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Comparing To Estimate The Use Of Alternative Energy Over Grid Energy

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Abstract **–The objective of this paper is to see the energy potential .i.e. either Electrical or Thermal energy at Acharya campus using Biodegradable waste,Solar energy and wind energy at campus space. The Biodegradable waste that can be collected through various sources like, Kamakshi canteen, Sri Durga Mess, HKG hostel Kitchen, Upcoming food court, Dry leaves, Lawn - Plantation andAnimal dung. The total biodegradable waste would be calculated on the number of working day at campus.**

The Solar potential at campus is calculated on the installing capacity over constructed (Building) roof-tops and area available for further expansion. Based on 220W panel dimensions we are calculating the total solar energy potential for available area. Considering 9hours of isolation at campus and 80% of energy conversion capability we can estimate the total energy potential from sun at campus.

The wind potential at campus is calculated on the installing capacity over the edge of the constructed building roof-tops and area available for further expansion. Based on 1 kW wind generator we are calculating the total wind energy potential for available area. Considering 20 hours of isolation at campus and 300 days of operation and 40% of energy conversion capability we can estimate the total energy potential form wind at campus.

The energy potential from bio-gas plat and solar energy and wind energy would give us the total energy potential estimated at campus for consumption. Load dynamics at campus varies from 9am to 5pm during regular working days. There is a need to calculate the demand for energy during each month and the energy generated is distributed in an efficient manner.

***Keywords*— Bio-Gas plant, Solar energy, wind energy, built-up area, digester, turbine, charge controller.**

I. INTRODUCTION

The objective of this paper is to see, how much potential is present at Acharya campus to generate energy .i.e. both Electrical and Thermal. The efforts will be to generate energy though Bio-Gas plant and Solar Energy and wind energy.

By calculating the total biodegradable waste generated per day at campus through various food centers and Animal waste, if any. The total generated waste per day is mixed to 1:1 ratio with water before feeding in to Digester. The Process of converting biodegradable waste to useful energy is through Anaerobic, Fermentation. The biodegradable waste is mixed with water and through inlet valve they are passed on to Digester for production of Methane rich gas. The Bio-Gas contains 70-80% of CH4 [1].

Before utilizing this gas it must be free or treated through filters such that they are free from moistures, H2S and other gaseous which are dangerous. Present of moisture and H2S would lead to corrosion of storage tank or engines running on these gases. There are three outcomes from these biodegradable wastes,

1) Generation of bio-gas for Electrical Energy conversion.
2) Generation of bio-gas for Thermal energy utilization.
3) End product of biodegradable waste, as fertilizers which are rich potent in nitrate, potash and phosphorous.

The other non-conventional sources of energy, Solar Energy. The potential or energy available in sun is converted to electrical or Thermal energy through photovoltaiccells (PV) or solar thermal (ST).

The rapid growth of solar and wind powers is due in part to favorable global political climate towards these energies, efforts to reduce carbon dioxide (CO2) and greenhouse gases (GHG) and other power plant pollutants, global awareness of climate changes, and the urgency to develop renewable energy sources. Other factors such as lucrative tax incentives and legislation mandating national renewable energy standards have accelerated the march towards solar and wind energies.

The wind energy generated power is the latest technology in china and around the world. It fully utilizes the local wind energy using mini type wind power dynamo (PMDC) motor.

The paper aims to see the potential at Acharya campus in generating solar energy from the available solar radiation. It is know that, this energy is more during summer and the demand or necessity of electrical energy is also more during this season. The availability of solar radiation is less during winter or any other seasons. In-short solar radiation is not constant and their variations are complex when compared to generation of energy from Bio-Gas.By calculating, potential for generating electrical energy from solar radiation from the available build-up roof tops and vacant or area for further expansion at Acharya campus. Hitherto, energy calculations were seen different. Paper aims to see the total energy generating potential at Acharya campus.

