SUSTAINABLE BIO-ENERGY THROUGH BAGASSE CO-GENERATION TECHNOLOGY: A PESTEL ANALYSIS OF SUGAR HUB OF INDIA, SOLAPUR

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Abstract: Technological innovations and researches are incomplete without social science perspective. The new area termed as social technology is emerging to expound this gap. This paper aims to explore scenarios for sustainable bio-energy through bagasse cogeneration technology. The paper applies an innovative transdiscplinary futures methods termed as PESTEL political (P), economic (E), social (S), technological (T), environmental (E) and legal (L) for exploring intricate causalities between technology and society. The study is conducted at one of the sugar hubs of India, Solapur district in Maharashtra state. The paper concludes that the scenarios constructed based on PESTEL analysis provides vital inputs for policy makers and sustainable production of clean energy through bagasse cogeneration technology.

Keywords: Futures methods, PESTEL, Bio-energy, Bagasse, Cogeneration technology, India

I.INTRIDUCTION:

The aspiration for universal access to modern energy and the use of renewable energy technologies (RETs) as a means of delivering low carbon solutions are driven by several local and global factors, including climate change, Paris Agreement, population increase and sustainable future energy security. India is the fourth largest greenhouse gas emitter globally. Therefore, it has become a crucial agenda towards the Indian Government to reduce such emission for sustainable energy security. In this context the Modi Government has taken keen initiatives to achieve the renewable energy target of 175 GW by the year 2022. This includes 60 GW from wind power, 100 GW from solar power, 10 GW from biomass power and 5 GW from small hydro power (See PIB, 2017).

Bagasse cogeneration by Sugar Factories in India

Electricity production through cogeneration in sugar mills in India is an important avenue for supplying low-cost, non-conventional power to mitigate sustainable energy challenges. Indian sugar industry is the second largest producer of sugar in the world after Brazil. In India, sugar industry is the second largest industry after textiles. The country is the second largest sugar producer in the world (accounting 13% of the world's sugar production). As sugar production is high in country bagasse which is leftover of sugarcane is available abundantly which is further used to generate electricity by cogeneration process.

What is Bagasse cogeneration technology (BCT)?

In India, interest in high-efficiency bagasse based cogeneration started in the 1980s when electricity supply started falling short of demand. The salient features of BCT are described as bellow:

- Bagasse is the fibrous matter that remains after sugarcane stalks are crushed to extract their juice and is a by product generated in the process of manufacture of sugar.
- The concept of cogeneration produces two types of energy from one fuel simultaneously in the forms of heat and the other may be electrical energy. The bagasse produced in a sugar factory is however used for generation of steam which in turn is used as a fuel source and the surplus generation is exported to the power grids of state governments.

The distinctive process of the functioning of bagasse cogeneration in sugar factory is described in the following diagram no 1.

