Integration Of Renewable Energy Technologies In Multispecialty Hospital With Case Study

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Abstract - *Hospitals are institutions for the care of the sick and injured and usually function 24 hours per day, all year round. They usually consist of large buildings, and careful control of their internal climate is considered necessary. Substantial amount of heat is normally generated internally by the occupants and operating equipment. An effective cooling and ventilation systems combined with good insulation of* ***hospital building, usually reduce hospital's sensitivity*** *to the outside weather. Hospitals also require standby electricity generators to ensure a continuous supply of power in emergencies and critical operations. The typical hospital building is designed for long-term use and, in practice, is often used for longer periods than its builders ever intended. The actual lifetime is normally over 50 years. During this period, the building is retrofitted and renovated many times. Reasons for this include the shorter life of technical equipment, the development of new types of equipment and health care facilities, new regulations, renewable energy technologies and the ageing of the building itself. I have done case study of ASTER AADHAR HOAPITAL, Kolhapur. After studying this case, we recommended two installations with annual saving of Rs. 19,56,592/- with feasible payback period.*

Key Words: Digester , renewable energy , solar power

1. INTRODUCTION

Hospitals are considered in commercial sector. Hospitals are the backbone of the health care delivery system in India. Until early 1980s, the government run hospitals and those operated by charitable organizations were the main providers of health care facilities. However in the 1980s and thereafter the sector has been attracting private capital in setting up hospitals and nursing homes.

According to a world health organization study, currently India has approximately 860 beds per million populations, which is only one fifth of the world average of 3960. Large corporate groups and charitable organizations have brought private finance and these resources are being invested in developing health infrastructure and modern equipments and technologies leading to the availability of super-specialty hospitals across the country, especially in big cities. However these developments have led to higher energy-intensiveness in the hospital sector in India. Many modern hospitals may consume ten to fifteen times more energy per bed as compared to a typical government hospital, and this trend is likely to strain India's power sector substantially in the coming years.

Sample studies in hospital sector have shown number of cost effective energy conservation opportunities, which have remained untapped due to several reasons. The major barriers have been low awareness among the management of the hospitals and limited availability of in-house expertise to identify and implement energy saving projects. Good energy management structure can bring in not only an energy efficient culture within the hospital but also provide substantial reduction in energy expenses without compromising on the quality of health care facilities to the patients.

2. ENERGY USAGE IN HOSPITAL

Traditionally in hospital we use 3 major energy sources.

2.1. Electrical energy from grid
2.2. LPG cylinders
2.3. Fuel oil

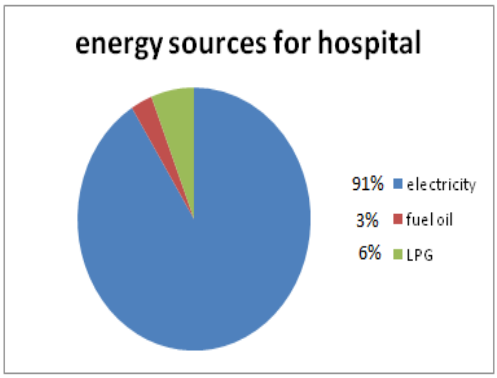

Chart -1: Energy Usage In Hospital

2.1. Electrical energy from grid-

All hospitals are mainly depends on electrical energy from grid.

Applications of electrical energy in hospital

i. HVAC

In many large and centrally air-conditioned hospitals, HVAC systems may consume 40% of total electricity consumption. Air conditioning and ventilation system in hospitals is required for:

•Maintaining the requisite indoor temperature, air distribution and humidity levels for thermal comfort.

•Maintaining indoor air quality, particularly in areas requiring prevention of infection building envelope design plays a very important role in the determination of hvac capacity in the hospital.

ii. Lighting

Lighting is a major electricity consumer next only to hvac systems. Requirement of lights in a hospital varies widely depending upon the activity, time of day and the occupancy level. The complexity can be well understood from the simple fact that national building code (NBC) 2005 recommends luminance level varying from one lux for night lighting in some areas to 750 lux in operation theaters for general requirements. At times special lights are used with luminance of 10,000- 50,000 lux in operation theaters.

iii. Water pumps

Water is consumed in different sections of the hospitals for various requirements. In most hospitals, water pumping systems may account for 5-15% of total electricity consumption and offer scope for reducing energy consumption.

iv. Biomedical instruments

In the hospital, there are so many biomedical instruments which run on electricity. Such as x-ray machine, ventilator, CT scan machine, pathological instruments, mammography instrument etc.

v. Other devices

In a multispecialty hospital, there are large number of computers, Xerox machines, printers, televisions, refrigerators, ovens which consumes considerable amount of electrical energy.

vi. Elevators

In multistoried hospital elevator is very essential. Elevator consumes considerable amount of electrical energy.

vii. Water geyser

In some hospitals, electric water heaters are used for water heating purpose.

viii. CAS (compressed air system)

In hospital compressed air required for medical purpose, so compressed air system (CAS) is used, it consumes high amount electrical of energy.

