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SITUATION AND SWOT ANALYSIS OF SMALL WIND- SOLAR- BIOMASS TRIBID ENERGY SYSTEM INSTALLED AT UNIVERSITY INSTITUTE OF TECHNOLOGY, BHOPAL M.P., (INDIA)

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ABSTRACT

The concept paper represents possible potential of solar, wind and biomass hybrid system also the existing situation analysis for power generation in the Indian context for strategic investment in Remote area Development. To determine its feasibility the Energy Centre Rajeev Gandhi Technological University Bhopal M.P (India) has installed a solar-wind-biomass tribid power station in Bhopal mainly for educational and research purposes. This11.6 kW capacity power station generates electricity from solar, wind and biomass at 230V and 50Hz frequency. An effort is made in this direction to obtain situation and SWOTanalysis of proposed hybrid system.

Keywords: *Solar, Wind, Biomass, Hybrid system, SWOT etc.*

Introduction

The project aims to develop a Hybrid system of non-conventional energy resources i.e. solar, wind and biomass, which could give un- interrupted power supply. Optimum sizing of each element in the Hybrid system. Also assess the approach which may be adopted and hence their Techno-Economic Evaluation in general. A comprehensive literature survey has revealed gaps in the research on hybridizing biomass Gasifier with other renewable i.e. solar and wind.

Situation Analysis for the Tribid System

Renewable power (Renewable -to-electricity power generation) is a proven electricity-generating option in the India. With about 10 GW of installed capacity, Renewable power is one of the largest sources of electricity. This installed capacity consists of about 7 GW derived from forest-product-industry and agricultural-industry residues, about 2.5 GW of municipal solid waste (MSW) generating capacity, and 0.5 GW of other capacity such as landfill gas-based production. (Jain Subodh K., 2007) The electricity production from biomass is being used, and is expected to continue to be used, as base load power in the existing electric-power system.

International Development in the Area of Project

The use of renewable alternative energy sources such as solar, wind and Biomass for different type of application is continuously going on. It has been estimated that many countries, including U.S. the United Kingdom, Denmark and Netherlands are easily generating 20-40% of their electricity from R.E.S. power. The current world wide installed capacity of wind farms is

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over12500MW. Renewable alternative energy sources such as solar, wind and Biomass are either used stand-alone or in combination of two technologies i.e. conventional energy non-conventional energy or both non-conventional energy element i.e. solar -wind etc.(Demirbas A.,2002)

The concept using renewable alternative energy sources such as solar, wind and Biomass for electricity generation is not new. They are either used stand-alone or in combination of two technologies i.e. conventional energy non-conventional energy or both non-conventional energy elements i.e. solar-wind etc. but hybrid of three technologies not heard so far or the concept is still limited to academic work only.

History of Power Production from Renewables and Their Hybriding

The process of gasification to produce combustible from organic feeds was used in blast furnaces over 180 years ago. The possibility of using this gas for heating and power generation was soon realized and there emerged in Europe producer gas systems, which used charcoal and peat as feed material. At the turn of the century petroleum gained wider use as a fuel, but during both world wars and particularly World War II, shortage in petroleum supplies led to widespread re-introduction of gasification. By 1945 the gas was being used to power trucks, buses and agricultural and industrial machines. It is estimated that there were Close to 9000,000 Vehicles running on producer gas all over the world9. After World War II the lack of strategic impetus and the availability of cheap fossil fuels led to general decline in the producer gas industry. (Jain Subodh K., 2007) However Sweden continued to work on producer gas technology and the work was accelerated after 1956 Suez Canal crisis. A decision was then made to include Gasifier in Swedish strategic emergency plans. Research into suitable designs of wood Gasifier, essentially for transport use, was carried out at the National Swedish Institute for Agricultural Machinery Testing and is still in progress10. The contemporary interest in small-scale Gasifier R&D, for most part dates from 1973 oil crisis. The manufacturing also took off with increased interest shown in gasification technology. At present there are about 64 gasification equipment manufacturers all over the world. (Jain Subodh K., 2007)

Bluenergy has created the world's first hybrid system, which generates electricity from solar cell encapsulated wind vanes in a double-helix shape – a natural shape using nature's forces Bluenergy Solar wind, Inc., was established in 2006 to manufacture the Solar wind.

Status and Policy

Although there are an appreciable number of windy days in many parts of India, the possibility of wind energy generation has not been completed yet and therefore local research is ongoing. There are many regions with significant wind power potential in India.