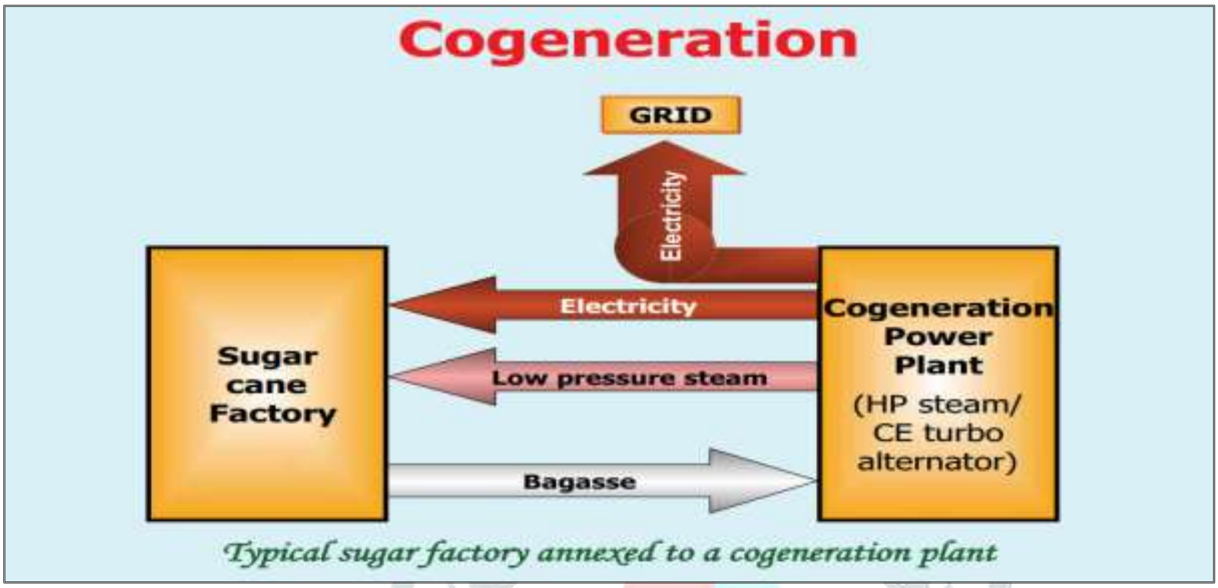

Figure 1: BCT in Indian sugar factories

Source: http://www.zionenggworks.com/images/zion-cogen-process.jpg

Generally the electricity produced by the bagasse cogeneration plant (henceforth BCP) mainly during sugar production period is used by the concerned Sugar factory and the surplus energy is being transferred to the grid. This concept provides few vital advantages: no fuel cost, employment to the local population, strengthening sugar factories socio-economic potency, energy security and reduction in transmission and distribution fatalities.

II.MATERIALS AND METHODS:

Aim of the study:

The prime aim of this research is to lend insight into the future of Sustainable Bio-energy through bagasse cogeneration technology by sugar factories and to explore the structural intricacies involved in the process of producing Bio-energy through bagasse cogeneration technology by sugar factories (BCSF).

Methods:

In order to apply the aforementioned study objectives the following corresponding appropriate futures method is used:

PESTEL method:

Any structural intricacies of the system consist with multiple dimensions. Therefore, the method of PESTLE analysis was used here to identify all of the various internal/ external political, economic, social, technological, legal and environmental factors that might affect a system. This exercise helped a lot to assess the contemporary risks and future possible coping strategies for the sustainability. To make the PESTEL analysis operational Delphi method was also used to collect primary data. For the present research we adopted face-to-face meetings with panellists (technologist, policy makers and researchers) called as mini-Delphi. It has benefited to gauge the subtle causalities linked with clean energy production, sugar factory and cogeneration technology. Altogether 20 experts were gathered together to discuss on the intended objectives and to bring their own argued future views into the discussion during June-August, 2017.

III.RESULTS AND DISCUSSION:

Through PESTEL analysis the study identified five to six prime factors/drivers from each variable that helped to understand "big picture" and 'forces of contemporary/future intricacies' involved in this (BCSF) sector at the macro level and in particularly in the context of Solapur district these are as follows:

I) POLITICAL:

i)Sustaining Sugar hub: Legacy of influential political leadership

It is said that in India the rural leadership born out of the struggles and establishment of different cooperatives long back even during British era in 1940-50s. In particularly the leaders who developed sugar cooperative movements in the Soalpur district were among the pioneers at state level cooperative movement. Majority of them have bagged key political positions in Indian National Congress Party and even became high profile ministers such as Dy Chief Minister, State Home Minister and Agriculture Minister. Therefore, it can be concluded that Solapur is emerging as one of the vibrant districts in terms of its political strength in establishing sugar cooperatives and new models like energy production through bagasse cogeneration. This kind of legacy can be a key driver for the sustainability of the sugar sector in Solapur district.

ii) Strong political economy of sugar co-operatives

The sugar industry in India operates under high political influence. The farmers usually deal through co-operative societies, on which the local parties have a strong influence. To protect the interest of sugar producers, the government came up with FRP pricing. There is an indirect mutual agreement between the state (political parties) and members of sugar cooperatives. To protect such a huge vote bank and the dominance on rural socio-political fabric in India Governments always develop and design new models for their welfare. The energy cogeneration plants through sugar factories can be seen as an upcoming strategy with two fold objectives: i) to produce clean and affordable energy and ii) to sustain vote bank by providing alternative means and sources of surplus production to the political elites.

