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Compound Renewal Energy Systems Challenges And Scopes

Ved Prakash Sharma, Anup Pandey
EC dept. RJIT Tekanpur Gwalior MP, India Vedsh071@gmail.com
Student, EC dept. RJIT Tekanpur Gwalior MP, India

Abstract—
Renewal energy sources offer an effective solution to the complex situation for our growing energy demands at one end and the depleting conventional sources at the other end. They appear to be efficient in reducing problems due to conventional sources such as cost, pollution control, waste management, efficiency etc. In spite of their wide availability and advantages, the complexities in installation, usage and irregularity limit their implementations. These complexities can be much reduced by interfacing various renewal resources in co-operative mode. This paper explains some renewable energy systems with their challenges and complexities. Here we propose to interface solar and wind energy systems to a bio-digestner system to increase output products and enhance the overall performance of the system
Keywords—*Renewable energy; solar; wind; biodigestner*

I. INTRODUCTION

The conventional energy sources have limited availability but their demand continues to increase with population and development. This affects our budget, life conditions and living standard. Further their production and usage has serious impact on our environment, climate due to pollution and by products. Contrary to this non-conventional renewal sources are abundantly available, their usage may reduce environmental and pollution problems. But the implementation and conversion processes (in a form usable for our use) are critical in terms of time, cost, conversion ratio, seasonal and geographic locations. The proper care and attention to such issues is a major concern of current research in this field.

The co-operative interfacing of various renewal systems [1] can result in an effective system in terms of time, cost and residual energy so that individual system specific problems are minimized, but performance and efficiency of the overall system are improved. "smart mix" of renewable energy sources can be used to reliably meet electricity demand[2, 24]

There are various types of renewal energy sources available around us – solar, wind, tidal, geothermal, offshore, hydro, biomass and biogas. In countries like India, China and others we have energy shortage at one end and waste disposal problems at next. The enhanced use of bio-digestners [27, 28, 29] for the production of biogas from disposal waste and bio-mass can provide a boost to economy and reduce pollution problems.

II. VIABILITY OF THE CONCEPT

Renewable energy technologies are becoming cost effective and cheaper due to technological changes in production, installation, implementation, mass production and market competition[2]. The price of PV modules per MW has fallen by 60 percent since the summer 2008, Wind turbine prices have also fallen by 18 percent per MW[23]. Similarly low cost, modular and manageable bio digestners are becoming available or can be customized as per need [3,11, 29].

III. SOLAR ENERGY

The energy from Sun is brightest, long range promising solution for immediate and future needs. It is available freely, everywhere and will continue to remain for years. It is the source of all other energy resources. It provides a clean and pollution free solution to our energy demands. Solar energy resource is inherently variable; the output varies throughout the day, seasons, climate and cloud [2]. Solar energy can be utilized directly or through solar cookers, solar PVT units, solar distillatory, solar air heaters and many more other devices [12, 14]. Some of them are discussed below:

SOLAR PV&T

A single solar cell is represented as a resistance Rs in series with a parallel combination of current source, exponential diode and a parallel resistance [26].

Solar photovoltaic and thermal panels [9, 12, 16, 17] produce electricity and thermal energy at same time. The photovoltaic cell converts electromagnetic radiation (photons) into electricity, and solar thermal collector captures the solar energy to convert in heat and remove away. Solar panels developed by chemical vapour deposition technique are flexible and capable to produce voltages more than 50v. PVT modules capture both electricity and heat, this makes them more energy efficient than solar photovoltaic (PV) or solar thermal alone [13]. The thermal collectors can be of air cooled, liquid cooled or hybrid type. In a standard fluid based system, a working fluid, typically water, glycol or mineral oil is piped through tube pipes attached below the PV Panels as chillers. The heat from the PV cells are conducted through the metal and absorbed by the working fluid (presuming that the working fluid is cooler than the operating temperature of the cells). In closed-loop systems this heat is either exhausted (to cool it), or transferred at a heat exchanger, where it flows to its application. In open-loop systems, this heat is used, or exhausted before the fluid returns to the PV cells[16].

Fig.1- Solar PVT [26]

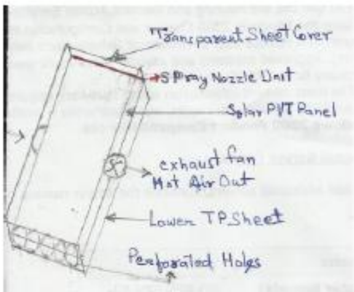


Fig.2-Proposed cooled PVT Panel

The efficiency of solar PVT panel may be increased by air cooling, water spraying , efficient tracking etc [12,13]

For our system we propose PVT panel with 5-8 mm air gap between PV &T panels, periodic air cooling at front and bottom and periodic water cooling at front surface, all controlled electronically.

