POWER GENXT

Volume 10

10th National Seminar on

CLIMATE COMMITMENT: PHASING OUT OF INDIAN COAL BASED POWER PLANTS BY RENEWABLES

NEED
National Energy Excellence Drive

ENGINEERS' WELFARE FORUM

THE WEST BENGAL POWER DEVELOPMENT CORPORATION LIMITED

Recognised by WBPDCL
Vide Letter No. : PDCL/CORP./HR/305/1495, Dated 3.3.2012
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VOLUME : 10

NEED
National Energy Excellence Drive

Published on the day of 10th National Seminar
(9th January, 2022)
on

CLIMATE COMMITMENT : PHASING OUT OF INDIAN COAL BASED POWER PLANTS BY RENEWABLES

Engineers' Welfare Forum
WBPDCL
ISO 9001 : 2015 CERTIFIED

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MESSAGE

*I am very much glad and proud that "**Engineers' Welfare Forum, WBPDCL** has organized their annual program NEED - National Energy Excellence Drive, 10th National Seminar in Virtual mode in this pandemic situation on **"CLIMATE COMMITMENT: PHASING OUT OF INDIAN COAL BASED POWER PLANTS BY RENEWABLES"** on 9th January, 2022 at WBPDCL Auditorium "Bidyut Unnayan Bhaban", Salt Lake City, Kolkata-700106.*

Now-a-day the proposed topic is the burning issue to the nation to enhance the electricity generation capacity by using natural source without the use of fossil fuel which is going to end from our nature. This will reduce the pollution content in our atmosphere. This seminar will help to create a platform for knowledge shearing among the well experienced engineers of different power sectors.

*On the same auspicious day, Engineers' Welfare Forum, WBPDCL will publish their technical journal **"POWER GENXT, Vol-X"** which will also be the knowledge shearing platform for the Engineers.*

I extend my best wishes for grand success of the seminar.

(MANOJIT KUMAR BASAK)

SAVE ENERGY :: PRODUCE GREEN :: SAVE COUNTRY :: SAVE UNIVERSE

Climate Commitment: Phasing out of Indian Coal based Power Plants by Renewables

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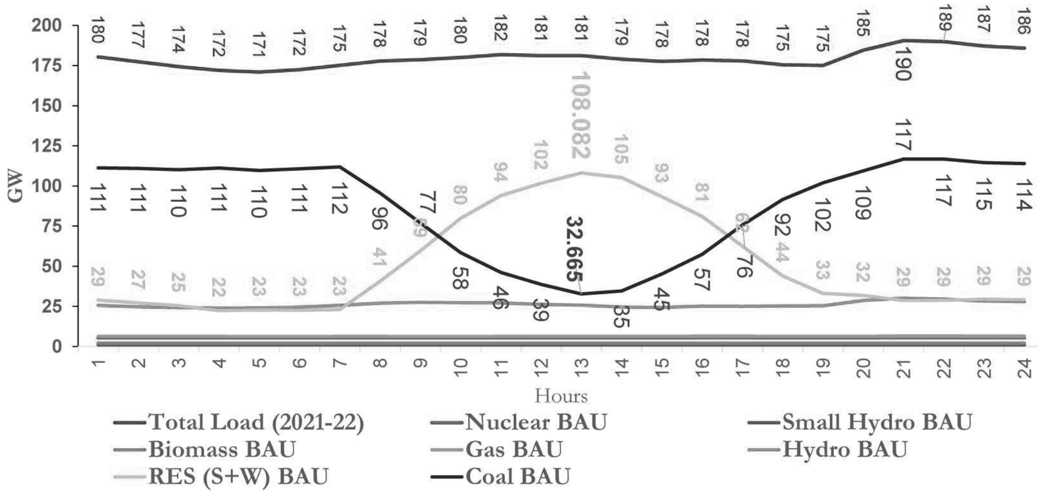
Introduction

India has committed to a Nationally Determined Contributions (NDC) target of achieving 40% of its total electricity generation from non-fossil fuel sources by 2030. In line with GoI target of 500 GW, NTPC has also set an ambitious target of 60 GW RE capacity by 2032. The challenge with RE is the high uncertainty and variability in generation and additional resources are required for balancing the variations. Hydro & Gas based stations are designed for fast ramping but in India without having sufficient availabilities of cheap gas and limited installed capacity of hydro, power sector is depending on flexibility of coal based generating units. Due to the current 'must run' status of RE and limited peaking power availability, it is the coal plants which were designed for base load operation and but now are being forced to cycle and provide balancing power.. Paper will throw light on immediate and long-term action plan for flexibilization of coal based unit for gradual phasing down of traditional coal units instead of phasing out by renewables into the grid.

Challenges in RE integration

Renewable power output has three major key limitations: variability varies from moment to moment, uncertainty cannot be predicted with any certainty in advance and concentration is concentrated during a limited number of hours of the year. Thus creating a need for the balancing the demand on various time scales for proper functioning and security of the grid. As the majority of the generation (75%) is from thermal power, hence the balancing support shall have to be provided by the existing fleet of thermal plants.



The figure shows the impact of the renewable generation on the daily net load demand of the grid. The top red curve is the load demand forecasted for the year 2021-22. The yellow curve is the power output considering the proposed installed capacity of solar and wind. The net load demand (black) is to be met by the fleet of thermal power units in the grid which is very steep. It creates demand of large flexible power from the base load thermal plants, reducing their minimum operating load and requiring steep ramp rates. A significant proportion of the older coal-fired plants, are based on conventional sub-critical technology which were originally designed and built with steady base load operation. The major change like operating cyclically daily has major impact on coal-fired plant in several areas: operation and maintenance, plant life and economics. Hence, in a scenario of high penetration of renewables (175GW) in 2022 there is an urgent requirement of developing the flexible capability of existing thermal power plants for minimum loading operation of at least upto 40% with higher ramping rate. Gradually with more and more integration further steeper ramp rate and lower minimum loading will be required.

Flexibilization tests conducted in NTPC-

Following Pilot studies were conducted for minimum loading operation and with higher ramp rate as mentioned below-

Associates	Plant	Study period	Scope
IGEF/VGB, Germany	Dadri Unit 6	Jan- Aug 2018	MTL (40%) & 3% Ramping
USAID/BHEL	Mauda Unit 2	April-Aug 2019	MTL (40%)

Associates	Plant	Study period	Scope
J-Coal/TEPCO, Japan	Vindhyachal Unit 11, Mauda Unit 3,4	March–July 2019	MTL 55% with 3% ramping. Efficiency at different part load condition

Major observation during pilot studies-

- Excessive fluctuations in Steam temperatures both in MS and HRH
- Fluctuation in Drum level during ramping and min loading operation
- Flue gas temp at APH outlet at 40% min loading reaching temp below Acid Dew point.
- Feed water temp at Economiser outlet at min loading will come down temp below saturation temp corresponding to Drum pressure causing steaming
- PA fan stalling at low loading operation with 3 Mills in service
- Poor Flame intensity with Furnace Disturbance.
- With 3% ramping final ramp rate achieved in entire load range (1.3-1.4%) with manual milling system operation.

Good O&M Practices before introducing Flexibilization in coal based units:

It is essential that some basic practices are followed before preparing a unit for flexing. The below indicative list contains the broad preparation items and is not exhaustive.

- All auto loops should be available and fine tuning of CMC must be carried out to minimize the deviation of parameters like MS/HRH steam temperature, throttle pressure, drum level, excess O2% at economiser outlet and flue gas temperature at boiler outlet.
- Attemperator system (isolating valves and control valves) and control valves are to be set tight and must give fast response to the changing system demand.
- Optimise minimum coal loading in a mill by fine tuning primary air flow vs coal flow curve to avoid lean air mixture and possible flame failure tripping.
- Dirty air flow test at regular interval to evaluate partially plugged coal pipes and burners
- Burner tilts should be operational in full range in auto mode and SADC damper operation should be checked and correct feedback must be made available.
- WWSB and LRSB operation scheduling should be done at higher load during such opportunity.
- Air heater soot blowing must be carried out at least once in a shift

- Air heater air leakages and other tramp air should be minimised.
- Replacement or repairing of expansion joints if required and major duct re-vamping if any.
- Water chemistry instrumentation should be set right and linked with DCS.
- SCAPH operation to be made through to contain flue gas temperature less than acid dew points
- Check condenser- air- leak. Helium leak detection may be deployed
- DM water storage will require nitrogen blanketing to prevent oxygen in feed water system
- Boiler side high energy piping hanger indicator are to be marked and monitored.
- Low load FRS to be used to reduce flow rate in economiser during cold or warm start up.
- Turbine stop and control valves to be inspected.
- Ensuring availability of deaerator pegging heating with auxiliary steam sources.
- Feed water treatment with AVT(O) or AVT(R) is to be suitably deployed.

Suggested Solutions

The following solutions can help address the issue of parameter deviations like steam temp, drum level, furnace pressure etc. during the Pilot Studies on flexible operation of the units.

Fine tuning of existing CMC logics

The responses of the existing CMC logics resulted in high deviations in parameters during the tests conducted at 3%/minute ramp rate. These deviations in actual ramp rate achieved can be mitigated by fine tuning of existing control loops. CMC logic loops need to be tuned for controls at low load condition of 40% TMCR. Also, the load ramping for entire new operating range from 40% TMCR to 100% TMCR also needs to be established with CMC Ramp rate of 3% without much deviation in Steam temp parameters.

Steam Temperature Control:

Apart from existing control loop tuning, Advance Process Control can assist in reducing parametric variations, especially Steam Temperatures. During the tests, the main steam temperature deviations were very high and this can potentially result in higher lifetime consumption of boiler parts. The major task of the temperature controller is to achieve stable steam temperatures using a load dependent set point in all load situations. In normal load operation, set point changes occur very rarely. Disturbances have to be compensated for quickly, so as to allow the unit to be operated close to the material limits in the most critical situation.

The reheat steam temperature should be controlled using burner tilts as part of the automated control, else if the tilts are operated manually, reheat steam temperatures drop during low load operation. During the Studies, further test runs were conducted to investigate the influence of the burner tilts as well as the design and integration of the logic for automated reheat steam temperature control.

