Two Days National Seminar on

Alternative Energy Sources

August 27-28, 2005

Co-sponsored by

Pitambari Products Pvt Ltd

Supported by

Ministry of Non-conventional Energy Sources, Govt. of India

Organised by

VPM's POLYTECHNIC, THANE

Jnanadweepa', Thane College Campus,
Chendani Bunder Road, Thane 400 601, MS, India.

Approved by : All India Council for Technical Education, New Delhi
Affiliated to : Directorate of Technical Education, Maharashtra State, Mumbai 400 001
Maharashtra State Board of Technical Education, Mumbai 400 051.
Accredited by : National Board of Accreditation, New Delhi*

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Please Note:
The Authors of the papers are alone responsible for technical content of the papers and references cited therein.

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NON-CONVENTIONAL
ENERGY &
HORTICULTURE
GOVERNMENT OF MAHARASHTRA
MANTRALAYA, MUMBAI 400032

Date : 18th August, 05

I have received your invitation sent to Hon. Minister for Non-conventional Energy & Horticulture, as Chief Guest for inauguration of the National Seminar on Alternative Energy Sources to be held on 27th & 28th August 2005.

In fact Hon. Minister expressed his desire to attend the programme as the Chief Guest & inaugurate the seminar personally. But due to pre-occupied programme he could not attend the same.

It is heartening to note that your Institute is accredited by the National Board of Accreditation. By conducting the Seminar you are providing a platform for academic, scientific and industrial community to share their views about the role of **Alternative Energy Sources** to minimize the energy problem.

Heartiest blessing!

Thanking you.

Sd/-
(PRAKASH KADAM)
Private Secretary

Mrs. N. V. Vader
Chief Coordinator,
Vidya Prasarak Mandal's Polytechnic,
Thane.

Prakash Paranjpe
Member of Parliament
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Date : 20-08-2005

Message

Hon'ble Shri. Prakash Paranjpe
Member of Parliament, Thane

Chief Guest for Inauguration of National Seminar
On
"Alternative Energy Sources"

I am very happy to acknowledge the National Seminar on Alternative Energy Sources on 27th and 28th August 2005. The generation of awareness at the grass root levels is the need of the hour. Such type of seminars helps to promote the ability of our young men and women to absorb and master new technologies. We ought to find out viable solutions in the process of changing our society and environment in a healthy, respectful and sustainable way.

I extend my best wishes to V.P.M.'s Polytechnic, Thane, which has carved a niche among other polytechnics by continuously sustaining their efforts in attaining excellence.

8, Dr. Bishamber Das Marg, New Delhi, Tel. 2335 9610

Prof. B.P. Tale
Director, MSBTE, Mumbai,
Maharashtra State

Message

Guest of Honour for the Inauguration of National Seminar

On

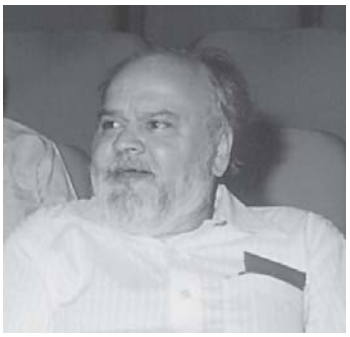
"Alternative Energy Sources"

Protection of the Environment and Climate, and their preservation for the generations to come is a demanding social, scientific and economical task. Utilization of renewable energy, efficient conversions of fossil fuel are not only environmentally and climatically beneficial, they also preserve the finite energy sources. The price jumps in the oil scenario, has surely made the scientific community know the importance of safe and secured energy supplies for the highly industrialized nations.

Keeping in view of the latest trend and to bridge the gap between the latest developments, the economy related to the development of projects in the field of Energy and the present day education system, MSBTE proposes to start an Advanced diploma course in Energy Management. The course will include Energy Audit and Clean Development Management. This will not only create awareness among the youth but also create new jobs for them.

I appeal to the teaching fraternity to update themselves in this upcoming field so that the teachers who are the pillars in our education system can lay a strong foundation for generations to come.

Realizing the need for **"Alternate Energy Sources"** and to highlight the development in this field, V.P.M's Polytechnic, Thane has organized a National Seminar. My best wishes and compliments to the management of the Polytechnic for thoughtfully organizing this seminar.



Chairman's Address

I heartily congratulate the contributors and participants to this seminar on the subject Alternative Energy Sources (1), the importance of which can hardly be debated. Since the Scientific and Industrial Revolution in the 17th and 18th Century, we have been trying to enhance every human activity with the aid of a machine or chemicals, least realising that this will ever cost damage to our environment and to man himself (2). Every activity of modern man requires energy. To reach any distance man has to walk in which energy production and consumption is within his body. We enhanced his ability to reach distance in speed by devising machines what we commonly call as cars and aeroplanes. What is true for covering distance is true for every human activity. We have railways, air-conditioners, refrigerators and kitchen appliances etc to help man improve his quality of life. All these devices have to work on energy and the commonly used sources of energy today to generate electricity are coal and gas. These are conventional sources of energy popularly known as fossil fuels. The availability of these machines radically changed our lifestyles. As a matter of fact every inch we advanced in our modernity, which we called as progress (3), was responsible for consuming tonnes of fossil fuel generating greenhouse gases.

In the middle of the last century, amidst the clamour of modernity and progress, some scientists started warning of the damage caused by this so-called modern lifestyle to our own environment. Initially their voice was weak and meek. Many of their colleagues even tried to ignore these warnings and assured society that they should not bother about this doomsday mentality. It took a very long time, energy and patience on the part of scientists to prove that greenhouse gases are not just hypotheses but hard reality of life (4). The change in Polar Regions was enough proof that we have already caused significant damage to our ozone layer. The root cause of this damage was the source of energy that we used for our modern gadgets. So energy issue and environmental issue are closely linked and needs to be discussed together rather than in isolation.

This realisation, of pollution of our environment due to use of fossil fuel, also gave birth to today's environmental movement. The most successful outcome of this movement was Kyoto Protocol (5). This protocol demands cuts in greenhouse emissions to 5.2% below 1990 levels by 2008-2012. Obviously, these restrictions were to be taken seriously by developed countries, as they were major contributors to the greenhouse gases due to their lifestyle. To minimize this damage, the industrial production of these products, which had changed our lifestyle, either needed radical change in their structure or less usage of these products by consumers. The change in product means new research, new technology. The cost implications for these changes are enormous. Similarly reduced consumption would mean reduced profits.

The whole issue of alternative energy sources took momentum from these discussions and realization of scientific community and people at large that finding alternative sources of energy

is the only way to reduce the greenhouse gases. Scientists started looking to nature and technology for solutions. So started discussion of solar, wind, bio, tidal, nuclear and hydrogen energy as alternative to the fossil fuel.

After the initial euphoria of Kyoto Protocol, came the hard realization in the developed world, especially in the USA, that the less emission of greenhouse gases means less consumption or change in technology. The industrial lobby in USA started manoeuvring science and scientists who started challenging global warming and anthropomorphic activities responsible for it (6). The Kyoto protocol did not impose the same restrictions on the emission of greenhouse gases on the developing world. This was an opportunity given to the developing world to change and not a licence for indiscriminate usage of fossil fuels. (7)

During this decade, there were rapid changes in the manufacturing and service sectors and their employment pattern. As a part of globalisation, undeveloped and developing world started changing their conventional ideological outlook in the realm of economy. This was given the name of reform or economic liberalisation. In the effort in reducing the final cost of product, which is essential in competitive free-trade environment, developed world started shifting their manufacturing and services to developing world. This is popularly called as outsourcing. Though this is benefitting developing countries, it is reducing the job opportunities in the developed world. The whole problem thus becomes that of economics. This was the reason why USA flatly refused to ratify Kyoto Protocol. USA being the largest contributor to the greenhouse gases, without their participation, these treaties become toothless and meaningless (8). However, the commitment of European Union to Kyoto Protocol seems to be firm. This is the reason why alternative energy sources are put to use more in European countries than any other part of the world.

The search for alternative energy sources is strongly rooted in the realisation that the conventional energy sources are polluting and they are not renewable and thus limited (9). The central theme of all these activities is the human lifestyle. The obvious options are only two: either drastically reduce energy needs and consumption or search for alternative energy sources. The problem is complex and cannot be solved by technology alone. There is always resistance to any change. To reduce the unacceptability of this change and while also not resorting to any draconian laws, what is required is education in the subject.

This seminar is a step in that direction. We know our limitations of resources but no step is a small step in search of solutions of such a complex problem. I am sure proceedings of this two-day National Seminar will throw light on many dark corners of these problems at the end of the day.

Thank you

Dr. Vijay V. Bedekar
Chairman,
Vidya Prasarak Mandal

Notes and References

(1) VPM's Polytechnic is conducting national seminars annually on important topics, which will help students and teachers to learn more about the subjects which are complimentary but outside their Syllabus. This year's topic is **Alternative Energy Sources** to be held on Saturday 27th and Sunday 28th August 2005

Seminars conducted in the past are :

3rd March 2004 - One Day Seminar on **IT and Careers**

8th August 2004 - One Day National Seminar on **Pollution of Water Bodies in Urban Areas Case Study (Thane)**

27th & 28th August 2005 - Two Days National Seminar on **Alternative Energy Sources**

(2) One of the best books on the subject is **Silent Spring** authored by Rachel Carson. The book is written during 1958-1962. It deals with the damaging effects of insecticides and pesticides have on the Environment. She was branded as lunatic by her contemporaries, but prophecy of her writings was realized soon. More on http://www.rachelcarson.org/

(3) For more on Modernity and Progress readers can refer to my paper **Science Technology and Human Development Vol I p 231-236** presented at a CASTME-UNESCO-HBCSE International Conference held at Goa,India during February 20-23, 2001

(4) United Nations Environmental Programme and World Meteorological Organization jointly created the **Intergovernmental Panel on Climate Change (IPCC)** in the year 1988. In its most recent assessment, IPCC has stated unequivocally that the consensus of scientific opinion is that "Earth's climate is being affected by human activities". More on IPCC at: http://www.ipcc.ch/about/about.htm Also see *Climate change 2001: Impacts,Adaptation, and vulnerability* edited by J.J.McCarthy *et al* Published by Cambridge University Press, Cambridge, 2001.

(5)The complete text of the protocol is available at http://unfccc.int/resource/docs/convkp/kpeng.html

(6) On Wednesday June 08, 2005 New York Times Late Edition in its National Desk section (Section A, Page 1, Column 2) carried an article by Andrew C.Revkin titled *Bush Aide Edited Climate Reports*. The abstract of the article is:

" Internal documents show that White House official Philip A Cooney, who once led oil industry fight against limits on greenhouse gases, has repeatedly edited government climate reports in ways that play down links between such emissions and global warming; Cooney is now chief of staff for White House Council on Environmental Quality; dozens of wording changes convey air of doubt about findings that most climate experts say are robust; examples; photos of altered pages; Cooney, lawyer with no scientific training, was American Petroleum Institute lobbyist leading 'climate team' until 2001; documents were obtained by The New York Times from Government Accountability Project, which helps whistle-blowers and is representing Rick S Piltz, who resigned in March from government office that issued documents edited by Cooney; Piltz says White House editing and other actions threaten to taint effort to clarify climate issue (M)"

Also see article *Oil: Never Cry Wolf- Why the Petroleum Age Is Far From over* by Leonardo Maugerl in **Science** Vol. 304 No 5674, 21 May 2004 p: 1114-1115; and related correspondence in **Science** Vol.309 No.5731 p: 52-56

(7) A meeting in the Argentinean capital Buenos Aires, the 10th conference of Parties to the Convention held in August 2005 discussed how Brazil, China and India can be persuaded to participate actively in international efforts to tackle global warming.

India's record in this respect is not satisfactory.

Also see the draft of a recent meeting held at Vientiane, Laos of Asia-Pacific Partnership on Clean Development and Climate by USA, Australia, China, Japan, South Korea and India. It supposed to complement and not replace the Kyoto Treaty. USA and Australia have refused to ratify the Kyoto treaty. Some of the wordings of this draft are worth noting- " seek to address energy, climate change and air-pollution issues within a paradigm of economic development". It is clear that economical issues are gaining upper hand on energy and climate issues.

(8) A recent editorial in **Nature** (Vol.436 Issue No.7047, 7th July 2005) title: **Climate of distrust** speaks volumes on the lack of political will of today's USA Government on the issues related to energy and pollution.

Recent meeting of G8 countries held at Gleneagles, Scotland U.K. also could not deliver any substantial commitment on these issues by USA. See **Nature** Vol.436, Issue No.7048, 17th July 2005 P: 156-157.

(9) A recent issue of **National Geographic**, August 2005 gives valuable information on alternative energy initiatives in Europe and USA.

Also see the issue of **New Scientist** of 4th June P: 08-09 for such initiatives world over.

Some Petroleum companies are also taking active interest in alternative energy sources research. BP is developing a power station in Scotland U.K., which will run on Hydrogen, and produce electricity with 90% lower carbon emission for 250,000 homes.

ADVISORY COMMITTEE MESSAGE

NATIONAL SEMINAR ON ALTERNATIVE ENERGY SOURCES

Background-

Out of the known World petroleum reserves, only a part may be technically economically feasible to explore. This fact, coupled with the present and expected consumption rates implies that these reserves may not last beyond the next 30 years. For India, the situation could be even more difficult. Given limited reserves, present known stocks may not last even 10 years at the current consumption rate.

Potential of alternative energy sources in India

At one end, the rapid industrialization has led to increased use of fossil fuels such as coal, oil etc, to meet its power and steam requirement. For which, the developing nations like India are paying huge import bills putting stress on its economy. At other end, a naturally available energy sources such as solar, wind, biomass, biogas etc are not effectively used.

India has potential to generate 45,000 MW from wind energy, 19,000 MW from biomass energy, 15,000 MW from small hydro projects. In addition to it the urban areas in India produce @ 30 million of solid waste and 4400 Million cubic meters of liquid waste every year. The same can be exploited to generate power and meet a part of the ever increasing demand of urban areas.
Therefore, the need of the hour is to conserve petroleum by its judicious use, substituting it by other resources ***wherever techno-commercially feasible*** *and restricting its use only to the essential needs.*

The present seminar being organized by VPM polytechnic is one such step in that direction.

We, all the advisory committee members wish to see very successful seminar and more so the resolve by the younger generation to make this country a self reliant in its energy usage resulting in total energy security for India. This is the only way to achieve the sustainable growth for developing country like ours.

Prof. D.K. Nayak
Principal

Foreword

All education spring from the images of the future and all education create the images of future. Our Polytechnic is trying to diversify its commitment to do some creative activity in futuristic subjects for the benefit of the mankind. The two days national seminar on Alternative Energy Sources is the subject of global attention. The present mismatch between energy generation and consumption, depletion of sources of conventional energy are serious in nature. Unless a long term planning is done to handle these issues and commercially viable and environment friendly alternative technologies are developed, it will spell a doom. Various energy forums around the globe are formed in developed countries to explore Alternative Energy generation technologies, its viability, commercialization and sustainability.

India, being one of the most populated and developing countries, will be affected to the maximum. Presently most of the petroleum products are imported and steady rise in their prices is affecting the Indian economy. Our country can step this financial drain only by self-sustainability in the energy sector.

India has huge prospects in developing energy through alternate sources. What is lacking at present is the focused desire and serious efforts in research and development. The bureaucratic think tank should channelise their ideas and funds in this direction so that by the time the requirement reaches its necessity level, adequate technology can take over.

The national seminar will throw light on major options available to get energy. The products on display will indicate efforts of our manufactures in this area. However it is essential that awareness about energy system should be brought in the minds of people so that they will become conservative and start adopting the new technologies. Unless more and more people start using these in near future, the energy scarcity may reach alarming levels.

India is a country having over 300 sunny days a year and solar systems can prove a boon. Research and development by few established companies have provided good results. However, the total contribution of energy through these alternative means is still less than four percent of the total energy generation as of today.

The seminar intends to focus on Solar, Wind, Biogas, Biomass, Hydrogen, Energy from waste etc. Efforts are made to get experts from all these areas to understand the present level of activity. It is our duty to train today's youngsters in this field and motivate them to do research in these areas so that efficient, clean and economic energy can be made available to the industries and masses.

We have confidence in the today's generation that they will do considerable amount of work in this field. We are anticipating active support and participation of all the authorities such as Municipal Corporation, Energy Boards, Non Conventional Energy Departments, Energy Institutes and Forums engaged in these ventures.

The two-day deliberations are likely to yield good results with the participation of experts and technical papers of innovative qualities. This will set a trend for further developments in this area for continued progress.

I compliment all the chairpersons, speakers, and delegates for having shown keen interest on this subject. Sponsorships and Exhibition participations have helped us in managing the programme to a great extent. Thanks to all the individuals and organizations for taking part in this subject of global importance.

Preface

India is one of the five fast developing countries.

Energy is the primary and most universal measure of all kinds of work by human beings and nature. Whatever happens in the world is only the expression of flow of energy in either of its forms.

Energy is a crucial input in the process of economic, social and industrial development. Energy consumption in the developing countries is increasing at a faster rate. As conventional energy sources are depleting day by day, utilization of alternative energy sources is the only solution.

India has made rapid strides towards economic self reliance over the last few years. On the energy demand and supply side, India is facing severe shortages. To overcome energy crisis, government has developed many projects related to alternative energy sources. The new agricultural technologies can be developed based on non-conventional energy sources.

The requirement of alternative energy sources needs serious thoughts. This seminar will definitely lead to a fruitful outcome. Since it has provided a platform for academic and scientific community to share their views, I am very sure that it must have also motivated the people to think over the global energy problems and adopt use of alternative energy sources in day to day life.

We are thankful to Vidya Prasarak Mandal and principal Prof. D.K. Nayak, for giving us this opportunity to conduct this seminar.

We are also thankful to the members of advisory committee for extending cooperation and guidance.

We are grateful to Pitambari Products Pvt. Ltd. and Maharashtra State Board of Technical Education (MSBTE) for sponsoring this programme.

Our thanks are due to all the delegates and participants of this seminar.

Last but not the least, we are thankful to all the members who have helped us directly or indirectly in making this seminar grand success.

Mrs. N.V. Vader
Chief Coordinator
NSAES
Head of Electrical Power Systems Department

From Convener 's Desk

Alternative energy for Sustainable Development

Mrs. Anice Alias

Power plays a great role wherever man lives and works. The living standard and prosperity of a nation vary directly with the increase in the use of power. The electricity requirement of the world is increasing at an alarming rate due to industrial growth, increased and extensive use of electrical gadgets.

According to world energy report, we get around 80% of our energy from conventional fossil fuels like oil (36%), natural gas (21%) and coal (23%). It is well known that the time is not so far when all these sources will be completely exhausted. Nuclear energy is a comparatively clean source of energy. However, safe handling of nuclear energy reactor is a sophisticated task and only around 7% of the world's total energy requirement is being satisfied by it today.

As human needs know no bounds, today most of the nations worldwide have been passing through a phase of power deficit. The crisis is more critical among the developing nations.

In India, energy demand is increasing at the rate of 9% per annum and supply is not keeping pace. Present deficit of electrical energy is 8%.

The increased power demand, depleting fossil fuel resources and growing environmental pollution have led the world to think seriously for other alternative sources of energy. Basic concept of alternative energy relates to issues of sustainability, renewability and pollution reduction. In reality alternative energy means anything other than deriving energy via fossil fuel combustion.

Various forms of alternative energy sources are solar, wind, biogas/biomass, tidal, geothermal, fuel cell, hydrogen energy, small hydropower etc.

Solution to long-term energy problem will come only through Research and Development in the field of alternative energy sources.

Many rural communities consume little electricity, and extending electricity grids to meet their energy needs may prove more costly and take longer than harnessing new and alternative sources of energy already available in these communities — wind, solar, and biomass — through Renewable Energy Technologies (RETs). The attraction of these sources lies primarily in their abundance and ready access. The RETs for exploiting these sources include biogas plants, solar lanterns, solar home lighting systems, improved cook stoves, improved kerosene lanterns, solar water pumping systems, solar water heating systems and water mills.

Solar energy panels are little costly considering our average economic standard.

Studies indicate that cooking with biogas (a highly combustible fuel comprising methane, carbon dioxide, nitrogen, hydrogen and hydrogen sulphide produced through anaerobic fermentation of organic matter) can be cheaper than cooking with any commercial fuel.

Due to limited oil reserves, India has to depend on substantial imports for meeting its present and future requirement. The bulk of demand for oil is from transport sector and in order to reduce the pressure from this sector it is necessary to explore possibilities of developing substitute fuels like biomass and producer gas.

Wind power has also proved to be a viable energy alternative. In India, more than 1.3 giga watts of wind energy capacity has been added over the past six years exclusively in the private sector, which either sells electricity to the electric utilities or wheels it over the utility grid for self-consumption.

BENEFITS OF ALTERNATIVE ENERGY OPTIONS

Alternative energy options enable local institutions to manage their own energy needs and thus provide rural development opportunities. This situation encourages decentralized decision making, which has far-reaching implications for the governance of a community. In addition, dissemination and popularization of energy-efficient devices and alternatives to conventional fuels can do the following:

- ***Provide better lighting***. Better lighting enables the poor to stretch their period of economic activity; their children can help them in daily chores and then study in the evenings.

- ***Help the environment***. Efficient use of conventional sources of energy or use of renewable energy helps save the environment from further degradation and gives it an opportunity to regenerate.

- ***Provide sustainable fuel systems***. Afforestation and agro forestry, combined with the introduction of energy-efficient devices, can help to create a sustainable fuel-use system within the rural community and sustain the ecological balance of a region.

- ***Benefit women.*** Lower dependency on fuel wood and other household fuel sources reduces the drudgery of women by shortening or eliminating the distances they travel for fuel collection. The improved cook stove, for example, has been associated with an average net annual saving of seven person-days of labour a year in India.

- ***Benefit human health***. Use of improved cook stoves and biogas plants, for example, helps reduce or eliminate health problems associated with using conventional cook stoves, including respiratory diseases and eye problems.

- ***Enhance income***. Alternative energy sources can provide local employment opportunities through direct use of energy in small-scale industry and agriculture, through construction, repair, and maintenance of energy devices, or through the sale of energy to local utilities. In India, for example, biomass gasification systems are used to dry horticulture produce (such as large cardamom and ginger). Another example is the use of solar water-heating systems to meet the hot-water demand of hotels and hospitals.

  Energy Problem is a global problem. The Government cannot do every thing, however individual or co-operative efforts can do a lot.

In this context, we are organizing a National Seminar on Alternative Energy Sources to provide a forum for experts, educationalists and industrialists from these fields to exchange ideas and to bring out the status of these sources and latest technologies and practical applications in this advanced technical era.

The main objective of the seminar is

- To make aware of the present energy scenario.
- To make aware of the global energy problem and leading role of the alternative energy sources for future survival.
- To gather, review and publicize the success stories involving alternative energy sources.
- To encourage public organizations to adopt these sources in their premises for a reliable, safe and quality based power supply.
- To provide a forum for experts in this field, research scholars, industrialists to share their views and innovative ideas about the topics.
- To encourage students and invite innovative ideas from younger generation.

Keeping these objectives in view the major areas of interest of this Seminar are:

- Wind energy
- Solar energy
- Biogas / Biomass
- Energy From Waste
- Other alternative sources of energy such as fuel cell, hydrogen energy, tidal, geothermal, energy management, etc

We are also arranging a Product display cum Project Exhibition related to the Alternative Energy Sources between 26th and 28th August 2005.

This Seminar and the Exhibition is a vital step in popularizing various alternative energy sources and new technologies. The abundant availability of these sources may play a major role to help India to become a super power in years to come.

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ENERGY SCENARIO

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Introduction

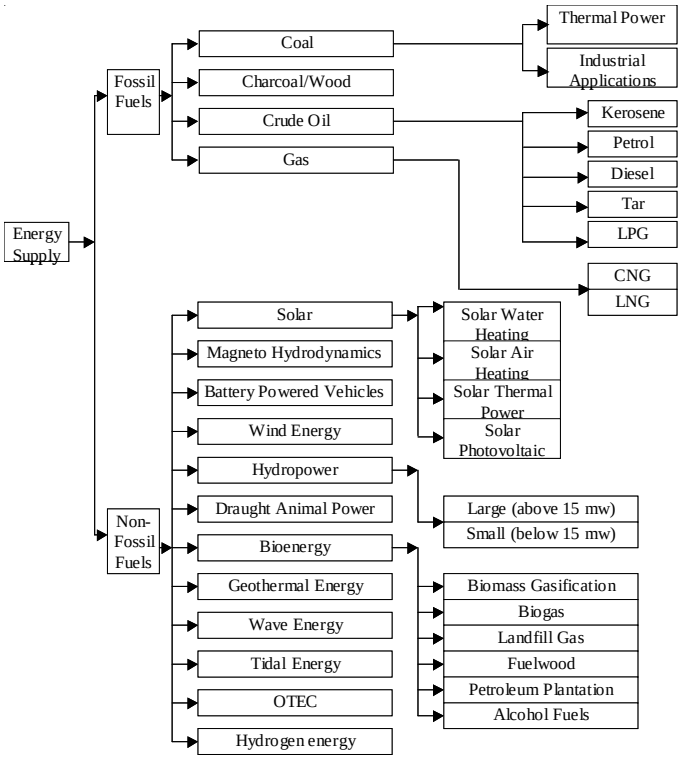
Energy is the basis of human life. There is hardly any activity or moment that is independent of energy. Every moment of the day we are using energy. Earlier man used muscle power, then fire and animal power. Next, he learned to harness energy, convert it to useful form and put it to various uses.

Over the past few decades, energy is the backbone of technology and economic development. In addition to men, machines and money, 'energy' is now the fourth factor of production. Without energy, no machine will run, electricity is needed for every things. Hence, our energy requirements have increased in the years following the industrial revolution. This rapid increase in use of energy has created problems of demand and supply. If this growing world energy demand is to be met with fossil fuels, they will be no more available for producing the energy after few years. It is a need of today's world to concentrate on renewable energy source to satisfy the demand and conserve our finite natural resources for the generation to come.

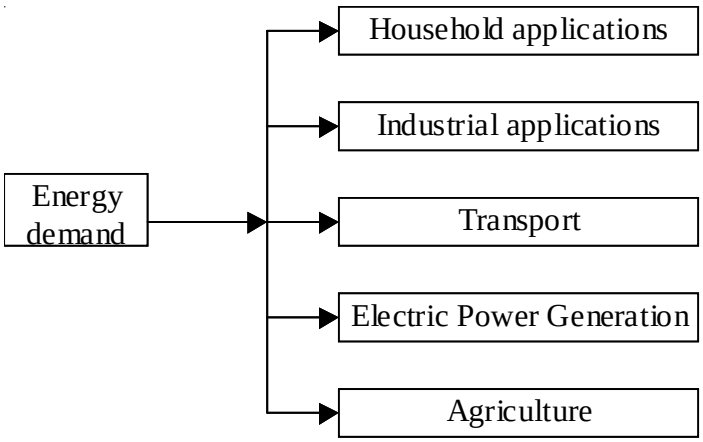
This is a try to present an overview of the concerns about energy demand and supply ratio and how to conserve energy as well how to maximum use of renewable energy.

Energy supply and demand

Sources of different forms of energy supply



Demand



Conventional energy supply scenario

Although there is an increasing interest in alternate energy sources such as solar, wind, biomass etc. a major of the energy comes from fossil fuel, oil and natural gas.

Following tables shows the demand and supply forecast for all the conventional energy sources mentioned above.

Table 1 Coal demand and supply forecasts for India (million tonnes)

	1997/98	2001/02	2006/07	2011/12
Demand	323	400	576	872
Domestic supply	298	360	484	652
Deficit	25	40	92	220

Table 2 Oil demand and supply in India (million barrels per day)

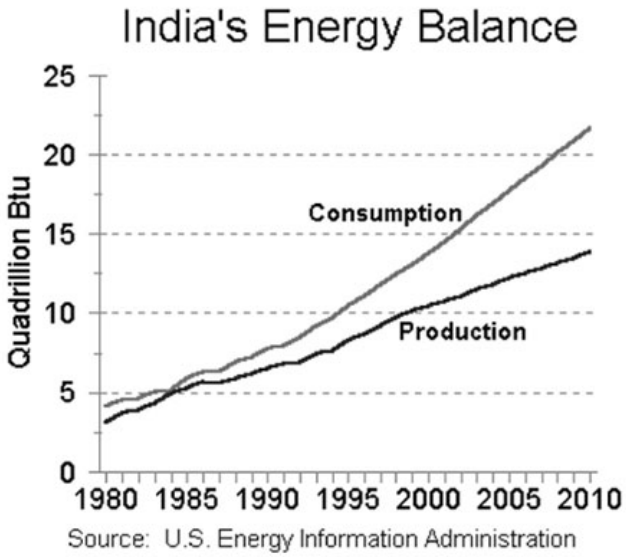
Year	Crude production	Crude imports	Petroleum products demand	Self reliance (%)
1997/98	0.69	0.62	1.68	39
2001/02	0.74	1.57	2.1	33
2006/07	0.8	2.2	2.89	26
2011/12	0.9	3.31	4.06	21

Table 3 Natural gas demand and supply in India (million cubic metres per day)

	1996/97	2001/02	2006/07	2011/12
Demand	52.1	117.8	167.1	216.4
Production	49.3	71.2	57.5	43.8
Gap	2.8	46.6	109.6	172.6

Table 4 Demand and supply forecasts for power in India (GW)

	2001/02	2006/07	2011/12
Peak load	95.76	130.94	176.65
Installed capacity	126.04	181.1	242
Peaking capability [a]	88.92	129.82	146.67



Taking the overview of these forecasts it is observed that in each and every area demand is more and the supply is less. If this situation persists no conventional source will remain to supply energy.

The draft renewable energy policy of the Govt. of India sets the following targets to be achieved.

- 30 million more households to have improved cookstoves
- 3 million more family-size biogas plants to be set up 5 million solar lanterns
- Decentralized electricity, including village grid tail-end injection systems, to be provided to one-quarter of these villages in the following manner, through power plants with an average installed capacity of 100 kWp per plant:
- 500 solar photovoltaics plants
- 2000 biomass gasifier-based power plants
- 1000 small hydro power plants
- 2 million solar home systems
- 5 million square metres of collector area for low-temperature solar water-heating systems, comprising (1) domestic systems for 1 million households, each with a capacity of 100 litres per day and (2) 2.5 million square metres of collector area for industrial applications.

Non-conventional energy supply scenario

Table shows the status of renewable energy technologies in India.

Table 5 Status of renewable energy technologies in India as on 30 April 2000

Technology	Cumulative installations
Family-size biogas plants	3 million
Improved cookstoves	32 million
Solar cookers	487 000
Solar hot water systems	500 000 million square metres
PV (Photovoltaic) water pumps (aggregate capacity)	3371
PV power units	1165 kWp
PV community lights and street lights	39 000
PV home systems	117 000
PV lanterns	278 000
Water-pumping windmills	637
Small aerogenerators	55 kW
Wind farms	1167 MW
Biomass power	222 MW
Biomass gasifiers	34 MW
Wind–solar PV hybrid systems	76.5 MW
Small hydel	217 MW
Energy from wastes	15.2 MW

- In addition, it is targeted to install 1000 medium-temperature, solar-concentrator-based solar process heating systems, each equivalent to a steam generation capacity of 10 tonnes per day
- 1000 MW to be installed through thermal applications
- Renewable sources of energy to contribute 10%, or about 12 000 MW, to the capacity addition of 120 000 MW

Option – Alternative :

The demand for energy is increasing day by day. The ever increasing use of modern means of transport, changing lifestyles and mechanization of labour have lead to a sudden and very large spurt in energy requirement. There is still a considerable potential for alternative energy sources. Increased use of renewable energy sources for energy generation will not only meet the energy demand but also result in substantial environmental benefits.

ALTERNATIVE ENERGY SOURCES

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Abstract

The past few years have seen a flurry of activities in the field of "Alternative Energy", the main impetus is as a result of the energy crisis of the early seventies. After the 1973 oil embargo, there was a resurgence of interest in solar energy. Currently, there is a need for allocating increased resources in solar research. Compared to the old forms of depletable energy (coal, oil, nuclear), solar energy offers a clean renewable form of energy.

The particular branch of 'Alternative Energy' most immediately relevant to us is of course photovoltaic. Most engineers are now aware of the basic facts about photoelectric energy conversion. Photovoltaic conversion is a direct method of solar energy utilization. This presentation will provide an overview of PV terminology and the past, present and future of solar energy along with

- Why is solar energy being used by indigenous cultures?
- Where solar energy projects being implemented the most?

Keywords: *photovoltaic, PV terminology, current research in solar energy, current drawbacks, future of solar energy, solar energy applications.*

Introduction

Solar energy is one the most resourceful sources of energy for the future. One of the reasons for this is that the total energy we receive each year from the sun is around 35,000 times the total energy used by man. However, about 1/3 of this energy is either absorbed by the outer atmosphere or reflected back into space (a process called albedo)*.

Solar energy is the energy force that sustains life on the earth for all plants, animals, and people. The earth receives this radiant energy from the sun in the form of electromagnetic waves, which the sun continually emits into space. The earth is essentially a huge solar energy collector receiving large quantities of this energy which manifests itself in various forms, such as direct sunlight used through photosynthesis by plants, heated air masses causing wind, and evaporation of the oceans resulting as rain which can form rivers. This solar energy can be tapped directly as solar energy (thermal and photovoltaic), and indirectly as wind, biomass, waterpower, wave energy, and ocean temperature difference.

Solar energy is a renewable resource that is inexhaustible and is locally available. It is a clean energy source that allows for local energy independence. The sun's power flow reaching the earth is typically about 1,000 Watts per square meter (W/m2), although availability varies with location and time of year. Capturing solar energy typically requires equipment with a relatively high initial capital cost. However, over the lifetime of the solar equipment, these systems can prove to be cost-competitive, as compared to conventional energy technologies. The key to successful solar energy installation is to use quality components that have long lifetimes and require minimal maintenance.

Electricy from Sunlight (Photovoltaics) and PV Terminology

Electricity can be produced from sunlight through direct heating of fluids to generate steam for large-scale centralized electrical generation (solar thermal electrical generation). Electricity can alternatively be produced from sunlight through a process called photovoltaic (PV)[1], which can be applied, in either a centralized or decentralized fashion.

Solar Cell: The PV cell is the component responsible for converting light to electricity. Some materials (e.g., silicon is the most common) produce a photovoltaic effect, where sunlight frees electrons striking the silicon material. The freed electrons cannot return to the positively charged sites ('holes') without flowing through an external circuit, thus generating current. Solar cells are designed to absorb as much light as possible and are interconnected in series and parallel electrical connections to produce desired voltages and currents.

PV Module: A PV module is composed of interconnected solar cells that are encapsulated between a glass cover and weatherproof backing. The modules are typically framed in aluminum frames suitable for mounting. PV modules are rated by their total power output, or peak Watts[2]. A thin silicon cell, four inches across, can produce more than one watt of direct current (DC) electrical power in full sun. Individual solar cells can be connected in series and parallel to obtain desired voltages and currents. These groups of cells are packaged into standard modules that protect the cells from the environment while providing useful voltages and currents. PV modules are extremely reliable since they are solid state and there are no moving parts. Silicon PV cells manufactured today can provide over thirty years of useful service life. A 50 Wp PV module in direct sunlight operating at 25°C will generate 50 Watts per hour (referred to as a Watt-hour-[Wh]). This same module will produce less power at higher temperatures; at 55°C this same module can only produce about 42.5 W. Modules can be connected together in series and/or parallel in an array to provide required voltages and currents for a particular application. PV systems are made up of a variety of components, which aside from the modules, may include conductors, fuses, disconnects, controls, batteries, trackers, and inverters. Components will vary somewhat depending on the application. PV systems are modular by nature, thus systems can be readily expanded and components easily repaired or replaced if needed. PV systems are cost effective for many remote power applications, as well as for small stand-alone power applications in proximity to the existing electric grid.

PV is a relatively new and unknown technology, which offers a new vision for consumers and business as to how power can be provided. PV technology is already proving to be a force for social change in rural areas in less developed countries. The unique aspect of PV is that it is a 'radical' or 'disruptive' type of technology as compared to conventional power generation technologies. PV is a technology that does not build from the old technology base, but rather replaces that base from the bottom up. PV allows people the opportunity to ignore traditional electrical power supply structures and meet their own power needs locally. In rural regions of the world today, where there are no power companies offering electricity, PV is often the technology of choice.

The best performing renewable energy electrification systems are those that meet the

expectations of the users. It is important to satisfy the basic needs of the user in order to ensure acceptance of renewable energy systems. Ownership and subsequent accountability is the key to system sustainability for PV.

One 50 Wp PV module is enough to power four or five small fluorescent bulbs, a radio, and a 15-inch black-and-white television set for up to 5 hours a day. Obviously this is only a modest amount of energy, however, this represents an important quality of life improvement for many rural people without electricity. PV Array[3] is used for increasing total available power output to the needed voltage and current for a particular application.

Global Photo Voltaic Markets

The fast growing world market for PV greatly reflects the growing rural electrification demand of less developed countries around the world. The global PV market has grown at an average rate of 16 percent per year over the decade with village power driving demand. Table 1 shows the total worldwide PV production in 1980 was only 6.5 megawatts (MW) and by 1997 this had increased to 126.7 MW.

Table 1. Worldwide PV production

	1980	1986	1989	1991	1993	1996	1997
TOTAL (MW)	6.5	26	40.2	55.4	60.1	88.6	126.7

There are over 500,000 homes using PV today in villages around the world for electricity. In Kenya**, more rural households receive electricity from PV than from the conventional power grid. The single largest market sector for PV is village power at about 45 percent of worldwide sales. This is mostly comprised of small home lighting systems and water pumping. Remote industrial applications such as communications are the second largest market segment.

Photovoltaic Costs

For many applications, especially remote site and small power applications, PV power is the most cost-effective option available, not to mention its environmental benefits. New PV modules generally retail for about Rs.225 per peak watt, depending on quantities purchased. Batteries, inverters, and other balance of system components can raise the overall price of a PV system to over Rs.450 – Rs.675 per installed Watt. Manufacturers from 10 to 20 years today guarantee PV modules in the market, while many of these should provide over 30 years of useful life. It is important when designing PV systems to be realistic and flexible, and not to over design the system or overestimate energy requirements (e.g., overestimating water-pumping requirements) so as not to have to spend more money than needed. PV conversion efficiencies and manufacturing processes will continue to improve, causing prices to gradually decrease.

PV conversion efficiencies have increased with commercially available modules that are from 12 to 17 percent efficient, and research laboratory cells demonstrate efficiencies above 34 percent. A well-designed PV system will operate unattended and requires minimum periodic maintenance, which can result in significant labour savings. PV modules on the market today are

guaranteed by the manufacturer from 10 to 25 years and should last well over 30 years. PV conversion efficiencies and manufacturing processes will continue to improve, causing prices to gradually decrease, however no dramatic overnight price breakthroughs are expected.

Common Photovoltaic Applications

PV is best suited for remote site applications that have small to moderate power requirements, or small power consuming applications even where the grid is in existence. A few power companies are also promoting limited grid-connected PV systems, but the large market for this technology is for stand-alone (off grid) applications. Some common PV applications are as follows:

Water Pumping: Pumping water is one of the most competitive arenas for PV power since it is simple, reliable, and requires almost no maintenance. Agricultural watering needs are usually greatest during sunnier periods when more water can be pumped with a solar system. PV powered pumping systems are excellent for small to medium scale pumping needs (e.g., livestock tanks) and rarely exceed applications requiring more than a 2 hp motor. PV pumping systems main advantages are that no fuel is required and little maintenance is needed.

PV powered water pumping system is similar to any other pumping system, only the power source is solar energy; PV pumping systems have, as a minimum, a PV array, a motor, and a pump. PV water pumping arrays are fixed mounted or sometimes placed on passive trackers (which use no motors) to increase pumping time and volume. AC and DC motors with centrifugal or displacement pumps are used with PV pumping systems.

Gate Openers

Commercially available PV powered electric gate openers use wireless remote controls that start a motorized actuator that releases a gate latch, opens the gate, and closes the gate behind the vehicle. Gates are designed to stop if resistance is met as a safety mechanism. Units are available that can be used on gates up to 16 feet wide and weighing up to 250 pounds. Small PV modules of only a few watts charge batteries. Digital keypads are available to allow access with an entry code for persons without a transmitter. Solar powered gate-opening assemblies with a PV module and transmitter sell for about RS.31500.

Electric Fences

PV power can be used to electrify fences for livestock and animals. Commercially available packaged units have maintenance free 6 or 12 volt sealed gel cell batteries (never need to add water) for day and night operation. These units deliver safe (non-burning) power spikes (shocks) typically in the 8,000 to 12,000 volt range. Commercial units are UL rated and can effectively electrify about 25 to 30 miles of fencing.

Water Tank De-Icers

For the north plains of Texas in the winter, PV power can be used to melt ice for livestock tanks, which frees a rancher from going out to the tank with an axe to break the surface ice so that the cows can drink the water. The PV module provides power to a small compressor on the tank bottom that generates air bubbles underwater, which rise to the surface of the tank. This movement of the water with the air bubbles melts the tank's surface ice. Commercially available units are

recommended for tanks 10 feet in diameter or greater, and can also be used with ponds. Performance is the best for tanks that are sheltered and insulated. Installation is not recommended for small, unsheltered tanks in extremely cold and windy sites. An approximate cost for a complete owner-installed system, including a PV module, compressor, and mounting pole is about Rs.20250.

Commercial Lighting

PV powered lighting systems are reliable and a low cost alternative widely used. Security, billboard sign, area, and outdoor lighting are all viable applications for PV. It's often cheaper to put in a PV lighting system as opposed to installing a grid lighting system that requires a new transformer, trenching across parking lots, etc. Most stand-alone PV lighting systems operate at 12 or 24 volts DC. Efficient fluorescent or sodium lamps are recommended for their high efficiency of lumens per watt. Batteries are required for PV lighting systems. Deep cycle batteries specifically designed for PV applications should be used for energy storage for lighting systems. Batteries should be located in protective enclosures, and manufacturer's installation and maintenance instructions should be followed. Batteries should be regulated with a quality charge controller. Lighting systems prices vary depending on the size.

