

Conventional Energy Conservation to Protect the Environment by the Application of Renewable Energy Sources in Agriculture and Industries

M. Ali Saloda¹, Narendra S. Rathore²

¹Mechanical Engineering Department, CTAE, MPUAT, Udaipur, India

²College of Technology and Engineering, MPUAT, Udaipur, India

¹masaloda@gmail.com, ²nsrdsr@gmail.com

Abstract-There are numbers of unit operations in agricultural industries and production industries consuming a measurable amount of conventional energy sources. Regarding implementation of energy conservation in the agricultural and production industry, it is observed that though some measures based on conventional fuel conservation strategy are implemented in large-scale factories, other based on renewable energy sources can be implemented in small and medium scale production factories. There are numbers of renewable energy sources which can easily be integrated in the production or manufacturing industries for conventional energy conservation such as solar energy for cooling, heating, steaming, drying and electricity generation etc., bio-energy for process heat for different unit operation and biomass improved cook stoves & furnace for thermal energy etc. Further, methods for reducing the methane and nitrous oxide emissions from manufacturing operations and developing wastewater treatment technologies that capture methane from wastes and use the methane as an energy source are also additional field for energy conservation in agricultural industries. The scarcity and reduction of the stored conventional energy sources motivated the author to work on the conservation of energy in agriculture industries. This paper deals with the conventional energy conservation measures by the application of Renewable Energy in agricultural and production industries involved in producing value added products. The essential points required for meeting energy conservation based on Renewable Energy Sources are also included in this paper.

Keywords- Renewable energy; Production; Agricultural; Energy conservation

I. INTRODUCTION

There are numbers of unit operations in manufacturing industries consuming bulk of conventional energy sources such as machining operations on all conventional and non conventional machines, CNC machines and machining centers, machining and forming with the help of radiant energy sources i.e. LASER beam, Electron beam working. Apart from that, many unit operations in agricultural industries consume a measurable amount of conventional energy sources such as drying & dehydration, concentration, densification and process heat availability for different thermal applications, etc. There are numbers of renewable energy sources which can easily be integrated in the manufacturing industries as well as agricultural industries for energy conservation.

The energy conservation potential observed that reducing the energy consumption as well as, implementing various new and renewable energy sources in manufacturing industries. Also it is observed that the cleaning modification, condensate recovery, increase additional effect evaporator and heat recovery from the combustion gases could be implemented in the agricultural industries. A review of current and future costs of three forms of renewable energy technology by comparing data from a range of international and Australian-specific studies, taking care to compare data on the same basis of financial assumptions (discount rates) and resource quality was done [10]. The purpose was to compare the absolute costs and the rate of decrease in costs, and to understand the reason for differences between the studies.

Energy conservation in manufacturing industries can effectively be carried out by developing new technologies to improve energy efficiency on factory, hot water production and recirculation, machinery and water pumping by using renewable energy supplies on factory and in manufacturing plants. The energy conservation possibilities and potentials in the manufacturing industries based on Renewable Energy Sources may be a new direction to small and medium manufacturing industries such as solar energy, bio-energy and biomass improved cook stoves and furnace etc. Energy conservation is also possible by energy auditing and implementing the various measures suggested by energy auditing in industries.

Renewable energy is one of the most promising and important opportunities for value-added products in manufacturing industries. The type of renewable energy technology used in manufacturing industries depends on the type of energy required, access to the renewable energy source and the design of the manufacturing facilities and processes. In India, these facilities use energy mainly for equipment such as pre heating of water for boilers, water heaters and coolers, vacuum pumps, charging of batteries, lighting and ventilation.

Renewable energy sources also called non-conventional sources such as solar energy, wind energy, bio-energy & bio-fuels, hydropower etc. are continuously replenished by natural processes. A renewable energy system converts the energy found in sunlight, wind, falling-water, sea-waves, geothermal heat, or biomass into a form, which can be used as heat or electricity.

Most of the renewable energy comes either directly or indirectly from sun & wind and can never be exhausted, and therefore they are called renewable. There is significant potential for application of Renewable Energy Sources in manufacturing industries for reducing hydrocarbon emissions as well as saving the conventional fuels. Renewable energy can address many concerns related to fossil energy use. It produces little or no environmental emissions and does not rely on imported fuels. Renewable resources are not finite (as fossil fuels are) and many are available throughout the country.