iii) Private sugar factories: An emerging model for future

In view of the rapid technological and policy changes in the electricity sector, the political consensus about its management faces serious challenges. The emergence of the new interests and new issues in the sector has complicated the situation further, but it has also opened new avenues of patronage for the political system. And the one such new alternative was energy production from private cooperatives by using bagasse. This has paved wave for the politization of bio energy by opening up private sugar factories in Maharashtra. Favourable policies had been enacted for the glorification of this sector to attract stakeholder's attention and for economic benefits through their private sugar factories. (Apart from 99 cooperative mills, there are also 79 private mills in the state) almost majority of the private mills are connected with political leaders. At present near about 60 % cogeneration plants in Soalpur district operated by private sugar factories with effective management and transparency than the so called cooperatives.

iv) Motivated and modernised perspective among the new generation of Sugar Leaders

At present due to new rules, regulation and growing awareness among the shareholders of the sugar factories mainly among the cooperatives it has become more strategically difficult for the rural traditional political elites who controls the sugar cooperative lobby in Solapur district to manage this sector for economic and political profit. Therefore, they have opened new avenues for their upcoming generation through models like private cogeneration, ethanol and cogeneration industries, and formation of Energy Company etc. The earlier generation was not much educationally sound. However, the new generation is highly educated in English convent school few of them have completed their education from USA based elite business institutes and majority of them have completed degrees in agricultural science.

v)Conducive policy for the cogeneration however unconducive for small factory

The central and State governments are both providing conducive policies for the growth of cogeneration. However, the policies restrict small scale sugar factories to establish cogeneration plants. As per the norm the government provides fund only to the Bagasse Co-generation projects by cooperative/ public sector sugar mills which have minimum 40 bar and above 60 bar and above 80 bar and beyond. This kind of policy excludes number of small scale sugar factories their right to produce clean energy there is a huge amount bagasse remain unused.

vi) Political shift in power pave way for controlled stagnation

In Maharashtra in general and Solapur in particular majority of the sugar factories both (Cooperative and Private) established and managed by leaders belonging to Indian National Congress (INC) and National Congress Party (NCP). For a long time its political leadership came from the rural areas, mainly from the rich and middle Maratha farmers and leaders of co-operatives. However, the Bhartiya Janata Party (BJP) is a fairly urban dominant party with leaders from elite urban middle class. At present after a long period in Maharashtra there is a BJP and Shiv Sena lead coalition government. The shift in the government also reflected in the cooperative sector by tightening policies and strict regulations to improve the sector which was earlier got liberal state patronage. There is conflict between bagasse cogeneration energy producing factories and state with regard to electricity purchase agreement.

II) ECONOMICAL:

i)Need of flexible and adequate fund for new models of cogeneration plant

According to a Government policy regulating cooperative sugar factories, the State Government provides 5% of the capital expenditure on the cogeneration project while the factory concerned puts in an equal amount. The Sugar Development Fund of the Union Government provides 30% funding of capital investment and the remaining is secured through institutional funding. An investment of around Rs 4.50 crore per MW is needed to start a cogeneration plant in a cooperative factory. Therefore there is a need to increase subsidy for establishing new models like cluster based cogeneration project.

ii) Can Maharashtra's sugar mills spring back?

