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Socio-Economic & Environmental Challenges of Thermal Power Plant with Measures to Mitigate the Same in Indian Scenario.

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Abstract :- This paper tries to explore the socio economic impacts of coal based thermal power stations of two major power stations in Maharashtra State i.e. Chandrapur Super Thermal Power Station & Bhusawal Thermal Power Station by studying three parameters on which the basis of Socio Economic Effects can be analyzed. The study also extends to environmental impacts of BTPS and CSTPS in the premises of the plants and surrounding villages up to a radius of 20 km from the plant.
The three socio economic parameters studied are Rehabilitation and Resettlement (R&R), local civic amenities and work related hazards to employees of the power plants in these power plants. The objective of this paper is to quantify these impacts in order to understand them better, to understand the challenges faced by India on these aspects and analyze the climate concerns in India, the effect of carbon emissions, deciding on whether India's economy would improve by reducing carbon emissions or not, various challenges faced by India like the availability of water as a national resource for the working of TPS in the near future & socio economic impact of non-availability of water.
The paper concludes giving energy strategy for the future in the form of reforms in the energy sector, giving thrust on development of renewable energy sources like wind power projects so as to get clean and green energy.
Keywords:- CBTPP (Coal Based Thermal Power Plant), AAQ (Ambient Air Quality), BTPS(Bhusawal Thermal Power Station), CSTPS (Chandrapur Super Thermal Power Station), CSR(Corporate Social Responsibility), R&M(Renovation & Modernization), PAP (Project Affected Person), MPCB(Maharashtra Pollution Control Board).

I INTRODUCTION

To begin with we have tried to analyse the energy needs of India for the next two decades and existing and projected generation scenario of CBTPS. An analysis of GHG gases, their effects, steps needed to reduce GHG emissions, mathematical approach to decide on whether reducing GHG emissions would be economical for India or otherwise are described. The impacts of CBTPS based on Rapid social assessment report of five villages located from BTPS at a distance of 4 to 20km and of villages in the vicinity of CSTPS is studied. Then the environmental impactsi.e. air pollution, water environment pollution based on statistical survey of three years, occupational health and safety hazards of BTPS are studied.

II ENERGY SCENARIO OF INDIA

A. Sources of Electricity Generation

Are Shown in the table 1 shows the scenario of electric generation and thermal fuel demand by resource, based on average annual GDP growth of 9 % is seen. The oil demand includes secondary fuel oil required for power generation.[1,3] From the enclosed table for electricity generation based on different energy sources, it is seen that thermal energy accounts for 80.32% of the total generation for year 20011-12 with Hydro, Nuclear and Renewable sources contributing to 12.74 %, 5.84 % and 1.01 %. The situation for the 15th five year plan for the year 2027-2032 would be 82.19 % contribution by Thermal energy sources, 8.92 % by Hydro, 8.35 % by Nuclear and 0.53% by renewable energy sources.

Table I

Year	Electricity Generation (TWh)	Hydro (TWh)	Nuclear (TWh)	Renewable (TWh)	Thermal (TWh)	Thermal Fuel Demand		
						Coal (MT)	NG (BCM)	Oil (MT)
2003-04	592	74	17	3	498	318	11	6

2006-07	724	87	39	8	590	379	14	6
2011-12	1091	139	64	11	877	521	21	8
2016-17	1577	204	118	14	1241	678	37	10
2021-22	2280	270	172	18	1820	936	59	12
2026-27	3201	335	274	21	2571	1248	87	15
2031-32	4493	401	375	24	3693	1659	134	20

Source : Planning commission -2006

From above table it is seen that the annual requirement for coal is the highest as compared to the annual requirements for oil or gas. According to the Planning Commission scenarios, coal based capacity of utility plants is likely to be in the range of 200- 400GW in 2030 up from 68GW in 2005. With the large no. of CBTPS expected to go online, annual coal consumption in the power sector is projected to be in the range of 380MT-500MT by 2011-12 & 1 BT by 2031-32(CEA, 2004a, Planning Commission 2006). The projected high growth of coal power has significant implications for India's GHG emissions. Given coal power's rate of growth, it will continue to be the major contributor to carbon emissions from the country.

B. Green House gases, their effects, steps to be taken to reduce GHG emissions

Green house gases are generated by the combustion of fossil fuels i.e water vapors, carbon dioxide, methane. These gases capture the heat radiated by the earth's surface back to the atmosphere leading to a phenomenon named global warming. This causes an increase in the earth's surface temperature. In nature plants absorb the CO2 which is a major GHG but due to de-forestation, situation is very acute. The only way is to reduce GHG emissions [4]. It is estimated that by year 2100, on a worldwide average, the temperature would rise by 1-3.5 Deg C & global MSL would rise by 15-95cm. This would cause problems like loss of habitat in low lying areas, problems in agriculture which is an important economic sector. It would lead to extreme weather conditions like hot or cold spells of temperature, wet or dry spells of rainfall, cyclones or floods.

The challenge for India is to strike a balance between increase in coal power growth on the one hand and the need to address climate issues on the other. It needs to identify a target or limit for GHG gases so that climate does not change. It can also think of concentrating on greenhouse gas sinks instead of actual GHG concentrations. Some of the other activities that can be undertaken are a forestation, use of energy efficient equipment. It is found that an incandescent lamp of 60W gives CO2 emission of 65gm/Hr& a CFL uses 1/4th the energy used by incandescent lamp of 15W while it gives 16gm/Hr CO2 emission. There should be widespread awareness and proportional activities regarding energy conservation practices. We could resort to non-conventional energy sources like wind projects, solar projects etc., using supercritical pulverized coal technologies with higher efficiency, using pollution control technologies like flue gas de-sulphurises [5].