A. *Benefits of Renewable Energy Sources in Present Context*

Renewable energy technologies can help:

- Reduce building operation costs
- Decrease reliance on imported fossil fuels
- Cut pollution and greenhouse gas generation
- Enhance state and local economies by creating jobs

Certain renewable energy technologies can also provide:

- Reduced peak demand for electricity
- Waste mitigation and odor management
- Compliance with environmental regulations

There are numbers of renewable energy sources which can easily be used in the manufacturing industries for energy conservation such as bio-energy for process heat and biomass improved cook stoves and furnace for thermal energy, solar energy for cooling, heating, steaming, drying, air-conditioning and electricity generation etc. Different renewable technologies are at different stages in their development. Some are commercially available or nearly so, and others have potential for the longer term.

II. BIOMASS ENERGY

Biomass energy has the potential to supply a significant portion of country energy needs while revitalizing rural economies, increase energy independence, and reduce pollution. Discussion of renewable energy from biomass centers on the concept of the "bio-refinery", where new technologies are being used to extract energy and other valuable products from biomass resources. Like oil refineries, bio-refineries are envisioned as industrial facilities that convert a stream of raw material into a varied slate of products, maximizing value by shifting the mix of output to match dynamic market conditions. Potential bio-refinery products include liquid fuels, such as ethanol and bio-diesel, electricity, steam, and high-value chemicals and materials. Many of these products have the potential to replace petroleum, either as a vehicle fuel or as a chemical feedstock, resulting in increased energy security and reduced environmental emissions.

In a sense, bio-refineries already exist. They process corn into ethanol, corn syrup, animal feed, and other products, or transform trees into a variety of uses such as, electricity, and heat. A thermo-chemical process (the syngas platform) involves heating biomass to turn it into a gas composed of a few basic molecules, then processing this raw material into fuels and products through chemical or biological techniques. India has significant biomass resources. It has been estimated that the cellulose available from just forestland and agricultural land, the two largest potential biomass sources, could amount to about one billion dry tons per year. Another biomass resource with significant potential is municipal solid waste, a byproduct of modern life.

A. *Biomass Gasifier*

Biomass has high potential to contribute to energy need of modern society worldwide. The gasifier provides a practical solution for production of a low calorific value gas for small scale agro based industries for thermal application. Biomass gasification is basically conversion of solid biomass (i.e. wood/wood waste, agricultural residue etc.) into a combustible gas mixture normally called "producer gas" [1]. The process is typically used for "woody" biomass and it involves partial combustion of such biomass. Biomass will play an important role in the future global energy infrastructure for the generation of power and heat. The dominant biomass conversion technology will be gasification, as the gases from biomass gasification are intermediates in the high-efficient power production or the synthesis from chemicals and fuels. In the discussion on the utilization of gases from biomass gasification it is important to understand that the composition of the gasification gas is very dependent on the type of gasification process and especially the gasification temperature. Biosyngas and Product gas are the two main types of gasification gas [11].

The basic application modes of biomass gasification available in India, are Power Generation, Irrigation/other mechanical modes and direct thermal applications. Biomass can be efficiently used for power generation. There are two possible routes for power generation, which can be employed for power generation in decentralized manner. Dendro Thermal Power Generation basically involves external combustion of biomass. The thermal energy is converted into shaft power either directly or through various inter-mediate stages of conversion, involving steam or the organic fluid, etc. Basically it consists of dryer, boiler, steam

turbine, condenser and generator. The dryer is used to reduce the dampness of the uneven wood to a lower level. In the dryer a part of the flue gas from the boiler, supplies the drying energy. The dried wood is fed into the boiler. It is then burnt in suspension in the boiler to raise a high-pressure steam.

As far as power generation from Dendro Thermal Based Power generation is concerned it make use of three commonly available thermodynamic cycles i.e. Brayton, Sterling and Rankine cycles. In simple fashion, heat of combustion gases can be used to run gas turbine for power generation through Brayton cycle or alternately it can pass through heat exchangers for exciting a working fluid and finally to run a gas engine through a Sterling cycle. The heat of combustion gases can be used to generate steam vapour and to use it in steam/vapour engine through Rankine cycle.

The gasifier based power generation system consists of fuel preparation unit, gasifier, cleaning and cooling unit, internal combustion engine/alternator set and switch gear necessary for power transmission. The wood or the agricultural residue should be cut into proper size. They may have to be briquetted in case of some agricultural residues. The gasifier accepts wood chips, agricultural residues, shredded or in briquette form. The biomass undergoes pyrolysis, oxidation, reduction and produces producer gas having low calorific value of 1000 - 1200 K cal/m³. Carbon monoxide, hydrogen and methane are the main combustible components of the producer gas.

