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Solar techniques to offset STP power supply in residential buildings

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ABSTRACT

There is more energy crisis is occurring in India. We are in a situation to produce own renewable energies. Many industrial and commercial sectors have started producing their own renewable energies. Only if the residential sectors start to produce their own energies, we can overcome the energy crisis. Sewage treatment plant is one of most power consuming source in a residential building. Sewage treatment is the process of removing contaminants from wastewater, primarily from household sewage. It includes physical, chemical, and biological processes to remove these contaminants and produce environmentally safe treated wastewater (or treated effluent). The types and the energy consumption are studied in this paper. Also, suitable source of energy is given as a solution to offset the power supply of STP in residential building.

Keywords: *Sewage Treatment Plant, Energy Consumption, Residential Building, Renewable Energies*

1. INTRODUCTION

Buildings account for approximately 40% of the worldwide annual energy consumption (WBCSD 2009). Total global energy consumption in 2007 was 495 quadrillion British thermal units (Btu), meaning the buildings sector consumed about 198 quadrillion Btu. According to the Energy Information Agency, worldwide energy consumption is expected to increase 1.4% per year through 2035, implying that buildings will consume 296 quadrillion Btu by the year 2035 (EIA 2010). Fossil fuels meet a majority of world energy needs and because buildings are a large energy consumer, they are also a major contributor to global carbon emissions and greenhouse gas (GHG) production. It is now largely recognized that addressing energy use in buildings can reduce total fossil fuel consumption and associated GHG emissions. Benefits such as decreased building operational energy costs have prompted growing interest among policy makers, the technical community, and the general public in addressing building energy issues and investigating solutions for decreasing building energy consumption.

2. AIM

To analyze and come out with a proposal for a mid-range residential project as a prototype model to minimize the energy consumption of Sewage treatment plant through retrofitting the existing technology with a more energy conservative approach and using other renewable energy sources in supplying power to STP.

3. OBJECTIVES

- To study the various principle of STP and energy consumption pattern.
- Identify an alternate source of energy for running, thereby reducing the conventional energy cost.
- Identify a mid-range residential unit and proposing a prototype model for the STP to reduce the energy consumption by offering through retro fitting and alternate source of energy.

4. SCOPE

The scope of this study is to cut off the electricity cost and save energy in a residential building. The main scope of this study is to reduce the electricity supply for STP.

5. METHODOLOGY

The methodology of this study goes as below:

JOURNAL STUDY
- To identify journals related to the topic.
- Journal review has to be done.

LITERATURE STUDY
- To know the types of STP and its working principle.
- Different ways to save energy in a residential building.

NET CASE STUDY
- Identify suitable net case study.
- Compare it with the literature study.

LIVE CASE STUDY
- Identify a live case study.
- Propose the suitable solar technique to offset the STP power supply in this building.

Fig 1: Methodology

7. LIVE CASE STUDY

7.1 Project Details

NAME : KOCHAR GARDENS
NO. OF FLOORS : 4 FLOORS
NO. OF UNITS : 136 UNITS
NO. OF BLOCKS : 4 BLOCKS A,B,C AND D
AREA : 10200 SQ.FT/ floor
LOCATION :GERUGAMBAKAM (CHENNAI)

7.1.1 Site Plan

Fig 2: Site plan Kochar gardens (Chennai)

7.2 Description of the project

It has about 50 sq.ft of OTS in each unit.

7.2.1 Floor Plans

Fig 3: Floor plan Kochar gardens (Chennai)

7.3 Design

The sewage treatment plant capacity is designed for 75 KLD @ 20 hours operation. It is designed using FBBR.

7.3.1 Raw sewage for design

Table 1: Raw sewage for design

S.No	Description of Parameter	Value
1.	PH	6.5 – 7.5
2.	BOD (Biological Oxygen Demand)	300 Mg/Liters
3.	COD (Chemical Oxygen Demand)	900 Mg/Liters
4.	TSS (Total Suspended Demand)	150 Mg/Liters
5.	Oil & Grease	50 Mg/Liters

7.3.2 Treated sewage characteristics

Table 2: Treated sewage characteristics

S.No	Description of Parameter	Value
1.	pH	6.5 – 8.5
2.	BOD (Biological oxygen demand)	Less than 20 mg/liters
3.	COD (Chemical oxygen demand)	Less than 100 mg/liters
4.	TSS (Total Suspended demand)	Less than 30 mg/liters
5.	Oil & Grease	Less than 5 mg/liters

7.4 Treatment Scheme

There are three treatment steps for achieving required outlet of quality.

