ECO CITY:

POLLUTION SENSORIUM TO MONITOR AND CONTROL VEHICULAR EMMISION USING BIG DATA ANALYTICS AND SMART NUMBER PLATES

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Abstract—

This paper refers to the advanced use of sensors, pollution detection and regulation techniques. These techniques unleash a plethora of dimensions to future research and application. The basic idea is about regulation of major vehicle pollutants, their depiction and analysis at the primary and secondary level using graphical representation and extensive detailed causatives and after effects of these pollutants.

In this day and age, the idea of a 'Smart' and 'Eco' city has become synonymous with sustainable growth. It has become extremely vital for the future scope of development of rapidly growing economies like India. This idea coalesces perfectly with countries which believe in investment on technical integration and strive to make themselves huge manufacturing hubs. This idea is an answer to our immediate requirements of economic growth as well as environmental safety.

A prototype of a Pollution Indicator and Control Device (PICD) will be used for the regulation and control of emissions. A binding government ordinance will bring these devices into extensive use by its application into every new vehicle being introduced onto the roads. Its application and impact will gradually extend to 85% of the vehicles plying in areas under regulation in a period of 7-10yrs.This idea calls for a prototype and experimental implementation at any feasible scale.

Index Terms:

PICD – Pollution indication and control device
SAMR- Strategic Analytical Modulated Response
VUIDN-Vehicle Unique Identification number
Master-Slave: IC- Integrated circuit components as functional pair

INTRODUCTION:

The concept all started with an idea for automation and strategic implementation of advanced comprehensive pollution control devices that could help in easy but strict enforcement of control for vehicular emission standards and would be directly answerable to all the air pollution caused by them by implementation of a five step process as described below:

The proposed device to be developed and implemented in the process would be **PICD (Pollution Indication and Control Device)** having a three step functioning namely control, sensing and indication, safety and warning that would operate under a pre-defined set Rules of Procedure named as **SAMR (Strategic Analytical Modulated Response)**. It would define in detail the algorithm of functioning, safety measures, synchronization standards and troubleshooting properties.

The project would consist of a 5-step split-up hierarchical process:-

1. Adsorbents and filters:

This involves the modular integration of basic air filters at an exhaust level that purifies unburnt carbon, sooty particles and suspended particulate pollutants. Use of an integral and partially replenishable system of basic air pollutant adsorbents such as charcoal, silica and activated carbon along with specialized ones pertaining to city specific pollution standards to be used along with the filters to act as a comprehensive solution to primary regulation of vehicular exhaust pollution at a small scale. These used with suitable additives in the fuel that reduces unnecessary smoke as

well as use of bio-fuel in near future would really prove to be beneficial at larger scale.

2. Sensors And IC's:

This would consist of an embedded network of sensors that are specific to the major air pollutant levels of that city where the PICD devices would be brought into initial use. It can be the use of CO2 sensors like MQ-7 to that of NOx and other particulate pollutant sensors that would detect the adsorbed pollutant levels in the adsorbate and would forecast an early response about replenishment of the adsorbent refills or a signal response using RFID for warnings on high polluting levels involving beeps, led indicators to initiating a reminder over mobile messaging or email to the internal car radio receiver.

3. Transmission and retrieval, Security and The Smart Number Plate:

This whole device would add an cost of about Rs.7500 for individual consumers and existing improvements in the present radio towers, mobile telephone network towers to that even of the signaling system at strategic traffic locations around the city that would involve the master components to receive the emitted signal responses by the slave chip systems embedded in the PICD of vehicles. This would add to the signal transmission using radio frequency along with added security with a small information sensor in the smart number plate in simple harmony with the slave IC that helps in confirming identity of the vehicles and helps in preventing criminal activities associated after vehicular thefts due to the non-removable PICD associated with the engine and exhaust components and specified previously by the manufacturers itself. For the benefit of those who haven't heard of OBD II. OBD II - is on board diagnostics standard II for vehicles. This basically can be viewed as a computer inside your car which can give several parameters like speed, engine RPM, coolant pressure, fuel level input. With those cryptic values we can derive meaningful values like fuel usage, carbon emission level, driving pattern etc..

The idea is to help governments to use OBD II to control pollution by tracking the Carbon emission. This can be done by installing smart number plates into vehicles. A number plate with a Micro-controller (something like Arduino). The Arduino micro-controller can be imagined as computer in layman terms but small capacity and it can be programmed with "C" like code.
Programs in Cloud can derive meaningful values and send alerts to both government committees/boards who track pollution and to the vehicle owner so he/she can fix or even change the vehicle to reduce carbon emission.

