

Strategies to Mitigate the Influence of Power Generation on Environmental Pollution

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Abstract- All forms of electricity generation have an environmental impact on our air, water and land. The emissions caused by electricity generation vary across the country due to many factors, including how much electricity is generated, Electricity generation technologies used, and Air pollution control devices used. Ours is a country of one billion plus people with fast growing economy, our requirement for power is ever increasing. To meet our power requirement, we need to establish generating stations which could be conventional, like thermal power, hydro power, nuclear power and non-conventional, like wind power, tidal power or geo-thermal power. Conventional power stations play much bigger role in power generation but give rise to lot of atmospheric contamination and cause air, water and land pollution. Environmental pollution arising out of different types of power stations and strategies to control the pollution has been discussed in this paper.

I. INTRODUCTION

Electrical energy is the backbone of economy of any country. The production of energy is vital to economy. Ultimate source of energy is the sun. Cost effective technology to extract energy from the sun is yet to be developed. Non-conventional sources of energy, like wind power, tidal power, geo-thermal power, etc., are being gradually tapped for meeting our requirements. But the uncertainties with generation of power by non conventional energy sources compel us to lay major emphasis on generation of power by conventional means. Thermal power generation, hydro electric power generation and nuclear power generation are commonly adopted ways of generation electric power. Table 1 presents the installed capacity of different types of power stations in our country.

Nuclear power stations pose a threat to human life because of nuclear radiations. Hence the nuclear power can not contribute much which can be seen from table 1. We are finally left with thermal power and hydro-electric power generation. Thermal and super-thermal plants are located along the coal belts and are responsible for environmental pollution. The problem of pollution starts with the production of coal itself. Blasting operations produce large clouds of dust. This becomes one cause of pollution. Ash content of coal is another problem. Thus on one side we get electric power and on the other side we come across pollution problems.

Hydro-electric power stations are considered to be the cleanest source of power generation. But they pose problems of different type. Hydro-plant reservoir submerges huge area, uproots large population and creates social and other problems. By and large, whichever types of power stations are developed, we will have to sort out major problems of environmental damage including air pollution, water pollution and land pollution.

The link between economic progress and environmental conservation came up in several international forums. These issues were exclusively discussed at the United Nation's World Conference in Stockholm on Human Environment in June in 1972. In her address in this conference, Mrs. Indira Gandhi, the then Prime Minister of India had said that 'poverty is the worst form of pollution – the inherent conflict is not between environment and development but between environment and reckless exploitation of earth's resources by man in the name of development.

Installed Capacity as on	Thermal (MW)				Nuclear (MW)	Renewable (MW)			Total (MW)	% Growth (on yearly basis)
	Coal	Gas	Diesel	Sub-Total Thermal		Hydro	Other Renewable	Sub-Total Renewable		
31-Dec-1947	756	-	98	854	-	508	-	508	1,362	-
31-Dec-1950	1,004	-	149	1,153	-	560	-	560	1,713	8.59%
31-Mar-1956	1,597	-	228	1,825	-	1,061	-	1,061	2,886	13.04%
31-Mar-1961	2,436	-	300	2,736	-	1,917	-	1,917	4,653	12.25%
31-Mar-1966	4,417	137	352	4,903	-	4,124	-	4,124	9,027	18.80%
31-Mar-1974	8,652	165	241	9,058	640	6,966	-	6,966	16,664	10.58%
31-Mar-1979	14,875	168	164	15,207	640	10,833	-	10,833	26,680	12.02%
31-Mar-1985	26,311	542	177	27,030	1,095	14,460	-	14,460	42,585	9.94%
31-Mar-1990	41,236	2,343	165	43,764	1,565	18,307	-	18,307	63,636	9.89%
31-Mar-1997	54,154	6,562	294	61,010	2,225	21,658	902	22,560	85,795	4.94%
31-Mar-2002	62,131	11,163	1,135	74,429	2,720	26,269	1,628	27,897	105,046	4.49%
31-Mar-2007	71,121	13,692	1,202	86,015	3,900	34,654	7,760	42,414	132,329	5.19%
31-Mar-2012	112,022	18,381	1,200	131,603	4,780	38,990	24,503	63,493	199,877	9.00%
31-Mar-2017	192,163	25,329	838	218,330	6,780	44,478	57,260	101,138	326,841	10.31%
31-Mar-2018 ⁽⁴⁾	197,171	24,897	838	222,906	6,780	45,293	69,022	114,315	344,002	5.25%