Residential power

Over 500,000 homes worldwide use PV power as their only source of electricity. In Texas, a residence located more than a mile from the electric grid can install a PV system more inexpensively than extending the electric grid. A Texas residence opting to go solar requires about a 2 kW PV array to meet its energy needs, at a cost of about Rs. 675,000. The first rule with PV is always energy efficiency. A PV system can provide enough power for an energy efficient refrigerator, lights, television, stereo, and other common household appliances.

Evaporative Cooling

PV powered packaged evaporative cooling units are commercially available and take advantage of the natural relation that when maximum cooling is required is when maximum solar energy is available. These units are most appropriate for comfort cooling in the dry climate of West Texas where performance is best. Direct evaporative coolers save 70% of the energy over refrigerated units. Battery storage is obviously required if cooler operation is desired at night. Array size would vary with the power requirements of the cooler motor. A linear current booster (LCB) is useful between the PV modules and the cooler's DC motor if the cooler is coupled directly to the PV array. Packaged PV evaporative cooling systems for residences generally run from Rs. 22500 to Rs.67500, depending on size.

Telecommunications

This was one of the early important markets for PV technologies, and continues to be an important market. Isolated mountaintops and other rural areas are ideal for stand-alone PV systems where maintenance and power accessibility makes PV the ideal technology. These are often large systems, sometimes placed in hybrid applications with propane or other type of generators.

Consumer Electronics

Consumer electronics that have low power requirements are one of the most common uses

for PV technologies today. Solar powered watches, calculators, and cameras are all everyday applications for PV technologies. Typically, these applications use amorphous PV technologies that work well even in artificial light environments such as offices and classrooms.

Current Research in Solar Energy

Today, solar energy research has a similar pattern to nuclear energy. The emphasis is on a narrow technical options and test facilities.

An example is a power tower§, which is a system for collection solar energy from a large field of mirrors and converting it to heat at high temperature for efficient generation of electricity. All the mirrors track the sun and the heat is focused on a single broiler thermal system. The purpose is to only cover the midday load as experienced by utilities. To counter the effect of passing cloud, there is a thermal storage capability filled with oil.

Collector Systems

This area concentrates more on materials research, which primarily deals with what materials will efficiently absorb solar energy. The idea is to have solar collectors for heating pool, interior of house during winter or for providing hot water.

Other thermal applications include intermediate applications. Solar energy can be used to produce steam for industrial processes. The iron industries for example, consume 23% of energy. Imagine the billions of rupees that can be saved by reducing their reliance on the congenital form of power. The other application is the use of water pumps for irrigation.

First church in the world with solar power

Currently, solar cells have proved to be cost effective. Other than space satellites, the photovoltaic cells are being used in rural health clinics for refrigeration, water pumps for irrigation and for small-scale power generation.

Solar power for agriculture

Solar cells are also being used in developing countries. Solar panels can power a 17" b/w TV, a radio or a fan. Some electric lighting systems provide sufficient current for up to 10 hours of lightning each evening. Locally produced car batteries can provide up to 5 nights of energy for an 8-watt DC fluorescent light.

The new Mazda 929, uses solar cells to activate a fan to ventilate the car when the car is idle and parked during a sunny hot day.

Solar power for agriculture

Current Drawbacks of Photovoltaic Cells

The use of silicon crystals in the Photovoltaic cells makes it expensive. First of all, silicon crystals are currently assembled manually. Secondly, silicon purification is difficult and a lot of silicon is wasted. In addition, the operation of silicon cells requires a cooling system, because performance degrades at high temperatures. However, it has convinced analysts that solar cells

will become a significant source of energy by the end of the century.

Research is underway for new fabrication techniques, like those used for microchips. Alternative materials like cadmium sulphide and gallium arsenide are at an experimental stage. Reduction of cost will depend the economies of scale.

Oil companies for example, are aware of the renewed interest in solar power. They are diversifying their holdings in other forms of energy. Today, the chemical giant Exxon is the second largest producer of solar cells.

Future of Solar Energy

The success of solar power will depend on the answer to the following question: 'What do you do when the sun goes down?'

The simple answer is to build an auxiliary system that will store energy when the sun is out. However, the problem is that such storage systems are unavailable today. Simple systems, like water pipes surrounded by vacuum, do exist. It is based on the concept that provided the pipes are insulated, the water will store thermal energy.

The ocean is a natural reservoir of solar power and could be used as a source for thermal energy. If we can draw warm water from the surface and cold water from the depths, an ocean thermal plant could operate 24 hours a day. Cold water from the pipe and warm water from the surface were pumped into a plant on shore. It produced 22KW when the water temperatures were optimum and 12KW when seasonal current fluctuation reduced the efficiency.

There are also the hybrid systems. Wyoming has a system that holds backwater on a neighboring hydroelectric plant when the wind is blowing, which for the time being, runs the turbines. As discussed earlier, wind is an indirect form of solar energy. Thus the hybrid system is used in the fuel saver mode.

Research on photovoltaic cells will continue. Compared to the other options, majority of the resources will probably flow into research for developing better and more efficient solar cells. Parallel to that, more research will be undertaken to develop rechargeable batteries that will last longer hours.

Why is solar energy being used by indigenous cultures?

There are many reasonable answers for this. One could be that we are in trouble of running out of fossil fuel and environmentalists will eventually have their way with dams. Another could be that there is a market in solar energy. Governments are beginning to get involved and policies in these countries are shaping that encourage use of solar energy.

Indigenous cultures are usually off of the grid, meaning they have no access to electricity. For fuel, many of these cultures use firewood or kerosene. Investors of traditional energy sources aren't typically interested in these rural communities because of economic inopportunity. Providing traditional sources of electricity for these traditional communities is terribly expensive and environmentally harmful.

Although these areas are being electrified decades after many places in the world, this form of electricity is wise because it is beginning from a source of renewable energy-the sun. The use of solar as a form of energy embellishes the sustainable form of life these people have been leading while also advancing them in technology toward an increased standard in living. However, one must remember that in this day and age, no new development program comes without incentive, usually a marketable one. Solar implementation in developing nations is marketable because it allows these poor places to enter into the global market. But before we get too critical about globalization, the benefit of this type of development is that is environmentally sound and involves the people that live in these areas.

Where are solar energy projects being implemented the most?

The answer is-in developing nations. More specifically we find them in Asia, Africa, the Caribbean and Latin America. One example of the application of solar energy is in this village in Ghana, Africa. For just under $200,000, this community of 300,000 people will be using solar energy. Not only will they be solar electrified, but also a solar learning center will be built teaching classes about such things as solar cooking.

The World Bank has a programme to install home lighting system in 200,000 homes to Indonesia.

- SELF (Solar Electric Light Fund, Inc.) operates a rural solar enterprise in Karnataka, which provides solar services to rural households, and arrange financing and leasing of solar electric system.
- The largest percentage of solar energy in the world is being utilized by developing nations

Conclusions

The future is bright for continued PV technology dissemination around the world. PV technology fills a significant need in supplying electricity, creating local jobs and promoting economic development in rural areas, while also having the positive benefits of avoiding the external environmental costs associated with traditional electrical generation technologies. People who choose to pursue a renewable and sustainable energy future now, are the ones showing the way for the future.

Solar energy is presently being used on a smaller scale in furnaces for homes and to heat up swimming pools. On a larger scale, solar energy could be used to run cars, power plants, and space ships.

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* Winteringham, F. Peter W.
Energy Use and the Environment, Lweis Publishers, Ann Arbor; 1992

1. "Photovoltaic refers to light and "voltaic" to voltage. The term describes a solid-state electronic cell that produces direct current electrical energy from the radiant energy of the sun. Solar cells are made of semi-conducting material, most commonly silicon, coated with special additives. When light strikes the cell, electrons are knocked loose from the silicon atoms and flow in a built-in circuit, producing electricity .
2. A peak Watt is the amount of power output a PV module produces at Standard Test Conditions (STC) of a module operating temperature of 25°C in full noontime sunshine (irradiance) of 1,000 Watts per square meter.
3. PV modules are connected in series and parallel to form an array of modules

!. Flavin and O'Meara, 1998b

**. Kozloff and Shobowale, 1994

§ Steckborn, Switzerland. First church in the world with solar power

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ENERGY OF FUTURE – HYDROGEN

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Introduction

With a vision of clean and abundant energy for all, UNIDO-ICHET (United Nations Industrial Development Organisation-International Centre for Hydrogen Energy Technologies), Turkey is doing a serious effort through Energy Institutes established for this purpose.

IAHE (International Association for Hydrogen Energy), Florida, USA was founded with the aim of helping to convert the world to the Hydrogen economy by informing energy and environmental scientists, politicians and decision makers alongwith the general public.

Scientists working in this field strongly feel that Hydrogen Energy System will be a permanent solution to the projected global crisis in energy supply. This is mainly because all the current fossil fuel resources are in their mid-depletion region and the pollution levels have already reached unsafe levels.

As Hydrogen is to be produced from water, it is supposed to be one of the lightest, most efficient, cost effective and cleanest fuel on the planet, if the matured technology is developed. This is realistic since over 72% of the globe is covered with water and byproduct again is water. In other words Hydrogen economy starts and ends with water. It can avoid all harmful gases, acid rains, pollutants, ozone depleting chemicals and oil spillages due to conventional fuels. Use of Hydrogen can afford the development of clean and adequate energy for sustainable development of all.

Ever growing demand for energy and the rising concern caused by the use of conventional fossil fuels, call for new and clean fuels. Among all kinds of energy sources, hydrogen is the best choice as a clean fuel. The main advantage of hydrogen as energy source lies in the fact that its byproduct is water, and it can be easily regenerated.

Hydrogen is the simplest element; an atom of hydrogen consists of only one proton and one electron. It is also the most plentiful element in the universe. Despite its simplicity and abundance, hydrogen doesn't occur naturally as a gas on the Earth—it is always combined with other elements. Water, for example, is a combination of hydrogen and oxygen (H_2O). Hydrogen is also found in many organic compounds, notably the "hydrocarbons" that make up many of our fuels, such as gasoline, natural gas, methanol, and propane.

In this presentation we would like to highlight the production, storage, Transportation & application of hydrogen energy. We have focused on the storage of Hydrogen through carbon nanotubes. In its pure form, hydrogen is colorless and odourless gas. It is an energy carrier, not an energy source.

Production of Hydrogen

The various technologies that are involved in the production of hydrogen are

- Thermo Chemical process.
- Electrolytic process.
- Photolytic process.

Thermo Chemical Process

1) Steam Methane Reforming: - High temperature steam is used to extract hydrogen from any methane source. This is the most common method of producing hydrogen.

2) Partial Oxidation: - Methods are being is explored in which simultaneously oxygen is separated from air and partially oxidizing methane to produce hydrogen.

3) Splitting water using heat from a solar concentrator.

4) Burning to generate gas, which is then reformed to produce hydrogen.

Electrolytic Process

Electricity is used to separate water (H2O) into hydrogen and oxygen.

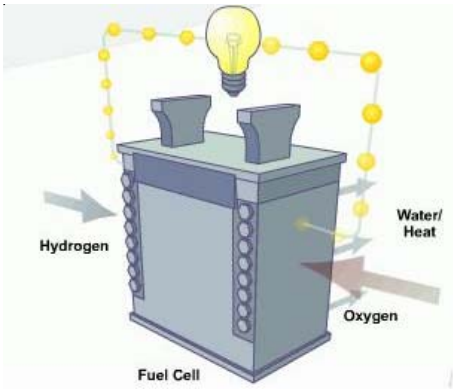
Photolytic Process:

In this, Sunlight is used to split water. Two photolytic processes are being studied.

1) Photo biological methods: - This involves the exposure of microbes to Sunlight, split water to produce Hydrogen.

2) Photo Electrolysis: - Here, Semiconductors, when exposed to Sunlight & immersed in water, generates enough electricity to produce hydrogen by splitting water.

Thus Hydrogen can be produced in large scale and transported or locally produced depending on the method used. The delivery infrastructure for hydrogen will require high-pressure compressors for gaseous hydrogen and liquefaction for Cryogenic Hydrogen. These methods have significant capital and operating costs. They also have energy inefficiency associated with them.



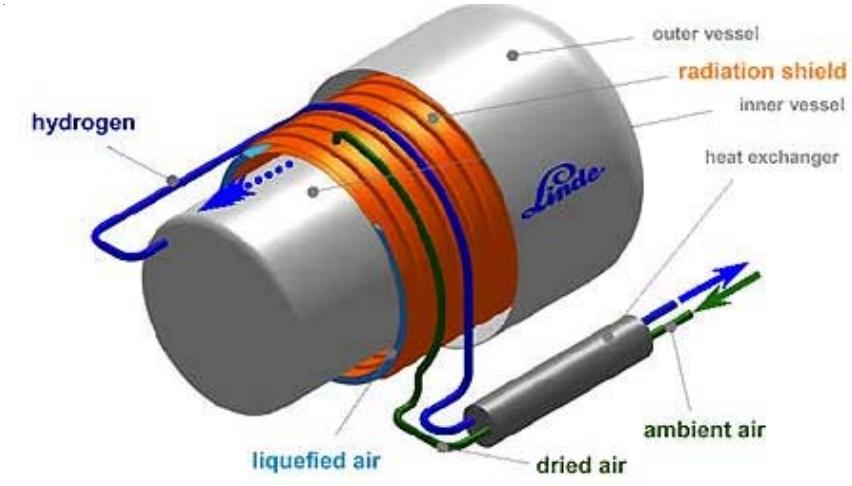
Fuel Cell

Storage Of Hydrogen

Various technologies are available for the storage of hydrogen.

- **High pressure tanks :** Hydrogen gas can be compressed and stored in storage tanks at high pressure. These tanks must be strong, durable Liquid Hydrogen: It can be stored as liquid but has to be kept at cold.
- Hydrogen combines with some metals which can result in higher storage capacity compared to high pressure gas or liquid.
- Carbon Nanotubes can store hydrogen.

Liquid Hydrogen Storage

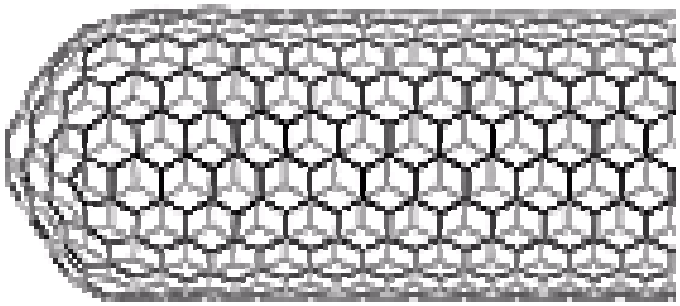


Challenges

For transportation, the overloading technical challenge for hydrogen storage is how to store the amount of hydrogen required for a conventional driving range, within the vehicular constraints of weight, volume efficiency, safety and cost. The performance lifetime durability of these systems must also be verified and validated. The main challenges are:

- Weight & Volume: - The weight and volume of hydrogen storage systems are presently too high.
- Efficiency: - Energy efficiency is a challenge for all hydrogen storage approaches.
- Durability: - Materials and components are needed that allow hydrogen storage systems with a lifetime of 1500 cycles.
- Refueling Time: - There is a need to develop hydrogen storage systems with refueling times being very low.
- Codes and Standards: - Codes and Standards for hydrogen storage systems and interface technologies which will help commercialization and implementation on a large scale and assure safety, have not been established.

Carbon Nanotube Fabrication

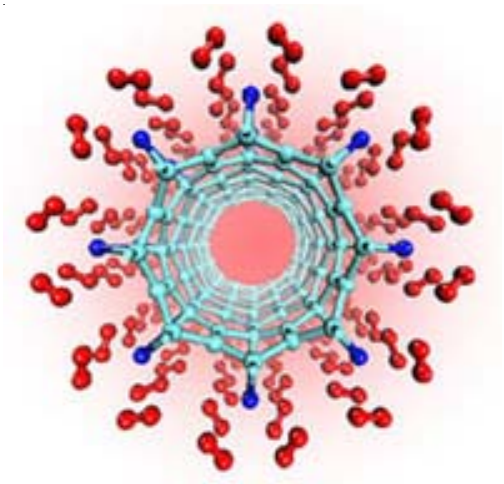


Many new methods use carbon as a storage medium and bring us a step closer to the widespread use of hydrogen as a fuel source. Scientists are using various approaches to shape carbon into microscopic cylindrical structures known as nanotubes.

The first method of producing nanotubes uses an electric arc to vaporize a metal-impregnated carbon electrode. The second method uses a laser to vaporize a heated carbon target that has been treated with a metal such as nickel, cobalt or iron.

The third method is known as catalytic chemical vapor deposition (CCVD), and researchers at Washington University in St. Louis believe this is the most promising approach. In the CCVD technique, a heated metal element breaks down a hydrocarbon gas (such as methane, ethylene, acetylene, etc.) into carbon and hydrogen. The hydrogen gas is released while the carbon is extruded as a nanofiber. The advantage of CCVD is that it is a low-temperature technique and is suitable for large-scale production.

Storage Of Hydrogen In Carbon Nanotube



One of the critical factors in nanotubes' usefulness as a hydrogen storage medium is the ratio of stored hydrogen to carbon. According to the US Department of Energy, a carbon material needs to store 6.5% of its own weight in hydrogen to make fuel cells practical in cars. Such fuel cell cars could then travel 300 miles between refueling stops.

Researchers at MIT claim to have produced nanotube clusters with the ability to store 4.2% of their own weight in hydrogen. In recent months, scientists from the National University of Singapore have released figures for nanotubes and nanofibers that can store 10-20% of their weight in hydrogen. These results, when combined with new car manufacturing technologies have the potential of transforming our transportation industries.

Single-walled carbon nanotubes are remarkable forms of elemental carbon. Their unique properties have stimulated the imaginations of many scientists and engineers to propose a wide range of applications.

Nanotubes do have a dramatic visual Impact. If beauty rests on symmetry, nanotubes have inherent beauty. Further, their cylindrical structures led to suggestions that they would be ideal gas storage materials. The appearance of these potential storage materials conveniently coincided with the revivification of interest in the hydrogen economy. The potential for coupling carbon-based storage materials to supply pure hydrogen to automotive fuel cell power plants was quickly seen. Initial reports of experiments showing high levels of hydrogen storage were encouraging. Theoreticians were then quick to calculate the possible amounts of hydrogen that could be stored using arrays of tubes of various sizes and packing parameters. Since the appearance of the initial reports, the results have been varied and controversial. Some are higher, some lower; some imply physisorption, and some chemisorption. It is clear that storage is a complex issue, partly because the, materials are more far complex than the visual comprehension of the single ideal nanotube would allow.

Studies have been conducted and it has been found that purified Multi walled carbon nanotubes (MWNT) can be used for bulk storage of hydrogen. Multi walled carbon nanotubes have been synthesised by catalytic decomposition of hydrocarbon using a floating catalyst method. The mean diameter of the MWNTs was found to be 5.1 nm. The MWNTs are then purified and hydrogen storage techniques are used. It is found that the gravimetric hydrogen storage capacity of purified MWNTs is much higher than that of as-prepared one which means that purification process is very important for hydrogen storage. This could be attributed to the fact that there is more exposure to more surfaces of the multiwalled nanotubes. The ends were seen to be opened up. This allowed hydrogen to more easily move into the hollow core of MWNTs.

XPS spectra of C1s of the purified sample is narrower and has no notable peak in the range of high electron binding energy. This indicates that the sample is in simple chemical state. This simple chemical state of C and lower oxygen contained groups correspond higher hydrogen storage capacity of carbon nanotubes.

There are many questions that must still be answered regarding nanotube hydrogen storage: How do we make process more efficient at lower temperatures in order to increase supply and decrease cost? What is the capacity loss with each storage cycle? Can other forms of carbon produce

the same results just as effectively? What additional applications can increase demand and research into nanotubes?

Existing Transport and Storage Methods

Hydrogen is currently stored in tanks as a compressed gas or cryogenic liquid. The tanks can be transported by truck or the compressed gas can be sent across distances of less than 50 miles by pipeline

Hydrogen Safety

Safety is essential in the entire energy conversion process. This begins with production, storage, transport, distribution and utilization. Each energy form poses its own specific risk, which should be taken care. The safety of combustible energy carriers in their ignition, combustion, explosion and detonation behaviour when mixed with air is still under study.

Applications

Hydrogen is high in energy, yet an engine that burns pure hydrogen produces almost no pollution. NASA has used liquid hydrogen since the 1970s to propel the space shuttle and other rockets into orbit. Hydrogen *fuel cells* power the shuttle's electrical systems, producing a clean byproduct—pure water, which the crew drinks. You can think of a fuel cell as a battery that is constantly replenished by adding fuel to it—it never loses its charge. A device has been designed to generate hydrogen to drive a cellular phone.

Fuel cells are a promising technology for use as a source of heat and electricity for buildings, and as an electrical power source for electric vehicles. Although these applications would ideally run off pure hydrogen, in the near future they are likely to be fueled with natural gas, methanol, or even gasoline. Reforming these fuels to create hydrogen will allow the use of much of our current energy infrastructure—gas stations, natural gas pipelines, etc.—while fuel cells are phased in.

In the future, hydrogen could also join electricity as an important *energy carrier*. An energy carrier stores, moves, and delivers energy in a usable form to consumers. Renewable energy sources, like the sun, can't produce energy all the time. The sun doesn't always shine. But hydrogen can store this energy until it is needed and can be transported to where it is needed.

Some experts think that hydrogen will form the basic energy infrastructure that will power future societies, replacing today's natural gas, oil, coal, and electricity infrastructures. They see a new *hydrogen economy* to replace our current energy economies, although that vision probably won't happen until far in the future.

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STATE OF ART DEVELOPMENT IN WIND ENERGY

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Synopsis

Most of the Electricity Boards and Private Utilities in India are against connecting the Power from Wind Energy Resources due to their bad experience of drawing reactive power from the grid and the fluctuations in voltage. Moreover, the Conventional Wind Mills using Induction generation use very high quantity of capacitors to reduce the intake of reactive power which causes very high amount of serge in the grid. In fact, use of capacitor banks should not be more than 30% of the generator rating which in real practice in India is touching even 60 to 70% causing frequent surges to the grid.

Enercon has developed a technology which uses Synchronous type generator and AC-DC-AC conversion of power and hence Enercon Wind Energy Converter can supply "Right quality of Power" through out the life of the machine.

Introduction of the Company in Brief

Enercon (India) Limited is a subsidiary of Enercon GmbH of Germany. Enercon has manufacturing facilities in Germany, Brazil, Turkey and at Daman in India.

Enercon (India) manufactures the Synchronous Generators right from winding stage, Blades using latest technology with FRP and Epoxy Rasin and also electronic controllers. Enercon (India) manufactures these machine for Indian market and also export them regularly back to Germany.

Enercon (India) has so far manufactured and installed 1310 no. of Wind Energy Converters totaling to 577 MW.

Enercon (India) undertakes complete turnkey projects for the Wind Energy right from selection of the site and operation and maintenance contract for the life time which is comprehensive type. Enercon have established Wind Farms in India in Tamilnadu, Karnataka, Maharashtra, Madhya Pradesh, Gujarat, Rajasthan and Andhra Pradesh.

Enercon GmbH has installed 7300 MW in 37 countries so far.

The Largest Wind Energy Converter

Enercon GmbH has manufactured and installed world's largest Wind Energy Converter of 4.5 MW capacity.

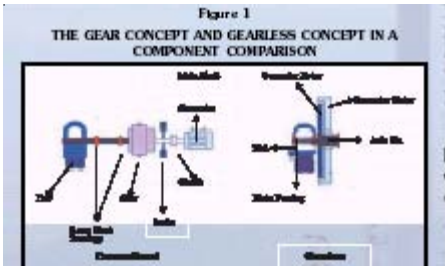

Fig-1

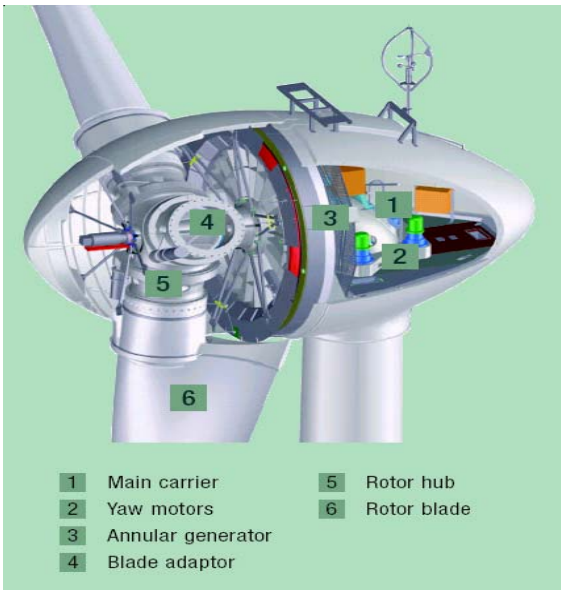

Fig. 2 Cut-View of 800 KW type E-48

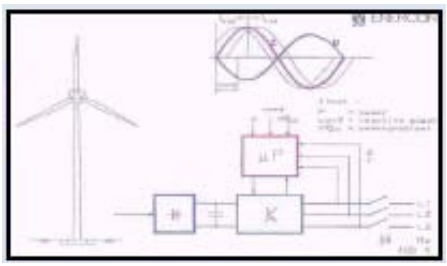

Fig. 3 Emercon Grid Management System

Emercon Grid Management System

It is clear from the diagram in Fig-3 that the AC Energy produced by the Synchronous type Generator is converted into DC and then again converted to AC. However, before it is fed to the Grid, a Grid Watching Card having Micro-Processor checks the parameters of the Grid to which this Power is to be fed and then it will automatically feed the power at matching frequency of the Grid and also at near Unity Power Factor or if the Grid Power Factor is already low, it will automatically feed Reactive Power to the Grid, which will help improving the power factor without using capacitors.

Feeding of Reactive Power to the Grid is regulated as per the Fig-3, which is managed by the Grid Watching Card and the current from the machine is fed to the Grid by adjusting an angle between the Voltage and Current, which ultimately manages the Power Factor.

Advantage of Converting the Power from DC to AC

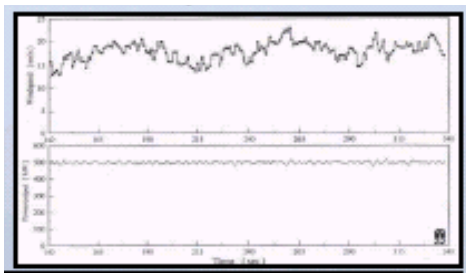

Fig. 4 WEC -48, Ronltime of Power Output to the Grid Samplegrate

It will be clear from Fig-4 that due to fluctuation in the Wind Speeds, the AC power generated at Generator Terminals has tremendous fluctuations which is harmful to the Grid. Therefore, it is necessary to convert it to DC and then again convert it to AC by which the fluctuations are almost eliminated.

Deleting the use of Capacitor for Power Factor Control

The Conventional Technology of Wind Mills uses Induction Generators and Capacitors due to which there are frequent surges in the Grid, Transformers, Generators etc. which are harmful and now a days looking to the penalty imposed by the Electricity Boards, most of the manufacturers are using higher rating of Capacitors which is against the IE rule and ultimately causes extreme high surges in the Grid.

Use of Synchronous Generators

Since Enercon uses Synchronous type Generators in place of Induction type and also due to use of Converters and Inverters, the power factor to the Grid is without such harmful surges and a very negligible amount of reactive power is consumed from the Grid. Another reason is that there is no motoring action in case of Synchronous Generators as it is necessary for Induction Generators and hence, the consumption of Reactive Power from the Grid is very negligible.

Capturing More Energy

1) Slower Speed of Generators & Blades

- The Conventional Machines have Generators with 1000 / 1500 RPM causing still higher speed of the Blade Tips.
- The Slower Speed of the Generators & Blades facilitate better control of pitching and **Optimum Capture of Energy.** Hence, Enercon Generator Speed is maximum 31.5 RPM.

2) Matching Characteristics of Wind

It is important to match the characteristics of Wind to get maximum output.

The most important characteristic is Variable Speed of Wind and frequent changes in the direction.

We are matching these characteristics by following ways :

a) Use of Inverter for Variable Speed of Generator

b) Use of Continuous Pitch Operation of Blades

c) Automatic yawing operation

Enercon's Revolutionary Design Blades

The conventional blades being used even today have Cp value of 40 to 42% which includes the NASA designs. Enercon for the first time have developed a new profile of blades which is fully tested and is proven to achieve 50 to 52% Cp value.

The 800 kW, E-48 machine of Enercon in India is also being supplied with this revolutionary blades which are manufactured in India at Daman.

Figure-4

U.S.P. of Enercon

- Gearless construction with synchronous type generator mounted on same shaft eliminating Gear box.
- Negligible drawing of Reactive Power from the grid since no motoring is required for Synchronous Generator.
- Generator *achieving rated output* at only 16 RPM for800 KW machine.
- Minimum wear and tear since the system eliminates mechanical brakes which are not needed due to low speed Generator.

- Variable Speed function ensuring optimum efficiency at all times having Speed range of 16 to 31.5 RPM.
- Near Unity Power factor at all times.
- Grid Supportive Features due to no voltage peaks at any time.
- Operating range of the WEC with voltage fluctuation Of ± 20%
- Lowest cut in wind speed of 3 m/sec.
- FRP with epoxy resin material ensures light weight and Eliminates warping of Blades.
- Incorporates Integrated lightning protection system, which includes blades also.
- Three independent Braking System.
- Steel tubular towers highly robust and flexible ensures more dependability for earthquake and cyclone prone zones.

WIND POWER GENERATION TECHNOLOGY

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Abstract

The paper deals with the technical details involved in the generation of power through wind technology. It discusses the factors responsible for generation of wind power and the limitations of the generator. While the emphasis is given on the various schemes used for production of electricity using wind power, the paper also gives insight into energy storage methods, safety precautions and site selection criteria.

Introduction

Energy is the primary and most universal measure of all kinds of work by human beings and nature. Everything that happens in the world is the expression of flow of energy in one of its forms Energy is an important input in all sectors of a country's economy. The standard of living is directly related to per capita energy consumption.

Due to rapid increase in the population and standard of living, we are faced with energy crisis. Conventional sources of energy are increasingly depleted. Hence, Non Conventional Energy Sources have emerged as potential source of energy in India and world at large.

Among the various non-conventional energy sources, wind energy is emerging as the potential major source of energy for growth.

Wind Energy

Wind results from air in motion due to pressure gradient that is caused by the solar energy irradiating the earth.

Wind Power

Wind possesses energy by virtue of its motion .Any device capable of slowing down the mass of moving air can extract part of the energy and convert into useful work.

Following factors control the output of wind energy converter : -

* The wind speed
* Cross-section of the wind swept by rotor
* Conversion efficiently of rotor
* Generator
* Transmission system

Theoretically it is possible to get 100% efficiency by halting and preventing the passage of

air through the rotor. However, a rotor is able to decelerate the air column only to one third of its free velocity.

A 100% efficient wind generator is able to convert maximum up to 60% of the available energy in wind into mechanical energy. In addition to this, losses incurred in the generator or pump decrease the overall efficiency of power generation to 35%.

Principle of Energy Conversion

Wind mills or turbines works on the principle of converting kinetic energy of the wind in to mechanical energy.

Power available from wind mill}= ½ ρA V^3

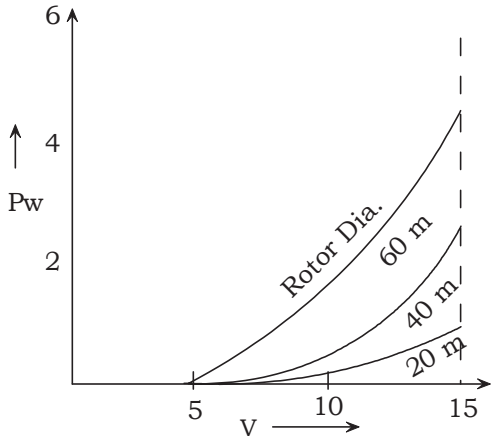
Where, ρ – air density = 1.225 Kg. / m^3 at sea level.(changes by 10-15% due to temperature and pressure variations)

A – area swept by windmill rotor = ΠD^2 sq-m. (D – diameter)

V – wind speed m/sec.

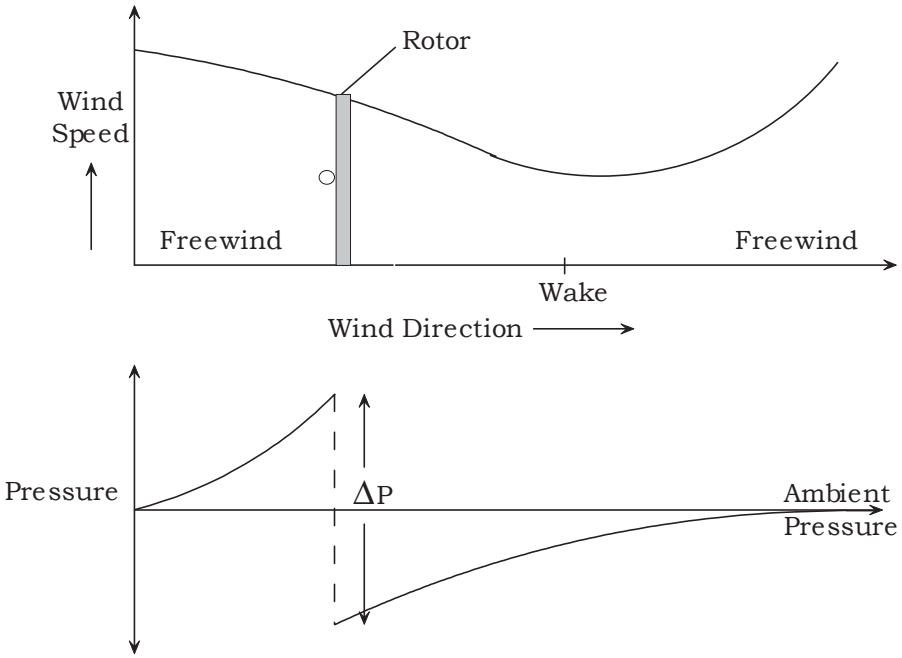
Air density, which linearly affects the power output at a given speed, is a function of altitude, temperature and barometric pressure. Variation in temperature and pressure can affect air density up to 10 % in either direction. Warm climate reduces air density.

This equation tells us that maximum power available depends on rotor diameter. The combined effects of wind speed and rotor diameter can be observed by the following graph



This graph indicates that wind machines should have large rotors and should be located in areas of high wind speeds.

Practically, wind turbines are able to convert only a fraction of available wind power into useful power. As the free wind stream passes through the rotor, it transfers some of its energy to the rotor and its speed decreases to a minimum in the rotor wake. After some distance from the rotor wind stream regains its speed from the surrounding air. We can also observe drop in pressure as the wind stream passes through the rotor. Finally air speed and pressure increases to ambient atmospheric condition. This is illustrated in the following graphs



Site Selection

Following factors are to be considered for selection of good site for wind power generation:-

- High annual wind speed.
- No tall obstructions for a radius of 3 Km.
- Open plain or open shore
- Top of a smooth, well rounded hill with gentle slopes
- Mountain gap which produces wind funneling.

Generating System

Wind - electric conversion system consists of the following components :-

1) Wind Turbine(WT)- Converts wind energy into rotational(mechanical) energy
2) Gear system and coupling (G/C)- It steps up the speed and transmits it to the generator rotor
3) Generator(G)- Converts rotational energy into electrical energy.

Types of generators used:-

For Small rating systems - P.M.type d.c. generators

Medium rating systems - P.M.type d.c. generators

Induction generators

Synchronous Generators

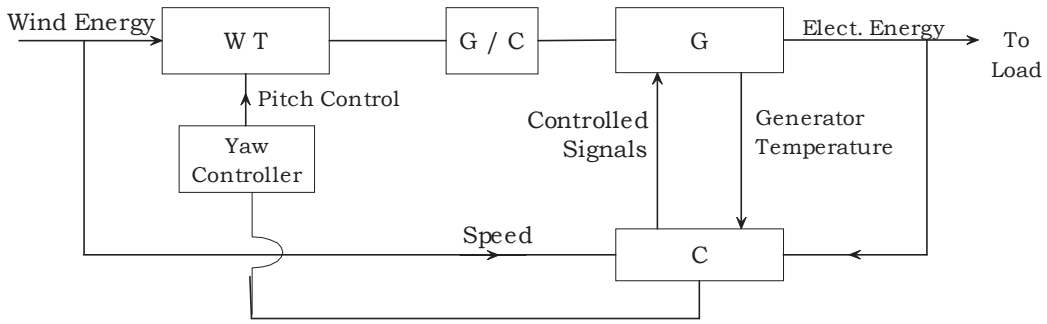
Large rating systems - Induction generators (3-phase)

Synchronous Generators (3 phase)

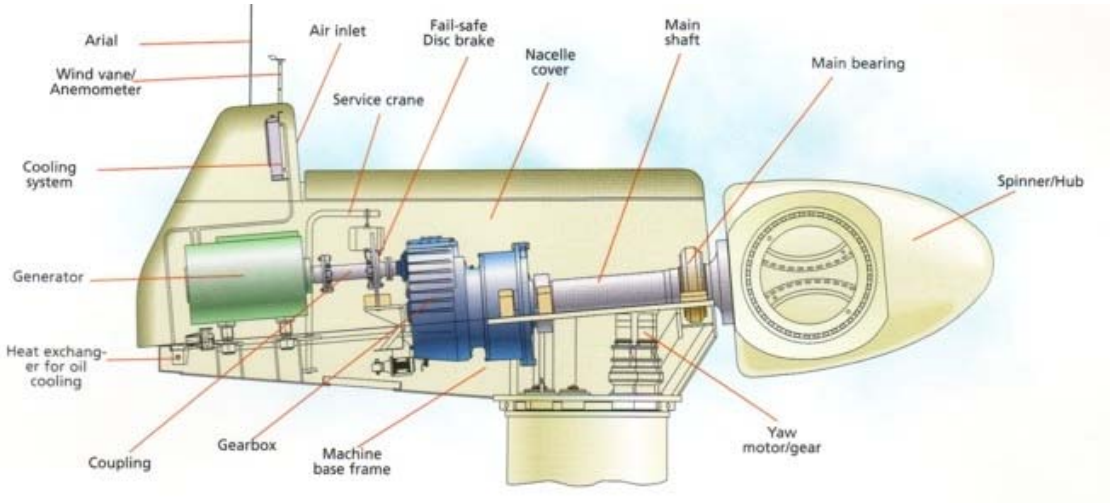
4) Controller(C)-Senses wind direction, wind speed generator output and temperature and initiates appropriate control signals to take control action.

5) Yaw motor gear- The area of the wind stream swept by the wind turbine is maximum when blades face into the wind. Alignment of the blade angle with respect to the wind direction to get maximum wind energy can be achieved with the help of yaw control that rotates wind turbine about the vertical axis.

In smaller wind turbines, yaw action is controlled by tail vane whereas, in larger turbines, it is operated by servomechanism.



Wind Electric conversion System



Cross-sectional View

Apart from the above components, protective schemes for excessive temperature rise of generator, against electrical faults and turbulent wind conditions are also provided in the system.

Practically, Wind power generating system ratings are divided into three groups:-

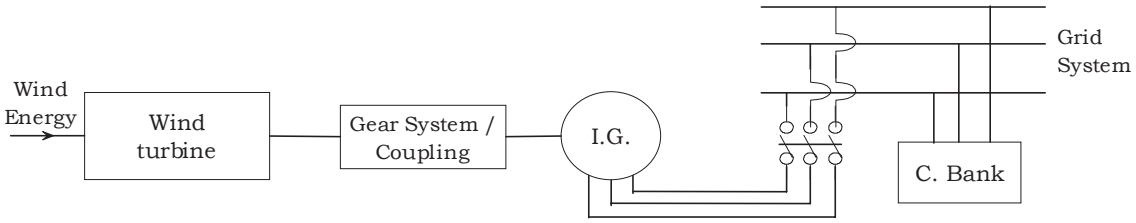
- Small up to 1KW
- Medium 1 KW to 50 KW
- Large 200KW to Megawatts

Schemes for Wind Power Generation

Based on the speed and frequency, generally following schemes are identified:

I. CSCFS (Constant Speed Constant Frequency Scheme):-

Constant speed drives are used for large generators that feed the generated power to the grid. Commonly synchronous generators or induction generators are used for power generation



If the stator of an induction machine is connected to the power grid and if the rotor is driven above Synchronous speed, Ns, the machine delivers a constant line frequency (f=PNs/120) power to the grid. The slip of the generators is between 0 and 0.05.The torque of the machine should not exceed max. torque to prevent 'run away'(speed continues to increase unchecked).

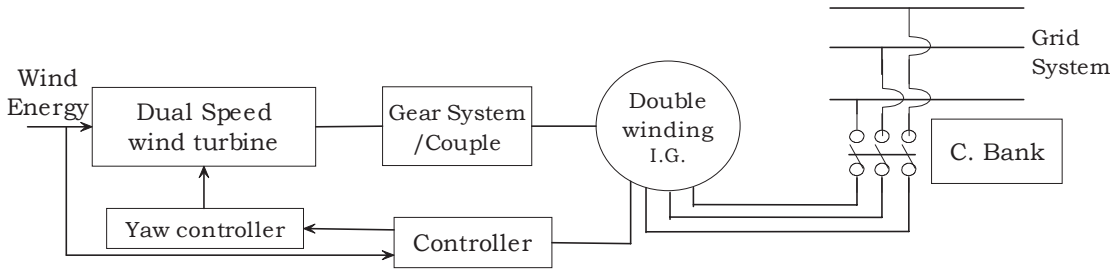
Compared to synchronous generator, Induction generators are preferred because they are simpler, economical, easier to operate, control and maintain and have no synchronization problem. However, Capacitors have to be used to avoid reactive volt ampere burden on the grid.

