria like rain fall pattern, volume, duration of dry period and demand estimation and also sometimes sophisticated need calculations are made. The capacity of storage tank can be calculated by; Mean rain water supply in m^3 = (mean annual rain fall in mm/year)*(surface area of catchment in m^2)*(run-off coefficient). The run-off coefficient describes the losses due to evaporation, splashing, leakage, overflow etc. which is normally taken as 0.8. Storage tanks are 90% of total cost of rain water harvesting technology. These are generally made up of concrete materials. After the storage tank the filters are used and water is purified for drinking purpose. The storage tank can be made inside the soil by digging the soil and a pump is used to supply water to the house.

Roof top rain water harvesting can be used in various methods such that; the storage water can be directly used in the house, water from storage tank can be directly used for gardening and washing etc without filtration. The main purpose of rain water harvesting is to save water and also to save energy incurred in the transportation and distribution of water in doorstep. This also conserves groundwater, if it is being extracted to meet the demand when rains are on. Ground water can be recharged through bore wells, dog wells, pits, trenches and percolation tank etc. The maintenance of filter and rooftop and downpipes are necessary in a required interval of time.

3. Measuring of Rainfall and rain water harvesting

Table 3.1: Average annual rainfall in different regions :

Region	Annual rainfall [mm]
Desert	0 - 100
Semi-desert	100 - 250
Arid	250 - 500
Semi-arid	500 - 750
Semi-humid	900 - 1500
Wet Tropics	Over 2000

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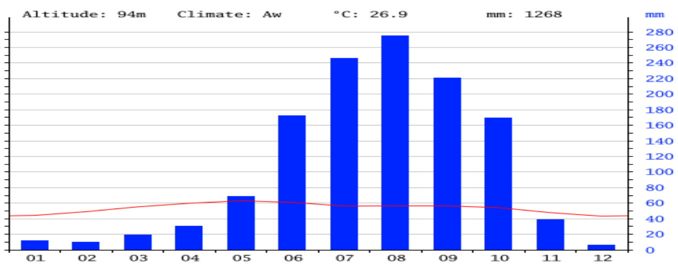
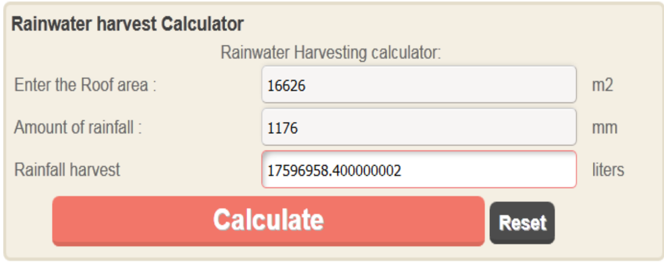


Fig. 3.1: Monthly wise rainfall in Gunupur

The rainfall pattern over the year plays a key role in determining whether RWH can compete with other water supply systems. Tropical climates with short (one to four months) dry seasons and multiple high-intensity rainstorms provide the most suitable conditions for water harvesting. In addition, rainwater harvesting may also be valuable in wet tropical climates, where the water quality of surface water may vary greatly throughout the year. As a general rule, rainfall should be over 50 mm/month for at least half a year or 300 mm/year (unless other sources are extremely scarce) to make RWH environmentally feasible.

4. Catchment Area:

To be 'suitable' the roof should be made of some hard material that does not absorb the rain or pollute the run off. Thus, tiles, metal sheets and most plastics are suitable.
Total rooftop catchment area in GIET campus: 16,626 sq.m.



Rainfall harvest = (RA * AF * 0.9)
Where, RA - Roof Area AF - Amount of Rainfall 0.9 - Amount of total rainwater expected for harvesting.
Total water can be collected from roof=17596958 Litres

Yearly water requirement:

To assess the water requirement in GIET campus, a complete survey has been done with rooftop area available in block wise and also the approximate water requirement in block wise.

As shown in Table 5.2; The total area of all blocks are 16626 sq.m and approximate water requirement per day is 98850 litres and by considering 275 working days of the campus; the yearly requirement is
Total requirement of water for campus in a year
= 275 × 98850 = 2, 71, 83,750 Litres

Table 3.2: Approximate water requirement per day

Location	Area in Sq.m	Approx. water required/day
Basic Science	726	500
EEE/Central library	1154	300
CSE	847	500
Temple	138	100
Admin	1346	300
R&D	1316	500
BT	378	250
Workshop	918	200
Central Auditorium	372	50
Chemical	735	250
Canteen	168	5000
Shopping Complex	288	100
Mini Guest House	304	300
Staff Quarters	1233	8000
Hostel 123	112	6000
Hostel 4	687	6000
Hostel 5	687	6000
Hostel 6	697	6000

Hostel 7	408	6000
Hostel 8	771	6000
Hostel 9	557	6000
Hostel 10	548	6000
Hostel 11	697	6000
Hostel 12	585	8000
GPS 1	527	250
GPS 2	427	250
Cooking , cleaning	---	10000
Gardening	----	10000
Total	**16626**	**98850**

