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A Review of Cogeneration Techniques of Renewable Energyand its Impact on REC Trading

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Abstract

The rapid growth of Industrialization has exposed the high level of risk in environment. The serious issues of global warming, pollutions, greenhouse gases emission and depletion of ground water level which cannot be addressed with the government intervention alone. Corporate Social responsibility is the buzzword and it's time for the corporate to do bit for the environment which has been endangered with the Industrial activities. The India has rich in renewable energy resources and in the concern of climate change the renewable energy resources is the best way to reduce greenhouse gas which control global warming. To encourage the renewable energy sources of generation the CERC notified regulations on Renewable Energy certificate dated 14th January 2010, for the fulfillment of renewable energy sources and development of market in electricity. In renewable energy sector many research have done regarding renewable energy technologies which helps in cogeneration of renewable energy. This paper discusses about to know the cogenerationtechniquesbased on the Renewable Energy sources which increase the generation of electricity and to get RECthat controls pollution and brings good development in Environment.

Key words:*Cogeneration, Renewable Energy Resources, Green Houses Gases, Renewable Energy Certificate.*

Introduction

The quality of natural environment resources will be affected by climate change frequently drives the need for increased efficiency of goods and services, when resources are limited, the effective corporate climate management effects the corporate reputation and offer opportunity to develop new carbon technologies and to consider the use of alternative energy sources that is renewable energy. The renewable energy will replace oil, coal and other fuel energy and reduce the carbon foot print. The support frame works for renewable energy technologies design helps to undertake effective technology transition management as a basic idea is to minimize the present value of additional cost of supporting commercially immature technology.Cogeneration or CHP (combined heat and power)has been gaining considerable attention because it not only generates electricity by using renewable sources, but it also makes of heat-by-product generated in that process. Cogeneration is increasingly becoming more renewable and enables the uptake of more renewables in our energy system. CHP is becoming more renewable, as RES share in CHP has doubled over the past 10 years reaching 20%. Indeed, CHP is the best way to increase the efficiency of biomass and biogas energy production to more than 70%, whereas the average efficiency of a biomass power plant can be as low as 33%.To reduce emissions in an economic cost effective way, the technology sharing and joint investment into research and development in renewable technology make an important role in cutting greenhouse gas emission in the environment. Renewable energy technology will play a key role of cost reduction which achieve the goal of:

1. Ensuring universal access to modern energy services.
2. Doubling the global rate of improvement in energy efficiency and
3. Doubling the share of renewable energy the global energy mix.

To achieving low carbon energy system, the currently significant cost reductions wide spread deployment available in RET is not only sufficient, it requires rapid growth in current technology, continuous technology innovation and commercialization will be required to achieve mitigation of emission targets , problems of energy security and climate change.

Objective of the study

The basic need for cogeneration is to enhance the efficiency of power plants and to keep the overall cost to minimum. The objective of this study is to know the innovativetechniques of cogeneration of energy by renewable sources which helps in cost saving and leads to reduce carbon foot print. The paper content is largely based on secondary data i.e., from research journal, research paper, books, internet and different types of research.

Innovation concepts

Innovation is the domain of renewable energy technologies shows many similarities to innovation in other sectors. A useful definition of innovation provided by the organization for economic co-operation and development (OECD) identifies four unique categories:

1. **Product innovation:** It involves goods or service that is new or significantly improvement in technical specification, components and materials, incorporatedsoftware or other functional characteristics
2. **Process Innovation:** It involves a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.
3. **Marketing Innovation:** it involves a new marketing method involving significant changes in product or packaging design, product placement, product promotion or pricing.
4. **Organization Innovation:** It involves introducing a new organizational method in the firm's business practice, worked place organization or external relations.

The capacity of innovation arises through social interaction between people commonly cultivated within commercial enterprise or firms. Non firm's actors are essential contributors to innovative capacity. Non firms includes universities, national research laboratories, standards bodies and industry groups which is rooted in specific social networks, innovative networks and activity change over time in relations to the maturity of this technology.