C. Mathematical approach to decide between reducing carbon emissions or otherwise

Analysis of climatic concerns based on evaluation of two parameters i.e. Costs of reducing carbon emissions[2] till 350 ppm (CR)and costs incurred for not reducing carbon emissions (CN)was a recent research activity carried out . If CN> CR, then reducing carbon emissions would have a negative impact on India's objectives of development and eradicating poverty, else if CN< CR, then reducing carbon emissions would have a positive impact on India's objectives and India should aim to reduce carbon emissions. According to a study released by group Economics of Climate Adaptation-ECA [Swiss Re, McCaskey's Co, Climate works, the European Commission, Rockefeller Foundation & Standard Chartered Bank make up the ECA working group], under climate scenarios, the climate related disasters can result in 19 % loss of India's GDP by 2030 i.e.CNis19 %. The value of CR is 2.3 % of GDP. The difference costs of CN - CR = 16.7 % of GDP i.e. India would actually save 16.7 % of GDP subjected to the reasons presented above if it aims at reducing the emissions. These savings can be used for economic development and reducing poverty and hence social problems.

III SOCIO – ECONOMIC ASPECTS BASED ON RESETTLEMENT AND EHABILITATION (R&R), LOCAL CIVIC AMENITIES & WORK RELATED HAZARDS TO EMPLOYEES OF POWER PLANTS

A. Rapid Social Assessment

This section describes the study of the Socio Economic effects based on Resettlement and Rehabilitation of project affected people in the vicinity of the plant by conducting RSA of 13 villages situated within a radius of 10 km from the Bhusawal Thermal power station. In paper the RSA report of 1 villages is given Bhusawal TPS – Sample Survey Report Village Gahukheda(about 20km from plant) With the joint effort of MSPGCL Bhusawal TPS and the social institute Chandrapur, BTPS undertaken the Project for Rapid Social Assessment. Village Gahukheda is a small village having population of 1700. Only one Anganwadi,one primary school, 6 MahilaBachat Groups are active, they are doing therefore their betterment.Under the above project, , Socio – Eco survey of 32 families have been taken with the help of Sarpanch, Grampanchayat members and the

respected persons of this village discussion started with specialist As per the group discussion held with people, when BTPS was started in 1962 expectation of people was that villagers will get employment, sufficient electric supply and compensation. Peoples expectation were not fulfilled in any way and again the second phase of BTPS started in 1982 and till date they are deprived of help. As per the discussion held with people, they have given some feedback which is given as below in Table-II.

Table-II

Sr. No.	Losses due to Establishment of Power Station	Feedback
1	Fly ash harms the living beings and they are affected with skin diseases and constant burning of eyes	Tree plantation programme to be carried out.
2	Crops of banana, sugar cane and others are spoiled by constant spill of ash and its productivity is lesser.	Formulate a mechanism for an adequate grievance redress process.
3	Water pollution is so high that it has become difficult to get fresh drinking water	Fresh drinking water arrangement to be made.
4	On health of cattle due to pollution of air, water and fodder	Awareness programme to be carried out through social activity. Permanent dispensary should be made available to PAP.
5	Facilities like road, sanitation, electricity has been increased but the Grampanchayat cannot afford it.	To work towards key factors that promotes community development – Health, Education, Drinking water, Peripheral development etc.
6	Health facilities and emergency facilities not available	Permanent dispensary should be made available to project hazard people and 24 Hrs ambulance facility should be made available.

Benefits due to establishment of power station

- Due to the BTPS, commercial and industrial work has been increased and developed.
- Sufficient supply of electricity.
- Education facilities are increased.
- Transport facilities are increased.
- Project hazard people are getting compassion.

B. CSR Vision

To actively contribute to the social and economic development of communities. In doing so to build a better, sustainable way of life for society and raise the human development index.

1) CSR Objectives:-

a) Measure for community development in the neighbourhood areas of thermal stations with emphasis on vulnerable community's viz. women, children, disable persons and aged persons.
b) Attempts towards socio-cultural integration.
c) Effective delivery of community development programs.
d) To work towards key factors that promotes community development – Health, Education, Drinking water, Peripheral development etc.

2) CSR Approach:-

The environmental and social aspects relate to the following concerns:

The Social concern: Safety, Health, Education, Natural calamity, Direct and indirect employment for local labor, Sports and cultural programs.

The environmental concern: Environment Management plan, Energy efficiency and conservation, Cremation center for nearby villages, motivating formers for fly Ash utilization of Health check up camps have been regularly organized at nearby villages by CSTPS authorities shown in Table-III

Table-III

Health Camp Date	Name of City	No. of Persons checked	Types of disease observed
27.11.2009	Durgapur	600	Hemoglobin, Blood pressure lungs Test, Eye disease & Cataract, Anemia Respiratory disorders and skin disease.
28.11.2009	Urjanagar	550	Hemoglobin, Blood pressure lungs Test,

			Eye disease & Cataract, Anemia Respiratory disorders and skin disease.
29.11.2009	Khairgaon	550	Hemoglobin, Blood pressure lungs Test, Eye disease &Cataract, Anemia Respiratory disorders and skin disease.
30.11.2009	Ambhora	500	Hemoglobin, Blood pressure lungs Test, Eye disease & Cataract, Anemia Respiratory disorders and skin disease

Following programmes completed in CSTPS through corporate level.

a) Irrigation facility
b) Sanitation
c) Pollution control
d) Animal care
e) Promotion of Sports & Games
f) Promotion of Art & culture
g) Construction of community canters
h) Imparting vocational training
i) Setting of skill development canters
j) Scholarship to meritorious students
k) Entrepreneurship development

3)Environmental Impact on account of Coal Based TPS:-

Environmental monitoring is carried out at BTPS on a regular basis at the locations specified by the MPCB and the same is reported to the Board regularly.