Unit Control and Automatic Mill Operation (Mill Scheduler):

The main task of the unit control is to provide set points for the steam generator and the turbine, which meet specific requirements defined by the operator or load dispatcher. The two main variables - steam pressure and unit load - have to be controlled by the slow acting boiler and the fast-acting turbine. The dynamic behavior of the plant is replicated using a simplified model of the unit dynamics, which only includes the components for boiler dynamics and steam storage. An additional task of the unit control is to take fans, boiler feed pumps and mills automatically into operation during load ramps in order to allow smooth and uninterrupted load changes.

A mill scheduler is subordinate to the unit control and switches coal mills ON / OFF automatically depending on the firing demand and the actual number of firing devices in service.

Flue Gas Temperature Control

The steam air preheater (SCAPH) should be taken into operation automatically, when needed. This control combined with the upgraded temperature control would prevent corrosion in rotary air preheaters.

Boiler Fatigue Monitoring System:

The Boiler Fatigue Monitoring System can determine the residual lifetime of highly stressed components by calculating the creep and low-cycle fatigue of specific components during real-time operation. These components are water and steam piping systems with limited service-life, such as boiler headers, drums, separator, attemperators, and piping. The system enables deviations to be detected online and early on, based on real time signals and active management of an operating database. The benefits include the following.

- Transparency in operating mode on residual life
- Detection of high-wear operating modes
- In-time notifications for overhaul and inspection
- Enhanced power plant safety and reliability
- Utilization of component material reserves
- Cost-effective in-service monitoring and analysis

EOH (Equivalent Operating Hours):

The EOH (Equivalent Operating Hours) concept provides an overview of the life consumption of standard operating hours as well as of equivalent start up hours (ESH) that reflect load changes and actual stress on the turbine components being subjected to ramp up and ramp down. The so-called equivalent start-up hours ESH are calculated from temperature differences in thick-walled turbine components arising during turbine start-ups, shut-downs and load changes with distinct steam temperature changes. Hence the ESH represent the turbine service life expenditure caused by temperature induced stresses.

Feed water recirculation valve:

For stable operation of TDBFPs, the feed water recirculation valves need to be replaced from ON/OFF valves to modulating type control valves. The new feed water control valves would be kept full open for base load operation.

Combustion optimisation using an online coal flow measurement & balancing system

An online coal flow measurement system provides detailed information about the coal distribution between mills and the coal pipes, and a real time balancing system enables combustion to be optimized at all load conditions.

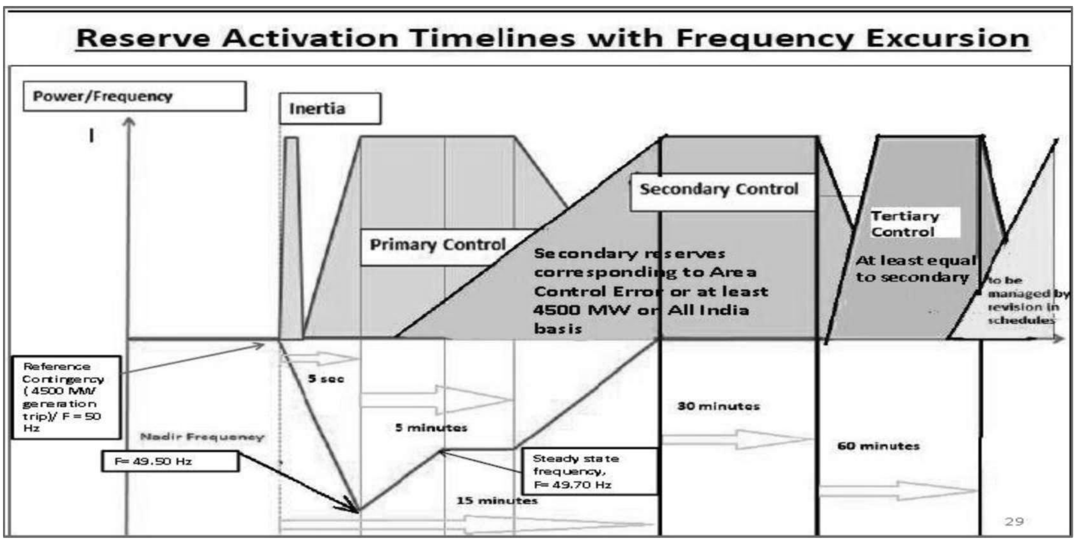
Requirement of Ancillary Services:

Ancillary Services means in relation to power system (or grid) operation, the services necessary to support the power system (or grid) operation in maintaining power quality, reliability and security of the grid and includes secondary response, tertiary response, active power support for load following, reactive power support etc. But in Indian context focus primarily is on frequency control of the grid, but requirement of such services will increase manifold with large and large RE integration.

Primary control refers to local automatic control available in all conventional generators, which delivers reserve power proportional to frequency change following a generating unit outage in the grid. Typically, a 500 MW unit operating at 450 MW would automatically increase its output by 4 % (of 500 MW) or 20 MW for every 0.1 Hz reduction in frequency from the nominal value of 50 Hz. So primary control is able to arrest sharp drop in frequency following a generation outage and the frequency stabilizes at a value nearer to 50 Hz

Secondary control involves Automatic Generation Control (AGC) which delivers reserve power in order to bring back the frequency to 50.0 Hz and the area interchange to their target values viz. the scheduled value. For AGC, units as well as load dispatch centres have to be equipped with necessary software & communication infrastructure, as it involves sending automated control signals from the LDC to the generator based on grid conditions.

Tertiary control refers to manual change in the dispatching and unit commitment in order to restore the secondary control reserve, as loss of generator may cause a system contingency that lasts for several hours.



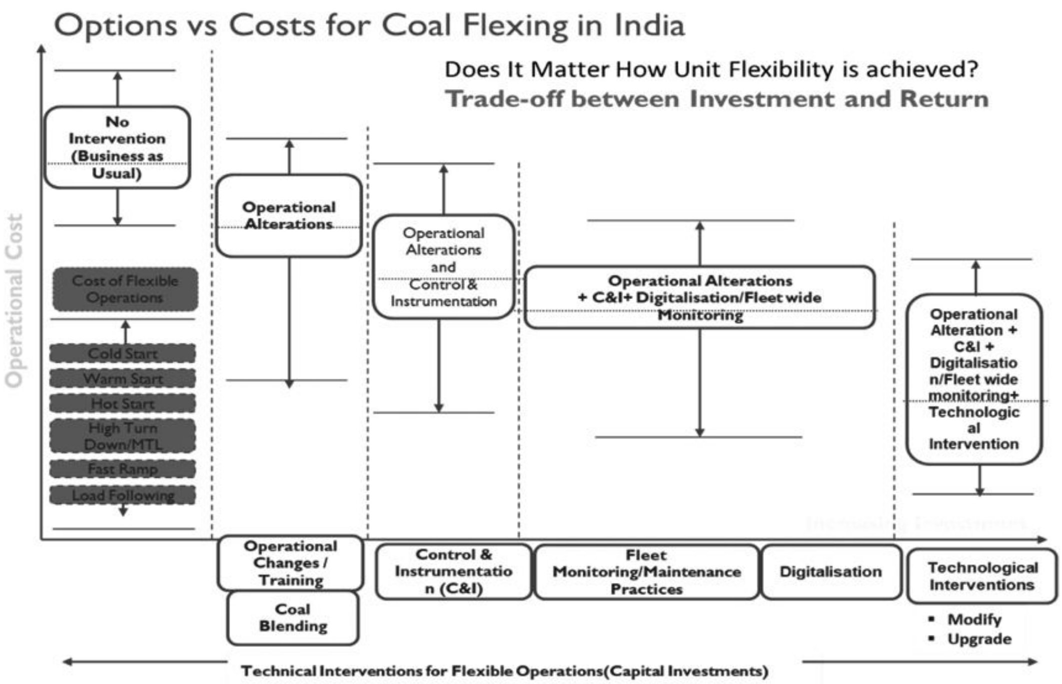
Roadblocks & Mitigation strategies:

The pilot studies and subsequent operations presented some challenges which were taken up with international partners for suggestive mitigation plans. A brief of the roadblocks, mitigation plans and the retrofit requirements is given below for readymade actions.

Sno	Roadblocks/ Challenges	Mitigation plan	Retrofitting requirement
1	**Achieving overall Ramp rate>1%** from tech min to full load frequently during the day without any major parameter deviation.	Addressing excursions of boiler metal temp and MS/HRH steam temperatures swing and Pressure swing, drum level fluctuation.	Control loop tuning, modified sliding mode of operation, Milling system automation, Replacement of BFP R/C valves with regulating type.
2	**Minimum loading operation-** Difficult to reduce load below 55% MCR without oil support	Establish program; Implement a Systematic Approach to Minimum Load Reduction	Control loop tuning upto 40% MTL with modified sliding pressure mode milling automation.

3	**Flow accelerated corrosion** in Economiser tube and Feed water temp reaching saturation temp corresponding to drum pressure	Introduction of program of Flow Accelerated corrosion (FAC). Modified Sliding pressure mode operation.	VFD in LP Dosing pump to maintain PH.
4	**Steam Temperature control** needs improvement following synchronization to mitigate reported excursions in major SH/RH components; Mismatch in heat pick up in MS left & right	Close monitoring of deviation of MS/HRH and metal temp during ramping.	Advance process control of steam/water cycle and load control, SH/RH spray control valves upgrade
5	**APH gas temperature** below acid dew point.	SCAPH to be made through during low load operation.	Automation in SCAPH control to maintain APH gas temp
6	**Drum level swing during ramping and low load.**	Auto loop tunning of feed water cycle	Single pump operation and installing regulating type recirculation valves
7	**PA fan Stalling**	Continuous tracking of PA fan characteristics curve and provisioning of alarm much before fan operating near the stalling zone	Single PA fan operation in automated mode at low load.
8	**Thermal Fatigue and Creep Damage** in thick walled components in boiler and turbine	Integrate thermal mitigation strategy.	Boiler fatigue monitoring system and Installation of EOH.
9	**Milling Performance at low load**; No provision to measure fuel flow imbalance in mills;	Mill performance mapping of coal flow in coal pipe at various load with off line dirty pitot tube and balancing it.	Milling system coal pipe measurement system installation for online balancing and combustion optimisation.
10	**Poor flame stability** and load responsiveness with 40% - 55% high ash domestic Indian coal and / or low quality imported coals	Flame Quality Scanner Performance improvement- Optimizing milling operation for optimal Primary to secondary air ratio.	Flame scanner upgrade in control, repositioning of scanners

11	**Chemical parameters control** at start-up (e.g. controlling DO, Boiler water PH, Condensate ACC)	Improve strategy for start-up and part load operations	Nitrogen sparging in condensate storage system.
12	**Maintaining Chemistry parameters at load less than 55% (say at 40%)**		CPU installation even in all sub critical units.



