Reconceptualizing the Application of Renewable Energy Sources in Industry: A Review

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Abstract-*This paper aims to focus upon the applications of renewable energy sources in industries. Till current scenario not much attention is diverted towards their potential for industrial applications. Researchers have shown that up till 2050 majority of processing will be done by harnessing renewable energy sources. They are likely to provide nearly 50% share at favorable cost as compared to other sources till 2050.Solar energy sources will be emerging as a dominant source above all renewable due to their compatibility with all kind of systems. In this paper a detailed review for technological updation to explore the potential of renewable energy sources in industries has been proposed and the key findings and methods needed to be elaborated for such frameworks has been discussed.*

Key Words - Renewable Energy, Industry, Solar, Wind, Biomass.

1. INTRODUCTION

Industries today are intensive in energy. This industries uses a chain of various chemical, electrical and mechanical complex processes, moreover they all includes high temperature and pressure requirement which should be continuous in nature. For the same, the supply of energy should be intermittent. The cost of energy is a serious offence in these industries which can take over the overall cost therefore the energy system to be used should be highly compatible and stable with overall working conditions[3]. Indian government has now started imposing penalties on industries regarding various pollution issues which is again a important factor to consider and also it requires additional investments for various pollutant emission control processes such as carbon capture, sequestration etc. This pressure to diversify supply energy sources for industries is overcome by including the imminent and inevitable renewable sources of energy[1]. Their advantages include inexhaustible sources, non polluting, low operation and maintenance cost, no refueling cost, employment to rural areas etc as well as they have many cons too such as their output is site specific with varying speed of wind and solar irradiance, high installation cost etc. A systematic operation methodology is required to successfully frame the renewable sources in industries since industries are based on heavy equipments of large scale and also their demand is of large volume. Firstly, one straight forward way is to employ them at certain part only so that it matches the demand of a particular section and the whole system won't get hampered. Secondly they can be remotely operated around plants or can be transferred by way of external energy suppliers[2]. If the entire demand side can't be met then it should be designed to meet some specific area of plant. All the above statement should be justified with systematic investment evaluation. However the history of large scale employment of renewable in industries is very short and thus there seems a clear gap between the two. To bridge the gap between renewable and industries some novel framework are discussed here in this article which includes various techniques for employability of renewable energy sources in industries.

2. METHODOLOGY

This section deals with methodologies adopted by various author to integrate renewable or Hybrid renewable energy sources (HRES) with industries. we have quoted two examples and have reviewed many others too. The author presents a detailed development to explore the use of renewable in industry. The author investigates a simulation framework and has computed capacity of hybrid renewable energy sources such as solar, wind power, diesel and batteries. Here the matching of actual supply and demand side supply has been involved to emerge as a new system. A total of eight frameworks have been proposed here to evaluate the applicability of renewable with industries[3]. It is technically possible to shift half of industrial demand to renewable in which the dominating source will be

Biomass with a share of 75%. Fig.1 shows the potential that can be harnessed from renewable by 2050 including final energy and feedstock as done by UNIDO Solar applications are also a second large option for industries. From the total energy use in manufacturing reductions of GHG in industrial sector. The pattern of consumption can be summarized approximately and Table 1 shows the same pattern from 2006 to 2030 estimated globally whereas the use of various forms of energy in industrial sector for developing and developed countries is summarized and categorized as per their recent upliftments towards industrial applications. Table 2 shows the energy used in industrial sector currently. According to the researchers the global energy consumption will raise up to 75,000 TWh till 2050 as shown in Fig.2 whereas Table 3shows Key Findings with various renewable options for industrial applications.