2.2. LPG cylinders

In hospital, LPG cylinders are used for cooking food and water heating system. (Gas geyser)

2.3. Fuel oil

In most of the hospitals, fuel oil is mainly used for standby power generation sets, which are used for considerable period due to inadequate power supply from the utilities in many states of India.

3. Renewable energy technologies in hospital.

Part of energy demand can fulfill by renewable energy sources, this can minimize commercial energy consumption, these includes following techniques.

3.1 Solar photovoltaic system-

We can install solar photovoltaic panels on available surface area of hospital to get electrical energy. If we design solar system without battery direct connected to grid, it will be very cost effective.

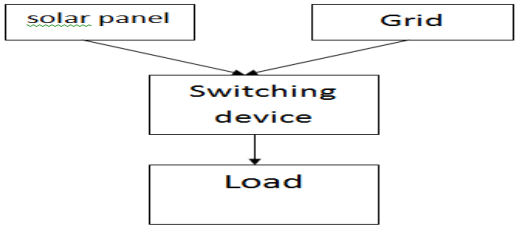

Fig.1 Block Diagram of Solar Photovoltaic System Without Battery Storage

3.2 Solar water heating system

In hospital large amount of hot water is required. We can install solar water heater on the terrace of the hospital so that we get hot water at zero operating cost. Payback period for solar water heater is about 2 years.

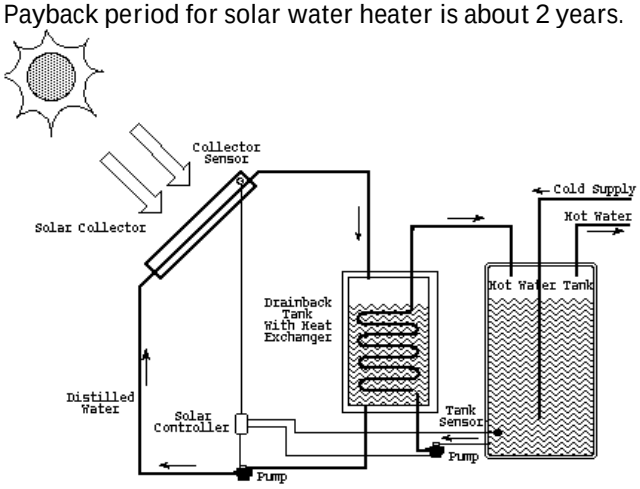

Fig.2 Solar water heating system

3.3 Biogas plant

In a hospital, there are so many people live. Naturally they use hospital's washrooms, in this way they left human waste in the hospital, that human waste can be use for a biogas plant. We can add kitchen waste, biomedical waste to that biogas plant. This plant will generate biogas, that gas they can use for cooking purpose or any other heating application. This plant will reduce number of LPG cylinders required. In this way it will be cost effective.

4. CASE STUDY

Name of Hospital- ASTER AADHAR Multispecialty Hospital, Kolhapur.

Main power (Electrical) source –MSEDCL

Connected load (kW)- 1045 kW

Contract demand (kVA)- 600 kVA

Total consumption- 1,00,000 kWh approx / month

Tariff rate – Rs. 7.65/- per kWh
Consumption bill- Rs. 9,00,000/- per month (approx)

Energy consumption (other) –
Gas- 48 commercial LPG cylinders of 19 kg per month.

Building –
Plot area- 5763 sq. meter
Carpet area-5000 sq. meter
Area available on terrace= 50m *35m=1750 sq. m.

Suggestions after case study

After the study of energy management at ASTER AADHAR MULTISPECIALITY HOSPITAL, Kolhapur we recommend following installations.