Components of the Cost of Flexibilisation:

The effects of thermal power plant flexibility on the costs are mainly exhibited through

- Capital Cost spent on retrofits/replacement
- Increased forced outages thereby reducing availability, decreasing component life and increasing costs. Increased replacement energy & capacity cost due to increased EFOR
- Increased start-up costs due to increased frequency of start-ups.
- Increased O&M costs due to changes in O&M strategies
- Increased cost of fuel due to reduced efficiency-Heat Rate and APC increase.

- Increased spends on water, chemicals, manpower and other miscellaneous activities.
- Increased chances of non-conformance to grid regulations leading to financial losses.

Conclusion

Gradually with more or more RE integration flexibilization measures are to be taken in coal based units while doing so competency building and exposure to changing business practices are one of the most important critical input to adopt such changes. Machines will be affected in the process but our efforts will be to minimise its impact on the machines with measures like introduction of advance process control, adopting new maintenance strategies and installation of suitable hardware components.

Renewable energy sources: Biodiesel – a mini review

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Abstract:

An increase in energy consumption, combined with environmental damage caused by petroleum products has compelled us to think for the alternative renewable sources. Biofuels are being emphasized because of its less GHG emission, eco-friendly than conventional fossil fuels. Although various seeds can be explored for biodiesel production but due to several reasons the commercial production and its suitable implementation has been faced during commercialization. Thus several other alternatives such as 3G biofuel production, uses of waste oil, lignocelluloses, industrial/animal residues, sewages and application of oleaginous microbes are the major thrust of present era.

Key words: Biodiesel, Algae, Wastewater treatment, Co-cultivation, Alternative energy

1. Introduction

Increased fuel use, global warming, fossil fuel depletion, and high fuel prices have prompted the quest for alternate energy generation options. The hunt for renewable energy sourcesthat haslong-term and reduced environmental effect which has been fueled by rapid rise in both worldwide demand for energy and carbon-dioxide (CO_2) emissions linked with the usage of petroleum fuels. Biomass has the chance of meeting 14% of the world's energy demands. Biofuels for transportation (such as bioethanol and biodiesel), goods for generating power and heat (such as wood chips and pellets), and biogas (such as biohydrogen and biomethane) created from the clarification of biological materials from industrial and municipal waste source (IEA, 2013).Several technologies for converting biomass to liquid, solid, and gaseous fuels have been developed during the last few decades. In connection with transportation, high energy density and storage, liquid biofuels outperform solid and gaseous biofuels. They also have the benefit of being able to be employed in existing engines, boilers, or turbines.

Drawback of the use of plant seeds or animal fats for biodiesel production had been debatable for a long period and also the increase in the price of edible oil has effects in the production of biodiesel. Therefore, there is a need to use a source that cannot hinder the production of biodiesel and one of the best sources of biodiesel production is oleaginous microorganism using sustainable feed stocks. Currently, the third generation biodiesel productions mainly pay attention to microbial oil produced from an oleaginous microorganism. The oleaginous nature of microorganism states the potential of the cell to accumulate lipid more than 20% of its total biomass. In the case of oleaginous microbes such as bacteria, yeast, algae, and fungi lipid production is commonly caused by nutrient limitation mostly nitrogen limitation.

The major problem in biodiesel production is the economic feasibility of microbial oil because of the high cost of the substrate utilized during the production. Substrate costs 40 - 80% of total cost of production of biodiesel. To overcome these issues, it is preferred to go for a low-cost substrate for the production of biodiesel using oleaginous microorganisms. One of the best examples of a cost-free substrate is municipal wastewater as it is produced in large quantities also it requires biological treatment before mixing it with water bodies to meet the standards of effluent discharge.. Various generations of feedstocks and biomass used for biofuel are being discussed in this article.

2. Feedstock for generation of biofuel:

Sugarcane, corn, and vegetable oils are examples of food crops, which are categorised as feedstocks of first generation. Feedstocks of second-generation include lignocellulosic compounds generated from agriculture and forestry leftovers, as well as urban garbage. Due to the ecological and socio-economic restrictions of first-generation feedstocks, lignocellulosic biomass has received more attention, although conversion technologies are still facing significant barriers to full commercial implementation.

Bioenergy accounts for over 60% of total energy production derived from land-based first-generation feedstocks, raising concerns about water and land scarcity for feed and food production, as well as other ecological concerns connected to usage of land changes. As a result, the utilisation of wastes and residues for bioenergy generation has sparked attention, as they are frequently and easily accessible in most nations.

The continuous trend in the utilization/consumption of biofuels in last ten years have accounted for 3.4 % of the world's fuel demand in transportation sector, with a significant allocation in Brazil (~ 21 %), the European Union (EU: 3%) and a rising share in the United States (US: 4%)(IEA, 2013). Bioenergy crops are grown on over 40 gross MH (million hectares), 2.5 % of worldwide farmland (FAOSTAT, 2011), mostly for production of biofuel such as biodiesel and bioethanol, as well as biogas, all of which need arable food crops. Starchy and/or sugar crops (for bioethanol) and oil seeds (for biodiesel) are the two most common feedstocks for first-generation of biofuels (for biodiesel). Although there are a serious effort taken by the scientific community but only the plant resources cannot meet the demand and thus there is a huge scope for exploring the possibilities of 1G, 2G, 3G, 4G, etc avenues to meet the required target.

2.1. Feedstocks of the 3G biofuel:

Algae's ability to supply biomass for generation of biofuel has long been recognised. Algae are photosynthetic aquatic microbes that develop quickly in coastal seawater, salty water, wastewater from municipal, or on terrain that is inappropriate for cultivation and agriculture. Figure 1 represents the schematics on the overview of algal biofuel. They can convert light and CO_2 into a number of compounds, such as carbohydrates, proteins, vitamins, lipids and pigments, which have a vast range of uses in the chemical and pharmaceutical sectors, as well as cosmetics, health, foods and feed additives. The majority of lipids are accumulated by microalgal species as Triacylglycerols. *Chlorella* and *Botryococcus* have lofty lipid substance (50–80%), making them suitable for production of biodiesel.

Algal production of biofuel is 5-fold higher than that of palmoil derived biooil. Furthermore, algae contain low hemicellulose content and zero lignin, since they have higher hydrolysis efficiency, higher fermentation yields, and thus lower costs. Other than biodiesel and bioethanol, algae biomass may be utilised to make a variety of sustainable biofuels. Another common product that may be utilised in fuel cells is biohydrogen, while biomethane generated as part of incorporated processes has been utilized for shipping, heating, orenergy production.

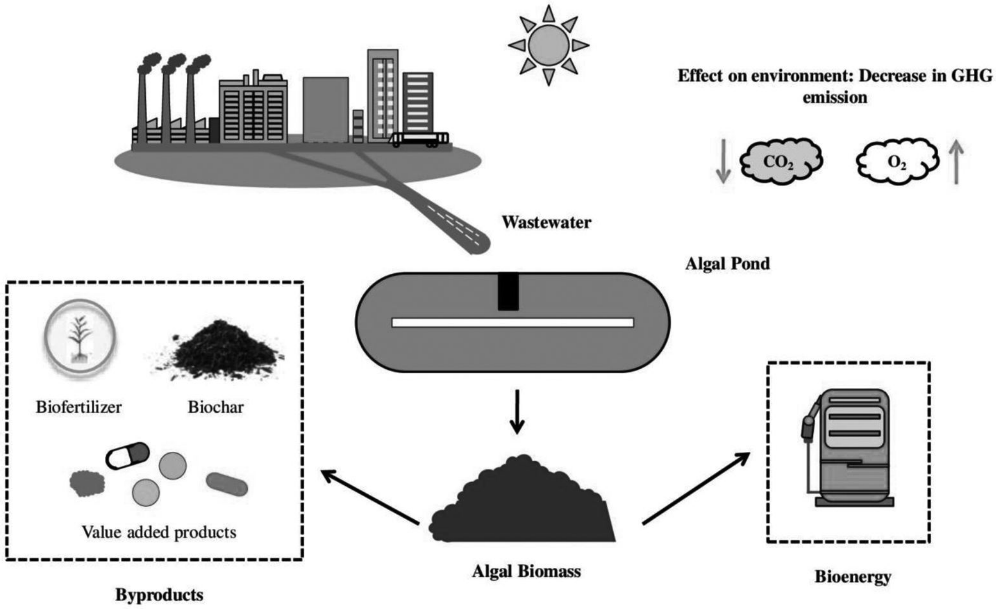

Figure 1: An illustration of the benefits of algal biomass in terms of environmental, energy and value-added product creation.

Apart from algal derived biofuel, various other microbes are also utilized with a variety of feedstock/wastes to enhance a range of biofuel production. Few example of which is explained in the following table 1.

Table 1: Lipid generation using a variety of microorganisms

Organism	Biomass	Lipid Yield
Mortierella isabellina (Fungi)	Corn stover	0.063 g/g
Rhodococcus opacus (Bacterium)	Effluent from lignocellulosic pretreatment	26.9 %
	Biomass gasification wastewate	54.3 %
Rhodosporidium toruloide (Yeast)	Corn stover	0.29 g/g
Rhodotorula kratochvilovae HIMPA1	Pulp and paper industry effluent	61.7 %
Cryptococcus curvatus ATCC 20509 (Fungi)	Corn stover	0.129 g/g
Chlorella vulgaris (Algae)	High ammonia wastewater	32 %
Chlamydomonas debaryana(Algae)	Dairy wastewater	45.33 %
Ankistrodesmus sp. + *Rhizobium sp*(Microalgae + bacteria)	Artificial medium	35.1 %

Chlorella sp. + *Rhodotorulaglutini*(Microalgae + Yeast)	Crude glycerol	35.9 %
Chlorella sp. + *Rhodosporidiumtoruloides*(Microalgae + Yeast)	Wine distillery wastewate	63.4 %
Chlorella minutissima+ *Aspergillus awamori*(Microalgae + Fungi)	N11 + Glycerol	3.4–5.1 fold increase

Co-cultivation:

Researchers are concentrating their efforts on creating new microalgal co-cultivation systems that would boost total biomass and lipid yield while lowering overall production costs. Co-culture refers to a cell culture setting in which more than one distinct microbe are grown collectively with some level of interaction. Co-cultivation of microalgae and yeast in the most basic and economical cultivation method, even in wastewater, could be regarded a possible feedstock for production of biodiesel in this direction (Rakesh&Karthikeyan, 2019). This co-culture approach has been regarded as an effective method for allowing multiple organisms to coexist in a natural setup. Few examples of co-cultivation method of lipid productions are listed in table 1. Biodiesel manufacturing was examined using a co-culture of microalgae and fungus. Synergistic effects on cumulative biomass and lipid yields were enhanced by co-culture (Dash & Banerjee, 2017.