Potential of Renewable Energy in M.P. (India)

Electricity is of critical importance in the energy sector. The demand for electricity is also increasing even in industrialized countries fed up with energy. The present M.P. power scenario is Hydro-1919 MW.Thermal (coal)-2157.5MW.NTPC. (Power import)-1120MW,Wind-22.6MW, Solar-100KWp.The recent continuing increase in electrical power generation through Solar, Wind and Biomass energy in some areas of the country has drawn attention to this kind of renewable energy in M.P. The total installed wind generation capacity in India is 3000 MW. Total Installed Power Generating Capacity in India is over 1, 18,000 MW, of which Thermal Generation is over 70% contributing primarily to the Green House Gas Emission (GHG). Although there is no GHG reduction challenge for India but it has taken steps through adoption of Renewable Energy Technologies, combined cycles, Co-generation, Coal beneficiation, plant performance optimization

etc. (Bhatia A.L. (2007)

Under the Kyoto Protocol, Clean Development Mechanism (CDM) has been conceived to reduce cost of GHG mitigation, while promoting sustainable development as per Framework Convention on climate change (FCCC).

Due to its geographic position, India is under the influence of different air masses. These air masses give rise to potential wind generation possibilities in different areas. The government aims to generate 10000MW from renewable by 2012 out of which 5000-7000MW will be sourced from wind**.** According to the India Wind Association, the installed wind power capacity was 30 MW in 1990. It increased to 2 117 MW in 2002, the fifth largest in the world. Installed capacity increased to 3 000 MW in 2004.The first wind power development was a government supported demonstration plant in 1986. India had notable wind power developments by the late 1990s, largely due to incentives such an accelerated depreciation allowance of capital costs and exemptions from excise duties and sales taxes, and regionally administered feed-in tariffs. A tax rebate of 80% on the income from power generation for the first ten years of operation has encouraged commercial investment, as has the attraction of power supply for use in businesses. Since the first demonstration plant, some 2 052 MW of installed wind capacity has been developed by commercial interests. In some cases they are not well integrated as the wind turbines produce more power that the weak distribution system can handle.

The government Center of Wind Energy Technology (C-WET) in Chennai is a specialized institution for research and development, standardization, testing and certification, along with resource assessment. National Laboratory provided technical assistance for its establishment. With rapid growth in wind power development in the 1990s, the capacity of the grids in the wind farm regions in Tamil Nadu and Gujarat was insufficient to accommodate the wind power. It caused frequent outages of the grid and reduced the return from the wind farms. In 1998, Risø and C-WET collaborated on a research project to study wind power integration in weak grids in India. India has developed indigenous wind energy equipment manufacturing with a capacity of about 1 000 MW per years.

Global Concern for Reduction in Emission

The global concern for reduction in emission of green house gases (GHG) especially CO2 emissions are likely to put pressure on Indian Power System for adoption of improved generation technologies. Although India does not have GHG reduction targets, it has actively taken steps to address the climate change issues. Mitigation options for CO2 reductions, which have been taken up vigorously, include GHG emission reduction in power sector through adoption of Co-generation, Combined cycle, Clean Coal Technologies and Coal Beneficiation and use of renewable sources. Before the intervention of man, the capacity of forests, grazing land and other natural resources was 1500 crore ton. Man has already destroyed its 12% and uses its 27% directly. (Bhatia A.L. 2007) For the rest of the animal kingdom only 60% resources are left. In this manner only one species (Human) is exploiting 40% of earth's resources. Modern technology aims to exploit more than 40% of such resources. (Bhatia A.L. 2007)

A major thrust on CO2 reduction on long term and sustainable basis would however come through adoption of advanced technologies of power generation like Supercritical/ Ultra supercritical power cycles, Integrated gasification combined Cycles (IGCC), Fluidized bed combustion/ Gasification technologies and targeting at least 10% Renewable Energy share by 2012 (i.e. 11th five year plan end)

The use of renewable energy resources is essential for economic development, which will bring benefits by development/ adoption of Renewable Energy System of Solar, Wind and

Biomass. It is consequence of striving towards sustainable economic development, stimulated by a growing concern about the impact of CO_2 emission and consequence global warming. (Togrul, M.C. 1996) For reliable supply of power in remote locations or inaccessible rural areas it will be possible and sometimes necessary to design and setup Hybrid system, which combines the advantages of two or more different technologies, to take care of base load requirements. An integrated Hybrid System would ensure that power supply could be maintained at an optimum level during adverse condition like cloudy days (for PV system), low wind conditions (for wind electric generators) and no availability of Biomass in rainy season. (Elliot, D.2000)