4. Big Data Analytics:

This is the overall server control over these chips, sensors and transmission mechanism and involves creation of a huge and reliable database in the process. This creates specific synchronizations between the government law enforcing bodies along with the vehicle users who are able to log in into their privatized account to be aware of their pollution levels and regulation safety standards. It would specify dates to visit vehicular pollution testing centers periodically and without fail for requisite fuel additives and adsorbent refueling. The system would include extensive network of radio towers, satellites, blade servers and cloud storage as the umbrella program.

Big data analytics examines large amounts of data to uncover hidden patterns, correlations and other insights. With today's technology, it's possible to analyze your data and get answers from it almost immediately – an effort that's slower and less efficient with more traditional business intelligence solutions.
A typical Big Data use case in the modern Enterprise includes the collection and storage of sensor data, executing data analytics at scale, generating forecasts, creating visualization portals, and automatically raising alerts in the case of abnormal deviations or threshold breaches.

This will focus on an implemented use case: monitoring and analyzing air quality sensor data using Axibase Time-Series Database and R Language.

Steps taken by the data science team to execute the use case:

- Collect historical data from AirNow into ATSD
- Stream current data from AirNow into ATSD
- Use R Language to execute data analytics and generate forecasts for all collected entities and metrics
- Create Holt-Winters forecasts in ATSD for all collected entities and metrics
- Build a visualization portal
- Setup alert and notification rules in the ATSD Rule Engine

Cloud Computing:

Cloud computing is a type of computing that relies on *sharing computing resources* rather than having local servers or personal devices to handle applications.

5. Government Regulations:

Set up of a government body or an existing one, which will regulate the functioning of the program PICD. The program would refer to a protocol name SAMR which targets the enforcement and enactments towards several existent vehicular pollution acts. The initial process would start with passing an ordinance by the CPCB-Central Pollution Control Board of India which will bring this program into commission under the Environmental Protection Act.

This will bring about a permanent solution to mitigate vehicular pollution and reduce emission levels thereby substituting instant systems which provide only short-term and dissatisfactory results.

OBJECTIVES OF THE PAPER:

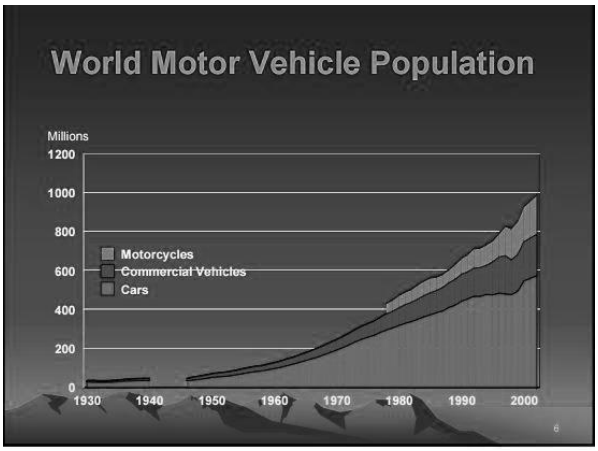
- To develop research methodologies and present concept of technology, perception and meaning of automated pollution control devices and detailed warning systems.
- To take Integrated circuits and Arduino out into the real vehicle-computer interaction world.
- To determine the particular Hardware, Software requirements and ideas to make PICD (Pollution Control and Indication Device) a reality.
- To basically define the most improved and compatible hardware requirements dynamically emulated to be configured to specific vehicle-city interaction systems due to use of pre calculated pollutant quantities.
- To give a new dimension and progress a step into a generation forward of modern green vehicle engineering, pollution control and management and Eco-City: Converting a dream into a reality.

SCOPE OF STUDY:

This proposed concept aims towards a permanent solution at an individual to community pollution safety standard scale focusing on reducing emissions specifically from all grades of vehicles plying on road and mitigation measures to control and regulate air pollution at individual city scale then extending the scope of the project into country and global levels. The initiative is expected to bind to the heart and minds of the public as a solution to the never ending problem.

PROBLEM FACED:

We see that there is no alternative if the people don't check their vehicle's pollution level. During the period of checking some people are caught by the traffic police and some are not. But during the period of no checking people ride their vehicle which causes the emission beyond the maximum threshold pollution level on the road with any fear. According to the survey in cities like Delhi and Gurgaon the quality of the air is very poor means to take a breath in these cities regularly will be a cause of serious threats to the human's health. Emission from the motor vehicle is reasonable for the two by third of air pollution which causes of many environmental issues like climate change, global warming etc. and affects human's health in terms of diseases. Therefore there is a need of system which can detect the level of percentage of carbon present in the smoke and control automatically and easily without any need of hard work. Population of India is increasing day by day and definitely the number of vehicles are also increasing in correspond too. If we don't give our efforts to reduce the emission from motor vehicle right from today, it will be a very serious threat to human's life and nature. So I proposed system to detect and control the emission level from the motor vehicle.