II. BLOCK DIAGRAM

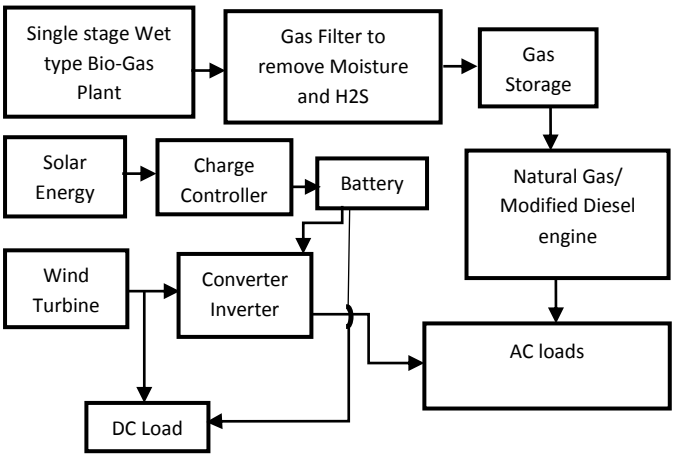

Fig.2 Envisaged block diagram for Bio-Gas & Solar Energy Installation.

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A.Biodegradable potential

Bio-Gas is produced from wet biomass with about 90-95% water content by the action of anaerobic bacteria. Part of the carbon is oxidized and another part reduces to produce CO2 and CH4. These bacteria live and grow without oxygen. The process is guided by wet, dark and warm conditions. The air-tight equipment used for conversion is known as Digester or biogas plant. The conversion process is known as anaerobic fermentation. The energy conversion efficiency of the process is 70-90%.

Different species of bacteria are able to survive at different temperature ranges. Ones living optimally at temperatures between 35 and 40 °C are called mesophiles or mesophilic bacteria. Some of the bacteria can survive at the hotter and more hostile conditions of 55 to 60 °C; these are called thermophiles or thermophilic bacteria[1]. Methanogens come from the domain of archaea. This family includes species that can grow in the hostile conditions of hydrothermal vents, so are more resistant to heat, and can, therefore, operate at high temperatures, a property unique to thermophiles.

Many micro-organisms are involved in the process of anaerobic digestion, including acetic acid-forming bacteria (acetogens) and methane-forming archaea (methanogens). These organisms feed upon the initial feedstock, which undergoes a number of different processes, converting it to intermediate molecules, including sugars, hydrogen, and acetic acid, before finally being converted to biogas.

Bio-Gas required for cooking is about 0.227m3/person/day. Bio-Gas required for lighting 160W lamp is about .126m3/hour. Bio-Gas producing 2m3/day could replace a fuel equivalent of 26Kg of Liquid Petroleum Gas [3],[4], [6].

Equivalent Quantities to 1m3 of Bio-Gas as stated in annexure III NABARD Model Bankable Projects is as shown belowTable 1 [2].

Fuel	Kerosene	Fire-wood	Cow-Dung	Charcoal	Coal gas
Equivalent to 1m3 of bio-gas	0.620 L	3.474 kg	12.2 kg	1.458 kg	1.17 m3

Table1. Equivalent quantities for $1m^3$ of Bio-Gas

B. Bio-Gas to Electrical conversions

The Equivalent Quantities for 1m3 of Bio-Gas in term of electrical energy is 6.388KWh of electrical energy, Table 2.

1 Watt	1 joule second-1
1 Wh	1 x 3600 joules
1 Kwh	3600000 J
1 Kwh	3.6 MJ
1m3 of bio-gas 23MJ	23/3.6 = 6.388KWh
Electrical conversion efficiency	80 %
Therefore 1m3 biogas	5.16 Kwh

Table2. For biogas to electrical energy conversion [2]

III BIO-GAS POTENTIAL – ACHARYA CAMPUS

An experimental biogas plant was set up in the Indian Institute of Science and operated since the end of 1976 to obtain reliable information of gas yields, gas composition, Nitrogen content of sludge etc., over 18 months of operation. This experimental plant showed the following performance:

(1) Biogas composition: 80% methane and 40% carbon dioxide.

(2) 2.16% Nitrogen in biogas sludge.

The calorific value of biogas is appreciably high around 23 MJ at around 55-60% methane content [2], [4].

Acharya Institution is spread across 120 acres, floating population at present greater than 10,000 personal. Estimated generated biodegradable waste is about 10,000kg and 1500 kiloliters of waste water. Lawn spread across 2 acres, 1 acres of hedge plantation, 1200 tress of more than 15 varieties, as shown in Table 3.

Particular	Area in acres	Area in %
Building	14.4	15
Stadium	5.1	5
Farmland	5.7	5
Forest	23.9	20
Unused Land	62.9	55

Table3. Land use details

a) *Kamakshi canteen*: Kamakshi canteen located at 15* 05’ 5.74’’ N; 77* 28’ 55.67’’ E. The total biodegradable waste generated is categorized in two; vegetable waste & Food waste is as sown in Table 4.