SOLAR DISTILLATION SYSTEM

This is an economic, portable and easy to use system that purify water. Limited availability of clean water resources against requirement and abundance of impure water indicates potential for this system and solution to problems like water shortage for sanitation, diminished agricultural yields, waste disposal, misuse and pollution of water resources harming biodiversity, regional conflicts over scarce water resource and so on [2, 7].

From the results of project calculations a truthful estimate was made to prototype[9] the most effective geometries of the distiller and trough concentration system one to maximize evaporation/condensation and recapture waste heat to minimize thermal losses.

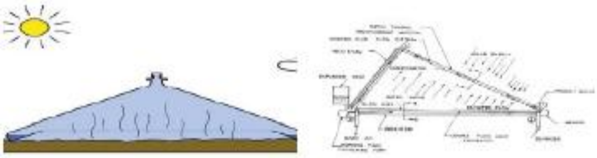


Fig.3-Two surface evaporation & high performance [9]

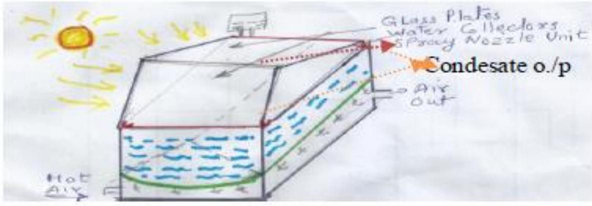


Fig. 4 Our Proposed Solar Still

A practical model was observed at energy centre MANIT Bhopal[12] and performance variation was observed in terms of Sun directions, periodic air and water cooling. Such distillatory with minor modification in water storage basin and micro controller for spraying are a part of our proposal.

SOLAR AIR HEATER

The simplest and the most efficient method of using solar energy is to convert it into thermal energy for heating applications through solar collectors. They can be used for crop drying, timber seasoning, space heating, cooking etc. The thermal efficiency of solar air heater is low due low thermal capacity of air and low convective heat transfer coefficient between absorber plate and flowing air in the duct. The heat transfer rate can be enhanced by use of extending surface and artificial roughness[10]

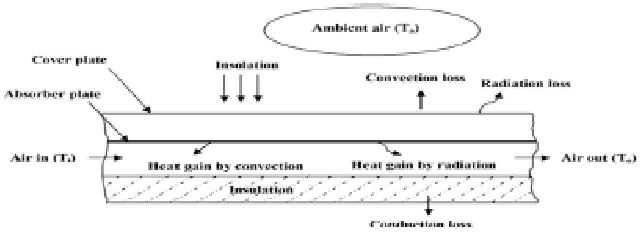
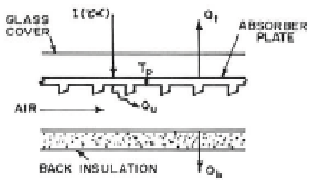


Fig.5- Energy balance of Solar Air Heater [12]



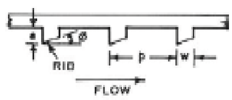


Fig.6-Roughened Absorber Plate Fig.7-Integral chamfered rib

Further improved version displayed at energy center, MANIT Bhopal is a multicavity solar air heater with extended roughened surface [14]. In our proposal we consider taking that one such component with minor modifications.

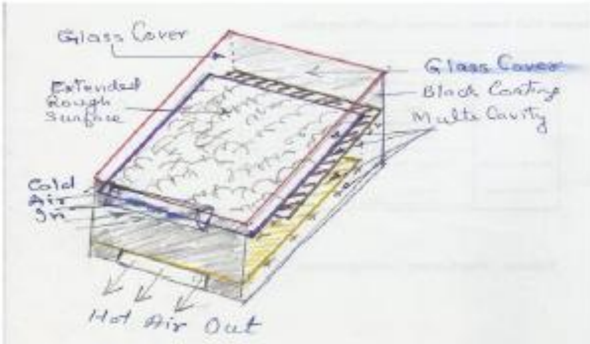


Fig.8- Our Proposed Solar Air Heater

IV. BIOMASS ENERGY

Biomass power comes from plants(crops, grasses, forest residue) that have captured and stored energy from sun. Biomass power is roughly half of all the renewable energy produced in the United States [2, 3]. The biomass can be treated in different ways for various energy forms as liquid biofuels, heat or electricity-

- Burned in power plants to produce heat and electricity, with harmful emissions lower than coal.
- Fermented for vehicle fuels like ethanol.
- Digested by bacteria to create methane gas to power turbines.
- Heated under special conditions to form gassified gas mixture, that is burned for electricity and other range of products (diesel to gasoline to chemicals).