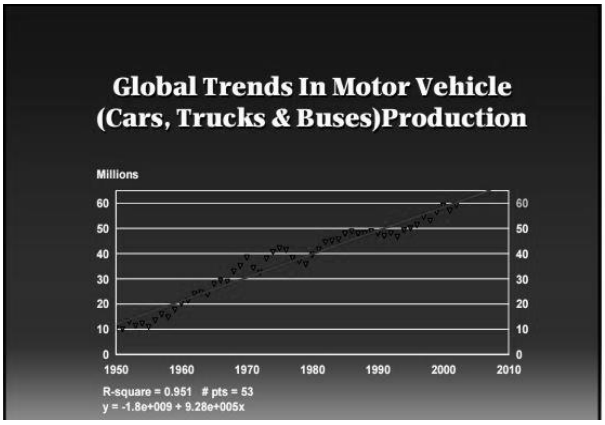


Source: World vehicle purchase and usage statistics UN

THEORY:

Despite rising interest in sustainability in many locations, and demonstrated capacity for urban design solutions, cities today are having difficulty investing in systems that are long term and ecological. Whatever the explanation, the simple concept of investing in sustainability and resiliency has become extremely difficult for cities to put into action. Policies, plans, and projects are assessed for their abilities to provide short-term financial returns, and economic valuations are based on narrowly structured Cost-benefit analyses from the perspectives of single stakeholders. To achieve ecological and economic sustainability, decision-making needs to be clearly guided by a holistic perspective. This entails a new accounting and

assessment framework that allows every city to adopt a lifecycle perspective and make investments. That is fair to all stakeholders, effective at preserving all assets (manufactures, natural, human and social), and good for long-term fiscal health. This entails adopting a new range of indicators and benchmarks for assessing and rewarding the performance of all stakeholders. Longer time horizons and lifecycle analysis of the implications of policies and investment options and strategies among multiple stakeholders will need to be carried out to reflect a truer, more inclusive, and more complete picture. All capital assets (Manufactured, natural, human and social) and the services they provide should be appropriately valued or priced—and monitored through indicators. The combination of indicators should be viewed as a whole, so that the qualitative dimensions of city life (cultural, historical, and aesthetic) cannot be ignored when assessing costs and benefits.



Source: Wiki production trends

ECO CITY:

An eco-city is a city built from the principles of living within environment means. The ultimate goal of many eco-cities is to eliminate all carbon waste (zero-carbon city), to produce energy entirely through renewable resources, and to merge the city harmoniously with the natural environment; however, eco-cities also have the intentions of stimulating economic growth, reducing poverty, using higher population densities, and therefore obtaining higher efficiency, and improving health. The concept of the "eco-city" was born out of one of the first organizations focused on eco-city development, "Urban Ecology."

Several sets of criteria for Eco-cities have been suggested, encompassing the economic, social, and environmental qualities that an eco-city should satisfy. The ideal "eco-city" has been described as a city that fulfills the following requirements:

- Operates on a self-contained economy, resources needed are found locally
- Has completely carbon-neutral and renewable energy production
- Has a well-planned city layout and public transportation system that makes the priority methods of transportation as follows possible: walking first, then cycling, and then public transportation.
- Resource conservation—maximizing efficiency of water and energy resources, constructing a waste management system that can recycle waste and reuse it, creating a zero-waste system
- Restores environmentally damaged urban areas
- Ensures decent and affordable housing for all socio-economic and ethnic groups and improve jobs opportunities for disadvantaged groups, such as women, minorities, and the disabled
- Supports local agriculture and produce
- Promotes voluntary simplicity in lifestyle choices, decreasing material consumption, and increasing awareness of environmental and sustainability issues

In addition to these initial requirements, the city design must be able to grow and evolve as the population grows and the needs of the population change. This is especially important when taking into consideration infrastructure designs, such as for water systems, power lines, etc. These must be built in such a way that they are easy to modernize (as opposed to the dominant current strategy of placing them underground, and therefore making them highly inaccessible).

Each individual eco-city development has also set its own requirements to ensure their city is environmentally sustainable; these criteria range from zero-waste and zero-carbon emissions

A city based approach:

A development program that supports cities in making good decisions and implementing these decisions using all levers of city influence and control. A planning philosophy that recognizes the fundamental role played by local ecological assets in the health and wealth of cities and their surrounding rural communities. An action-oriented network that provides city leaders with the full support of national governments.

The international development community (including the World Bank), and global best practice cities.

An expanded platform for collaborative design and decision-making:

A three-tier platform that enables a city to collaborate:
(1) As a model corporation, engaging all city departments.
(2) As a provider of services, engaging residents, businesses, and contractors; and
(3) As a leader and partner within the urban region, engaging senior government officials, utilities, rural Settlements, private sector stakeholders, nongovernmental, organizations, and academia.