The future of cogeneration project set by the sugar factory is exclusively based on the financial condition of the concerned factory. However, the financial condition of mills mainly cooperative is quite dismal. Even the financial condition of cooperative sugar factories in Solapur district also equally dismal five big factories has already received notice from Government. The mills have run up arrears of Rs 3,500 crore; inefficiencies and political interference threaten the future of the state's co-operative mills (Jog, 2015).

iii) Attractive tariff by State

The Maharashtra Electricity Regulatory Commission (MERC) has been declaring attractive tariff for cogeneration power projects from time to time. This has resulted in having 102 cogeneration power projects totalling 1775.85 MW commissioned in the state. The prevailing regulated tariff declared by the commission on 29th April, 2016 for Cogeneration projects is Rs. 6.73 per unit. "A cogeneration plant needs about 1.8 kg of bagasse to produce a unit of power. At the current rate of bagasse (Rs 1,500 per unit), the cost of production works out to about Rs 2.70 per unit of electricity. Selling to the government is, however, not that unattractive. The government generally signs a power purchase agreement (PPA) for 10 to 20 years (MEDA 2017).

iv) Intricacies in power purchase agreement (PPA):

A private power company cannot provide a long-term assurance. Some cogenerators, especially in Maharashtra and Karnataka, have signed contracts with state governments but have broken them for a higher price from private companies (expert's opinion at Delphi). Hence, there is a close competition among the producers and buyers in the market. There are differences of Tariff rates State wise (E.g: Karnataka State offers higher price than Maharashtra). Solapur is located very close to the Karnataka state therefore factories from Solapur also facing the same problems.

v)Cost of production is comparatively chief than conventional energy

Cogeneration is relatively cheaper since bagasse is produced in house. For every tonne of sugarcane crushed, mills get 300-350 kg of bagasse. National level potential of power generation through Bagasse co-generation as per MNRE, GoI study is about 3500 MW, whereas the potential in Maharashtra is 1250 MW. The promotion of Bagasse co-generation in sugar mills for surplus power generation is one of the important schemes of MEDA.

III) SOCIAL:

i) Empowerment of rural marginal groups

About 7.5% of the rural population banks on sugarcane farming. The sugar industry directly employs around 2 million workers, and there is also significant indirect employment generation through various services. At present there are 173 cooperative sugar factories in operation, employing 165,000 people. 800,000 people are engaged in the harvesting and transportation of sugarcane to factories from the fields (MSCSSF, 2017).

ii)Dawn of the next generation of clean energy entrepreneurs

With the advent of global climate crises there is a rising pathways to a low carbon future. Businesses and industries also contributing in this endeavour through scaling up clean energy entrepreneurship. In Maharashtra near about 35 % and Solapur (40 %) sugar factories are joining their hands in this clean energy process.

iii) Dawn of new ancillary services

With the dawn of new avenues like cogeneration plants in the sugar factories there are signs of new services at rural areas such as: energy specialists, power banks, chemical centres, transport etc

iv) New avenue for Corporate Social Responsibility

Being one of the oldest Industries, set up in the rural pockets of the country, Sugar factories has been practising CSR activities in the name of humanity and community services, right from the beginning –Skill development and empowerment of weaker sections. The areas are growing such as socio, economic and environmental issues to their key stakeholders – farmers, farm labourers, employees, shareholders and the consumers – customers (Patil et al, 2010).

v) Infrastructure development

The presence of industry has led to development of rural places, from which the sugarcane is drawn to factories, including an improved road network, transportation facilities, medical facilities, education facilities, and banking.

IV) TECHNOLOGICAL:

i.Standardization of technologies & packages

The lack of standardization of cogeneration technologies for high pressure configuration in small sugar mills is a major technical barrier. Hence, there is an urgent need to standardize, package document, and validate the technologies for economically viable and technically feasible export oriented cogeneration in these mills.

ii.Lack of Grid Connectivity:

Lack of grid connectivity is also a barrier in bagasse cogeneration mainly at the far flung rural areas of Maharashtra and Solapur in particular.

iii)Reliance on traditional technology

Using traditional equipment such as low-pressure boilers and counter-pressure turbo alternators, the level and reliability of electricity production is not sufficient to change the energy balance and attract interest for export to the electric power grid(See: Bioenergy,2017).

