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Mixing of Various Renewable Energy Technologies Towards Development of Village Energy Need

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ABSTRACT

This paper mainly deals with mixing of various Renewable energy technologies towards development of the village energy need. Main technologies are: solar & biomass. The energy crisis and environmental degradation are currently two vital issues for global sustainable development. Smart Village means Electricity 24 hr as electricity is the key factor for the development. Need, Methodology & Vision of this study is sustainable development as it is believed to develop India starts with developing Rural India first. This paper focuses on technical feasibility only.

Keywords: *Hybrid Energy Optimization; Mixing of Technology; Rural Electrification; Solar & Biomass*.

1.0 Introduction

Energy is one of the main sources for the advancement of human civilization and is required for every activity and therefore plays a vital role in the development of society.

India is facing an energy crisis and at least 500 million rural residents lack access to consistent electricity supply due to insufficient Grid Infrastructure.

These household still use kerosene and wood to cook their food due to lack of fuel supply for cooking applications.

In many villages, there is Lack of Education as absolutely no power is available during nights, therefore children cannot study.

Providing access to electricity in rural areas of India is a major challenge.

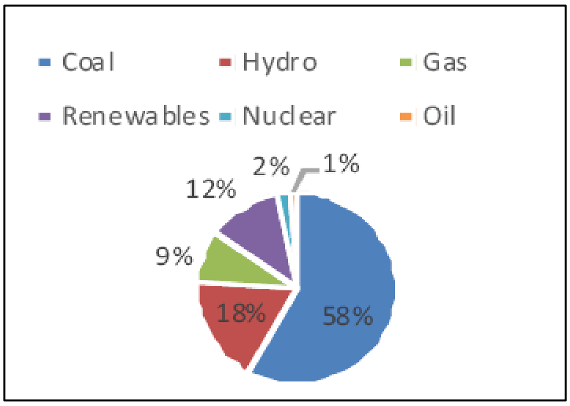
The current power supply is unreliable and access is limited.

The unsustainable use of locally sourced biomass and an increasing dependence on fossil fuels are causing environmental degradation, lack of communication media, education and health services.

Fuels used for cooking all over India are LPG, kerosene, fire wood, crop residue, cow dung cake and coal.

2.0 Power Scenario in India

Fig 1: Power Sources Distribution (Source: CEA, Ernst & Young analysis; as on 31 March 2013[10])



India has the 5th largest power generation portfolio worldwide.

Coal and Gas are the popular sources and account for 58% and 9%, share, respectively.

The country transitioned from being the world's 7th largest energy consumer in 2000 to the 3rdlargest one within a decade. Subsidies,

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Tax benefits, attractive bank loans scheme and foreign direct investment are favouring and promoting renewable energy sector. Energy demand is pacing at high rate because of need of economic growth & rapid industrialization.

3.0 Literature Review

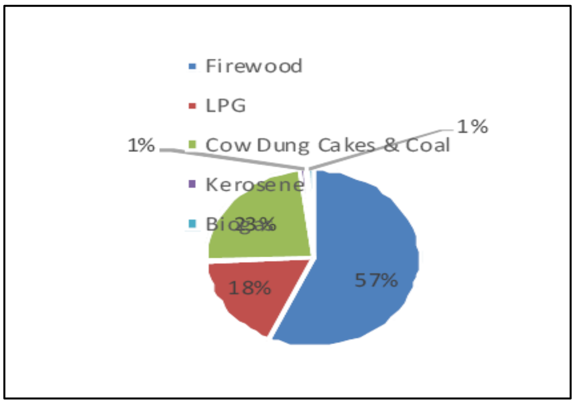
Panda (2007) [1] focusses on the importance of electricity supply strategy resulted by domination of demand of rural electrification in India. In Addition, Rehman et al. (2012) [2] highlight the problems faced by electrification of rural India by enhancing on the demand– supply gap. Khandker et al. (2010) [3], discuss the corelation of electricity and poverty of rural India, stated the problem faced by villages because of insufficient energy supply which disrupts their day to day work, also added the doubt whether energy leads to economic development or vice versa. In this framework, Panda (2007) [1] explained there are opportunities for consumers to earn incomes by integration of utility facility. Modi et al. (2005) [4] describe one of the goals of UN's Millennium Development modern is providing access to energy provision.