II. DSCFS (Dual Speed Constant Frequency Scheme):-

In this scheme a dual speed wind turbine is coupled to double winding Induction generator that is specially fabricated with 2 stator windings wound with different number of poles P1& P2 (P1 > P2).

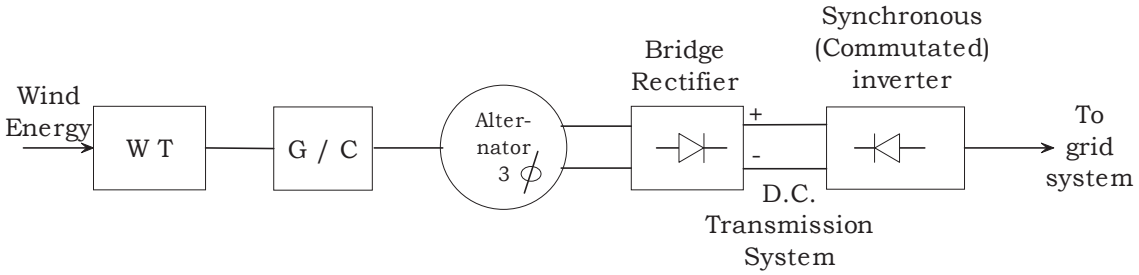
When wind speed is ***low***, winding with P1 poles gets connected and power is generated with grid frequency. Similarly, when wind speed is ***high***, winding with P2 poles gets connected and feed the power to grid at the same frequency.

It is Important to note that the difference in speed should be small. Reactive power required by the Induction Generator can be supplied by installing the Capacitor bank.



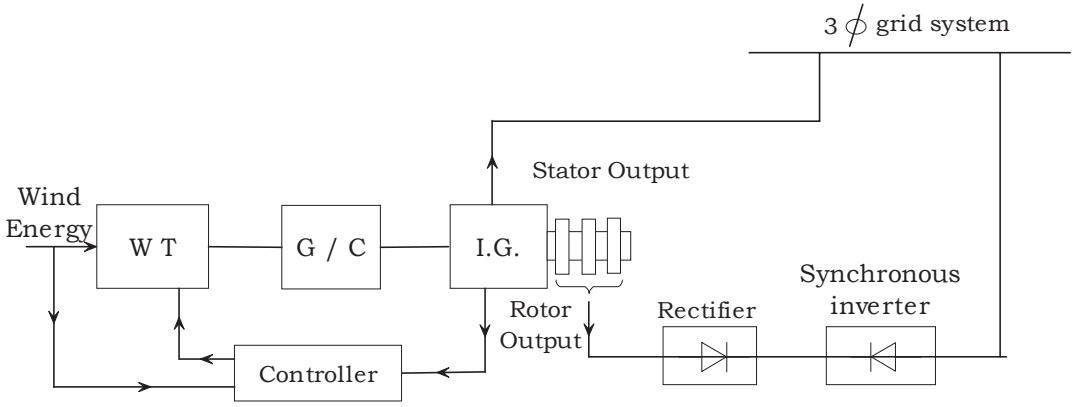
III. VSCFS (Variable speed constant frequency scheme)

In this scheme output of three phase alternator (synchronous generator) is rectified by bridge rectifier. The DC output is transmitted through DC transmission lines and then converted back to AC using synchronous inverters and fed to grid system.



This scheme, involving small wind generators is commonly used in autonomous applications such as street lighting. Due to variable speed operation, it yields higher power for both low and high wind speeds. Both horizontal axis and vertical axis turbines are suitable.

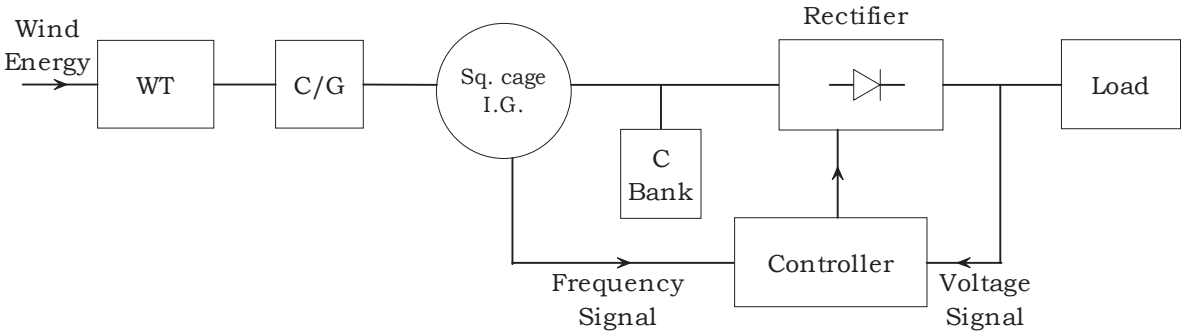
IV. Variable speed constant frequency with double output (VSCF with DO)



In this scheme, to increase the power generating capacity of the system, squirrel cage induction generators are replaced by slip ring Induction generator. Rotor power output at slip frequency is converted to line frequency power using rectifier. Output power is obtained both from stator and rotor. Rotor output power increases with increase in slip and speeds. Therefore, operating speed range is Ns to 2Ns i.e. slip ranging from 0 to 1.

V. (VSVFS) Variable speed variable frequency schemes

This scheme is suitable for loads that are frequency insensitive such as heating load.



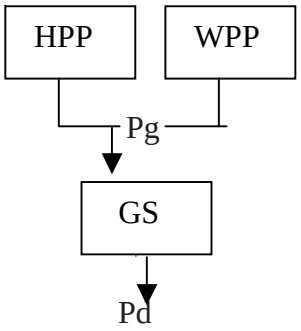
Depending upon the wind speed, squirrel cage Induction Generator generates power at variable frequency. Such generators are excited by Capacitor-bank. The magnitude and frequency of the generated emf depends upon the wind turbine speed, excitation capacitance and load impedance.

If load requires constant dc voltage, output of generators is converted into d.c. using chopper controlled rectifiers. Feedback system can be used to monitor and control to get desired performance.

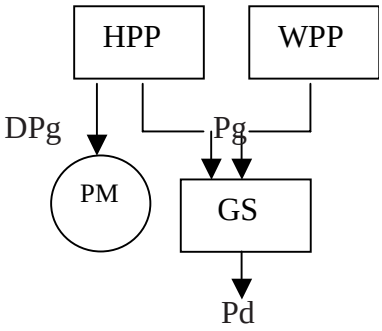
Energy Storage

Wind power turbines have operational limitations over very high and very low speeds. When the power generated exceeds the demand, excess energy can be stored to be used at other times.

* Excess energy can be conveniently stored in storage batteries in the form of chemical energy.
* Excess energy can also be stored in water power storage in the form of mechanical energy. Wind power plant (WPP) along with Hydroelectric power plant (HPP), when generated power (Pg) exceeds the power demand (Pd), helps to partly divert hydro power plant output to Pumping motor (PM) to pump water from an auxiliary reservoir at the bottom of the dam to main reservoir.

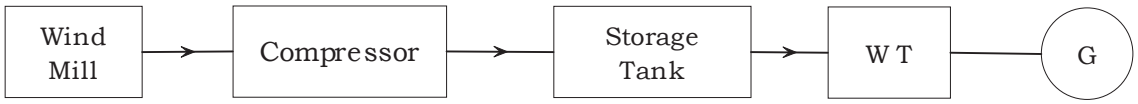


Pg = Pd



Pg > Pd

* Excess energy can also be stored in the form of compressed air.



When wind is not blowing, energy stored in compressed air could be used to drive wind turbine whose shaft would then drive a generator, thus supplying the needed power.

Generator Capacity

Wind Farms in India

S. No.	Location	Capacity
1	Mandavi (Gujarat)	1.15 MW
2	Tuticorin(Tamilnadu)	550 KW
3	Okha (Gujarat)	550KW
4	Puri (Orissa)	550 KW
5	Deogarh (Maharashtra)	550 KW

Safety Interlocks

1. Modern wind turbines are controlled by computers. If it shows any error in operational parameters, then wind turbine is stopped.
2. Emergency stop – During unfavourable conditions for wind turbines, it can be immediately stopped using emergency stop.
3. Wind velocity is measured and if gusts of wind are too strong or if the average speed is too high, wind turbine is stopped.
4. To prevent rotor from racing, two revolution counters are mounted on the shaft. If wind turbine speed exceeds 24 rpm, it activates the emergency stop system.

5. If the wind turbine speed exceeds 28 rpm, a parachute attached to the blade tip is pulled out and thereby speed of the wind turbine decreases.
6. The three blades and wind turbine cap are grounded through lightening rods to protect them from lightning.

Conclusion

The new mantra of the 21st century is sustainable development, which means that the local population should be able to absorb the development of a country or region. The people should be financially, mentally and physically able to support the improvement in the quality of their lives. We want the entire population to have access to uninterrupted supply of electricity. This puts a huge burden on the limited fossil fuel resources. The benefits of using wind power over other resources lies in its minimum operational cost.

Depending on field of applications, various schemes can be adopted to get optimum output. Various option of storage facility makes it versatile source of energy. Modern turbines are totally controlled by computers that are totally safe. Since wind is clean source of energy, the power conversion does not pose any environmental hazard.

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WIND POWER GENERATION BY WINDMILL

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Guided by : N.V. Vader

Introduction

An estimated of 1 to 3 percent of the energy from the Sun is converted into wind energy. This is about 50 to 100 times more energy than is converted into biomass by all the plants on earth through photosynthesis. Most of this wind energy can be found at high altitudes where continuous wind speeds of over 160 km/h (100 mph) are common. Eventually, the wind energy is converted through friction into diffuse heat all through the earth's surface and atmosphere.

While the exact kinetics of wind are extremely complicated and relatively little understood, the basics of its origins are relatively simple. The earth is not heated evenly by the sun. Not only do the poles receive less energy from the sun than the equator does, but dry land heats up (and cools down) more quickly than the seas do. This powers a global atmospheric convection system reaching from the earth's surface to the stratosphere which acts as a virtual ceiling. The change of seasons, change of day and night, the Coriolis effect, the irregular albedo (reflectivity) of land and water, humidity, and the friction of wind over different terrain are some of the many factors which complicate the flow of wind over the surface.

History

Windmills were first used to pump water and mill grain. The first wind generators were placed atop brick towers, or other buildings. Since early recorded history, people have been harnessing the energy of the wind. Wind energy propelled boats along the Nile River as early as 5000 B.C. By 200 B.C., simple windmills in China were pumping water, while vertical-axis windmills with woven reed sails were grinding grain in Persia and the Middle East.

Early in the twentieth century, windmills were commonly used across the Great Plains to pump water and to generate electricity.

By the 11th century, people in the Middle East were using windmills extensively for food production; returning merchants and crusaders carried this idea back to Europe. When settlers took this technology to the New World in the late 19th century, they began using windmills to pump water for farms and ranches, and later, to generate electricity for homes and industry. Industrialization, first in Europe and later in America, led to a gradual decline in the use of windmills. The steam engine replaced European water-pumping windmills.

By the 1930s they were mainly used to generate electricity on farms. The most famous make was the Jacobs Electric. Jacobs discovered and pioneered the modern three-blade, high-speed wind-turbine, with an integrated, low-speed, ungeared generator. In this

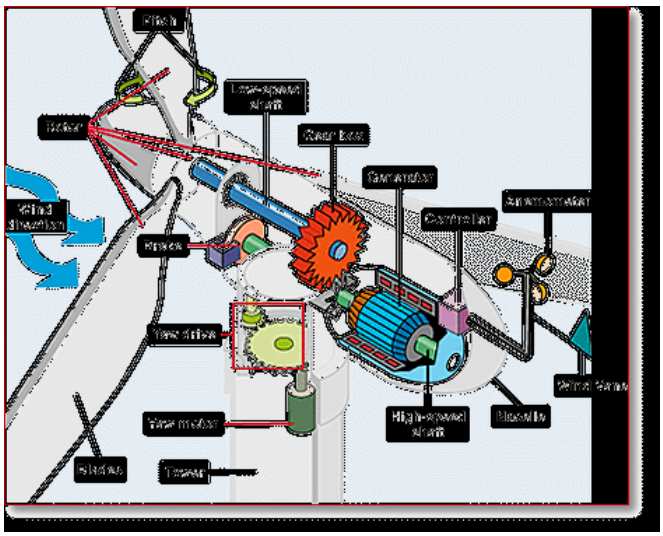
period, high tensile steel was cheap, and windmills were placed atop prefabricated open steel lattice towers. . In the 1930s, the Rural Electrification Administration's programmes brought inexpensive electric power to most rural areas in the United States. Commonly called wind turbines, these machines appeared in Denmark as early as 1890.The most famous application of the Jacobs wind-generator was to power the radio for the second polar year expedition to the south pole. Nearly thirty years later, during the IGY, explorers found the Jacobs windmill still turning, despite off-the-scale readings on a maximum-measuring wind-speed meter left as an experiment.

In the 1940s, the U.S. had a rural electrification project that killed the natural market for wind-generated power. The techniques were almost lost. . In the 1940s the largest wind turbine of the time began operating on a Vermont hilltop known as Grandpa's Knob. This turbine, rated at 1.25 megawatts in winds of about 30 mph, fed electric power to the local utility network for several months during World War II.

Solar cells were too expensive for small-scale electrical generation, so practical people turned to windmills. At first they built ad-hoc designs using wood and automobile parts. Most people discovered that a reliable wind generator is a moderately complex engineering project, well beyond the ability of most romantics.

Originally, wind generators were built right next to where their power was needed. With the availability of long distance electric power transmission , wind generators are now often on wind farms in windy locations and huge ones are being built offshore. Since they're a renewable means of generating electricity, they are being widely deployed, but their cost is often subsidised by governments, either directly or through renewable energy credits . Much depends on the cost of alternative sources of electricity.

Technology



1. Anemometer:- Measures the wind speed and transmits wind speed data to the controller.
2. Blades:- Most turbines have either two or three blades. Wind blowing over the blades causes the blades to "lift" and rotate.

4. Controller:- The controller starts up the machine at wind speeds of about 8 to 16 miles per hour (mph) and shuts off the machine at about 65 mph. Turbines cannot operate at wind speeds above about 65 mph because their generators could overheat.
5. Gear box:- Gears connect the low-speed shaft to the high-speed shaft and increase the rotational speeds from about 30 to 60 rotations per minute (rpm) to about 1200 to 1500 rpm, the rotational speed required by most generators to produce electricity. The gear box is a costly (and heavy) part of the wind turbine and engineers are exploring 'direct-drive' generators that operate at lower rotational speeds and don't need gear boxes.
6. Generator:- Usually an off-the-shelf induction generator that produces 60-cycle AC electricity.
7. High-speed shaft:- Drives the generator.

   Low-speed shaft:- The rotor turns the low-speed shaft at about 30 to 60 rotations per minute.
8. Nacelle:- The rotor attaches to the nacelle, which sits atop the tower and includes the gear box, low- and high-speed shafts, generator, controller, and brake. A cover protects the components inside the nacelle. Some nacelles are large enough for a technician to stand inside while working.
9. Pitch :- Blades are turned, or pitched, out of the wind to keep the rotor from turning in winds that are too high or too low to produce electricity.
10. Rotor :- The blades and the hub together are called the rotor.
11. Tower :- Towers are made from tubular steel (shown here) or steel lattice. Because wind speed increases with height, taller towers enable turbines to capture more energy and generate more electricity.
12. Wind direction :- This is an 'upwind' turbine, so-called because it operates facing into the wind. Other turbines are designed to run 'downwind', facing away from the wind.
13. Wind vane :- Measures wind direction and communicates with the yaw drive to orient the turbine properly with respect to the wind.
14. Yaw drive :- Upwind turbines face into the wind; the yaw drive is used to keep the rotor facing into the wind as the wind direction changes. Downwind turbines don't require a yaw drive, the wind blows the rotor downwind.
15. Yaw motor :- Powers the yaw drive

Site Selection

1. High annual average wind speed.
2. Availiability of wind curve at the proposed site.
3. Availiability of anemometry data.
4. Wind structure at the proposed site.
5. Attitude of the proposed site.
6. Terrain and it's aerodynamic.

7. Local ecology.
8. Distance to roads and railways.
9. Nature of ground.
10. Nearness of site to local centre\users.
11. Favourable land cost.

Limitations

1. Wind energy is available in dilute and fluctuating in nature.
2. Unlike water energy wind energy needs storage capacity because of irregularity.
3. Noisy operation:-Large unit can be heard many km away.
4. It has relatively high overall weight because they involve construction of high towers and include gearbox, hub and pitch changer, a generator coupling shaft.
5. Large areas are needed.
6. Present system is neither maintenance free not practically reliable.

Indian Scenerio

The year wise generation is as follows:

1991-92	287
1992-93	301
1993-94	324
1994-95	351
1995-96	380
1996-97	394
1997-98	420
1998-99	448
1999-00	480
2000-01	499.45
2001-02	515.27

Installed Capacity

The all India installed capacity of electric power generating stations under utilities was 104917.50 MW as on 31.3.2002 consisting of 26261.22 MW hydro, 74428.82 MW thermal and 2720 MW nuclear and 1507.46 MW wind.

Capacity

Country	Operating Wind Power Capacity (MW)
Germany	15,600.00
Spain	7,049.00
U.S.A	6,371.00
Denmark	3,121.00
India	2,169.00
Netherlands	1,002.00

Applications

1. Acid rain control (neutralization via aeration of dugouts, lakes, ponds).
2. Aeration, agitation (preventing freeze-over and oxygen depletion of lakes, ponds, dug outs).
3. Aqua culture maintenance.
4. Air compression.
5. Irrigation.
6. Drainage (featuring portable application).
7. Ventilation (barns, chicken coops, corn cribs, granaries).
8. Water Filtration.
9. Desalination (salt removal from water).
10. Sewage processing (including farm run-off waste control).
11. Domestic water pumping (mechanical or air operated).
12. Water or oil heating (resistance heating).
13. Washing (clothing, fiber, metal and gem stone prospecting).
14. Mining (portable ventilation, water pumping, washing, tumbling, polishing).
15. Fiber processing (hammer mills).
16. Boat propulsion (omni-directional, no tacking required).
17. Lawn and garden care (irrigation and drainage)
18. Hydroponics (automated plant maintenance)
19. Fountains (garden fountains, indoor fountains, all season)
20. Wind chimes

21. Wind operated puppets (Lawn ornaments, Window puppets)
22. Wind operated toys and whirligigs (indoor and outdoor)
23. Gem /stone polishing, tumbling
24. Sailboat bailing pumps, water pumps, toy boat propulsion
25. Ventilation (attics, sheds, garages, etc)
26. Bird bath fountains, (automated filling, filtration and aeration)
27. Garden decorative pond management (fountains, aeration and filtration)

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SOLAR PV POWER PLANT THE NEED OF THE DAY

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Abstract

It is worth noting that while man's large scale use of commercial energy has led to better quality of life, it has also created many problems. Perhaps the most serious of these is the harmful effect on the environment. Also it is now clear that the fossil fuel era of non-renewable resources is gradually coming to an end, oil will be first to be depleted, followed by natural gas and coal.

In India energy problem is very serious and main objective is now to find solution to match demand and supply of energy sources. Therefore the need for conserving energy and developing alternative energy is must. One of the promising options is solar energy and its uses in variety of thermal energy applications.

The study is focused on photovoltaic solar cells and its uses in day-to-day life. The main advantage is in its availability and clean source of energy with low operating cost. The main limitation lies in availability with time, dilute source of energy, with large initial cost. Collection and storage adds to the cost. However it is cheaper in comparison to conventional source of energy.

Key words: solar, PV

Iintroduction

Photovoltaic solar cells, which directly convert sunlight into electricity, are made up of semi conducing materials. The simplest PV cells-power are watches and calculators, while more complex systems can light houses and provide power to the electrical grid.

In the most common cell production process, very pure silicon is reduced to its molten form. Through a painstaking and time-consuming process, the silicon is reformed into a solid single crystal cylinder called an ingot. Extremely thin slices cut from the ingot are chemically treated to form PV cells. Wires attached to the –ve and +ve surfaces of the cell complete the electrical circuit. Direct current electricity flows through the circuit when the cell is exposed to light.

Photovoltaic

Solar cells operate according to what is called the photovoltaic effect (photo-light, voltaic-electricity). In the photovoltaic effect, bullets of sunlight-photons striking the surface of semiconductor material such as silicon, liberates electron from materials atom. Certain chemicals added to the materials composition help to establish a path of the freed electrons. This creates an electron current. The cells are wafer-thin circles or rectangles about 3 to 4 inches cross-section. The photovoltaic effect, a typical 10 sq.cm silicon cell produces about one watt of direct electricity.

Technologies

Crystalline silicon (c-si) is the leading commercial material for PV cells and is used in several forms- monocrystalline silicon, polycrystalline silicon, ribbon and sheet silicon, thin layer silicon.

Thin Film Technology

As the quantity of semiconductor material required for thin films is far smaller than for traditional PV cells, the cost of thin film manufacturing is far less than for crystalline silicon. In thin film technology normally amorphous silicon (a-si) is used as a semiconductor material which has no crystal structure.

High Efficiency Multifunction Devices.

Multifunction devices stack individual solar cells on top of each other to maximize the capture and conversion of solar energy. The top layer(junction) captures the highest –energy light and passes the rest on to be absorbed by the lower layers e.g. Ceallium arsenide can be allowed with the elements such as indium, phosphorus and aluminum to create semiconductors that respond to different energies of sunlight.

Although two junction cells have been built, most research is focusing on three junction and four junction devices, using materials such as germanium (Ge) to capture the lowest energy light in lowest layer.

Working Principle

If a piece of semiconductor material such as silicon is doped on one side by phosphorus becomes an n-type semiconductor. When other side of the same material is doped by boron becomes a p-type semiconductor. Such a piece of semiconductor with one side of the p-type and the other the n-type called p-n junction.

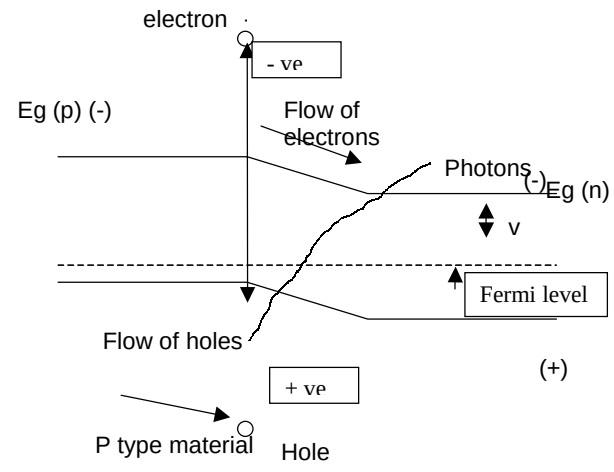


Fig 1 P-N junction

In this junction after the photons are absorbed, the free electrons of the n-side will tend to flow to the p side and holes of the p-side will tend to flow to the n-region to compensate for their

respective deficiencies. This diffusion will create an electric field from the n-region to the p-region.

If the electrical contacts are made with the two semiconductor materials and the contacts are connected through an external electrical conductor, the free electrons will flow from the n-type material through the conductor to the p-type material. Here the free electrons will enter the holes and become bound electrons; thus both free electrons and holes will be removed. The flow of electrons through the external conductor constitutes an electric current which will continue as long as more free electrons and holes are being formed by the solar radiation. This is the basis of the PV conversion; that is the conversion of solar energy into electrical energy. The combination of n-type and p-type semiconductors thus constitutes a PV cell or solar cell. All such cells generate direct current.

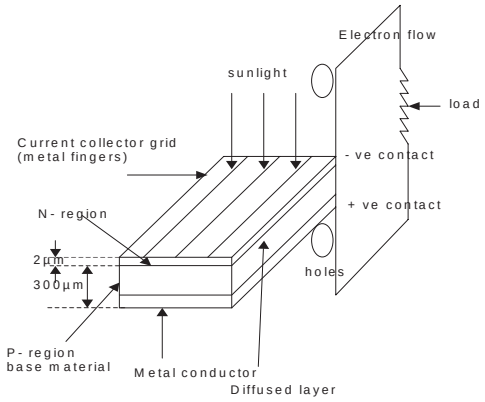
Fabrication of Solar Cell

A solar cell consists of:-

1. Semiconductor in which electron hole pairs are created by absorption of incident solar radiation.
2. Region containing a drift field for charge separation
3. Charge collecting front and back electrodes.

This p-n junction is usually obtained by putting p-type base material into a diffusion furnace containing a gaseous n-type dopant such as phosphorus and allowing the n-dopant to diffuse into surface about 0.2 μm. The junction is thus formed slightly below the planer surface of the cell and light impinges perpendicular to the junction. The positive and negative charges created by the absorption of the photons are thus encouraged to drift to the front and back of the solar cell. The back is completely covered by a metallic contact to remove the charges to the electric load. The collection of charges from the front of the cell is aided by a fine grid of narrow metallic fingers having surface coverage about 5% in order to allow as much light as possible to reach active junction area. An anti-reflective coating is applied on top of the cell. Fig. 2. Demonstrates how this p-n junction provides an electrical field that sweeps the electron in one direction and positive holes in the other.

If the junction is in thermodynamic equilibrium then the Fermi energy must be uniform

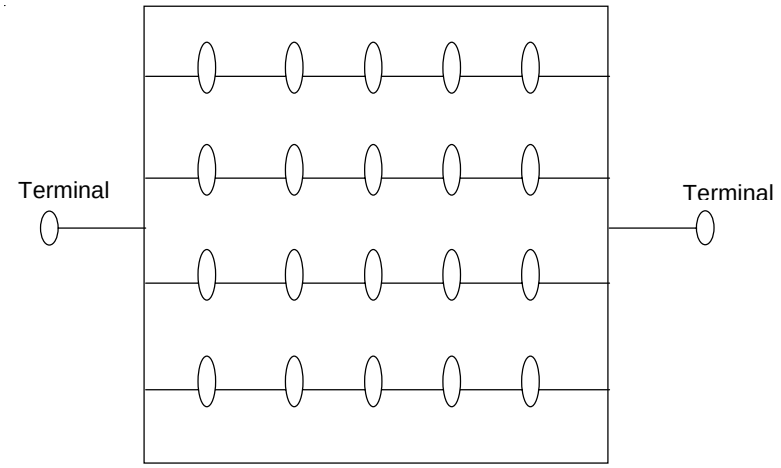


Schematic view of a typical cell figure 2

throughout. Since the Fermi level is near the top of the gap of an n-doped material and near the bottom of the p-doped side, an electric field must exist at junction providing the charge separation function of the cell. Important characteristic of the Fermi level is that , in thermodynamic equilibrium, it is always continuous across the contact between the two materials.

PV Module

Each of the individual solar cells will produce power at about 0.5V with current directly proportional to the cell's area. Cells may be connected in parallel to achieve the desired current and then stacked in series to achieve the desired voltage. For efficiency and practicality, multiple cells are wired together in series / parallel to produce the required voltage and powers which are placed in glass covered housing and hermetically sealed for protection against corrosion, moisture, pollution and weathering. Many such modules have been built in various power sizes.



Eg – 37 Wp,75 Wp

Efficiency

PV cells are made of semiconductor that generates electricity when they absorb light. Not all the solar radiation energy falling on a solar cell can be converted into electrical energy. A specific amount of energy is required to produce a free electron and hole in the semiconductor material. E.g. In silicon, the energy minimum is 1.1 μm or less which can be converted into alternating current, if desired. The limit of efficiency for silicon PV cell is estimated to be about 30%. Due to internal losses arising from minute amounts of impurities, from defects in the silicon crystal and from recombination of electrons and holes before they can be separated and external losses from reflection, most commercial silicon cells have average conversion efficiency out about 12%.

When the cells and system can be made to operate at higher efficiency levels, the cost of a system may be lower because fewer cells will be needed to generate the desired amount of electricity. In full sunlight the solar energy reaching the ground is 1000 w/sq.m.Efficiency is the power developed per unit area of array divided by the solar energy flux reaching the surface area.

Power Output

P = VI Power output in watts is equal to the product of voltage and current. The optimum

operating voltage of a PV cell is about 0.45 v at the normal temperatures, and the current is full sunlight may be taken to be 270 amp/sq.m. of exposed surface.

So the power is P = 0.45 X 270 = 120 watts per sq.m.

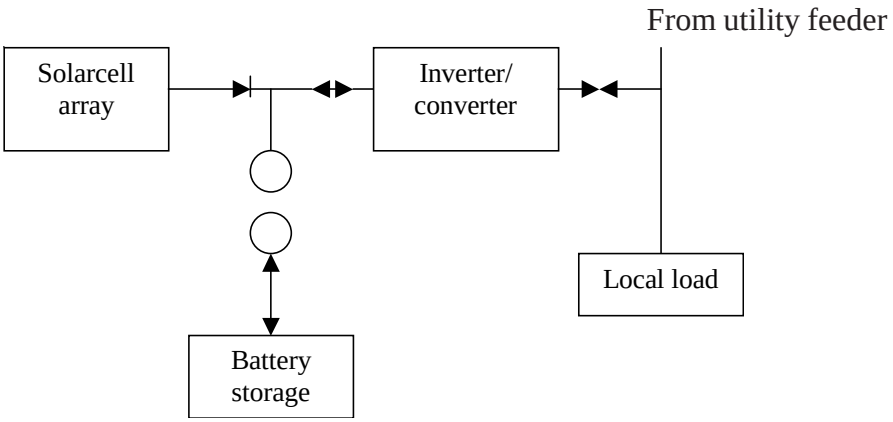
Cost Effectiveness

PV cells are expensive to produce but are cost competitive and readily available utility power because of high cost of semi conducting materials. Cost reduction can be achieved by reducing manufacturing cost. As manufacturing capacity increases cost of manufacturing decreases. PV system gives 20 year life span and probable payback period of about 10 years.Today costs are 180 Rs per peak watt.

Future Research

Presently, photovoltaic research is focused on manufacturing and applications. Within the area of manufacturing, both methods and materials are being explored. Scientists are investigating the use of multicrystal and noncrystal silicon in PV cells. Semiconductors materials other than silicon also are receiving attention. Manufacturing methods being researched include new ways of purifying silicon to solar grade better methods of slicing cell wafers from silicon ingots and more efficient production of cell material by casting into blocks, drawing it out into ribbons or sheets or depositing a thin film of material on an inert base.

A Basic Photovolatic System for Power Generation



Solar Cell Array

A combination of suitable modules constitutes an array large or small , which converts the isolation to useful electric power. PV arrays can produce as much direct current electricity as desired through the addition of more modules.

A Blocking Diode

It lets an array generated power flow only toward the battery or grid. Without a blocking diode the battery would discharge back through the solar array during times of no isolation.

Battery Storage

Solar PV system can produce an output only if sunlight is present. If it is required to be used during non sunshine hours, suitable storage batteries will be required in which solar generated electric energy may be stored. The commonly used lead acid batteries, in automobiles are probably the best available sources.

Invertor / Convertor

PV module or arrays produce direct current (DC) electricity. Because most appliances and equipments are designed to be powered by alternating current (AC), PV produced electricity must be converted. This is accomplished by an invertors. This converts DC current into AC current compatible with that sent over utility grids. It is clear that the PV system offers an option of DC power or AC power.

Grid Interconnected System

Residential PV systems will probably be connected to the utility grid as well as the home. In what way, excess power would be sent into the grid for credit during sunny periods, and power would be drawn from the utility at night and on cloudy days. In some cases, utilities allow net metering, which allows the owner to sell excess power back to utility.

Advantages

1 Absence of moving parts.
2. Modular in nature in which desired currents, voltage and power levels can be achieved by mere integration.
3. They consume no fuel to operate on solar energy.
4. Maintenance cost is low as they are easy to operate.
5. They do not create pollution.
6. They have long effective life.
7. They have high power to weight ratio.
8. They have wide power handling capabilities from microwatts to kilowatts or megawatts when modules are combined into large area arrays. Solar cells can be used in combination with power conducting circuits to feed power into utility grid.

Appications

1. Home lighting systems
2. Street and garden lighting system
3. Traffic control system
4. Railway signaling equipment
5. Battery charging eg. Mobile, telephones.

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ECONOMICS OF SOLAR WATER HEATING SYSTEM

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Abstract

The primary energy comes from non-renewable and fossil sources. These reserves are continuously diminishing with increase in consumption and will not exist for future generation. One of the options, is to make more extensive use of the renewable sources like sun, wind, biomass etc.

Solar energy is one of the main renewable energy sources. It is abundantly available in India and a free source of energy. Solar energy plays a very important role in providing requirement of electrical power for various utilities. In winter days, storage water heaters/ geysers / immersion water heaters or LPG are generally used by the 80% of medium class families in India, to heat the water. It is observed that the electricity consumption is increased due to conventional water heating system used by the people.

It is possible for medium class families in India, to replace conventional water heating system with solar water heating system, in spite of its high capital cost.

In this paper following points of solar water heating system have been discussed.

- Comparison of cost analysis of conventional water heating system with solar water heating system.
- Financing and Incentives available.
- Selection of solar water heating system.
- Suggestive measures.

Introduction

Energy has always been the key to the man's greatest goals and to his dreams of a better world. The stone age man started on the path to civilization, when he discovered the energy in fire and light and utilized the energy in his body to hunt for food and survival. Today, man has come a long, long way and discovered innumerable ways to make various forms of energy work for him. One of the major forms of energy is an electrical energy. We can't imagine today's world without electrical energy. Most of the electrical energy comes from non-renewable and fossil sources. These reserves are continuously diminishing with increase in consumption and will not exist for future generation.

Switching of the electrical gadgets is not a solution to the energy crises. The development of mankind depends in direct proportion to the amount of energy consumed and the gross national per capita income is dependent on the energy consumed by the nation. Hence, we have to switch on to the renewable energy sources for better development.

One of the most important and basic renewable energy sources is solar energy. Other renewable energy sources like, wind, bio-mass, geo-thermal, ocean thermal, ocean wave, ocean

tide find their origin in the sun. The solar energy is abundantly available, clean and cheap renewable energy.

Solar energy can be utilized by direct methods and indirect methods. (Wind, biomass, wave energy, ocean thermal etc.) The direct method means solar thermal conversion and solar photovoltaic conversion. In this paper we will deal with solar conversion method.

Solar Water Heating System (SWHS)

Solar water heaters provide hot water for domestic, commercial and industrial applications. The system collects the sun's energy (radiation) to heat the water directly or heat transfer fluid and indirectly transfer heat to water.

The solar water heating system consists of solar collectors, insulated storage tank and other accessories like piping and different controls. Depending upon the type of system, it also consists of a electric pump operated on solar photovoltaic cell. Basically two types of collectors are available in SWHS for domestic and commercial applications.

1. Flat plate collectors

Flat plate collector is an insulated weather proofed box containing a dark absorber plate under one or more transparent or translucent covers.

2. Evacuated tube collectors

Evacuated tube collector is made of double layer borosilicate glass tubes evacuated for providing insulation. The outer wall of the inner tube is coated with selective absorbing material, which helps in absorption of solar radiation, and transfers the heat to water.

Salient Features of SWHS

1. Delivers water at 60 to 80 ^{0}C (Round the clock and almost round the year)
2. Available in wide range from 100 LPD to 500 LPD to suit different applications.
3. Works on partially cloudy days and during winter.
4. No moving parts, hence maintenance free.
5. Less area requirement (100 LPD SWHS require approx. 2 Sq. meter area)
6. 100% safe and 100% environment friendly.
7. Long life (15 to 20 years)

Econmics of SWHS

The SWHS of 100 LPD to 300 LPD capacities are suited for domestic applications, according to number of persons in the family. 100 LPD system is suited for 1 to 3 people. The approximate cost for 100 LPD SWHS is Rs. 12000/-. The SWHS available in India gives a hot water at 60 to 80^{0} C. Considering the above data, the electrical energy consumption per year to heat the 100 Liter Water per day using electrical heater is as follows.

Output Energy (Energy received by water)	=	Mass x Specific heat x Rise in Temperature
	=	100 x 1 x (60-25)
	=	3500 kcal (1 kwh = 860 kcal)
	=	4.0 kwh
Assuming 80% efficiency of electrical water heater, the energy consumption	=	4.0 / 0.8
	=	5 kwh
The electrical consumption per year (Assuming 300 operating days)	=	300 x 5
	=	1500 kwh
Yearly saving in Rs. For domestic consumer, who uses less than 300 units per month, excluding other charges and taxes.	=	2.90 x 1500
	=	**4350/-**
Yearly saving in Rs. For domestic consumer, who uses more than 300 units per month, excluding other charges and	=	4.00 x 1500
	=	**6000/-**

Pay Back Period

The pay back period for the domestic consumer is from 2 to 3 year only. The pay back period goes on decreasing for high capacity system used by commercial consumers if electricity is replaced.

Fuel Saving

A 100 LPD SWHS can replace an electric geyser for residential use and save 1500 units of electricity annually.

Contribution to Peak Load Saving

The use of 1000 SWHS of 100 LPD each can contribute to a peak load saving of 1 MW.

Environmental Benifits

A 100 LPD SWHS can prevent emission of approx. 1.5 tones of carbon dioxide per year.

A case study by US department of energy shows the following readings.

The reduction in energy consumption per household is 1570 kwh.

The average annual emissions reduction per household is-

Carbon dioxide- 1392 kg.

Sulphur dioxide – 5 kg.

Nitrogen oxides – 4 kg.

Financing and Incentives Available Softloan

The soft loan scheme is available from Indian Renewable Energy Development Agency (IREDA), New Delhi, under MNES interest subsidy scheme. Under this scheme the soft loan are provided by banks and other financial institution for installation of SWHS of any capacity to any end user, (Individual, Institution, Non profit organization or commercial organization including hotels) for any applications. The rate of interest is only 5% per annum and loan repayment period is 5 years. The repayment starts at the 3 months after the release of funds to the consumer.

Promotional Incentives

The amount of Rs.300/- will also be made available by MNES to the bank as promotional incentives / business development charge for each loan distributed irrespective of the size of the system.

Additional Subsidy

In India some states offer subsidy on domestic as well as commercial SWHS.(eg. Karnataka State)

Maintenance Gurantee

Under IREDA soft loan / MNES subsidy interest scheme, solar thermal manufactures will be responsible for maintenance of the system of 5 years. Some of the manufactures are providing 10-year guarantee for solar collectors.

Suggestive Measures

1. **Public awareness programmes**

   Most of the population is not aware about SWHS, therefore, concerted efforts must be put by mass media like TV and newspaper about SWHS and benefit accrued.

2. **Provision of fund**

   Enough funds should be provided for the public awareness campaigning of SWHS.

3. **Provision of subsidy**

   The initial cost of SWHS is much more than conventional water heater being used for heating the water; therefore, it is difficult for the people for buying the SWHS. Therefore, suitable subsidy should be given for purchase of SWHS.

4. **Rebate on electricity bill**

   To motivate the people about maximum use of SWHS, enough rebate in the electricity bill should be provided by the supply utility to use of SWHS.

5. **Statutory provision for compulsory use of SWHS.**

   A statutory provision should be made in the building law / National Electrical Code / Electricity Act for compulsory use of SWHS in buildings such as hospitals, hostels etc.

There should be penal provision for prosecuting the building owner not observing this provision of the law.

Conclusion

Though the initial investment for a SWHS is high as compared to electrical heating system but save the money and energy for many years. Solar energy means a fossil fuel saving, emission free environment, contribution to energy conservation, better economy and modern life style with clean and cheap renewable energy.

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APPLICATIONS OF SOLAR POWER GENERATING SYSTEMS IN INDUSTRY

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India is one of the fortunate countries to have abundant resources of renewable energy in the form of sunlight. We are blessed with 320 days of bright sunshine which can be harnessed to generate electricity using Solar Photo Voltaic modules and for heating of the medium using Solar Collectors.

India's energy demand is expected to rise by 9% annually, one amongst the highest in the world. At 4-7 KWh/m2 Solar insolation we receive energy equivalent to 5000 trillion KWh/year. Potential in terms generation of energy with respect to area is almost 20MW/ sq.Km and we are harnessing only 0.8 sq.Km which leaves lot of space to be explored in future.

Solar Energy market is growing at the rate of 30% year on year in India which is helping us to bridge the gap between demand and supply. This growth in our country is one of the fastest next to few countries like Japan and Germany where government initiative for grid feed systems have boosted the demand.

Use of Solar Energy in India has not only restricted to domestic water heating systems and lighting systems but they have gone beyond that and catering to many niche and critical applications in various Industries like Oil and Gas, Railways, Telecom, Highway Furniture and Eco friendly Green buildings. Over a period of time, growth in these sectors is primarily fueled by reliable and stable technology, availability at remote places at a very low maintenance and cost effective in many niche applications.

Oil and Gas is one of the booming sectors worldwide and Solar Photo Voltaic technology finds many applications in this sector. The applications range from powering loads like Telemetry / SCADA, Gas Detection systems, Emergency lighting systems and Navigational Aids of unmanned offshore platforms of Oil exploring companies. Typically these offshore platforms are 100-150 Kms away from shore deep inside the sea and Solar photovoltaic modules becomes only reliable source of power at such locations. Commercially also it becomes more viable to run these electrical loads with solar rather laying submarine power cables or run and maintain DG sets at such remote locations.

India is in news recently for cross country pipelines carrying various petroleum products from different places. The existing grid of these pipelines operated by various oil companies in India is more than 5000 kms. To maintain the pressure of the pipeline and serviceability of pipeline, various booster stations and compressor stations are set up across the pipeline at every 100 km. Availability of Grid power at these stations to operate control valves for opening and closure of pipelines may be or may not be available. The station where Grid has not reached in the vicinity powering of the electrical and communication equipments is done by Solar Photo voltaic.

Unmanned Offshore Platforms

To maintain pipe line in healthy condition and delay degradation, artificial charge is induced through equipment called as Cathodic Protection Unit at almost every 80 Km of pipeline, again the places where grid is not available in vicinity the energy requirement of this Cathodic protection units and small lighting loads is taken care by Solar Photovoltaic. Now a days many of the utilities are running on gas fuel and accurate metering of the gas to the customer by utility service provider is of equal important as that of transportation. This custody transfer metering at the point of the customer is done using field mounted Mass flow meters. Due to remoteness of the location and very low power requirement of Mass flow meters they are ideally powered by Solar Photovoltaic.