Wind energy offers the potential to generate substantial of electricity without causing pollution. Several countries began to formulate expensive Research and Development program to exploit solar energy. Biomass based power plants and Co-generation plants are coming up all over country as a result of initiative taken by ministry of Non- conventional energy sources. . (Hepbasli A 2004) Biomass, Solar and Wind sources of Energy are being exploited for power generation for optimization of power potential through these renewable sources however a hybrid system of solar wind and biomass could give un- interrupted power supply.

The present paper focuses on optimum mix of Solar Wind and Biomass for meeting base load and demand over longer period of the year. To carryout studies an optimum mix of Solar and Wind an experimental test facility set up at RGPV Energy Park has been used.

Future Projections

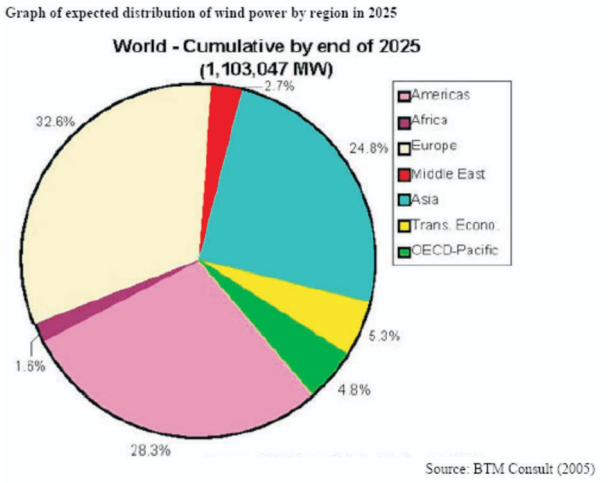

Figure 1: Expected Distribution of Wind Power by Region in 2025

The development of wind energy in the future is expected to increase dramatically (BTM Consult, 2005) as shown in Figure 2.3 above. Cumulative capacity is expected to increase from 48,000 MW in 2004, to 271,512 MW in 2015. This represents a forecast growth in annual installation of 13.5% per annum and an average growth in cumulative installation of 17.1% per annum. The fastest growing regions are expected to be USA, China and India. In the US, General Electric (GE) the large energy utility, is now recognized as the market leader and is providing more than 60 per cent of the 2500 MW of wind energy capacity expected to be installed in the US in 2005(Hepbasli, 2003). At the time of writing the US wind capacity will power approximately 10,600MW ('Operating wind power capacity' 2006b), enough to power 2.5 million homes. (John cairns Jr.2007)

Wind Resource in India

India Meteorological Department (IMD) has been collecting wind data routinely at various locations, for over a century. This data has been very helpful in giving qualitative indication of wind power availability in the country. IMD collects routinely the synoptic data from their observatories mostly located in city centers or townships.

Government of India, in its guidelines indicated that sites which exhibit wind power density of more than 200W/m2 may be considered for setting up wind turbines .on a regular basis the list of such sites which exhibit WPDs beyond 200W/m2 is made available to all users.

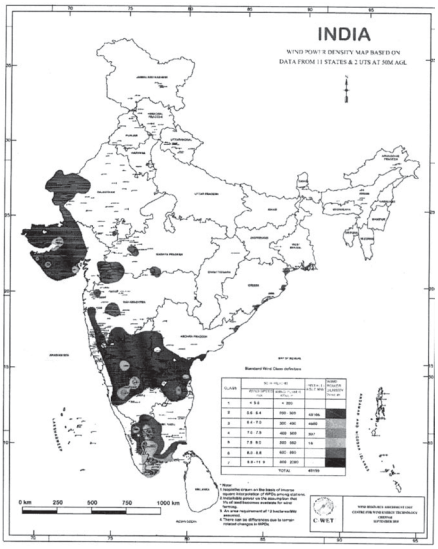

Figure 2: Wind Power Potential Map of India

A capacity of 230 MW was installed in 1994-95, 382 MW in 1995-96, 170 MW in 19967-97. Between 1993 and1997, growth in the wind energy sector represented approximately 6% of new generating capacity installed in the country. Graph shown fig.1.2 depicts the growth in installed capacity of wind energy in India, from 1990 onwards. By the end of 2001-02 the total wind power installed capacity in India was 1627.3 MW .A capacity of 241.2 MW was installed in 2002-03, 615.2 MW in 2003-04, which raised the total wind power installed capacity in India to 2483.7 MW2003-04.