III. SOLAR ENERGY

Solar energy is the most readily available and free source of energy since prehistoric times. It is clean and unlimited, capturing the solar energy for light, heat, hot water, and electricity can be a convenient way to save money, increase self-reliance and reduce pollution. Solar technologies produce electrical or thermal energy. Photovoltaic (PV) cells (or "solar cells") that convert sunlight directly into electricity are made of semiconductors such as crystalline silicon or various thin-film materials. Whether drying crops, heating buildings, or powering a water pump, using the solar energy, can make the agricultural farms and manufacturing industries more economical and efficient [6].

Solar thermal technologies collect heat from the sun and then use it directly for space and water heating or convert it to electricity through conventional steam cycles, heat engines, or other generating technologies (concentrating solar systems). In the future, solar energy could produce hydrogen to provide transportation fuels, chemicals, and electricity, and to serve as energy storage at times when the sun is not shining.

It is estimated that every year solar energy equivalent to over 15,000 times the world's annual commercial energy consumption reaches the earth. India receives solar energy in the region of 5 to 7 kWh/m² for 300 to 330 days in a year. As per the literature available this energy is sufficient to set up 20 MW solar power plants per square kilometer land area [7].

In manufacturing industries, solar thermal energy for cooling, heating, steaming and drying and solar PV for power generation can economically provide energy where the distance is too great to justify new system. Solar electric systems are used to provide electricity for lighting, battery charging, running of small motors, water pumping, and electric fencing etc. Manufacturing industries often have substantial air and water heating requirements as commercial industries uses large amounts of energy to heat water for cleaning equipment. Heating water and cooling can account for up to 40 percent of the energy used in any manufacturing industry. Solar water heating systems may be used to supply all or part of these hot water requirements. Some of application of solar energy with its associated device is presented in Table I and Table II for thermal and photovoltaic route respectively.

TABLE I SOLAR THERMAL APPLICATION AND DEVICES

S.No.	Application	Devices
1	Solar Cooking	Direct/Focusing, Indirect/Box, Advanced type steam cooker, Solar oven, Parabolic type, Separate collector and Cooking chamber type
2	Solar Water Heater	Collector coupled to storage tank, Collector cum storage, Direct and indirect natural circulation type solar water heater
3	Solar Distillation	Horizontal basin type: single effect & double effect and Tilted tray
4	Solar Drying	Direct and indirect type solar dryer, Natural & Forced convection and Green house solar dryer
5	Solar Space Heating	<u>Active heating</u> : Solar air and liquid collectors. <u>Passive heating</u> : Direct gain type, Thermal storage wall, Attached sun space, Trombe wall, water wall, Thermal storage roof system, Connective loop system
6	Solar Refrigeration and Air-Conditioning	Absorption Cycle with liquid and solid absorbents, Vapors compression cycle and natural passive cooling
7	Electricity Generation	Solar pond
8	Industrial Process Heat	Single len, Multiple len, Single paraboloid direct type solar furnace, Heliostat type solar furnace.
9	Solar Greenhouse Technology	Attached type, Free standing & pit type: Winter and Summer green house
10	Solar Thermal Power Generation	Centralized tower system, Distributed farm concept type system.

TABLE II SOLAR PHOTOVOLTAIC APPLICATION AND DEVICES

S.No.	Application	Devices
1	Water Pumping	Shallow well and Deep well
2	Lighting and Power Generation	Domestic: Solar lantern, Street lighting, Community centre application, Domestic appliances
3	Refrigeration and Air Conditioning	Refrigerators and Air conditioner
4	Power and Process Heat Generation	Oil sectors

Solar thermal systems can greatly contribute to energy savings during the production processes in the manufacturing industries, which demand water temperature less than 80°C [8]. The hot water produced by the solar collectors can also be used for pre-heating the water in steam boiler.

A. Bio-Methanation of Manufacturing Industries Effluent

The waste from manufacturing industries, which are not only creating nuisance in terms of foul smells in atmosphere but also dangerous for animals if dump in isolation which is contaminated by toxic substances. There are numbers of promising options to treat the industrial effluent such as anaerobic digestion, incineration for thermal energy, alcoholic fermentation by acid hydrolysis and gasification through partial combustion. In Indian context, among all sources of non-conventional sources of energy, Bio-methanation or biogas generation is most suited in all prospective. The scope of biogas has been enlarged by coupling all type of organic waste along with dung recycling including manufacturing industries waste [1]. Presently biogas is not only recognized as gas production from dung recycling but also it is known as all organic waste recycling for resource recovery system in terms of biogas & enriched manure [2]. In fact, there is no waste, all waste can be used as a source for wealth. In India there is good potential of waste material, which can easily be converted in biogas. Biogas generation is essentially an anaerobic process which requires control of number of operating parameters. Factors affecting biogas production are given in Table III. In fact all these factors requires immediate attention before recycling any waste for biogas generation.