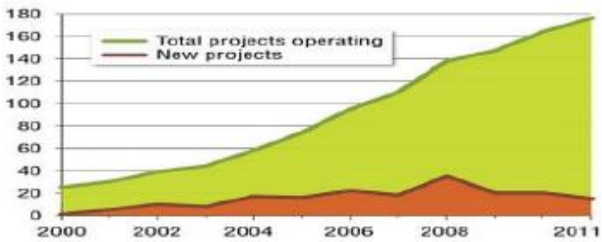


Fig.9- BioMass Energy Consumption [3]

BIOGAS ENERGY

Biogas comes from animal waste, manure and allow farmers to produce electricity without water contamination, odor pollution, or global warming emissions. It is produced when bacteria decompose manure in absence of oxygen, as a gas mixture having 60-70 percent methane[9]. This can be used to generate heat, hot water or electricity, and the left over used as fertilizer. According to EPA's AgSTAR report[3] in 2010 about 8,000 U.S. farms had biogas systems, providing about 1,600 megawatts of energy and reducing emissions of global warming pollution by about 1.8 million metric tons of methane. Biogas systems includes: a waste collection system, an anaerobic digestner (covered lagoon/tank) for methane production, gas handling system (pipes, generator, and gas storage tank.

BIO-DIGESTNERS

Bio-digesters are important as they eliminate need of septic tanks, charcoal, firewood, bottled gas and kerosene, thus saves money and improve the quality of life dramatically [11]. Digestner types include - covered lagoons (simplest and most popular) limited to warmer climates, Plug-flow digesters (long, narrow, partially underground to retain the heat) for dairy manure or complete-mix digesters made of reinforced concrete or steel with a mechanical, hydraulic or gas-powered mixing system. They generally require a diluted manure mix. Now also available in low cost polythene models[29].

Fig.10 - Bio-digestner for biomass and biogas energy

As a complement to the biogas plant, biogas lamps offering ample light, are safe, odourless and clean.

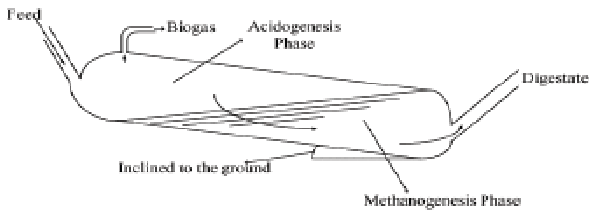
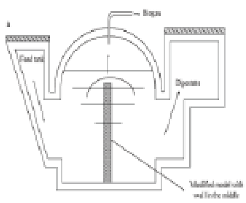


Fig.11- Plug Flow Digestner [11]



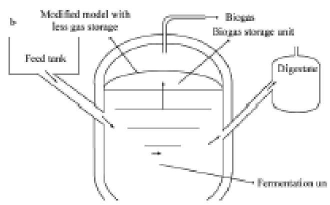


Fig.12- Janta Model[11] Fig.13- Deenbandhu Model[11]

The bio digestners are the only solution to decompose biomass and human wastage in hilly and colder areas like J&K, Laddakh, they stop working due to low temperatures. To solve this, bacteria is being used to decompose. However volta experiment[18] shows that hydrolysis of water decompose it to gases. So we can employ electrolysis process to the slurry at biodegester to decompose it to gasses and reduce the overall volume of final residue. This principle when used in [19], the voltage and currents required are quite low, usable from solar PVT panels or storage batteries, reducing chemicals in residue output. The current density of 0.03 A/cm2 for pH 7 at 140min the COD removal was 85%, anaerobic digestion was most successful, COD reduction was 1536 to 240 mg/L and BOD reduction was 873 to 36 mg/L

V. GEOTHERMAL ENERGY

Geothermal energy comes from steam reservoirs and hot water beneath the earth's surface. It is the least explored resources. In 2010, geothermal energy was just 3,000 MW (less than .5% of electricity) used in USA[7].Today with 200 geothermal projects, with capacity of 7,800 MW, are under development in 15 states, largely in the West[7]. It needs careful siting and strong environmental protections due to negative environmental impacts- threats to local groundwater, contamination of underground drinking water, increased seismicity due to drilling, management of toxic waste. The high energy content of this source may be used for electricity, heating, cooling, industrial processes, or melting snow on roads. It can be used to fuel power plants, heat spas, pools, homes, greenhouses, aquaculture ponds and to dry /dehydrate agriculture products.[8] On a smaller scale it can be used through a geothermal heat pump to exploit the temperature difference between the earth's surface and the air. In most places, the temperature at 10 feet below ground level remains between 50-60 degrees Fahrenheit year-round. During winter, a geothermal heat pump pulls heat from the warmer ground to a building and in summer it cools the building by pulling warmer air to cooler ground, to heat water.