Waste produced/day	Vegetable waste	20kg
	Food waste	40Kg
	Total	60kg
Operation day/year		330days
Total quality of waste generated/year		19800kg – 20,000kg

Table4.Represents the total biodegradable waste generated in a year

b) *Sri Durga Mess*: Sri Durga mess located at 13* 5’ 27.26’’N; 77* 29’ 10.36’’ E.The total biodegradable waste generated is categorized in two; vegetable waste & Food waste are as shown in below Table 5.

Waste produced/day	Vegetable waste	30kg
	Food waste	40Kg
	Total	70kg
Operation day/year		330days
Total quality of waste generated/year		23100kg – 27,000kg

Table5. Represents the total biodegradable waste generated in a year

c) *HKG-Hostel canteen*: HKG hostel canteen located at 138 50’, 21’’ N; 778 28’, 48.92’’E.The total biodegradable waste generated is categorized in two; vegetable waste & Food waste are as shown in below Table 6.

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Waste produced/day	Vegetable waste	220kg
	Food waste	220kg
	Total	440kg
Operation day/year		330days
Total quality of waste generated/year		1,45,200kg–2,00,000kg

Table6.Represents the total biodegradable waste generated in a year

d) *Existing Sewage Treatment Plant*: The existing sewage treatment plant at Acharya process 150 kiloliters/day; the wet sludge is treated, dried in sludge drying beds. The dried sludge is then deposited at respective compost pit and is mixed with cow-dug for compositing. The sludge generated through this process is about 50kg/day.

e) *Waste from cow shed & fodder farm*:There are about 30 cattle, 120 sheep's, 5 horses and two acres of land that being used for growing fodder for animals. The total biodegradable waste generated from cow shed and fodder farm are shown in below Table 7.

30cattle 250kg	5 Horses 50kg	120 sheep's 80kg	2 acres of land for fodder

Table7. Waste from cow & fodder form

Waste from Plantation: -Campus is covered with 23.9 acres of forest, 1 acres of hedge plantation along with more than 1000 trees with 15 varieties. The wastes that can be feed in to digester for generation of electricity are, Dry leaves - 50kg; Weeds - 5kg; Trimmings - 10kg

C. *Biodegradable waste summary*

Sl	Source	Quantity of Bio-waste/day in kg
1	Kamakshi canteen	60
2	Sri Durga Mess	70
3	HKG hostel Kitchen	440
4	Upcoming food court	150
5	Dry leaves	50
6	Lawn & Plantation	15
7	Animal dung	380
8	Total	1165

Table8. Total Biodegradable waste at Acharya campus.

IV. SOLAR ENERGY

The voluminous solar energy can be converted to electrical energy or thermal energy. We are more interested in using it for electrical conversion. We are aware of Jawaharlal Nehru National Solar Mission was launched on the 11th January, 2010. The Mission has set the ambitious target of deploying 20,000 MW of grid connected solar power by 2022 is aimed at reducing the cost of solar power generation in the country [9]. It promotes domestic generation of solar energy.

A. *The technical requirement of PV Module*

The PV modules used in the grid solar power projects must qualify to the latest edition of any of the following IEC PV module qualification test or equivalent BIS standards, as shown in below Table 9 [9].

Crystalline Silicon Solar Cell Modules	IEC 61215
Thin Film Modules	IEC 61646
Concentrator PV modules	IEC 62108
Safety qualification testing	IEC 61730

Table9. BIS standard for PV modules

B. *Scalability Of Solar Energy*

India is endowed with vast solar energy potential. About 5,000 trillion kWh per year energy is incident over India's land area with most parts receiving 4-7 kWh per sq. m per day. Hence both technology routes for conversion of solar radiation into heat and electricity, namely, solar thermal and solar photo voltaic, can effectively be harnessed providing huge scalability for solar in India [9].

V. SOLAR ENERGY POTENTIAL AT ACHARYA CAMPUS

Acharya campus is spread about 120acres. Present built-up area about 12, 02,729 Sq feet.

Present Buildings, with their built-up area as shown in below Table 10.

Total built-up area for 15 buildings (excluding further expansion) is
2, 27,361 sq feet……..…… (1)

85 -95 % of this total built-up area will give us the available roof top.
2, 27,361 * .872 = 1, 98,258.792sq feet ……..…….. (2)

1, 98,258.792 Sq feet is available at our end to trap solar energy.