IV .STACK EMISSION

The statistical stack emission monitoring of BTPS units 2 & 3 for the years 2007-08, 2008-09 and 2009-10, carried out by Environ Engineers, are shown below. (Fig - 1 to 5). From the charts it is seen that the SPM levels are above the MPCB prescribed limits for the unit 2 for the three years 2006-07, 07-08 and 08-09 & within the prescribed limits for unit 3 for years 2006-07 & 07-08 & above the prescribed limits for year 2008-09. The NOx emissions of Units 2 and 3 are above prescribed limits for all three years.
The SO2 emissions of units 2 and 3 are well below prescribed limits for all three years.

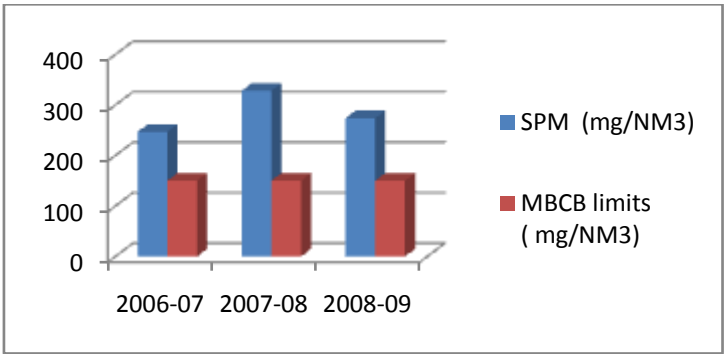

Fig-1*:* Stack Emission (Particulate Matter) (U2)

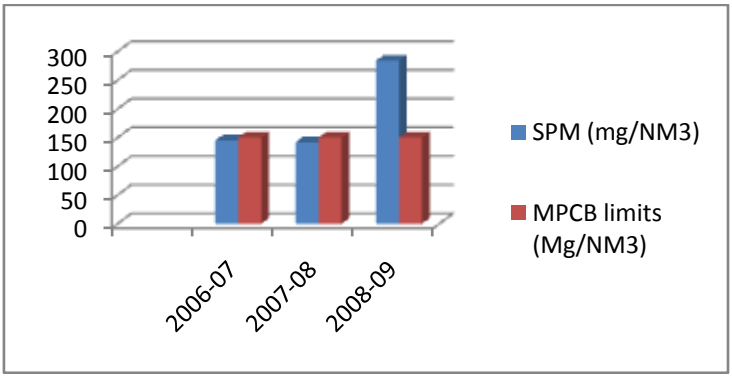

Fig-2: Stack Emission (Particulate Matter) (U3)

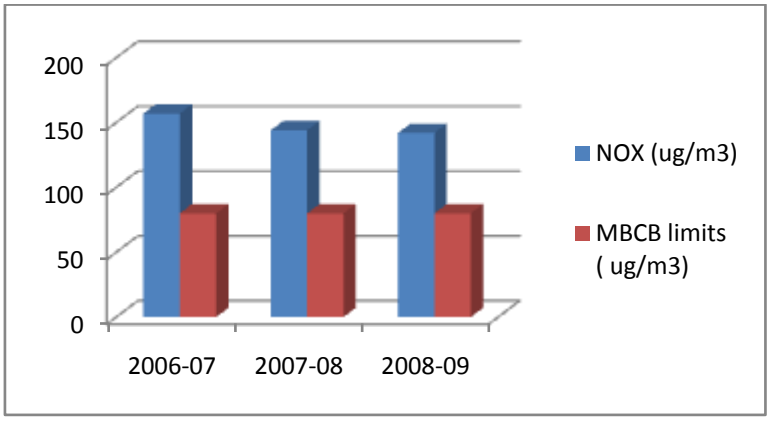

Fig- 3: Stack Emission (NOx) (U2)

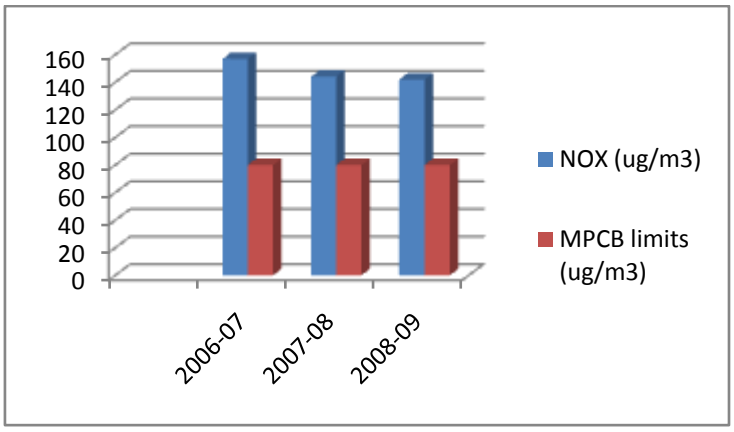

Fig- 4: Stack Emission (NOx)(U3)