Though, Cook (2011) [5] states that increased stress on rural electrification results in the more focus on poverty eradication rather than electrification. (Chaurey et al. 2004) [6] States in India 90 per cent of electrification is attained by nine states only and rest are at only 50% or below. (Palit and Chaurey 2011) [7] Discuss problems and challenges in fulfilling the rural electrification target such as more importance to urban development, inappropriate infrastructure, ineffectual implementation technique and low quality of power. (Balachandra 2012) [8]Discuss about the 1950-1980 planning period when prominence was more to irrigation in support of green revolution rather than providing households access to electricity and Kutir Jyoti scheme of government of India also focused on single line connection only. Nitesh Dutt et.al (2011)[9] analysed, compared renewable source technology i.e. biomass waste including solid waste, sewage waste, and waste cooking oil in IIT Roorkee campus to calculate potential generation of total 396870 KWh annually of electricity out of which 180000 KWh from MSW, 72,000 KWh from kitchen waste, 870 KWh by Waste cooking oil and 144000 KWh from sewage treatment from 1.3 million litres per day of sewage water from MSW of 2190 Tonnes/ year and 238 tonnes per year of kitchen waste. He carried out cost assessment of cost per KWh without subsidy which was Rs 3.70 for Kitchen waste, Rs 2.80 for MSW and Rs 38.80 from Sewage treatment.

4.0 Problem Faced by Rural India

According to India's census 2011 data, fire wood is predominantly used as a cooking fuel in the households especially in rural parts Out of 168 million rural households; 63% use firewood, 11% use LPG, 24% use crop residues, cow dung cakes and coal, 1% use kerosene, 1% use biogas or electricity.

Fig 2: Cooking Fuel Usage Distribution (Source: India Census 2011) [11]



Fire wood and traditional methods of cooking have various challenges such as Firewood is collected by villagers either from their own plantations or from government forests, results in deforestation.

Gathering fire wood involves a lot of hard work in walking long distances and carrying head loads.

These efforts are carried out mostly by women and girls in the villages which results in their underdevelopment.

The women and children suffer respiratory diseases, which is an obvious impact of using fire wood and traditional methods of cooking. Using dried cow dung cakes would utilize only 10% of its total energy.

Use of LPG also has challenges; People normally travel to distant place, high steep hills to get the LPG cylinder; hence the landed cost of cylinder increases.

Typical reasons why villagers are not willing to entirely switch over to modern energy sources like

LPG are either the fuel is very expensive or it is not easily available.

5.0 Solution Solar-Biogas Hybrid Model

Solar- Biogas Hybrid model is proposed for the Solution to problems discussed earlier. Since no single technology is capable of switching to renewable energy and moreover in Villages main activities are agriculture and Cattle feeding.

We are utilizing the Cattle Dung & Agriculture waste to run Biogas Plant and installing Solar Panels on Houses to build Solar PV Plant. The tariff structure can be set to make the project viable economically by selling excess power to nearby industries.

There is the possibility of paying back the capital cost over a short term period. Financial structure involves the participation of local bodies of villages, investors, NGO's. It will create employment opportunities for the village residents as they will be trained to operate and maintain the plant and revenue generated from gas and slurry can make projects viable by providing salaries and payback installments for investors and provide social-economic, educational & environmental benefits.

Financing of these projects will need long term capital at favorable terms. The project is a helping held in Hon'ble PM Narendra Modi's vision: "Swach Bharat Mission".

6.0 Case Study Undertaken

A case study is done of 7 Villages near Roorkee. In Combined it consists of on an average 700 houses. Considering each house has 4 members. So total population is 700*4= 2800.

Considering each house has 2 cattle and 1hectare of agriculture land. So in total cattle there are 2*700 = 1400 and 1*700=700 Hectare of agriculture land. On an average 100 water pumps have been taken into account.

Village consists of 2 Health Centre, 1 Community Centre, 1 Senior Sec. School, 1 Primary School &1 post office.

6.1 Computation of energy need

Following numerical computation has been carried out for Villages near by Roorkee, Uttarakhand has shown in Table 1 & Table 2 respectively. Similarly the pie chart is also shown in figure 3.

Table 1: Load Calculation of 7 Villages that have been Under Consideration

Type	Items (per type)	Watts	Quantity(per type)	Total (Watts)
House	Tube Light	40	2	80
	Fan	80	1	80
	Television	140	1	140
			Total	300*700 Houses = 210 KW
School				
Senior Secondary	Tube Light	40	20	800
	Fan	80	20	1600
	Miscellaneous	400		400
Primary	Tube Light	40	35	1400
	Fan	80	35	2800
	Miscellaneous	800		800
			Total	**7 KW**
Post Office	Tube Light	40	4	160
	Fan	80	5	400
			Total	**0.66 KW**
Community Centre				**2 KW**
Health Centre				**3 KW**
Pumps		1500	100	**150 KW**
Miscellaneous		500000		**500 KW**
			Total Wattage	**873 KW**

Miscellaneous load is taken which includes machines such as flour milling, reaper, threshing, milk processing, etc.