Table 1 Growth of Installed Capacity in India

A committee was set up by the Govt. of India in the same year to co-ordinate environmental issues. 42nd amendment of constitution took place in 1976 for ensuring environment protection. Subsequently, major policies have been framed to devise strategies, schemes and regulations for protection of environment to ensure sustainable development. Our main focus in this paper has been on suggesting the remedial measures to reduce the environmental damage that can be caused by (i) Thermal power stations, (ii) hydro-electric power station and (iii) nuclear power stations. Finally, we shall discuss about the global protocols related to environment protection and National policies for preserving the environment.

GENERAL IMPACT OF INDUSTRIES AND POWER HOUSES ON ENVIRONMENT (RAJASTHAN AND SURI, 2009) :

Industrial units and thermal power houses release the following pollutants into the air: (i) Sulphur dioxide, (ii) Carbon dioxide, (iii) Carbon monoxide, (iv) hydrogen sulphide, (v) chlorine, (vi) nitrous oxide, (vii) arsenic, (viii) ozone and (ix) ash and number of other gases. Suspended particulate matter (SPM) in the form of fine dust and soot is also emitted by thermal power stations and industries.

II. IMPACT OF POLLUTANT

1. Soot emission from cooking stoves and coal burning furnaces has profound climate effects. Soot emission causes absorption of sunlight, heats up the air and makes the atmosphere more unstable.
2. Carbon dioxide emission from automobiles and power plants continually builds up in the atmosphere and is the primary driver of global warming.
3. Ozone at ground level proves toxic for plant growth, harms health and irritates eyes.
4. Carbon monoxide has an affinity with hemoglobin. It enters the blood stream and replaces oxygen from hemoglobin to combine with it. This leads to concentration of carbon dioxide in the blood stream. This causes headache, eye irritation, nausea, breathing problems, unconsciousness and death.
5. Carbon dioxide and nitrous oxide belong to the basket of 6 greenhouse gases (GHGs). GHGs are mainly responsible for global warming contribution to the changes in earth's climate.

IMPACT OF POWER STATIONS ON ENVIRONMENT AND SUGGESTIONS TO REDUCE THE IMPACT

Coal is required as the main source of energy and is used in thermal power plants. Indian coal has a low sulphur content of 0.35% but ash content is around 30 to 50%. A modern super thermal power plant with 2000 Mw installed capacity burns 20,000 to 25,000 of coal daily and produces about 5000 to 8000 tonne of ash daily. The large quantities of ash to be handled and its erosion characteristic pose a serious problem in the design of boilers and ash handling plants. The major emissions are smoke, dust, flyash, carbon-ash, CO, CO₂, SO₂ and N₂O. SO₂ gradually oxidizes to SO₃ which in turn interacts with atmospheric moisture and forms sulphuric acid, which is a health hazard.

1. Super critical pressure boilers with 160 kg/cm² 560°C and 90% efficiency are used to reduce the emissions.
2. Particulate emission has to be kept within the prescribed limit to ensure minimum air pollution. Electrostatic precipitators with very high efficiency should be installed with each unit to reduce the particulate to minimum-most level.
3. Ash should be used as land fill.
4. Flyash can be put to proper use. Brick industry has started using mix of clay and ash which has considerably reduced the pressure of ash dumping.
5. Ash disposal line and dumping area should be developed for storage of we ash.
6. Protection of aquatic life.
7. Closed cycle cooling system with cooling towers should be adopted. This will protect the aquatic life from possible hazards.
8. Wastewater management: For processing and making use of the wastewater from various auxiliary plants, wastewater management scheme should be used.
9. Quality of ambient air: Quality of atmosphere surrounding the plant needs to be maintained.
 - (i) Air quality monitoring stations should be installed in the planned area.
 - (ii) Mobile units should be used for inspection of quality in the nearby areas to monitor quality of ambient air during operation of the power station.
 - (iii) Coal handling to control fugitive emissions from coal conveyor system.
 - (iv) Dust extraction and ventilation system should be installed which will control the fugitive emissions.
 - (v) Sprinkler system should be erected to take care of coal dust from the coal stored in the stock pile areas.
 - (vi) Growing of green-belt: Plantation should be done within the plant and nearby area. One tree annually consumes 3.5 tonne of CO₂ and exudes 1 tonne of oxygen. Thus it works as many air conditioners. According to the study of ecologists, 33% of land area (Samanta, 2000) should have forest cover. India is having only 19% cover. We have, therefore, to raise the forest covers as early as possible by adopting large scale afforestation programme.