The maturity of a particulars life cycle of a technology can be divided into five stages:

1. Basic science and research &development
2. Applied R&D
3. Demonstration
4. Market development and
5. Commercial diffusion

These stages are contextualize helps in advancement of new technology at a given time and determine which type of policy instruments might be appropriate to a specific technology at a specific risk stage and maturity.

Renewable energy innovation in the context of energy development goals are

1. Energy security: It focuses on reducing dependence on vulnerable energy supplies.
2. Energy access: It focus on reducing energy poverty and expanding access to secure, reliable and low cost energy.
3. Energy cost: It focus on reducing exposure to persistently costly energy services
4. International competitiveness: It focus on achieving Internal energy competitiveness market in a greater proportion
5. Modernization: It focus on modernizing national energy system.
6. GHG Emission Reduction: It focus on reducing Green House Gas emission which impact on environment.

National across the global recognize that energy security is critical to fuel their economic and development engines, the fast development of industries, the world is facing a significant threat by non-renewable energy resources depleting. India ranks sixth in the world energy demands in the fastest growing of economic development in the world from this India facing formidable challenges to meet energy needs. To overcome challenges it is diversifying its energy basket with renewable sources and promoting energy efficiency measure in the industry.

In the face of this enormous challenges, we find solution to operating on clean energy and cutting down carbon emission is being propagated by government, organization, civil service and industries. to hedge the rising cost of energy the all dictating a growing organizations they are implement in g energy efficiency interactions and adoption of renewable energy technologies and they lies in a best practices benchmarking in the global best standards. Adoption of industrial energy has the best practices from across the industries, from different industrial sectors namely agriculture, automatic energy, engineering, financial services, FMCG, materials, IT and other. It provides an opportunity for corporate to learn from and emulate the best practice from the leading organizations.

Factors such as saving accrued, investment required payback period, tons of CO2 emission saved were considered while describing the intervention of renewable energy. India has volunteered a reduction of 20% to 25% carbon intensity by 2002 from 2005 lends through policy intervention of renewable energy.

Introduction to Renewable Energy

India is 4th largest country in the installation of RE power generation capacity it realized the important and relevance of RE as a plausible option for catering the rising demand of energy. The development of RE took mainly for energy security concern to reduce emission of greenhouse gas and interest towards developing and increasing share of clean energy technologies. The government has establishing institution such as, Alternate Hydro Energy Centre (AHEC), Centre of Wind Energy Technology (CWET) and Solar Energy Centre (SEC) to aiding in technology development and bring symmetry in information for the stakeholder.

In the field of RE the development took rapid growth with the support of government, the average annual grow rate of RE is 15% from last few years, the government introduced various policy and fiscal tools such as accelerated department, generation based incentives capital subsidy, freed in tariffed., with have boost confidence for investment and the newly introduced RPO and with the advent of renewable power exchange like IEX and PXIL had help in further capacity addition for renewable energy.

The private sector had shown attitude and has extended involvement towards in developing renewable sector throughout its value chain starting from in house capacity addition generation, manufacturing, transmission and Research & Development, the various organizations had displayed their work in RE space and championed the cause of sustainable development.

Introduction to Biomass Power:

Biomass has always been an important energy source for the country considering the benefits it offers. It is renewable, widely available, and carbon-neutral and has the potential to provide significant employment in the rural areas. Biomass is also capable of providing firm energy. About 32% of the total primary energy use in the country is still derived from biomass and more than 70% of the country's population depends upon it for its energy needs. Ministry of New and Renewable Energy has realised the potential and role of biomass energy in the Indian context and hence has initiated a number of programmes for promotion of efficient technologies for its use in various sectors of the economy to ensure derivation of maximum benefits Biomass power generation in India is an industry that attracts investments of over Rs.600 crores every year, generating more than 5000 million units of electricity and yearly employment of more than 10 million man-days in the rural areas. For efficient utilization of biomass, bagasse based cogeneration in sugar mills and biomass power generation have been taken up under biomass power and cogeneration programme.

Biomass power & cogeneration programme is implemented with the main objective of promoting technologies for optimum use of country's biomass resources for grid power generation. Biomass materials used for power generation include bagasse, rice husk, straw, cotton stalk, coconut shells, soya husk, de-oiled cakes, coffee waste, jute wastes, and groundnut shells, saw dust etc.