iv)Need of updating advanced technology options

Revamping the boiler house of sugar mills with high pressure boilers and condensing extraction steam turbine can substantially increase the level of exportable electricity. This experience has been witnessed in Mauritius, where, following major changes in the processing configurations, the exportable electricity from its sugar factory increased from around 30-40 kWh to around 100–140 kWh per ton cane crushed. Extra high pressure at 87 bars and 510°C, configuration comparable to those in Mauritius, is the current trend and there are about several projects commissioned and operating in India and Brazil. The average increase of power export from 40 bars to 60 bars to 80 bars stages is usually in the range of 7-10% (see: https://www.bioenergyconsult.com/cogeneration-of-bagasse/).

v) Lack of technological awareness and fund to its updating

The data received during the Delphi exercise offers the fact that the managers of cogeneration plants are not much aware about the advanced technological changes in this sector. There is a lack of updated information and professionalism this kind of trend is more prevalent among the traditional cooperative sugar factories than the private one.

vi) Advanced technology: Hybrid of steam and gas turbines

Steam-injected gas turbine cycle (STIG) or expanding through a steam turbine to boost power output and efficiency in a gas turbine/steam turbine combined cycle (GTCC). Gas turbines, unlike steam turbines, are characterized by lower unit capital costs at modest scale, and the most efficient cycles are considerably more efficient than comparably sized steam turbines.

vii) Mixed reactions in terms of technological challenges in Solapur

The primary inquiry of the status of technological adoption at cogeneration plants at Solapur confirms that only few plants have advanced technologies that are up to 50-60 bars. However they still rely on steam turbines. Therefore there is a huge scope for future potential to harness the untapped clean energy from the bagasse.

V)ENVIRONMENTAL:

i) Produces carbon neutral electricity

The power produced through co-generation substitutes the conventional thermal alternative and reduces greenhouse gas emissions. High-efficiency bagasse cogeneration was perceived as an attractive technology both in terms of its potential to produce carbon neutral electricity.

ii)Bagasse-based cogeneration earns carbon credits

Burning bagasse produces no sulphur dioxide and very little ash as compared to lignite, the lowest rank of coal. Most coal available in India is of low grade. Bagasse-based cogeneration earns carbon credits since CO_2 absorbed by sugarcane plants while growing is more than the CO_2 produced in burning bagasse.

iii)A sign of air pollutant

The study conducted by Sahu et al (2015) article provides the first ever estimation, current status and overview of magnitude of air pollutant emissions from rapidly growing bagasse based cogeneration technology in Indian sugar mills. The estimated emission from the world's second largest sugar industry in India for particulate matter, NO_X, SO_2, CO and CO_2 is estimated to be 444 ± 225 Gg yr^{-1}, 188 ± 95 Gg yr^{-1}, 43 ± 22 Gg yr^{-1}, 463 ± 240 Gg yr^{-1} and 47.4 ± 9 Tg yr^{-1}, respectively in 2014(Sahu, 2015).

iv) Serious threat for sugar crop due to climate change: Solapur a vulnerable case

Due to climatic aberrations especially rainfall and maximum temperature affect productivity, sugar recovery and burning in sugarcane crop likewise poor forecasting systems and mitigating strategies also matters a lot. The extent of climate change impact on sugarcane is connected with geographic place and adaptive ability. Sugar production in India set to drop 9% in 2017 as drought hits Maharashtra, Karnataka a forecast made by Indian Sugar Mills Association (ISMA) (See: **http://www.financialexpress.com**). Solapur district, with 32 sugar mills, is the most hit, where the area under sugarcane cultivation has come down by 22,367 hectares. The total reduction of such crop areas in the state is 63,457 hectares in 2014-15(Biswas, 2015).

v) Acute water crises during summer

In water-stressed regions like Solapur, Marathwada, the increase in area for sugarcane cultivation has resulted in severe depletion of the groundwater level, causing acute water crises during summer that creates serious threat for the sustainability of sugar crop.