3. Harvesting technique

The biomass collection from the fermented broth is the first stage in downstream processing for biodiesel generation. This method mainly depends upon the microorganism used and its characteristics. Because of a small cell size of fungi, yeast and bacteria (<5 ìm), one of the most challenging and crucial steps in the production of biodiesel is the separation of biomass from the medium. For cost effective production of biodiesel a suitable harvesting method need to be identified. There are various techniques for harvesting which includes centrifugation, flocculation and encapsulation.

4. Extraction:

Algal lipid extraction by mechanical process includes bead beating, expeller press, microwave and ultrasonic associated extraction. Solvent free extraction methods like isotonic extraction method, osmotic pressure method, enzyme associated extraction method.

4.1 Conventional extraction method: Extraction of lipid from microorganisms occurs in two stages, the first of which includes all cell disruption methods such as physical, chemical, and enzymatic, and the second of which includes traditional extraction methods such as Soxhlet, Bligh & Dyer, Folch method, and their modified forms (Yellapu et al., 2018). The two most frequently used extraction methods are Bligh & Dyer and Folch and the solvent used in these methods is chloroform and methanol. In the case of lipid extraction from the oleaginous microbes, the most standard method was the Bligh and Dyer, in this method methanol, chloroform, and water act as a solvent (Bligh & Dyer, 1959). The second conventional method used was the Folch method (Folch et al., 1987).

4.2 Chemical extraction method: Acid hydrolysis is a chemical process of cell disruption that is used to break down the oleaginous yeast cell wall for lipid extraction (Jacob, 1992). In acid hydrolysis, the acid attacks the cell wall directly, releasing glucose, mannose, and glucosamine monomers (Schiavone et al., 2014).

4.3 Microwave assisted method of extraction: Microwave assisted extraction is a method through which microwave energy is used to separate analytes from the sample by heating the solvent. The heat released by this method is more particular to a polar solvent like water and produces steam which directly breaks the cell wall and intercellular components come out and help in the oil extraction process (Mandal et al., 2007).

4.4 Enzyme assisted extraction method: Enzyme-assisted lipid extraction is a technology that relies exclusively on the cell wall properties of all oleaginous microbes (Nadar et al., 2018). Cell wall disruption enzymes such as glucanases, cellulase, mannanase, amylase, pectinase, xylanase, papain, hemicelluloses and pectinase, are used (Singh et al., 2020).

5. Transesterification:

In general, alkali and acid catalysed transesterification processes were utilised to convert lipids to biodiesel. Normally, the alkali catalysed approach has the benefit of being quicker than the acid catalysed method. During this process, a substantial number of byproducts such as glycerin are created, making the whole process very energy intensive and costly. To overcome these drawbacks, new technologies such as the supercritical process, ultrasound-assisted process, and microwave-assisted process and in situ methods have recently been developed (Kumar et al., 2017). Enzyme-mediated transesterification process is widely used method with lipases as primary enzymes and it act as a biocatalyst (Dash & Banerjee, 2017).

6. Properties and standards for biodiesel:

There are two categories of criteria that determine the quality of biodiesel. The first category includes generic criteria that are also applicable to mineral oil-based fuels, whereas the second group focuses on the chemical composition and purity of fatty acid alkyl esters. Various nations have varied biodiesel standards, which include the following: The American Society for Testing and Materials (ASTM), the European Committee for Standardization (CEN), the Bureau of Indian Standards (BIS), and Italy and Germany each have their own sets of standards. Vegetable oil specific parameters which includes, Methanol/ethanol content, ester content, (mono, di, tri) - glyceride content, total glycerol and iodine numbers. Generic criteria includes, density, viscosity, flash point, cold filter plugging point, pour point, cetane number, etc., used to determine the quality of biodiesel.

7. Policies for Biofuel in India:

In 2018, India set forth apioneering biofuel policy, aiming to replace 20% of fossil fuel-based transportation with biodiesel and bioethanol. Diesel is the most efficient fuel for heavy transportation used in India and abroad. It accounts for about 72% of the total transportation fuel demand followed by petrol which accounts for only 23% along with other CNG, LPG etc. with steady increasing demand. In order to decrease import dependency by 10% by 2022 the impetus should be on increase in biofuel production.

Government has taken multiple interventions in order to increase biofuel production and their usage in daily life. One of which is the National Biodiesel Mission and Biodiesel Blending Programme as reported by National Policy on Biofuels. The government has taken initiatives like incentives, pricing regulations, sale of biodiesel to bulk and retail customers and increased R&D expenditure which can have a supposed impact on biofuel programmes in the country (National Policy on Biofuels - 2018).

8. Conclusion and future prospective:

Bioenergy is expected to supply up to 20?30 % of global principal energy by the year 2035 as reported in IEA, 2013. Government support has aided and will continue to aide biofuel production for transportation. To achieve the scenario of new policies lofty goals, availability of various types of biomass will have to amplify by numerousfolds of magnitude, posing significant challenges for forestry and agriculture, as well as raising concerns about social-economic and environmental consequences. Advanced biofuels generated from algal and lignocellulosicbiomass, on the other hand, have the potential to increase biofuel supply while reducing land use and improving greenhouse gas mitigation. The second generation technologies are quite developed at this time, has a small number of large-scale commercial plants and about 100 pilot plants for demonstration across the world, but the technologies of third generation are still in the R&D stage. Before the technologies can be commercialised globally, some technical and policy hurdles must be overcome.Biofuels made from lignocellulosic materials are less cost-effective than fossil fuels. Low-cost raw materials must be available on a consistent and long-term basis if production costs are to be reduced. To improve the economic viability of the processing of biorefinery system, all biomass components and its intermediates and by-products produced if any, should be evaluated with most care and utilised wisely.

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A brief write-up on dependency of Thermal Power Plant on Indian Economy

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Abstract

Coal based Thermal Power Plant provided 74.3% of Indian electricity generation in the financial year 2018–19 vis-a-vis contribute approximately half of India's CO2 emissions. At the same time it will be immensely difficult for Coal India (CIL), to reach an annual production level of one billion tonnes by 2024.

This paper briefly discuss economic dependency on electricity generated from coal based thermal power plant besides the analysis accounting of climate change impacts in the form of a cost of carbon. In fact so far it is not established any proven straight forward mathematical models to measure the amount of CO2 absorption by the surrounding green belts vis-a-vis the mitigation risks.

Introduction

Energy is the prime mover of economic growth and is vital to the sustenance of a modern economy. Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible and environmentally friendly.

A diverse developing society like India provides various challenges in the areas of economic, social, political, cultural and environmental. The deterioration of the environment has been a matter of concern in the backdrop of increasing urbanization, industrial and vehicular pollution and pollution of water resources due to the discharge of effluents without treatment.

The effect of global warming is now virtually felt by mankind through climate changes, melting ice caps i.e. less ice found deposited in artic zone, rise in sea level, i.e. reduction in the land area etc. All these are believed to the effect of increasing greenhouse gases (GHG); the main component is CO2. The expected solution to the global warming lies in the development of the green cover or forest cover to absorb the excess CO_2, together with harnessing renewable sources of energy in lieu of fossil fuel so as to arrest the Green House Gas level from further increasing.

The draft energy policy of the Government of India in 2017 projects an increase in coal power capacity of 70 to 130 percent by 2040 and calls for large increases in investment in coal mining infrastructure. The International Energy Agency's World Energy Outlook 2020 (IEA, 2020) projects coal based electricity generation to grow by approximately 20% in business as usual scenarios while declining by as much as 85% in sustainable development scenarios. A draft National Electricity Policy dated February 2021 continues to recommend expansion of the coal power fleet emphasizing that it is the cheapest source of electricity. Policies regulating coal in the Indian power sector might have a significant impact on the difficulty in meeting the stringent carbon budget of the IPCC Special Report on Global Warming of 1.5 °C (IPCC, 2018).

Analysis

We need to establish a mathematics of CO_2 absorption by the surrounding green belts vis-à-vis the equation of environmental cost to establish against the concept of net zero emissions. The concept of net zero emission is going against the growth of Indian Industrial progress.

It is also to be noted that for developing countries in the short and medium term, carbon dioxide emissions continue to be a necessary part of growth and development. We are not sure that in near future the cost of electricity from renewables with storage will be comparable to the electricity generated from new coal plants in all respects.

Renewables never be the reliable source of electricity for our country in near future. Wind and solar generation requires significant government assistance to put power on the electricity grid and even then, wind and solar power is not reliable. Unreliable power risks lives, our security and our economy. Renewable energy generators must have fossil fuels as a backup when inevitably the wind stops blowing or the sun isn't shining on solar panels, Renewables cannot be the foundation of a dependable electricity grid

Conclusion

Coal based Thermal Power Plants with cheaper CO_2 sequestration, SO_x & NO_x options, eliminating the use of presently available SCR & FGD technologies, shall be the future of Indian Economy.

EV with PV & IoT: Journey from Kolkata

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Abstract:

As India is one of the worst sufferer of climate change, global warming and severe air pollution, it is the task before all of us to ensure cleaning of air of this country .The country has adopted strategies to reduce its Green House Gas (GHG) emissions through enhanced Renewable Energy penetration and phase-wise replacement of the fossil fuel driven transport system by electric vehicles. [2]

In the present article, some unique features like convergence of EV with Solar PV and Information Technology is proposed to ensure more E-Vehicle on road. PV can reduce the cost of charging. App based single window system for users to take informed decision. AI application for time optimisation of charging exercises for on road e-vehicles can make things easier for users.