VI. WIND ENERGY

At the end of 2012 USA had 45,000 turbines with 60,000 MW of output, majority of them located in central region from Texas to Canada [31]. Once installed and operational, wind turbines are the only renewable energy resource that have maximum conversion ratio to output, standard efficiency of Encore turbines is stated to be about 45%. The output is also in AC form, land area per kilowatt-hour (kWh) of electricity is less, compatible for grazing and crops. Energy generation starts just within 3 months of setup with no gas emissions or air pollution, expected life period is 20–25 years. The output voltage is at 670 v, that is to be down converted for household purpose, or up converted to 33Kv for feeding to grid through exchanger. The AC output of wind turbine is given by

V= ½ AⱣ V3

Where A is area covered, V is wind speed, Ᵽ is a constant

Fig.14- Wind Farms near Dewas Ujjain, India

But the challenges are : millions of bird fatalities every year has devastating impacts on future agriculture production. Wind turbines catch fire and explode. In 2011, an upper New York state wind turbine exploded and spread debris for one-fourth mile. In colder regions, blades of turbines have thrown refrigerator-sized pieces of ice hundreds of yards during winter season[2]. Moreover the cost of a turbine is very high, 6-6.5 crore for 1 MW, and the trend is to install more capacity turbines That are to be more heavy and need higher towers. Normally a turbine weighs about 90 tones and tower height of about 90 mtr. Blades weigh about 3 tones each. So installation is very hectic. Before installation, the site study requires 3-6 years. In case of natural disasters or calamities like Uttarakhand wind turbines may cause severe losses.

Wind turbines require external power supplies to heat them in the winter and provide initial blade rotations. For the wind speed below 2.5 m/s wind turbines do not produce electricity, and for wind speeds above 25 m/s, the turbines need to be shut down to avoid damage. Intermittent operation of wind turbines require fast responding fossil-fuel electricity sources to maintain continuity of electricity supply. Poor performance of backup electricity supply may reduce or even eliminate wind turbine’s savings of fossil fuel use. According to the wind industry’s trade magazine, North American Wind Power [25], thirteen years is the life-expectancy of these things.

Fig.15- Grid Integration of Wind Turbine [32]

Our Proposed System

We proposed a compound system of renewal sources[1] that included improvised solar PVT panel, Solar air heater, solar distillation system and a plug flow type bio digester system with air heating, tube heating and Electrolysis process[19] implementation to enhance the decomposition process, minimizing energy wastage and to increase overall efficiency. In this paper we include a window turbine system also whose electrical output is fed to grid through changeover units in wind farms can be used for underground biodigestners, the towers can be utilized to hold the solar panels. The DC output of solar panels can be mixed, fed to an inverter and then to grid, biodigestner or other device.

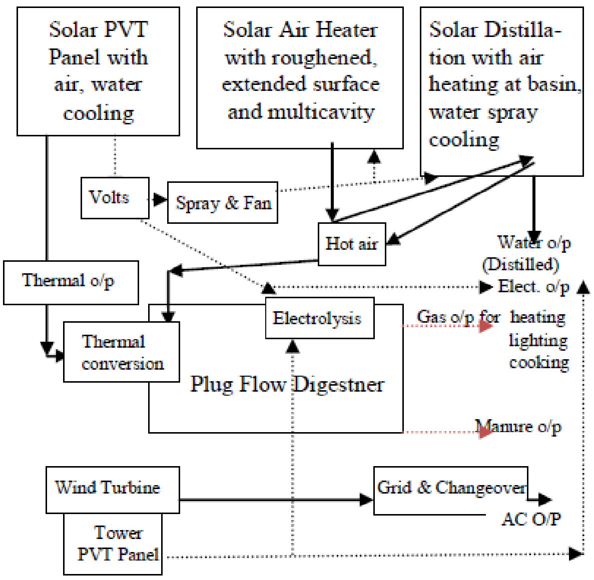


Fig.16- Proposed Compound RE System

As electrochemical treatment in Biodegestner have been success full in faster decompostion of carbohydrates, sugars, lignin, proteins, alcohols, waxes and colouring compounds, reducing secondary pollutants and enhancing more gass output. [19] COD reduction from an average 5760 to 896mg/L meeting the discharge standards. This means that the digestner output will be enhanced, odour free and more clean.

The efficiency of individual systems will increase due to residual effect, even if main source of energy goes off for some time. Solar panels of improved design that works even with diffused, refracted and other light sources are to further enhance the capacity our proposed system.The distillate output is supposed to increase as the evaporation temperature is enhanced sufficient.

VII. Conclusion

The proposed model interconnects naturally variable energy resources that can offer smart demand response management . The model seems to be energy efficient by minimising energy losses in various systems, utilze residual energy of individual systems in co-opeartive manner, i.e. utilizing problems of one system as boost factor for other system. This compound system with necessary improvements is under the proce of modelling. If the simulation results verify our expectationbe, then the difference in physical results and simulated ones are to affect its design. However such a system clearly indicate that renewal energy resources enhance for a clean, pollution free atmosphere.

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