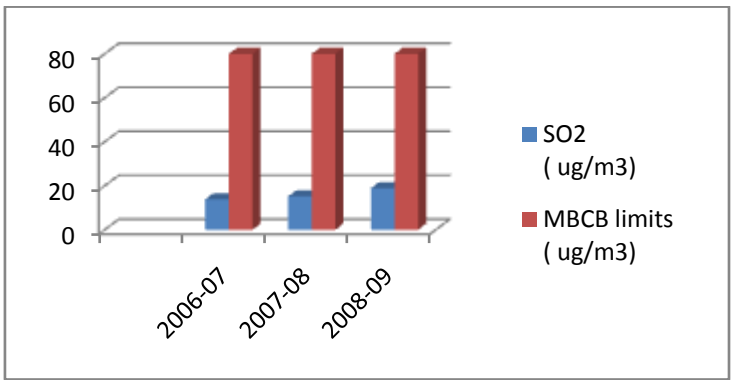

Fig-5: Stack Emission (So2) (U2)

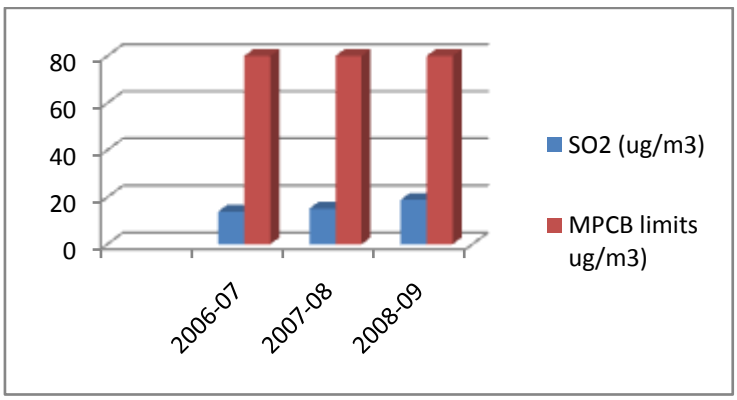

Fig- 6: Stack Emission (So2) (U3)

BTPS has ESP as pollution control equipment for control of stack emissions. ESPs of Unit 2 and Unit 3 were designed prior to the implementation of the air act. Now ESP modification work will be carried out in the R&M of unit 2. Ammonia Injection system which dozes ammonia at ESP inlet at each pass proposal is being worked at. This reduces the SPM levels.

V AMBIENT AIR QUALITY

Air pollution is the presence of one or more air contaminants e.g. dust, fumes, smoke, gases, mist dour. The air pollutants are emissions from suspended particulate matter (SPM), oxides of Nitrogen (NOx) and Sulphur Dioxide (SO2) which are primary air pollutants. Fly ash is generated as a byproduct of coal combustion arising along with gases in the form of finely divided non combustible particles and has particle size between 1-1000 um & can be air borne if it is less than 1-20 um and settle able particles are more than 10 um.

VI EFFECTS OF AIR POLLUTION

TABLE-IV

Name of Air Pollutant	Effect
Particulate matter (SPM)	Visibility of air is reduced, is more harmful in the presence of gaseous pollutants& affects respiratory system
CO	CO in blood affects hemoglobin. The CO absorbed by the lungs reduces the O2 carrying capacity in the bloodstream and visual discrimination is decreased.
HC	Eye irritation
Pb	Anemia defects, brain effects
NOx	Respiratory disorders

Hence AAQ is regularly and scientifically monitored at various locations as prescribed by the PCB and resultant AAQ is compared with national AAQ standards if air quality is affected or not. Pollution Standard Indices for each pollution is calculated from the equation

Pollution standard Index =	Observed value of pollutant	x 100
	Prescribed Standard	

TABLE-V

PSI value of all parameters	Quality of air
0-50	Good
51-99	Moderate
100-199	Unhealthy
200-	Bad

National Ambient Air Quality Standards (NAAQs)

TABLE – VI

Pollutant	Time weighted average	Concentration in air (ug/m^3), Industrial areas
Oxides of Nitrogen (NOx)	Annual average	80
Sulphur Dioxide (SO2)	Annual average	80
Suspended Particulate Matter (SPM)	Annual average	100
Respirable Particulate matter particle size	Annual average	120
Lead (Pb)	Annual average	1
Carbon Monoxide (CO)	Annual average	4

From the PSI values of all the parameters, the AAQ of BTPS for the above three years is between moderate and good.

VII HEAT LOSS DUE TO PARTIAL COMBUSTION

In the furnace, Coal with the help of oxygen is burnt for heating water to generate steam. To ensure proper utilization of coal i.e. to produce maximum heat, plant need to control Air to Fuel ratio. If enough air is not present or the fuel/air mixture is insufficient, then the burning gases are partially cooled below the ignition temperature and the combustion process remains incomplete. The flue gas still contain unburnt components mainly carbon monoxide CO, carbon C (soot) and various hydrocarbons CxHy. The Carbon Monoxide content in the flue gases is a good indicator of incomplete combustion. We shall now quantify the effects of Heat loss due to partial combustion

CO formation (Mco) = CO (in

Mf = Fuel consumption in kg/Hr =	148638
Heat Loss per hour = Mco x 5744 =	3585862
Generation per day for one 210MW unit in MUS =	5
Sp. coal consumption in kg/Kwh =	0.8
Coal Required per day in kg =	4000000
Coal CV in kcal/Kg =	3000

ppm) x 10^{-6} x Mf x 28
Coal lost per in kg /H = 1195.28734
Coal lost in kg /day = 28686.896
Coal cost per kg in Rs 3.5
Hence the amount lost per day due to coal lost will be Rs. 100403.52
Amount lost per year in Rs .= 36647284.8
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Amount lost per year in Rs.= 36647284.8
This shows that by optimizing combustion the heat loss due to partial combustion can be avoided and subsequently the loss of fuel can be saved.