III. HYDRO-ELECTRIC POWER STATION

Hydro Electric Power station can have a potentially adverse impact on the environment, so care must be taken in the planning and installation stages. As such, it is vital to obtain permission from the Environment Agency before installing a hydroelectricity system. The Environment Agency will not grant permission to a scheme that does not

comply with environmental legislation and has the potential for doing harm to the surrounding area. This applies to small scale installations as well as larger, more invasive operations. There are three main areas where installing a hydroelectric plant can have an effect on the environment:

- The impact on land use.
- The environmental impact on wildlife.
- The impact on emissions.

1. Large Hydro Electric plant that involve the building of a dam, the impact on the use of the surrounding land can be large and significant. The required large area results in destruction and degradation of forest, tree and wild life. This finally leads to heavy soil erosion, erratic rainfall, recurring floods, etc.

2. Large scale hydroelectric will have a huge impact on wildlife, destroying habitats that will need to be replaced when water builds up in reservoirs following the installation of something like a dam. For run-of-the-river systems you need to take into account what the effect the plant will have on water life as well as the impact noise and construction will have on local wildlife. With tidal hydro there are similar concerns, especially as the construction has to be large to generate the power required.

3. Hydroelectric plants, both large and small, are not totally emission free. Small run-of-the-river plants will typically emit between 0.01 and 0.03 pounds of CO₂ per kWh whilst for larger hydroelectric dams the impact is much greater (not to mention the vegetation that is destroyed in the process) at around 0.5 pounds per kWh.

4. Another consideration is the impact that the system will have on the local fish population. Fish which pass through turbines can be seriously harmed, so the Environment Agency will check that you have made provision for this too. This will often take the form of adequate screening before the turbine and the construction of fish passages, which allow migrating fish to bypass the obstruction caused by the system

IV. NUCLEAR POWER STATION

A nuclear power plant starts disturbing the environment during the plant construction. This kind of disturbance, however, is a common problem to any major enterprise, as for example, a non-nuclear power plant. Normal processes of plant construction as well as ancillary operations, not necessarily related to the nuclear nature of the power plant fuel, do disturb the surrounding environment. New roads, increasing traffic flow in the existing roads, excavations, cutting trees and other plants, frightened animals, are some of the environmental impacts to be expected from the construction of a power plant. In the case of a hydroelectric plant a large man-made lake which will replace free-flowing rivers is also to be built. In addition to all those impacts the builders of power plants should minimize, under the guidance of the legally competent authorities, disturbance to any prehistoric petrified plants and animals or to any archeological remains of early civilizations, graveyards, monuments, ruins, aqueducts and so on. Site selection for nuclear power plants should be carefully made to avoid, or minimize to the extent possible, most of those impacts.

- (i) Radioactive contamination of air, soil and water.
- (ii) Thermal pollution due to discharge of cooling water.
- (iii) Deforestation.
- (iv) Radioactive waste-disposal.
- (v) Rehabilitation

EFFECTS OF RADIATION ON HUMAN

The biological effects of radiations on humans depend on: (i) Amount of dose absorbed, (ii) duration of exposure, (iii) sensitivity and recovery of recipient organism, (iv) distribution of active material within body. A whole body dose of about 400 REMs may cause death. A whole body dose of about 200 REMs or exposure of only a few parts

of the body may cause radiation sickness like nausea and intestinal hemorrhage. These effects are curable. A long time exposure to even a small dose leads to delayed effects, like life shortening, leukemia and genetic disorders.