1. Primary treatment
2. Secondary treatment
3. Tertiary treatment

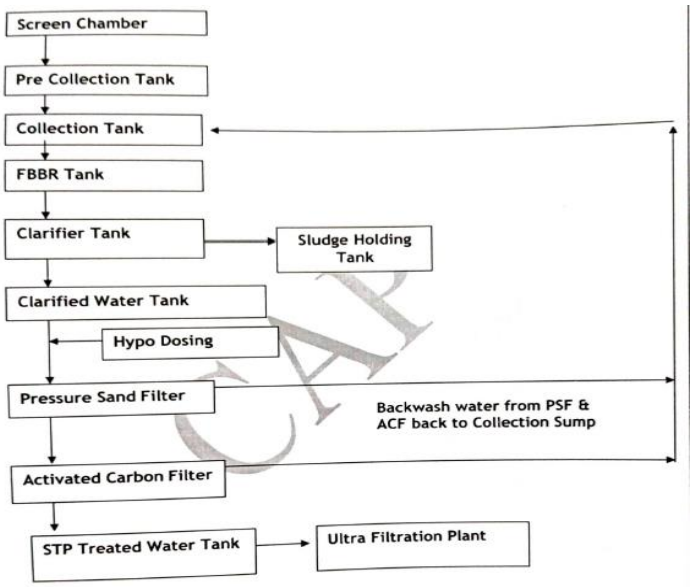

Fig 4: STP Treatment scheme

7.4.1 Electrical load as per the design

Table 3: Electrical load as per the design

S. No	Description	Operating Load (Kw)	Total Load (Kw)	Quantity	Running Hours	Total Kwh/Day
1.	Collection Sewage Transfer Pump	0.375	0.75	2 Nos	20	7.5
2.	Blower With Motor	3.75	7.5	2 Nos	24	90.0
3.	Sludge Transfer Pump	0.375	0.375	2	0.5	0.187
4.	Filter Feed Pump	1.1	2.2	2	20	22.0
5.	Hypo Dosing System	0.04	0.04	1	20	0.8
Total Load						120.487
80% Of Total Load						96.3

S. No	Description	Operating Load (Kw)	Total Load (Kw)	Quantity	Running Hours	Total Kwh/Day
1.	UF feed pump	2.25	4.5	2 Nos	15.0	33.75
2.	Back wash pump	1.125	1.125	1 Nos	5.0	0.567
3.	Hypo dosing pump for feed	0.04	0.08	1	15.0	0.6
4.	Hypo dosing pump for backwash	0.04	0.08	1	0.5	0.02
Total Load						34.93
80% Of Total Load						27.94

7.4.2 Asset list of STP plant

Table 4 Asset list of STP plant

S.no	List	Numbers
1.	Raw Sewage Transfer Pump	2
2.	Air Blowers	2
3.	Sludge pump	2
4.	Filter feed pump	2
5.	Dosing pump	1
6.	Pressure sand filter	1
7.	Activated carbon Filter	1
8.	UV system	1
9.	Filter press	1
10.	Screw pump	2

7.4.3 Asset list of ultra-Filtration plant

Table 5: Asset list of Ultra filtration plant

S.no	List	Numbers
1.	UF feed pump	2
2.	UF backwash pump	2
3.	Dosing pump	2
4.	CIP pump (clean in place)	1

7.5 Output of electrical load used in STP

The data is observed on day basis. They have observed and noted as per units of current. This is observed for each units and STP and for clubhouse separately. This data is as per April month readings.

(NOTE: A unit (as mentioned on the electricity bills) is represented in **kWH** or **Kilowatt Hour**.)

