Indian Sustainable Environment Policy and effect on Standby Power Generation Infrastructure: An Energy Environment Sectoral Policy Analysis

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Abstract:

With India's commitment to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and efforts to limit the temperature increase even further to 1.5 degrees Celsius. The Government of India has been working on different methods to reduce the carbon footprint. India has already achieved its voluntary pre-2020 goal of reducing emission intensity by 20-25% from 2005 levels by 2020. Its values and belief guide India in sustainable lifestyles, which respects nature. Our share in cumulative historical global GHG emissions is only about 3 per cent and our per capita emissions are just about one-third of the global average despite being significant on the population.

There are fundamental challenges such as access to finance, technology transfer and capacity building, which are the key enablers to achieve the objectives. Access to adequate climate finance, non-regression in these commitments and more substantial commitment to the cause of technology is essential for developing countries like India to be confident in a collective journey towards sustainable development. This paper intent to dwell on the policies related to the clear air improvement and reduction of pollution in the environment and discuss the implementation methods and their effect on the Standby Power Generation Industry end consumer critically.

Key Words: PM, , NACP, CPCB, Standby Power, GHG, AQI

1.0 Introduction

India has been going through a phase of accelerated industrial activities for the past three decades. The associated growth in industrialization and urbanization has led to a multi-fold increase in pollution. In recent years, medium and small towns and cities have also witnessed an increase in pollution, thus getting fast reflected as India's polluted cities. Air pollution has increasingly become a serious concern, predominantly because of its health impacts. The reported perplexing statistics in various international reports, correlating air pollution with health impacts without using indigenous dose-response functions, further complicate the issue by possibly creating an ambiguous public perception. Air pollution emission issues are associated with many sectors, which inter-alia include power, transport, industry, residential, construction, and agriculture. Burning fossil fuels causes air pollution that both contribute to global climate change and also contributes to air pollution. Global climate change is caused by the overabundance of greenhouse gas (GHG) emissions in the atmosphere. The local air quality generally refers to the level of pollutants in the air that we breathe, which is typically found in the lowest part of the atmosphere, and the air quality is reduced by an excess concentration of specific pollutants, namely, PM10, PM2.5, NOx, SOx, CO, and other hydrocarbons. There exists considerable quantitative literature estimating the local pollution co-benefits of climate change mitigation interventions. The sectors in which fuel combustion contributes to GHG emissions, such as energy, buildings, industry, and transport, are the ones with the most significant air quality co-benefits and the most substantial quantitative literature. In energy and industry, the most significant co-benefits come from replacing coal combustion with less polluting fossil fuels, replacing fossil fuels with renewable energy, improving energy efficiency, and improving the characteristics of Coal via coal washing and briquetting. The most significant air quality co-benefits are typically linked to improvements in energy efficiency for buildings, a significant component of the green building certifications and modifications in cooking methods. Transport studies typically aggregate the effects from a collection of interventions, including greater use of public transport and improving vehicle fuel efficiency, but transport-related studies also often aggregate health outcomes from other non-pollution effects such as benefits from increased walking and cycling. The impact of air pollution is not limited to health but extends to agriculture and the general well-being of humans, floral population.

Furthermore, since air pollution is not a localized phenomenon, the effect is felt in cities and towns far away from the source, thus creating the need for regional-level initiatives through inter-state and inter-city coordination in addition to multi-sectoral synchronization. Air pollution is mainly urban-centric. Studies show the regional scale pollution is more concentrated in the Indo-Gangetic plains and more industrialized states. Incidences of air pollution during the winters in Delhi NCR have attracted significant media attention, thus bringing the entire issue of air pollution under a lens.

1.1 Sources of Air Pollution

Data generated from National Air Quality Monitoring Programme reveals that particulate matters (PM10 and PM2.5) are the major challenge that is found to be exceeding the Ambient Air Quality Standard all across the country, more specifically in urban areas of the Indo-Gangetic plain. Other pollutants such as SOx, NOx and ozone (O3) are mainly within the prescribed national standards. The sources of emissions in India have been estimated emissions in several research studies. While there could be some variations due to differences in methodologies and the year of estimation, the estimates agree. While vehicles, industries, rampant constructions, biomass burning, diesel gen-sets, commercial and domestic use of fuel are significant sources of pollution, the inherent disadvantages of the Indo-Gangetic plain stem from its geographical location and soil composition as stated earlier also, compounds the air pollution woes. The Indo-Gangetic plain is essentially landlocked. The Himalayas prevent polluted air from escaping to the north, creating the so-called "valley effect", and dry alluvial soil significantly contributes to wind-blown dust. The share in PM2.5 emissions is dominated by the industrial (36%) and residential combustion (39%) sectors (Sharma and Kumar , 2016). Transport contributes to just 4% of PM2.5 emissions at the national scale. However, these emissions are concentrated in the urban centres.

Moreover, being stationary sources, their contribution to overall air quality levels could be much high. Open burning of agricultural residue in rural areas contributes about 7% to the total PM2.5 emissions. Other sectors cumulatively contribute 11% of emissions. Power plants contribute 4% of PM2.5 emissions; however, these may contribute significantly to the pollution levels in the power plants' specific zones of influence. The current inventories of NOx emissions show the dominance of the transport sector (35%), power plants (22%), and DG and agricultural pump sets (15%). SO2 emissions are estimated to be generated mainly by the industry (49%) and power sectors (43%). Hydrocarbon emissions are mainly generated from biomass combustion activities in the residential sector.

There is a drastic difference in the contribution of sources at the urban scales. CPCB, 2011, shows comprehensive source apportionment studies in six cities during 2007–2010, namely, Bengaluru, Chennai, Delhi, Kanpur, Mumbai, and Pune. The results show that dust from road dust re-suspension, construction activities, and soil has a significant contribution of 6%–58% to PM10 concentrations in these six cities. The share of the transport sector remains smaller in PM10 but increases significantly in PM2.5 finer fractions concentrations. Secondary particulates formed due to chemical conversion of gaseous pollutants such as SO2 and NOx also contribute significantly to PM2.5 concentrations in different cities. A study conducted by IIT-Kanpur titled "Comprehensive Study on Air Pollution and Green House Gases GHGs in Delhi" indicated secondary particulates 30% and vehicular emissions 25% to be significant source pollution in the summer(DPCC, 2016). Construction and road dust 31%, Coal and fly ash 26% contributing majorly during the winter. Diesel exhaust gas contains higher amount of particulate matter and NO_x emissions that are responsible of severe environmental and health problems (Prasad and Bella, 2010). Health experts have concluded that pollutants emitted by diesel engines affect human health adversely and cause acid rains, ground-level ozone, and reduce visibility. Studies have shown that exposure to diesel exhaust gas causes lung damage and respiratory problems, and there are concrete evidences that diesel emissions may cause cancer in humans (Sydbom et al. 2001; Lloyd and Cackette 2001; Whichmann 2006; Lewtas 2007; Burr and Gregory 2011).

The composition of diesel exhaust gas is as given below (Khair and Majewski 2006). Pollutant emissions have a rate of less than 1 % in diesel exhaust gas. NOx has the highest proportion of diesel pollutant emissions with a rate of more than 50 %. After NOx emissions, PM has the second in proportion in pollutant emissions. Because diesel engines are lean combustion engines, and the concentration of CO and HC is minimal. Besides, pollutant emissions include a component of SO2 gas, dependent on the sulphur's content in diesel fuel. It is produced by the sulfur content contained in diesel fuel. For the present, there is not any after-treatment system like a catalytic converter to eliminate SO2. Nowadays, most oil companies have been producing ad supplying ultra-low sulfur diesel (ULSD) for diesel engines to prevent the harmful effect of SO2.