SUGGESTIONS TO CONTROL THE ILL EFFECT OF NUCLEAR RADIATIONS (Gupta, 2008, 2009)

- (i) Nuclear power stations should be located in thinly populated areas.
 - (ii) The recommendation of the international committee of Radiological Protection should be scrupulously followed. For a person who can be employed at the age of say 18 year, the maximum permissible dose is given by the formula:
Max^m Permissible Dose = 5 (N-18) REMs
Where N is age I year,
The implied max^m weekly dose = 0.1 REMs
Maximum permissible accumulated dose during 13 consecutive weeks is 3 REMs. General public should not receive more than 0.5 REMs per year.
 - (iii) The site fence for a nuclear installation should be properly arranged so that the dose will not exceed for persons living outside the fence.
 - (iv) The entry to radiation and contamination zones should be regulated. Proper devices, like film badge and lithium pads should be used to measure the dose received.
 - (v) Adequate shielding has to be provided to guard humans and delicate instruments.
No single material is effective in shielding against all types of radiations. Lead, concrete steel and cadmium are normally used as shielding materials. In nuclear reactors, a thermal shield of several cm thickness surrounded by about 3 m thick concrete is used.
 - (a) Water in concrete slows down fast neutrons.
 - (b) Iron, barium or steel turnings which are mixed in concrete, attenuate gamma rays and absorb thermal neutrons.
- Policies adopted by the Govt. of India for environment protection: (Rajaram and Suri, 2009): India faces environmental challenges on two fronts: (i) Poverty and (ii) economic development.
- (a) Poverty and excess of population compel people to overuse land, water, forests and other resources without giving any thought for future generations.
 - (b) Uncontrolled economic development, urbanization and industrialization are also responsible for deforestation, overuse of groundwater system and pollution of natural resources.

To control the situation with reference to protection of environment, the Govt. of India has taken the matter quite seriously and has taken following steps:

1. It is a signatory to the Stockholm Conference on Human environment (1972).
2. It has established the Central Pollution Control Board under the provision of water (Prevention and Control of Pollution) Act, 1974.
3. It has incorporated environmental concerns in the 42nd Constitution Amendment Act of 1976.
4. It has set up a committee in 1980, for ensuring environmental protection.
5. IT has formed a Ministry of Environment and Forests at the Centre in 1985 for lanning, promoting ad co-ordinating environmental and forestry programmes.
6. It has formulated the National Forest Policy in 1988 and the policy statement for Abatement of Pollution in 1992.
7. It has initiated the programme for biodiversity conservation in 1991-92. The Biological Diversity bill has been passed by Parliament in Dec. 2002.
8. Vehicular pollution is sought to be controlled by prescribing emission norms similar to EU emission standards.
9. It has ratified the Kyoto Protocol in 2001-2002.
10. There are several action plans, like National Wildlife Action Plan, Project Tiger Plan, Conservation of Elephant Habitats, National Zoo Policy, etc., adopted by the Govt. of India.
11. All industrial projects including power stations to be launched need environmental clearance from the 'Environmental Impact Assessment (EIA) Committee. This ensures that there will not be undesirable consequences due to the project which may nullify the socio-economic benefits.

Thus, our country is making all our efforts to protect the environment and we feel assured that the environment will not degenerate further and sustainable development will be possible.

GLOBAL WARMING AND GREENHOUSE EFFECT (RAJARAM AND Suri, 2009)

The earth's climate is driven by solar radiation. In the long term, the energy absorbed from the sun must be balanced by outgoing long wave thermal radiation from the earth and the atmosphere. Part of this outgoing energy is absorbed and re-emitted by radioactive atmosphere gases (greenhouse gases) thereby reducing net emission of energy to space. To maintain the global energy balance, both the atmosphere and the surface will warm until the outgoing energy equals the incoming energy. This is the greenhouse effect.