Potential

The current availability of biomass in India is estimated at about 500 million metric tons per year. Studies sponsored by the Ministry has estimated surplus biomass availability at about 120

– 150 million metric tons per annum covering agricultural and forestry residues corresponding to a potential of about 18,000 MW. This apart, about 5000 MW additional power could be generated through bagasse based cogeneration in the country's 550 Sugar mills, if these sugar mills were to adopt technically and economically optimal levels of cogeneration for extracting power from the bagasse produced by them

Technology:

Combustion

The thermo chemical processes for conversion of biomass to useful products involve combustion, gasification or pyrolysis. The most commonly used route is combustion. The advantage is that the technology used is similar to that of a thermal plant based on coal, except for the boiler. The cycle used is the conventional ranking cycle with biomass being burnt in high pressure boiler to generate steam and operating a turbine with generated steam. The net power cycle efficiencies that can be achieved are about 23-25%. The exhaust of the steam turbine can either be fully condensed to produce power, or used partly or fully for another useful heating activity. The latter mode is called cogeneration. In India, cogeneration route finds application mainly in industries.

10 MW Biomass Power Project, Gadchiroli Distt. (Maharashtra State)

Cogeneration in Sugar Mills

Sugar industry has been traditionally practicing cogeneration by using bagasse as a fuel. With the advancement in the technology for generation and utilization of steam at high temperature and pressure, sugar industry can produce electricity and steam for their own requirements. It can also produce significant surplus electricity for sale to the grid using same quantity of bagasse. For example, if steam generation temperature/pressure is raised from 400oC/33 bar to 485oC/66 bar, more than 80 KWh of additional electricity can be produced for each ton of cane crushed. The sale of surplus power generated through optimum cogeneration would help a sugar mill to improve its viability, apart from adding to the power generation capacity of the country.

30 MW Bagasse Cogen project at a Sugar Mill in Maharashtra

Deployment

The Ministry has been implementing biomass power/co-generation programme since mid-nineties. A total of 288 biomass power and cogeneration projects aggregating to 2665 MW capacity have been installed in the country for feeding power to the grid consisting of 130 biomass power projects aggregating to 999.0 MW and 158 bagasse cogeneration projects in sugar mills with surplus capacity aggregating to 1666.0 MW. In addition, around 30 biomass power projects aggregating to about 350 MW are under various stages of

implementation. Around 70 Cogeneration projects are under implementation with surplus capacity aggregating to 800 MW. States which have taken leadership position in implementation of bagasse cogeneration projects are Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Uttar Pradesh. The leading States for biomass power projects are Andhra Pradesh, Chattisgarh, Maharashtra, Madhya Pradesh, Gujarat and Tamil Nadu.

Manufacturing Base

Manufacturing capability exists in the country for the equipment/machinery required for setting up Biomass Projects. Except for some critical control equipment, most of the equipments can be procured from indigenous sources.

1. **Boilers**

   A number of large manufacturers have established capabilities for manufacturing spreader stoker fired, traveling grate/dumping grate boilers; atmospheric pressure fluidized bed boilers and circulating fluidized bed boilers.

   Due to recent upsurge of interest in co-generation for surplus power, leading manufacturers are further upgrading their capabilities for high efficiency boilers.

2. **Steam Turbines**

   Almost all combinations – condensing, single extraction/double extraction condensing, back pressure, etc. are now being manufactured in the country with full after sales services. The efficiencies of turbines now being offered are comparable to the best in the world.

3. **Other Equipment**

   Apart from the main equipment, there is a well-established capability and capacity for manufacture of related equipment for use of biomass for energy including harvesters, balers, briquetting equipment, handling and firing equipment, pollution control systems etc. Many multinational companies have set up manufacturing facilities in the country for such equipment.

Promotional Policies

Besides the Central Financial Assistance mentioned in para 8, fiscal incentives such as 80% accelerated depreciation, concessional import duty, excise duty, tax holiday for 10 years etc., are available for Biomass power projects. The benefit of concessional custom duty and excise duty exemption are available on equipment required for initial setting up of biomass projects based on certification by Ministry. In addition, State Electricity Regulatory Commissions have determined preferential tariffs and Renewable Purchase Standards (RPS). Indian Renewable Energy Development Agency (IREDA) provides loan for setting up biomass power and bagasse cogeneration projects.