A brief description of each of the exhaust components is as given in figure 1.

Carbon-Monoxide

Due to incomplete combustion, carbon monoxide are produced. It occurs at the place where the oxidation process does not occur completely in the cylinder of the diesel engine. This concentration is mainly dependent on the air/fuel mixture and it is highest where the excess-air factor (λ) is less than 1.0 is a rich mixture (Wu et al. 2004). It is caused more when starting and instantaneous acceleration of engine where the air-fuel mixtures require to be rich. In such a case, due to air deficiency and reactant concentration, all the carbon cannot convert to CO2 and results in the formation of CO. CO are produced during operation in rich mixtures. A small CO is produced under lean conditions because of chemical kinetic effects (Faiz et al. 1996).
Diesel engines are lean combustion engines with a high air-fuel ratio (λ>1). The formation of CO is least in diesel engines. CO is produced only if an excessive amount of fuel is injected into the diesel engine or if insufficient pressure is created in the combustion chamber (Demers and Walters 1999). It is an odourless and colourless gas. CO concentration in the air is inhaled by the human lungs and transmitted into the bloodstream. It latches to haemoglobin and inhibits its capacity to transfer oxygen. The CO concentration in the air leads to asphyxiation, affecting the function of different organs, resulting in impaired concentration, slow reflexes, and confusion (Raub 1999; Kampa and Castanas 2008; Walsh 2011; Strauss et al. 2004).

Hydro-Carbons

Hydrocarbon emissions are composed of unburned fuels, which is caused due to lower temperatures near the cylinder walls. The air-fuel mixture is comparatively less than the centre of the cylinder (Demers and Walters 1999; Correa and Arbilla 2008). Hydrocarbons consist of alkanes, alkenes, and aromatics. They usually are in terms of equivalent CH4 content (Hiroyuki et al., 2011).
Diesel engines emit low levels of hydrocarbons. Diesel hydrocarbon emissions commonly occur at light loads. The reason for light-load hydrocarbon emissions is lean air-fuel mixing. In lean mixtures, due to

low flame speeds, complete combustion does not occur during the power stroke, and these conditions cause high hydrocarbon emissions (Zheng et al., 2008). In Diesel engines, the fuel type, the fuel injection timings, and the design affect the content of hydrocarbons produced. Besides, HC emissions in the exhaust gas depending on operating conditions. High levels of the instantaneous change in engine speed, improper injection, excessive nozzle cavity volumes, and injector needle bounce can cause significant quantities of unburned fuel to pass into the exhaust (Payri et al. 2009).

These hydrocarbons also are in the exhaust is the temperature of the exhaust is above 600 deg C in the presence of oxygen, hence with higher temperature in the exhaust, the hydrocarbons are lower compared to hydrocarbons leaving the combustion cylinder ((Faiz et al.,1996). The hydrocarbon emission is not only present in the exhaust pipe but also in the engine crankcase, the fuels system and from the venting of vapours in the fuel line from the high-pressure fuel pump (Faiz et al., 1996). Hydrocarbon emissions from the crankcase and other emissions due to evaporative losses are 20%-35% on the former and 15%–25 % on the latter, while hydrocarbon emissions have 50–60 % on the tailpipe of total hydrocarbon emissions (Dhariwal,1997). They have harmful effects on the environment and human health. Other pollutant emissions play a significant role in the formation of ground-level ozone. Vehicles are responsible for about 50 %of the emissions that form ozone. They are toxic with the potential to respiratory tract irritation and cause cancer (Diaz-Sanchez, 1997; Krzyzanowski et al., 2005).

Particulate Matter

Particulate matter in the exhaust gas is due to the combustion process. Particulate matter is originated from an assemblage of tiny particles of partly burned fuel, partly burned lubricating oil, fuel oil, and cylinder lube oil or sulfates and water (Demers and Walters 1999; Maricq 2007). PM is a result of incomplete combustion of the hydrocarbons in the fuel and lube oil. In an experimental study conducted, the typical particle composition of a heavy-duty diesel engine ranges from (31-41 %) carbon, 7 % unburned fuel,(25%-40%) unburned oil, (7%-14 %) sulfate and water, 13 % ash, and other may be metals and other substances((Kittelson 1998; Agarwal,2007).
Diesel particulate matters are spherical in about 15–40 nanometer in diameter, and approximately more than 90 % of the PM content is smaller than 1 micrometre in diameter. The PM emissions are dependant on many factors such as the combustion and expansion process, quality of fuel (sulfur and ash content), quality of Lubricating oil and its consumption, combustion temperature, exhaust gas cooling (Burtscher 2005).
Particulate matter from diesel engines is considerably higher (six to ten times) than gasoline. Diesel particle emissions consist of three main components

a) soot,
b) a soluble organic fraction,
c) an inorganic fraction.

More than 50 % of the total Particulate matter is soot out of the exhaust as black smoke. Soluble organic fraction is of hydrocarbons adsorbed or condensed on the soot. It is partly from the lubricating oil, partly from unburned fuel, and partly from compounds formed during combustion. SOF values are too high at light engine loads when exhaust temperatures are low (Sarvi et al. 2011; Tighe et al. 2012; Burtscher 2005; Metts et al. 2005; Stanmore et al. 2001; Sharma et al. 2005). Many kinds of research have been performed to detect the impact of PM on the environment and human health. It is documented that inhaling these particles may cause critical health problems such as asthma, lung cancer, and other cardiovascular issues. These emissions contribute to pollution of air, water, and soil; soiling of buildings; reductions in visibility; impact on the agriculture productivity; global climate change (Englert 2004; OECD 2002; Michael and Kleinman 2000).

Nitrogen oxides

The present diesel engines to increase the power uses compressed air to provide the excess air required for combustion. Air, which constitutes oxygen and nitrogen, is compressed by the turbo. The compressed air is injected into the air induction manifold after cooling, induced in the combustion chamber. Then, the fuel is injected directly into this compressed air at about the top of the compression stroke in the combustion chamber. The fuel is burned, and the power stroke is achieved. The combustion air contains nitrogen which does not react with the oxygen and released out of the exhaust. However, high temperatures above 1,600 C in the combustion chambers cause the nitrogen to react with oxygen and generate. Significant influencer's of NOx formation are the temperature and concentration of oxygen in the combustion. The amount of produced NOx is associated with the temperature in the cylinder, oxygen concentrations in compressed air and the time of reaction. Increase in the temperature of combustion increases the amount of NOx by as much as threefold for every 100 C increase (Lee et al. 2013; Bosch 2005). Nitrogen oxides are referred to as nitrogen oxide (NO) and nitrogen dioxide (NO2). NO constitutes 85–95 % of NOx. It is gradually converted to NO2 in atmospheric air. The NO and NO2 are lumped together as NOx; Nitrous oxide is a colourless and odourless gas, whereas Nitric oxide is a reddish-brown gas with a pungent odour (Chong et al. 2010; Hoekman and Robbins 2012).
Road transport contributes the most to urban NOx emissions worldwide, contributing to 40–70 % of the NOx. Among various types of vehicles, diesel vehicles are the most important contributors to the environmental pollution. The NOx emissions are produced during high-temperature combustions, which happens more in diesel engines as the diesel gets ignited with high compression in the presence of oxygen; these diesel engines are primarily responsible for about 85% of all Nox emissions from all mobile sources. (Lee et al., 2013; Wang et al., 2012).
These gases are responsible, to a large extent, the cause for health and environmental disturbance. These emissions contribute to deteriorating air by the acidic properties and could lead to acidic rain and Smog formation, which has become a considerable problem in cities worldwide(Grewe et al. 2012). These gases react with the other pollutants to form tropospheric ozone, one of the essential components of smog and other toxic pollutants. NO, and NO2 is considered toxic, but NO2 has a level of toxicity five times greater than that of NO, and it is also a direct concern of human lung disease. Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infection (such as influenza). NOx emissions are essential precursors to acid rain that may affect both terrestrial and aquatic ecosystems. Nitrogen dioxide and airborne nitrate also contribute to pollutant haze, impairs visibility (Kagawa 2002; Hoeft et al. 2012).