VI) LEGAL:

i) Impact of liberalization

Winds of liberalization have touched sugar industry also. Due to relaxation of licensing rule after economic liberalization took place in 1991, the imports of sugar was freely allowed and exports were deregulated to some extent that has created way for mushrooming sugar factories and associated industries like bagasse cogeneration.

ii) Legal provisions for producing energy through non-conventional

The Government of Maharashtra enacted New Policy for Power Generation from Non - Conventional Source of Energy-2008 vide Government Resolution (i) No.APAU(NCE)-2007/ Pra.Kra.693/ Urja-7 dated 14th October 2008 (ii) Amendment dated 03-08-2009.

iii) Guaranty for RE Purchase

The 2003 Electricity Act recommended states buy a minimum of 10 per cent power from renewable energy sources. It put the onus of fixing tariffs for renewable energy on state commissions.

iii) Sale of Power and Tariff

It shall be binding on Developers to sell 100% of electricity generated to Licensee or Client in the State. This provision also limits the producers to purchase/sell energy to different states. Solapur is very much vulnerable in this context because it is an adjoining state to Karnataka.

iv) Incentives and General benefits

No electricity duty for first 10 years for captive use/ third party sale.

• For Bagasse project Capital grant of Rs.1 Cr./ project for HV/ EHV substation, if project runs with minimum 80% PLF for minimum one year.

• If Co-operative sugar factory installs projects 100% exemption for the next 10 years to be given on 3% purchase tax which is charged on sugar cane purchased for crushing.

v) Electricity Act 2003; opened way for private players

This opened the door for private players to enter the field of electricity transmission and distribution. It allowed open access, due to such inclusive policy the number of private factories and cogeneration plants are increasing at higher rate than cooperative. In last ten years the new factories opened in Solapur district are mainly private one.

IV.CONCLUSION:

The mounting crisis in the energy sector and depletion of natural resources at global level is one of the biggest challenges in front of policy makers. Conditions are more severe especially in the countries like India. Given India's status as the fourth largest greenhouse gas emitter globally, the progress that the country makes towards reducing such emissions will be of crucial importance. To overcome these challenges India needs to shift to clean energy resources. Technological revolution paved way for alternative innovative spheres for RE production. Bagasse cogeneration technology has tremendous potential to produce ethanal and RE in India. However, technology and innovations never functions in vacuum. To make technological innovations successful at societal level the policy makers and technocrats also essentially have to gauge various drivers associated with society and technology. This paper based on PESTEL analysis provides concrete micro, meso and macro insights and causalities interlinked with technology and societal spheres. Thus, the analysis suggest paradigm shift that has potential to offer long term sustainable solutions for India's bio energy policy with reference to BCT. It is evident from the above study that holistic approaches like (PESTEL) are crucial for strengthening India's RE sector however, it necessitates deep-seated policy decisions at both local and national level.

REFERENCES:

[1]Biswas Parath, "Sugarcane area down in State, Solapur worst hit", retrieved on July 11, 2017 from: https://indianexpress.com/article/cities/pune/sugarcane-area-down-in-state

[2]Bioenergy, "Bioenergy Consult", retrieved on June 9, 2017 from- https://www.bioenergyconsult.com/cogeneration-of-bagasse/

[3]Financial Express, "Sugar hits by drought to Maharashtra and Karnataka", retrieved on June 9, 2017 from: **http://www.financialexpress.com/market/commodities/sugar-production**

[4]Jog Sanjay, "Can Maharashtra's sugar mills bounce back?", Business Standard, May 7, 2015.

[5]MEDA, "Bagasse Based Cogeneration Power Project", retrieved on July 11, 2017 from https://www.mahaurja.com/meda/grid_connected_power/bagasse

[6]MSCSSF, "Sugar Status in India", retrieved on July 18, 2017 from http://www.mahasugarfed.org/Reports/memberfactories.aspx

[7]Patil DA, Dhere AM, Pawar CB. Connecting Power: Biomass Electrification, Social Change and Management in Indian Village. International Journal of Rural Management. 2010 Apr;6(1):33-62.

[8]Sahu SK, Ohara T, Beig G, Kurokawa J, Nagashima T. Rising critical emission of air pollutants from renewable biomass based cogeneration from the sugar industry in India. Environmental Research Letters. 2015 Sep 1;10(9):095002.