Experts and policy makers are busy with exercises to reduce the GDP loss due to climate catastrophes, across the globe. Here it is proposed to flourish EV coupled with Solar PV and IoT ,so that after mitigating the climate issuers , India can enhance its GDP through export of de carbonization and can be in the Driver's Seat in EV .

Key Words: EV with PV & IoT

INTRODUCTION

The Covid 19 Pandemic has taught us that at more concentration of suspended pollutant particles (PM 2.5) in the atmosphere, droplets sustain more. It makes Indian Metro cities the worst sufferer of the pandemic. The World Air Quality Report, 2020 shows that 17 lac people in India die every year due to air pollution. Enhanced penetration of Green House Gases (GHG) in the atmosphere causes the warming. Nearly 200 countries in this planet have agreed to limit the global atmospheric temperature rise within 1.5 degree celcius by 2030.Temperature rise leads to severe climate catastrophes like cloud burst, flood, landslides, super cyclones. The sixth assessment report (August, 2021) of Inter-Governmental Panel on Climate Change (IPCC) records 1.09 degree celcius warming on average in last 10 years in this planet whereas for Kolkata, the recorded temperature hike is 2.66 degree celcius. The 2020 cyclone Amphan which has devastated Kolkata has been identified as the deadliest one in respect of damage of properties and resources in recent past. The Global Climate Risk Index, 2021 has ranked India the seventh worst affected country by weather extremes. Before the Conference of Parties (CoP 26) at Glasgow (Oct-Nov, 2021) , the British Prime Minister has appealed before India to upgrade its climate targets.

India's Green House Gas (GHG) emissions reduction strategies are linked with enhanced Renewable Energy and electric vehicles in a time bound manner. Steps are taken for e-bus penetration, e-two wheeler penetration, Performance Based Incentive schemes for indigenous manufacturing of battery, motor in India, developing more road side Charging Stations etc.

As defined in the Paris Climate Accord, 2015; the emission density of GDP of India should be in the range of 33 to 35% by 2030. The structural adjustment cost associated with reducing India's Emission profile is expected to be significant, but the cost of inaction will be creator. In this context, in this article, it is proposed to take an alternative and smarter technology adoption path. Unlike to other countries, accepting the China, India could chart a more prosperous path towards low emission future and can accelerate India's progress to the rest of the world by exporting key technologies, process and know-how. On one hand, it reduce the fossil fuel dependency of Indian Transport sector (the second largest emitter of GHG in India) and on other hand through exporting its de-carbonisation technologies like EV with PV & IoT , India can be the global leader in EV. [8]

Electric Vehicle: The Government policies and initiatives:

The Department of Heavy Industry (DHI), Govt. of India has launched the Faster Adoption and Manufacturing of Electric Vehicle in India (FAME India), Phase-II in order to promote EVs to curve Air Pollution in major cities of India.

To accelerate faster deployment of EVs, the Ministry of Power (MoP), Govt. of India has formulated the Charging Infrastructure for Electric Vehicle : guidelines and standards: 2018 for establishment Public Charging Stations (PCS) in selected cities and highway corridors. The peak power procurement due to increased EV load, suitable revenue models are needed to be worked out to support the network strengthening of Distribution Companies (DISCOMS). The operational management of EV charging is essential for accommodating the impacts on the power network and accessing the associate financial implications. [3]

The Ministry of Housing and Urban Affairs (MoHUA), Govt. of India has amended the Model Building Bye-Laws in order to provide dedicated space for Electric Vehicle Charging Infrastructure (EVCI) in new and existing buildings. This is introduced at different urban bodies like the Kolkata Municipal Corporation.[6]

Possible Electric Vehicle nos in Kolkata in coming days: A forecast

The current penetration of EVs in India is very low. But, in recent past, a number of essential steps have been taken to accelerate the implementation of EVs and public charging stations to attain notable EV roll outs in India by 2030. Based on current conventional vehicles' concentration, the government initiatives, up-coming EV technologies, and potential customer interests; the future EV penetrations for years 2025 and 2030 in Kolkata is estimated. [5]

Sl no	Type of vehicles	Total vehicles on road in 2025	Considered % for EVs	Expected EVs on road in 2025
1.	Two Wheelers	1991219	25	497805
2.	Three Wheelers	47825	15	7174
3.	Commercial Four Wheelers	87322	05	4366
4.	Commercial Heavy Vehicles	265168	05	13258

Table-I: Expected EV by 2025

Sl no	Type of vehicles	Total vehicles on road in 2030	Considered % for EVs	Expected EVs on road in 2030
1.	Two Wheelers	2843382	50	1421691
2.	Three Wheelers	57235	30	17171
3.	Commercial Four Wheelers	106129	10	10631
4.	Commercial Heavy Vehicles	323178	10	32318

Table-II: Expected EV by 2030

Proposed measures: [4]

From the so far discussion, the pertaining issues are:

- The peak power procurement modality due to increased EV load is to be fixed up.

- The Standard Operational Protocol (SoP) for operational management of EV charging is to be framed up.
- App based single window system for users to take informed decision, AI application for time optimisation of charging exercises for on road e-vehicles are to be introduced to ensure hassle free, faster charging experiences.
- Introduction of Grid Connected and Off Grid Solar charging stations to reduce dependency on coal based electricity.
- Developing an eco-system for easy availability of spares and post-sale maintenance services.

As this is a very complicated environment comprising of stakes like Grid Availability of the Distribution Company, availability of charging station, availability of on road e vehicles; a IT based charging solution is needed.

IOT-BASED EV CHARGING APP DESIGN APPROACH:

IoT based information systems in communication platforms with associated sensing devices can bring the ultimate of fast-charging solutions that are flexible enough to support the faster charging of all EVs on road.

Salient features of an EV charging app:

An EV charging app must have the following essential features:

- Real-time location detection and providing information about available charging stations.
- Scheduling of charging date and time, setting reminders, getting notifications and tracking usage.
- Real-time updates of the charging status.
- Feedback from users about charging station.
- Payment directly through the app.
- Finding all stations along the road trip route.
- Checking station ratings and description.
- Notification to alert when there’s a charging station nearby.

Technology components to develop an EV charging app:

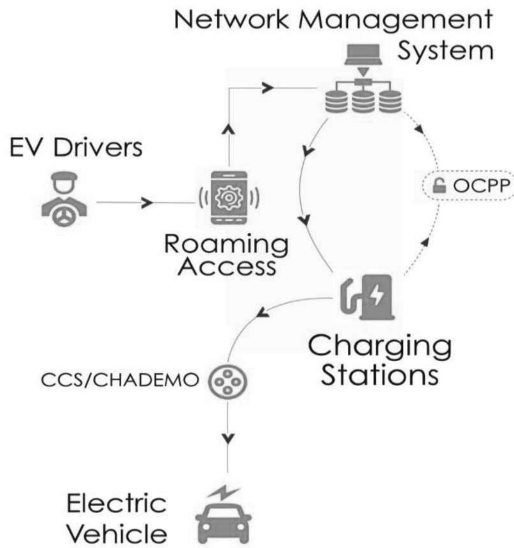
- **Cloud environment:** AWS, Google, Azure

- **Database:** MongoDB, Hbase, MySQL, Cassandra, Mail Chimp Integration, PostgreSQL.
- **Communication Protocol:** OCPP
- **Real-time analytics:** Big Data, Hadoop, Spark, Apache Flink, Cisco.
- **Server:** NGINX
- **Framework:** Laravel
- **Find user location:** Google Places API, Google Maps, Core Location Framework
- **Payments:** Paypal, Braintree, Stripe, EWallets
- **Push Notifications:** Push, Twilio, Amazon SNS, Urban Airship, Firebase Cloud Messaging.
- **MS, Voice and Phone verification:** Twilio, Nexmo
- **Front-end:** ReactJS, HTML, Bootstrap and CSS for web application. Kotlin, Swift, Objective C for mobile applications.
- **Back-end:** Node JS for new micro services and review for existing services, Python and JS

Open Charge Point Protocol (OCPP) for an EV charging station:

It is an application protocol that allows communication between charging stations and their management systems, which is as follows:

- As soon as, the charging station is turned on, the OCPP tries to connect with the management software. The software verifies the identity of the charging station. After successful verification, the IT backend sends a signal to the EV charging station management system to identify its availability. The station responds by providing its current status with the date and time.
- The authorization process begins when a user requests to start the charging. In response to the request, the power supply nozzle is unlocked and plugged into the e-vehicle to start charging. At this stage, OCPP sends another transaction message denoting that the charging process has begun.
- When the user wants to stop charging, identification verification is required again at the charging station through the mobile app. When the Stop Transaction message is sent to the station, the charging is stopped and the user is ready to leave the charging station.



Standard and Secure EV Charging Process with Background Activities:

1. The customer selects the charging station using the mobile app. The map on the application allows users to locate and check the status of charging stations. Available stations display the details, including charging standards (CCS or CHAdeMO), price per minute, location, address, and charging station power. The mobile application also allows reserving the available charger for a specific duration.

2. At the station, the customer plugs the charging pistol into the EV. Once it recognizes the app interaction, it begins to communicate the next steps through the cloud service back end. The user needs to log in using their credentials to get the receipt of charging.