Six gases, namely, CO₂ (carbon dioxide), CH₄ (methane), N₂O (nitrous oxide), HFCs (hydrofluoro carbone), PFCs (perfluoro carbons) and SF₆ (sulphur hexafluoride) are known as greenhouse gases. We cannot do much about the GHGs which are already in the atmosphere but we can reduce the future emissions.

V. INTERNATIONAL APPROACH

There is a growing concern about the impact of emissions of GHGs on global climate. This has led many countries to enact Environment Protection Act. The brief description of international agreements is given here.

In 1992 first Earth Summit was held in Riode Janeiro (Brazil). UNFCCC (United Nations Framework Convent Change) was signed at Earth Summit in Rio de Janeiro in 1994. 164 nations had signed it by 1996. Conference of Parties (CoP) was envisaged to take place periodically. As a follow up CoP-1 was held in Berlin in 1995, Cop-2 was held in Geneva in July 1996 and CoP-3 was held in Kyoto (Japan) in Dec. 1997. It wa in CoP-3, that the Kyoto Protocol was adopted which established a legal binding obligation on annex-I countries t reduce emissions of GHGs. The Buenos Aires Plan of Action was adopted at CoP-4 I Nov. 1998 with the decision of completing the programme of work on Kyoto mechanism by the end of 2000. According to Kyoto Protocol the developed countries are committed to reduce GHGs emission by an average of 5% during the commitment period or 2008-2012 with reference to 1990 level of emissions. CoP-6 was held in 2000 at Hague (Netherlands) to finalize the various issues relating to Kyoto Protocol but the delegates failed to reach any agreement. CoP-6 part II was held in 2001 at Bonn (Germany) Bonn agreement is the result of it. CoP-7 was held in 2001 at Marrkech (Motocco). As a result of this meeting the statement was passed to the World Summit on Sustainable Development (WSSD). India ratified Kyoto Protocol in 2001-02 and CoP-8 was held in 2002 at New Delhi. The conference was very much a 'working' meeting to build on the agreements at previous meetings, with progress made on inventory and reporting methodology. CoP-9 was held in meeting was rules for carbon sink projects. CoP-10 was supposed to be held in Dec. 2004 at Buenos Aires (Argentina) (details no available). The above international approach indicates the global concern for GHGs emissions.

VI. CONCLUSION

Changes caused by global warming due to GHGs emissions have already started showing across the world, say experts. The cluster of recent events, like rainfall of 942 mm in one day (26.07.2005) in Mumbai, Torrential continuous rains in Chennai, the 27 day long heat wave in Andra that left 4000 dead and cold spell that gripped the north, support the projection by IPCC (Inter Governmental Panel on Climate Change) that there is likelihood of more extreme events, such as floods, droughts, heat waves, etc. (Times of India, 15.01.2008).

- (i) Environmental protection with reference to pollution of air, water, land and atmosphere has become essential to avoid extreme climatic changes.
- (ii) Sustainable development should be the basic objective while progressing with the developmental process. World Commission on Environment and Development (1987) has adopted the general principle that the current generations should meet their needs without compromising the ability of future generations to meet their own needs. This principle should be followed in practice.

Renewable energy sources should be used to the maximum extent.

REFERENCES

- [1] International energy agency. Retrieved 6 October 2017.

- [2] Central Electricity Authority www.cea.nic.in
- [3] Government of India Ministry of Power “powermin.nic.in/en/content/generation-capacity”
- [4] “All India installed Capacity of utility power stations” retrieved 6 April 2018
- [5] Gupta, B.R. 2008. Generation of electrical energy (revised and enlarged edn). Durasia Publishing House (P) Ltd., New Delhi.
- [6] Gupta, B.K. 2009. Generation, distribution and utilization of electrical energy (Revised and enlarged edn). New Age International (P) Ltd., New Delhi
- [7] Rajaram, Kalpana and R.K. Suri. 2009. Science and technology in India (revised and enlarged edn). Spectrum Books (P) Ltd., New Delhi.
- [8] Samanta, B.K. 2000. International Symposium on Environmental issues and management in coal fields of India, Nagpur. Oxford and IBH Press.