Summary of Biomass Power Cogeneration Tariff across States

(AS ON 31.03.2011)

State	**Tariff fixed by Commissions**	**RP0 %**
Andhra Pradesh	@Rs.4.28/kWh, (2010-11) (BM) Rs.3.48/kWh (Cogen)	Min. 3.75%
Chattishgarh	@Rs.3.93/Unit (2010-11) (BM)	5%
Gujarat	@ Rs.4.40/unit (with accelerated depre.) (BM)@ Rs.4.55/unit (with accelerated depre.) for 1st 10 yrs(Cogen)	10%
Haryana	@ Rs.4.00/unit (BM) @ Rs.3.74/unit (Cogen) 3%escalation (base year 2007-08)	1%
Karnataka	@Rs.3.66 per unit (PPA signing date) Rs.4.13 (10^{th} year) (BM)@ Rs.3.59/unit, (PPA signing date) Rs.4.14/unit (10^{th} Year) (Cogen)	Min.10%
Kerala	@ Rs.2.80/unit (BM) escalated at 5% for five years (2000-01)	3%
Maharashtra	@ Rs. 4.98 (2010-11) (BM)@Rs.4.79/unit (Comm yr.) (Cogen)	6%

Madhya Pradesh	@ Rs.3.33 to 5.14 /unit paise for 20 yrs. With escl of 3- 8paise	0.8%
Punjab	@Rs.5.05 /unit, (2010-11) (BM) @Rs.4.57/unit (2010-11) (Cogen)escalated at 5% -cogen, & 5%-BM	Min. 3%
Rajasthan	@ Rs.4.72 / unit-water cooled (2010-11)- & Rs.5.17-air cooled(2010-11)-(BM)	1.75%
Tamil Nadu	@ Rs.4.50-4.74/unit (2010-11) – (BM) @ Rs.4.37-4.49/unit (2010-11)-(Cogen)(Escalation 2%)	Min. 13%
Uttaranchal	@ Rs.3.06/unit. (2010-11) - BM@Rs(link sends e-mail).3.12/unit (2010-11)-(Cogen) (new projects)	9%
U.P.	@ Rs.4.29 / unit, for existing and 4.38 for new with escalated at 4 paise/year, base year (2006)	4%
West Bengal	Rs. 4.36/unit fixed for 10 years-BIOMASS	4%
Bihar	Rs. 4.17/unit (2010-11)–BIOMASSRs.4.25/unit (2010-11) – existing (Cogen)Rs.4.46/unit (2010-11) – new (Cogen)	1.5%
Orissa	Rs.4.09/unit	

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State-Wise/Year-Wise List of Commissioned Biomass Power/Cogeneration Projects (As On 31.03.2011) (In Mw)

S.No.	**State**	**Upto 31.03.2003**	**2003-04**	**2004-05**	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**Total**
1	Andhra Pradesh	160.05	37.70	69.50	12.00	22.00	33.00	9.00	20.00	..	363.25

2	Bihar		--	--	--	--	--	--	--	9.50	9.50
3	Chattisgarh	11.00	--	--	16.50	85.80	33.00	9.80	43.80	32.00	231.90
4	Gujarat	0.50	--	--	--	--	--	--	--	--	0.50
5	Haryana	4.00	--	2.00	--	--	--	--	1.8	28.00	35.80
6	Karnataka	109.38	26.00	16.60	72.50	29.80	8.00	31.90	42.00	29.00	365.18
7	Madhya Pradesh		1.00	--	--	--	--	--	--	--	1.00
8	Maharashtra	24.50	--	11.50	--	40.00	38.00	71.50	33	184.50	403.00
9	Punjab	22.00	--	--	6.00	--	--	--	34.50	12.00	74.50
10	Rajasthan		7.80	--	7.50	8.00	--	8.00	--	42.00	73.30
11	Tamil Nadu	106.00	44.50	22.50	--	42.50	75.00	43.20	62.00	92.50	488.20
12	Uttarakhand	--	--	--	--	--	--	--	--	10.00	10.00
13	Uttar Pradesh	46.50	12.50	14.00	48.50	--	79.00	172.00	194.50	25.50	592.50
14	West Bengal		--	--	--	--	--	--	16.00	--	16.00
	Total	**483.93**	**129.50**	**136.10**	**163.00**	**228.10**	**266.00**	**345.40**	**447.60**	**465.00**	**2664.63**