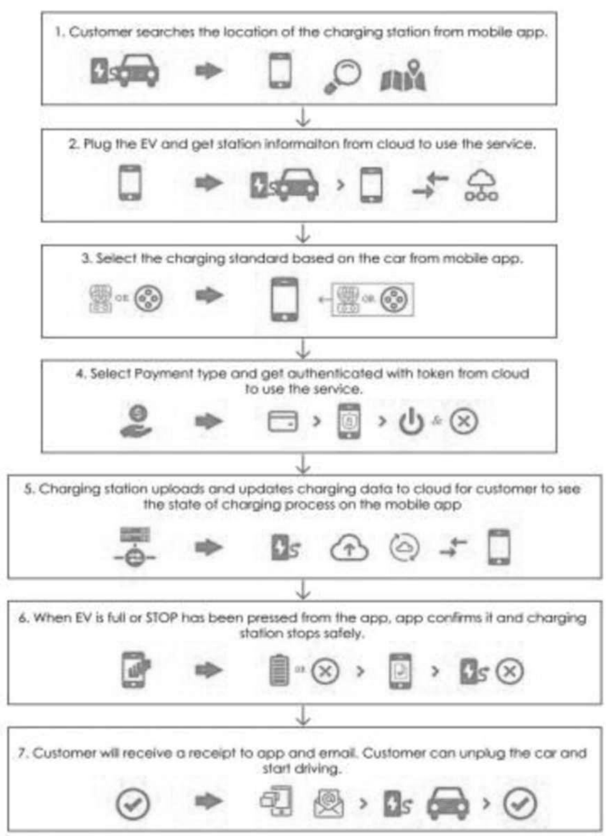
3. Charging stations may offer either one or both CCS and CHAdeMO standards. The users can select the desired charging standard pistol using the mobile app. Besides, if the station provides only one charging standard, the app indicates the available port by app visualization or environment colouring.

4. Payment options depend on the service provider; however, it must support the most common debit, credit cards and UPIs. The payment service provider uses a tokenization procedure to grant the token to accomplish payment. A valid Token provides customers temporary time-based access to start and stop actions of the app. The app sends the action over API to the cloud and then the updated information is displayed to the customer.

5. It takes approximately 10 to 40 minutes to complete the charging process using fast charging technology. Meanwhile, regular updates are provided to the customer. The charging station sends data to the cloud and forwards it to APIs. The mobile application reads the RESTful API Json data and updates the user interface.

6. When charging is complete, or the stop button has been pressed, the mobile app will send an HTTP API request to the cloud back end apply changes to the controller. The controller will lower the current and voltage and indicate to remove it from the EV safely.

7. When the charging is completed, the user will receive a receipt of the charging. It includes energy displayed in kW/h, price per minute, total amount and duration of charging. The start and stop time of charging is recorded and kept for at least ten years due to law regulations. The authentication token is deleted after the charging process is complete.



Introducing Solar PV charging Station: a WBTC case study:

There are 80 Electric Buses currently in West Bengal Transport Corporation (WBTC) fleet. 75 are running in Kolkata and 5 are running (from Digha depot) within Midnapore. Tata Motors has supplied all the 80 Electric Buses along with 80 nos. grid connected DC EV Chargers in 2018-19.The chargers make Tellus Power from Hyd.There are 60 slow Chargers (60 KW @80A) and 20 Fast Chargers (120KW @160A). [1]

Presently, buses at Depots are charged overnight using Slow Charger (5-6 hrs) and also charged in between trips at Terminuses (and nearest depot) with Fast Chargers [1-2 hrs depending on 'state-of-charging' (SOC)].

Objective of WBTC is to increase frequency of e-Buses trips (150-180 Kms per bus/ day) across Kolkata and suburbs with more Solar powered EV Charging station installations at all terminuses and augment fast Charging facilities at all Depots on Solar. At times when buses are not charging during the day, Depot power requirements may be met with the generated solar power. In case of adverse weather condition, when Solar Power will not be sufficient, power can be drawn from the utility grid. [7]

Costing Solar PV Charging Stations:

For a 120KW Fast DC Charger, a solar PV power plant of 150kWp capacity (with 0.8 Power Factor) can meet the purpose. Considering the present benchmark cost of the Govt. of India @Rs.39,080/-per kWp; this cost is applicable for the range of 100kWp to 500kWp PV power plant) comes to Rs.58,62,000/-. The cost of generation of Solar Power is presently in the range of Rs. 1.99 / unit to Rs. 2.49 / unit, which is cheaper than Thermal power. In fact, since the year 2000, Solar Power has become the cheapest source of electricity in India. The RoI is within 4.5years.

Benefits:

With the present charging arrangement, buses are charged through conventional electricity and so at somewhere coal is burnt. Charging through Solar power can be an emission less transport system where both at the point of travel and at the point of charging source, emission is nil. The financial benefits are as following:

Type of Bus	Type of fuel used	Cost (Rs. /km)
Non-A.C	Diesel	35
A.C	Diesel	50
A.C EV	Conventional Electricity	25
AC : EV + PV	Solar	16

Table III: Cost Comparison

Conclusions:

Worldwide countries are fighting for climate mitigation exercises because climate induced calamities correspond to loss of G.D.P. On part of India, it can be an unique opportunity to enhance its G.D.P in the name of aggressive and planned intervention in PV & EV through Export of de Carbonizationto the world. India can act now to prevent the country 35T$ in economic potential of damage in next 50 years due to unlimited climate change. So, more and effective penetration of E-Vehicles with PV Charging and IoT based infrastructure management mechanism will not only reduce fossil fuel dependency, but also , it will lead India's transition towards a Green Economy which can export de-carbonization through technologies like PV,EV and PV-EV combined. Other than organised sector employment, an eco-system for ancillary, maintenance services can also be developed like what has happened for India's top car maker Maruti. India has a distinct opportunity to become the global leader in the upcoming electric vehicle revolution. This will reduce the GHG emissions, enhance EV penetration and will provide new scope of employment to the youth of this country. Converging EV with PV, IT &IoT can ensure best possible penetration for EV in India and India can be the Global Leader in EV in coming days.

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Solar Energy penetration in India: some alternatives

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Background:

Since the Rio De Janeiro Earth Summit in 1992[the first Conference of Parties (CoP)] , the Climate Change has surfaced as one of the worst threat against the very existence of human civilisation in this planet earth.

The Indian Meteorology Department in its 'Climate of India during 2020' report, as released on 04.01.2021 says that the year 2020 was the 8th warmest year in India since 1901.Extreme weather has killed some 1400 people in India in 2020.The Ministry of Health & Family Welfare; Govt. of India in its report in December, 2020 has shown that some 15 lacs of people have died in 2020 in India from Air Pollution.

For the ongoing Covid 19 pandemic, it is further observed that polluted air (where the PM 2.5 penetration is higher) contributes more towards infection and that's why cities (like Kolkata, Delhi, Mumbai, Ahmedabad) with higher air pollution level have become the worst sufferer of Covid spread.

In such a position, the country has taken adaptation [climate resilient agriculture, climate resilient shelter etc] and mitigation strategies to reduce its Green House Gas (GHG) emissions. These are through capacity addition from Renewable Energy and phase-wise replacing the fossil fuel driven transport system by electric vehicles.

In 2015, India had fixed up the target to add 175 GW of Renewable Energy [RE] in its grid. At the recently concluded COP26 in Glasgow[Nov.,2021], India has said that by 2030, it would elevate its renewable power capacity to 500 GW from 150 GW today, and that it would meet 50% of its energy requirements from renewable energy. So, we are in the middle of an unprecedented expansion in the renewable energy sector. As for solar energy, between 2014 and 2021, India has increased its capacity 15-fold. The government now aims to increase the 2020 installed solar capacity of 37 GW three-fold by 2022, to a staggering 270 GW —even more. India's noble ambitions for solar energy, clearly, are soaring.

In the above said background, the large scale solar energy programmes is reviewed and some alternatives are suggested here.

Capacity versus generation:

The Paris Climate Accord, targets: 'reducing the GHG emissions at 33 to 35 % below of 2005 emission intensity level of GDP [unconditional] and 'non-fossil fuel share of cumulative power generation capacity of 40% by 2030 [conditional].' These exercises are aimed to limit the global temperature rise within 1.5 degree Celsius by 2100.

The Paris Climate Accord, 2015 has targeted through the Nationally Determined Contribution [NDC] in terms of cumulative installed capacity. But, if it is linked with GHG emission reduction, it is to be linked with electricity consumption. Very clearly, instead of GW , it is to be linked with MU .Generally, generation of electricity from coal sources involves GHG emissions in the tune of 830 gms / unit and consumption of water @ 3 liters / unit. So, temperature rise of the atmosphere is linked with GHG emissions. So, if the real target is to keep the atmospheric temperature rise within 1.5 degree celcius, it is to be linked with electricity consumption.

The present scenario is as following:

Name of energy source	Presently percentage in terms of its contribution to total installed capacity in India	Presently percentage in terms of its contribution to total energy generation in India
Coal	69%	71.90%
Large Hydro	11%	11.3%
RE excepting large hydro	19%	9.30%

[source: Central Electricity Authority, December,2021]

So, to achieve 50% of electricity generation from RE sources involve change of existing Transmission & Distribution network, policies and regulations.
The present strategy and ownership mechanism:

Name of energy source	**Presently percentage in terms of its ownership by government organisations**	**Presently percentage in terms of its ownership by private organisations**
Coal	62.44%	37.56%
Large Hydro	**92.57%**	0.07%
RE excepting large hydro	0.044%	**95.56%**

[source: Central Electricity Authority, December,2021]

Why alternatives : So, it is clear that RE development, especially in Wind and Solar is taking place in private sector and the opposite is there for large hydro projects. For large hydro projects, inundation of habitation and agricultural land is involved and for large scale solar, destruction of the eco-system for the so called waste land is involved. So, a critical review and a judicious balance is needed.

Alternatives:

State specific target: In the NDC, there is a national target. But, there is no state specific target. So, the implementation / achieving RE capacity addition, especially solar is not actually linked with the RE potential of different states. For ensuring climate responsive development in this regard, state specific potential assessment and implementation strategies are to be formulated.

Tapping the degraded land with agrovoltaic: For land use in respect of Solar projects, instead of using existing barren or wasteland, judicious utilisation of unused land at industrial parks, (transmission, distribution) sub-stations and agro voltaic application for degraded agricultural lands [nearly 11 million hectares] can protect the ecosystem and can potentially transform the rural economy of these regions.[source : The report of The Alliance for Reversal of Ecosystem Service Threats: The Hindu : 31.12.2021]

PV with storage: In Energy transition, the pace of grid capacity penetration is concerned, the RE capacity addition is taking first than the grid is enhancing its capacity. So, storage is inevitable. Storage like pumped storage with PV can be an option. We must think about, more storage options.