TERI and Automotive Research Association of India (ARAI) which conducted a study for the Department of Heavy Industry on 'Source Apportionment of PM2.5 & PM10 of Delhi NCR for Identification of Major Sources 2013', stated that seasonal variation of PM10 showed the higher contribution of dusty sources in summers as compared winters in Delhi and the NCR region(DOHI ,2018). Dry conditions and higher wind velocities in summers resulting in the entrainment of dust. However, dusty sources, e.g., such as road, construction and soil dust, were also significant in the winter season 23%–31%. The contribution of vehicles to PM10 was slightly higher in winters, 17%– 18% in Delhi and NCR regions, than in summers 15%–16%. Biomass burning contribution was slightly higher in winters in Delhi 14% than in summers 12%, whereas in the NCR regions, the contribution was similar in both the seasons, 15%–16%. Contribution from industrial sources was similar in both the summer and winter seasons in Delhi 10%–12% and NCR regions 14%–15%. Contribution in the NCR regions was higher as compared to Delhi due to the proximity of industries. Other sources, which include DG sets, showed an equal contribution of about 4%–5%. The contribution of secondary ions to PM10 is significantly higher in winters, 23%–25%, than in summers, 11%–15% in Delhi and the NCR regions. Seasonal variation of PM2.5 shows the significantly higher contribution of dusty sources in summers, 31%–34% compared to winters 15% in Delhi and the NCR regions. Higher contribution of the dusty sources, even in PM2.5, can be attributed to dry weather conditions and higher wind velocities in summers, resulting in contribution from far-off sources. Vehicles' primary contribution to PM2.5 was higher in winters, 20%–23% in Delhi and the NCR regions, than in summers 18%–20%. Biomass burning contribution was significantly higher in winters in Delhi and the NCR regions 22% than in summers 15%. Contribution from industrial sources was similar in both the summer and winter seasons in Delhi 10%–11% and NCR regions 13%. Contribution in the NCR regions was higher than in Delhi due to the presence of industries in the proximity. Other sources, which include DG sets, showed a contribution of less than 5%. The contribution of secondary ions to PM2.5 was higher in winters, 26% than in summer, 17%–18% in Delhi and the NCR regions.

The study concluded that significantly higher contribution of dust in PM10 and PM2.5, particularly in the summer season, may be attributed to the transboundary contribution(DOHI ,2018). Variation in the contribution of sources, such as vehicles 15%–23%, biomass burning 12%–22%, and dust 15%–42%, may be attributed to the variation in activities at local the level and meteorology.

Contribution from sources outside Delhi, such as residential cooking, agricultural waste burning, industries emission's, and dust particles, are likely due to winds carrying pollution with the incoming air towards Delhi and the NCR regions, indicating the regional aspect of air pollution. Current knowledge on the urban sources provided a basis to initiate action in the different sectors. However, city-specific source apportionment studies were needed to refine air quality management plans for the city. Accordingly, the air quality management framework included strategies at different levels, i.e. local, city, state, regional and transboundary level, for effective control of pollution.

2.0 Government Initiatives On Emission Control

The Government is executing a nationwide programme of ambient air quality monitoring known as NAMP. The network consists of 703 manual operating stations covering 307 cities/towns in 29 states and 6 Union Territories. Under NAMP, four air pollutants viz. SO2, NO2, suspended particulate matter PM10, and fine particulate matter PM2.5 have been identified for regular monitoring at all locations. There are 134 real-time Continuous Ambient Air Quality Monitoring stations CAAQMS in 71 cities across 17 states, monitoring 08 pollutants viz. PM10, PM2.5, SO2, NOx, ammonia (NH3), CO, ozone O3, and benzene. PM10 are inhalable coarse particles, which are particles with a diameter between 2.5 and 10 micrometre's (µm), and PM2.5 are fine particles with a diameter of 2.5 µm or less. Particulates are the deadliest form of air pollutants due to their ability to penetrate deep into the lungs and bloodstreams unfiltered. The smaller PM2.5 are particularly deadly as they can penetrate deep into the lungs.

2.1.Emission monitoring

2.1.1 National Air Quality Management Programme; NAMP

The objectives of NAMP are:

1. Determine the status and trends of ambient air quality
2. Ascertain whether the prescribed ambient air quality standards are violated
3. Identify non-attainment cities
4. Obtain the knowledge and understanding necessary for developing preventive and corrective measures
5. Understand the natural cleansing process in the environment through pollution dilution, dispersion, wind-based movement, dry deposition, precipitation, and chemical transformation of the pollutants generated.

The monitoring of meteorological parameters, such as wind speed and wind direction, relative humidity RH, and temperature, was also integrated with air quality monitoring. The CPCB coordinates with State pollution control boards, pollution control committee's and National Environmental Engineering Research Institute agencies to ensure uniformity and consistency of air quality data and provides technical and financial support for operating the monitoring stations. A lot of personnel and equipment's are involved in the sampling, chemical analysis, data reporting. It increases the probability of variation and personnel biases reflecting in the data. Hence it is pertinent to mention that these data be treated as indicative rather than absolute.

2.1.2 National Ambient Air Quality

Ambient air quality refers to the condition or quality of the outdoor air. NAAQs are the standards for ambient air quality concerning variously identified pollutant notified by the CPCB under the Air (Prevention and Control of Pollution) Act, 1981.

The primary objectives of NAAQS are:

1. Indicate necessary air quality levels and appropriate margins required to ensure the protection of vegetation, health, and property,
2. Provide a uniform yardstick for the assessment of air quality at the national level
3. Indicate the extent and need of the monitoring programme.

Annual standards are the annual arithmetic mean of a minimum of 104 measurements in a year, at a particular site taken twice a week, at a uniform 24-hourly interval and either a 24 hourly, eight hourly, or one hourly monitored values, as applicable, shall be complied with 98% of the time in a year. However, there is a 2% chance of exceeding the limits but not on two consecutive monitoring days. This Standard was notified in November 2009.

Additionally, the MoEF&CC has notified environmental standards for 84 sectors, out of which the effluent standards have been notified for 45 industrial sectors, and the emission standards have been notified for 63 industrial sectors. Besides, ambient air quality standards and general standards for emission and effluent have also been developed. An online continuous (24x7) monitoring system has been made mandatory in 17 categories of highly polluting industries.