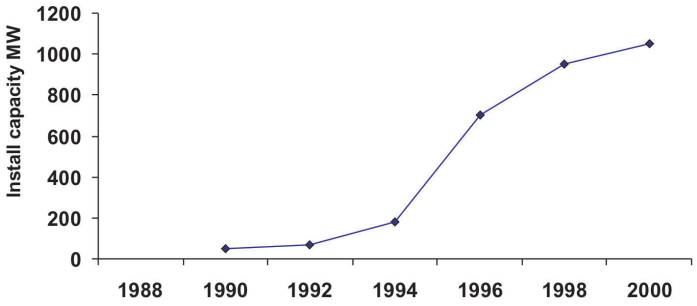

Figure 3: Growth of Installed Capacity of Wind Energy in India Since 1990

SWOT Analysis of Tribid (Solar, Wind and Biomass) System

A tribid renewable energy system in which three different renewable energy sources (solar-photovoltaic, wind and biomass, etc) are integrated to supply electricity or heat, or both, to the same demand

Strength for Tribid Systems

- Hybrid systems offer flexible solutions for the energy supply of small rural settlements the combination and proportions of different local energy resources (solar, wind, hydro, biomass etc) can be integrated to suit the local demand. (Hovsepion A.,1997)
- Hybrid systems can offer a reliable energy supply in regions that are either not grid-connected or that have poor access to the grid.
- If the amount of energy consumption increases, it makes sense to combine PV with other renewable energy technologies such as small hydro, wind, and biogas generators and also with diesel or natural gas generators. The reason is that these other technologies can provide lower cost per Kilowatt-hour if they are scaled up to a certain level. (Sahin A.Z.,2000)
- Save a minimum of 360 tonnes of greenhouse gas emissions per GWh
- Inexhaustible energy source, if managed correctly
- Steady, reliable energy 24 hours a day, 365 days a year
- Reduces the need for new electrical generation
- Market ready and quickly installed
- Average total maintenance costs are 1/3 less that of conventional systems
- Inside air is cleaner and free from outdoor pollutants.
- Underground installations are more secure
- Reduces dependency upon fossil fuels
- Diversity in potential applications and sustainable energy sources
- The hybrid systems offer the most adequate solutions for the electrification of small rural settlements, the combination and the ratio of the types of energy supplied by various renewable sources (solar, wind and biomass) depending greatly on the resources locally available in each geographical area. (Gunes M.,2001)These resources can be accurately evaluated only after a period of typically one year of monitoring the basic parameters (wind speed, solar radiation, etc.), necessary for sizing and implementing such systems in the respective areas.

Weakness of Tribid System

- Higher initial cost compared to conventional systems
- Low public awareness and recognition
- Deficiencies in some past installations
- Limited supplier capability
- Lack of training, certification and support for installers and customers
- Lack of tracked information to support claims of value
- Poor customer follows through on servicing and/or repair
- Design issues regarding some underground loops

- Regulatory constraints

Although renewable energy is universally available, there are limitations that should be considered prior to installation. These limitations include:

- The need for many older homes and buildings to insulate or upgrade prior to installation of a renewable system.
- The need for a property footprint large enough to allow sufficient drilling.
- An imbalance between space heating and cooling load requirements in certain regions of world.
- The need for some fossil fuel generated electricity to run the system's heat pump (eventually, a renewable energy source could be used for this).
- Despite a well-established technology, there has been a history of early failures, which has highlighted the need for better training, better quality assurance and other market transformation measures.
- Quality standards are lacking as well as the market and industry infrastructure to promote renewable to both residential and commercial consumers and major utility operators.