Table 6: Output of electrical load used in STP(4 days)

S.no	Pump	Units	STP	Units	Clubhouse	Units
1.	DAY 1	80	**DAY 1**	**247**	DAY 1	84
2.	DAY 2	75	**DAY 2**	**222**	DAY 2	57
3.	DAY 3	82	**DAY 3**	**247**	DAY 3	63
4.	DAY 4	78	**DAY 4**	**245**	DAY 4	73

S.no	Block A	Units	Block B	Units	Block C	Units	Block D	Units
1.	DAY 1	24	DAY 1	41	DAY 1	24	DAY 1	13
2.	DAY 2	21	DAY 2	54	DAY 2	23	DAY 2	12
3.	DAY 3	24	DAY 3	48	DAY 3	23	DAY 3	13
4.	DAY 4	23	DAY 4	56	DAY 4	23	DAY 4	14

7.6 COST OF STP FOR ONE DAY IN KOCHAR GARDENS

Table 7: Cost of STP for one day in Kochar garden

S. No	STP	Avg units	Cost / Unit (TNERC)	Cost Of STP of Kochar gardens
1.	DAY 1	238	6.54 Rupees	1,556 RS / DAY

7.7 Electricity usage of STP & Motor APR 2021

Table 8: Electricity usage of STP and motor Apr 2021

S.No	Pump	Units	STP	Units	Clubhouse	Units
1.	DAY 1	80	DAY 1	**247**	DAY 1	84
2.	DAY 2	75	DAY 2	**222**	DAY 2	57
3.	DAY 3	82	DAY 3	**247**	DAY 3	63
4.	DAY 4	78	DAY 4	**245**	DAY 4	73
5.	DAY 5	75	DAY 5	**247**	DAY 5	62
6.	DAY 6	77	DAY 6	**243**	DAY 6	65
7.	DAY 7	80	DAY 7	**234**	DAY 7	64
8.	DAY 8	40	DAY 8	**247**	DAY 8	61
9.	DAY 9	55	DAY 9	**326**	DAY 9	62
10.	DAY 10	58	DAY 10	**242**	DAY 10	78
11.	DAY 11	61	DAY 11	**242**	DAY 11	38
12.	DAY 12	62	DAY 12	**242**	DAY 12	49
13.	DAY 13	58	DAY 13	**259**	DAY 13	49
14.	DAY 14	70	DAY 14	**251**	DAY 14	42
15.	DAY 15	70	DAY 15	**234**	DAY 15	25
16.	DAY 16	62	DAY 16	**223**	DAY 16	24
17.	DAY 17	70	DAY 17	**222**	DAY 17	18
18.	DAY 18	52	DAY 18	**242**	DAY 18	12
19.	DAY 19	63	DAY 19	**235**	DAY 19	12
20.	DAY 20	64	DAY 20	**267**	DAY 20	39
21.	DAY 21	56	DAY 21	**246**	DAY 21	39
22.	DAY 22	56	DAY 22	**251**	DAY 22	45
23.	DAY 23	56	DAY 23	**234**	DAY 23	39
24.	DAY 24	56	DAY 24	**267**	DAY 24	40
25.	DAY 25	56	DAY 25	**237**	DAY 25	41
26.	DAY 26	62	DAY 26	**238**	DAY 26	20
27.	DAY 27	53	DAY 27	**239**	DAY 27	32
28.	DAY 28	53	DAY 28	**239**	DAY 28	32
29.	DAY 29	62	DAY 29	**227**	DAY 29	40
30.	DAY 30	62	DAY 30	**248**	DAY 30	41

7.8 Common electricity usage APR 2021

Table 9: Common electricity usage Apr 2021

S.no	Block A	Units	Block B	Units	Block C	Units	Block D	Units
1.	DAY 1	24	DAY 1	41	DAY 1	24	DAY 1	13
2.	DAY 2	21	DAY 2	54	DAY 2	23	DAY 2	12
3.	DAY 3	24	DAY 3	48	DAY 3	23	DAY 3	13
4.	DAY 4	23	DAY 4	56	DAY 4	23	DAY 4	14
5.	DAY 5	23	DAY 5	47	DAY 5	23	DAY 5	13
6.	DAY 6	23	DAY 6	46	DAY 6	23	DAY 6	13
7.	DAY 7	18	DAY 7	44	DAY 7	23	DAY 7	13
8.	DAY 8	21	DAY 8	76	DAY 8	23	DAY 8	14
9.	DAY 9	24	DAY 9	54	DAY 9	24	DAY 9	14
10.	DAY 10	22	DAY 10	48	DAY 10	40	DAY 10	14
11.	DAY 11	22	DAY 11	67	DAY 11	28	DAY 11	21
12.	DAY 12	20	DAY 12	17	DAY 12	23	DAY 12	23
13.	DAY 13	18	DAY 13	54	DAY 13	24	DAY 13	28
14.	DAY 14	17	DAY 14	26	DAY 14	24	DAY 14	61
15.	DAY 15	20	DAY 15	26	DAY 15	25	DAY 15	67
16.	DAY 16	22	DAY 16	33	DAY 16	23	DAY 16	68
17.	DAY 17	22	DAY 17	44	DAY 17	23	DAY 17	10
18.	DAY 18	23	DAY 18	36	DAY 18	22	DAY 18	15
19.	DAY 19	23	DAY 19	38	DAY 19	22	DAY 19	10