2.1.3 Air Quality Index (AQI)

The AQI was launched by the Prime Minister in April 2015, starting with 14 cities and now extended to 71 cities in 17 states. The AQI is a tool for the effective communication of air quality status to people in terms, which are easy to understand. It transforms complex air quality data of various pollutants into a single number (index value), nomenclature and colour. There are six AQI categories: good, satisfactory, moderately polluted, inadequate, inferior, and severe. Each of these categories is decided based on air pollutants' ambient concentration values and their likely health impacts (known as health breakpoints). The AQ sub-index and health breakpoints are evolved for eight pollutants (PM10, PM2.5, NO2, SO2, CO, O3, NH3, and Lead (Pb)) for which short-term (up to 24-hours) National Ambient Air Quality Standards are prescribed. Based on the measured ambient concentrations of a pollutant, a sub-index is calculated, which is a linear function of concentration (e.g., the sub-index for PM2.5 will be 51 at concentration 31 µg/m3, 100 at concentration 60 µg/ m3, and 75 at a concentration of 45 µg/m3).

3.0 Action Points Issued by the Government

The CPCB has issued a comprehensive set of directions under Section 18 (1) (b) of the Air (Prevention and Control of Pollution) Act, 1986, for the implementation of 42 measures to mitigate air pollution in the major cities, including Delhi and NCR comprising action points to counter air pollution, which include control and mitigation measures related to
1) vehicular emissions,
2) re-suspension of road dust and other fugitive emissions,
3) bio-mass/municipal solid waste (MSW) burning,

4) industrial pollution,
5)construction and demolition (C&D) activities,
6) and other general steps.
Directions containing 42 action points issued initially for implementation in NCR were subsequently extended to state boards for implementation in other non-attainment cities.

3.1.1 Environment Pollution Control Authority (EPCA)

Environment Pollution (Prevention and Control) Authority (EPCA) was constituted under Section 3(3) of Environment (Protection) Act, 1986, in 1998 in pursuance of the Hon'ble Supreme Court Order dated 7.1.1998 in Writ Petition (C) no. 13029/1985 in M.C. Mehta vs Union of India & Others to look into environmental pollution in the NCR region. As per the order, the authority was proposed to comprise Shri Bhure Lal, Secretary, CVC as Chairman; and Shri D K Biswas, Shri Anil Aggarwal, Shri Jagdish Khattar, and Smt Kiran Dhingra as members. Accordingly, this ministry notified the constitution of the EPCA to vide notification no. SO 93(E) dated 29.2.1998 for two years comprising the above-stated members and TOR. In the notification, the EPCA jurisdiction has been stated as the NCR region as defined in clause (f) of section 2 of the National Capital Region Planning Board Act, 1985 (2 of 1985). EPCA subsequently re-constituted from time to time, extending the authority's tenure and substituting or including new members.

3.1.2 Graded Response Action Plan (GRAP)

The Government has notified a graded response action plan for Delhi and the NCR region, which comprises the graded measures for each source framed according to the AQI categories. It also takes note of the broad health advisory for each AQI level adopted by India and the AQI. The proposal has been framed keeping in view the critical pollution sources in Delhi and the NCR region. While the significant sources of pollution, including vehicles, road dust, biomass burning, construction, power plants, and industries, remain continuous throughout all seasons. The episodic pollution from stubble burning increases biomass burning across seasons. When PM2.5 levels cross 300 µg/m3 or PM10 level cross 500 µg/m3 (5 times above the Standard) and persist for 48 hours or more following action plan is to be carried out

1. Stop entry of truck traffic into Delhi (except essential commodities)
2. Stop Construction activities.
3. Introduction of Odd and Even number schemes for private vehicles based on the license plate numbers and minimize exemption

When the PM2.5 is more than 250 µg/m3, and PM10 levels are more than 430 µg/m3 following actions are proposed to be taken.

1. Closure of stone crushing plants, Hot mix plants and brick kilns.
2. Shutting down the thermal power plant and maximizing power generation from the gas-based power plants reduces coal-based plants' operation.
3. Increase the public transport service and have a differential pricing for the travel during peak and off-peak hours.
4. Intensify Mechanized cleaning of roads and a sprinkling of water on the roads to settle the dust.

When the PM2.5 is in between 121- 250 µg/m3, and PM10 levels are more than 351-430 µg/m3 following actions are proposed to be taken.

1. Stop use of Diesel generating sets
2. Enhance parking fee by 3-4 times
3. Increase the public transport system by increasing the frequency of metro rail, buses and augmenting contract buses.
4. Stop use of Coal and firewood in open, Hotels and restaurants.

When the PM2.5 is in between 91- 120 µg/m3 and PM10 levels are more than 251-350 µg/m3, and PM2.5 levels are in between 61-90 µg/m3
Furthermore, PM10 levels are between 101-250 following actions are proposed to be taken.

1. Stringent enforce /Stop garbage burning in landfill, and other places impose heavy fines if not followed.
2. Closely enforce all pollution control regulations in brick kilns and Industries.
3. Stringent enforcement of pollution control measures in coal-based thermal powerplants and monitoring by PCB.
4. Mechanized cleaning of the roads with heavy traffic and water sprinkling on the unpaved roads every two days.
5. Strict Vigilance and no tolerance for visible emissions -stop plying visibly polluting vehicles by impounding or imposing a heavy fine on them.
6. Strict vigilance norms and enforcement of PUC
7. Strictly enforce rules for dust control activities and close non -complaint sites.
8. Deploy traffic police for smooth traffic flow at identified vulnerable areas
9. Strictly enforce Supreme Court order on diversion of non-destined truck traffic and ensure only trucks registered after 2005 are allowed entry into Delhi.
10. Strictly enforce Supreme Court on firecrackers ban.
11. Ensure fly ash ponds are water every alternate day during the summer months (March-May).

During winters, the relative share of vehicles, biomass burning, MSW burning, firecracker, stubble burning, construction, and secondary particles increase. During summers, the influence of road dust, fly ash, vehicles, biomass burning is quite a lot. According to the AQI, the proposed graded measure approach has considered all these aspects and includes appropriate measures for each level of pollution. The graded measures according to the AQI are listed, starting from the public health emergency level and then progressing downwards. The measures are cumulative. The emergency and severe levels include cumulatively all other measures listed in the lower levels of the AQI, including very poor, needy, and moderate. It is also clear that the poor category's actions need to be implemented throughout the year. However, during months when the weather conditions turn adverse, there is a need for greater scrutiny on enforcements.

3.1.3 Other Measures

On pollution from waste, five waste management rules on solid waste, hazardous waste, plastic waste, biomedical waste, and e-waste have been revised. The rules about construction and demolition waste as a significant source of dust pollution were newly notified during 2016. Further, a ban was imposed on the burning of leaves, biomass, and MSW. There are other measures that the Government took for improvements in energy efficiency and air pollution control in India. Some of which are cited below:

1. Advanced vehicle emission and fuel quality standards– BSIV from 2017 and BS-VI from 2020.
2. Plan to introduce a voluntary fleet modernization and an old vehicle scrappage programme in India.
3. Introducing a National Electric Mobility Mission Plan 2020.
    a) Introducing gas as an automotive fuel in many cities.

5. Introduction and enhancement of the metro-rail and bus-based public

Transport systems in selected cities.

1. Ujjawala scheme to accelerate the LPG penetration programme for cooking in households.
2. Electrification to reduce kerosene consumption for lighting.
3. Introducing an energy-efficiency labelling programme for energy-intensive home appliances such as air conditioners.
4. Notifying new stringent standards for diesel generator sets for standby Power generation.