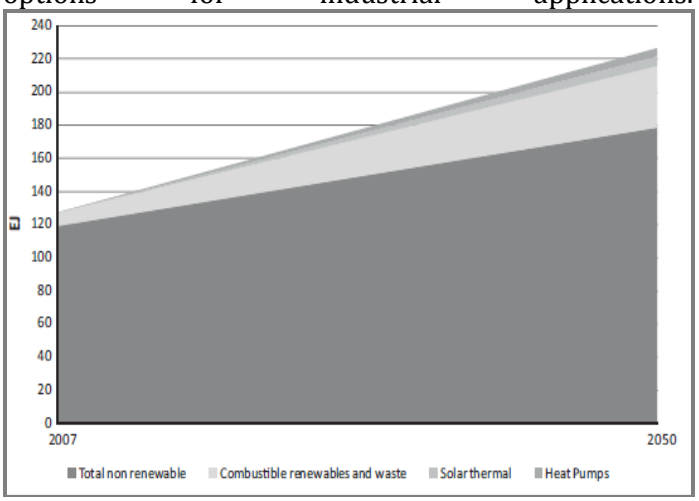

Fig-1: Renewable Potential in Industry by 2050, Final Energy & Feedstock. (UNIDO Analysis)

Table-1:- Estimated Global industrial energy consumption fuel pattern from2006 to 2030

Sources of Energy	2006	2030
Liquid	34.6	28.6
Natural Gas	24.1	25.6
Coal	24.8	24.3
Electricity	14.9	19.7
Renewable	1.5	1.8

Table-2:- Estimated Global industrial energy

Country	Industrial Sector Energy Use (%)
China	70
Malaysia	48
Turkey	35
USA	33
India	38.5

Similarly, another author estimated the renewable for a load such as a cement plant. A load of a industries 21% will be contributed by renewable up till 2050 which accounts a potential of 50 Exajoules/year of energy. The use of direct and indirect renewable energy will add up to 10% till 2050 which is about 25% of total energy generation.

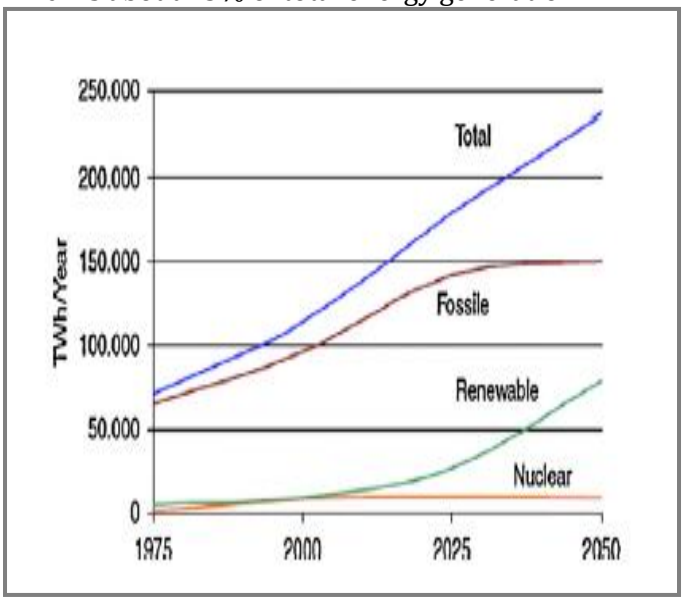

Fig-2:Global Energy Consumption

Table 3 shows the total consumption of final energy and the dominance of biomass and solar energy in industries uptill 2050

Table-3:- Potential in Biomass & Solar energy for industrial applications.

Industrial Sector	Final Energy	Biomass (2050)	Solar (2050)
Chemical & Petrochemical	40.6	22	0
Construction	2.5	6	0
Food & Tobacco	10	9	26
Iron & Steel	30.5	2	0
Machinery	7.2	0	16
Minning & Quarrying	4.1	0	20
Non Metallic Minerals	17.1	29	0
Paper,Pulp & Printing	11.9	54	0
Textile & Leather	3.6	3	14
Transport Equipment	2.3	0	14
Wood & Wood Product	3.5	67	0
Feedstocks	49.8	14	0
Non Specified	32.5	18	0
Total	**226.2**	**16**	**2**

cement technology institute is selected and compared with an existing system and a system is

proposed so as to find the most feasible system to improve reliability and lower emissions with coal saving. The existing system is a grid supply system whereas the proposed method is a PV bio diesel hybrid energy system. The proposed system comprising 25kW PV array, 28kW bio diesel generator, 10kW inverter and 10kW rectifier supplies power to the cement technology institute. It saves 55.080kg of coal and preserves the atmosphere from addition of 27.744 tones of year. The proposed system also improves reliability from 93.18%to 100%. [10]Various researchers have investigated the employment of renewable energy sources for industrial applications, some of which are summarized in Table 4.