20.	DAY 20	23	DAY 20	43	DAY 20	22	DAY 20	13
21.	DAY 21	20	DAY 21	43	DAY 21	22	DAY 21	13
22.	DAY 22	20	DAY 22	43	DAY 22	23	DAY 22	11
23.	DAY 23	20	DAY 23	43	DAY 23	23	DAY 23	11
24.	DAY 24	20	DAY 24	43	DAY 24	23	DAY 24	12
25.	DAY 25	21	DAY 25	39	DAY 25	23	DAY 25	12
26.	DAY 26	18	DAY 26	71	DAY 26	23	DAY 26	12
27.	DAY 27	18	DAY 27	72	DAY 27	23	DAY 27	15
28.	DAY 28	17	DAY 28	65	DAY 28	23	DAY 28	16
29.	DAY 29	20	DAY 29	65	DAY 29	20	DAY 29	17
30.	DAY 30	21	DAY 30	47	DAY 30	21	DAY 30	18

7.9 Total electricity usage in 1 Day

Table 10: Total electricity usage in a day

S.no	Days	Total
1.	DAY 1	513
2.	DAY 2	464
3.	DAY 3	500
4.	DAY 4	512
5.	DAY 5	490
6.	DAY 6	490
7.	DAY 7	476
8.	DAY 8	482
9.	DAY 9	559
10.	DAY 10	502
11.	DAY 11	479
12.	DAY 12	436
13.	DAY 13	490
14.	DAY 14	491
15.	DAY 15	467
16.	DAY 16	455
17.	DAY 17	409
18.	DAY 18	402
19.	DAY 19	403
20.	DAY 20	471
21.	DAY 21	439
22.	DAY 22	449
23.	DAY 23	426
24.	DAY 24	461
25.	DAY 25	429
26.	DAY 26	444
27.	DAY 27	452
28.	DAY 28	445
29.	DAY 29	451
30.	DAY 30	458
TOTAL		13945

- The average electricity cost for one day is 465 units
- The average electricity used by STP is 7133 units
- The average electricity used by STP is 51% of the total electricity per month.

7.6 TERRACE CALCULATIONS –
Flat Overall Terrace Area=12,320 SQFT

Required to reduce
1.OPEN TERRACE IN BELOW FLOOR=890 SQ FT
2.LIFT =55 SQ FT
3.SHAFT=235 SQ FT
4.STAIRCASE =85 SQ FT
5.MEP LINES= 750 SQFT

TOTAL=2,000 SQFT

AVAILABLE FREE SPACE IN TERRACE =12,320 - 2000 =10,320

TOTAL FREE SPACE IN TERRACE = 10,320 SQ FT
TOTAL TERRACE AREA AVAILABLE IN 3 BLOCKS = 10,320 X 3 = 30,960 SQ FT

7.7 Solar Panels Calculations

Average solar irradiation in TAMIL NADU state is 1266.52 W / sq.m

1kWp solar rooftop plant will generate on an average over the year 5.0 kWh of electricity per day (considering 5.5 sunshine hours)

1. Size of Power Plant	
Feasible Plant size as per your Roof Top Area :	57.6kW
2. Cost of the Plant :	
MNRE current Benchmark Cost :	Rs. 38000 Rs. / kW
Without subsidy (Based on current MNRE benchmark) :	Rs. 2188800
With subsidy 40% upto 3kW & 20% above 3kW upto 10kW (Based on current MNRE benchmark) :	Rs. 2090000
3. Total Electricity Generation from Solar Plant :	
Annual :	86400kWh
Life-Time (25 years):	2160000kWh
4) Financial Savings :	
a) Tariff @ Rs.6.54/ kWh (for top slab of traffic) - No increase assumed over 25 years :	
Monthly :	Rs. 47088
Annually :	Rs. 565056
Life-Time (25 years) :	Rs. 14126400