VIII WATER ENVIRONMENT IMPACT AT BTPS

Waste water sources in Power Station.: Use of water is always accompanied by generation of waste water. Wastewater characteristics depend on its source. Such waste water cannot be discharged in to the environment around a Thermal Power Station, as they can affect the quality of receiving water or land soil. Hence they have to be treated to meet pollution board criteria. Effects of waste water discharges on land & soil & methods of treatment are given in the table-VII

Table VII

S. N.	Waste Water	Effects		Method of treatment
		Water	Land	
1	WTP	Addl. turbidity	Water logging	Settling, decantation & reuse of supernatant.
2	DM/ Softener Plants	Increase in acidity /alkalinity	Ground water contamination	Dilution, neutralization
3	CT Pond blow down	Increase in algae	Water logging	Destruction of algae/ dilution & reuse for ash handling
4	AHP/CHP	Siltation	Water logging	Settling, decantation & reuse of supernatant for ash handling
5	Sewage	Biological pollution	Soil sickness, ground water contamination	Biological treatment for removal of organic matter, disinfection and reuse for ash handling

Water sources in CBTPS & its characterizes

Table VIII

S.N.	Source	Characteristics
1	Water Treatment Plant (WTP)	High concentration of suspended solids (SS)
	Clarification	"
	Sedimentation	"
2	Demineralization plant	
	Regenerant washes from cation exchanger	Highly acidic. Total dissolved solids
	Regenerant washes from anion exchanger	Highly alkaline. Totaldissolved solids
	Regenerant washes from softener	Saline water
3	Cooling tower blowdown	High TDS, algae, pH
4	Boiler Blowdown	High S.S
5	Colony waste water / sewage	High organic matter, S.S, disease causing microorganisms
6	Ash Handling Plant	High S.S
7	Coal Handling Plant	High S.S

Pollution parameter (MPCB consent limit in mg/lit) except PH	Qty of pollutants in discharge kg/day	Concentration of pollutants in discharge mg/lit	% of variation from prescribed standards
PH	—	7.4-8.5	Within limit
Suspended solids	71	40	Within limit
Copper	0	0	Within limit
Zinc	0	0	Within limit
Chromium	0	0	Within limit
Phosphate	0	0	Within limit
Oil & Grease	0	0	Within limit
Chloride	—	0	Within limit
Iron	0	0	Within limit

Effluent recovered through ETP & reused for ash disposal in this period (kL) : 1281395
% of ETP recovery = 90.99
This effluent water cost = Rs 13,326,508

At present BTPS is complying with the standards prescribed by the MPCB for the effluent discharge and the actual values are well within limits. A full fledged sewage treatment plant is under operation and the effluent discharge from this plant is meeting the Consent Condition.

A. Analysis Reports of water sample

Table - X

Parameters	**IS : 2296 Class "C" limits**	**Sample 1**	**Sample 2**	**Sample 3**	**Units**
Physical parameters					
Colour	300	1	1	1	Hazen units
Chemical Parameters					
pH	6.5-8.5	7.8	7.9	7.4	_
Total dissolved solids	1500	800	780	790	mg/lit
Total hardness	$	492	384	394	mg/lit as CaCO3
Calcium	$	93.8	89.3	116	mg/lit as Ca
Magnesium	$	62.4	60.1	48.4	mg/lit as Mg
Iron	50	<0.03	<0.03	<0.03	mg/lit as Fe
Chlorides	600	82	87	80	mg/lit as Cl
Sulphates	400	76	68	73	mg/lit as SO4
Nitrates	50	0.98	1.25	1.36	mg/lit as NO3
Cyanide	0.05	<0.01	<0.01	<0.01	mg/lit as CN
Fluorides	1.5	1.2	1	1.2	mg/lit as F
Phenolic compounds	0.005	<0.001	<0.001	<0.001	mg/lit as C6H5OH
Metals/ Heavy metals					
Lead	0.1	<0.005	<0.005	<0.005	mg/lit as Pb
Cadmium	0.001	<0.008	<0.008	<0.008	mg/lit as Cd
Arsenic	0.2	<0.01	<0.01	<0.01	mg/lit as As
Selenium	0.005	<0.005	<0.005	<0.005	mg/lit as Se
Mercury	$	<0.001	<0.001	<0.001	mg/lit as Hg
Sample 1 : Well at bottom of old Ash bund no 1					
Sample 2 : Well at bottom of Velhala Ash bund no 22					
Sample 3 : Well in Asara temple near Ash bund					

The surface water is analyzed and compared with the drinking water standards IS 2296 Class ”C” limits for any variations. It is found that all the parameters are within limits.