Including the area for further expansion, 80% of the expansion area
9, 75,368 * .8 = 7, 80,294.4 Sq feet ……..…….. (3)

Hence Total Area available for solar energy at Acharya campus
9, 78,553.192 Sq feet ……..…… (4)

Sl	Present Building	Built-up area in sq feet
1	Administration	10724
2	Seminar Hall	12083
3	Student Activity center	6223
4	Information & Computer Science	10534
5	Mechanical	20219
6	MBA & MCA	11471

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7	Electronics & Electrical	16635
8	College of Pharmacy	11351
9	Central library	12460
10	Canteen	2400
11	Polytechnic	19237
12	A pre-university college	20650
13	Hostel	27128
14	Acharya school of management	12000
15	Acharya NRV school of Architecture	34246
16	Area for further expansion	975368
Total Area available for solar energy at Acharya		**9, 78,553.192 Sq feet**

Table10. Solar energy potential at Acharya campus

Sharp Corporation of Australia pvt ltd provides ND-220E1F module which are IEC61215& IEC61730 certifications and ISO9001 certified factory (which must be according to central government for applying grants) [7], [8], [10].

Total area occupied by 220W solar panel (in feet) is
3.26115 * 5.419948 = 17.67 Sq. feet …… (5)

Total area available for solar energy at Acharya campus
9, 78,553.192 Sq. feet …… (6)

Total area occupied by 220W solar panel
17.67 Sq. feet ……..... (7)

Total area occupied by 220W solar panel (in feet) is
3.26115 * 5.419948 = 17.67 Sq feet …..... (8)

Total area available for solar energy at Acharya campus
9, 78,553.192 Sq. feet ……..... (9)

Total area occupied by 220W solar panel
17.67 Sq. feet ……..…… (10)

Considering 80% of efficiency in energy conversion, the total energy available at campus is 10.144MW power with the available roof-tops and area for further expansions.

V. WIND ENERGY POTENTIAL AT ACHARYA CAMPUS

Net length for 15 buildings (excluding further expansion) is135m……. (11)

Including the area for further expansion we get
269.24m…… (12)

Total length available for solar energy at Acharya campus is404.24m…… (13)

Assuming only 60% of length can be used for wind mill installation 404.24*.6 = 242.544m……. (14)

For 1 KW wind generator by Shenzhen Green Elec Technical Co., LtdBlade length = 1.09m …….. (15)

Rated power o/p of wind generator = 1KW…… (16)

Avg power available = .4 Kw……. (17)

For 300 working days in a year Kwh generated for 57 units

= (.4*24*57*300)= 1, 64,160Kwh…… (18)

Total units generated = 1, 64,160 per year…….. (19)

Tariff equivalent to production =164160*7.8……. (20)

(Commercial unit in Bangalore @ Rs.7.87)= Rs.1280448 ≈ Rs.12.8 lakh
…… (21)

V. ESTIMATED TOTAL ENERGY AT ACHARYA

The objective of this paper is to observe (estimate) the total energy available at campus,
1) Efficient management of biodegradable waste.
2) Utilizing available area over roof-tops and future expansion.

A. Efficient management of biodegradable waste

The total Biodegradable waste generated at campus is estimated about 1165 kg/day through various means as discussed above. The approximate bio-gas generated for energy rich resource is about 50-70 m^3/day.

We know that $1m^3$ of bio-gas generates 6.38KWh of electrical energy. For the generated waste add 1:1 ratio of water and feed in to inlet of digester, biogas plant [4].

The Electrical energy generated for 1165 kg/day is
383.28 KWh……. (22)

Assuming 80% efficiency in energy conversion, the total energy generated through biogas per day is
383.28 *.8 = 306.624 KWh ……. (23)

B. *UTILIZING AVAILABLE AREA OVER ROOF-TOPS AND FUTURE EXPANSION*

Total Area available for solar energy at Acharya campus is **9, 78,553.192 Sq feet**……..…… (24)

Total area occupied by 220W solar panel (in feet) is
3.26115 * 5.419948 = 17.67 Sq feet ……..…….. (25)

Solar panel considered for calculation is Sharp Corporation of Australia pvt ltd.
The total solar panel capacity that can be installed is about
12.1832MW …… (26)

The total solar energy that can be generated is
12.1832MW * 6 hour mean insolation per day is
73.0992 MWh …… (27)

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Total length of roof-top edge available for wind energy at Acharya campus = 404.24m……. (28)

Assuming only 60% of the length is available for windmill installation =404.24*0.6 = 242.544m……... (29)

For 1 KW wind generator by Shenzhen Green Elec Technical Co. Ltd., Blade length = 1.09m……. (30)

Rated power o/p of wind generator = 1KW……. (31)

Average power available = .4 Kw……. (32)

For 300 working days in a year Kwh generated for 57 units = (.4*24*57*300) = 1, 64,160Kwh……. (33)

Total units generated = 1, 64,160 per year……. (34)

Total energy estimated at Acharya campus is about 237.25 MW h.