Fig 5: MNRE Subsidy for the design solar panel in Kochar gardens

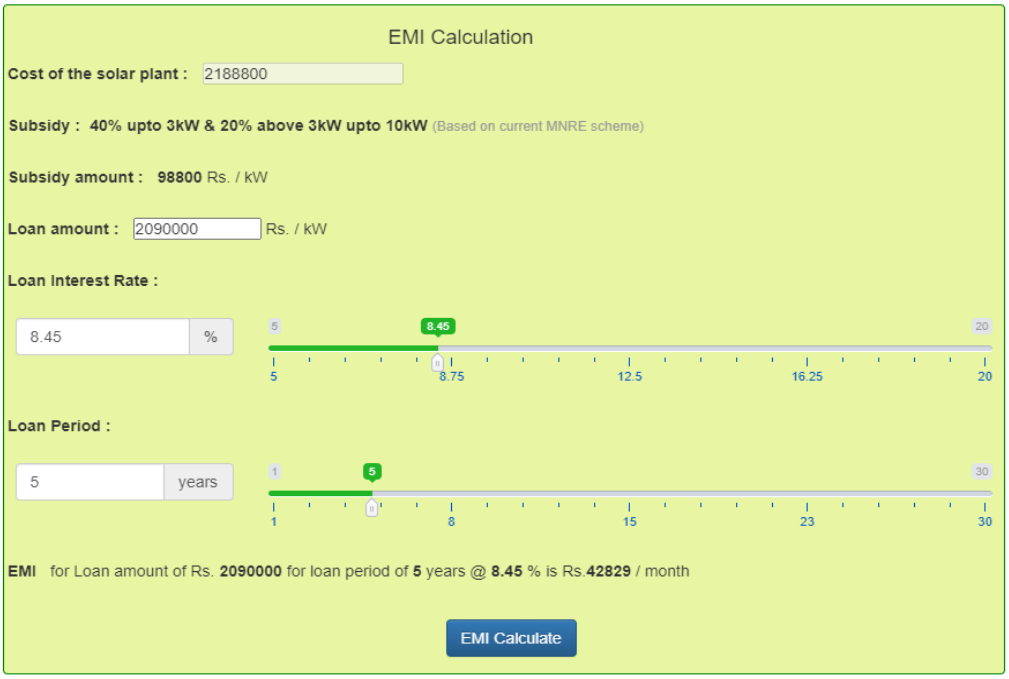

Fig 6: EMI for the design solar panel in Kochar garden

7.8 Inference

- The area required to install 57.6 kw is 6200 sq ft.
- For a loan amount of 20,90,000.Rs the EMI to be paid per months is Rs.42,829.
- The EMI amount to be paid by 1 house per month is Rs.315 for 5 years.
- There is a total of 136 houses.
- The unit tariff of STP is 10.Rs.The avg STP electricity per month is 7133 units which is 71,330.Rs for one year.
- Payback period is 2.4 years.

8. REFERENCES

[1] http://www.iosrjournals.org/iosr-jestft/papers/vol4-issue5/R045113121.pdf
[2] https://www.ijcrt.org/papers/IJCRT2006637.pdf
[3] https://www.vikramsolar.com/solar-calculator/
[4] https://www.bijlibachao.com/solar/solar-panel-cell-cost-manufacturer-price-list-in-india.html

[5] https://nzeb.in/case-studies/nzebs-in-india/nzebs-in-india-case-studies-list/ipb-case-study/
[6] https://www.slideshare.net/supergirlanchal/indira-paryavaran-bhawan-and-griha-49343513
[7] https://www.slideshare.net/apartmentadda/stp-in-residential-complexes
[8] https://www.researchgate.net/publication/339644542_A_Case_Study_on_Sewage_Treatment_Plant_STP_Delawas_Jaipur
[9] https://www.researchgate.net/publication/257799149_A_study_of_the_effectiveness_of_sewage_treatment_plants_in_Delhi_region
[10] https://www.tsijournals.com/articles/design-approach-for-sewage-treatment-plant-a-case-study-of-srikakulam-greater-municipality-india.html
[11] https://letsavelectricity.com/cost-of-solar-system-in-india/#:~:text=The%20MNRE%20benchmark%20cost%20for%20solar%20on%20grid%20system%20(2019,kW%20to%20Rs%203%2C000%20%2F%20kW.
[12] https://www.saurenergy.com/rooftop-epc/tamil-nadu-energy-development-agency-teda
[13] https://www.greenmatch.co.uk/blog/2015/09/types-of-solar-panels
[14] https://www.8msolar.com/types-of-solar-panels