2.1 Modeling Softwares

Opportunity exists for project to utilize energy modeling software to help evaluate design decisions in terms of life-cycle cost impacts in order to maximize performance. Building energy performance is a function of numerous, interdependent internal and external factors, such as material selection, mechanical and electrical systems, solar orientation, climate, and occupant usage. Modification of various design components can produce complex interactions that are difficult to analyze in isolation. For that only the energy simulation softwares provide tools for evaluating energy impacts across dynamic interrelated systems. These are the overall steps followed to create an energy model

Step 1-Collects data at the site enough to fully define the building and energy consuming features o Inputs that are unknown should be highlighted and used as calibration parameters

Step 2- Fills out the model and run the simulation

Step 3- Uses the model to run various "what if" scenarios to calculate energy savings associated with identified energy conservation measures.

To implement various industrial power systems some software are used for brief analysis:-

HOMER-Hybrid optimization of multiple electric renewable (HOMER) software simulates favorable optimization cases in many of research. A Grid system together with renewable can be easily simulated using this software developed by National Renewable Energy Laboratory (NREL), US. For designing any system the temperature resources, wind power etc data for location is extracted from solar energy database, national solar mission by Indian government for Indian specific origins and from National Aeronautics & Space Administration (NASA) surface meteorology data centre.

SAM-System Advisor Model (SAM) can be other option for modeling power system of any industry. It provides a techno-economic modeling which facilitates decision making. PV systems from small to large scale integration, concentrating solar power system including MPPT system, industrial process heat, wind power, tidal systems, biomass etc can be modeled using SAM.

3. CONCLUSIONS & FUTURE SCOPE

The economy of any country depends upon its industrial growth and these industries can't rely completely on renewable energy sources due to excess demand; also the global warming situations together with energy crisis can be overcome experimenting other options with industries. Therefore the researchers have preferably suggested upgrading the systems with grid. Large PV systems, wind, biomass, small hydro can be integrated for system competency and growing energy crisis owing to consumption of fossil fuels in coming years. The operating cost and maintenance cost is low with the renewable and is a long time and single time investment. On the other hand industries personnel are also willing to pay a low and reliable per unit cost for their processes and production. Other techniques like a solar tracking system, commercially and low cut in speed wind turbines etc. can also be employed for enhancing the industrial system with overall low carbon products emissions and for saving the penalties imposed by governments.