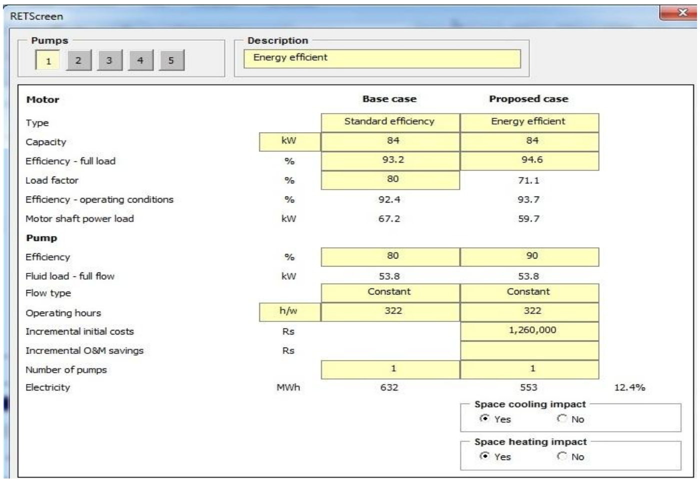
Table: 3.3 Amount of water to be pumped after rain water harvesting

Particulars	**Water requirement**
Total requirement of water for GIET campus in a year	2,71,83,750 Liters
Through rain water harvesting water can be collected	1,75,96,958 Liters
The amount of water to be pumped from ground	95, 86,792 liters

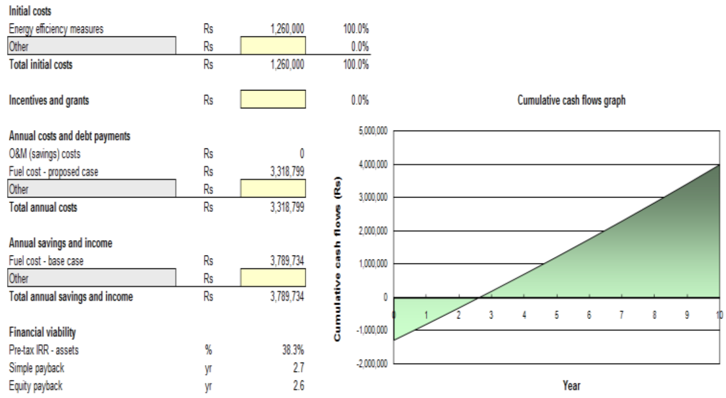
5. Energy conservation with Energy efficient Pumps

Table 3.4: Total pump capacity and no. of units consumed in a day

configuration of the Pumps	No. of pumps	Pump capacity in Kw	No. of operating hours/day	Load in kWh	units/day
1 HP	7	5950	2	11900	
1 HP	8	6800	3	20400	
2 HP	3	5100	3	15300	
2 HP	3	5100	4	20400	
3 HP	4	10200	3	30600	
5 HP	3	12750	3	38250	
5 HP	3	12750	4	51000	
7.5 HP	3	19125	6	114750	
7.5 HP	1	6375	18	114750	
Total load in KW		84.150		417350	417.35 units/day



As shown in above fig. the percentage of savings will be around 12.4 % with an investment of 12, 60,000 Rs/-



Hence, the payback period is 2.7 years and all the analysis done by RETScreen excels based software.

5.1 RWH integrated with Energy efficient Pumps

As shown in Table 5.4 the water pump capacity decreases to 147 KW as per the below equation.

$$New\ pump\ capacity\ requirment = \frac{water\ to\ be\ pumped\ after\ RWH}{Total\ water\ required} X\ Total\ pump\ capacity$$

$$= \frac{9586792}{27183750} X\ 84 = 29.6\ Kw$$

Hence, the total power consumption after rain water harvesting
= 29.6 kw× 275* 46hrs/day * 6 Rs/- = 22, 46, 640 Rs/- * 1/4
= 5, 61, 660 Rs/-
The total cost of installation for rain water harvesting is = 25, 00,000 Rs/-

Table 5.1: Total savings

S.N.	Particulars	Savings
1	Initial power consumption before rainwater harvesting	37,92,000 Rs/-
2	with energy efficient pumping	33,18,000 Rs/-
3	With Rainwater harvesting	5,61,660 Rs/-
4	Total savings after rainwater harvesting and energy efficient pumping [1-2+3]	10,35,660 Rs/-

Table 5.2 Payback period calculations

S.N.	Particulars	Savings
1	Investment for Energy efficient pumping	12,60,000 Rs/-
2	Investment for Rain water harvesting	25,00,000 Rs/-
3	Total investment [1+2]	37,60,000 Rs/-
4	Total savings from Table 5.6	10,35,660 Rs/-
5	Payback Period 3/4	3.63 years

Hence, the energy efficient pumping with Rainwater harvesting is a best choice for water scarcity and at the same time for energy conservation. With an investment of 37, 60,000 Rs/- the savings will be around 10,35,660 Rs/-

CONCLUSION

In this Paper, an analysis has been done about the chances of rain water harvesting related to better energy efficient pumping system in a college campus. The final report of the project has shown about the Rain water harvesting with technical parameters and also in terms of savings in electrical power consumption.

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