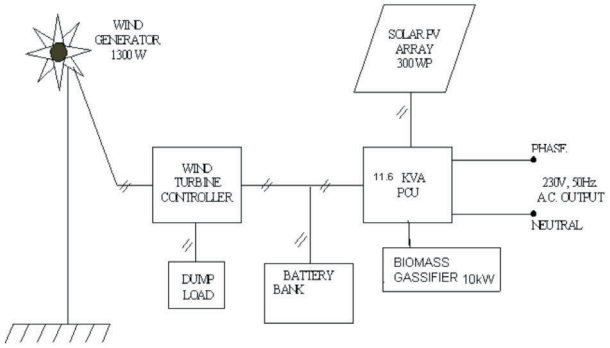

Figure 4: 11.6 kW solar, wind and biomass hybrid system installed at UIT RGTU Bhopal (India)

Opportunities for Tribid Systems

HYBRID systems based on renewable energy can contribute to a sustainable development, and are thus very appropriate for the start of the 21st Century.

An Untapped Potential

Although there are no hard statistics in other countries, sustainable resource management has almost always prompted sustainable economies. Due to the labour intensive nature of renewable energy, many studies in the world have demonstrated a large advantage in job creation and economic enhancement. For example, the State of Wisconsin's Department of Administration economic model showed that renewable energy investments produced three times more jobs, income and economic activity than for the same amount of electricity generated from coal and natural gas power plants.

The Next Decade

Over the next 10 years, the Energy Plan is asking electricity distributors to pursue a voluntary goal that 50 per cent of new electricity be acquired from clean alternative energy sources a goal that could signify an economic boom.

- Renewable energy is well positioned to assist electricity distributors in meeting this goal. By working cooperatively with its many partners, Renewable energy companies can offer an efficient technological solution that not only reduces electrical demand but is also environmentally, socially and economically friendly.
- The greenhouse industry will benefit from the innovative applications currently under development for their unique environment.
- The creation of a whole new market for the financial sector.
- There are a number of research programme looking at the integration of different energy sources, both electrical and thermal, and the delivery of the energy to consumers.
- The possibility to combine two or more renewable energy sources, based on the natural local potential of the users
- Environmental protection, especially in terms of CO2 emissions reduction
- Low cost – wind energy, and also solar energy can be competitive with nuclear, coal and gas especially considering possible future cost trends for fossil and nuclear energy.
- Diversity and security of supply
- Rapid deployment - modular and quick to install
- Fuel is abundant, free and inexhaustible
- Costs are predictable and not influenced by fuel price fluctuations, although fluctuations in the price of batteries will be an influence where these are incorporated.

The directive for the promotion of electricity from renewable energy sources (RES-E Directive) represents the general EU legal framework for the development of PV and wind electricity based on specific support schemes adopted by the member states. The Directive foresees a EU wide target and determines the framework for the administration procedure, the grid access, the green electricity guarantee and supporting measures, as a EU wide target is fixed.

Threats for Tribid System

Some hybrid heating systems combine different and innovative technologies, e.g. active and passive solar heating, heat storage and other components. The difficulty of characterizing the behavior of such complicated and new energy systems sets especially difficult challenges for the planning engineer.

- Lack of government plans, support and promotion
- Lack of tax incentives
- Lack of standardized practices and certification
- Lack of training and mentorship, especially for installers
- Lack of a regulatory body to assist consumers
- Lack of familiarity for architects, engineers and contractors
- Lack of a performance insurance plan
- Lack of information coordination and public education
- Lack of technology understanding which leads municipalities to impose
- 100 per cent back-up with standard technologies, negating the economic advantages of geoexchange systems

- Lack of collaboration among competing organizations from outside BC

It is necessary to also ensure the minimum level of power for the functioning of the systems even during least unfavorable periods (at night, on cloudy and windless days) Electric energy for these periods, is provided from energy storage batteries (their autonomy and capacity being determined on a case-to-case basis).

The electric input parameters should be compatible with the electric output parameters, especially taking into account:

- The wide range of variation of the electric output parameters of the solar or wind generator, due to the variation of solar radiation intensity or of wind speed
- The reduced range of variation of the accumulator batteries load - unload electric parameters, this mode having to be controlled by means of a charge controller
- Compatibility in various operating modes of the load by interconnecting adequate interfaces (both for the D.C. part and for the A.C. part).

Conclusions

Achieving sustainable development is a target for developing countries that is now widely seen as important to worldwide public opinion In this regard, in the planning and implementation of the future studies for India's energy sector, it is essential to know situational analysis and SWOT analysis of energy resources. .In this context, the utilization of renewable energy resources such as solar, wind and biomass energy appears to be one of the most efficient and effective ways of achieving this target. It is expected that this study, which focuses on the necessity of hybrid system of renewable energy sources, will fill a considerably large gap since it is the important attempt towards the investigation of these resources in terms of the history.

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