Within any country, Railway is the fastest growing sector for use of Solar photovoltaic. Due to its vast network / reach, reliable and low power requirement Solar technology is becoming natural partner to solve their power problems. The popular applications where Solar Photo voltaic modules are used in manned as well as unmanned Level crossing gates, UHF / UHF charging sets, Integrated Power supply, Signaling equipments and even way side yards and railway stations.

Solar Module at Level Crossing Gates

Powering of lamp posts, flashers, Cabin lighting and motors for automated opening and closure of the gates is done by Solar Photovoltaic panels at Level crossing gates. Microwave repeaters stations have been replaced by UHF / VHF technology to establish communication links within different station. The charging of VHF and UHF sets is now a days popularly done by Solar Photovoltaic modules. Integrated power supply is a huge Battery Bank with various DC voltage tapings to feed energy needs of various signaling as well as other equipments in station. Conventionally, these IPS sets are used to be charged by grid power / DG sets but power cuts and sharp rise in Diesel prices with increased confidence on Solar Photo voltaic technology has led to the use of Solar Panels charging this battery bank. Some of the way side yards or even way side stations used for shunting various trains which do not fall on main lines have been illuminated by Solar Power generating systems.

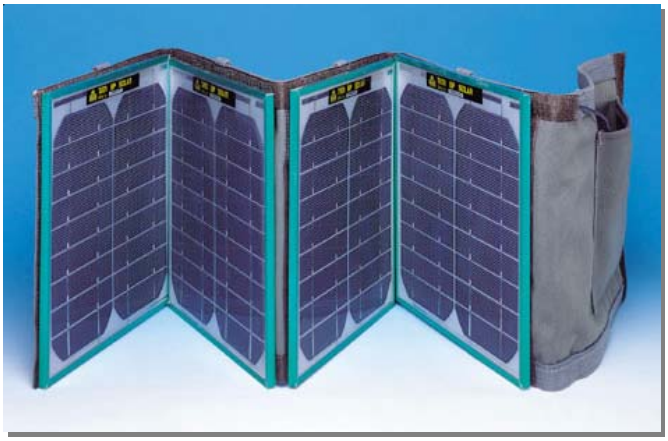
Communication has seen a sea change in India in last ten years and shall see it more aggressively developed in coming years ahead. Low power requirement of Communication equipments and Government of India's commitment to take communication to last mile has seen tremendous boost in use of Solar Power Generating equipments in this sector. The popular applications in this sector are powering rural telecom exchanges, CDMA repeaters as well as base stations, Handsets of Fixed wireless terminals, GSM towers, Rural telephony and Cell on wheel.

VSAT Equipments powered by Solar

All the communication equipments require reliable source of power, availability in rural areas and generating DC energy hence solar panels becomes natural choice for such applications. There are many rural telephone exchanges varying from 132 to 256 lines either running independently on solar or in hybrid mode of Grid and Solar where Solar Modules gives back up during power cuts. Similar is the case with BTS (base transmitting stations) and Repeater towers for CDMA technology. High way coverage is becoming part of competitive strategy for various GSM service providers and to power GSM repeaters at various odd locations on the highway Solar has come to help of these operators. Making temporarily coverage available at various non reachable locations by GSM operators is catching up in India especially during visit of politicians in remote places or to test the market potential of the area before actually launching service in the area. This concept is

bought into reality by operators by mounting GSM tower which is foldable on Truck which can be moved and made available where ever coverage is required popularly called as 'Cell on Wheel'

Defence is also looking very seriously towards using Solar panels in various applications mainly for communication and illumination. Foldable Solar panels are popularly used by Jawans which can be carried on the back and used in the field to power communication equipment. Defence is also looking towards illuminating border area with standalone Solar street lighting systems decentralizing source of power and avoiding possibility of sabotage by enemies. Wire fencing project is pursued by GOI very aggressively. Inducing current on the fence as well as powering ground sensors and motion detectors is done by solar photovoltaic modules.



Foldable Solar Module

Last but not the least, buildings, bridges, highways are getting constructed across the country in mega way. This has also facilitated use of safety equipments on Highways like Solar powered road studs, dividers, flashers, traffic junctions, medical help centers etc which are using Solar panels for energy needs rather than conventional power sources. Awareness among corporate towards cleaner environment, greener buildings has resulted in usage of Solar power in various commercial buildings. Improvement in Solar Photovoltaic technology has also made it possible to use these modules as a part of building called as 'Building Integrated Photovoltaic Modules'. These modules replace conventional glass material in façade, sun breakers, pergola, sky lighting and sky domes.

As per increasing demand various manufacturers of Solar photo voltaic modules are gearing up for expanding production facilities and increasing support centers to increase penetration of Solar technology length and breadth of country.

WIND ENERGY AND SOLAR ENERGY AS ALTERNATE ENERGY SOURCES WITH PARTICULAR REFERENCE TO INDIA

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Abstract

Wind energy is the kinetic energy associated with the movement of atmospheric air and this energy is converted to more useful forms of power using wind energy systems. It has been used for hundreds of years for sailing, grinding grain and it is being used to generate electric power. Windmills for water pumping have been installed in many countries particularly in the rural areas. The power generation projects contribute to the socio-economic development of the country.

India is now recognized as a leading country in the world in the development and utilization of renewable energy, in general, and in the development of wind power, in particular. Along with the growth in the Indian economy energy consumption is also increasing to meet the growing demands of the industries. Power generation from renewable energy sources has assumed significance in the context of environmental hazards posed by the excessive use of fossil fuels. Exploiting an alternate source of energy is the need of the day in view of the increased power demand and depletion of conventional energy resources such as fossil fuel. Also, wind energy generation will save valuable foreign exchange, which otherwise is being used for importing oil for power generation by conventional resources.

Another type of non-conventional energy that can be made available is solar energy. Solar heat can also be used to generate electricity. Solar energy has applications in many devices that convert solar energy directly into electricity Solar thermal energy is being used in India for heating water for both industrial and domestic purposes. In this presentation an attempt has been made to project and discuss the current scenario prevailing in our country regarding the use of these two types of energy.

Introduction

Windmill is an old invention and new application. For long time energy is being harnessed from wind to sail ships, grind grains and pump water. Wind power is the world's fastest growing energy resources growing at the rate of 27% per year. The sale of wind turbines in the year 2000 was to the tune of 4 billion dollars. In 2000, wind turbines produced almost 18000 megawatts of electricity worldwide and that is enough to meet the needs of 5.5 million homes. If the current growth is maintained it could produce about 10% of the world electricity needs by 2020.

Wind can be used to do work. The kinetic energy of the wind can be changed into other forms of energy, either mechanical energy or electrical energy. The wind energy conversion technology functions in the following way. The wind while passing the windmill, converts its velocity with the help of windmill blades into mechanical energy and the mechanical energy is converted into electric power by means of a generator.

For a wind turbine to work efficiently, wind speeds usually must be above 12 to 14 miles per hour to turn the turbines fast enough to generate electricity. The turbines usually produce about 50 to 300 kilowatts of electricity each. Once electricity is made by the turbine, the electricity from the

entire wind farm is collected together and sent through a transformer. There the voltage is increased to send it long distances over high power lines.

Wind power is known as 'Green Power', because of its technical and commercial viability and its environment-friendly nature. The special features of wind energy that makes it attractive are zero cost fuels, low gestation period, quicker benefits and usefulness for sustainable economic development.

Present Scenario Of Wind Energy In India

With an installed capacity of 2,483 MW as on March 31, 2004, India is now the fifth largest wind power producing nation in the world after Germany, USA, Spain and Denmark. Today, India has earned recognition as a new Wind Super Power.

The capital cost of wind energy projects in the country ranges from Rs. 4 crore to Rs. 4.5 crore per MW. The cost of power generation is estimated to be Rs. 2 to Rs. 2.50 per KWh, depending on the site. The cost per unit of power comes down to 50 KWh, five years after the project commissioning due to the cost of fuel being nil.

Thereafter, for the next 15 years, it would stay at this level, as the only recurring cost would be on the operations and maintenance of the plant. Therefore, wind harvested power is both cheaper and reliable than other conventional sources of power.

Need for the use of energy through solar, wind and biomass sources in remote areas is increasing and will put the nation at the forefront of renewable power used; with the government recently proposing renewable energy standard for the nation.

A press release on the Web site for the Press Information Bureau (PIB) in New Delhi, outlines the renewable resources that are currently utilized in India, and the Government's Common Minimum Program to establish enough renewable energy sources to electrify all Indian villages by 2010. Under the program, an additional 4,000 MW of power from renewable sources would be added to the nation's current power generation by 2007, and the government has set a goal of elevating the share of renewable energy sources to 10% by 2012.

Currently, according to the Bureau, renewable energy contributes about 5,000 MW of the nation's power needs. That is only 4.5 percent of the total installed generating capacity from all available power sources in India Wind power alone accounts for 2,483 MW, which makes the nation's wind energy program the fifth largest in the world. The features of wind energy that makes it attractive are zero fuel costs, and quicker benefits and usefulness for sustainable economic development. Gross wind energy potential in the country is estimated at 45,000 MW, and the states with high wind power potential are Tamil Nadu, Maharashtra, Gujarat, Andhra Pradesh, Karnataka, Kerala, Rajasthan and Madhya Pradesh.

The development of infrastructure facilities, will expedite the process of economic development. Energy is the most crucial input for power generation projects and this will certainly contribute to the socio-economic development of the country. Even after rapid industrialization, India is still dependent on agriculture, which is the backbone of Indian economy. To increase the agriculture production irrigation facilities, for which electricity is needed, have to be installed.

Rural electrification is very essential for the social development. Energy generation by wind reduces the generation cost and will help in balancing the cost of energy.

Wind energy is pollution-free as wind fans have potential to reduce CO2 emissions. Wind energy is inexhaustible, environment-friendly, emits no pollutant? or waste heat and needs no cooling water.

India is one of the few countries in the world that has made significant attempts to harness these indigenous energy sources.

Wind power potential of the country is estimated to the tune of 20000 MW. By the end of 20th century energy production through non-conventional energy sources is about 6000 MW through biomass, followed by 5000 MW from wind energy and 2000 MW from solar energy. Of all these sources, wind power is found to be most cost effective and economically viable. In collaboration with Pioneer Asia Wind Turbines, a division of Pioneer Asia Industries, Chennai, is offering 850 kw wind turbines in India. An independent wind farm developing in India is also proving to be successful with the achievements of Chennai-based Indio Wind Energy Ltd.

A special mention has to be made about, Muppandal in Tamil Nadu, which has the highest number of wind farms in Asia and the third highest in the world. Its highest capacity utilization of 42% has been achieved in a commercial project followed by Jogimattic in Kamataka. The industry average is 20%.

Based on the capabilities the ministry of non-conventional energy sources, it is planned to get an additional 15,000-MW wind power capacity during the 10th Five Year Plan. Faster growth of wind power generation in the country is necessary to dose in the gap between the real and potential, as envisaged by wind industry and environmentalists.

Gujarat is one of the many potential states in India for development of wind power projects. There are 18 wind-monitoring stations in operation and 12 sites have been identified with annual mean wind speed of 18 KMPH (Kilometer per hour) and above. Many companies are engaged in the field of manufacture and installation of Wind Turbine Generators. NEPC MICON Ltd, a Chennai-based company is the pioneer and leader in India for wind energy technology. The company has created wind farm of 178 MW with 711 Wind Turbine Generators and has created Asia's largest wind farm Another company, which is harnessing the wind for power is Windia Power Ltd, a joint venture company promoted by Weizmann Ltd. and Ned Wind Rhenen of Netherlands. They mainly manufacture and market Turbine Generators (WTGs) in India.

Some of the world's most prominent names in wind power industry like NEG, Micon, Vestas, Enercon, Ecotechia, GE wind etc. are also in India with fully owned subsidiaries or as joint ventures with Indian partners.

Here special mention has to be made of the Project Pawanshakti (means wind power) in Gujarat. Pawanshakti is the joint venture of Indian initiative and expertise with Danish technical and financial assistance. With the help of Danish International Development Agency (DANIDA), Department of Non-conventional Energy Sources, Ministry of Energy, Government of India (DNES) and Gujarat Electricity Board, the Gujarat Energy Development Agency has executed the project in a record time of eighteen months. It is situated in Lamba village, 50 km north of Porbandar on

the Saurashtra coast in Gujarat State. Project Pawanshakti with its sophisticated technology can easily provide power to irrigate 10000 hectares of land. The project generates 20 million units of electrical energy every year.

A notable feature of the Indian programme has been the interest among private investors/ developers in setting up of commercial wind power projects. The gross potential is 45,000 MW (source MNES) and a total of about 1869 MW of commercial projects have been established until March 2003. About 8.8 billion units of electricity have been fed to various State grids from wind power projects.

The breakup of projects implemented in prominent wind potential states is given in the Table

WIND POWER INSTALLED CAPACITY IN INDIA (MW)

State	Gross Potential	Total capacity till 30.09.2004	Technical Potential
Andhra Pradesh	8275	101.3	1750
Gujarat	9675	218.05	1780
Karnataka	6620	274.2	1120
Kerala	875	2	605
Madhya Pradesh	5500	26.35	825
Maharashtra	3650	411.15	3020
Rajasthan	5400	212	895
Tamil Nadu	3050	1683.6	1750
West Bengal	450	1.1	450
Others	2990	3.1	-
Total	**45195**	**2884.75**	**12875**

SOLAR ENERGY

Introduction

Most of the all-renewable energy comes directly or indirectly from the sun. The three man types of energy system comes from solar energy can be classified into passive, active and photovoltaic. Sun differentially heats the atmosphere, causing winds, evaporates water and recycles it as rain, which lets our rivers flow and thus hydropower and wind power is also derived from sun. Potentially sun is the most abundant source of energy and even if a small portion of this energy were harnessed, it could solve many of our current energy requirement problems. In order to harness this energy large power plants are required, which are capital-intensive investment.

Passive solar heating is most cost-effective way of warming buildings. Houses heated by passive solar energy have energy-efficient windows that face south, so they absorb as much heat as possible from sun. Modern passive solar design stresses well-insulated buildings to keep heat in, when it is cold outside and keep the interior cool when it is hot outside. Passive solar strategies include the installation of large south facing windows, which will allow incoming sunlight.

A building's energy consumption can also be reduced by utilizing active solar techniques. Active solar heating systems have heat-collecting boxes, which absorb solar radiation and converted into heat that is carried away from the box by water flowing through pipes or by air circulated by a fan. The heat is used to warm an insulated storage tank of water and the air or water is then returned to the collector. Solar heat can also be used to generate electricity.

Solar cells or photovoltaic are devices that convert solar energy directly into electricity using semiconductor technology. This technology involves the use of various silicon substances. A solar cell consists of thin wafers of semiconductors that give out electrons when struck by light energy. The electrons flow out of the wafers as electric current. A solar cell can be used as a battery charger that works merely by exposing it to light. The potential lies in the application of photovoltaic to power homes, factories and other commercial activities. They are in use for telecommunication and signaling devices in space application such as satellites and manned space missions. They are also used in providing power to small villages.

Present Scenario Of Solar Energy Program In India

India is blessed with abundance of sunlight, water and biomass. To accelerate the momentum of development and large-scale utilization of renewable energy sources, the Indian Renewable Energy Development Agency Limited (IREDA) was incorporated in March 1987 under the Ministry of Non-Conventional Energy Sources (MNES), Government of India.

By 2010, IREDA hopes to add about 3000 MW of power generation capacity through renewable energy projects it funds. More and more possibilities are being explored in environment friendly energy fields.

IREDA estimates a potential of 5,000 trillion kwh per year of the solar thermal energy.

3 million square meters of solar thermal systems have been installed providing 15 million liters per day of hot water. In addition, there are 372,293 solar cookers.

The public sector units CEL and BHEL (Bharat Heavy Electrical Ltd) are the major manufacturers of solar cells in India.

In the private sector, RESPV and TATA-BP Solar (India) are the major players. In addition, Pentafour Solec Technology Ltd is a new and promising entrant in the field, setting up a solar cells manufacturing line of 3 MW per annum. Production efficiencies of 13 percent are being obtained for cells manufactured in India for single crystal silicon.

The demand in India of single crystal PV modules in 1994 was 5.6 MW.

The Indian Department of Telecommunications still forms 70 percent of the domestic market. There are also 954 PV community lights/TV and community facilities; 85,000 PV domestic lighting units/Lanterns; 32,872 PV street lights; and 1,373 PV water pumps

India receives a good level of solar radiation, the daily incidence ranging from 4 to7 kWh/m^2 depending on location. Solar thermal and solar photovoltaic technologies are both encompassed by the Solar Energy Programme that is being implemented by the MNES. The Programme, regarded as one of the largest in the world, plans to utilize India's estimated solar

power potential of 20 MW/km^2 and 35 MW/km^2 solar thermal. The country has also developed a substantial manufacturing capability, becoming a lead producer in the developing world.

The principal objective of the Solar Thermal Programme is the market development and commercialization of solar water heaters, solar cookers etc.

Solar water heating has been applied in a wide variety of circumstances from individual residences to hotels to industrial processes.

The MNES has been promoting the sales of box solar cookers since the early 1980's. In March 1999 the world's largest Solar Steam Cooking System was installed at Mount Abu, Rajasthan. It is a hybrid system with back-up oil-fired boilers and is designed to prepare food for 10 000 people.

There is also a separate Solar Buildings Programme aimed at creating an awareness of the potential for solar-efficient buildings. The passive solar design concept is a climate-responsive architectural practice that is now being researched developed and implemented throughout the country.

A Solar PV Programme has been developed by the MNES for the past two decades, aimed particularly at rural and remote areas.

The MNES has instituted a plan for establishing solar PV power generation of 1 MW for use in specialized applications, voltage support at rural sub-stations and peak shaving in urban centers. At the present time 15 grid-interactive solar PV power projects have been installed in seven states and further 10 are under construction.

Solar water heaters (SWHs) have proved the most popular so far. A conservative estimate of solar water heating systems installed in the country is over 475000 sq. meters of the conventional flat plate collectors. Solar water heaters are cost competitive in most applications when you account for the total energy costs over the life of the system.

Solar photovoltaic (PV) for decentralized power supply are fast becoming popular in rural and remote areas. Today, solar PV systems are at work converting the radiation of sun directly to electricity. PV generated power has three main advantages over all other types of remote power generation- free inexhaustible power, simplicity and low maintenance. PV power is practical and extremely handy where access to conventional electric lines is difficult and costly, and for low and portable power needs.

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TIDAL ENERGY - LATEST DEVELOPMENT

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Abstract

Tidal energy is one of the best renewable energy in the world. Tidal energy power systems are expected to be very competitive with other conventional energy sources, and excellent cost advantages arise from there being no pollution or environmental expenses. There are two new kinds of devices to harness the energy of tidal currents (AKA 'tidal streams') and generate renewable, pollution-free electricity. These new devices may be distinguished as Vertical-axis and Horizontal axis models, determined by the orientation of a subsea, rotating shaft that turns a gearbox linked to a turbine with the help of large, slow-moving rotor blades. While horizontal-axis turbine prototypes are now being tested in northern Europe (the UK and Norway) a vertical-axis turbine has already been successfully tested in Canada. Tidal current or tidal stream technologies are capable of exploiting and generating renewable energy in many marine environments that exist worldwide.

Keywords : *Hydrodynamics, Blue energy, Greenhouse gas, Greenpeace.*

Introduction

The oldest technology to harness tidal power for the generation of electricity involves building a dam, known as a barrage, across a bay or estuary that has large differences in elevation between high and low tides. Water retained behind a dam at high tide generates a power head sufficient to generate electricity as the tide ebbs and water released from within the dam turns conventional turbines. Though the American and Canadian governments considered constructing ocean dams to harness the power of the Atlantic tides in the 1930s, the first commercial scale tidal generating barrage rated at 240 MW was built in La Rance. This plant continues to operate today as does a smaller plant constructed in 1984 with the Annapolis Royal Tidal Generating Station in Nova Scotia, rated at 20 megawatts (enough power for 4,500 homes). Other tidal generating station operating today, is located near Murmansk on the White Sea in Russia, rated at 0.5 megawatts.

These first-generation tidal power plants have all withstood the rigours of the marine environment and been in continuous pollution-free operation for many years. But due to the very high cost of building an ocean dam to harness tidal power, and environmental problems from the accumulation of silt within the catchment area of the dam (which requires regular, expensive dredging), engineers no longer consider barrage-style tidal power feasible for energy generation. Engineers have recently created two new kinds of devices to harness the energy of tidal currents (AKA 'tidal streams') and generate renewable, pollution-free electricity. These new devices may be distinguished as Vertical-axis and Horizontal axis models, determined by the orientation of a subsea, rotating shaft that turns a gearbox linked to a turbine with the help of large, slow-moving rotor blades. Both models can be considered a kind of underwater windmill. While horizontal-axis turbine prototypes are now being tested in northern Europe (the UK and Norway). A vertical-axis turbine has already been successfully tested in Canada. Tidal current energy systems have been

endorsed by leading environmental organizations, including Greenpeace, the Sierra Club of British Columbia and the David Suzuki Foundation as having 'the lightest of environmental footprints,' compared to other large-scale energy systems.

Materials and Methods

Vertical-axis tidal turbine – Canadian connection

A Canadian company – Blue Energy Canada Inc. – has completed six successful prototypes of its vertical-axis 'Davis Hydro Turbine, named after its inventor, the late Barry Davis. Barry Davis got trained as an aerospace engineer, worked on the renowned Canadian Avro 'Arrow' project, as well on the equally-remarkable 'Bras D'Or' hydrofoil project of the Canadian Navy. Barry, then decided to apply his knowledge of hydrodynamics in creating a tidal energy generator. Barry received support from the Canadian National Research Council and successfully tested 5 turbine prototypes in the St. Lawrence Seaway and on the eastern seaboard. Blue Energy is presently raising funds for a commercial demonstration project of the Davis Hydro Turbine.

Fig.2 : **Cutaway graphic of a 'mid-range-scale' (2 x 250 kW) vertical-axis tidal turbine.**

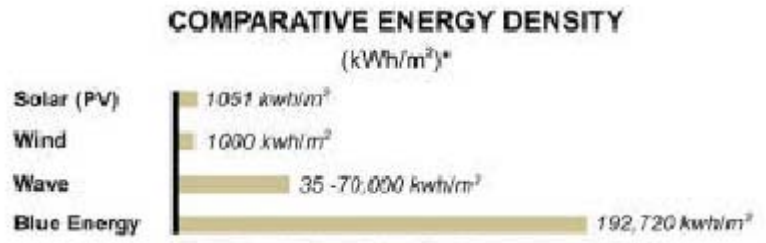

Fig. 3 : Chart illustrating the comparative energy advantage of Blue Energy's vertical-axis tidal current turbine system over other renewable energy options.

Horizontal-axis tidal turbine

Although, such tidal turbines were proposed during the oil crisis of the 1970s, the first tidal turbines began operating in the mid-1990s when a 15-kilowatt horizontal-axis tidal turbine was installed in Loch Linnhe on the west coast of Scotland, north of Glasgow. Now, two companies in

the United Kingdom are planning to initiate horizontal-axis tidal turbine demonstration projects while another demonstration project has begun off the coast of Norway. A US company has also designed a working prototype. Horizontal-axis tidal turbines closely resemble wind turbines, except that the turbine and blades are completely submerged in water.

Fig 4 : Graphic depicting Hammerfest Strom horizontal-axis, 'water mill' tidal stream turbine. Turbine propellers consist of 15-16 m blades mounted on towers placed on the sea bed. Tidal currents drive the propellers, with blades automatically adjusting toward the prevailing current. Each propeller is coupled to a subsea generator from which the produced electricity is fed via shore-connecting cables to a transformer and then on into the grid.

Fig 5 : Hammerfest Strøm horizontal-axis turbine about to be deployed in demonstration project, Northern Norway, 2003.

Discussion

Like the ocean dam models of France, Canada and Russia, vertical and horizontalaxis tidal current energy generators are fueled by the renewable and free forces of the tides, and produce no pollution or greenhouse gas emissions. As an improvement on ocean dam models, however, the new models offer many additional advantages:

- As the new tidal current models do not require the construction of a dam, they are considered much less costly.
- As the new tidal current models do not require the construction of a dam, they are considered much more environmental-friendly.

- As the new tidal current models do not require the construction of a dam,further cost-reductions are realized from not having to dredge a catchment area.
- tidal current generators are also considered more efficient because they can produce electricity while tides are ebbing (going out) and surging (coming in), whereas barrage-style structures only generate electricity while the tide is ebbing.
- Vertical-axis tidal generators may be stacked and joined together in series to span a passage of water such as a fiord and offer a transportation corridor (bridge), essentially providing two infrastructure services for the price of one.
- Vertical-axis tidal generators may be joined together in series to create a 'tidalfence' capable of generating electricity on a scale comparable to the largest existing fossil fuel-based, hydroelectric and nuclear energy generation facilities.
- Tidal current energy, though intermittent, is predictable with exceptional accuracy many years in advance. In other words, power suppliers will easily be able to schedule the integration of tidal energy with backup sources well in advance of requirements. Thus, among the emerging renewable energy field, tidal energy represents a much more reliable energy source than wind, solar and wave, which are not predictable.
- present tidal current, or tidal stream technologies are capable of exploiting and generating renewable energy in many marine environments that exist worldwide. Canada and the US, by virtue of the very significant tidal current regimes on its Atlantic and Pacific coastlines – proximal to existing, significant electro transportation infrastructure - is blessed with exceptional opportunities to generate large-scale, renewable energy for domestic use and export.

Tidal energy power systems are expected to be very competitive with other conventional energy sources, and excellent cost advantages arise from there being no pollution or environmental expenses to remediate nor are their fuel expenses (the kinetic energy of tidal currents is free). Further, ongoing maintenance costs are expected to be modest, as they are with other large-scale marine infrastructures, e.g. bridges, ships, etc., and a non-polluting tidal energy regime will qualify for valuable carbon offset credits. A 2002 feasibility report on tidal current energy in British Columbia by Triton Consultants for BC Hydro stated, "Future energy costs are expected to reduce considerably as both existing and new technologies are developed over the next few years. Assuming that maximum currents larger than 3.5 m/s can be exploited and present design developments continue, it is estimated that future tidal current energy costs between 5C / kWh and 7C / kWh are achievable."

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WAVE ENERGY AS A POTENTIAL RENEWABLE ENERGY RESOURCE

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Key Words : Tidal Energy, Fossil Fuel, Geographic Location

Introduction

Energy is the basic requirement for human life. In fact agriculture, industry, transportation, communication and all other economic activities consume a large amount of energy. Overall development of a nation is judged from the amount of energy it produces and consumes in relation to its size & population. Present energy consumption patterns are unsustainable leading to a large scale destruction of environment & natural capital resources of earth. Therefore the challenge before all of us is the provision of the energy services to the poor with affordable financial investment. At present most of the energy needs are met through fossil fuels & oil. Therefore developing countries are dependent on oil imports for their energy needs. At present there are about two billion people without access to electricity. Therefore there is an urgent need all over world to tap renewable energy sources. Total renewable energy sources account for 56 EJ of energy, almost 14% of the total world energy i.e. 401 EJ.

Wave energy

2.1 Background

Waves in sea are generated by the action of winds blowing over water and can be used as a renewable source of energy. In fact sea could be viewed as a vast collector of energy transferred by wind over large sea. Surface and stored as wave energy. Wave energy potential varies from place to place depending upon its geographic location. Two factors affecting the magnitude of wave energy are wind strength & uninterrupted distance over the sea that the wind can blow.

2.2 Potential

The total wave power potential of the world is 2×10^6 MW. The tidal energy is wavering with 250 Kw available from December to March, 75 Kw between April to November and has peak value of 150 Kw. The economics of wave energy power, though not yet competitive with fossil fuels, are promising and the situation is improving with more advanced technology. Capital costs for 100 MW installation is $1200 to $1500/Kw with operating costs of 5 cents / Kwh & load factor around 20%. Estimated international cost for power from wave energy is around 9.2 C/KwH.

2.3 Current Status

The first commercial wave plant in the world, Limpet 500, was installed on the island of Islay, Scotland, in 2000 and has been providing power to the grid for U.K. The Limpet 500 is a 0.5 MW capacity plant for sitting on exposed shores, utilizing an oscillating column. design. In India 150 KW system is set at Thiruvananthpuram. The United Kingdom is said to be the dominant player in wave power with a forecast capacity of 14.7 MW. Portugal, Spain and Denmark are other significant markets but lag far behind U.K.

2.4 Leading Wave Technologies

Wave energy is moving off shore. Although a number of successful devices have been installed at shoreline locations, the true potential of wave energy can only be realized in the offshore environment where large developments are conceivable.

In terms of power potential, offshore locations offer more than shoreline locations. The negative side is that devices in offshore locations have more difficult conditions to contend with. Shore line technologies have the benefit of easy access for maintenance purposes, whereas offshore technologies are, in most cases more difficult to access. Improving reliability and accessibility are, therefore important in commercialization of wave energy harnessing. Shoreline wave energy is limited by fewer potential sites & high installation cost whereas a 50 MW wave farm is conceivable on offshore locations. No shoreline wave energy converter is able to offer such potential for deployment in this way. Deployment costs for shoreline wave energy devices are high because they are individual projects and economics of scale are, therefore, largely inapplicable. Shoreline devices only account for 8% of forecast capacity between 2004-2008. Offshore represents the most significant wave energy sector, with 58% of all forecast capacity. Offshore is so dominant because devices are typically of a larger capacity than their nearshore compatriots.

Ocean Power Delivery Pelamis

In the present time OPD is viewed as market leader which has developed 'pelamis' concept. The 'pelamis' is made up of five cylindrical segments connected by hinged joints. The wave induced motion on these sections is resisted by hydraulic rams which pump high pressure fluid through hydraulic motors via smoothing accumulators to drive electric generators. The power is fed through a cable to a junction on the sea floor where a single cable carries the electricity to the shore. The first full-size pelamis has a rated capacity of 750 KW.

Wave Dragon A/S – Wave Oragon.

Wave Dragon is the first operational grid connected offshore wave energy device, installed in Denmark. The prototype wave dragon has an output of 20 KW. The device is under study to gain more knowledge & experience. The different models of 7MW, 4 MW & 11 MW capacity are proposed for the different levels of wave resource.

Wavegen – Limpet

Wavegen is one of the market leaders in wave energy, having installed their Limpet shoreline devices in Scotland in 2000. It is also developing technology which generates power from wave energy, whilest also acting as an artificial reef. The device which rests on the sea bed, could in some cases and coastal protection. The technology is of particular benefit to island communities.

2.5 Environmental Impacts

Small-scale wave energy plants are likely to have minimal environmental impacts. However some of the very large-scale projects that have been proposed have the potential of harming the ocean ecosystems covering very large areas of the surface of the oceans with wave energy devices would harm marine life and could have more wide-spread effects. Changes in waves and currents

would most directly impact species that spend their lives nearer to the surfaces. The dampening of waves may reduce erosion on the shoreline and may have damaging ecologies effects, that need to be scientifically proved.

Conclusion

Wave energy is promising holds huge potential to reduce reliance on fossil fuels. Carefully choosing sites that can withstand the alterations to the environment caused by power plants will be crucial to effectively develop these technologies without harming the ocean.

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OCEAN THERMAL ENERGY CONVERSION

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Introduction

Energy is a crucial input in the process of economical, social and industrial development. High energy consumption has traditionally been associated with higher quality of life, which in turn is related to the Gross National Product (GNP). Variation in magnitude of energy resources , differing mix of energy resource profiles , lack of adequate resources of fossil fuels in many nations, dispersed geographical location of energy resources within nations and in the world are some of the complexities that characterize the global energy scene.Sources that are replenished more rapidly are termed as '**renewable**'.These include solar,wind and ocean which are inexhaustible.

Significance of Ocean Energy

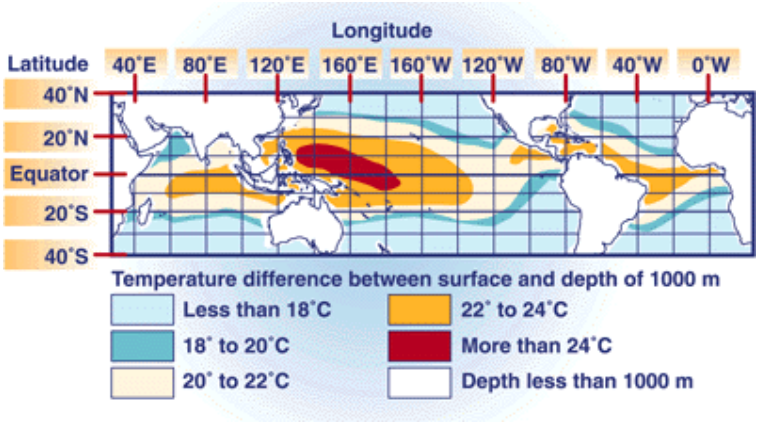
Oceans cover more than 70% of earth's surface, making them the world's largest solar collectors. The sun's heat warms the surface of water a lot more than the deep ocean water and this temperature difference creates thermal energy.Just a small portion of the heat trapped in the ocean could power the world.

Ocean can produce two types of energy: thermal energy from the sun's heat and mechanical energy from the tides and waves. **Ocean thermal energy** is used for many applications including electricity generation. There are three types of electricity conversion systems: closed cycle, open cycle and hybrid. **Ocean mechanical energy** is quite different from ocean thermal energy. Even though the sun affects all ocean activities, tides are driven primarily by the gravitational pull of the moon and waves are driven primarily by the winds. As a result, tides and waves are intermittent sources of energy while ocean thermal energy is fairly constant. Also, unlike thermal energy, the electricity conversion of both tidal and wave energy usually involves mechanical devices.

OCEAN THERMAL ENERGY CONVERSION

Ocean Thermal Energy Conversion (OTEC) utilises the temperature difference between the warm surface sea water and cold deep ocean water to generate electricity. For OTEC to produce a net output of energy, the temperature difference between the surface water and water at a depth of 1000m needs to be about $20^{o}C$.

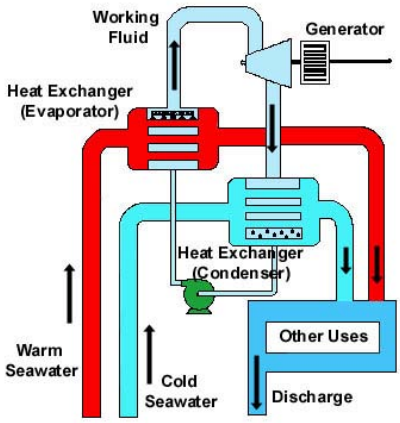
Temperature difference between surface and sub surface (1000m) sea water
The concept of OTEC is envisioned by Jacque's D'Arsonval in 1881. However, D'Arsonval did not live to see his idea to fruition, and the task was completed by his student Georges Claude in 1930. Although the theoretical efficiency of OTEC is small (~2%), there are vast quantities of sea water available for use in power generation. It has been estimated that there could be as much as 10^{7}MW power available worldwide.



Otec Systems are Classified into Three Categories

(1) Closed Cycle Otec

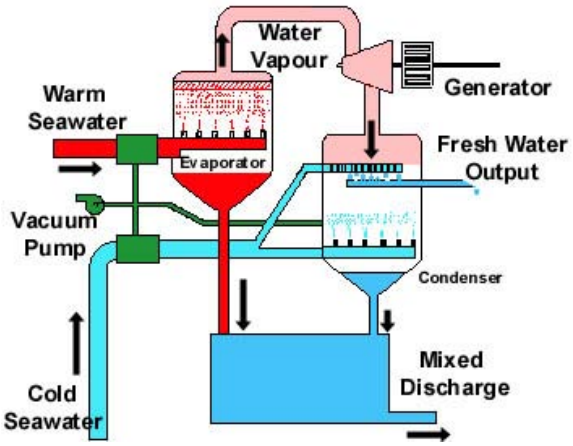
D'Arsonval's original concept used a working fluid with a low boiling point, such as ammonia, which is vapourised using the heat extracted from the warm surface water. The heated working fluid is used to turn a turbine to produce electricity. Cold deep sea water is used to condense the working fluid in a second heat exchanger prior to being recirculated to the first heat exchanger.



Closed Cycle OTEC

(2) Open Cycle Otec

Open cycle OTEC is very similar to the closed cycle one. The only difference is that an open cycle OTEC does not use intermediate fluid with low boiling point but uses the sea water as working fluid that drives the turbine. The warm sea water on the ocean surface is turned into low-pressure vapour under a partly vacuumed environment.The steam is then condensed either by a second heat exchanger, as in the closed cycle, or by mixing with the deep cold water.



Open Cycle OTECH

(3) Hybrid Otec System

Hybrid Cycle OTEC is a theoretical method of maximizing the use of ocean thermal energy. There are two concepts. The first one is to use a closed cycle OTEC to generate electricity to create the necessary low-pressure environment for the open cycle OTEC. The second concept is to integrate two open cycle OTEC (one is used to create the vacuumed environment) so that there will be twice the amount of the original desalinated water.

Benefits of Ocean Thermal Energy Conversion

OTEC's economic benefits include these:

· Helps produce fuels such as hydrogen, ammonia, and methanol

· Produces base load electrical energy

· Produces desalinated water for industrial, agricultural, and residential uses

· Is a resource for on-shore and near-shore mariculture operations

· Provides air-conditioning for buildings

· Provides moderate-temperature refrigeration

· Has significant potential to provide clean, cost-effective electricity for the future.

OTEC's non economic benefits

· Promotes competitiveness and international trade

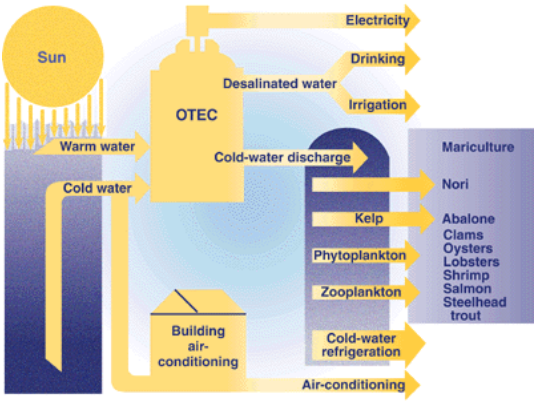
· Enhances energy independence and energy security

· Promotes international sociopolitical stability

· Has potential to mitigate greenhouse gas emissions resulting from burning fossil fuels.

Applications of Otec

Aside from the generation of electricity, it has been proposed that OTEC plants could assist ocean based industries, such as aquaculture, refrigeration and air conditioning, desalinated water crop irrigation and consumption as well as mineral extraction through the use of the fresh and chilled water byproducts as shown in figure .



Applications of OTEC

OTEC has important benefits other than power production.

1) Air conditioning

Air conditioning can be a byproduct. Spent cold seawater from an OTEC plant can chill fresh water in a heat exchanger or flow directly into a cooling system. Chilled-

2) Soil agriculture

OTEC technology also supports chilled-soil agriculture. When cold seawater flows through underground pipes, it chills the surrounding soil. The temperature difference between plant roots in the cool soil and plant leaves in the warm air allows many plants that evolved in temperate climates to be grown in the subtropics.

3) Desalination

An OTEC plant that generates 2-MW of net electricity could produce about 4,300 cubic meters (14,118.3 cubic feet) of desalinated water each day.

4) Mineral extraction

An OTEC plant that generates 2-MW of net electricity could produce about 4,300 cubic meters (14,118.3 cubic feet) of desalinated water each day.

Some Major Otec Power Plants in World

Sr. No.	Location	Year	Capacity(kw)
1.	Matanzas Bay Hawana Cuba	1930	NA
2.	Abidjan, Ivory coast	1956	7000
3.	Hawaii, U.S.A.	1979	50
4.	Hawaii, U.S.A.	1981	1000
5.	Republic of Nauru – central Pacific	1981	100
6.	Tokunoshima, Japan	1982	52
7.	Hawaii, U.S.A.	Proposed	49000
8.	Bali, Indonesia	Proposed	230
9.	Jamaica, West Indies	Proposed	1580
10.	Tahiti, Central Pacific	Proposed	5000
11.	Republic of Nauru – central Pacific	Proposed	2500
12.	Kalashakharapattnam, Tamilnadu, India	Proposed	100000
13.	Andhra Pradesh, India	Proposed	100000

Developments in India

India possess excellent thermal gradients and some of the best sites in the world for harnessing OTEC power India has a potential of exploiting 80,000 MW of OTEC based power. Some of the coastal regions of Tamil Nadu and Andhra Pradesh provide excellent sites for OTEC plants..

Conclusion

Although the theoretical efficiency of OTEC is small (~2%), there are vast quantities of sea water available for use in power generation. It has been estimated that there could be as much as 10^7MW power available worldwide.

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BIOMASS AS ENERGY SOURCE

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Biomass is plentifully available in the rural regions. It is already being used by the rural people as a major source of energy, mainly in cooking food, which constitutes almost 50% of the total energy consumption. Assuming that there are about 140 million households in rural India, and assuming that each family uses annually about 3 tonnes of biomass as fuel, one comes to the figure of about 400 million tonnes of biomass utilised annually only for domestic cooking.

Our engineers and energy scientists generally think only of the calorific value of fuels and of fuel use efficiency. But there is also a third dimension to fuel use, and that is the pollution arising due to burning of biomass. As cooking is done within the confines of a house, the pollution caused by cooking fires is generally not taken very seriously. But according to statistics published by the World Health Organisation, annually about 500,000 women and children die prematurely in India due to air pollution caused by cooking fires in rural households. Considering the fact that almost 70% of our population is rural, giving the rural women a cleanly burning biofuel is a major task, which is unfortunately not tackled by any of our major research centres. There are many options for providing a clean and economical burning biofuel. The biomass that is currently available to villagers is free of cost.