CPCB had identified a list of polluted cities in which the prescribed NAAQS are violated. These cities have been identified based on the ambient air quality data obtained (2011–2015) under NAMP. PM10 has been exceeding 94 cities consecutively for five years, and NO2 exceeds five cities' limits. PM2.5 data since 2015 indicates 16 cities as non-attainment cities. In April 2018, the WHO has updated the fourth Ambient Air Quality Database on its website based on PM2.5 data. Its database aimed to reflect the monitoring efforts undertaken in countries reflected in the list. This was further to raise awareness and facilitate adequate response to protect public health from the adverse impacts of outdoor air pollution.

With all the above action plans in place, some Improvements were seen. However, there are time-bound action plans to have a higher level of focus, time-bound at both the cities and rural level, to address the better air quality standards at a national level scale. In this context, the National Clean Air Action Plan was formulated to reduce air pollution at both regional and urban scale with the following action plan and objectives in place.

4.0 National Clean Air Programme

4.1 Timelines

Mid-term five (5) years action plan to keep 2019 as the base year. Further extendable to 20-25 years in long-term after a mid-term review of the outcomes.

4.2 Objective of National Clean Air Programme

a) Stringent implementation of mitigation measures for prevention control and abatement of air pollution
b) Augment and strengthen the air quality network across the country.
c) Augment public awareness and capacity-building measures.

4.3 Approach

1. Multi-Sectoral and collaborative.
2. Mainstreaming and integration into the existing policies and programmes of GOI, including NAPCC.
3. Use Smart Cities framework to launch NCAP in the 43 smart cities falling in 102 non-attainment cities. The national-level target of 20-30% reduces On of PM2.5 and PM10 concentration by 2024.

4.4 Goal

The Goal of NCAP is to meet the prescribed annual average ambient air quality standards at all country locations in a stipulated time frame. (Long Term)

4.5 Target

The global experiences highlight the fact that internationally has been city-specific rather than country-oriented and, according to the statistics, indicates 35%-40% PM2.5 reduction in 5 years in cities such as Beijing and Seoul. In contrast, cities such as Santiago and Mexico, have shown 73% and 61% reduction in 22 to 25 Years with regards to PM2.5 and PM 10 concentrations.
A study conducted by Peking University School of Public Health on the impact of China's Air Pollution Prevention And Control Action Plan 2013-2017 has shown that the average concentration of PM2.5 levels decreased by 33% and PM10 levels reduced by 27.8% in 74 key cities in China where it was implemented. Sulphur dioxide reduced by 54,1%, and Carbon monoxide by 28.2% in the years the action pollution control plan was implemented. However, no or fewer improvements were seen in reducing nitrous oxide and increasing the ozone layer.

TERI and ARAI report dated August 2018 analyzed various interventions and estimated their possible impacts over PM2.5 and PM10 concentrations in Delhi and NCR. An alternative scenario has been developed considering the interventions which can provide maximum air quality benefits. The alternative scenario results in a reduction of 58% and 61% in PM2.5 and PM 10 concentrations in 2030, in Delhi and NCR concerning the business-as-usual scenario, and achieves the daily ambient air quality standards for PM10 and PM2.5. In Delhi and NCR, the initiatives started in 1992 with the EPCA's creation and have a definite edge over other non-attainment cities. The tentative national level target of 20%–30% reduction of PM2.5 and PM10 concentration by 2024 was proposed under the NCAP, keeping 2017 as the base year to compare concentration.

4.6 Implementation of NCAP

The CPCB shall, in consonance with the Air (Prevention and Control of Pollution) Act, 1981, and in particular with the provision of Section 16(2)(b) of the Act, execute the nationwide programme for the prevention, control, and abetment of air pollution within the framework of the NCAP.

In this study, we will understand the steps taken under NCAP to reduce Industrial emissions.

Industrial pollution is another area of concern that contributes majorly to the air pollution in India. Industries are growing at common centres/estates/parks as the resources, workforce, transportation, and marketing are feasible. Generally, medium- and small-scale industries are developed in such areas and form industrial clusters. These industrial clusters constitute a significant hub of pollution, indicating a lack of awareness and enforcement issues. To address the issue of enforcement and awareness in the industrial clusters, the CPCB has developed the Comprehensive Environmental Pollution Index (CEPI) to characterize the environment's quality. In 2009, 88 prominent industrial clusters were identified for a CEPI analysis. Out of identified 88 prominent industrial clusters, 43 industrial clusters in 17 States with a CEPI score of 70 and above are identified as Critically Polluted Areas (CPAs).
Further, 32 industrial clusters with CEPI scores between 60 and below 70 are categorized as severely polluted areas (SPAs). The CPCB has revised the CEPI concept and, subsequently, issued directions during April 2016 to all SPCBs/PCCs for taking stringent measures concerning the revised CEPI concept, including environmental quality monitoring CPAs, installation of continuous ambient air quality monitoring stations. It was also directed to undertake environmental quality monitoring in the critically polluted areas falling under their jurisdiction through a third-party agency (laboratory)

recognized under the Environment (Protection) Act, 1986. The environmental quality data, including the CEPI score of the industrial area, as per the revised concept, shall be placed in the public domain by the concerned SPCBs/ PCCs through the Internet and also be published by the State Government periodically. Control of Industrial Pollution has become a governance problem within India and is marred by law enforcement issues. Lack of accurate, independent and easily accessible data on emissions creates hurdles in ensuring compliance to law enforcement standards. In one of the experiments conducted in Gujarat through randomized evaluation, it was observed that random assignment of auditors to industrial plants, payment from a shared pool, their monitoring for accuracy and providing them with financial incentives for better reports for compliance auditing led to 80% less likeliness of submission of false pollution readings. In addition to this, according to a study, industrial plants too reduced their air and water-polluting emissions by 28%.

The ministry has developed a total of 63 industry-specific emission standards. Ten emission standards (diesel and LPG/CNG gensets; petrol and LPG/CNG gensets; dedicated LPG/CNG gensets; industrial boiler; SO2 and NOx standards for glass, lime kiln, reheating furnaces, foundry, ceramic industry, and airport noise) have been evolved and six emission standards (thermal power plant, sugar, man-made fibres, fertilizer, cement, and brick kiln) have been revised during 2014–till date. Criteria for categorizing industries in red/orange/green/white categories, which have been adopted by SPCBs/PCCs for strengthening the enforcement mechanism of environmental norms, have been revised.
.
It has been noted that though the CPCB has notified various emission norms for manufacturers of diesel generators, there is no regulation for generators in use after commissioning (except the 800 KW and above category). PM is the primary source of air pollution in our country. Accordingly, 91% of DG Sets have no regulations beyond the point of manufacture. Studies show that as DG Sets get older, they might emit 11 times more than the manufacturers' standards. Overall, DG Sets contribute 7-18% to the ambient air pollution in non-attainment cities. As the current norms only address new generators and a limited population of old generators, it becomes crucial to address older in-use generators' emissions.