B. Ground Water Analysis

Table – XI

Physical-Chemical & Heavy Metal Parameters	**Results**	**Units**	**IS:1050 limits**
Color	Colorless		
pH.	7.1		
Turbidity	2	NTU	6.5-8.5
TDS	424	mg/lit	500
Total Hardness	200	mg/lit as CaCO3	300
Calcium	11.18	mg/lit as Ca	75
Magnesium	80.31	mg/lit as Mg	30
Iron	nil	mg/lit as Fe	0.3
Chlorides	221.1	mg/lit as Cl	250
Sulphates	58.2	mg/lit as SO4	200
Nitrates	3.4	mg/lit as NO3	45
Fluorides	0.001	mg/lit as F	1
Phenolic Compounds	0.005	mg/lit as C6H5OH	0.001
Cyanide	0.003	mg/lit as CN	0.005
Arsenic	0.007	mg/lit as As	0.01
Cadmium	nil	mg/lit as Cd	0.01
Lead	nil	mg/lit as Pb	0.05
Mercury	0.001	mg/lit as Hg	0.001
Selenium	0.004	mg/lit as Se	0.01
Manganese	nil	mg/lit as Mn	0.1

The ground water analysis also shows that all the parameters are within limits.

IX SOLID WASTES

TABLE-XII

Description	**Total Qty (MT)**	**Total Qty (MT)**
	2007-08	2008-09
1.From process		
Slag Ash	200304	141549
Fly ash	801216	566194
Total ash generated	**1001520**	**707743**
2. From Pollution control facilities	500	600
3. Qty recycled or utilized at ETP	1200	1500
Disposed	Nil	Nil

The fly ash is utilized by local brick manufacturers, cement manufacturers and by the cultivator for up gradation of soil in the agricultural field.Some solid waste from STP is used as manure in the gardens developed in the premises of plant and colony.

Utilization of Ash (Average on yearly basis)

TABLE-XIII

Year	**Agricultural use (MT)**	**For brick manufacturing (MT)**	**For land filling & other (MT)**	**Cement (MT)**	**Total**	**%**
2007-08	28312	333869	1917	245018	609116	60.82
2008-09	11144	242277	959	263605	609116	74.8

A. Ash Disposal

1. Both fly and slag ash is being disposed to Velhala forest valley since Sept 1993. Thus pollution in the Tapi river on this account is totally stopped.

2. At Velhala ash bund area 115 hect land acquired and construction of additional bund is completed.

B. Green belt development

Massive tree plantation programTable-14 is taken up in the power station as well as around ash bund area. This has resulted in the formation of green belt around the plant as well as Velhala Ash Disposal area.

TABLE - XIV

Particulars	Plant and Colony
No of trees planted during 2008-09	9200
Expenses incurred (Rs)	686900

X RECENT STUDIES CITED

Radio elemental characterization of fly ash from CSTPS, Maharashtra[6]It says natural radioactivity due to the presence of 40K,238U and 232Th was measured in the fly ash emissions collected from CSTPS plant, which indicates an elevated concentration of these radionuclide's that may provide an exposure pathway through inhalation of air borne ash and could probably cause severe environmental and human health problems.

Coal ash is more radioactive than for nuclear waste, published in Scientific American : The fly ash emitted by a power plant carries into the surrounding environment 100 times more radiation than a nuclear power plant producing the same amount of energy. Fly ash uranium sometimes leaches into the soil and water surrounding a coal plant, affecting crop land and, in turn, food. People living within a radius of 0.8-1.6km radius of a coal plant's smoke stacks might then ingest small amounts of radiation. Fly ash is also disposed of in landfills and abandoned mines and quarries, posing a potential risk to people living around those areas. The result: estimated radiation doses ingested by people living near coal plants were equal to or higher than doses for people living around nuclear facilities.

XI OCCUPATIONAL HEALTH AND SAFETY ASSESSMENT

Mahagenco is committed to achieve its Environmental, Health and its safety mission and has established a Corporate Environment Health and Safety Unit (CEHSU) to be responsible for its EHS policy. In this regard Mahagenco has instituted a dedicated safety department at BTPS which is responsible for addressing the policy, undertaking and implementing the measures for achieving the set targets with regard to safety and reporting its performance to higher management.

A. Safety analysis

The performance of the plant with respect to the safety has been analysed for the last three years. No of accidents(both of contract labors & BTPS employees) have reduced by 0.22% & 0.98 % in the year 2010 from 0.33% & 1.10 %in year 2008. This is due to improved awareness among the employees about safety procedures.

The cause of accidents based on Unsafe Act & Unsafe Condition. Unsafe acts may be defined as the actions of a worker in a manner which may vary from the accepted or legislated safe practice and create a hazard to themselves, another person or equipment. Unsafe condition is a conditions in which something exists that varies from a normal accepted safe condition, and if not corrected, could cause injury, death or property damage.

B. Worker Awareness and Involvement

While the top management is ultimately responsible for health and safety issues of the workers, the workers also play an important role in ensuring successful implementation of EHS policy. The EHS policy recognizes awareness building through training and other means of communication as an important contribution towards successful implementation of safety policy.

Personal protective equipment (PPE) are useful in reducing injuries to workers due to hazards.PPE such as shoes, helmets, goggles, belts and masks have been provided for the workers at BTPS. The list of the PPE to be used is maintained with the safety department. The workers and contractors have been communicated about the type of PPE to be used based on the nature of the work activity. The management has initiated efforts for ensuring increased use of PPE by the workers by denying entry to the workers without using safety shoes and helmets.

C. Training

In house annual training calendar indicating annual training & awareness programs schedule is maintained by HR department. OH & S specific program in the annual calendar for the year 2015-16 are Disaster Management Plan, Awareness about heart disease, Awareness about hypertension, Stress management, Awareness about diabetes, Awareness about asthma, awareness about occupational diseases and health, use of safety and firefighting equipment. Training for the use of portable fire extinguishers is imparted to the staff at their location by actually making use of the extinguisher. This goes on throughout the year.