One way of tackling this problem is to redesign the cooking devices in such a way that they burn the biomass more cleanly, so that the pollution caused by them is reduced. This is achieved by providing the fuel with sufficient air, so that it burns completely, reducing automatically the carbon monoxide and the particular matter in the fuel gases. Another strategy is to design a stove in such a way that waste of heat is avoided and a major part of the heat generated by the burning biomass is transferred to the pot. This results in higher fuel use efficiency, requiring the user to burn less fuel. Pollution is naturally reduced if the amount of fuel is reduced. Both the strategies are combined in modern improved cookstoves. However, in practical terms, both the strategies often fail, because the fuel that is used in the laboratory while designing the stove differs from the fuel that the rural housewife actually uses. In a laboratory experiment, one normally uses good quality firewood, that has been properly dried and cut into pieces of adequate size. In contrast to this, the fuel used by the rural housewife consists of stalks of plants like cotton, maize, safflower, arhar, or of bushes growing in the vicinity, maize cobs, dung cakes, rhizomes of sugarcane, etc. The traditional cookstove is designed to burn such material and therefore, the housewife often finds that the improved cookstove emits more smoke and soot than her traditional stove, comparatively.

Standardisation of fuel is, therefore, another strategy that is considered in the context of using biomass as cooking fuel. The easiest way of standardising woody biomass is to cut it into uniform, small pieces called chips. Highly efficient and non-polluting stoves can be designed to burn these chips, but unfortunately not much effort has been made in this direction in India. The second and traditional method of converting a non-standard fuel into standard one is to char it into

charcoal. It is the volatile matter in biomass that gives rise to the particulate matter in the flue gases. In the process of charring, the volatiles are removed from the biomass to leave only the carbon and non-combustible matter behind. Therefore, when charcoal burns, it burns cleanly, without producing any smoke or soot. However, the traditional method of producing charcoal is itself highly polluting, because the volatiles are released into the atmosphere in this process. Sophisticated technologies are now available for charring, in which the volatiles are burned in the process of charring itself, to produce the heat required in the process.

Agricultural waste is an ideal source of charcoal. When one harvests any crop, one generally harvests only grain, fruits, pods, tubers or rhizomes. This constitutes only about 30 to 40% of the total biomass. This means that about 60 to 70% of the total agricultural biomass, or almost 600 million tonnes, is the waste biomass produced annually in India. A small part of it is used as fodder for cattle, but the rest is just wasted. Our Institute developed a technology to convert the agricultural waste into charcoal and to use it as domestic fuel in the form of char briquettes. Our Institute has also standardised a stove-and-cooker system called the Sarai cooker, which can cook the meal for five persons, using just 100 g of our char briquettes. About 15,000 households in Maharashtra are already using the Sarai cooker.

Another form of standardised fuel which is already being used in the rural areas is that of biogenous methane. The biological process of methane production results in a mixture of methane and carbon dioxide, which is called biogas. Burnt in a properly designed burner, biogas produces a blue flame, which is absolutely clean. This technology is at least 150 years old. Traditionally, cattle dung is used as feedstock for producing biogas, and therefore it is also called gobar gas in India. During the last 50 years, the Government of India has made great efforts to popularise the gobar gas technology, but the present figures indicate that there are only about 2.5 million working domestic biogas plants in India, covering hardly 1.8% of the rural households. The failure of the gobar gas technology in India was due to the fact that it is not a very user-friendly technology. It requires dung from at least 6 to 8 heads of cattle. In order that the dung be easily available, the cattle must be penned and not allowed to roam. The present technology also requires the dung to be mixed with equal volume of water to form a slurry. Villagers do not have tap water in their houses. Therefore, the water has to be fetched by the women from a source that is often far away from the house. The water is generally carried in pots balanced on their heads. Fetching water for the household is itself quite a strenuous task. Fetching daily additional 40 to 50 litres of water for the biogas plant only adds to the women's burden, which they generally resent. The drudgery doesn't just stop at fetching dung and water. Disposal of daily about 80 litres of spent slurry is also often a problem.

Our Institute produced a more user-friendly biogas system based on starchy or sugary feedstock. Just 2 kg of sugar yield as much biogas as 40 kg of dung, and while dung requires a retention period of about 40 days, sugar yields the gas within just a single day. Starch also works equally well as feedstock. Our novel biogas system operates on waste starchy or sugary material such as leftover food, oilcake of non-edible oilseeds, fruits, tubers, rhizomes or grain that cannot be marketed due to poor quality, or non-edible material like rhizomes of banana, fruits of wild ficus etc. A biogas plant based on this technology is quite small, having a capacity of just 1000 litres, and its cost is also much less, only about Rs.6000. We have already installed about 200 of these gas plants in various parts of Maharashtra, and we hope to install a total of 2000 such biogas plants in

the next year.

Biogas can also be used as fuel in internal combustion engines. The CNG technology that is currently available in India can be used in both ways as bigas or an automotive fuel.

Wood gas is the third alternative representing standardized fuel made from biomass. This technology does not lend itself well to being used in domestic cookstoves, but larger stoves, used in bakeries, langars or restaurants can be based on it. However, wood gas is currently being used as fuel in internal combustion engines for generating electricity. Many such units are being operated all over the country. Biogas based electricity generation should be seriously considered by our planners and administrators as a means of supplying electricity to villages. The electricity demand of a village is not very high. Supply of such small amount of electricity from a central generating facility is generally very costly because of the capital expense of the conduction system. There are also losses and theft of electricity when it is transmitted over such long distances. The village level generators should be operated by the villagers themselves. They can then generate electricity as and when they want and also use it for whatever purpose they want.

This discussion would not be completed without mentioning biodiesel and alcohol. Biodiesel is made from vegetable oil. In the Western countries, edible oil like soybean oil or rapeseed oil are used as a source of biodiesel. Our country, currently imports almost 50% of its total demand of edible oil. Under such circumstances, using edible oils for biodiesel is out of question. Among our indigenous plant species, castor and rice are the only sources of oil that are produced by farmers. Castor oil, having special chemical composition, is not only being used by industries but it is also exported, while rice bran oil is used almost entirely by the organised soap industry. The remaining non-edible oils, being produced from seeds of various uncultivated tree species, play only a minor role in our economy. Being uncultivated, their supply is unreliable and therefore one cannot base a major industry like biodiesel on them. Currently India requires annually about 50 million tonnes of diesel. Substituing just 5% of this by biodiesel would require 2.5 million tonnes of vegetable oil. Considering average yield of 500 kg oil per hectare, one would require an area of 5 million hectares under oilseed production. I quote these figures only to bring into focus the magnitude of this endeavour. There is talk of introducing Jatropha curcas as a new oil bearing plant. It is claimed that Jatropha requires very little water. As an agricultural scientist, let me make it clear, that all plant species, irrespective of whether they are drought tolerant or not, require monthly about 200 mm water, if they are to give a good yield. Tolerance to drought means only that the plant can survive under conditions of drought and that it does not die under drought. It does not mean that it would give high yield under such conditions. It has been shown that even Jatropha needs about 800 to 900 mm of water to become economically viable. If a farmer has at his disposal this much water, he would rather grow a cash crop like cotton, groundnut, soybean or onion, than a low yielding plant like Jatropha.

The situation of alcohol is similar to that of biodiesel. Currently, alcohol is made from molasses, a free by product of the sugar industry. As the cost of sugarcane, its harvest, transport, and processing are borne by sugar, the present cost of alcohol is low. But if crops like sugarcane, sugar beet or sweet sorghum are grown exclusively for alcohol production, the above mentioned costs would have to be borne by alcohol, which then would not be so cheap. Also the area required

to be planted to produce alcohol would be of the same magnitude as that required by biodiesel.

Production of biomass in any form requires the use of land, and it would require the involvement of rural people to do it. Chemical fertilizers, an important input required in agriculture, need a large quantities of fossil fuel in their production. Our Institute is developing the concept of conducting agriculture without using chemical fertilizers. This concept is based on the assumption that soil micro-organisms degrade the soil minerals to provide the green plants with all the mineral nutrients that they need. If the soil micro-organisms are adequately fed with organic matter, there is theoretically no need to apply chemical fertilizers to the soil. Traditional agricultural scientists recommend the application of organic matter in the form of compost. However, the nutritional value of composted organic matter is so low, that one has to apply 20 to 50 tonnes of compost per hectare. In practical terms, it means that one has to use the biomass produced in about 10 hectares for providing organic matter to one hectare. This is the reason why our planners and agricultural scientists consider organic farming to be impracticable.

Our own work shows that if organic matter having high nutritive value, like sugar, starch, protein etc. is used as manure, application of just 10 to 25 kg per hectare of it is enough to produce high crop yield without using any other form of chemical or organic nutrients. This new discovery would reduce the cost of agriculture substantially and would also reduce the cost of producing biomass.

NEW TECHNOLOGICAL OPTIONS OF BIOGAS SYSTEMS FOR HYGIENICALLY DISPOSAL OF MUNICIPAL SOLID WASTE - BIO-METHANATION PLANT

Past Performance

Britto Energy Engineers is pioneering company implementing non-Conventional Energy programme especially Biogas and Solar Water heating System since last many years. During this period our firm has installed around 5000 Nos. of Biogas Plants and Solar Water heating Systems of total capacity of 7.00 lacs lit/day. In biogas industry Company has designed and developed various types of Biogas plant based on animal dung, water hyacinth, Sugar cane's press mud, Poultry waste, Piggery waste and Kitchen waste. The first plant of this nature based on Kitchen waste and Biodegradable Municipal Solid Waste was designed, developed, installed and commissioned at M/s. Larsen & Toubro Ltd, during year 2000.

Based on this technology and the proto typed project, bigger plant of the same has been designed and developed and installed for daily capacity of 20 TPD of biodegradable (M.S.W.) at Chatrapati Shivaji Maharaj Hospital, Kahwa, Thane.

Introdution

Waste disposal is one of major problems being faced by all nations across the world. Generation of wastes both in the solid and liquid forms, is associated with the various activities of human beings. It is generally generated in Urban, Municipal and Industrial sectors. The solid wastes include human excretes, household wastes, city garbage, commercial wastes and industrial wastes. The liquid form includes domestic sewage and effluents from community, institutional and industrial activities. Due to improper waste management facilities and treatment, these wastes find their way into the environment.

The last two decades have seen the rapid urbanization and industrialization in Maharashtra that has caused tremendous increase in the amount of Municipal Solid Waste (MSW). The typical city in Maharashtra produces MSW 500 grm. per person of solid waste and 150 ltrs. of liquid waste. As a results quality of urban land water and air have drastically deteriorated causing various kinds of health problems. The situation today is alarming and its really 'Only God Can Save' situation.

The amount of MSW is increasing to an unmanageable extent. Existing landfills are filled beyond capacity. Search for new sites for waste dumping is difficult due to public protest. Even after, finding the new dumping yards after great difficulty, the longer distance from the city increases the transportation cost tremendously. The days are not far when the Municipal Corporations will have to pay heavy amounts to private parties to lift the garbage from cities. This will be similar to the concept of 'Tipping Fees' in Western Countries.

Biogas Technology

To overcome above serious problems, Biogas technology has been suggested. This will serve not only to treat waste but produce energy and manure reducing the effective volume of waste. Here again, decentralized installation system is advisable and recommended instead of

centralized dumping yard. This will solve many problem of transportation. Hence project capacity of 5/10 tons Municipal Solid Waste has been recommended at each site.

Parameters of 20 TPD Plant at Chatrapati Shivaji Maharaj , Kalwa, Thane

1	MSW requirement - TPD Segregated organic waste	Minimum 20 Tones Maximum 25 Tones
2	Retention Time (Days)	15 - 18 days
3	Biogas production (Cum/ day) -Equiv. LPG (No. of cylinders/ day) -Equiv. Electricity generation (Kwh/ day)	Minimum 1000 Maximum 1250 40-50 2000
4	Manure generation - Tone/year	1500
5	Life of the project (in year)	10 years
6	Payback period (years)	Minimum 5 years. Maximum 8 years.
7	Land requirement (acre)	50 m x 30 m

Brief Process Description

COMPONENTS: There will be following components for complete process

1) Material receiving platform
2) Skip Bucket System for mechanical lifting of M.S.W.
3) Mixer, Shredder for crushing and Pulping solid waste.
4) Pre digestion system
5) Solar Water heating system for water heating
6) Main methane reactor in Secondary digester
7) Manure pits for slurry drying alongwith filtration system
8) Waste water recovery system
9) Gas Distribution System alongwith appliances.

Process

The pre sorted i.e. segregated Bio degradable solid waste of minimum 20 tones (maximum 28 tones) will be shredded and crushed for making pulp slurry. The pulp slurry will be treated in two stages digester system i.e. first primary digester system and secondary digester system. In primary digestion system the slurry will be pre digested with help of hot water from solar system. Due to hot water mixing the growth of thermophilic bacteria is assured and thus temperature is

maintained. This will help for faster decomposition and degradation of solid waste. The pre-digester system is provided with some anchor typed mixing arrangements to minimize scum formation alongwith continuous mixing system for high rate of bio-methanization by blower/ compressor.

After the pre digestion treatment slurry is allowed to enter in main methane reactor and Gas generation system where it undergoes mainly an aerobic fermentation process resulting into generation of methane gas which will be used as fuel gas or generation of electricity. After about the period of one month high quality manure can be obtained from drying beds. There is no odour to manure at all. The gas generated is stored in metallic gas holder and it is taken to pipeline for domestic used

Biomethenization Plant Based on Municipal Solid Waste (20 Tonnes) Thane Municipal Corporation, Thane

Installed by M/S. Britto Bio Industries

BIOMETHANATION PLANT RENEWABLE METHANE FROM ANAEROBIC DIGESTION OF BIOMASS

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Key words: *biomass, fossil fuel, anaerobic digestion, carbon tax and compost*

Why renewable energy now?

A reviewed interest in renewable energy and related conversion technologies is emerging again. Although the eventual depletion of fossil fuels lurks in the background as a long-term incentive for the development of sustainable energy forms, more urgent incentives to re-emphasize renewable energy are related to global environmental quality. The first concern to emerge was release of toxic compounds and oxides of nitrogen and sulphur resulting from combustion of fossil fuels. These air pollutants contribute globally to health and environment problems, the most common of which is referred to as acid rain. The greatest threat is that of global warming related to an increased concentration of carbon dioxide and other upper atmospheric pollutants resulting from anthropogenic activities. Use of renewable biomass (including energy crops and organic wastes) as an energy resource is not only greener with respect to most pollutants, but it's use represents a closed balanced carbon cycle with respect to atmospheric carbon dioxide. It could also mitigate atmospheric carbon dioxide levels through replacement of fossil fuels. A third concern is the recognized need for effective methods of treatments and disposal of large quantities of municipal, industrial and agricultural organic wastes. These wastes may not only represent a threat to environmental quality, but also represents a significant renewable energy resource.

Why methane?

Biomass may be converted to a variety of energy forms including heat, steam, electricity, hydrogen, ethanol, methanol and methane. Selection of product for conversion is dependent upon a number of factors including need for direct heat or steam, conversion efficiencies, conversion and use of hardware and environmental impact of conversion process, waste stream and product use. Compared to other fossil fuels methane produces few atmospheric pollutants and generates less carbon dioxide per unit energy because methane is comparatively a clean fuel. The trend is towards its increased use for appliances, vehicles, industrial applications and power generation. Ethanol is becoming a popular biomass - derived fuel.

Conversion processes

Methane can be produced from biomass by either thermal gasification or biological classification. Economic application of thermal processes is limited to feeds with either low water content or those having the potential to be mechanically dewatered inexpensively. Feedstocks containing 15% of total solids require all of the feed energy for water removal. Thermal processes for methane production also are only economic at large scales and generate a mixture of gaseous products that must be upgraded to methane. The product gas is composed primarily of methane and carbon dioxide with traces of hydrogen sulphide and water vapour. The major limitation of biological gasification is that conversion is usually incomplete, often leaving as much as 50% of

the organic matter unconverted.

Principles of anaerobic digestion

It is the application of biological methanogenesis, which is anaerobic process responsible for degradation of much of the carbonaceous matter in natural environment, where organic accumulation results in depletion of oxygen for aerobic metabolism. This process, which is carried out by a consortium of different organisms is found in numerous environments, including sediments, flooded soils and land fills.

In generalized scheme for anaerobic digestion feedstock is harvested, shredded and placed into a reactor which has an active inoculum of microorganisms required for methane fermentation. A conventional reactor is mixed, fed once or more per day, heated to a temperature of 35^0C and operated at a hydraulic retention time of 20 – 30 days and loading rate of 1.7 kg VS m^3d^{-1}. Under these conditions about 60% reduction in organic matter is achieved corresponding to a methane yield of 0.24 m^3 per kg VS added. The biogas composition is typically 60% methane and 40% carbon dioxide with traces of hydrogen sulphide and water vapour. The conventional design is being replaced by more innovative designs influenced primarily by feed suspended solids content. The objective of these designs is to increase solids and microorganism retention, decrease reactor size and reduce process energy requirements. Improved designs have increased possible loading rates 20 fold, reduced residence times and improved process stability.

Renewable methane from biomass

Resource potential estimates for terrestrial biomass is estimated to be 22 EJ while for feed stocks like grass, wood, seaweed it is 7 EJ.The potential for marine biomass is huge at greater than 100 EJ per year.

As biomethanogenesis decomposes organic matter with production of useful energy products, anaerobic digestion of organic matter is receiving increased attention. Solid and agricultural wastes release undesired methane into the atmosphere due to anaerobic digestion in landfills, lagoons or stockpiles. Treatment and recovery of this gas in reactors would reduce this source of atmospheric methane. An attractive option for treatment of the organic fraction of these wastes is to separately treat organic fraction by composting and applying the stabilized residues in land as a soil amendment. The residues would reduce water needs and prevent erosion.

Conclusion

As population increases and technology development begin to result in significant resource depletion and environmental deterioration, we must take a universal view on the ground rules for sustaining our species in a manner that is compatible with preservation of biosphere. This will require production of feed, food and energy by technologies that are indefinitely sustainable and which have minimal environmental impacts. This will involve a major shift to renewable resources of energy, sustainable agricultural practices for production of food, feed and energy and recycle of all non- renewable resources.

Derivation of methane from energy crops and organic wastes has an important role towards achieving this objective.

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DEVELOPMENT OF NATURAL DRAFT GASIFIER FOR STEAM GENERATION

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Abstract

In India, fuelwood continues to play an important role both in domestic and industrial sector. It is estimated that about 7 to 10% of the total fuelwood consumption is in rural industries and village applications.

Biomass Gasifier can be utilized in providing the rural energy needs like lighting, irrigation, water pumping along with the energy requirements of rural agro based industries. This will also be helpful in providing a sustainable solution to rural energy problems. Biomass is available in almost all the villages and its utilization for generation of electricity will not only increase economic activities in villages through decentralized biomass power plants but also would be helpful in the development of the area leading to general prosperity of the rural people.

There is scope to introduce wood based gasifier with steam generator instead of conventional 'Chulha' and diesel/kerosene boiler in small agro-industries. Keeping these points in mind, natural draft gasifier is developed by Department of Bio Energy, Tamil Nadu Agricultural University. Natural draft gasifier does not require electricity for operation. Capacity of gasifier is 10 kg/h. Performance evaluation study was carried out on the system. Flame temperature of gas was found to be 630^0C. The mass and energy closure was found to be 93.73% and 78 % respectively.

Introduction

Steam is a vital part of the agro processing industry. It is used, both directly and indirectly, for heating, cooking, sanitizing, and sterlizing. The advent of the industrial revolution provided the impetus for the large scale processing of food. Steam was used as the medium. It was easy to produce and simple to transport at different places. Hence steam was taken for granted and no thought was given to improving the ways in which it can be used alternatively. The present method of steam generation is not hygienic and energy efficient. Identifying this area of concern, gasifier was developed and tested in Department of Bio Energy, Tamil Nadu Agricultural University, Coimbatore.

Materials and Methods

Natural Draft Gasifier System Description

Reactor

Reactor of the gasification system is a cylindrical structure. The inside of this is insulated with fire bricks lining.

Grate

A Grate is provided at the bottom of gasifier for material support and ash removal.

Grate agitator

A grate agitator was provided to move to and fro on the channel guide with the help of the handle. Due to the movement of the agitator, combing action on surface of the grate takes place, to remove the ash accumulated on it.

Air inlet

Air inlet pipe is provided below the grate. The air pipe is having valve to control the air supply to the gasifier.

Ash removal port

An ash removal door is provided below the grate for removal of ash and for firing of biomass while starting the gasifier.

Biomass feeding hopper

Biomass feeding to the gasifier is done from the side of the reactor. A hopper attached to the reactor is tapered and biomass is fed through the pipe to the reactor.

Sealing of biomass

A water seal at the opening of the biomass feeding hopper is provided.

Gas outlet

The gas generated in the reactor moves upward through a perforated plate having holes on the plate.

Burner

The gas burner is an integral part of the gasifier fitted just above the reactor. The producer gas burner is of aspirated and air swirling type. The swirl was noticed during the burning of the gases. The control of the air to the burner was provided using the valve fitted for the air supply.

Performance Evaluation of the Gasifier

Gasifier is tested for performance studies. Before that, properties of feedstock used were studied.

Gasifier efficiency Calculations

i) Temperature Profile of the Reactor

The temperature profile of the gasifier is measured using chromel-alumel thermocouples at 4 different locations i.e. at the 20 mm, 120 mm, 320 mm and 720 mm above the grate. The digital temperature indicator measures the temperature inside the gasifier.

ii) Flame Temperature

The flame temperature of the gas burning in the developed burner is measured using thermocouple (chromel-alumel) with temperature indicator. While measuring the temperature; air drift to the burner can be avoided. The maximum temperature of the flame is measured by shifting the thermocouple to different locations of the flame.

iii) Water boiling and Evaporation test

The most commonly used indicator to express the performance of the natural draft gasifier is the "Water Boiling & Evaporation Test". It is a measure of the extent of energy of the fuel burnt for the purpose of steam generation and may be expressed in the ratio of the heat used for the boiling / evaporation of water to the calorific value of the fuel consumed. The controlled water-boiling test is performed to estimate the time taken for boiling under fixed rate of charging of the fuel.

Results and Discussion

Table. Salient dimensions of Gasifier system are furnished below

	Part	Dimensions
1	**Natural Draft Gasifier**	
i.	Reactor	
	Inner shell	Diameter = 300 mm, Height = 1000 mm
	Outer shell	Diameter = 700 mm, Height = 1000 mm
ii.	Grate	Diameter = 300 mm,
		Ring thickness =120mm, Width of the ring = 40mm
		Bars size = 20 mm x 22 Nos, Width of the bars = 10mm
iii.	Feeding Hopper	Diameter = 300 mm, Diameter of Pipe 200 mm
iv.	Burner	Hole size = 5 mm x 456 Nos.
v.	Ash removal port	Outer plate= 150 x 150mm
vi.	Air inlet pipe	Diameter = 50 mm
viii.	Fire Bricks	Length=225mm,Width=113mm
		Thickness=200mm

Temperature profile in the reactor and flame temperature

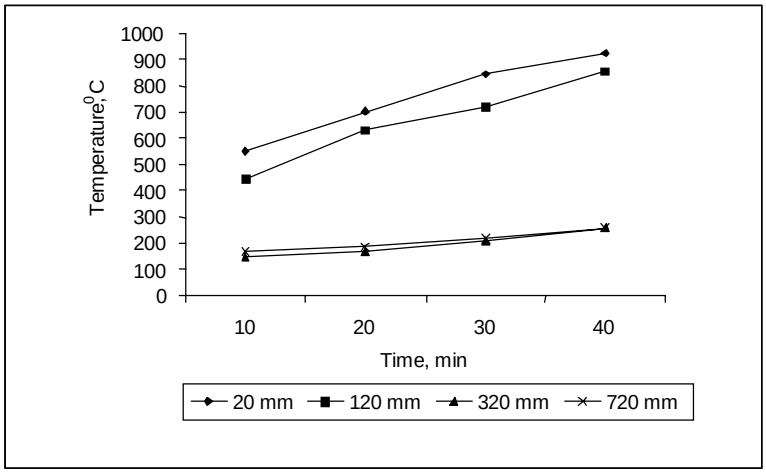

Fig 1: Reactor Temperature distribution (wood: 10kg)

Fig.1 gives the temperature profiles set up across the reactor in 10 kg trial with wood chips as feed material. Near the grate, temperature is gradually established upto a maximum of 923^{0}C. Temperature as high as 550°C can be reached in duration of 15-20 minutes near the grate and the gas temperature noted is 360°C. The temperature profile was found to fluctuate widely at different heights of 20 mm, 120mm, 320 mm and 720 mm above the grate.

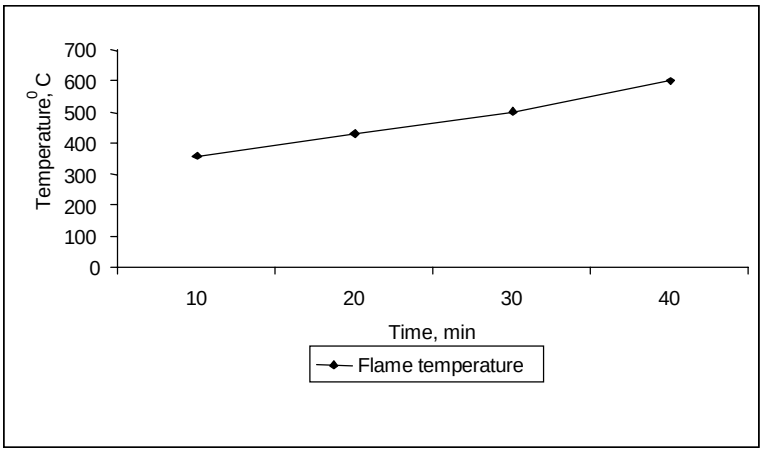

Fig 2: Flame temperature of Gas (wood: 10 kg)

The flame temperature measured at the exit of burner was found to vary from 360-603^{0}C (Fig.2).

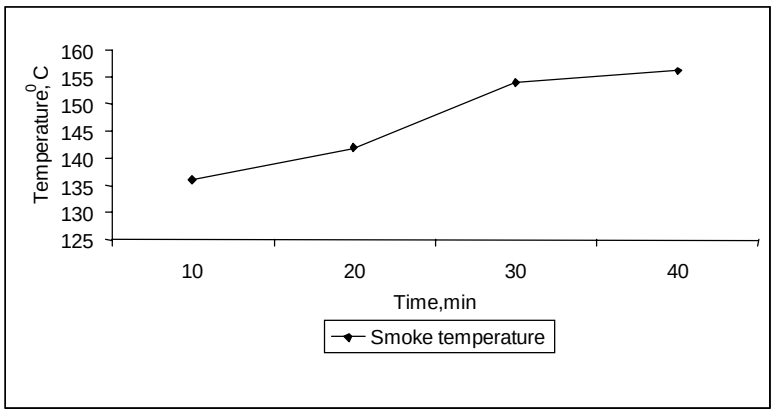

Fig 3: Smoke temperature (Wood: 10 kg)

Smoke temperature measured at the opening of chimney was found to be ranging from 136-156^{0}C (Fig.3). **It indicates that all the heat generated was utilized**. Inlet air temperature was measured at the opening of inlet pipe. Inlet air temperature was found to be in the range of 30.5-32.2^{0}C (Fig.4).

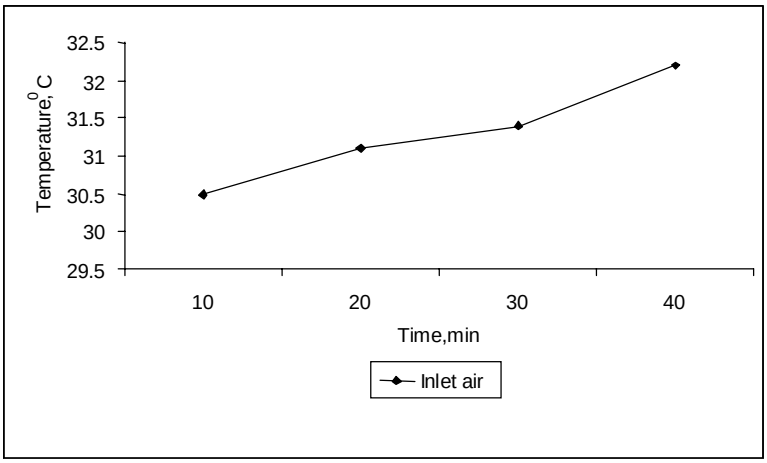

Fig 4: Inlet air temperature (wood: 10kg)

Overall thermal efficiency of gasifier

The overall thermal efficiency of gasifier burner system is evaluated by boiling test as stipulated by BIS for thermally efficient wood burning stoves. The overall efficiency of gasifier was found to be 17.21% (by water boiling test) which was much higher than that of efficiency of conventional chullas (10.22%) and the output of gasifier has worked out to be 24350 kcal/h (thermal). The power rating is nearly 30KW.

Mass and Energy balance of system

Mass balance is arrived at by measuring various inflow and outflow of materials; while energy balance can be calculated on the observation of energy content, temperatures of reactor etc. using appropriate equations of heat transfer. The mass closure was found to be 96.73%. Energy closure was 78 %.

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COMPARISON OF TECHNO-ECONOMIC ANALYSIS FOR WATER PUMP SET USING DIESEL ENGINE, ELECTRIC MOTOR & GASIFIER SYSTEM

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Abstract

This paper discusses the biomass gasifier system for water pumping. Actual data is collected for biomass gasifier system from GEDA. This paper emphasizes on the Techno Economic analysis for water pump set (3.72kW) using diesel engine, electric motor and gasifier system. The comparative study shows that the biomass gasifier save huge amount of fossil fuels and can be adapted for water pumping.

Literature Review

The massive pace of industrialization across the globe has been largely powered by energy that is overwhelmingly dependent on fossil fuels, hydro electric projects, thermal and nuclear plants. Only renewable energy source that is clean, green, free and inexhaustible could provide solution for environmental pollutions. Hence resource to renewable source of energy has become imperative and has become the need of the hour [1].

Conversion of raw biomass into secondary fuels (solid, liquid, or gas) for a variety of thermal, shaft power and electrical applications, through biological and thermal- chemical conversion processes has been promoted in India for about two decades [3].

At present 3.72 kW & 7.45 kW biomass gasifier systems for water pumping, & 3 kW to 500 kW terms for electrical power generation are commercially available in India [4].

This case study investigates the Techno-Economic analysis for water pump set (3.72kW) using diesel engine, electric motor and biomass gasifier system.

Introduction

Energy consumption is one of the indications of economics prosperity of a nation and also the extent of its industrialization. The massive pace of industrialization across the globe has been largely powered by energy that is overwhelmingly dependent on fossil fuels, hydro electric projects, thermal and nuclear plants. Only renewable energy source that is clean, green, free & inexhaustible could provide a solution. Hence resource to renewable source of energy has become imperative and has become the need of the hour.

Renewable Energy

The world is heavily relying on coal, oil, and natural gas for its energy. Fossil fuels are non-renewable, i.e. they draw on finite resource that will eventually dwindle, becoming too expensive or too environmentally damaging to retrieve. In contrast, renewable energy resources – such as

wind and solar energy are constantly replenished and will never run out. Most renewable energy comes either directly or indirectly from the sun.

Direct Solar - Solar Photovoltanic (PV)

- SolarThermal

Indirect - Water (Hydro Power)

- Ocean Thermal energy
- Wind Energy
- Biomass Energy

Biomass

The organic matter that make – up plants is known as biomass. Biomass can be used to produce electricity, transportation fuels, or chemicals. The energy content of dry biomass ranges from 15,904.9 kJ/ kg for straws to 17,579.1kJ/kg for wood. Domestic biomass resource include agricultural and forestry wastes, municipal solid wastes and industrial wastes. It provides the opportunity for local, regional and national energy self- sufficiency across the globe and energy derived from biomass does not have the negative environment impact associated with non- renewable energy sources.

Biomass contains energy is produced when plants are processed into other materials such as paper and animal wastes.

Gasifier Systems

Biomass gasification is basically the conversion of solid biomass into a combustible gas mixture called producer gas through partial combustion in a gasifier.

Up –Draft

- High quality charcoal is used as a fuel.
- Producer gas is badly contaminated with tar and is not suitable for IC Engines.
- Due to content products like oils and tars the calorific value of the gas produced is higher.

Downdraft

- Fuels are wood and agricultural waste
- Produces a relatively clean gas
- Mostly used for shaft power application.

Cross draft

- Fuel is high quality charcoal
- Not commonly used.

Case Study

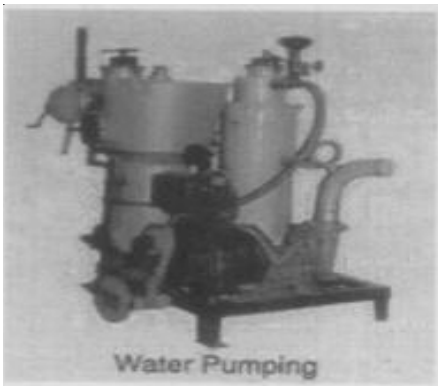


Figure 1 Biomass gasifier for water pumping

Techno Economics of Gasifier System

Consider a case of 3.72 kW systems usually available for water pump system.

Economic Viability

To estimate the operating cost of systems and establish the economic viability of these systems the following assumptions are calculated,

1. 10 Hr. operation per day.
2. 300 working days in a year.
3. Full load operation all the time.
4. Specific gravity of diesel as 0.8 kg / l
5. Average Calorific value of wood/ biomass – 1674.2 kJ/kg.
6. Average Calorific value of producer gas– 418.55 kJ/kg.
7. Gasification efficiency – 75 %
8. Quantity of gas produced - 28 m^3/kg.

a) Diesel Engine

Normal value of fuel consumption	=	0.26 kg/ kWh
Total diesel consumed / year	=	3,510 l
Cost of diesel for Rs. 35/l	=	Rs.1,22,850/-.
Total running cost per year	=	Rs.1,22,850/-.

b) Electrical Motor

Energy consumed by		
3.72kW motor pump set	=	3.6 * 300* 10
	=	10,800 kWh.
Cost of electricity @ Rs. 5/ kWh.	=	Rs. 54,000/-.
Total running cost per year	=	Rs. 54,000/-.

c) Gasifier based water pump set system:

Gasifier systems using water pump for irrigation will save 75 % diesel which is substituted by producer gas and thereby only 25 % diesel will be consumed per kWh. Therefore,

Diesel consumption		
for 2.5 % of 0.26 kg/ kWh	=	0.0065 kg/ kWh
Biomass consumed / kWh	=	0.7 kg/ kWh
Total input / kWh	=	0.7 kg of biomass
	+	0.0065 kg of diesel fuel
Diesel consumption	=	877.5 l
Cost of diesel Rs. 35 /l	=	Rs. 30,712.5/-
Biomass consumption 0.7* 300*10*3.6	=	7,560 Kg.
Average annual cost of biomass including Transport, etc for Rs. 1600 / metric tonne	=	Rs. 12,096/-
Total running cost per year	=	**Rs.45,832. 5/-**

This is based upon the assumptions starred earlier and that all other expenses towards operation and maintenance of the equipment remains unchanged.

Investment

1. **To run diesel pump set**

   cost of diesel pump set Rs. 12,000/-

2. **To run electrical motor**

   Cost of electrical motor and Other equipment's (wiring, meter.etc.) Rs 25,000/-

3. **To run gasifier based pump set**

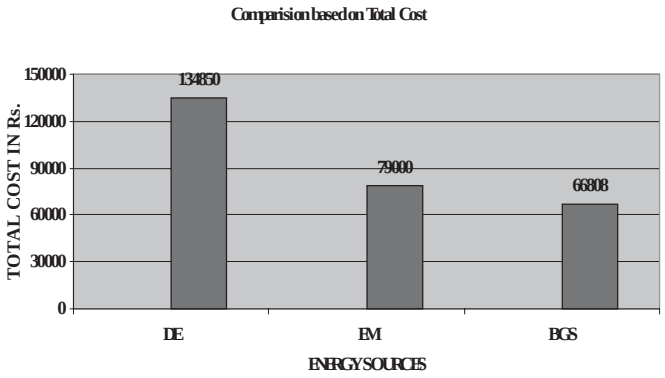
   Cost of gasifier with pump set Rs.32,000/-

   (25% Subsidy) Rs.24, 000/-

Conclusion

The total cost for the three different option of energizing a 3.72 kW. motor pump set are:

1. For diesel engine - pump set **Rs.1, 34,850/-**
2. For electrical motor - pump set **Rs.79, 000/-**
3. For gasifier based - pump set **Rs.66, 808/-**



If we considered that every year more than 1 million new irrigation pump sets are being added to the existing population of over 8 million sets. At least half a million new pump sets are being added are diesel based. Both types of pump set. i.e. electrical as well as diesel based, can be easily replaced by the gasifier engine pump combination.

Hence, if one million pump sets are to be energized annually, the investment for diesel option is Rs. 1,34,850/- crores, for electrical option is Rs.79,000/- crores and for gasifier based option it is only 66,808/- crores. The adoption of gasifier based systems could therefore result in national investment of saving alone of the order of Rs.68,042/- crores to Rs. 12,192/- crores per annum.

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WEALTH FROM AGRO WASTE

Dr. M.G. Gharpure and Mr. Shyam Rajale

Abstract

India has a large agriculture base but still there has been very little work done in the field of agro residue usage as fuel. Most of the industrialization has been considering liquid fuel as primary source of thermal energy. Coal, another fossil fuel, is primarily used in the power generation sector. There has been gross negligence by industry and public, at large, towards an un-harnessed potential of agro waste that has a large value as fuel.

The agro waste can be converted by an easy mechanical process to briquettes that can be used as fuel in the industry. This conversion is not only beneficial as fuel substitution but is a potential link between urban and rural economy.

Following article gives details of technical and commercial aspects of this unique opportunity, Wealth from Waste.

Prelude

Agricultural out put from India has seen phenomenal growth. Factors, which contributed to the development, were research in seeds, access to water and power, effective pesticides, communication and improvement in storage facility. With the growth in production of agricultural output agro-waste production is also increased. However, local thermal energy which are needs of rural sector were mainly managed through cow dung, wood, kerosene and lately LPG. Agro mass had few takers. In fact, storage of agro-mass posed problems such as security risk due to fire hazard, growth of pests, blockage of covered space etc. Simplest solution, which is even practiced today, is spread the waste and burn it.

On the other hand, in urban sector industrial growth is pushing the energy needs to hilt. Queues at petrol pump and chimneys spewing, fossil fuel burnt CO_2 are the concerns. Indian government had recognized and efforts to use biomass were started in 1980's. Some of the difficulties, which were noted in use of biomass, were:

- Low bulk density and tendency to scatter around.
- Moisture content.
- Transportation costs.

Drying and briquetting was therefore the right answer.

Fiscal and economical incentives were announced and that led to installation of various briquetting plants. Early birds however, did not have the beginner's advantage. On the contrary arm twisting techniques of urban buyers, poor credit facility, enforced most of the entrepreneurs to shut the shop.

Today however, due to movement called clean development mechanism, renewed vigour is felt in this area.

Briquetting process

The briquetting process is pretty simple. The machinery involved is a simple reciprocating machine that compresses the bio-mass to one fifth volume. The mechanical pressure exerted on

the biomass is equivalent to 1350 kg/cm^2. Due to this high-pressure mechanical operation, there is heat generation, which evaporates the entrapped moisture and gives a polished finishing. The compacted biomass is extruded through a die, which also decided the diameter of briquette.

Some raw materials are wet and do not form good solid compact briquette. There is a separate dryer provided in the system for making the material suitable for briquetting. Lubricating oil cooling system and electrical system are additionally required for briquetting plant. Power requirement for briquetting plant is proportional to tonnage. A broad requirement of 60 Units per ton of briquette can be considered as benchmark.

Raw Material

Though biomass is a very popularly talked about term, the real meaning of it is not clearly understood. Particularly, in the context of briquette manufacturing, all bio degradable agro wastes can be easily briquetted. The briquettable bio mass need not be always raw material in the same form. High moisture content bio mass needs be solar dried or dried by fuel firing before briquetting. Some of the raw materials are not easily briquetted. It is necessary to add agro or synthetic binders. Briquettes made out of such binders are not of desired quality, as the binders do not mix thoroughly and uniformly.

Machine selection

Machine has to be selected as per available raw material. Usually these are available as 25, 50, 60, 90 mm. Smaller M/c needs finer raw material where as if bigger agro mass such as corn cobs are to be briquetted 90mm dia is appropriate.

Bigger size M/c achieves good productivity and labour. Absence of grid power and its eruptive supply on the additive factors, which compel use of 90 mm M/c.

Manpower requirement

Usually raw material is handed over to factories by Tractor trolley. Manpower is needed for unloading, spreading for solar dryers and feed hopper belt. Usually one person per ton of briquette is required. A person with good Mechanical Engg. aptitude can maintain overall the M/c.

Business effectiveness

Manufacturing of briquette can be classified as high volume low cost business. Approximate breakup 45% raw material, 15% raw material transportation, 15% Power, 10% Investment (full production), 9% Other expenses and 6% Profit.

Thus, it is essential to procure raw material in time. The rural sector demands immediate cash payments. Therefore, liquidity by prompt recovery of dues is necessary. Business is quite sensitive to cost of transport fuel. Convenient Transporters who are having two-way business offer low rates. Planning of loading unloading manpower, knowledge of status of inventory at user end can affect profitability substantially.

Conclusion

Business of briquette manufacturing is seeing good growth in recent past. However, in this enthusiasm past mistakes should not be repeated. For enthusiastic entrepreneur business offers exciting opportunities.