TABLE III FACTORS AFFECTING ANAEROBIC DIGESTION

Environmental Factors		Operational Factors	
1.	pH	1.	Consumption of organic
2.	Alkalinity	2.	Retention time
3.	Volatile fatty acid concentration	3.	Substrate concentration
4.	Temperature	4.	Organic loading rate
5.	Nutrient availability	5.	Degree of mixing
6.	Toxic substances		

The characteristics of organic waste material depend on its internal properties [3], following are few important points to be considered in recycling of manufacturing industries waste material for biogas production.

1. The C/N ratio of wastes varies widely from waste to waste. The age, maturity and type of species greatly affect the C/N ratio. It is also reported that fresh crop waste has low C/N ratio, while after some time it increases. The optimum level is 30:1.

2. Pre-processing of organic wastes is also essential in-order to increase its density to feed required quantity in the digestion chamber, which also accelerates the anaerobic reaction. This process includes chopping, cutting, mixing with other feed, steaming if material is hard such as wood, to achieve the required C/N ratio to bring the concentration of solids to 7-9 per cent and reduce retention time.

3. The density of many organic wastes is less. Therefore, it is used such as; it may from scum on the top of slurry in the digester, thus, inhibiting methane production process.

4. Pre-digested crop wastes have low HRT, and it settles at the bottom, which require a perfect stirring mechanism, either mechanically or through gas recirculation. The system should be more reliable and effective for anaerobic digestion of the crop wastes.

B. Solar Drying

Solar drying is in practice since the time is in-memorabile for preservation of final products of agricultural and manufacturing industries. This was done particularly by open sun drying under open sky. This process has several disadvantages like spoilage of product due to adverse climatic condition like rain, wind, moisture, dust, loss of material due to birds and animals, deterioration of the material by decomposition, insects and fungus growth. Also the process is highly labor intensive, time consuming and requires large area. With cultural and industrial development artificial mechanical drying came in to practice. This process is highly energy intensive and expensive which ultimately increases product cost [5]. Thus solar drying is the best alternative as a solution of all the drawbacks of natural drying and artificial mechanical drying. Solar

drying is cost-effective and could be an effective alternative to the traditional mechanical drying system, especially in the region of good sunshine [9].

Solar dryers can be used in industrial drying processes; which can be proved to be most useful device from energy conservation point of view [6]. It not only saves energy but also saves lots of time, occupying less area, improves quality of the product, makes the process more efficient and protects environment. Solar dryers circumvent some of the major disadvantages of classical drying. Solar drying can be used for the entire drying process or for supplementing artificial drying systems, thus reducing the total amount of fuel energy required.

Solar dryer is a very useful device for

- Dairy industries for production of milk powder, casein etc.
- Seasoning of wood and timber;
- Textile industries for drying of textile materials;
- Drying the seeds and grains.

IV. SUMMARY

Widespread use of renewable energy technologies (RET) is vital in securing a sustainable global energy system. Advantages of RET include:

- In contrast to conventional energy sources, the potential supply from renewable is essentially infinite and largely free of external costs.
- RET currently have high installation costs, but operating costs are extremely low.
- Some RET are already competitive with conventional energy sources, for example biomass or biogas applications.
- RET equipment can be produced domestically. For example, manufacturers of low-temperature solar thermal applications.

Increased use of modern renewable energy sources can play a key role in overcoming these challenges.

- Renewable energy can contribute to slowing climate change by providing heat, cooling, power generation and fuel for transportation with no or only marginal direct and indirect CO₂ and other GHG emissions.
- Renewable energy improves supply security. Renewable energy sources are inexhaustible and their natural availability is 3,000 times higher than current global annual energy consumption. Even the current technical potential for renewable use is six times higher.
- Renewable energy provides greater flexibility. This offers a broad portfolio of applications, sources and technology solutions for different climatic and societal conditions. Also this satisfying the need for small and large-scale energy services in urban and rural regions.
- Offering technologies not only for power generation, but also for heat generation, cooling and fuels for transportation

To conclude, introducing modern technologies for renewable energy production and use can mitigate environmental damage, support the meeting of basic energy needs and foster productive activities.

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