PV with EV: For reducing the GHG into the atmosphere, the government has introduced the Electric mobility mission. For Electric vehicles, it does not emit anything at the point of transport. But, so far, mostly it charges through conventional fossil fuel based electricity. So, coupling the EV with PV and IoT can be a greener solution. So, more and effective penetration of E-Vehicles with PV Charging and IoT based infrastructure management mechanism will not only reduce fossil fuel dependency, but also , it will lead India's transition towards a Green Economy which can export de-carbonization through technologies like PV,EV and PV-EV combined.

Other than organised sector employment, an eco-system for ancillary, maintenance services can also be developed like what has happened for India's top car maker Maruti. India has a distinct opportunity to become the global leader in the upcoming electric vehicle revolution. **India can be the Global Leader in EV in coming days.**

Building Integrated Photovoltaic:

So far, Renewable energy targets are concerned; these are linked with Rooftop, Ground Mounted and Floating Solar plants. But, the facade, front opening of the buildings remain unutilized for Soalr generation. On other hand, as a large part of India including West Bengal has hot and humid climatic conditions, a balance is needed to optimise the simultaneous allowance of day light and heat to a building.

At this juncture, Building Integrated Photovoltaic [BIPV] is introduced at different parts of this world including India. Through BIPV, heat entry in a building is restricted sizably and electricity is also generated. So, it is more useful than Solar PV for hot and humid climatic conditions like that in West Bengal.

BIPV system has many unique features - (a) unique design that can yield more than 126% energy as compared to regular vertical BIPV, (b) it can be combined with thermal insulation to limit energy loss and regulate the inside temperature, (c) it gives clean electricity for use in HVAC and Lighting, (d) it is highly customisable in materials, shape, colour, dimensions for giving a one of its kind appearance of the building. A perfect integration can be done both vertically and horizontally.

Conclusions:

The scale of India's solar energy ambition, and the pace it has set to achieve this, certainly merit closer examination, particularly from an ecological standpoint, since the strongest argument in favour of these projects is environmental. We must therefore ask: how do we reconcile the putative benefits of power generation with potential ecological and human costs? With the present article, it is expected discussions can be initiated in this comparatively less discussed matter.

Bio-Diesel and the Environment

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Abstract

Biodiesel, the environment friendly fuel, extracted from renewable materials can be produced locally in any parts of our country and can provide local economies with a new market for their agricultural products and waste, reducing industry's disposal costs. Agro-industry residues such as slaughterhouse waste, restaurant cooking oil, non-food-grade virgin oil or agricultural surplus once destined for a landfill is a commodity in the biodiesel business. Biodiesel can be used with some precautions in diesel engines in many sectors including on-road vehicles, off-road mobile equipment and vehicles and stationary equipment. Biodiesel is mixed with diesel to create a blend. This blend is comprised of pure biodiesel, also referred to as B100 (100 % bio fuel), blended with petroleum diesel at varying concentrations. This write-up briefly discusses the use of Bio-Fuel and its impact on environment.

Introduction

On a national level, biodiesel incorporated in the energy mix will encourage new business opportunities, greater investment, employment, and provide a new energy alternative as well as leads to the energy independence at the every corners of the country. Biofuels like ethanol are the only tool readily available that can begin to address the challenge of energy security.

Biodiesel acts like a mild solvent and has a cleansing effect. It "cleans out" sediments formed over time in equipment and storage fuel tanks which can cause occasional filter plugging, especially in the early stage of switching from petroleum diesel to biodiesel blends. However, when it is used in low concentrations, such as B5 (5% biofuel is added with diesel), it should not cause major issues. Biodiesel-powered engines have been found to deliver similar torque and horsepower as diesel-powered engines.

Analysis

Like petroleum diesel, biodiesel can form crystals in cold weather which can lead to filter plugging. Laboratory tests show that a biodiesel blend forms crystals at a higher temperature than petroleum diesel. Actual experience with cold weather operations is influenced by many factors including the type of feedstock used as some types of biodiesel form crystals at lower temperatures than others, depending on the feedstock and characteristics of the fuel.

Potential solutions to cold weather problems are similar to those for petroleum diesel. They include using fuel additives and engine block or fuel filter heaters and storing vehicles in a building.

Several studies have shown the successful use of biodiesel blends in cold weather up to a certain low concentration. It is important for the fuel provider to choose the right biodiesel formulation, and the fuel blend level is adjusted, to meet the recommended temperature specifications for the season and region of use.

As we know plants store carbon in their roots, shoots and leaves. As a result, the world's plants and the soil in which they grow contain nearly three times as much carbon as the entire atmosphere. Plants use carbon dioxide during photosynthesis, the process whereby the plant converts the energy from the sun into a chemical carbohydrate molecule. Plants use this carbon chemical to grow. Once the plant's life cycle is over and it decomposes, carbon dioxide is formed again to return to the atmosphere and begin the cycle anew. What is the source of Carbon in Plants? Some of this source of carbon in plants is used to create healthier specimens and some is converted into carbon dioxide and released into the atmosphere, but some of the carbon is locked into the soil. This stored carbon helps to combat global warming by binding to minerals or remaining in organic forms that will slowly break down over time, aiding in the reduction of atmospheric carbon. Global warming is the result of the carbon cycle being out of synchronisation due to the burning of coal, oil and natural gas in large quantities and the resulting vast amounts of gas released from the ancient carbon stored in the ground for millennia.

A group of the agriculturists opined that, there is a huge imbalance between the carbons lost by ploughing up acers of agricultural land from the benefit we get from biofuels. "Carbon debt" embedded in any biofuel, which is going to end up as carbon dioxide in the atmosphere when we cut it down. Diverting food crops into fuel production leads to ever more land clearing as well.

Conclusion

The studies do find some benefit from biofuels but only when planted on agricultural land too dry or degraded for food production. Further we must approach to understand the entropic relations between burning of fossil fuels and use of biofuels with respect to the climate changes. The choice of sustainable climate friendly, location specific methodologies and use of technologies are yet to be developed by us.

Towards a doable and conducive Solar Energy Policy for West Bengal

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Introduction:

In nineties, solar energy programme was stated in West Bengal. These were solar home lighting systems, solar street lighting systems, solar water heating systems etc. Then, such systems were installed at un-electrified areas or at areas where the grid was not dependable. Through Rajiv Gandhi Gramin Vaidutikaran Yojana (RGGVY) and later on through Deendayal Upadhyaya Gram Jyoti Yojana, India has achieved 100% village electrification by 2019. Now, the target is to provide grid quality electricity at affordable cost and in environment friendly manner.

The Govt. of India has introduced National Action Plan on Climate Change (NAPCC) in 2008 which includes National Solar Mission. Since then, the focus of solar energy programme was shifted from limited hours' electricity supply source at un-electrified areas to one of the major power source at steady grid areas. Objective of such programmes has become different like enhancing capacity in energy mix in the grid as utility installation and reducing electricity bill of the consumer for rooftop installation.

After the Paris Climate accord, 2015, the target is to limit the global atmospheric temperature rise within 1.5 degree celcius by 2030.Temperature rise leads to severe climate catastrophes like cloud burst, flood, landslides, super cyclones. The sixth assessment report (August, 2021) of Inter-Governmental Panel on Climate Change (IPCC) records 1.09 degree celcius warming on average in last 10 years in this planet whereas for Kolkata, the recorded temperature hike is 2.66 degree celcius. The 2020 cyclone Amphan which has devastated Kolkata has been identified as the deadliest one in respect of damage of properties and resources in recent past. In such a position, appropriate mitigation (change of existing fossil fuel based energy sources) and adaptation (climate resilient technology applications) measures are required.

In 2012, West Bengal has introduced its first Renewable Energy policy. Since then, the energy scenario has changed completely across the globe and in India also, as already mentioned above. After 2015 Paris Climate Accord, India has declared its Nationally Determined Target [NDT] for capacity addition in terms of Renewable Energy. In 2009, West Bengal has installed the country's first Megawatt level Solar PV Power Plant at Jamuria. But, as compared to overall RE penetration, West Bengal, at present is not at a comfortable position. Here, in this article, some points are discussed towards formulation of a doable and conducive Solar Energy policy.

Land use for Ground Mounted project:

The popular perception about utilizing land for Ground Mounted Solar projects is using the so called barren land or waste land. Since last 4/5 years experts have published studies which indicate that aggressive use of such land may be disastrous for the ecology and environment. They propose for land specific agriculture and its coupling with Solar PV in the name of agrovoltaic. In such a position, we propose some alternatives.

Utilisation of unused lands of industry and at road dividers: West Bengal has many industries like Steel plants etc. who have unused land. Lands are there at Industrial Growth centres.WBSEDCL and WBSETCL has substation which have surplus land. At different states the road dividers are used for PV installation. A policy is required to make it clear about installation of Ground Mounted PV Power Plant as an industry application in the unused land of such industries.

Floating Solar: West Bengal has water bodies across the state. Some floating solar installation is already done by the generation company WBPDCL at water reservoir (as used for cooling of thermal power station).The distribution company WBSEDCL is in the process to install Solar PV Power Plant at the water body at Mukutmonipur. But, such exercises are discrete as compared to availability of water body in West Bengal.

An appropriate assessment of floating solar potential at different water bodies is needed with a Standard Operating Protocol [SoP] to ensure minimum damage to the marine ecosystem and marine life.

Solar Energy coupled with PV Charging Station:

India's Green House Gas (GHG) emissions reduction strategies are linked with enhanced Renewable Energy and electric vehicles in a time bound manner. Steps are taken for e-bus penetration, e-two wheeler penetration, Performance Based Incentive schemes for indigenous manufacturing of battery, motor in India, developing more road side Charging Stations etc.The Department of Power, Govt. of West Bengal in its 2019 notification has covered the EV charging station. Solar PV can be incorporated here.

The Kolkata Municipal Corporation has already amended its building by laws where it is mentioned that for approving any new building plan requires provision of Charging Station at each house hold for charging of electric vehicles. Different state governments have launched Electrical Vehicle Policy in 2021 with core objective to phase out fossil fuel based vehicle by 2030.

The proposed roadmap is as follows:

- Deployment of more E.Vs
- Conversion of 100% of Public Bus fleet into electrical buses
- All Government vehicles to be converted to E.V.