A TECHNO-ECONOMICALLY FEASIBLE APPROACH TO USING AGROWASTE AS A RENEWABLE SOURCE OF ENERGY

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Abstract

Among all renewable resources, biomass energy is the most neglected and underestimated. The main reason is that people think only of wood as a source of biomass energy. Due to excessive deforestation and related adverse environmental consequences, use of wood for energy production is generally considered to be an unsustainable practice. On the other hand, several billion tons of agricultural waste is generated annually in India, most of which goes totally waste. Technologies are already available for converting biomass into a variety of usable fuels such as briquettes, charcoal, biogas, woodgas, alcohol, biodiesel, etc. as well as usable forms of energy such as electricity, heat, etc. The biomass fuels are counterparts of the solid, liquid and gaseous fossil fuels that we are currently using. This means that the technologies that have been perfected over the last two hundred years or so for efficient utilization of the fossil fuels can continue to be useful in post-fossil fuel era, with only slight modifications required to accommodate the different characteristics of the corresponding biomass fuels. The financial and technological input required for a shift from fossil fuels to renewables is and should be an important consideration for a developing nation like India.

However, the agricultural waste is a low-density biomass, scattered all over the country. Also, it is available in a wide variety of forms having a wide variety of physical and chemical properties. As a result, in spite of its tremendous potential as a renewable source of energy, it has remained more or less neglected by the energy planners as well as technocrats. Also, almost all attempts at finding economically feasible ways of using biomass as a source of energy on a wide scale have proved unsuccessful and unsustainable. We however, believe that it is technoeconomically feasible to use biomass as a source of energy. An excellent example of the right approach to use of biomass energy is a chain of technologies developed and successfully commercialized by Appropriate Rural Technology Institute.

Every year, farmers in Maharashtra state alone are simply burning off millions of tons of sugarcane trash (dried leaves of sugarcane left in the field after harvesting of the cane). In 1997, the author undertook a project that attempted to explore means of converting this biomass into a value-added fuel, namely char briquettes.

Under the project an oven-and-retort type charring kiln was developed. It converted sugarcane trash into powdery char. We also standardised the machine and methodology for converting the char powder into char briquettes.

The charring kiln can be easily dismantled and transferred from one location to other, thereby eliminating the need to transport large quantities of loose biomass. Operated as a continuous batch

process, it consumes about 250 kg of trash to generate about 50 kg of char powder every day. Three unskilled labourers can operate two kilns simultaneously to produce 100 kg char powder per day. The powder can then be briquetted by using a briquetting machine. The production cost of the briquettes is about Rs. 8 per kg.

Kerosene, which is the preferred cooking fuel for of the urban poor, is getting costlier and costlier as the government is gradually withdrawing the subsidy on it. We felt that the char briquettes made from agricultural waste could be a suitable low cost alternative fuel for the urban poor. However, switching from one form of fuel to other also requires a switch over from one type of cooking stove to other. It was, therefore, necessary to develop a cooking stove that was designed to suit the combustion characteristics of the char briquettes. We, therefore, developed the Sarai cooker. The cooker combines the principle of a hotbox, with the principle of a fuel-efficient stove. The result is so energy efficient that it requires just about 100 gm of char briquettes to cook vegetables, rice and dal for a family of five, and another 50 gm or so for roasting rotis on the charcoal burning stove which is part of the cooker assembly. Even if the briquettes are available in the urban market at the rate of Rs.10 per kg, the Sarai system requires fuel worth just about Re.1 per meal. No other fuel-stove system has such a low operating cost.

The concept has taken off very well among urban as well as rural households in rice eating localities in Maharashtra. The reasons for it is its practical feasibility which is as follow:

1. Conventional thinking had always focused on producing tons of briquettes in a centrally located factory. This involves collection and transportation of widely scattered and low density raw material, and the transportation cost itself renders the entire project impractical. Our approach of decentralized production of char, and transportation of the char to a centrally located briquetting facility makes more economic sense.

2. The Sarai cooker is assembled using components already available in the utensils market. Thus, the production of the cooker does not involve any dedicated machinery or infrastructure. As a result, the cooker can be produced at a relatively low cost of about Rs.350-500 (depending mainly on the cost of stainless steel) making it affordable for the target users and profitable for the producer and retailers.

3. Because of the efficient design of the stove, the quantity of fuel required per meal is very less, keeping the cost of fuel per meal cooked at the lowest possible level for the consumer. This allows the per kg cost of the briquettes to be high enough to provide sufficient net income to the char producers, the briquetters, as well as the retailers.

This example clearly demonstrates that it is possible to find ways of using biomass energy in technoeconomically feasible ways. Considering the huge amount of agrowaste produced annually in India, it can be easily seen that the chain of technologies described here can have a tremendous positive impact on the rural economy of the country.

BIO-GAS -A GIFT FOR RURAL ELECTRIFICATION SYSTEM

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Introduction

The world today is behind two resources - energy and water. Over the years man has utilized positively or negatively various conventional resources to satisfy his needs and greed. Thus, limited storage of resources have been depleting steadily. Hence the propagation of non-conventional energy sources and their utilization is imperative today.

Why Bio-gas?

Bio gas generated from locally available waste material seems to be one of the answers to the energy problem in most rural areas of developing countries. (Refer Fig 3) Gas generation consumes about one fourth of the dung but available heat of gas is about 20% more than that of obtained by burning the entire amount of dung directly. This is mainly due to very high efficiency (60 %) of utilization compared to poor efficiency (11%) of burning dung cakes directly. The technology thus seeded and spawned is populist technology based on 'Nature's income and not on nature's capital' so being an agricultural country use of bio-gas as a fuel for cooking or lighting purpose can be the best solution for all Indian farmer families.

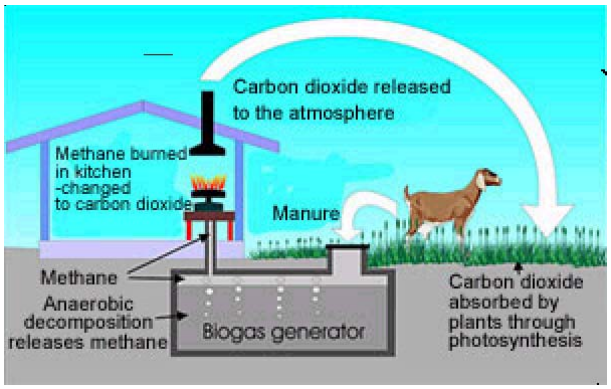

Fig.. 3 Bio-Gas as a Renewable Energy

Potential for Bio-gas energy

The potential of renewable energy in India is estimated as 1,00,000 MW while for bio-gas and bio-mass it is 19,500 MW. So there is need to bring about change in mind to focus on renewable sources of energy. No matter whether you get the power from Thermal Power station , Hydro Power Plant or from Bio-gas Plant, the end product is energy and power.

Bio-gas technology – General Description

Bio-gas or gober-gas is clear, odorless combustible gas which is produced when organic matter content in animal excrements like dung, human night soil, parts of a tender plants or residues like leaves, stems and straws are anaerobically fermented with the help of methenological bacteria in air and water tight containers called bio-gas digester.

Chemically, a useful gas is just a methane gas. It's chemical composition consist of one part of carbon (C) and four parts of Hydrogen molecule. It's chemical formula is CH_4 .Bio-gas burns with clear blue flame without giving any smoke. It's flame temperature is up to 800 ^oC and it has calorific value of 5650 KCAL/ m^3

Technical aspects

Bio-gas is a mixture of :

Methane (CH_4)	:	50 to 70 %
Carbon-dioxide (CO_2)	:	30 to 40 %
Hydrogen (H_2)	:	5 to 10 %
Nitrogen (N_2)	:	1 to 2 %
Hydrogen Sulphide (H_2S)	:	Small quantity

Bio-gas is generated when bacteria degrade biological material in absence of oxygen process known as anaerobic digestion. This process produces less temperature hence valuable in terms of energy conservation.

Components of Bio-gas Plant

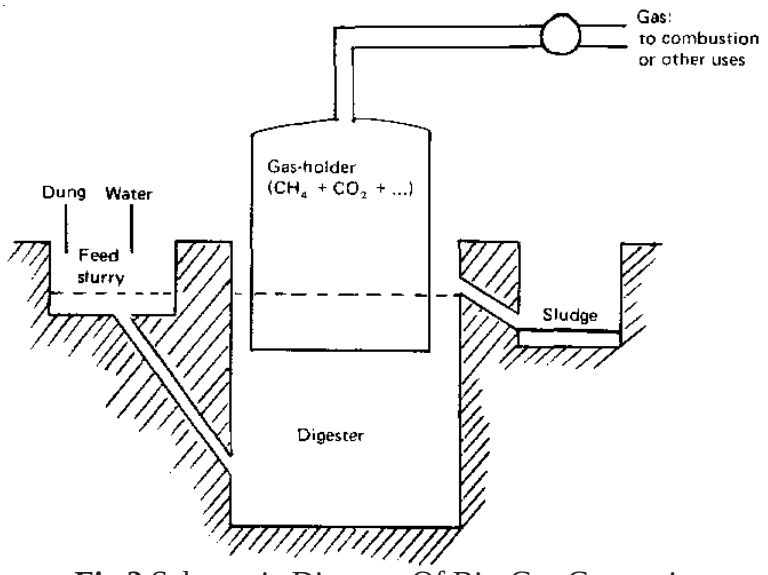

Fig 2 Schematic Diagram Of Bio-Gas Generation

A typical bio-gas plant has the following components (Ref . fig.no.2)

- A digester – in which the slurry (dung mixed with water) is fermented.
- An inlet tank - used to mix the feed and let it into the digester.
- A gas holder/ Dome – in which the generated gas is collected
- An outlet tank – to remove the used slurry
- Distribution pipe line – to take the gas to the place where it is required.
- A manure pit – where used slurry can store.

Bio-gas Digester

With bio-gas technology waste is stored in specially constructed containers while being digested and there are no of technologies used to accomplish this.

- Batch type digester – treat a large amount of materials at once. They are generally used for large scale applications.
- Continuous flow type – add and remove waste material on daily or regular basis. They are best suited for small scale domestic applications.

Digester Types

Fig. 1Fixed Dome Type Bio-Gas Plant

- Fixed Dome Type (refer fig. 1)
- Floating Drum
- Balloon Type

Information required to design and Install a bio-gas digester include

- size of family and daily cooking and lighting requirement
- availability of amount of feed stock (water, no & type of cattle)
- material available on site for construction of digester

With this information the type of digester, required digester volume and retention time can be determined.

Raw Material

Input material for biogas production is the waste that is found locally such as animal dung, agricultural residues, leaf litter from forest etc. Even human waste, poultry droppings, kitchen waste, paper waste, waste from sugarcane refineries can be used as input to biogas digester.

Basic factors of biogas production

Biogas generation serves a triple function- waste removal, management of environment and energy production. For fermentation of organic, matter to produce biogas, sufficient population and growth of methanogenic bacteria is essential, besides the carbon and nitrogen contents of raw materials in the digester. Some other essential factors are

- Airtight or anaerobic (Oxygen less) environment
- Conducive temperature

➢ The growth of methanogenic bacteria is affected by temperature inside the digester, which in turn is affected by atmospheric temperature at any given type.

➢ The optimum temperature for biogas production is 30^{o}C

➢ Biogas production could be increased up to 45 to 55^{o}C, but the biogas production could be hampered due to destruction of enzymes at temperature higher than 55^{o}C.

➢ Biogas could be produced at temperature of 12 to 18^{o}C but information technology would not be economically beneficial.

➢ Biogas production stops at temperature below 10^{o}C

- **PH-**

➢ PH has decisive role in biogas production as methanogenic bacteria are very sensitive to pH

➢ For mesophilic and thermophilic bacteria pH of 6-7 is appropriate.

- **Dilution**

➢ Water is essential for the fermentation of organic matter for production of biogas.

➢ Water requirement by weight is as much as that of organic material.

- Carbon /nitrogen (C/N) ratio

➢ For anaerobic digestion C/N ratio of 1:20-1:30 is considered appropriate.

➢ A C/N ratio of 1:33 is optimum.

➢ A C/N ratio should not be more than 1:35.

- Retention time

➢ The feed mixture of organic material and water fed into digester has to be retained inside for sometime to allow complete decomposition and give out biogas before coming out a slurry. The length of time elapsed between the time of feeding and coming out of the slurry is called retention time.

➢ The length of time depends upon the rate of decomposition, which in turn affected by atmosphere.

Temperature (°C)	Min retention time (Day)	Optimum retention time (Day)
20	11	28
25	8	20
30	6	14
35	4	10
40	4	10

Advantages

- One cubic meter of biogas is equivalent to –

  3.47 Kg of wood
  0.63 liter of kerosene oil
  0.61 liter of diesel oil
  1.5 Kg Of coal
  1.25 KWh of electricity
  0.45 Kg of LPG
  13 Kg of fuel dung
  0.5 Kg of butane.

- It is non polluting
- It gives cheap and easily available energy.
- It uses waste like animal and human excreta and plant residues, which can otherwise create undesirable conditions. So it can give hygienic, clean and safe atmosphere around populated areas.
- Its slurry could be used as a nutrient rich manure in farms and could tremendously improved agriculture production (refer following table)

Manure type	Nitrogen %	Potassium %	Phosphorous %
Farm yard manure	0.5-1	0.5-0.8	0.5-1
Digested slurry(Liquid)	1.5 –2	1	1
Digested slurry (Dried)	1.3-1.7	0.85	0.85

- It can substitute firewood for cooking, heating, fuel and kerosene for lighting so saving in foreign currency normally spent in fuel and fertilizers.
- Socially it can save a lot of time and labour in activities such as cleaning, washing and cooking, which they can use for other income generating /saving activities to care more for their children and to learn.

- Environmentally information technology can save wood and through that help to save vulnerable forest, soil, water and clean of the environment.

The substituting effect of biogas produced from different sized plants

Size of plant (m^3)	Dung needed (kg/day)	Operation of oven (hour/day)	Daily gas production (m^3 /day)	Substitute for			
				Wood (Kg/day)	Coal (Kg/day)	Kerosene (Kg/day)	Dung (Kg/day)
6	36	4	1.62	5.62	2.43	1	21.06
8	48	6	2.16	7.5	3.24	1.34	28.08
10	60	7	2.7	9.37	4.05	1.67	35.1

Details Of existing model

Installed at - Shri Gopal Goushala – Adgaon, Tal. Bhiwandi, Dist. Thane

Specifications

Number of Cattle – 750

Dung available – 5.2 Tones

Dung Utilized per day –1 to 2 Tones

Digester Volume – 45 cubic meters

Digester Height – 1.8 meter

Retention Time – 2 days

Specifications of Alternator

Model RGA 315

3 Phase, 15 KVA, 415 Volt, 20.9 Amp, 1500 rpm, 0.8 power factor

Process

Dung diluted with water is fed to digester. Generated gas in combination with Diesel is used to run Duel Fuel Generator. Proportion of fuel is approx. 80% of gas & 20% Diesel. Electricity generated is not stored but utilized directly for pumping water,house lighting & for small scale industry for approximately 8 hours.

Future Scope

Today as only 20% of available dung is used, future expansion is possible by Increasing number & size of digesters. Also efficiency of the plant can be increased by using hot water for dilution.

Limitations

- Bio-gas plants can only be installed in household with required number of animals for daily dung supply.

- It increases the work load by way of feeding bio-gas plants and handling slurry.
- A water supply is needed nearby, to supply enough water to dilute fresh dung.
- Bio-gas production being dependent on temperature cannot be used at altitudes above 2000 mtrs. above mean sea level.
- Remoteness of installation site pose a problem for the transportation of raw materials.

Durability

The structural durability of biogas plant is taken as 20 years for digester plant but gas drum and fittings could have shorter life.

Conclusion

Biogas is especially relevant for the introduction of small-scale decentralized energy systems, which are very appropriate for the country's pattern of rural and agricultural economy. Considering that organic wastes are anyway generated plentifully in any nation, it is always advantageous to view biogas as a renewable energy source, which holds considerable promise for meeting part of the energy needs of a nation.

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BIODIESEL FUELS FOR THE FUTURE

Presented by Pitambari

Cardinal product Pvt. Ltd.(R/586) R & D, Navi Mumbai - 400 701
Tel. No. 27696394 / 27696395 • Mobile 9820546402

Introduction

Company Structure,
Research and Development Centre,
Division: Agro, Healthcare and Homecare.

Biodiesel fuel for future

Global development in Biodiesel
Biodiesel program in India
Importance of Biodiesel

Opportunity of Biodiesel.

Economic Benefit
Benefit in national interest
Advantage of svo and Biodiesel

Non edible oil in India

Cultivation/Plantation of Jatropha and Karanj Plant.

Introduction
Benefit of Karanj & jatropha cultivation
Biodiesel plantation requirement
Nursery preparation

Extraction of oil

Specification of Karanj / jatropha oil

Acid value
Viscosity
Refractive Index
Specific Gravity
Parameters for pollution
Parameter for fuel

Biodiesel flow chart

SVO economics over diesel

Rural Employment

Scope of Karanj & jatropha plantation over aloe Vera plantation.

Activity in our organization

Our future task

Expectation & support from government.

BIODIESEL

FUELS FOR THE FUTURE

Biodiesel is produced from animal fats, Veg. Oil, waste cooking by lipid transesterification.

Forty years before the first diesel engine was demonstrated by Rudolf diesel on August 10, 1893 in Germany. He used a vegetable oil.

In remembrance of the event in 1893 August 10 has been declared **International Biodiesel Day.**

Global development in Biodiesel

Several countries like Australia, France, Germany, Hong Kong, Italy, Malaysia, Sweden, UK and USA biodiesel has been produced and tested within the period of the last 10 years.

Development in India on Biodiesel

India is the sixth country in the world with a billion population. Our country faces problems in regard to the fuel requirement for increased transportation demand and now imports about 70 % of its petroleum requirement .The petroleum import bill is about 14 billion dollars. The current yearly consumption of diesel oil in India is approximately 40 million tones forming 40 % of the total petroleum products consumption. The potential demand for Biodiesel at 20% blend is estimated at 13.38 million tones per annum by 2012.

In the present problematic traditional cultivation, raising of energy plantation to produce Biodiesel, farmers can develop and utilize waste lands and improve incomes, rural labour will have more employment opportunities and soil fertility and condition will improve.

Any vegetable oil can be converted in to Biodiesel; however, in India there is no surplus production of edible oil. Therefore, the oil that can be used as Biodiesel has to be non-edible oil.

Produced in abundance and with stand harsh climate, as they would be taken up in wastelands, the most suitable species in this regard are Jatropha and Pongamia. These plants could be grown on wasteland about 80 million hectares of which is available in India.

The oil extracted from the seed is used in place of diesel after simple filtration. After further processing this can be used in four wheelers. The seed cake after extraction of oil will be very good organic manure as it contain high nitrogen content. This cake can also be utilized for biogas production. The pruned leaves are used as green leaf manure.

Biodiesel program in India

In India most of the trials were done using bio diesel from Karanj and Jatropha.

(Ref. chemical weekly)

In December 31, 2002: - Indian Railway Conducted a successful trial run of an Express Passenger train on the Delhi-Amritsar rout using 5% of biodiesel as fuel.

Indian Oil Corporation began in January 2004 field trials of running buses on diesel doped with 5% biodiesel.

Hariyana Roadway buses used of Biodiesel.

Automobile manufacturers like Mahindra and Mahindra, Ashok Leyland etc. have already tried biodiesel mix as a fuel for their vehicles.

Harbinsons Biotech Pvt. Ltd. has set up pilot plant at Gurgaon. IIT Delhi, IIT Chennai, have already set up a biodiesel products facility of 60 kg/day at Faridabad.

Mahindra and Mahindra Ltd. has a pilot plant using **Karanj for Biodiesel production in Mumbai.**

What are biofuels

- Renewable fuels from biosources.
- Include

1. Ethanol
2. Biodiesel
3. Biogas

Why Biofuels

- Pollution threat
- Reduction of green house gas emission
- Regional development
- Social structure & Agriculture
- Security of supply.

Importance of Biodiesel

- Environment friendly
- Clean burning
- Renewable fuel
- No engine modification
- Increase in Engine life
- Biodegradable & non toxic
- Easy to handle and store.

Economic Benefits. (Credit opportunities of Biodiesel)

Sr.	Parameters	Quantity /	Rs in crores
1	Imports Currently Petroleum Products.	70.00%	1,27,000
2	Petroleum products Demand Target (2006-07)	120.4 MT	
3	Domestic Production of Crude oil and Natural Gas	33.97 MT	
4	Huge gap Between Demand and Production	86.43 MT	
5	Current Consumption of Diesel in India Approximately	40 MT	
6	Consumption Expected to reach in 2006-07 (5.6 % increases)	52.32 MT	
7	Crude Oil Requirement	105 MT	
8	Imports Of Crude Oil	70.00%	
9	Present Production of Crude Oil	30.00%	
10	Demand of Crude oil in 2006-07	78.00 MT	

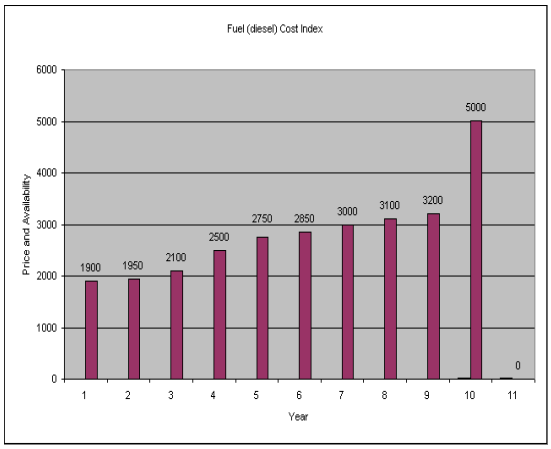
The economy of a country mainly depends upon its energy source. Energy source is the main contribution factor for the development and growth of the developing countries. Among the various sources identified for alternate fuel Non-edible oils were considered to be ideal in view of compatible properties with respect to diesel. This Biodiesel concept is been adopted with Jatropha and Karanj oils in our country.

India has vast tract of degraded lands, mostly in areas with adverse Agro - Climatic condition, where hardy tree bone oil seed Species like jatropha, Karanj, etc. can be grown easily. Even 30 million Hectares planted for Biodiesel can completely replace the current use of Fossil fuel. Our oil bill is presently $ 6 Million a Year and the Waste Land Development would required only about 1000 Crores per Year for 20 Years to make India self sufficient forever in oil.

Developing A strong market for Biodiesel would have Treatmendous economic Benefits. Investment in Biodiesel will have great Future.

FUEL DIESELCOST INDEX

Title	1	2	3	4	5	6	7	8	9	10	11
Year	94-95	95-96	210	250	99-2000	2001-02	2002-03	2003-04	2004-05	2020-2025	2030
Price	1900	1950	2100	2500	2750	2850	3000	3100	3200	5000	Not Available



BIODIESEL

Benefits in national interest

1. Recent trends are indicative of tremendous increase in production of commercial vehicles and consumption of diesel. So biodiesel shows good potentials growth for demand.
2. Superior eco friendly fuel in economic point of view.
3. Energy independent
4. Environmental safety
5. Self dependent - industries, transportation, other industries
6. Barren land will be under cultivation
7. Self employment in rural region
8. Self dependent villages
9. Stable economy
10. Generating power to meet their basic needs
11. Increasing local employment during dry season
12. By generating extra income from irrigated lands during off seasons
13. Using the oil cake residue as organic fertilizer and thus reducing the use of chemical fertilizer
14. Reducing the use fossil fuel
15. Income from barren land by cultivation
16. Rural development

Advantages OF SVO & BIODIESEL

1. 100% domestic fuel.
2. In future cheaper than diesel.
3. Oil is safe, toxic and Biodegradable.
4. Need no change in refueling infrastructures and spare part inventories.
5. Cetane number is significant higher than diesel.
6. Has a high flash point compare to diesel
7. Less polluting: - They emit approximately 80% less CO2 and almost 100% less Sulphur dioxide.
8. Oil contains 11 % oxygen. So that it burn totally. Whereas in diesel oxygen is nil.
9. 20 % or 30 % oil can mix in diesel.

Non-edible oil seeds and oil in India

State	Gross Potential	Total capacity till 30.09.2004	Technical Potential
Andhra Pradesh	8275	101.3	1750
Gujarat	9675	218.05	1780
Karnataka	6620	274.2	1120
Kerala	875	2	605
Madhya Pradesh	5500	26.35	825
Maharashtra	3650	411.15	3020
Rajasthan	5400	212	895
Tamil Nadu	3050	1683.6	1750
West Bengal	450	1.1	450
Others	2990	3.1	-
Total	**45195**	**2884.75**	**12875**

Karanj and Jatropha cultivation

Introduction

Bio Diesel is source of energy, supplement for Petroleum products. Bio Diesel is manufactured by using different edible and non-edible oils but edible oils use is not economical and no surplus production for costing purposes. So other sources are non-edible oils, such as Karanj oil, Neem oil, Mahua Oil, Jatropha oil, and Karanj oil. In compression ignition and spark ignition engines for different utilities Since India can not affroad the use of edible vegetable oils as power sources because of short supply, Researcher and planner suggested the use of non edible vegetable oils as alternatives fuels like Pongamia, Jatropha and Neem etc .As India consists of 40% of waste land .It is develop all theses lands by growing non edible oil plants which not only gives the oil but also enriches the environment by adding the green forest cover for Ecological balance.

According to Indian climate and Research Government of India decided to undertake plantation of Karanj and Jatropha plants in barren, waste and unfertile soil from North to South and East to West, Government of India decided two Non Edible oils from Karanj and Jatropha plants are suitable for Biodiesel manufacturing.

So it is better to use the available plants, which produce the non-edible oil seeds to cater the needs at rural level for self-sustainability. Though there are more than 300 different species of trees which produces oil bearing seeds, pongamia and jatropha are the drought resistant plants, which grow with limited water which has enough potential to meet the fossil fuel demand at rural level. Hence these plants can well be utilized to produce the Biodiesel at rural and industrial level.

Karanj plant is known by different names as per local level. ***Pongamia pinnata*** is botanical name from leguminosea family. It has different uses, medicinal as well as Ayurvedic. Karanj has long life from 60 to 80 years. It has tendency to stay in drought condition, no need of irrigation. Karanj plant is resistant to diseases and insects free. They also used as road shading tree because it is green in summer also. So it helps to increase the natural beauty and decrease the soil erosion. Karanj cake and leaves also helpful in organic manure accordingly it helps to increase the economy of Indian farmers.

Now a days agriculture forestry Dept. worked on different varieties of Karanj plant for high yielding and high oil percentage. Some institutions like SuTRA, Dept. of Mechanical Engg., Indian Institute of Science, Bangalore has developed the hybrid variety by grafting which is high yielding and oil percentages.

Planting methods, fertilizers and new techniques also developed. Stump technique is method in which plants are grown for one year in nursery and transfer in the field after one year by making stump shape by removing leaves and branches which is more convenient for transportation. It saves the money and nursery accessories. Other technique is tissue culture, helps to produce good quality seed plant in short time.

Jatropha curcus is plant belongs to Euphorbiaceae family known by Mogali Erand, Ratan jyot, Ratna jyot in Telagu Nepalam and Yellamunaka, in Kannada Kadalabudu.etc. in different regions of India . Jatropha plant is used by local and Adivasi people for different purpose. All parts of plants are used by local people. It has medicinal value. Its roots are used against Aatisaar, stem used for dental problem an4 tooth cleaning, leaf extract also useful in cattle problem.

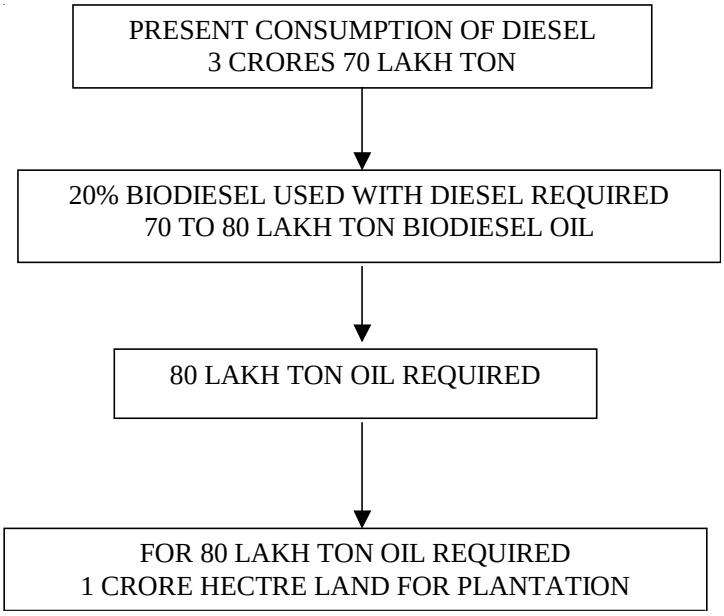
Benefits of Karnj and Jatropha cultivation: -

- Cultivation of Karanj and Jatropha plants prevents soil erosion and makes the soil fertile.
- Cost of cultivation is low as compare to other plants.
- Low requirement of water and also stay in low ground water level.
- Seasonal and regional acceptance.
- Often cheated by unfavorable monsoon.
- Lack of insurance coverage.
- Long life plant
- Low insect and disease damage.
- It increases rural employment.
- Pollution control.

- It helps to increase the economy level of farmer.

Bio-Diesel

Plantation Requirement



Nursery preparation

1. In our R&D - R/586 we are going to prepare 10,000 Karanj nursery plants (from seed and grafting).
2. Now we have prepared 500 Karanj plants from seed, and 200 jatropha plants from seed and grafting.
3. 80 hybrid Karanj plants procured from SuTRA, Bangalore for grafting.

Procurement of Karanj seed

Seeds are collected from local area, Shahad.

Bag filling for plants

Bag filling is done in 1:1:1 proportion. One part of soil, one part of sand and one part of organic manure (Gomay).

Germination of seed

Seeds are incubated at 35°C temperature in incubator till germination. After germination theses seeds are transferred in polythene Bag.

Grafting of nursery Karanj plant

Grafting will be carried after 6 months of seedling but it is not practiced in R&D, but work is going on.

Cutting/ grafting of Jatropha plant

For Cutting/ grafting high yield plants are identified from Angaon local area and 30 cm stem pieces are used for grafting.

Oil extraction

We have planned for oil extraction from different non-edible seeds like Neem, Mahua, Karanj, jatropha and castor, edible seeds like sesamum.

Now at Angaon unit we are installing the oil expeller for oil extraction and seed Decorticator.

Karanj seed/ jatropha seed purchase

For quality seeds of Karanj and jatropha we are standardizing the soxhlet oil extraction method at our R&D level.

Oils from

- jatropha complete seed
- jatropha embryo
- jatropha seed coat
- Karanj seed

For our quality seed yields and oil percentage we are developing Demonstration plot of Karanj at Angaon as a quality objective taken by our management.

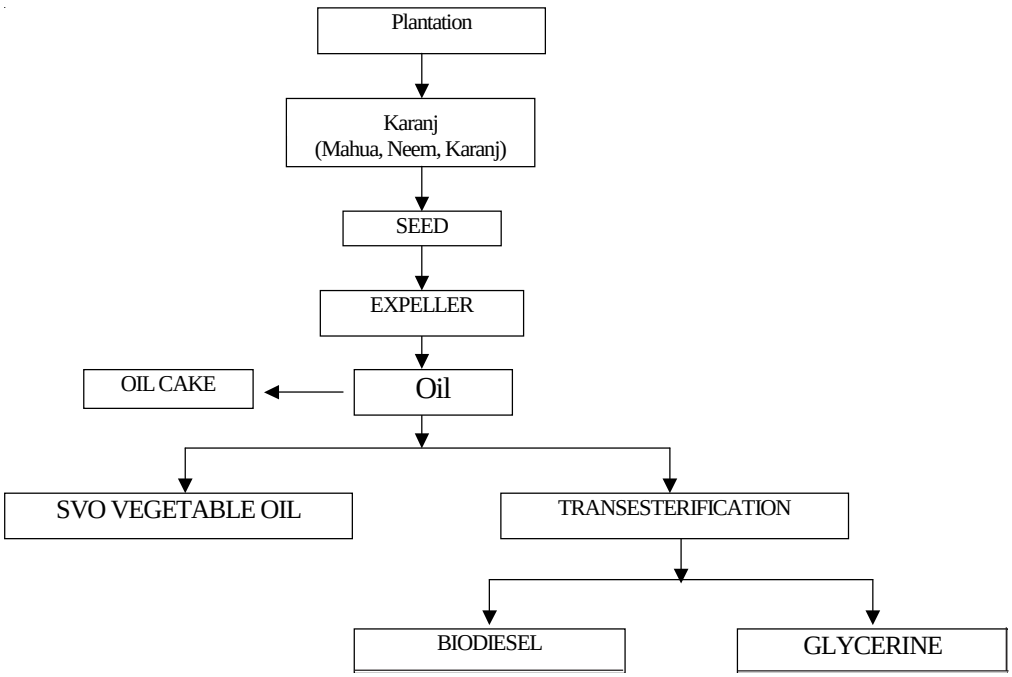
Specification of Jatropha oil

Sr. No.	Charactersistics	Speciation
1	*Description*	
	a) Appearance	clear
	b) Odour	Peculiar pungent (disagreeable odour)
	c) Colour	Light Reddish brown
2	*Physicochemical test*	
	a) Refractive index	1.465- 1.475
	b) Specific gravity	0.910-0.922
	c) Viscosity (Flow cup)	20-23
	d) Sap value	185-196
	e) Acid value	Below 5
	f) Iodine value	93 - 107
3	GLC - Composition	
	a) Palmitic acid	12 -17%
	b) Oliec acid	37 -63 %
	c) Steraric acid	5 - 9.7 %
	d) Linoleic acid	19-41 %

Specification of Karanj oil

Sr. No.	Charactersistics	Speciation
1	***Description***	
	a) Appearance	clear
	b) Odour	Peculiar pungent
	c) Colour	Yellow orange
2	***Physicochemical test***	
	a) Refractive index	1.478 -1.482
	b) Specific gravity	0.915-0.935
	c) Viscosity (Flow Cup)	23-26 sec
	d) Sap value	178-190
	e) Acid value	Below 7
	f) Iodine value	90-120
3	**GLC - Composition**	
	a) Palmitic acid	3 - 11 %
	b) Oliec acid	44-71 %
	c) Steraric acid	2.4 - 8.9 %
	d) Linoleic acid	10 - 19 %

PROJECT BIO DIESEL



SVO Economic over diesel

Sr. No.	Process	Cost (Rs.)
1	Seed cost/kg.	8
2	(Oil yield 30%) for 1 lt. Oil	26.8
3	Conversion cost of oil	3
4	Total oil cost	29.8
5	Cost of oil cake as FYM	-5
6	Actual cost of oil	24.8
7	Cost of diesel	37.8

RURAL EMPLOYMENT

Employment Generation and Cost in Jatropha and Karanj Plantation.

1	Site preparation i.e. cleaning and leveling of fields 10 Acre	600		10	
2	Alignment and staking	300		5	
3	Digging of pits (2500 Nos) of 30 CM^3 size @ 50 pits per Employ	3000		50	
4	Cost of FYM (including carriage) 2 kg per pit during first year (2 MT) 1 kg per pit during second year onwards @ Rs. 400MT	2000		20	
5	Cost of fertilizers @ Rs. 6 per kg (50 gm per plant) during first year and 25 gm from second year onwards and 2 MT for each application	870	495	2	1
6	Mixing of FYM, insecticides, fertilizers and refilling of pits @ 100 pits per employee	1500		25	
7	Cost of plants (Including carriage 2500 Nos during first year and 500 Nos of plants during second year for replanting @ Rs. 4 per plant.	10000	2000	100	20
8	Planting and replanting cost 100 plants per employee.	1500	300	25	5
9	Irrigation 3 irrigations during first year and one irrigation during second year @ Rs. 500 per irrigation	1500	500	5	2
10	Weeding and soil working 10 employee x 2 time for 2 years	1200	1200	20	20
11	Plant protection measures	300		1	—
	Subtotal	22770	4495	263	48
	Contingency (approximate 10% of the above)	2230	505		
	Grand Total	25000	5000	268	48

SCOPE OF KARANJ, JATROPHA PLANTATION

OVER

ALOE VERA PLANTATION

Before 4 to 5 years aloe Vera cultivation / aloe Vera product have greater demand in India. During that time many private organization and Government has declared many subsidies and by back schemes. Indian farmers had cultivated Aloe Vera in large area of India because of there visual benefit/profit .In reality they could not get such expected profit/benefit. So farmers had wasted their land on Aloe Vera cultivation and get loss.

Now a days bio diesel project has such demand because of increasing demand and cost of petroleum products. Biodiesel is prepared by non-edible oil of Karanj, Jatropha and Mahua etc. for supply of oil; Jatropha and Karanj plant cultivation is essential.

Selected Jatropha and Karanj plant cultivation gives surplus and continuous production of seeds for year after year. So these project /cultivation has large potential and bright future because of

1. Low cost expenditure
2. One time investment
3. Govt. subsidies
4. Plant life is 60 to 80 years
5. Inter cropping is possible (vegetables/pluses)
6. Seed storage possible
7. Oil extraction and storage possible
8. Oil can be used to generate Electricity, DG Generator Set, Own Farm Pump, Vehicles, Stove and Lantern.

Compare to Biodiesel Aloe Vera has not such potential because of aloe Vera storage and

BIODIESEL

Our Future Task

1. Developed a Karanj Tissue culture technique
2. Prepare 10,0000 Karanj grafting plant (high yielding variety)
3. Karanj plantation in 1000-acre barren/waste/Unfertile land.
4. Seed collection from Rural Area.
5. Promotion of Bio diesel and Plantation.
6. Generate local Electricity Unit from Pongamia oil and Supply it to Villagers.

Pulp perish ability problem so it is essential to process immediately after harvesting.

BIODIESEL

Sr. No.	Particulars **Activity in**	**our organization** Present status
1	Plants identification	High yield variety of Karanj is identified
2	Plantation	
	1 nursery plant grafting (high yield variety)	Targeted 1,00,000 plants this year 10000 plants are ready tissue culture lab has been set at our R&D Centre
	2 tissue culturing	Tissue culture under process will start producing the hybrid variety of Karanj plant within next 6 months.
	3 Demo plot	Already prepared (For demonstrate for prospective customer
	4 Oil expeller	Installed with capacity of 500 kg per shift
	5 Seed collection from different parts	In process
	6 Mask scale cultivation of plant	In process
	7 monitoring	
3	Oil processing	Depend on availability of seed
4	Etherification	Under lab study
6	Installation of pilot etherification unit	In process
7	Installation of bio diesel plant	

7. Local Employment in Project.
8. Set a Bio Diesel Plant and expeller
9. Contract farming or Buy back farming

BIODIESEL

Expectation / support form government

- Barren land for cultivation on lease basis
- Seed collection centre in villages
- Promote Biodiesel in rural area
- Promote Karanj plantation in barren land
- Support to small scale industries.

FORMATION AND TESTING OF HONGE OIL AS A BIODIESEL

Prof. C. C. Handa*, Mr. N. L. Shegokar** , Mr. S. R. Ikhar**

HOD Mech., KDKCE,Nagpur, Lecturer, KDKCE,Nagpur.*

Abstract

The increasing industrialization and motorization of the world is leading to a steep rise in the demand of petroleum products. The petroleum-based fuels are stored fossil fuels in the earth. There are limited reserves of these fossil fuels. It is feared that they are not going to last long. In this paper, the authors have made an attempt to introduce **honge oil**, which is blended with diesel in its production and properties (when used in I.C.engine). The performance characteristics compared with conventional (diesel) fuel and their environmental pollution characteristics are also discussed. A single cylinder of Kirloskar make, water-cooled engine, was used in experimental setup.

Introduction

There are near about 300 varieties of non-edible oil seed bearing trees in our country. Many of the foresters were of the view that the Honge Tree is God's gift to India. It is very versatile tree that grows in land as well as in coastal area and all these without much care. Growing these trees enhances the maintenance of environment of the surrounding and offers employment opportunities. Honge oil is extracted from the seed of Honge tree, whose Latin name is Pongammia Pinnata and whose international name is Pongammia Pinnata Perry. Honge oil can be produced on a commercial scale provided the right strategies are followed. The performance of the engine with Honge oil is found to be satisfactory. The viscosity of Honge oil has to be corrected by preheating the oil. The output of the engine remains almost the same though the calorific value is slightly lower. Taken into account the sale value of cake which is a good fertilizer, Honge oil works out to be cheaper (i.e. Rs 13 per kg) compared to current price of diesel. The high viscosity of Honge oil interferes with injection process and leads to poor fuel atomization. The high viscosity has to be overcome by using methyl ester honge oil. The transformation of Honge oil to its methyl ester reduces molecular weight to one third, reduces viscosity to one eighth and increases the diesel index.

An approach more likely to be successful is to use methyl ester honge oil diesel blend without engine modification.

Manufacturing Process

1. Honge oil is filtered to remove solid particles.
2. Honge oil is then heated to remove water content.
3. Titration is done to determine how much catalyst is needed.
4. Exact quantity of potassium hydroxide is then thoroughly mixed in Methanol till it dissolves completely to get potassium methoxide.
5. Honge oil is heated if required (during winter) and mixed in the potassium methaoxide while with agitator running.
6. It is then alloy, led to settle and glycerine is removed from the bottom.

7. Biodiesel fraction is then washed and dry.
8. It is then checked for quality.

In trans-esterification KOH and methanol are mixed to create potassium methaoxide when mixed in it. These strong polar-blended chemicals break the transfatty acid into glycerine and ester chain (biodiesel).

Extraction of Oil

The oil is separated from its food source with hexane as other petroleum solvents and then boiled to drive off the toxic solvents.

The oil is next refined bleached and deodorized by heating it to over 400 degrees Fahrenheit. The oil extracted this way still contains some undesirable solvent residue. While the amounts of many key nutrients especially Vitamin E) are significantly reduced. Antioxidants and preservatives are then frequently added. The resulting product lacks flavour, aroma, pigments and nutrients. All that can be said for such oil is that it has an extended shelf life has a clear uniform colour and oily texture.

This method is universally being used by the big commercial oil processors because it gets more oils out in quicker and cheaper manner. About 98% of the soy oil in the U.S. is solvent extracted.