Table-4 Summary of Renewables for Industrial Applications

S. No.	Authors	Year	Title	Proposed Method	Findings	Uniqueness
Source 1	Emanuele Taibi et al.	2012	The potential for renewable energy industrial applications	Analysis of potential for Renewable in industries.	If the renewable shares are 50% then definitely the share of direct and indirect renewable energy use rise.	Method to contribute about 10 % GHG emission reduction in industries.
Source 2	R Mekhile et al.	2012	A review on solar energy use in industries	Integration of solar energy systems in industry.	Solar PV systems are feasible for industries whose overall efficiency can be improved by proper system integration and design of solar collectors.	System comprises many other technical variables such as wear and tear, initial and running costs, economic incentives, PV module diminishing price rate and oil price raises etc.
Source 3	Md. Mehe Hasan et a	2015	Efficient Hybrid Renewable Energy System for Industrial Sector with On-Grid Management	Analysis of hybrid renewable energy sources together with co production of diesel generator, solar PV and grid system in Tongi industrial area, Bangladesh.	Grid pressure is reduced by implementing on grid solar diesel hybrid system in industry.	Proposed combination of energy system for compensating regular grid failure and minimizing electricity demand 's pressure thus minimizing system life cycle cost.
Source 4	R.P.Martin et al.	2015	Renewable Energy Sources Insertion in a Timber Industry – Case Study	A PV/wind/grid following distributed generation concept for economic viability in a timber industry.	Case studies to facilate application of renewable energy in industries.	Renewable sources in timber industrial applications.
Source 5	S. Shahnewa Siddiquee	2015	Optimized Hybrid Renewable Energy System For Efficient Industrial Electrification	Analysis of the PV based hybrid energy system in Chittagong, the industrial capital of Bangladesh with the existing system containing diesel set and grid.	Designed a system in which power from PV will be available during day time and grid power will be utilized at night time which can help to reduce the grid demand by industries with a backup from diesel generator.	Designed a low carbon emission system with a low cost system over its life span.
Source 6	Jun Hyung Ryu et al.	2016	Techno-economic Simulation Approach in Preparation of Employing Renewable Energies Process Industry	A simulation framework to analyze the application of multiple energy sources (solar, wind and diesel batteries) for process industry.	A total of eight configurations is propose industrial implementation.	IT uses Markov Chain Monte Carlo (MCMC) method denoting algorithms for sampling from a probability distribution based on constructing a Markov chain that has the desired distribution as its equilibrium distribution.
Source 7	S.P. Makhi et al.	2016	Feasibility analysis of distributed solar electricity penetration in cement manufacturing plants	To find most feasible systen cement manufacturing plant.	Syatem designed to reduced pollutant emissions considerably by 23% with slight Increase in NPC and COE by 3.075% and 0.6436%, respectively. The system saves 7,09,139 kg coal per year with 0.6437% increase in cement production cost.	Distributed generation system without battery and with renewable to analyze NPC, LCOE, emissions.
Source 8	Satya Prakash Makhija et	2016	Optimally sized hybrid energy system for auxiliaries of a cement manufacturing unit with diesel fuel price sensitivity analysis	Hybrid system containing solar PV, wind, batteries and a diesel for running auxiliary load of a cement manufacturing unit located in Durg district of Chhattisgarh, India.	The results show that diesel price increment from $1.01 to $1.09 does not affect optimal system size but only net present cost and levelised cost of energy. When diesel price increases beyond $1.09, the optimal system size increases resulting in capital cost increment. It attains a new optimal system size at a diesel price of $1.13.	Designed optimal sized system for the areas showing diesel price hikes.
Source 9	Muhamma Bilal et al.	2016	Wheeling Hybrid Energy System Industries	Finding a low cost system for wheeling 36 MW grid connected hybrid systems for Gadoon industrial load in Pakistan. Five cases under consideration.	System with 66% renewable fractio derived also advantageous in long ru decreasing grid consumption to 33.98% lowest COE as compared with existing sys	A grid system with solar PV, wind and hydal systems is used to overcome energy crisis in industrial sector.

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BIOGRAPHIES

Tanu Rizvi has done her B.E in EEE in 2008 from SSTC (Pt. R.S.S.U) followed by M.Tech (PSE) in 2012(CSVTU). She bagged 2nd position in University Toppers List in her graduation followed by honors in M.Tech. Presently she is pursuing her PhD in EE from CSVTU, Bhilai. She is Working as Assistant Professor in EE Dept., SSTC, Bhilai from 2008 onwards to till date. She is also coordinator of spoken tutorial IIT Bombay.

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Dr. Nagendra Tripathi has done his B.Tech in Electrical from BIT, Durg r in year1998 followed by M. Techin Instrumentation & Control Engineering from BIT, Durg in 2008 and PhD from C.V. Raman University in 2015. Presently he is working as a Professor in department of Electrical Engineering, BIT, Durg with a total teaching experience of 20years and 7 months till date. His research area includes Renewable Energy, Electrical Machines, Digital Electronics etc.