For early user adoption and enabling ecosystem, some proposed policy incentives:

- 100% exemption on Registration Charges.
- 100% exemption on Road Tax for Solar Powered EV charging
- 90% exemption of Electricity Duty on E.V. Charging Stations.
- 100% waiver on Parking Charges for Solar Powered EV charging

For manufacturing of E.V. or their components, following Manufacturing Based Incentives (MBI) are proposed:

- Capital Subsidy
- Power Subsidy
- Interest Subsidy
- Income Tax Exemption
- GST / SGST reimbursement
- Employment Cost Subsidy
- Stamp Duty reimbursement.

Hybrid Solar (Rooftop + Ground Mounted + BIPV) for urban residential complexes:

From available data, it is observed that household consumption of electricity in West Bengal is sizeable. So special attention of RE policy in this regard, is proposed here.

a. It is proposed that the Solar Photovoltaic Power Plant with appropriate capacity can be encouraged to cater the entire energy consumption required for the common area. The energy requirement at the common area consists of same for lighting, lift and pump. For example, the capacity of the Solar Power Plant to cater the entire electricity requirement of the common area is say 50kW. So

50kW capacity will be allowed.

b. In addition to above, for internal residential consumption: 10% of the connected load may be allowed for PV Power Plant. For example, if a residential complex have 10nos. of flats and each flat has 5KW of connected load, so total connected load of the complex for internal domestic consumption stands for 5KW x10nos.=50KW. Here 10% will be allowed means 10% of 50KW means 5KW can be allowed.

c. In West Bengal, most of the places have hot and humid weather condition. When light is allowed inside the building, at the same time heat is also entered into the building. So for such cases when optimum utilization of day light is required, it enhances the ambient temperature of the building. Then the air conditioning load of the building enhances. So, while decreasing the electricity consumption for lighting, electricity requirement for air conditioning increases. In case of Building Integrated Photovoltaic, it allows only lighting to pass on and restricts heat to enter into the building. So, for such case, air conditioning load of the building does not enhance. So, for a state with mostly hot and humid weather condition, BIPV may be an ideal application which produces electricity and its installation takes place at areas where normal Solar PV installation is not possible. It is proposed to have no upper cap for BIPV (Building Integrated Photovoltaic) application.

d. **No upper cap for PV for charging of Electric Vehicles(E.V)**

An exclusive scheme for cold storage and commercial shades:

The MNRE, Govt. of India has introduced Solar Powered cold storage scheme. In this line, the Government of Chhattisgarh has introduced a scheme. West Bengal has potential in this sector. The following propositions are suggested:

a. The existing Time of the Day [ToD] meter may be replaced by ToD Net-meter.
b. 50% of the contract demand may be allowed for rooftop PV
c. No upper cap for BIPV (Building Integrated Photovoltaic) application.

Third party selling of Renewable Energy: DISCOM as RESCO

On 16th August, 2021: The Ministry of Power, Govt. of India has issued draft Renewable Energy Open Access Regulation.

Green energy Open Access.- The Appropriate Commission shall put in place regulations in accordance with this Rule to provide Green Energy Open Access to consumers who are willing to consume the Green energy. All applications for open access of Green Energy shall be granted within a maximum of 15 days.

Provided that only Consumers who have contracted demand/sanctioned load of hundred kW and above shall be eligible to take power through green energy open access. There shall be no limit of supply of power for the captive consumers taking power under green energy open access.

Provided further that reasonable conditions such as the minimum number of time blocks for which the consumer shall not change the quantum of power consumed through open access may be imposed so as to avoid high variation in demand to be met by the distribution licensee.

It is matter when the consumer, owner of the group may involve a developer in the name of Energy Service Company/Renewable Energy Service Company (RESCO) etc. Here, the RESCO will have one agreement with the consumer to sell the power. With all practical proposition, for enabling this proposed regulation, like the private players [M/s Tata Power Solar: they are solar power developer and Distribution company also at different states] **,** government owned DISCOMs can also play the role of a developer or RESCO.

Change of DISCOM mindset and approach of Regulators

Historically, in India, the electricity distribution was started with diesel power. Then it was shifted to Coal based thermal power. Now, days have come for Solar and Wind power. But, DISCOMs in general consider Soalr Power as a threat to their existence. This mindset is required to be changed to meet the present day ground reality. Rather considering it as threat, it is to be considered as an opportunity to grow business. In last 2 years, all the major thermal generation companies like Coal India, NTPC, Adani Power have started large scale solar energy programmes. So, the same is inevitable for DISCOMs.

At distribution companies like WBSEDCL, CESC etc some terminologies are used for providing electricity connection, deciding tariff of a consumer etc. These terminologies are not exactly relevant for deciding the capacity of Solar PV power plant. For example, if the connected load of a consumer is 3kW and it is operational for 10 hours a day; the monthly electricity consumption of that consumer comes to 900kWh (3kWp X 10hrs. per day X 30 days in a month.). Other than hilly area of West Bengal annually 1300 kWh of solar electricity is generated from each kWp of PV power plant. So, monthly it is average 108 kWh. In the regulation for net metering of WBERC, valid upto 31.12.2021, 90% of electricity consumption of a consumer can be adjusted through Solar PV generation. So for the present case, maximum upto 810kWh of solar electricity can be adjusted in a month for the present consumer under discussion. So to produce 810 kWh of solar electricity in a month; a 75kWp Solar PV power plant is required to be installed. So for a connected load of 3kW, as per WBERC regulation, 75 kWp PV power plant is to be installed to have maximum adjustment of electricity bill of a consumer through Solar power generation, as per regulation.. So the connected load (the terminology of Distribution Company) is not directly relevant to the capacity of installation for Solar PV.

The DISCOM has a popular myth that when any consumer applies for Solar Net metering, DISCOM charges for load enhancement. This is absolutely not required for reasons as detailed in the above paragraph.

In India, on an average 31% is the Accumulated Technical and Commercial (ATC) loss of a DISCOM. Whereas, the PV generation is used by the consumer and fed to the grid at the point of generation. This corresponds to zero ATC loss.

When the surplus solar power is fed to the grid of DISCOM, the DISCOM enjoys this power against no investment on their part. This is because such plants are developed by consumers at their own cost.

The WBERC has given the generic tariff of RS.3.12which makes the RESCO (Renewable Energy Service Company) model non-viable.

The WBERC has fixed up the wheeling charges @Rs.1.32 which again makes the Solar developer option as non-viable.

Manufacturing of Solar PV Cell and Module: can **the 'Maruti Story' be repeated?**

In India's total RE capacity, now Solar PV is nearly 35 GW. Present indigenous manufacturing capacity for Solar cells is 2GW annually and it is nearly double for Modules. So, for the sake of Self Reliance or to make India '*Atmonirbhar*' in Solar Energy Sector, India's indigenous cell and module manufacturing facility requires rapid capacity addition. These new manufacturing units can create larger employment opportunity, both in formal and informal sectors. This can ensure the re-creation of earning sources to the distressed people, till recent past who were totally dependent on coal mining for their income.

Such recent initiatives of Adani Green, Tata, Vikram, Loongi etc can be compared with that of India's top car maker. For Maruti, along with the car maker an entire range of ancillary industry also comes into reality. Here, for Solar also, elevating local manufacturing can create an ecosystem of suppliers for solar cells, modules, spares etc. This can open scope for more employment in both formal and non-formal sector. Otherwise RE transition benefits will be limited to low salary, in organised sector jobs only.

To reduce our emissions to meet the un-conditional goal of Paris Accord, India has introduced National Hybrid Electric Mission where time bound more penetration of Electric Vehicle is coming as a reality. Almost 40 % of total cost of an EVehicle goes to its battery. Presently, these batteries are coming mostly from China. In this context, the Govt of India is preparing the advanced chemistry cell battery manufacturing policy. It is now in the final stage. Here also, a growth of ancillary industry is expected which can create more employment.

Proposal points in summary:

1. The existing renewable energy policy is to be revisited with changes like land use pattern for utility scale Solar Energy projects, EV charging with PV, exclusive rooftop scheme for cold storage, commercial shade, hybrid(rooftop +ground mounted +BIPV) Solar system for residential complexes, DISCOM as RESCO etc.
2. Optimum capacity utilization through net metering instead of restricted PV capacity is to be encouraged through conducive regulation.
3. Open access regulation for RE generator for directly feeding of RE based electricity to consumers.
4. Land Bank for utility scale RE projects using surplus, unutilized land of industries, industrial growth centres, electricity transmission and distribution substation.
5. Incentives for agricultural and residential consumers for RE installation.
6. Manufacturing based incentives for RE and EV manufacturing.
7. Convergence of Renewable Energy with storage and energy conservation for optimum reduction of Green House gases. In this process Green building, Green campus, Green complex, Green mall, Green office: through converged approach of RE, Storage and conservation such things can be created and it is in present day terminology be treated as net zero. Low interest financing for such initiative may be considered.
8. 2011, Census of India points out that 10 to 11% of urban population (mostly in slums) do not have access to grid quality electricity. So they use fossil fuel based energy sources for their primary energy need which corresponds to GHG emission to the atmosphere. So distributed solar power can be an ideal solution for this population. The same is for roadside vendors.
9. MSME Sector is one of the largest consumers of the electricity and with marginally higher tariff. May facilitated a solar potential mapping study in the MSME Sector.
10. Revisit of time zone for ensuring optimum utilization of daylight.
11. Doable RPO target with penalty provision.
12. Low property tax or direct rebate for initial 5years or upto 10 yrs. for RE developers, manufacturers, integrators etc.

West Bengal was a pioneering state in Renewable Energy development in India. Due to lack of appropriate policy initiated, infrastructure and failure to reach the change scenario West Bengal could not maintain its leading position in Renewable Energy in this country.

Now with the change global scenario, time has come to start afresh. In such a position pragmatic and doable policy are required to meet the Global challenges and also to make up the existing short falls.

In light of above, in the present paper some not to discuss issues are covered to facilitate the appropriate harnessing of Renewable Energy potential of the state of West Bengal, so that West Bengal can be one of the pioneering states in RE development in this country.

POWER GENXT ● Volume 10
Published on the day of 10th National Seminar ● 9th January, 2022
Published By: Er. Soumen Das, General Secretary (CEC)
Engineers' Welfare Forum, WBPDCL, Bidyut Unnayan Bhaban, 3/C, Block-LA, Sector-III, Bidhannagar, Kol.-106
Editor: Er. Manojit Kumar Basak ● Printed by: Millennium Graphics, Kolaghat, M. 9732748288