VI ENERGY IN UNITS PER YEAR

Installed capacity of 500KVA Transformer which comes under HT-2 (b) (i) rate schedule [11]. During the year 2011-2012 the total number of units consumed is 5, 47,425 [12].

For a year we receive 300 clear sunny days [13], thus 73.0992 MWh * 300 days = 21930 MWh/year …….. (35)

Typically Photovoltaic have a 15% efficiency level 21930 MWh/year * .15 = 3290MWh/year ……..... (36)

Thus we have 9.0136 MWh from solar energy and 306.24 KWh from bio-gas and 164.16MWh from wind. Total energy estimated as 479.41 MWh.

Source	**MWh**	**Units/day**	**Units/year**
Solar Energy	9.0136	9014	27,04,080
Bio-Gas	0.30624	306	1,11,778
Wind Energy	0.5472	547.2	164160
Total			**29,80,018**

Table11. Unit generations from BASH

Total cost for 10MW solar plant estimated at ₹160Crores [14]. The return of investment for 1MW plant is estimated as 4.3 years [13]. Unit generation from BASH is as shown in table11.

Input to plant	1165 kg/day
Generation of biogas/day	66m3/day
LPG equivalent of biogas/day	26kg/day
Saving through LPG per day	2000
Generation of biogas/year	19800m3
LPG equivalent of biogas/year	7800kg .i.e. 410 Cylinders
Saving through LPG per year	Rs.7,30,000
Generation of manure/year	36500Kg
Minimum cost of manure/kg	Rs.8
Saving through manure/year	Rs.2,92,000
Total returns from biogas and manure/year	Rs.10,22,000

Table12. Total returns from Bio-Gas plant per year [3]

Return of Investment for a period of 12 years	
Total units /year	28,15,858
Total units consumed/year	5, 47,425
Total cost(CC + OP)	Rs.38,40,00,100
Return on Investment	Rs.38,93,87,520
Return on Investment from Biogas Manure	Rs.1,22,64,000
Return on Investment from Wind Energy	Rs.2,36,39,040
Total ROI	Rs.42,52,90,560

Table13. Total ROI from BASH

Returns of investment for Bio-Gas are as shown in table 12. Considering the Purchasing Power agreement between Renewable energy developers and Gujarat state government [15] the ROI is as shown in table 13. Table 14 shows [16] other alternative sources for generating 3290Mwh energy.

Energy content of some fuels, 1Kilogram/m3/L of		**Fuel for 3290MWh/year in kg/m3/L**
Dry wood	5.3 Kwh	620755
Coal	8.1 Kwh	406172
Natural gas	8.8 Kwh	373864
Petrol	9.1 Kwh	361538
Diesel	10 Kwh	329000
Hydrogen	33.6 Kwh	97917
Uranium 235	22.2 million Kwh	0.147

Table 14 fuel required for 3290Mwh/year

VII CONCLUSION

The objective of this paper is to investigate the energy potential at Acharya campus by effective management of biodegradable waste along with utilizing the available roof-tops and future expansion area. Intension is to reduce dependence on supplied energy and domestic production or local production of energy.

India is endowed with vast solar energy potential. About 5,000 trillion kWh per year energy is incident over India's land area with most parts receiving 4-7 kWh per sq. m per day. Hence both technology routes for conversion of solar radiation into heat and electricity, namely, solar thermal and solar photovoltaic, can effectively be harnessed providing huge scalability for solar in India.

Bio-Gas potential in India as per National Bank for Agriculture & Rural Development is 175 million MWh/year.

Wind Energy potential in India as per Wikipedia has an installed capacity of 17,365.03 MW (as on March 31, 2012). In terms of wind power installed capacity, India is ranked 5th

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in the World. Today India is a major player in the global wind energy market.

The potential is far from exhausted. Indian Wind Energy Association has estimated that with the current level of technology, the 'on-shore' potential for utilization of wind energy for electricity generation is of the order of 102 GW. The unexploited resource availability has the potential to sustain the growth of wind energy sector in India in the years to come.

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