Esterification

The process of converting plant oil into biodiesel fuel is called as esterification. Estherification is a chemical reaction aims substituting glycerol of glyceride with mole of molecules of monoalcohol such as methanol. Then by obtaining molecules of methyl ester of honge oil.

Reasons for Esterification

1. Reduction of viscosity
2. The transformation of honge oil to its methyl ester reduces the molecular weight to one third, reduces viscosity to one eighth and increases its volatility leading to increase the diesel engine.

Properties of diesel and Methyl ester honge oil

Properties	Diesel	Methyl Ester honge oil
Calorific Value (C. V.)	42000	362000
Pour Point	23^0 C	6^0 C
Flash Point	73^0 C	141^0 C
Fire Point	78^0 C	179^0 C
Viscosity	3.6 cst	5.612cst
Density	836 kg / m^3	852kg /m^3
Anline Point Diesel Index	70^0 C	41^0 C
Diesel Index	55	41.91

Experimental Analysis

A single cylinder, Kirloskar make, diesel engine was used for performance calculation. Testing is carried out at various loads starting from no load condition to the rated full load condition at 1300 rpm. The tests are conducted at constant speed. The engine was loaded by band brake dynamometer. The different blends with diesel starting from 20% of biodiesel and 80%diesel for honge oil methyl ester was used. Successively proportion of biodiesel is increased by 20% and finally engine was run using 100% biodiesel as fuel. For comparison purpose 100% diesel is also used as fuel. Fuel consumption rate were measured by Burette. Exhaust gas temperature and speed were measured by electronics micro voltmeter and tachometer respectively. The engine tests were conducted for entire load range at constant speed of 1300rpm. The performance such as fuel consumption and exhaust gas temperature were measured after attaining a steady state (approximately 20 min)

DATA FOR B-80 (80% HONGE METHYL ESTE + 20% DIESEL)

Load L (Kg)	Fuel Cons. Mf.(kg/hr)	Break Power (kW)	BMEP (BAR)	BSFC (kg/kW/hr)	Break Thermal Efficiency (%)	BSEC
0	1.358	0	0	0	0	0
3	1.455	0.808	1.348	1.8	5.522	18.037
5	1.63	1.3481	2.25	1.209	8.334	12.11
7	1.6979	1.8874	3.15	0.899	11.06	9.0175
10	1.771	2.696	4.5	0.6568	15.13	6.581
15	1.94	4.044	6.7512	0.4797	20.73	4.8
17	2.397	4.583	7.6511	0.521	19.06	5.227

DATA FOR B-100

Load L (Kg)	Fuel Cons. Mf.(kg/hr)	Break Power (kW)	BMEP (BAR)	BSFC (kg/kW/hr)	Break Thermal Efficiency (%)	BSEC
0	1.455	0	0	0	0	0
3	1.509	0.808	1.348	1.867	5.324	18.708
5	1.734	1.3481	2.25	1.28	7.731	12.87
7	1.852	1.8874	3.15	0.9812	10.13	9.832
10	1.895	2.696	4.5	0.7028	14.14	7.042
15	2.144	4.044	6.7512	0.53	18.75	5.379
17	2.3285	4.583	7.6511	0.5062	19.576	5.0724

Experimental Result

A single cylinder, kirloskar make water cool, vertical diesel engine was used. The test was carried out at constant speed and at different load by using diesel and blend of honge methyl ester.

Data for Break Thermal Efficiency

BMEP (Bar)	Break Thermal Efficiency (%)					
	D-100	B-20	B-40	B-60	B-80	B-100
1.348	5	4.53	4.527	5.127	5.522	5.324
2.25	7.85	7.23	7.21	7.9	8.224	7.731
3.15	10.55	9.675	9.92	10.59	11.06	10.13
4.5	13.79	12.83	13.82	14.8	15.13	14.14
6.7512	19.24	17.77	19.25	19.76	20.73	18.75
7.6511	20.71	19.06	19.05	20.13	19.06	19.57

Various Emission Values

	B-40	B-60	B-80	B-100
CO%	0.01	0.02	0.02	0.02
HC ppm	2	8	8	8
CO_2%	2.1	2.14	1.58	2.42
NOx	1490	1470	1452	1505

Data for Smoke DENSITY

BMEP (Bar)	Break Thermal Efficiency (%)					
	B-20	B-40	B-60	B-80	B-100	D-100
0	11.2	10.1	7.42	5.9	6.2	13500
1.348	11.4	13.1	8.2	7.5	6.7	14.3
2.25	12	13.6	8.6	8.2	7.6	15.6
3.15	13	14.4	9.5	10	9.3	18
4.5	14	15.2	10.4	11.8	11	14.3
6.75	15.2	18.5	12.7	14.3	12.9	15.6
7.6511	16	18.8	16.4	16.4	15.2	16.8

Conclusion

Following conclusions were drawn

1) Brake thermal efficiency of Blend 80 of methyl ester honge oil higher than diesel.
2) Flash and fire point of ester was higher than diesel, making it safer to store from fire point of view.
3) Exhaust smoke density and NOx emissions were lower than diesel.
4) Blended with diesel gave better performance than solo running.
5) No engine modification is required.

ENERGY GENERATION BY HDR TECHNOLOGY

Deepak D. Chaudhari

TYEPS

Hot Rock Energy is a vast, environmentally friendly, economically attractive energy source. The concept is very simple.

Water is injected into a borehole and circulated through a "heat exchanger" of hot cracked rock several kilometres below the surface. The water is heated through contact with the rock and is then returned to the surface through another borehole where it is used to generate electricity. The water is then re-injected into the first borehole to be reheated and used again.

Hot Dry Rock Geothermal Energy

HDR geothermal energy relies on existing technologies and engineering processes, and is the only known source of renewable energy with a capacity to carry large base loads.

The concept behind HDR geothermal energy is relatively simple. Heat is generated by special high heat producing granites located 3km or more below the Earth's surface. The heat inside these granites is trapped by overlying rocks which act as an insulating blanket. The heat is extracted from these granites by circulating water through them in an engineered, artificial reservoir or underground heat exchanger.

HDR geothermal energy relies on existing technologies and engineering processes such as drilling and hydraulic fracturing, techniques established by the oil and gas industry. Standard geothermal power stations convert the extracted heat into electricity.

HDR geothermal energy is environmentally clean and does not produce greenhouse gases. It has been classified as renewable by National and International authorities.

The Hot Rock Energy system works with two closed circulation loops

The subsurface loop

This loop circulates water down an injection borehole where it passes through the underground "heat exchanger" and is heated. The superheated water is then recovered by one or more production boreholes which return it under pressure to the surface.

By keeping the water under pressure and preventing it turning to steam, any materials dissolved from the underground rock mass (such as silica or carbonates) are kept in solution and can be returned to the ground.

At the surface, the superheated water is passed through a metal heat exchanger where most of the heat is removed. The now cooled water is then returned to the injection borehole where it is sent down again to recover more heat.

The power station loop

At the surface a second closed loop fluid system is used to transfer the heat into the power station and generate the electricity in a turbine. The fluid used in the power station loop can be water, but more usually a lower boiling point fluid is used. Organic fluids such as refrigerants and

iso-pentane are often used.

The HDR Energy Extration Process

All modern HDR development work is based on the relatively simple concept described in a US Patent issued to Los Alamos when HDR technology was more theory than reality (Potter, et al., 1974). A well is first drilled into hot, crystalline rock. Water is then injected at pressures high enough to open the natural joints in the rock, thereby creating an engineered geothermal reservoir. The reservoir consists of a relatively small amount of water dispersed in a very large volume of hot rock. The relative dimensions and orientation of the reservoir are determined by the local geologic and stress conditions, while its ultimate volume is a function of the duration of the hydraulic fracturing operation and the fracturing pressures applied. Seismic techniques are used to follow the growth of the reservoir, to assess its location, and to determine its approximate dimensions. Using the seismic data as a guide, one or more production wells are subsequently drilled into the engineered reservoir at some distance from the first well. In a properly engineered HDR reservoir, there are a number of fluid-flow pathways between the injection and production wellbores.

Operation of an HDR heat mine is extremely simple. A high-pressure injection pump provides the sole motive force to circulate water through the engineered reservoir and deliver it to a power plant on the surface. The hydraulic pressure applied via the injection pump also serves to keep the joints within the reservoir propped open. The operating parameters applied to the injection pump thus greatly affect both the flow rate through the reservoir and its instantaneous fluid capacity. By using a combination of injection and production control measures, an almost limitless variety of operating scenarios may be employed to mine the heat.

The Major Components of a HDR System

1. One, or more, hot dry rock reservoirs are created artificially by hydraulically fracturing a deep well drilled into hot, impermeable, crystalline basement rock. The hydraulic fracturing, achieved by pumping water into the well at high pressure, forces open tiny pre-existing fractures in the rock, creating a system or "cloud" of fractures that extends for tens of meters around the well. The body of rock containing the fracture system is the reservoir of heat. The fracture system provides for the heat transport medium, water, to contact a large area of the rock surface in order to absorb the heat and bring it to the surface. More than one reservoir could supply hot water to a single power plant.

2. Deep wells are meant for production and injection of water. The wells are drilled with conventional rotary drilling technology similar to that used for drilling deep oil and gas wells. The total number of wells and the ratio of production wells to injection wells may vary. Experimental HDR systems to date have typically involved one injection well and one production well. The earliest commercial HDR systems will likely include a "triplet," two production wells for each injection well. A triplet of deep wells will support about 5 MW of power plant capacity, assuming adequate flow rates and fluid temperature. It is possible that other well configurations, such as a quadruplet (3 production wells per injection well) or a quintuplet (4 production wells per injection well) could be used.

However, the cost effectiveness of using a quadruplet or quintuplet has not been established. Also, the ellipsoidal, rather than spherical, shape of the fracture pattern at Fenton Hill suggests that one production well on each side of the injection well, on the long axis of the reservoir, is the

logical configuration. For these reasons, this analysis is limited to a ratio of two production wells per injection well, with earlier commercial systems limited to three wells total, and later systems using multiple triplets of wells. The original well, from which the fracture system is created, is used for injection. Two additional nearby wells are drilled directionally to intersect the fracture system and are used as production wells. Operation of the system involves pumping water into the fracture system through the injection well, forcing it through the fracture system where it becomes heated, and recovering it through the production wells.

3. A system of microseismic instruments in shallow holes around the well that is being fractured is used. During the fracturing operation, this system gathers seismic data, which is used to determine the extent and the orientation of the hydraulically created fracture system. This information is then used to guide the drilling of the production wells so that they intersect the fracture system at depth. Although the HDR system, once it is completed, can operate without it, the microseismic system is included here because itis an integral part of creating the HDR reservoir and because it may be left in place to gather additional information which could be useful later in the life of the HDR system.

4. A shallow water well to provide water (or other source of fresh water).

5. Surface piping, or gathering system, to transport water between the wells and power plant.

6. A binary power system is used to convert the heat in the water to electricity. This system is comprised of the following major components:

a. One or more turbines connected to one or more electric generators.

b. A heat exchange vessel to transfer heat from the hot water to a secondary working fluid with a low boiling temperature.

c. A heat rejection system to transfer waste heat to the atmosphere and condense the vapor exiting the turbine. A wet, or dry, cooling system can be used. The capital cost of a wet cooling system is only marginally less expensive than for a dry cooling system. However, this cost advantage is largely offset by the higher operating cost of the wet cooling system. For this reason, and since HDR sites in the U.S. are likely to be in arid areas with limited water supplies, this technology characterization is limited to a dry cooling system.

d. Injection pump(s) circulate the water through the HDR reservoir.

e. Pumps repressure the working fluid after it condenses and a vessel storing the working fluid.

f. Electrical controls and power conditioning equipment.

Development of an Engineered Artificial Reservoir

Granites have an internal fabric of cooling joints and fractures, a result of cooling down from a melt (like molten glass) to a solid that we see today. Developing an underground heat exchanger involves increasing the hydraulic pressure at the bottom of a deep drill hole (approx. 4-5km) until the existing fractures and joints are slightly opened.

The separated rock surfaces then slip past one another in response to natural stress conditions at that depth. When the hydraulic pressure is released the surfaces close together again, but not with the perfect mating they had before. Small gaps remain in the closed-up fractures.The combined gaps or voids on many fractures make up the underground heat exchanger.

At lower pressures, water can be circulated through this underground heat exchanger. This circulated water extracts heat from the hot granite (a natural heat exchanger).

Advantages of Geothermal Energy

Geothermal energy can be used instead of fossil fuels to produce electricity. Replacing fossil fuels will reduce the amount of air pollutants which can cause acid rain and contribute to global warming. Reducing the amount of oil shipped to the Big Island (officially called the Island of Hawaii) for electrical generation lessens the possibility of oil spills.

Electrical power generation. A 30-megawatt geothermal power plant on the Big Island displaces the need to burn about 500,000 barrels of fuel oil every year. It eliminates the need to ship that amount of fuel oil from the refineries on the Island of Oahu to the Big Island, thus significantly reducing the risk of oil spills

HDR electric plant could continuously generate power 24 hours a day and supply additional peak load power for a few hours each day. It is a reliable energy and stable with time since it does not depend on atmospheric or climatic conditions.

It respects the environment, and has little or no effect on it. It generates almost no polluting substances, very little carbon dioxide and only a small quantity of hydrogen sulfide (HS). Most of these products are reinjected into the groundwater and not into the environment.

Geothermal wells have a very limited visual impact. Once a well has been drilled it is completely invisible, since the wellhead is buried.

One of the main advantages of HDR geothermal energy is the low environmental impact. As the energy is derived from converting heat extracted from hot rocks there are no gas emissions. Unlike burning fossil fuels, no CO2 is released into the atmosphere.

The process does not produce any waste dumps and has a low noise impact. The construction of a HDR geothermal power plant leaves only a small environmental footprint. Site disturbance is limited to drill holes and pipelines, and a building to house the power plant.

Disadvantages of Geothermal Energy

Geothermal water is often saline, with a very high content of mineral salts – up to 100g/l, which is three times more than seawater! It can only be used through a heat exchanger, in other words a device through which it transfers its heat to a parallel heating circuit containing fresh water. The two liquids never come into contact resulting in a loss of efficiency.

Geothermal water is almost always corrosive. This corrosion (due to salt, but sometimes also bacteria) increases maintenance costs.

There is a risk of pollution when the extracted water contains heavy metals. This water has to be reinjected into the ground water.

Geothermal wells are sometimes vented for a few hours to clear the well and pipe lines resulting in a temporary release of steam and abated gases. Such events can be noisy for a short time. Some continuous low-level noise is also generated during normal power plant operations.

How do you choose the site for a geothermal well ?

Alain Despla: There are two main difficulties in drilling a geothermal well; the first is to find the best site within the chosen area, and the second is to prevent corrosion of the tubing. For the first point, maps are available to help choose the optimum location for a well, using the geothermal inventory made by the BRGM at the beginning of the 1980s. These maps were produced from oil prospecting data in sedimentary basins. If we drill far enough, we will find either oil or hot water. A failure for oil companies is a success for us! Like oil, geothermal water does not exist in a "reservoir" in a free state. It impregnates sand or friable rock and the fluid is driven to the surface under the effect of pressure, by drilling to expose the layer to the open air. Therefore, any geothermal operation must be preceded by exploration for a site. Note that a second inventory was made in the early 1990s at the request of EDF (Electricité de France), this time concentrating on surface geothermy (about 100m deep), as part of a program to install heat pumps. All these maps will be updated starting this year, with the assistance of the ADEME (French Agency for the Environment and Energy Control) and will be more easily accessible using new computer and communication storage technologies.

How do you fight corrosion ?

Corrosion was a very serious problem with early projects, but the problem is now perfectly controlled by injecting a chemical that prevents the development of bacteria that create corrosive sulfites. It is an in-depth treatment that needs to be carried out continuously. Provided that the treatment is not interrupted, tubes will not be corroded from the inside and can be used for at least 30 years. All that is necessary is to clean them, like a chimney needs cleaning regularly.

Environmental Effects

Under normal operating conditions there were no emissions from the HDR pilot facility except waste heat. The dissolved gases in the circulating fluid remained at low and essentially constant levels throughout the test. The only gas present in significant amounts was carbon dioxide. At the concentration found in the geofluid, all the gases remained in solution at pressures in the range of 2 MPa (300 psi). Since the circulating system pressure was kept at 4.8 MPa (700 psi), the gases in the fluid remained in solution and were not released to the atmosphere.

One important gas often encountered in underground fluids is hydrogen sulfide. This extremely toxic compound is heavier than air and tends to settle in low spots if it is

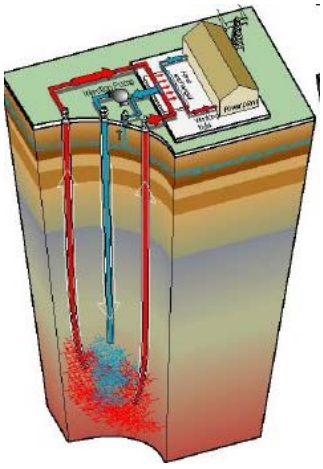
released. Although signs posted at the Fenton Hill HDR site warn of the potential danger from hydrogen sulfide and a number of automatic alarms would announce its presence at a level well below that at which it would present any danger, the concentration of hydrogen sulfide in the circulating fluid at Fenton Hill has always been extremely low (typically less than 1 ppm). Even in the event of an unexpected release to the atmosphere, the risk arising from this low level of hydrogen sulfide would be very small.

The dissolved solids found in the circulating fluid were generally those characteristic of normal slightly saline fluids, mostly sodium, magnesium , calcium, and chloride, but with small amount of other materials, such as silica and arsenic, which tend to be present in crystalline rock. At a total solids content of about 0.4%, the Fenton Hill fluid was nearly an order of magnitude less saline than the ocean which contains about 3% salt.

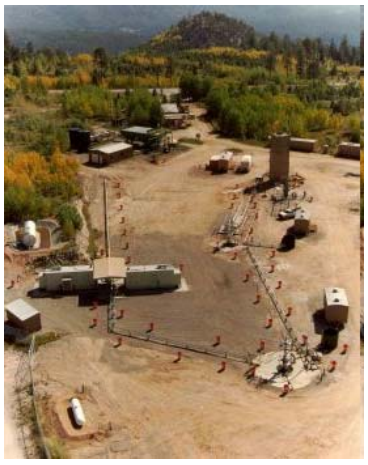
System Maintenance Issues

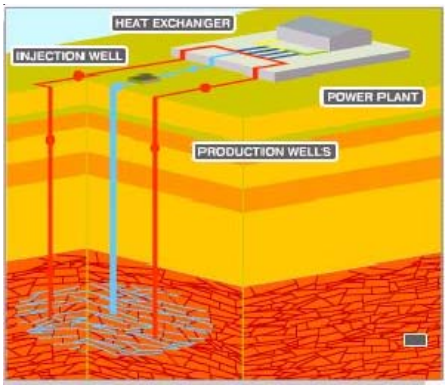
Except for the injection pump no major maintenance problems were encountered during the flow test period. Based on the low and stable levels of dissolved gases and solids, the almost total absence of suspended solids, and the relatively neutral pH of the circulating water (always greater than 5), neither scaling or corrosion would be expected A caliper log of the injection tubing was conducted in late 1993, several months after the flow test was terminated. In spite of the fact that the tubing had been installed nearly 10 years earlier, the walls showed no signs of deterioration or of excessive scale formation. In short, all the evidence at Fenton Hill indicates that facility maintenance should be relatively simple and inexpensive for HDR systems utilizing reservoirs created in hard, crystalline rock.

HDR Schematic (Now Decommissioned)

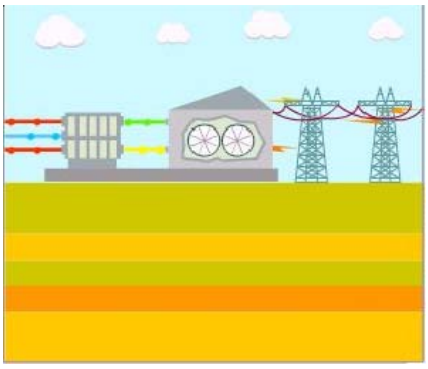


A picture of the Fenton Hill plant





Energy Generated by HDR Technology



Transmission of power

ENERGY MANAGEMENT -THE BIGGEST ENERGY SOURCE

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Abstract

This paper highlights some practical ways of reducing wastage of energy mentioning the various visible and invisible energy losses. The proper planning for energy sources for use is also suggested which if given due consideration can be further enhanced and worked out in detail for actual implementation. Both these aspects themselves will constitute a big energy source, which is to be harnessed with immediate effect so that we can make a cultural change to face the present and forthcoming energy problems in the advanced technical era.

Key Words : *Alternatives, Cost effective, Cultural change, Energy demands, Energy Management Petroleum based fuels, Six Sigma, Wastage of energy.*

Introduction

It is mandatory to understand the importance of energy management which includes, prominently;

1) Avoiding wastage of energy, what ever may be the source from which it is produced.

2) Proper planning of the usage of energy sources so as to make synergetically cost effective.

Why go for alternative sources?

Over the last few years it has been observed that present and up-coming trends in industrial as well as business demands, strenuous competition, growing population, mechanized living styles are causing increase in energy demands. Advanced technological developments, which are changing at a very fast rate, are adding to these demands substantially.

The ease of use and low cost, petroleum-based fuels gained dominant position as energy sources over a long period. Due to the continuously increasing consumption of these energy sources, the natural stocks of these sources have considerably reduced with time.

Hence these sources have lost economic leverage leading to increase in the use of alternatives, such as biomass, solar and wind energy, which have become attractive.[1]

Present scenario regarding wastage of energy

It is observed that much of the energy is wasted in various ways which results in decrease of the energy sources without any service to the mankind. A few of these are,

- Poor road condition results in more fuel consumption, more wear and tear of vehicles, higher maintenance cost of vehicles, more replacement of spare parts, more accidents

etc. Accidents alone result in further energy loss besides other serious losses. This energy loss is continuous and very big.

- Poor maintenance of machinery and equipments in industries, other companies, offices etc. result in wastage of energy. One can imagine total energy loss in this form.
- Municipal Corporations, Nagar Parishads and Gram Panchayats work include electricity and water supply. There are many reasons we can observe how a great amount of energy is wasted. Water supply needs a huge energy right from construction of dams till it reaches the consumer. Hence waste of one drop of water is a great energy loss. Same is the case with electric energy. In the year 1990 in a seminar on energy crisis, one paper was presented which stated that in a city the cost of electricity wasted due to early switching on and late switching off of street lights was Rs. 64,00,000. Hence, total wastage in this type is of the order of crores.
- Wastage of energy in the domestic use is of a high order. Much of the energy is lost due to misuse or non-required use.
- Wastage of energy in the form of electricity and water is of a very high order. Along with usual known wastage there are a great deal of indirect wastages. For example poor quality seeds will consume energy but will not give expected yield.

There are so many such practical losses which call for better energy management. Due to the continuous increase in consumption of these energy sources, the natural stocks of these sources have considerably reduced with time. Hence these sources have lost economic leverage leading to increase in the use of alternatives, such as biomass, solar and wind energy, which have become attractive.

Methodology to develop energy conversion system

To make a system almost wastage free, right from initial stages the system should be developed adopting Design For Six Sigma (DFSS) methodology. Steps involved will be-

Define : details including purpose, elements involved like machineries, transmission, distribution, use should be minutely decided.

Measure : Details of measurement system in all the phases should be decided.

Analyse : The elements of the first two phases be thoroughly analysed so that the system could effectively designed.

Design : Based on the above phases system should be completely designed.

Verification: Design is to be verified using problem redefinition technique and after practical verification final implementation is to be done. [2]

Methodology to use energy

Use of energy should also be based on Six Sigma methodology.

Define: Define the purpose of energy use clearly.

Measure: Measure the performance.

Analyse: Analyse the performance.

Improve: find ways to improve the performance.

Control: decide the parameters to be maintained for the future and see that they are within the control limits. [3]

Concluding remarks

Along with the methodologies suggested here overall planning of the energy sources should be done using these methodologies like which source of energy is to be adopted for which purpose. In hilly areas wind energy may be the best choice. Solar energy is best option for streetlights. Biogas energy may be the best alternative in remote villages.

Adoption of these methodologies will definitely lead to cost effective use of energy. It will also help conventional sources to last long and the alternative ones be the most useful to the mankind But this definitely needs a complete cultural change. Let us all work towards making it possible and make India more energetic.

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AVAILABILITY BASED TARIFF (ABT) A TECHNO-ECONOMIC SOLUTION FOR GRID DISCIPLINE

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Abstract

Availability based tariff was introduced in western region and for the first time in India, from 1st July2002 for the NTPC stations, for operational and commercial discipline. In order to ensure secure grid operation, ABT is definitely useful .The aim of this paper is to share the experience of state utilities like MSEB, GEB about the system operation and how to maintain grid discipline using ABT activities in present power crisis.

Availability Based tariff (ABT) has already been implemented in all the five regions of the country and the benefits derived by adopting this commercial mechanism are widely acknowledged. The mechanism helped in improving the availability of central generators for better grid discipline, a better grid parameters, utilisation of bottled up power and reduction in cost of power.

The ABT, gives incentive for enhancing the output capability of the power plants, which would enable more consumer load to be met during peak load hours. Secondly for backing down during off peak hours -there is no financial loss to he generating station and lastly shares of beneficiaries in the central generating stations allocated as per schedule and utilisation of power as per allocation so as to try to avoid overdrawl of power

Introduction

Maharashtra state is Constituent of the Western Regional Electricity Board (WREB). Other major constituent States are Gujrat, Madhya Pradesh, Chattigarh and Goa. These states are interconnected by strong 400 Kv and 220 Kv Networks so as to exchange their due shares (Central Sector Power) from the power Stations of NPC and NTPC in normal day to day working and to interchange the power in case of emergency. Bulk power supply in the regional grids mainly constitutes of power from multi-shared projects, better known as central sector stations in India. The tariff mechanism applied to such bulk power supplies at 400 KV and 220 KV levels affects the grid at large and the importance of right mechanism can never be overemphasized. The small changes in tariff structure can result in large in large savings or losses to the power ports. Disadvantages of PLF linked tariffs and resulting wastage of scare national recourse is too well known. Despite such clear disadvantages, the ABT (Availability Based Tariff) implementation is marred with legal hurdles. Till introduction of ABT, the existing mechanism has been operation for more than a decade and has not resulted in linking system operation with right commercial signals thereby causing problems in the form of -

- ✓ **Wastage of National Resources**
- ✓ **High Frequency operation due to poor planning and lost opportunities for exchange of surplus from power from one State/Region to another.**

Energy cannot be stored as such must be consumed as and when it is generated. In other words, Load Generation balance has to be maintained. It requires proper Generation Scheduling.

Excess generation results in unnecessary high frequency and shortage of generation results in low frequency, hence poor quality of power supply . To have a **Reliable and Quality of Supply better Planning of Generation scheduling and suitable tariff mechanism needs to be in place. So as to send commercial signals to Generators and Beneficiaries.**

Availability Based Tariff (ABT)

The Availability Based Tariff (ABT) has been implemented in the Western Region for the power received by the utilities from central sector generating stations. Normally, at rated frequency, the power from central sector stations would be cheaper than the power from private sector stations; which would be generating power, by using costly fuel like Naphtha. The ABT implies penal rates that may be higher than the cost of IPP power at frequencies lower than 49.0 Hz. The ABT regime also implies no payment for generation at frequency higher than 50.5 Hz. It means that, during load drop particularly in monsoon, the utilities may have to back down their own low cost generation to accommodate the *'TOP'* power sources. The normal concepts of Economic Load Dispatch, in such cases become different. The load dispatcher, therefore, has to be more careful in advising the maintenance schedule for thermal power stations to minimize the backing down of low cost generation. This is of particular relevance since low revenue Ag. Loads are minimum in monsoon and immediately after harvesting season.

This is instituted with a view to encouraging the regional utilities to operate the grid system at an agreed level of 49 Hz. and above. This condition, therefore, can compel the load dispatcher to carryout load sheding at low frequency regions, not only from the system security point of view, but also to economize on the cost of power delivered in the frequency levels in the Western Region is termed as **UI** (unscheduled interchange) charges. The term U1 indicates violation of scheduled limit of power drawl from central sector power stations by the constituent utilities in the region. This is worked out for intervals of 15 minutes over which the ruling average system frequency is taken as the basis.The integrated energy, as recorded in the Precision Energy Meters installed at the points of interchange of power between the interconnected utilities, is billed at the rates that rise sharply as the frequency deteriorates and at frequency of 49.0 Hz and below, the cheaper central sector power would cost as high as Rs 6.00 per KWH**. The Energy drawn at frequency higher than 50.5 Hz is available almost free, since such drawl helps the system in high frequency operation**. The table below indicates the **UI** rate at different frequency and as per present formula the rate changes by 6.0 Paise per KWH for every frequency change of 0.02 Hz.

The option is thus available for the utility to trade the surplus in high frequency conditions. Also the utility has to be carefully assessed so that the cost of power drawn from central sector stations in comparison to the cost of power available from private sector stations at command and on demand for a known duration is viable. The importance of ABT is demonstrated in the Western Grid by way of better system conditions and observance of Grid Discipline by the constituent states. The slabs of Availability Based Tariff at different frequency are given below:

Table: Penal rates for violating the frequency regime of 50 Hz.

Average frequency of time block	Unscheduled Interchange Rate in Paise/ kwh
Between 50.5 Hz and 51.5 Hz	00.00
50.0 Hz	1.50
49.90 Hz	1.80
49.56 Hz	318.00
49.10 Hz	525.00
49.02 Hz	5.70
49.0 Hz	5.70

Thus, Economical Load Dispatch is a very important resource management tool for the Load dispatcher. This aspect also imposes accountability and responsibility on the load dispatcher since he has to control the daily energy supply to the consumers in the state and therefore, all the thrift measures adopted by him contribute to the profit and loss account of the utility to a great extent. Providing adequate power to the consumers in higher tariff slabs obviously becomes more important. At the same proper attention must also be paid to the Agricultural consumers who contribute heavily to the national economy. The Load Dispatcher has an important role to play here.

Commercial Aspect of Availability Based Tariff

For maintaining frequency within 49.0 to 50.5 Hz and to regulate drawl from Central Sector. Power Stations CERC has introduced ABT in Western region from July 2002

- **Central sector power(NTPC)** stations with their capacity

Korba STPS	:	3X200+3X500	=	2100 MW
Vindyachal	:	6X200+2X500	=	2200 MW
Kawas GTPS	:	4X108+2X110	=	652 MW
GandhrGTPS	:	(3X144.0+224.5)	=	657.39MW
NPC Tarapur	:	2X160	=	320 MW
Kakrapar		2X220	=	440 MW
				Total ≥ 6433.59 MW

The Average Share of Maharashtra works out to be 2353.61 MW

Aux.Consumption @ 7% 164.75

Share at Bus_bar 2188.85

Transmission Losses@5%	109.44
Net Share at MSEB end at	**100%**
Stn availability —	**2079.41 MW**
Net CS Share at MSEB end at	**90% CS**
Stn availabilty	**1841.47 MW**

Scheduling

✓ Each Power Station in CS will indicate its availability in 15 Minutes block to WRLDC

✓ WRLDC will intimate the constituents,the quantum of their share in 15 min.block

✓ Constituent will inform their requirement of CS share from each P.S.

✓ WRLDC will intimate final allocation to each constituent.

✓ Constituent must draw their share in each block and maintain the frquency.

Payments

ABT Tariff in two parts :-

i) Capacity charge(CC)
(As per Share allocation) CC is in its Average avilability

ii) Energy Charge (EC)
(As per drawl Schedule)

EC=Schedule+delV (deviation from schedule)

iii) Unscheduled Interchange (UI)

Charges will depend upon frequency. UI rate varies in the slot of .02 Hz frequency and 5.70 paisa for a Freq above49.02 Hz.

✓ Incase of **Underdrawl** Energy Charges for the scheduled energy will be payble means it will be **TAKE OR PAY** Scheme (Annexure)

✓ In case of **Overdrawl** charges will depend upon frequencies.

Case Study

i) From ABT state in 15 minute block.Throughout the day if

a)	Actual Share	48531 MW
b)	Actual Drawl	46056 MW
c)	Net Drawl(a-b)	2504 MW

(i) For 24 Hrs 2504MWh = 2.504 MUs

(ii) Sum of UI Charges at 15 minutes block = 7056 x Rs. 1000 = **70.56 lakhs**

Average UI Charges (ii / i) =

70.56 Lakh / 2.504 x 10 = **2.82 Rs. per KWh** **(d)**

If we drawl Power from Tata at the rate of 2.50 per KWh **(e)**

= 2.504 x 2.50 = **Rs.62.60 Lakh**

From Above (d) & (e) it indicates Overdrawl from from Central Sector is Costly.

Better Planning and Scheduling

ABT (Availability Based Tariff) and Merit order despatching has prompted to their constitients be more realistic in planning their Load Generation Balance. It has resulted in realistic requisitions from all the constituents for scheduling of ISGS(Inter State Generating Stations) Generation. Frequency linked despatch coupled with merit order is leading towards flattening of load curve. It is also forcing constituents to implement time of the day tariff for their HT consumers.

Merit Order Scheduling By SEBs

ABT has acted as a catalyst in prompting all the constituents to follow Merit order generation to gain commercial advantage. It has prompted all the constituents to back down their costliest generation. For e.g. as the Thermal generation in Gujrat is costlier because their plants are situated away from the pithead, Gujrat tends to draw more than schedule from central sector during High frequency regime. However, as frequency comes down and UI (Unschedule Interchange) prices goes up, Gujrat maximizes its generation /increases load sheding such that their drawl is less than schedule to gain UI advantage.

Conclusion

The Grid collapsed on 30th July2002 after an experience of one year working with ABT in Western Region. It is encouraging to have more disciplined grid operation .ABT flexible mechanism permits UI to the extent frequency is maintained within accepted parameters. Thus UI must be seen as feature of pooled grid operation.

ABT has acted as a catalyst in prompting all the constituents to follow Merit order generation to gain commercial advantage. It has prompted all the constituents to back down their costliest generation.

Acknowledgement

The author acknowledges with thanks the guidance of Prof. G.A. Dhomne, GCOE, Amravati for permitting the publication of this paper. Author is very much thankful to Shri. A.G. Patil, Assistant Engineer, Load Despatch Centre, MSEB, Ambazri (M.S.)

Reference:

1) The required information has been taken from Load dispatch regional center of M.S. Electricity Board.

FUEL CELL-MOST EFFICIENT AND CLEAN SOURCE OF POWER

R. B. Sharma and S. N. Jawarkar

Introduction

A cell (or combination of cells) is capable of generating an electric current by converting the chemical energy of fuel directly into electrical energy. The fuel cell is similar to other electric cells in respect that it consists of positive and negative electrodes with an electrolyte between them. Fuel in suitable form is supplied to the negative electrode and oxygen often from air to the positive electrode when cell operates, the fuel cell is oxidized and the chemical reaction provides energy that is converted into electricity. Fuel cells differ from conventional cell in respect to that the active materials are not contained with in the cell but are supplied from outside.

Working of Fuel Cell

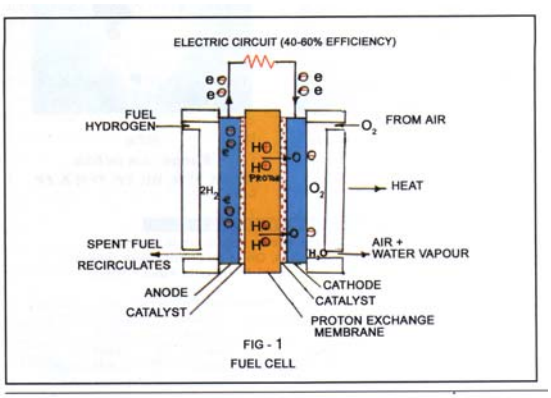

FIG - 1
FUEL CELL

Operation of fuel cell can best be described with reference to a specific device. Fuel cell can be adapted to variety of fuels by changing the catalyst. Here hydrogen, oxygen cell is described. As shown in fig.1 a proton exchange membrane (PEM) fuel cell comprises two thin porous electrodes, an anode and a cathode, separated by a catalyst coated polymer electrolyte that passes only protons. As soon as hydrogen fuel enters the flow channel the anode splits into electrons and protons. The electrons travel off via external circuit to power a drive motor or some other load. The protons migrate through the membrane to the cathode where it combines with returning electrons and oxygen from the air to form water due to catalytic action of PEM.

Why Hydrogen

Hydrogen is the perfect fuel because:

- ✓ It can be produced from variety of energy sources.
- ✓ It satisfies all energy needs from transportation to electric power generation.
- ✓ It is the least polluting since its use produces water.
- ✓ It is the perfect carrier for solar energy in that it affords solar a storage media.

Likewise, hydrogen is the perfect partner for electricity, and together they create an integrated energy system based on distributed power generation and use. Hydrogen and electricity interchangeable using fuel cell (to convert hydrogen to electricity) or an electrolyter for converting electricity to hydrogen. A regenerative fuel cell works either way, converting hydrogen to electricity and vice versa.

Hydrogen Generation

For almost all fuel cells, the fundamental fuel requirement is hydrogen. Hydrogen can be obtained from several fuel sources through variety of routs, of which reforming is perhaps the most important. Some visionaries of hydrogen economy believe that, in the distant future, petroleum use as a transportation fuel will be forbidden to save the remaining resources for production of high–value products such as drugs, building materials, and petrochemicals. Likewise, coal use will be banned for environmental reasons. Remaining primary energy sources, mostly renewable and nuclear power will then be used to generate electricity and hydrogen. Electricity will be converted into hydrogen when a supply exceeds demand and energy needs to be stored. Hydrogen will be converted back into electricity when required by a fuel cell vehicle.

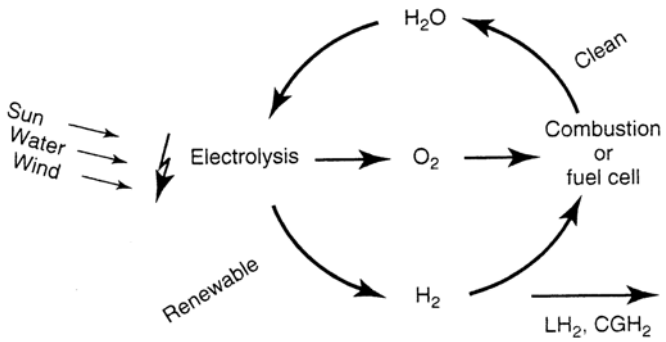

Figure 2 Renewable and clean energy/energy carrier for the future

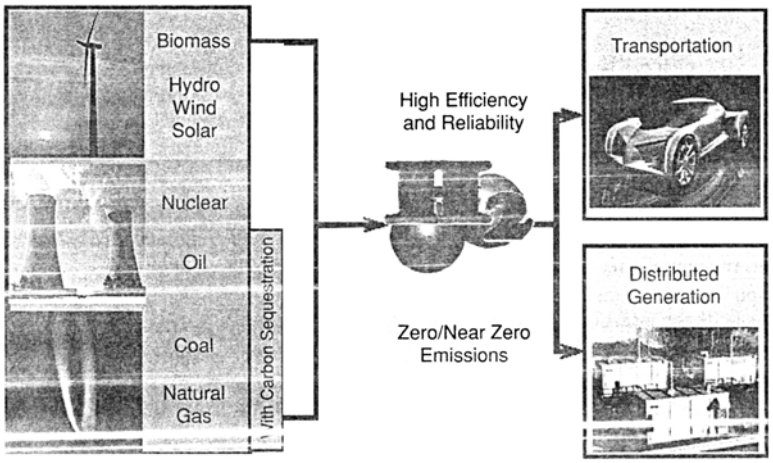

Figure 3 Hydrogen production and use diagrm

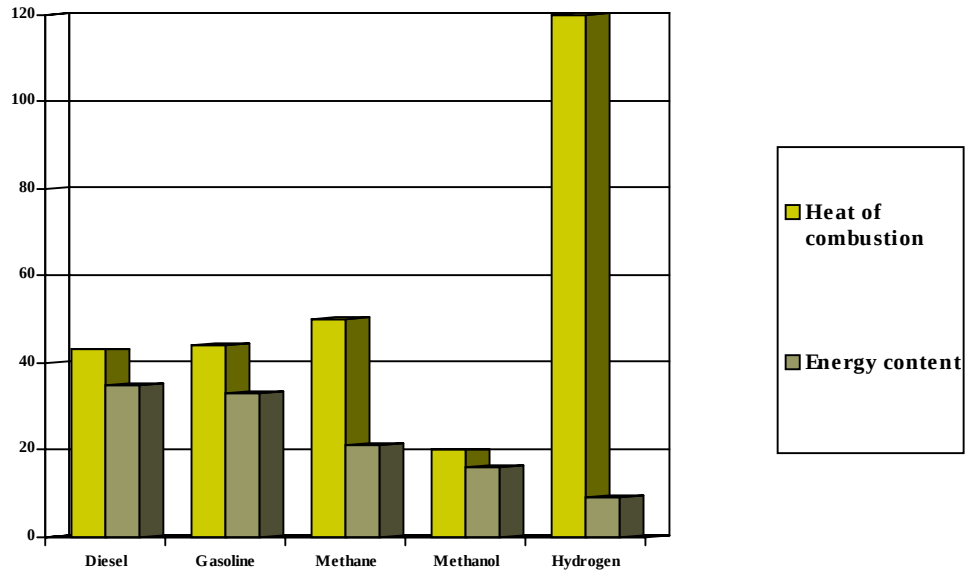

Fig.4 Heat of combustion for the energy content of different fuels.

Reformers

A reformer is a stuff that converts any fuel in hydrogen gas. It is the basic & most important component of fuel cell. A fuel cell system includes a "fuel reformer", which can utilize the hydrogen from any hydrogen fuel – from natural gas to methanol, and even gasoline.

Fuel cells generally run on hydrogen, but any hydrogen–rich material can serve as a possible fuel source. This includes fossil fuels -methanol, ethanol, natural gas, petroleum distillates, liquid propane and gasified coal. The hydrogen is produced from these materials by a process known as reforming. This is extremely useful where stored hydrogen is not available but must be used for power, for example, on a fuel cell powered vehicle.