Accordingly, it is proposed to formulate a notification on the control of pollution from diesel generators to include control and mitigation measures related to these generators. In addition to the formulation of standards by the CPCB, this may include the following:
Users would be required to a

1. Shift to gas-based generators either by retrofitting existing generators for partial usage of gas (a mixture of Diesel and gas) or buying new gas-based generators
2. Use retrofitted emission control equipment with diesel generators with a minimum specified particulate matter capturing at least 70% efficiency. This would be the lower-cost solution to consumers with a cost of less than 10% of the generator set.
3. The retrofit emission control devices/ gas retrofits can be certified by one of the following institutions (CPCB approved institutions which also provide emissions approval for diesel generators at the manufacturers' stage):
   (a) Automotive Research Association of India, Pune (Maharashtra);
   (b) International Centre for Automotive Technology, Manesar (Haryana);
   (c) Indian Oil Corporation, Research and Development Centre, Faridabad (Haryana);
   (d) Indian Institute of Petroleum, Dehradun (Uttarakhand); and
   (e) Vehicle Research Development Establishment, Ahmednagar (Maharashtra).

These institutions can be authorized to carry out such tests for giving certificates of Type Approval and Conformity of Production to emission control equipment manufacturers or products. As published by the CPCB for diesel engines, the Compliance and Testing Procedure can be followed."

5.0 Standby Power Generation Manufacturers History

In India, Players from the Czech Republic, companies like Skoda, SEMT Pielstick and Man engines slow speed engine manufacturers came into India in the year before 1970, with a Higher MW range of engines for Power generation to big industries like cement, power, textile, cement. Kirloskar is credited with the manufacture of diesel engine indigenously as an import substitute after India attained independence. Kirloskar Group enjoyed one of the highest growth rates in Indian history. As the demand for Kirloskar products proliferated across the nation, soaring markets queued for product diversification. With that notion, Kirloskar launched its first range of pumps. These revolutionary pumps were pivotal in bringing drinking water to various Indian cities. The venture was yet another successful venture of the company, which further laid the foundation of establishing 'Kirloskar Oil Engines Ltd.' in 1946.

Like any other visionary venture, the company focused its energies on going beyond boundaries to put India on the international map. Consequently, the company collaborated with SEMT Pielstick, France, to market their products in India and subsequently manufacture them in India with technical collaboration.

Ashok Leyland was founded in 1948 intended for the manufacture of Austin Cars India. Automobile subsequently ventured in commercial vehicles like trucks and buses and became one of the market leaders and started the Power generation business as a new vertical as Ley Power of late in 1990s.

In 1962, Cummins had a tie-up with Kirloskar Oil engines to manufacture their high sped engines for the Indian market; during that period, Kirloskar Cummins did several mini power station projects of 1 -10 MW within the year 1988. Greaves Cotton Limited, which was incorporated in India in 1922, required two Enfield India units to enhance that sore strengths in engine manufacture and marketing. During the year 1995-96, the company signed a joint venture agreement with SAME SpA Italy to manufacture Diesel Engines. During the year 1998-99, the company began the commercial production of diesel engines in SAME Greaves Ltd at Ranipet, a joint venture with SAME Deutz Fahr SpA.

The Industrial revolution starting from the late 1990s and opening up of the market to the imported products let the foreign manufacturers enter the growing market like India, which allowed them to get some market share from the growing market demand as the rate of increase in demand for power was more than the power production by the Power generation companies. As seen in history, the increase in industrialization allows the people for employment. It increases their Standard of livings, and the earlier luxuries at one point in time for the individuals became necessary.

With the increase in industrialization came the need for faster communication modes to meet up to the industries' speed of requirements, which led to the various communication methods other than the standard landlines and the government-run postal departments. As it is said that need is the driver for innovation, the first mobile introduction came into being in 1995, after which we have never looked back.

The mobile revolution started in 1995, about more than two decades then, India has emerged as the world's second-largest telecom market by subscribers. It remains among the fastest-growing in the world. Barring essential commodities, no other product or service has a base of a billion consumers. With the above sectors having the growth path which was much more than the government plan for creating the infrastructure to support them, again the need for power increased in multi-folds, which made companies venture into the standby power generation market to support the industrial growth and the telecom growth which continued and during that period since the pollution was not much. The air quality was much improved today due to various reasons that included lesser housing and commercial spaces.

Of late in the year, after the rapid growth in the IT space, Industrial space and Mobile space, the increase in demand for the housing and commercial spaces started picking up. In turn, reduced the green covers in the major metropolitan cities, and the pollution content coming out of the Diesel generating sets started contributing more towards the unhealthy environment. Even though the Government had various plans to monitor the air quality and control pollution, but more stringent norms were required to be put in place to control the air quality and provide a sustainable environment for all. Various countries in

Europe and the US started their standards for controlling their emissions coming out the diesel engines used in cars from 1992 onwards. The US's environmental protection agency was subsequently introduced to the stationary diesel engine market in the TEIR category.

Similarly, Europe also started to apply stringent emission policies place from 2000 onwards. There has been a decade in getting the emission strategies started in India. We started globalization during the 1990s, and the other countries in comparison had already achieved their industrialization growth by then and were much stabilized. More to add the population of our country compared to Europe and the US put together was more at that time and now.

In the year 2000, India came up with the first emission norms for the Diesel generating sets; after a lengthy study done by the Indian Institute of Science Bangalore, central pollution control board and other pollution monitoring agencies, came up to a conclusion that the 60% of the pollution on nitrous oxide, carbon monoxide hydrocarbons and the particulate matter come out of the stationary generating sets. This law, however, was only implemented in the later stage dues to the simultaneous implementation of the sound emission norms of the generating set. During that time, there were lots of suppliers of Diesel generating sets coming from export. This law was acting as a deterrent/speed breaker to their original strategic action plans on the marketing and sales of the generating sets, as they had to create an establishment here which was an additional cost and also to type test each of the engine that was sold along with the conformity of performance to conducted every year for the models sold in India. This was also applicable for sound insulated canopies up to 1000kva. However, subsequently, the was enforced upon, and the emission standards came into action.

Regarding the testing infrastructure, the Government created testing laboratories that tested the engines as the standard operating procedures issued by the central pollution control board using the ISO 8178 standards.

1. Automotive Research Association of India, Pune (Maharashtra);
2. International Centre for Automotive Technology, Manesar (Haryana)
3. Indian Oil Corporation, Research and Development Centre, Faridabad (Haryana);
4. Indian Institute of Petroleum, Dehradun (Uttarakhand)
5. Vehicle Research Development Establishment, Ahmednagar (Maharashtra).

All of these labs had a capacity for testing not more than 660mKW.

The emission compliance in the stationary diesel engine generating sets came in two forms one complying from 19mKw onwards to 800mKW, and one above as greater than 800mkW. In the former case, the engines would have to be type tested for the emissions and conformity of the engine's performance for each model sold during the year tested by one of certifying agency out of the five approved testing agencies as given above. As seen from above, the manufacturer's ratings had to get it approved in engine manufacturers test lab in India and abroad after the due approval of the test lab from the implementing agency CPCB. For diesel engines greater than 800mkW engines, the Government of India's notification permitted the manufacturers to import the engines with self-declaration and emission testing to be conducted at the state level central pollution control boards after the installation of the Diesel generating set in the projects. As Indian testing agencies did not possess the required dyno for testing of the engine greater than 800mKw.

6.0 Objective of the study

1. To critically anaylze the effect of Indian Sustainable Environment Policy and
2. To empirically analyze the effect of Sustainable Environment Policy on Standby Power Generation Infrastructure.