Fig 3: Load Distribution in KW

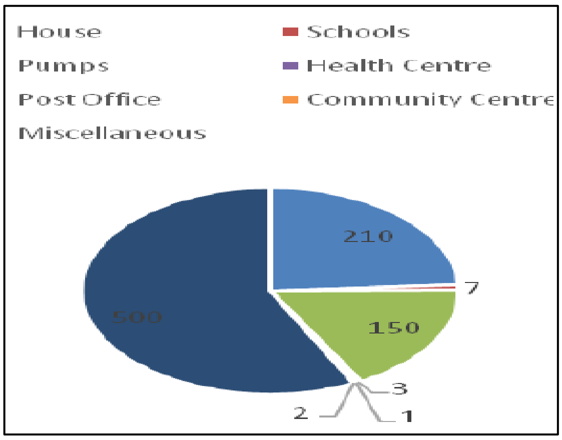


Table 2: Calculation Total Units Requirement by Considering Optimal Operational Hours

Type	Load (KW)	No. of Operational Hours	Units (KWh)
Houses	210	12	2520
Schools	7	8	54
Post Office	1	8	8
Community Centre	2	3	6
Health Centre	3	18	54
Miscellaneous	50	8	400
		Total	**3042**

6.2 Biomass Potential

The biomass potential for villages near Roorkee, Uttarakhand have been calculated by considering cattle dung and agricultural waste as a biogasifier feed.

6.2.1 Cattle Dung

- Dung Produced= 3 Kg/Cattle/ Day
- Total Dung produced = 3*1500= 4500 Kg/Day
- Biogas produced = .07 m3/Kg (with engine efficiency 28%, Generator efficiency 93%)
- Total Biogas produced = 315 m3/Day
- Gas required to produce 1 KWh/day = .72m3
- Total power produced= 315/.72 = 450 Kwh/ Day

6.2.2 Agricultural Waste

- Agriculture waste produced= 30 % of Total Production
- Total Cultivation land= 700 Hectare
- Production in 1Hectare= 3 Ton/ 3Months
- Total production= 2100 Ton/ 3months
- Daily Production= 2100/90= 23.33 Ton
- Waste produced = .3*23.33 = 7 Ton
- Biogas produced = 140 m3/Ton
- Total gas produced = 980 m3
- 72m3 gas generate 1KWh
- Total Power Generation = 1350 Kwh/ Day
- Total Power produced from Biogas = 450+1350 = 1800KWh/Day
- Plant Capacity = 100KW, taking 18 Hours of operation

6.3 Solar Potential

- Installing 2 Solar modules of 250 Wp on each house
- This gives total 700*250*2 = 350Kwp
- Taking Sun Hours = 4.5
- Total Electricity produced = 525*4.5 = 1575 KWh

7.0 Results & Discussion

The numerical computation has been carried out and following total load need is calculated which provides the feasibility of the Mixing technologies proposed as given below.

Total Peak Load Calculated = 3042 KW, Total Base load (considering 50 % of total peak load)= 1521 KW for 24hrs operation, Therefore Biogas plant can satisfy alone on Base Load demand which will produce 1800 units and for the Peak load demand Solar will alone contribute 1575 units.

So in total the solution Solar Biomass hybrid modal produces 4300 Units and requirement is 3042 units.

8.0 Conclusion

It is seen electrification plays major role in economic development of the community and higher electrification rate more income is generated per capita. No single technology is capable to switch to renewable energy but by mixing the technologies we can utilize benefits of both the technologies.

This solution involves in community participation of local village bodies, Village residents, NGO’s, and investors.

Training programme will be conducted to provide awareness of the project benefits; waste management, living standard, education, access to electricity to villages. Volunteers will be trained to operate and maintain the plant.

This training can be replicated to near-by villages and locations. Community biogas plant, biogas grid and Solar Plant appears as sustainable solutions to cater to the village cooking, agriculture, health and education energy needs. In addition to availability of raw material (cattle dung) for biogas plant, willingness and commitment of villagers is a key to success.

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