Fuel Processor

The job of fuel processor is to provide relatively pure hydrogen to a fuel cell, using a fuel that is readily available or easily transportable. Fuel processors must be able to do this in an efficient manner with a minimum of pollution –otherwise; they negate the benefits of using a fuel cell in the first place.

For car, the main issue is the energy storage. In order to avoid having large, heavy pressure tanks, a liquid fuel is preferable to a gas. Companies are working on fuel processor for liquid fuels like gasoline and methanol. A methanol is the most promising fuel in the short term; it can be stored and distributed in much the same as gasoline is now.

For houses and stationery power generation, fuels like natural gas or propane are preferred. Many power station and houses are already hooked up to the natural gas supplies by pipeline. So it makes sense to convert these fuels to hydrogen for use in stationery fuel cells.

Both methanol and natural gas can be converted to hydrogen in a steam reformer.

Benefits of fuel cells

- ✓ Fuel cell power plants produce dramatically fewer emissions, and their byproducts are primarily water and carbon dioxide.
- ✓ Fuel cell power plants are nearly twice as efficient as conventional power plants.
- ✓ Small-scale fuel cell plants are just as efficient as large ones, and operation at partial load is as efficient as at full load.
- ✓ High-grade waste heat from fuel cell systems is perfect for use in cogeneration, heating, and air-conditioning.
- ✓ The fuel cell stack is the basic component of a fuel cell power plant. Stacks are combined into modules, and the number of modules determines plant capacity. The individual modules can go from ideal to full load in minutes.
- ✓ Fuel cells are one of the most reliable power generation technologies.
- ✓ Fuel cell power plants are reliable and safe, and can be sited in environmentally sensitive areas.
- ✓ Fuel cell needs hydrogen, which can be generated internally from natural gas, coal, methanol, landfill gas or other fuels containing hydrocarbons.
- ✓ Fuel cell technology meets public demand for clean, quite and efficient power.

Conclusion

The fuel cell technology can free India from its dependence on foreign oil, while providing it with permanent self-sufficiency. It can relive our electric boards from long running issues of procuring waste coal in thermal plants, fighting power thefts and billing discrepancies.

Air pollution will dramatically reduce. Fuel cells can help in remote electrification projects. Installation of these machines in rural areas will act as a strong booster for rural economy.

Also we should remember that output of fuel cells is not only electrical energy but also drinking water.

Moving forward with this technology we can eliminate the drinking problem of many countries considering the international scenario.

To pave path for this new technology, the first and foremost thing that we need to create is awareness. Hydrogen, oxygen and natural gas are abundantly available on earth surface, so the day is not far when the people will not have to think of the cost of the power.

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FUEL CELL

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What is a Fuel Cell ?

A Fuel Cell is an electrochemical device in which a fuel and an oxidant react to directly produce electricity. Since this process is not governed by Carnot's law, high operating temperatures are not strictly needed to obtain a good efficiency. Apart from being efficient, fuel cells have the advantage of being silent and non-polluting.

Fuel conversion in a Fuel Cell

In a fuel cell, the oxidation and reduction reactions are separated by an electrolyte. The separation of reactions results in a build-up of negative charge at the anode, and positive charge at the cathode. By applying a current loop, electrical energy can be withdrawn from the reaction. Although there is great similarity with the processes occurring in batteries, it is important to realise that in a fuel cell, the reactants (fuel and oxygen) are supplied from an external source. The fuel cell, therefore, cannot be "empty", and does not need to be recharged.

The Technology

In principle, fuel cells are similar to batteries. The main difference is that batteries store electrical energy, while fuel cells generate electricity continuously as long as an external fuel source is supplied. That means their performance is not hindered by lengthy, inconvenient recharging times.

Fuel cells convert chemical energy into electrical energy by combining hydrogen or hydrogen-containing fuels and oxygen from the air. If pure hydrogen is used as the fuel source, the only products are electricity, heat and water. The solid oxide fuel cell is able to directly utilize commonly available fuels such as natural gas, liquefied petroleum gas, diesel and biogas. When operating on natural gas, carbon dioxide (CO_2) emissions are reduced by up to 60 percent compared with conventional electricity generation, with practically no emissions of nitrogen oxides (NO_x) and sulphur oxides (SO_x).

It's a simple process. In the fuel cell the electric current flows from the anode to the cathode. An electrolyte separating the anode and the cathode acts as a "one-way door," allowing protons to travel across the electrolyte while forcing the electrons to travel through the external circuit, producing electricity. Various types of fuel cells use different electrolytes, with different electrochemical reactions occurring, but the overall reaction is the same: hydrogen and oxygen combine to form water and release energy.

Many scientists believe that pure hydrogen, the most common element on earth, is destined to be the vehicle fuel of the future. Hydrogen can be extracted from thousands of compounds, including natural gas, water, sugar and many petroleum products. The extraction of hydrogen requires energy, making hydrogen an energy carrier rather than an energy source.

In transportation, and for many other applications, fuel cell technology is opening new doors of opportunity for hydrogen. Governments and industry around the world, including in Canada, are investing heavily in research and development into hydrogen fuel cells

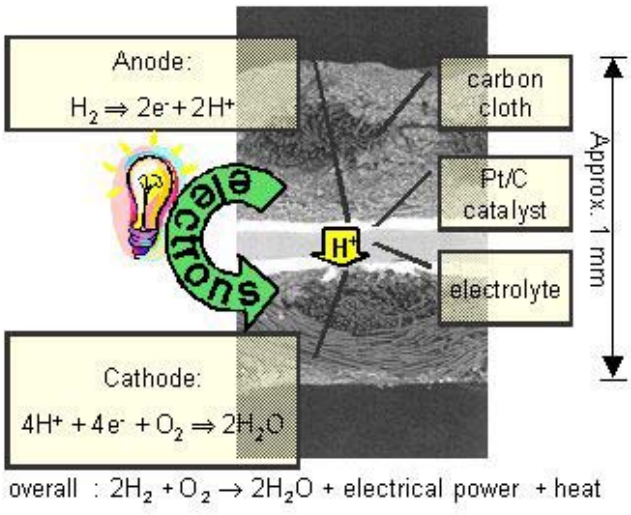
Types fuel cell

Fuel cells are generally (but not always) given names that refer to the electrolyte:

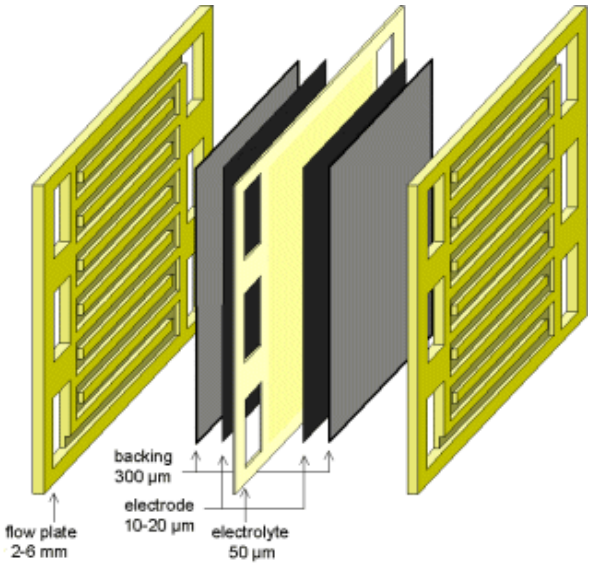
- **AFC: Alkaline Fuel Cell**
- **PAFC: Phosphoric Acid Fuel Cell**
- **MCFC: Molten Carbonate Fuel Cell**
- **SOFC: Solid Oxide Fuel Cell**
- **PEMFC: Proton Exchange Membrane Fuel Cell (or Polymer Electrolyte Fuel Cell)**
- **DMFC: Direct Methanol Fuel Cell (here is exception to the name giving rule)**

	AFC	**PEMFC**	**DMFC**	**PAFC**	**MCFC**
Operating temp. [^{o}C]	80	40-80	60-130	200	650
Fuel*	H_2	H_2 (/CO_2)	Methanol	H_2(/CO_2)	H_2, CO
Electrolyte	KOH	Polymer	Polymer	Phosphoric Acid	Molten Carbonate
Application	Space, (transport)	Transport, Distributed power, CHP**, Portable power	Portable power, Transport?	Distributed power, CHP**	Distributed power, CHP**

Picture of PEMFC cross-section

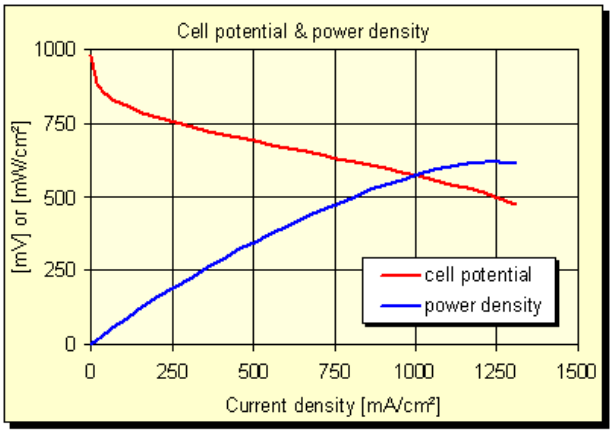


The PEMFC uses a polymer membrane as an electrolyte. The polymer is capable of conducting positive hydrogen ions: protons. The electrolyte is sandwiched between two electrodes, thin layers that contain Pt-based catalysts that help the oxidation and reduction reactions to take place. These electrodes are generally applied on a support of carbon cloth or graphite paper. The combination of electrodes and polymer membrane electrolyte is usually referred to as MEA (Membrane Electrode Assembly). The MEA is clamped between two gas flow field compartments to produce a single cell.



When hydrogen is fed to the anode compartment, and air or oxygen to the cathode compartment, an electrical potential of approximately 1Volt builds up. When the anode and cathode are externally connected by an electrical load, a current is produced and hydrogen and oxygen are consumed.

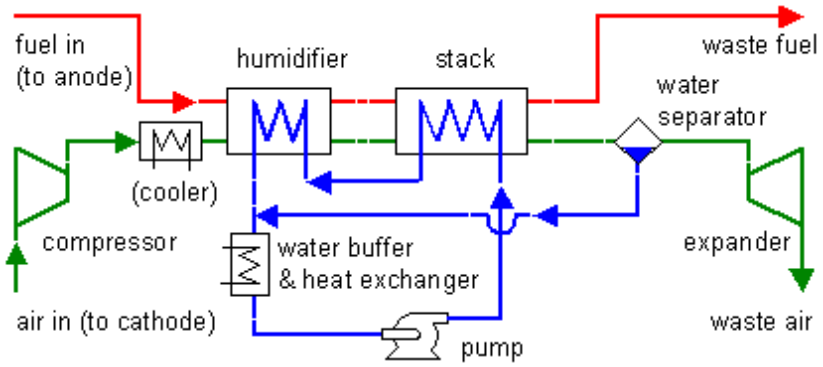
The potential of the PEMFC drops as a function of current drawn from the cell. After an initial steep drop in potential, there is an almost linear relation between current density and potential. The power increases as a function of load, according to an almost parabolic curve. At high current density, close to the highest power density, the potential starts to drop off non-linearly.



What makes a Fuel Cell Stack work?

Fuel cells need a continuous feed of air and hydrogen to produce current. During operation the fuel cell (stack) produces heat which has to be removed. Therefore, a stack needs ancillary components to operate. These components are:

- a compressor or blower to provide air for the cathode,
- a cooling circuit,
- a water separator to remove product water from the cathode exit gases
- a controller system
- a fuel supply system

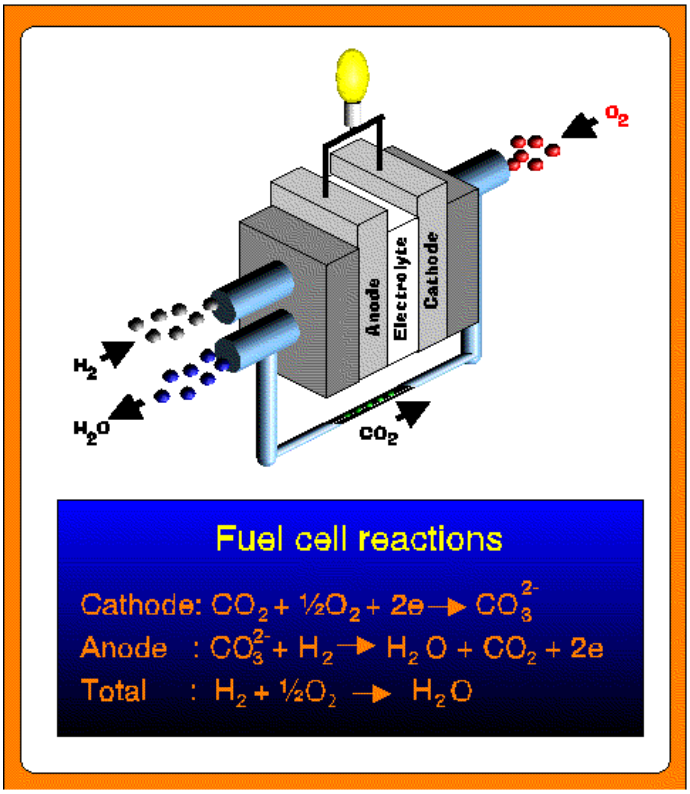


The fuel supply may be a simple cylinder containing compressed hydrogen and pressure controller. The use of liquid hydrogen or metal hydrides makes the system somewhat less simple, since heat must be provided to the tank. If instead of hydrogen a hydrocarbon is used as a fuel, the fuel supply system becomes more complicated. In this case a fuel processor (fuel reformer and gas purifier) is required to provide hydrogen for the fuel cells. The electrical energy produced by the fuel cell stack(s) can be fed to the motor invertor directly. In some cases, it may be attractive to use a buffer system, such as a battery, super capacitor or fly wheel. The buffer will supply peak power. This may be needed during start-up, or during acceleration. The buffer can also be used to absorb energy during regenerative braking. When a buffer is used, the system is referred to as a series hybrid system.

Molten Carbonate Fuel Cell (MCFC)

MCFC is under development. The electrolyte consists of molten carbonate in a matrix, which does not let threw the electrons but it lets threw ions.

The reaction is:



The working temperature for this type of cell is 500-700 ° C. With these high temperatures you can avoid expensive catalyst as platinum. The working temperature is a compromise you get a high efficiency but also a high corrosion speed.

MCFC can be made with relatively big units. Cells, which are 2 m, have been made. They give up to 2 kW. The efficiency is around 60 %

The lifespan is the biggest problem with the cells, its just around 5 000 hours.

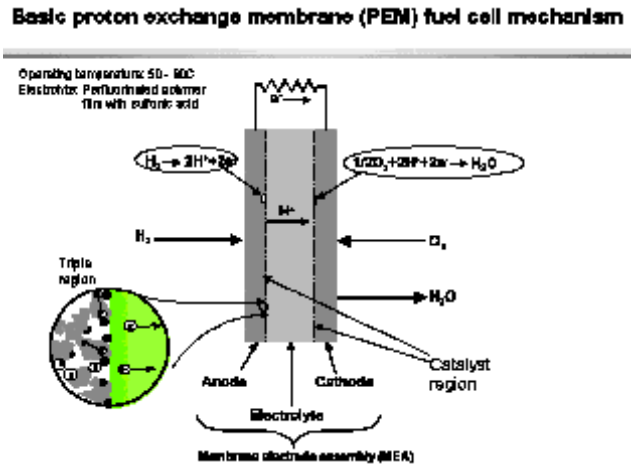
Advantages and disadvantages with MCFC

Advantages	Disadvantages
Inner reforming possible	The electrolyte has the be closely controlled
Can be connected to a distant heating net	Cathode and anode have a limited life span because of corrosion
CO does not pollute the cell	High sensitivity to sulfur
High efficiency	Los of electrolyte
Big cell areas possible and there by a better efficiency	High costs

USA and Japan lead the development of MCFC. Several test units are on its way and it looking good in the cell. If you pressurize the cell it can increase the efficiency by 10 %. The American company Westinghouse plans to introduce a commercial cell in the 2002.

Without a bottom cycle the efficiency is around 50 % for a SOFC in the MW class. With a ottom cycle the efficiency is about 70 %

Proton Exchange Membrane Fuel Cell



Proton Exchange Membrane (PEM) fuel cells, considered the most promising for automotive application of four current types of fuel cells. This was a brilliant innovation in the late 1950s by Len Niedrach and Tom Grubb. They did away with the liquid electrolyte which causes a lot of problems and replaced it with a solid polymer film. Platinum electrodes are added by pressing the power into the surface of the membrane, and the membranes are stacked up with bipolar spacers to provide for a flow of fuel and oxygen (or air) on alternative sides. This is the ultimate in simplicity of construction and operation. The cell does not have to be heated to start up, it is very efficient, it is very reliable and long lived, and it is potentially cheap. The membrane is very small, which makes the device compact and well adapted to vehicle uses. The low temperatures under 100° C also make the fuel cell an alternative to the engines of to day.

The PEM fuel can only be powered with air (oxygen) and hydrogen. That makes it necessary either to have hydrogen supply infrastructure or to use an onboard gas generator system with reformer producing hydrogen from any hydrogen rich liquid such as methanol. Options are divided about the choice of methanol or hydrogen in fuel cells vehicles.

Iceland's plans for a cleaner future

On Iceland it will soon be over with polluting cars. With the help of an agenda all traffic on the island will be changed to hydrogen energy, with just one waste product water. The Project is possible because of Iceland has enormous resources of renewable energy.

On Icelandic gas stations there will soon be an better alternative then unleaded gasoline: They will be able to refuel with hydrogen and there by not burden the environment with carbondioxid and other poisonous substances. Iceland has a chance to be the first place in earth where hydrogen forces out traditional engines. This optimistic vision is a result of co-operation between Vistorka (an Icelandic company), Daimler-Chrysler, Norwegian Hydro and Shell. The four companies have formed Iceland Hydrogen Fuel Cell Company and they work with the Icelandic government and

Reykjavik University to rearrange the Icelandic transport sector, so in 25-30 years it will only use hydrogen. The Icelandic government supports the project because they want Iceland to be an exporter of know-how and technology.

In the beginning it is just about getting practical experiences on the use of hydrogen and fuel cells. Iceland will be the whole wide worlds little test lab. This can be one of the 21st century's biggest challenges.

On the volcanic island there is an abundance of renewable energy sources, which at the moment only are exploited to a mild degree. For example, only eight percent of the hydro-energy are being used and just about 1.5 % of the geothermal energy.

At the start only the Reykjavik city busses will drive on hydrogen. The next phase will be to gradually change the internal-combustion engine's in the ordinary cars to hydrogen use. The last phase will be the Icelandic fishing fleet will be changed to hydrogen use. They will have a very limited oil import and this has decreased their carbodioxide emissions with 70 %. This is not bad for Iceland with its population of 265000 inhabitants, but with 133000 cars, 1500 busses and 800 ships. The Icelandic people can look forward to a great economic gain if this works. If it works other countries will follow in Iceland's footsteps, and there by the entire world will gain on Iceland's experiments.

Fuel cells for stationary electric production

Fuel cell is being used in experiments and demonstration purposes around the world. Fuel cells with SOFC and MCFC technology has a potential big market if small scale natural gas or oil production is available. Westinghouse plans on having a SOFC-GT (Solid oxide fuel cell combined with a gas turbine) on the market soon. A concurrent for the fuel cell is turbines that will use hydrogen as fuel, because of that fuel cells might not be used for big scale electric production.

Market and cost for fuel cells

As the technology is still in the development the cost are high. Calculations of cost for plants cannot be used based on demonstration plants. It must be built on larger series of fuel cells. Today its too expensive for fuel cell to reach a bigger market, but according to the companies that develop the fuel cell the cost will be greatly cut in the future.

1. Fuel cells for vehicles.
2. Distribute electric power.

Conclusions

1. The expectations on fuel cell technology is very big. If you could manufacture PEM with long enough life spans, it will change the vehicle market completely.
2. For small scale electric distribution there is a potential market provided that an acceptable fuel is near by. For relatively small scale electric and heat production MCFC and SOFC have the potential of high efficiency.
3. For lager scale power plants the image is not so clear, but one can reach a high efficiency.

DESIGN OF CURRICULUM FOR ADVANCED DIPLOMA IN NON CONVENTIONAL ENERGY SOURCES, ENERGY MANAGEMENT AND SAFETY.

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It is now widely recognized that fossil fuels and other conventional resources, presently used in generation of electrical energy may not be either sufficient or suitable to keep pace with the ever-increasing world demand for electrical energy. The prospects for meeting this demand and avoiding a crises in supply would be improved if new and alternative energy sources could be developed. Fortunately many such sources exist. Undoubtedly many of these would be exploited more and more in future [1].

Another frequently required aspect in an industry is safety engineering and environmental issues. It is very much essential for healthy survival of a human being in a society.

Also meeting a load demand only is not important bur conservation, energy audit also play vital role in an energy management programme. This minimizes wastages of energy and brings the optimum utilization of electrical energy. In this paper, suggestions are given to design curriculum for advanced diploma in non conventional energy sources, energy management and safety. It is a two semester course. Each semester contains theory papers and practicals / industrial visits as well as seminars. The second semester contains a project work where a student will prove the importance of non conventional energy source against conventional one and should be able to carry out energy audit and apply safety rules at his work place.

The course proposes all three important areas which keep pace with latest technological development.

Introduction – What industry needs?

Energy plays a major role in the economic development of a country. It is an indispensable component of industrial product, employment, environment and comfort [1]. Since conventional sources have limitations, non conventional sources become important , thus leading to non conventional plant erection which requires expert in that area.

When energy is generated at least cost at the same time energy wastages should be minimized. It is covered under the energy audit, conservation programmes etc. which is collectively termed 'Energy Management'.

The erection of a well equipped plant requires safety, hygiene and environmental issues to be considered which is proposed in the course.

As electrical energy plays a vital role in all round development of a country, a person skilled in electrical safety, energy audit and knowledge of non conventional energy sources is required in an industry.

Objectives of the course –

It is rare to get all three qualifications in one person, due to which industry has to appoint number of persons. This leads to the need for development of such course which focuses an all three aspects namely non convention energy, safety and energy audit.

The fast technological developments, increased industrial and population growth, the issue of energy crisis has forced engineers and scientists to invent new or alternative energy sources like solar, wind, biomass tidal etc., which are abundantly available in the nature. Growth rates of 7% per year for energy sector and 9% for power sector are likely to persist in future [3].

The generation of electrical energy from these non-conventional sources is the need of today, which has motivated us to propose this course.

For generating energy from these new sources well equipped power plant is required to be designed which uses non conventional sources as the fuel.

The installation of these plants require safety aspects to be taken into account. Therefore, persons in an industry / plant should be trained about electrical hazards, its consequences and steps taken to minimize / remove them. Apart from safety, people should be made aware about environmental issues like disposal of waste from plant, eco-friendly materials to be used in packing a product etc. so as to create a healthy atmosphere for survival of a human being. That is the aim of adding safety engineering part in this course.

Energy audit, energy conservation have become essential to minimize energy leakages. Systematic study of energy consumption, methods adopted to reduce leakages, minimize electrical bills and implementation of these measures to existing plant is important for saving electricity, which is taken care of in third part of this course, i.e. energy management.

The concepts of co-generation and captive- power plants are proposed in the syllabus which further leads to conservation of energy.

Keeping in mind the dependence of these three areas on each other, they are combined together. This also increases the employment opportunity of a student in future [4].

So we propose this one year advanced diploma course.

Qualification required

The basic qualification required for this course is Diploma in Electrical Engineering/ Electrical Power Systems / Instrumentation.

With this course a student should be able to develop the following [**2]**

1. Safety Consciousness
2. Health Consciousness
3. Creativity
4. Work Commitment

5. Defining a Problem
6. Design a Solution
7. Searching for Information
8. Impact of his activity on environment.

Course Structure

The proposed course is of two semesters. The first semester contains five subjects each of 100 marks theory and practical of 50 marks, based on the reports of industrial visits reports. The second semester consists of five subjects and one project work of 100 marks each. Both semesters include seminar by each student. The proposed project work expects some study or survey which will cover non conventional power plant, safety encountered in it and energy management in a plant. The details of subjects are given at the end in a tabular form.

Design and methodology

This course curriculum is in the form of suggestions. Efforts are made to include all three areas of utmost importance in today's industrial scenario and fast technical growth. Stress is given to almost all non conventional sources of generation, at the same time developing thinking skills and creativity in students so that they are ready to work in a non conventional power stations. Due importance is given to safety aspects in a plant where they work, which also takes into account hygiene and environmental issues. Environmental issue takes into account that non biodegradable material should be avoided or minimized. It is also proposed to make them familiar with ISO 14000, because for exporting a product to some countries like Europe ISO 14000 accreditation is mandatory [3].

Not only continuous availability of energy supply in adequate amount is necessary for the progress of industry but energy conservation efforts are also essential in today's competitive world where it is necessary to cut down overheads such as energy bills which is covered under the subjects of energy management and audit. In rural areas, where plant is located at remote places, transmission and distribution of energy increases infrastructure cost as well as running cost and T & D losses. This also calls for captive power plant and its erection in the premises or nearby places of industry and which can be owned by that plant. Most of the energy required by the plant is for illumination. Therefore, an audit of illumination system can indicate some savings. The introductory illumination topics are proposed under energy management / audit. To avoid wastage in energy further, a co-generation system is to be adopted which converts energy contained in a fuel into two or more usable forms. It is also proposed in the curriculum.

Along with theory, practicals in the form of industrial visit / visit to power station also should be organized for co-relating theory and practical reports based on visit which can be submitted as term work for that subject.

To enhance creativity and technical skills in a student, they have to undertake a project work which should include a case study or survey or they can design their own non conventional plant and implement safety norms and can also carry out energy audit for this proposed plant [4].

We have tried to balance theory and practicals / visits and it is assumed that a student is familiar with Basic Electrical Engg., Generation Engg., Power Systems, Measuring Instruments, Testing Procedures, Maintenance Schedules etc.

Conclusion

The paper has proposed a new course at post diploma level on non conventional energy sources, energy management and safety. The relevance and importance of this course in the context of today's industrial scenario and needs are enumerated.

The conventional sources of energy are depleting at a faster rate, it is required to have generation from non conventional sources. The students need to be given exposure to technologies and issues involved in non conventional energy sources such as wind, solar etc. Such a course will also help to make society at large aware of the application of non conventional energy sources in household use.

Energy audit has become an essential part of improvement activities in industry. It basically aims at identifying the unnecessary energy consumption and energy wastages / leakages. Students armed with knowledge of energy audit can contribute significantly in energy conservation programmes of industry.

This paper has also highlighted the ever important safety issues and growing realization in industry about the adherence to products and processes eco-friendly. Inclusion of safety and environmental issues in the curriculum will make the proposed course more meaningful and attractive in today's industrial scenario.

Distribution of Subjects

Proposed structure of advanced diploma in non conventional energy sources, safety and energy management –

SEMESTER I				
		Max. Marks		
Sr. No.	SUBJECT	TH	PR	SW
1	Non Conventional Energy Sources I	100	50	50
2	Safety Engineering	100	50	50
3	Safety, Health & Environmental Management	100	50	50
4	Energy Management-I	100	50	50
5	Power System Planning	100	50	50
6	Seminar	----	50	---

SEMESTER II				
		Max. Marks		
Sr. No.	SUBJECT	TH	PR	SW
1	Non Conventional Energy Sources II	100	50	50
2	Industrial Hygiene & Occupational Health	100	50	50
3	Advanced Safety Management & Engineering Techniques	100	50	50
4	Energy Management-II	100	50	50
5	Illumination Engg.	100	50	50
6	Seminar	----	50	---
7	Project	----	100	----

- TH – Theory
- PR – Practical
- SW –Sessional Work

Important topics covered under each subject-

SEMESTER I		
Sr. No.	Subject	Important Topics
1	Non Conventional Energy Sources I	Details of Solar energy, Wind energy, Biomass energy; its applications
2	Safety Engineering	Safety in the use of machines, Material handling, Electrical hazards, Housekeeping etc.
3	Safety, Health & Environmental Management	Social security - Laws, Acts, Environment protection, Legislations, Factories Act.
4	Energy Management-I	Energy conservation, Co-generation, Demand side, Management etc.
5	Power System Planning	Load forecasting – Short term and long term, Reliability engineering basics, Outage of a plant and related factors.
6	Seminar	Based on above related topic.

SEMESTER II		
Sr. No.	Subject	Important Topics
1	Non Conventional Energy Sources II	Tidal, OTEC, Hydrogen, Geothermal etc.
2	Industrial Hygiene & Occupational Health	Concepts of hygiene, Protective Equipments, Physiology of different body systems, different fitness tests etc.
3	Advanced Safety Management & Engineering Techniques	Plant siting, Process design, Risk assessment, Plant Inspection, Transport Safety.
4	Energy Management-II	Energy Audit, Captive Power Generation, Tariffs, Electricity Act 2003.
5	Illumination Engg.	Basic definitions, Design of illumination system, Calculation of required glaze / power etc. Modern lighting equipments in market.
6	Seminar	Based on above related topic.
7	Project	Case study or design of proposed plant.

Acknowledgements

We would like to sincerely thank Prof. B. P. Tale, Director MSBTE, Mumbai who encouraged us to design this course.

References

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2 A handbook of 'Curriculum for general Diploma in Electrical Engineering' by Maharashtra State Board Of Technical Exams., Maharashtra State, Mumbai.

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ENERGY AND THE LAW

The national Energy Policy 1980 was framed to ensure adequate energy supplies and project the environment from adverse impact of un regulated utilization of energy resources. It focuses on

- Intensification of exploration of oil and gas to increase indigenous production.
- Management of demand for soil and other forms of energy.
- Energy conservation and management, with a view to increasing energy productivity.
- Development and exploitation of new renewable sources of energy to meet the energy needs of rural areas.

Natural Energy Conservation Act 2001

The Energy Conservation Act 2001 is a statutory measure to regulate the energy efficiency and conservation due to an increase in the demand for electricity and fossil fuel and an increase dependence on commercial energy. The act tries to promote energy efficiency in the commercial sector, which is the largest user of energy. This would reduce the pressure on already existing resources and would be beneficial to the environment, as there will be a drastic reduction in greenhouse gas emissions.

Other laws

- The Coal Mines (Conservation and Development) Act, 1974
- Electricity (Supply) Act, 1948
- The Indian Electricity Act, 1910
- The Mines Act, 1952
- The Mines and Minerals (Regulation and Development) Act, 1957
- Motor Vehicles Act, 1939
- The Oil industries (Development) Act, 1974
- The Oil field (Regulation and development) Act, 1948
- The Oil and Natural Gas Commission Act, 1959

Conserve Energy

Avoid careless habits like leaving the lights and fans on when no one is around, keeping the car or scooter engine on while talking, running pumps and motors overtime, etc. – these contribute to wastage of energy.

Reduce your energy needs and consumption by installing energy saving devices like fluorescent bulbs, rechargeable batteries times, pressure cookers, etc. and practicing energy saving habits.

Reuse and recycle used paper, metal, containers, glass bottles, plastic and other material to save energy consumed in making new items.

Install smokeless chulhas in rural households that depend on firewood for cooking in order to conserve our forest wealth.

Do not waste items like food, cloths, tins boxes paper, drinking water, etc., these consume energy in their production.

Streamline procedural requirements for establishment of new capacities for production, generation, distribution, and consumption of all forms of all forms of energy.

Conclusion

The demand for energy is increasing day by day. The ever increasing use of modern means of transport systems, changing lifestyles and mechanization of labour have led to sudden and very large spurt in the energy requirements. There are several choices available in selecting an alternate source, but the cost factor is high and each is suitable only in a particular area. Since the renewable sources of energy have inbuilt constraints of use, almost 90% of the energy requirements have to for now be met from the finite sources available on this planet. With the impending energy crisis facing mankind, saving 'every bit of energy' is of great importance. This saved energy can then be put to same useful 'use' in future. We must remember 'energy saved is energy produced'. We have to practice sustainable consumption

V.P.M.'s Polytechnic, Thane

ISTE Report

Technical Paper Competition
On
Application of non-conventional energy sources

V.P.M.'s Polytechnic ISTE Chapter (Thane) co-sponsored by Maharashtra Energy Development Agency (MEDA) conducted Technical Paper presentation competition on 'Application of Non-Conventional Energy Sources' on 18th August 2005. This competition was held on the occasion of 'Rajiv Gandhi Renewable Energy Day' 20th August 2005 at V.P.M.'s Polytechnic, Thane.

Mr. Avinash Kubal, Deputy Director, Maharashtra Nature Park was the Chief Guest and Mr. Sunil Pote, Deputy City Engineer, Mr. Bodke were the guest of honour of the above competition.

Mr. S.V. Kulkarni, Director, SVK-CDM Technologies Pvt. Ltd., Thane and Mrs. Radha Natarajan, Geography Department, N.G. Bedekar College of Commerce, Thane were judges of the competition.

A total of twenty-two students of the following institutions presented the papers.

- Vidyavardhini Polytechnic (Vasai),
- Shad Adam Shaikh Polytechnic (Bhiwandi),
- S.S. Jondhale Polytechnic (Ambernath),
- Government Polytechnic (Mumbra),
- B.N. Bandodkar College of Science (Thane)
- V.P.M.'s Polytechnic (Thane)

All papers were very much informative and having innovative ideas. Papers covered the areas on solar energy, wind energy, bio diesel, bio fuels, geothermal, nuclear, ocean energy, tidal energy and hydro energy. The theme dominating the presentation was that- By using non-conventional sources of energy we can minimize pollution and solve many problems relating energy and its utilization.

Systematic presentation and innovative information were the two important factors of the success of the competition. Mrs. G.S. Ingawale, Senior Lecturer and ISTE Chapter Secretary was the coordinator of the competition.

Best Paper presented by

Ist-Mr. Aditya Muley,
TYIE, V.P.M.'s Polytechnic, Thane
IInd-Ms. Sumit Kaur Bhamra-
TYBSC, B.N. Bandodkar's College of Science
IIIrd-Mr. Ashtad Tavadia & Mr. Shrirang Deshpande,
TYCM, Vidyavardhini's B.V. Polytechnic, Vasai

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Bikalpa Shakti Bhavan,
Plot No. J-1/10, EP&GP Block,
Salt Lake Electronics Complex, Sector-V,
Kolkata-700 091.
Tel. : (033)-23575038, 23575348
Fax : (033)-23575037, 23575347

Nodal Agencies of India

- Delhi Energy Develoment Agency
  37,Trughlakabad Institutional Area
  New Delhi 110062.
- Agency for Non-Conventional Energy & Rural Technology
  Kesavadasapuram,
  Pottam Po No. 1094
  Thiruvananthapuram-695004,
- West Bengal Renewable Energy Devt. Agency
  LA Block B 04, Sector III,
  Salt Lake City, Kolkata-700 016.
- Non-Conventional Energy Development Agency of AP
  5-8-207/2, Pisgah Complex,
  Namapally, Hyderabad - 500001.
- Bihar Renewable Energy Development Agency
  Lal Kothi, Sikarpur House
  Dr. T.N. Bannerjee Road,
  Chajju Baug, Patna 800 001.
- Delhi Energy Devt. Agency
  11, Lancers Road, Timarpur,
  Delhi 110007.
- New & Renewable Sources of Energy Dept.
  Govt. of Sikkim, Gangtok 737101
- Gujarat Energy Development Agency
  2nd Floor, Suraj Plaza, Sayaji Gunj,
  Baroda - 390005.
- Haryana State Council for Science & Technology
  SCO No. 24, Sector 26
  Madhya Marg, Chandigarh 160026
- Himurja
  Urja Bhavan, SDA Complex
  Shimla 171009
- Orissa Renewable Energy Devt. Agency
  S/59, Macheshwar Industrail Estate,
  Bhubaneshwar - 751010
- Punjab Energy Devt. Agency
  54-56, Old Psaidc Bldg.
  Sector 17/A, Chandigarh 160036
- Govt. of Nagaland
  Kohima 797001
- Electricity Dept.
  Superintending Engineer
  Andaman & Nicobar Island
  Port Blair 0
- Dadra & Nagar Haveli Admn,
  Devt. & Planning Officer
  Dept. of Rural Dev & Energy Programme, Silvassa
- Admn. of UT of Lakshadweep,
  Department of Electricity,
  Asst. Exec. Engineer
  Kavaratti , Via Cochin - 682001
- Dept. of Science Tech. & Environment
  Assam Rifles Complex, Gorkhabasti,
  Kunjaban, P C Kunjaban Township,
  Agartala (Tripura) 799001
- J&K Energy Dev. Agency
  Dept. of Science & Technology
  Directorate of Jammu & Kashmir
  Civil Secretariat, Jammu 180001
- Distt. Rural Devt. Agency
  Govt. of Pondicherry
  75, Jawahar Lal Nehru Street
  Pondicherry 605001.

List of Agencies

1) Maharashtra Electricity Regulatory Commission
World Trade Centre, No.1, 13th floor,
Cuffe Parade, Mumbai - 400 005.

2) Info@indiacore.com
India Core Response Team
119 B, Jaina Tower II
District Centre, Janakpuri
New Delhi -110058, India
www.indiacore.com

3) National Hydroelectric Power Corporation Ltd.
(A Govt. of India Enterprise)
NHPC office complex, Sector 33
Faridabad 121003, Haryana, India
www.nhpc.co.in

4) TERI
Tata Energy & Resources Institute
Dabari Seth Block, Habitat Place,
Lodhi Road, New Delhi 110003, India
mailbox@teri.res.in • www.teri.in.org

5) BHEL
BHEL House, Sirifort,
New Delhi 110049

6) Bureau of Energy. Efficiency(BEE)
www.energymanagertraining.com
www.aipnpc.com.

7) Dr. Ambedkar Institute of Productivity
National Productivity Council
6, SIDCO Industrial Estate,
Ambuttur, Chennai 600 098.

8) MITCON Consultancy Services Ltd.
Kubera Chambers
Shivajinagar, Pune 411005
Tel. : 9120-25534322/3309
Fax : 9120-2553 3206
Email : kore2005@rediffmail.com

9) Maharashtra Chamber of Commerce Industries & Agriculture (MCCIA)
Tilak Road, Pune 0 411 002.
Tel. : 9120-4440371, 4440472
Fax : 9120-4447902
Web: www.mcciapune.com

10) Solar Energy Society of India(SESI)
Changi Ram Block, 334,
Asian Games Village,
New Delhi 110049.
Tel. : 011-26495001
Fax : 011-51751800

11) Department of Atomic Energy
Government of India,
Anushakti Bhavan,
Chatrapati Shivaji Maharaj Marg,
Mumbai 400 001. India
Tel. : 91-22-22026823/22028917

12) Nuclear Power Corporation of India Ltd.,
Vikram Sarabhai Bhawan,
Anushakti Nagar, Mumbai 400094.
Tel.: 91-22-25560222,2556 0140,
2556 0300
www. indusscitech.net

13) Central Power Research Institute
Government of India
New BEL Road, P.O.Box No. 8066,
Bangalore 560008.

Zagdu Singh Charitable Trust (Regd.)

THAKUR POLYTECHNIC

An ISO 9001 : 2000 Certified Institute
Thakur Complex, Kandivli (E), Mumbai 400 101.
Tel. : 2854 2481 / 2854 3540 / 2854 2433 Fax : 2854 1993
Email : tpoly@thakureducation.org • Web : www.thakureducation.org

Zagdu Singh Charitable Trust (Regd.)

Established in the year 1995, the Zagdu Singh Charitable Trust had set upon itself objectives of advancement of education for the benefit of society in general and to provide medical relief to needy, regardless of religion, caste or creed.

Thakur Polytechnic - in pursuit of excellence

Thakur Polytechnic was established in the year 1998 primarily to cater to the need of students desirous of pursuing technical education after the Secondary School Certificate examination.

Thakur Polytechnic is affiliated to the Maharashtra State Board of Technical Education and conducts courses approved by the All India Council of Technical Education (AICTE), New Delhi. It fulfills all the norms and standards set by the AICTE as well as the Maharashtra State Board of Technical Education. The Polytechnic was accorded approval by AICTE vide their letter No. F-740-80-819-(F)/FT/98 dt. 24th July 1998.

Courses Offered

The Polytechnic offers three year diploma courses with yearly examination pattern in various branches of engineering and technology, the syllabi of which are prescribed by the Maharashtra State Board of Technical Education (MSBTE). The course are approved by the All India Council of Technical Education (AICTE), New Delhi.

Course	Intake
Mechanical Engineering	60
Electronics & Telecommunication Engineering	60
Computer Engineering	90
Information Technology	60
Computer Technology	60
Electronics Engineering	60

V.P.M.'s Polytechnic, Thane

Three Years Post S.S.C. Full-time Diploma programmes

Sr. No.	Name of Programme(s)	Accreditation Status	Period of validity w.e.f. 19-03-2004
1	Chemical Engineering	Accredited	3 Years
2	Electrical Power System	Accredited	3 Years
3	Industrial Electronics	Accredited	3 Years
4	Instrumentation	Accredited	3 Years
5	Information Technology	New Course	-
6	Computer Engineering	New Course	-
7	Medical Electronics	New Course	-

Information Technology Centre

Govt. Recognised Part-time Courses

SN	Course Name	Eligibility	Duration
1	Advanced Diploma in Computer Software System Analysis and Applications	Engineering Diploma / Graduate with min 40% Marks	1 Year (3 Hrs Per Day)
2	Advanced Diploma in Industrial Safety	Engineering Diploma / Degree OR Graduate in Physics or Chemistry with 2	1 Year (6 Hrs Per Day)
3	Certificate Course in Computer Programming	HSC /CCIT	6 Months (2 Hrs Per Day)
4	Certificate Course in Information Technology (CCIT)	SSC	6 Months (2 Hrs Per Day)
5	Certificate Course in Web Page Design	SSC	6 Months (2 Hrs Per Day)
6	Maharashtra State Certificate in Information Technology	SSC	3 Months (2 Hrs Per Day)

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