7.0 Standby Power Generation Major Players In Indian Market

Major Engine Players in the Indian Market	Generator OEM
1) Cummins India limited	1) Sudhir, Powerica , Jackson
2) Kirloskar Oil Engines	2) Sold through dealers
3) Greaves engines	3) Many generating set OEMs
4) Ashok Leyland	4) Many Generating set OEMs
5) Caterpillar Engines	5) GAINWELL and GMMCO
6) Perkins Engine	6) Sterling,Supernova, Captiva
7) Escorts	7) Many GOEMS
8) Volvo	8) Sterling , Supernova, Paikane
9) Volvo -Eicher	9) Many OEMS
10) Tata	10) Many OEMs
11) MTU	11) Sterling , Captiva

7.1 Standby Power Generation Market Volume Statistics

Looking at the volume of the alternators sold for the Diesel generating set industry as given below for a period of the 2008-2018 and the data of the diesel generating sets for past 5 years as provided in Table 2.

Table 2 provides the historical volume of diesel generators trends 2013-2020. It shows clearly that there has been a downside in the year 2014 reasons easily attributed to the introduction of the emission norms for less than 800mKw popularly known as CPCB II which is equivalent to the Tier III norms of EPA .

8.0 Standby Power Generation Market Overview

Standby Power Generation market witnessed a slowdown in 2020 as we could see CAGR at 10 per cent or less. Market consumption pattern dropped in the numbers drastically in 2009-10 in the range of 250kva -500Kva due to the economic crisis seen during that period, similarly a reduction of the market size to the extent of 25% during the year 2013-14, and 2014-15 the period CPCB II was introduced.
However, we suddenly saw a growing market trend to the more prominent nodes due to India's data centres and IT sector growth. The market was surprised by a critical economic driver in the country called "Demonetization" announced by the Government in 2016 because market demand significantly reduced.

Overall 2020 DG market registering early double-digit degrowth vs FY19. This decline is mainly due to a massive drop in demand for DG units from the telecom segment, driving the market for the last few years, clocking around 90000 Units per year.

The other market, which is the range between 250Kva - 1010 kva, has been more or less flat in this year. This subdued demand is observed to be spread around, with almost all end-user segments registering negative or flat growth numbers. This year has seen a De-growth of 10%-14% in the higher Kva Range.

It is expected that the current economic slowdown to bottom out by the end of this year with gradual recovery starting from next year expected supported by the lagged effect of monetary policy easing and improved business sentiments from much anticipated big-ticket announcements of various policy reforms in the coming year.

9.0 Market Drivers

In this Covid Scenario, there have been sectors wherein some of the sectors have seen the growth, which may not impact the growth of the diesel generator market to a great extent but surely will add to the numbers at the degrowth period. Many Covid hospitals are coming up increasing the requirements by more than 10% of the medium-range generators. The banking sector has been showing a sign of revival compared to the last two year; with more bank branches opening up across the country, the need for standby power increases.

10. Recommendation and Suggestion

Due to the overall economic slowdown, the business sentiment continues to be subdued even after the Government announces various reforms. The corporate tax cut and bank recapitalization were a few of the central Government's critical measures in the recent past. However, the project investment decisions continue to get delayed, which has affected the HHP segment the most. Lower Kva (without telecom) and medium kVA segments were relatively less affected with around -5% degrowth (volume terms). Going forward, we expect this factor to continue restraining the market growth with some signs of revival starting only from the last quarter of this financial year.

For achieving the said policy requirements following points needs to be looked into from the point of achieving the objectives of NCAP for Sustainable Environment Policy . As this policy will not only effect the Diesel engine market in India .

The India diesel genset market size stood at $1,105.7 million in 2019, and it is projected to demonstrate a CAGR of 12.5% during the forecast period (2020–2030). The growth in the manufacturing sector of India, along with the rising demand for power for commercial applications, are the major factors driving the growth of the India diesel genset industry.

Commercial applications are further subcategorized into retail establishments, telecom towers, hospitals, hotels, and others. Among these, telecom towers are likely to witness the highest demand for diesel generators during the forecast period, on account of the constant requirement for prime power and backup power in the telecom sector. In addition, government initiatives, including the National Digital Communications Policy, are expected to draw investments of nearly $100 billion in the telecom sector by 2022 and facilitate the installation of an additional 100,000 mobile towers, to cater to the requirements of a compounding subscriber base.

It is not only going to effect the new business but also have an impact on the Industrial , IT , Housing , Infrastructure , Software and Data Centres to a large extent which could be to the tune of anywhere between one and half times to two times according to the mitigated options for the same requirements to achieve the emissions as per the Policy definitions defined out by the government .

To understand the effect of the emission policy on the diesel engine , we will need to understand the process required to be done to control the emission , which will be explained in brief, this will help us to understand the cost impact to the consumers and its effect on the sales of the Diesel Powered Standby Power Generation industry.

Going to the basics of the methods of operation of the Standby Powered Generation with diesel engine, the fuel is self-ignited as it is injected into air that has been heated by compression of the fuel resulting high temperature combustion / Explosion inside the cylinder which enable the piston to create the power stroke , which is mechanical energy converted to electrical energy with the help of the coupled generator. During the process of combustion , as we are already aware that energy is constant and is converted from one form of energy to another form , in this case it's is from chemical to mechanical and finally to electrical , in the process the process of conversion only converts not more than 40% of the heat energy in the fuel , the balance energy is lost majorly in heat in exhaust , and balance to heat rejection to coolant, radiation. Carbon and hydrogen construct the origin of diesel fuel like most fossil fuels. For ideal thermodynamic equilibrium, the complete combustion of diesel fuel would only generate CO2and H2O in the engine's combustion chambers (Prasad and Bella ,2010). However, for many reasons (the air-fuel ratio, ignition timing, turbulence in the combustion chamber, combustion form, air-fuel concentration, combustion temperature), it becomes difficult to achieve the theoretical situation thus resulting, in several harmful products are generated during combustion. The most significant harmful products are CO, HC, NOx, and PM.

From the Indian context , environmental protection has advanced to become a topic of central concern related to country as a whole , but also being committed to reduce the GHG and contribute to sustainable living for the human beings in this universe . Many agencies and organizations are tried to prevent damage to the environment and human health caused by greenhouse gases and pollutant emissions. Due to the adverse effects of diesel emissions on health and environment, government formulated policies to reduce permissible exhaust emission standards. To achieve these standards the involvement of diesel engine industry is required to a great extent .

In order to achieve the reduced particulate matter and Nox reductions , the diesel engine would require new technologies as listed below

a. Provision of Ultra low Sulphur diesel to reduce the Sulphur di-oxide emission ,

b. Reduction of Nox Emissions :

   Nox emission control in the diesel engines, most of the research and studies have been carried out to reduce the Nox as they are the major contributor to the emission content for the engine exhaust. From the researches so far, exhaust gas recirculation (EGR), lean NOx trap (LNT), and SCR are the most known technologies to substantially eliminate the NOx emissions. On Engine Technologies : Fuel System Upgrading the engine technology for the early combustion of the diesel to reduce the Nox emission, which calls for not only electronic controls for the fuel injection but also On -Engine solutions providing Exhaust Gas circulation . However, it cannot achieve by itself high NOx conversion efficiency and reduction which meets current emission standards for incredibly heavy-duty diesel engines. Also, due to the decrease in temperature in the cylinder, this technology generates an increase in HC and CO emissions. (Bauner et al., 2009). This has surely has a limitation on the power ratings of the engines meaning that these could be used only up to a certain power range of engines. Lean Nox reduction technology, also called NOx-storage-reduction Alternatively, NOx adsorber catalyst (NAC) has been developed to reduce NOx emission, especially under lean conditions. During lean engine conditions, Lean Nox technology stores NOx on the catalyst bed. Under the fuel optimised conditions, it releases and reacts the NOx by the usual three way type reactions. These Nox reduction catalysts mainly consist of three key components, an oxidation catalyst (Pt), a NOx storage environment like barium (Ba) or any oxides, along a reduction catalyst (Rh). In this technology, the most used catalyst is platinum because of its capability to reduce Nox at low temperature and stability with water and sulphur, which is a part of the exhaust gas. Like exhaust gas recirculation technology, the Nox reduction technology is insufficient for the larger powered diesel engines, which requires Selective catalytic reduction technology (SCR).