4.1 Solar PV system

Surface area available- 35m * 50m=1750 sq m

250 watt solar panel size- 1.65m length * 1m width * .05m thickness

- No of panels can be installed-

50/1=50_____so we take 40 panels in row

35/1.65= 21.21 ____so we take 20 panels in column

Total no. of panels= 40 * 20= 800 panels

- Specifications of 250 watt solar panel-

Nominal power output- 250watt

Voltage at PMAX VMPP - 30.2V

Current at PMAX IMPP- 8.3 A

- Design of panels-

8 panels in series gives - 30.2* 8= 241.6 V

100 sets of 8 panels are in series gives –

8.3 * 100= 830 A

Nominal capacity of system= 241V * 830A
=200kw

Actual output= 200 * .8= 160 kw

- Design of charge controller-

Available charge controller- MPPT 80A, 96V

No. of charge controllers

= V*I*1.1* no. of panels (solar panels)/V*I(C.C)

=30.2*8.3*1.1*800 /96*80

=28.64

So we have to take 30 charge controllers

- Design of inverter-

Available inverter size- 2000VA

No. of inverters

= V*I*1.1* no. of panels (solar panels)/inverter rating(VA)

= 30.2*8.3*1.1*800/2000

= 110

So we have to take 110 inverters

These inverters can be directly connect to mains of Hospital.

- Power Output-

Power available

=Installed capacity*efficiency of panel*efficiency of inverter

=200*.8*.9

=144kw

Energy per day(units) = power * day time
=144*6
= 864 kwh per day

Total units generated (annual)

= units per day * sunny days per annum

= 864 * 270

= 2,33,280 kwh per annum

Cost analysis

Investment

- Solar panels-

Rate- Rs. 40/- per watt (standard)

Solar panel cost = rate * capacity in watts

= 40*200000= Rs 80,00,000 /-

- Charge controller-

Price of 1 charge controller (MPPT 80A, 96V)- Rs. 50000/-

Charge controller cost = rate* no. of charge controllers

=50000 * 30 = Rs.15,00,000 /-

- Inverter-

Price of 1 inverter (2000VA) – Rs. 9000 /-

Cost of inverter = rate* no. of inverters

= 9000 * 110 = Rs. 9.90,000/-

- Installation cost and other cost- 5,00,000 (approx)

Total investment

=80,00,000+15,00,000+9,90,000+5,00,000

=Rs. 1,09,90,000 /-

Savings

Savings per year

= no. of units generated per year * tariff rate

= 2,33,280 * 7.65

= Rs.17,84,592 /- per annum

Simple payback period = Total investment/ savings per year

= 1,09,90,000/1784592

= 6.15 years

It means capital investment recovers in about 6 years.

4.2 Biogas plant

Kitchen waste per day- 55 kg/day

Density approx-80kg/cubic meter

Retention time- 20days

Fluid volume

= 55/80_____(density=80 kg/cubic meter)

=0.6875cubic meter

Volume of digester

=fluid volume * retention time

= 0.6875 * 20

= 13.75 cubic meter

Volume of biogas

=biogas yield * mass per day

= 0.24 * 55(biogas yield= 0.24)

= 13.2 m3/day

Volume of methane

= volume of biogas * methane proportion

= 13.2 * 0.8_____(methane proportion=0.8)

= 10.56 m3/day

= 10.56*30 = 316.8 m3/month

Volume in terms of butane

=volume of methane/butane equivalent_(considering C.V.)

= 316.8/3.325_(1 butane equivalent=3.325m3of methane)

= 95.27 m3 /month

Mass of equivalent butane gas

= volume * density

= 95.27 * 2.48_____(density of butane = 2.48 kg/m3

= 236.28 kg /month

Cost analysis

Investment

For digester and plant- Rs. 100,000 /-(approx)

Savings

Saving = 236.28 kg of LPG/ month

=236.28/19 commercial LPG cylinders per month

=12 commercial LPG cylinders

Saving of money = 12 * 1200

= Rs. 14,400 /- per month

= 14400 *12 = Rs. 1,72,000 /- per year

Simple payback period = Investment/ annual saving

= 100000/172000

= 0.6 years = 7 months

- Simple payback period = 7 months

So, the capital investment of biogas plan will recover in 7 months only.

Total savings per annum = 17,84,592+1,72,000

= Rs. 19,56,592/-

CONCLUSIONS

Hence , after study of energy management in hospital, renewable energy technologies and case study of "ASTER AADHAR HOSPITAL, Kolhapur" We can suggest following two installations with annual saving of Rs. 19,56,592/- with feasible payback period.

- Solar PV system of 200 kW
- Biogas plant of 13.75 cubic meter

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