D. Periodic Health Check up of Workers

Medical checkup of plant employees have been carried out periodically. The records of medical examinations are maintained by Medical Superintendent & his team. Workers have been trained in first aid and designated as Trained First Aiders. First aid boxes are kept at various sections and inspected / refilled periodically. The relevant records for periodic checkup and supplies refilling are maintained in the dispensary. Two ambulances are provided with basic first aid supplies.

Comprehensive documentation with regard to classification of diseases based on occupational exposure was not found in place.

E. Safety Drills

Safety / mock drills with regard to acid leak, chlorine leak, fire and Disaster Management Plan are conducted periodically to check the preparedness of the emergency response system, records of which are being maintained at the safety department.

F. Work Permit System

The work permit system is a formal written statement used to control certain type of potentially hazardous activities. It is also a means of communication between site management, operators and workers enabling coordination among various activities to ensure safe working environment. The work permit system does not make the job safe, but helps in ensuring that proper consideration is given to the risks , and they are dealt with prior to commencement of the work.

G. Environment, Health and Safety Policy

The EHS policy of the erstwhile MSEB has been displayed at multiple locations in the plant in English as well as the local language.

XII HAZARD IDENTIFICATION AND RISK ASSESSMENT(HIRA)

As hazard identification and risk assessment helps an organization in identifying, evaluating and controlling of OH & S risks, hence contributing to making the workplace safer. To effectively manage the health and safety of its employees, it is necessary for an organization to

- Identify any potentially hazardous situation which may cause injury, illness or disease in workplace on ongoing basis (Hazard identification)
- Assess the likelihood of each of the hazardous situations occurring (Risk assessment)
- Identify and effectively implement appropriate control measures to prevent the occurrence of such hazardous situations (Risk control)
- Review measures continually to ensure their effectiveness.

A. Hazard mat and Management

A classification of hazardous areas into 5 distinct areas 1. Chemical Hazard 2.Fire and Explosion Hazard 3.Terrorist Hazard 4.Natural Calamity and 5 Strike is done at BTPS.

Chemical Hazard Table – XV

Storage Area identified	Details of material	Safety Precautions taken
WTP plant	Acid Alkali Storage Tanks	1)Dike wall is built around the Acid / Alkali storage area Extra care is taken while handling corrosive material. 2)The personal protective equipment are being used while handling
Chlorination Plant	1) Hydrochloric acid (33%) stored in 4 Nos of internally rubber lined MS tanks of capacity 2 Nos 35MT each 2 Nos-28 MT each 2) Caustic soda (45%) stored in 2 Nos , 35 MT/ Each tanks No 25 MT/Ta	1)Every precaution is taken while dozing chlorine. 2) Only trained staff is authorized to carry out the operation. 3) Emergency kit and mask is kept near main entrance of the building and at main gate of the plant. 4) The chlorine gas absorption and evacuation system which operates automatically when limit exceeds 5 ppm. 5) Two nos of repairing kits are provided for a attending leakages. 6) Lime pit is provided for neutralizing the gas leakage, if any.

Fire And Explosion Hazard - Table-Xvi

Storage Area identified	Details of material / Work	Safety Precautions taken
Coal yard	Crushed coal is transported to bunkers through conveyor belts.	1) Fire hydrant is provided through out the CHP, which is charged for 24 Hrs. 2) Monitor system is installed around crushed coal yard. 3) Water spray is provided on conveyor belts. 4) Fire extinguishers are kept in Control room. 5) Static water tank is also provided in CHP.
Near Stage II units	1)FO tank : 2 Nos having 1500 kL capacity 2) LDO tank : 1No having 1360 kL capacity	1) Dike wall is constructed . 2) FO tanks are provided with foam protection and sprinkler system & also LDO tank is provided with sprinkler system. 3) Water monitors are installed around dike wall.
Cable galleries	Cables	1)Smoke detection system is provided 2) Fire hydrant points are provided throughout the plant. 3) The portable fire extinguishers are kept at all strategic locations.
	Welding / cutting work	1)Instructions for safe working are issued to all staff involved in work.
Hydrogen Cylinders situated outside the main plant	Hydrogen gas cylinders	1)All cylinders are tested for hydrogen purity. 2) Cylinders having purity above 99.9% are only accepted. 3) In generator cooling system, H2 pressure is maintained to 3.5kg/cm2 and purity is never allowed to fall below 99.8%. 4) As flammability limit of H2 gas is 4 to 75 % (by volume in air), there is no possibility of fire as purity is maintained above 99.8%. 5) In H2 plant , 20% H2 leak alarm is provided & on 80 % leak concentration compressor trip interlock is provided. 6) Empty cylinders are kept separately from filled cylinders.

terrorist hazard - TABLE-XVII

Area identified prone to disaster	Details of anticipated terrorist activity	Security measures taken
Boiler House	1)Bomb threat and bomb explosion	1)Strong security arrangement at all entry points to the power stations.
TG area	2) Parcel bomb or suspected parcel/ letter bomb	2) Information to district administration to take appropriate security action
Plant Control Room H2 plant, Chlorination plant		3) Only authorized person entry to the plant complex
Oil Handling plant		4) Close watch on suspicious unattended vehicles, persons around the complex
Raw Water Pump House		5) Prompt communication and information system
Residential area		6) The incident controller would be the Security officer

Natural calamity Hazard - TABLE-XVIII

Area identified prone to disaster	Measures taken
A) Earthquakes	1.Statistical and scientific study of occurrence .
1)Chimney and other tall structures	2. Equipment design after site specific studies taking