c. Particulate Emissions : The combustion process in the diesel engine increases the particulate matter in the process of low temperature combustion process to reduce the NOx emissions This paves way for the provision of the off Engines technology to reduce the particulate matter coming out of exhaust of the engine. Diesel particulate filtesr (DPFs) are used to remove the particulte emission from the exhaust gas by adopting a physical filtration method/ They are made of either cordierite ($2MgO–2Al_2O_3–5SiO_2$) or silicon carbide (SiC) honeycomb structure monolith with the tubular construction blocked at alternate ends. At each end, the plugged channels force the diesel particulates to move through the porous substrate walls, which act as a mechanical filter. As the particulate matter/soot particles pass through the tubes, they are transported into the pore walls by diffusion, where they latch themselves. This filter has a large of parallel tubes. The thickness of the tube walls is typically 300–400 micrometre. Their cell density specifies the size of the typical value: 100–300 cpsi (Kuki et al. 2004; Ohno et al. 2002; Tsuneyoshi and Yamamoto 2012). The optimum porosity design of the filters enables the exhaust gas to pass through their walls without much hindrance and sufficiently impervious to collect the particulate species. As the filter becomes increasingly saturated with exhaust soot, a layer of soot is formed on the surface of the tube walls, which helps in providing highly efficient surface filtration for the following operating phase. As the filters accumulate soot/particulate matter, it builds up back pressure, resulting in increased fuel consumption and power

reduction. To prevent these unwanted effects, the DPF has to be regenerated by burning trapped soot/ particulate matter.
Two types of regeneration processes can achieve this active regeneration and passive regeneration. Active regeneration is a process that is periodically applied to DPFs in which trapped soot is removed through controlled oxidation with O2 at 550 C or higher temperatures (Jeguirim et al. 2005). In an active regeneration of DPF, soot/ particulate matter is oxidized intermittently by heat supplied from outside sources, a flame-based burner or a spark with the fuel. The burning of PMs captured in the filter occurs as soon as the soot accumulation in the filter reaches a set limit as per the engine backpressure limits. The higher regeneration temperature and a large amount of heat supply are severe problems for active regeneration. While the temperatures as high as the melting point of the filter generates to failure of DPF, the necessity of energy for heating increases the production cost of the system due to complex supplements. These adverse effects regard active regeneration as being out of preference. Unlike active regeneration, passive regeneration of DPF, the oxidation of PMs occurs at the exhaust gas temperature by catalytic combustion promoted by depositing suitable catalysts within the trap itself. PM is oxidized by an ongoing catalytic reaction process that uses no additional fuel. Under a temperature range between 200 degree C and 450 degree C, small amounts of NO2 will promote the continuous oxidation of the deposited carbon particles. This forms a basis of the continuously regenerating trap (CRT) which uses NO2 continuously to oxide soot within relatively low temperatures over a DPF (York et al. 2007, Allansson et al. 2002)

10.1 Gas Based Standby Power Generation

Shift to gas-based generators either by retrofitting existing generators for partial usage of gas (a mixture of Diesel and gas) or buying new gas-based generators
Point of Contention: Facts

1. Availability of Natural Gas as per the reports, India currently accounts for 0.4% of global natural gas reserves and approximately 1% of production. [KPMG Oil & Gas Overview 2010], and there is still a large gap between supply and demand. Gas Plants finding a shortfall in the requirement to the tune of 84.01 mmscmd, with an average gas supply to the tune of 31mmscmd to the gas power plants as per the source from CEA.
2. Natural Gas Pipe Line network

The total length of Authorized Natural Gas Pipelines 30,769 Km
The total length of Operational Natural Gas Pipelines 16,994 Km
The total length of Under Construction Natural Gas Pipelines 13,775 Km
Source: Petroleum Natural Gas Regulatory Board web site
updated 2020

The above information shows that natural gas is already is scarce for replacing the operating gas-based power plants.

11. Policy Impact on the Standby Power generation Infrastructure.

The impact of the policy would attract a huge investment on the retro-fitment of the emission control equipment , due to the reason as this technology is not available in India as of now , and the components used of the reduction will call for an huge investment on the standby power generation infrastructure. The India diesel genset market size stood at $1,105.7 million in 2019, and it is projected to demonstrate a CAGR of 12.5% during the forecast period (2020–2030)(Perscient & Strategic Intelligence, the capital cost outlay to the firms for the after treatment would be to the tune of $1100 million on the infrastructure for the existing units which has been present for past more than 10 years . With respect to the impact on the DG infrastructure for would be to the tune of additional expense of more than $300 billion every year from the time the policy comes to effect .

12. Suggestion

1. To have set norms based on the usage of the diesel generating sets , as seen from the statistics most for of the urban cities have been having a steady power supply with hardly any power cuts , resulting the lower usage of the generating sets in these places . This would not only give the industry a boost in terms of the reduction of additional investments requirements for the retrofit emission control device, but also could invest the same amount in the expansion, manpower and other requirements during the difficult times of recovering economy.
2. To promote Gas based generating sets in the TIER II and TIER III cities wherein the manufacturing industries have their set ups and the power supply in these places are yet to reach the levels of the TIER I cities /urban cities for stability and reliability. This will not only increase the efficiency of the industry as a whole but also reduce the particulate matter in the environment . To achieve this the Government needs to provide the gas infrastructure and also give incentive to the industry for the use of Gas generating sets along with the reduction the custom duty for the import of the gas engines and reduction in the gas supply tax structure.

13. Direction For Further Study

This study has a limitation and is restricted to the Indian Sustainable Environment Policy and effect on Standby Power Generation Infrastructure, further studies could done on other policies of the government and its effect on the specific sectors .

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Abbreviations

GHG: Green House Gases
GW: Giga Watts
LED: Light emitting Diode
PM10: Inhalable particles, with diameters that are generally 10 micrometers and smaller
PM2.5 : Particulate matter fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller.
SOX: Sulphur-Dioxide.
Nox : Nitrous Oxide
O3: Ozone
DG : Diesel Generators
TERI : The Energy and Resources Institute
NCR: National Capital Region
CPCB : Central Pollution Control Board
SPCB: State Pollution Control Board
MOEF &CC : Ministry of Environment ,Forest and Climate Change
EPCA: Environment Pollution and Control Authority
GRAP: Graded Response Action Plan
NAAQS: National Ambient Air Quality Standards
NAMP: National Air Quality Management Proggramme
CAAQMS: Continious Ambient Air Quality Monitoring Station
NH3: Ammonia
CO : Carbon Monoxide
AQI: Air Quality Index
ARAI : Automotive Research Association Of India
NAPCC: National Climate Plan on Climate Change
NCAP: National Clean Air Proggramme
CEPI: Comprehensive Environmental Pollution Index
OCEMS: Online Continuous Emission/Effluent Monitoring System
mmScmd: Million Metric Standard Cubic Meter Per Day