It has been represented that there is a need to address the issues related to quantum of self-consumption of a bagasse based cogeneration plant with co-located load of sugar mill, where the capacity available for PPA based sales to the utility as per tariffs determined by the State Commission varies from season to season and year to year, depending on the nature of the internal consumption requirements of such co-gen units. In such cases, sum of the total capacity under PPA and capacity registered under REC for self-consumption may exceed the installed capacity which is an impediment under the present REC Regulations.

Bagasse based cogeneration power plants are generally established for meeting primarily the self-load requirement of Sugar Mills and sale of surplus quantum if any. In order to promote setting up of such power plants, the state and respective commissions have passed relevant regulations/orders for export of surplus power available after meeting their captive requirement.

Conclusion:

The innovative techniques of cogeneration based on renewable biomass energy contributes towards the generation of power for economic development of a country which eliminates the usage of Coal fuel energy which cause the Global warming. Biomass cogeneration of renewable energy enables to obtain REC and gets benefited to generators to earn revenue in both electricity and REC sales. This reduces the coal fuel uses, cost of energy generation and emits the CO2 which causes global warming and offset carbon footprint.

Reference:

Journals and Articles:

1. *Jan Abrell and HannesWeigt (2008), "The interaction of emission trading and renewable energy promotion". Germany, Dresden University of Technology.*
2. *Gireeshshrimali, SteffinJennes (2006), "Synthesizing past policy assessments to build an integrated econometric analysis of RPS effectiveness". Washington, D.C, ICF International.*
3. *Celine MCinerney (2014), "Optimal oversizing of wind generation facilities". London, London Business School*

4. *Maurizio, Ciarchini, Francesca, Claudio Socei& Rosita Petaroli, "The economic impact of the Green certificate market through the macro multiplier approach".Unviersity of Macerata,*
5. *S.K.Soonee, V.K.Agrawal, A.Mani, MinaxiGarg and SatyaPrakash (2012), "Analysis of Indian renewable energy certificate market". SSRN*
6. *Lincoln L. Davies,"Evaluating RPS Policy Design: Metrics, Gaps, Best Practices, and Paths to Innovation". Salt lake city, University of Utah*
7. *ABPS infrastructure advisory private limited (June, 2009), "Development of conceptual frame work for renewable energy certificate mechanism for India". India, Ministry of New and Renewable energy.*
8. *Sandra Schusser&Jaraite (June, 2006), "Explaining the Interplay of three Markets: Green certificates, Carbon Emission & Electricity". Sweden, Umea University.*
9. *GireeshShrimali, SumalaTirumalachetty, & David Nelson (2012), "Falling Short: An Evaluation of the Indian Renewable Certificate Market". Hyderabad, CPI- ISB report.*
10. *Soonee S K, MinaxiGarg, Saxena S C &SatyaPrakash (2012), "Implementation of Renewable Energy Certificate Mechanism in India". India, www.cigre.org*
11. *Ed Holt and Associates Inc. & Lori Bird National Renewable Energy Laboratory (January, 2005), "Emerging Markets for Renewable Energy Certificates: Opportunities and Challenges". National Renewable Energy Laboratory, Colorado.*
12. *Power System Operation Corporation Ltd., (July, 2018), "Renewable Energy Certificate Mechanism in India". New Delhi, India*
13. *N. Thilak Raj, S Iniyan&RankoGoic (Oct 2011, volume 15), "Areview of renewable energy based cogeneration technologies". Elsevier*

Web Sources

1. *www.ssrn.com*
2. *www.iexindia.com*
3. *www.powerexindia.com*
4. *www.businessstandards.com*
5. *shodhganga.inflibnet.ac.in*
6. *www.arthapedia.in.napcc*
7. *www.cigre.org*
8. *https://mnre.gov.in*