2) Boiler and its structures. 3) TG building, various floors, foundation of various equipments 4) Control room 5) Transmission towers and substation area 6) Coal Handling Plant crushers, crusher building, conveyor belts, coal bunkers B) Storms and Floods	into account stipulations of the various codes / standards on the subjects. 3) The incident controller would be the Executive Engineer(Civil Maint) , Welfare Officer
1) Any or all parts of the power station 2) Basement / underground facilities 3) Cable trenches 4) Coal handling plant underground conveyors , coal unloading systems	

Strike Hazard - Table-XIX

Area identified prone to disaster	Safety measures taken
Any of the sections in a power plant area	1 The incident controller would be Dy. Chief Engineer and Superintendent Engineer. 2. Well documented emergency plans. 3. The Plant Level Emergency Management Group (EMG) will have responsibilities a) to direct actions within affected area taking into consideration the priorities for safety of plant personnel; minimize damage to plant, property and environment. b)Direct fire and security for immediate action. c) To ensure that all non essential workers/ staff in the affected area evacuated to safer places. d) Set up communication points. e) Report all developments and requirements / assistance needed. f) Preserve all evidence so as to facilitate any inquiry into the cause and circumstances which caused or escalated the emergency. g) To co-ordinate with District administration for necessary finance, medical, law & order etc.

Firefighting services are available round the clock at the power station. Though all steps are taken for the safety of the plant, there is possibility of any untoward incidence occurring. In such emergency situation, it is necessary to handle the situation systematically to minimize loss to human life and property.

XIII ON SITE EMERGENCY MANAGEMENT / THE DISASTER MANAGEMENT PLAN

Takes care of any emergent situations that may surface and required safety precautions to avoid any untoward loss to life and property. On site, emergency team is formed to handle such situation with clear responsibility of each member in addition to normal duties.

Emergency preparedness and response plan has been displayed at various locations. Emergency telephone nos have been displayed at several locations

XIV ENERGY STRATEGY FOR THE FUTURE

- There should be reforms in the energy sector such as passing of a regulation which cuts anti-competitive behavior i.e. to allow private companies to own power plants and generate electricity as Independent Power users while giving lucrative incentives to them. This will result in a new dimension of electricity which would be treated like any other commodity that can be generated, sold and traded in the market as determined by the supply and demand.
- Significant financial constraints for new technologies in power sector in India are lack of private sector investment in the Indian private sector since the foreign investors continue to perceive Indian power projects as risky investments because of failure of IPP policy, the continued losses of the SEBs, high T&D losses and other factors.
- The various policy options to improve the efficiency in all elements of the power system like measuring of plant efficiency routinely.
- To carry out energy audits to assess their efficiency levels
- renovation and modernization of old units with focus on pollution control rather than technologies specifically improving the efficiency
- Use of better quality coal including washed coal to improve TPS efficiency, tariff based incentives to improve efficiency of plants
- Follow best practices to mitigate GHG emissions, reduce T&D losses, energy conservation measures, using super critical PC technologies to increase the efficiency over the sub critical counterpart.

- Focus on development of non-conventional energy sources like increase in the contribution of photovoltaic & wind based power plants to the total generation so as to get clean and green energy. The new technology area in wind power turbine is the recently patented bladeless wind turbine, which is based on a patent issued to Nikola Tesla in 1913.
- This wind turbine is christened as Fuller Wind Turbine.[7]The specialty of this turbine is that it has only one rotating part, known as turbine drive shaft and no moving blades. The entire machinery is assembled in housing. This turbine has a screened inlet and outlet. If you try to get a closer look at this wind turbine the only movement visible is as it adjusts to track the wind.
- Another advantage is that it is expected to deliver power at a cost at par with the coal fired plants. The lifetime operating costs are lower. Since the generating equipment are kept at ground level maintenance is easy.
- The key factors governing wind power economics in the country are capital costs, O&M costs, turbine life and the discount rate that reflects the cost of capital.
- Wind power obviously has negligible fuel costs, even if the cost of using conventional fuel for back up is included. Turbine prices in India havebeen consistently lower than the global average on account of the lower labour and production costs.
- The Indian Renewable Energy Development Agency (IREDA) is the most favorable agency for renewable projects at national level, provides project finance and equipment manufacturing. Its lending rates vary from 11.25% per annum to 11.9 % per annum and that for manufacturing is 12.75 %, bothwith a repayment period up to 10 years.
- In the last FY budget, government announced setting up of a clean energy fund by I projects including wind.
- Wind power projects can also benefit by registering their projects under the Kyoto Protocol's Clean Development Mechanism (CDM). According to industry experts, CDM benefits result in an improvement in the project internal rate of return of 0.9 to 1.3% for wind projects.
- But coming to a negative aspect of giving subsidies to such projects, some measures should be adopted to ensure that the subsidies are not being misused and measurement of benefits to economy accrued against subsidies given should be done in the long term. The power players should be accountable for the energy production and if not as per commitment, there should be a suitable mechanism for the recovery of costs.

XV CONCLUSION

Through this paper we have tried to explore the Socio Economic& Environmental Aspects of CBTPS i.e. impacts on air and water environment pollution and measures to mitigate them and also the occupational health and safety hazards of TPS.

Before implementation of coal based projects more and more studies related to socio economic aspects and how the environmental issues are to be mitigated are required to be carried out, if India is to achieve economic development and fulfill its development goals.

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