***Green City Index*: Share of Citizens Walking, Cycling or Taking Public Transportation to Work**

Overall Ranking	*Europe*		*U.S. and Canada*	
	City	*%*	*City*	*%*
1	Copenhagen	33.0	San Francisco	20.1
2	Stockholm	93.0	Vancouver	24.5
3	Oslo	57.0	New York City	37.2
4	Vienna	68.0	Seattle	13.2
5	Amsterdam	83.0	Denver	7.4
6	Zurich	62.0	Boston	18.3
7	Helsinki	44.7	Los Angeles	9.7
8	Berlin	54.8	Washington DC	17.9
9	Brussels	37.0	Toronto	28.0
10	Paris	40.4	Minneapolis	7.9
11	London	63.0	Chicago	15.3
12	Madrid	54.0	Ottawa	28.4

Global Sherpa, 2012 (www.globalsherpa.org); Sources: *European Green City Index*, *U.S. and Canada Green City Index*. Economist Intelligence Unit.

Source: www.globalsherpa.org

A one system approach:

Integrated infrastructure system design and management focusing on enhancing the efficiency of Resource flows in an urban area. Coordinated spatial development that integrates urban forms with urban flows, combining land use, urban design, urban density, and other spatial attributes with infrastructure scenarios Integrated implementation by:
(1) Correctly sequencing investments,
(2) Creating a policy environment
That enables an integrated approach,
(3) Coordinating a full range of policy tools,
(4) collaborating, with stakeholders to align key policies with long-term goals,
(5) Targeting new policies to reflect the
Differing circumstances involved in urbanization in new areas and in improving existing urban areas. Provide just-in-time training and capacity building, arrange for multiple opportunities for local professionals to become comfortable with the one-system approach, and make the best use of technical support so it may be truly transformative and valuable.
Conduct a series of integrated design workshops to create important opportunities for planners, designers, and engineers to come together and use new methods and information; a series of short workshops can clarify goals and set targets; the long-term planning framework can guide, design, and stimulate creative solutions.
Explore design solutions and prepare a concept plan for review; an integrated design process should be used to generate alternative
Proposals on ways to design, construct, and manage the project; an intensive, multiday urban systems design charrette can facilitate
The integrated design process; the integrated design process should culminate in a recommended concept plan for implementation, including any policy reforms.
Align a full set of policy tools to ensure successful implementation, in collaboration with stakeholders, to sequence and enable a one system approach and to coordinate actions across sectors; a strategic action plan can be prepared to clarify who is responsible for what tasks and to show how policies interact. Use a lifecycle costing method or tool to understand the lifecycle costs and cash flows.
Develop and adopt indicators for assessing the four types of capital and for benchmarking performance.
Forecast the impacts of plausible changes in climate, markets, resource availability, demographics, and technology by hosting a
Forecast workshop.
Implement a catalyst project in ways that protect and enhance capital assets and reduce vulnerabilities; the best way to learn the
Accounting methods is in practice in a catalyst project; a base case scenario may be developed as a benchmark for comparing
Alternative approaches
Monitor feedback results, learn, and adapt to improve performance.

FOCUS ON VEHICULAR POLLUTION ANALYSIS, MITIGATION AND WARNING FOR ECO CITIES:

Passenger vehicles are a major pollution contributor, producing significant amounts of nitrogen oxides, carbon monoxide, and other pollution. In 2013, transportation contributed more than half of the carbon monoxide and nitrogen oxides, and almost a quarter of the hydrocarbons emitted into our air.

Not all pollution produced by cars is the same. In fact, there are two types of pollution discharged by petrol vehicles. Exhaust emissions: including dangerous gases such as carbon monoxide, oxides of nitrogen, hydrocarbons and particulates.

In general, an exhaust gas is a gas emitted through a combustion process. The exhaust gas is actually a combination of many different gases: N_2, CO_2, H_2O and O_2. Though some are harmless, there are few that are harmful and are considered major pollutants. One of the most dangerous of these is CO, carbon monoxide.

Combustion products. In theory, you should be able to burn a 'hydrocarbon' fuel (petrol, diesel, gas etic) with air in an engine to produce just carbon dioxide (CO_2) and water (H_2O). The rest of the exhaust would be the nitrogen (N_2) that came in with the air.

Exhaust gas or flue gas is emitted as a result of the combustion of fuels such as natural gas, gasoline, petrol, biodiesel blends, diesel fuel, fuel oil, or coal. According to the type of engine, it is discharged into the atmosphere through an exhaust pipe, flue gas stack, or propelling nozzle. It often disperses downwind in a pattern called an **exhaust plume**.

It is a major component of **motor vehicle emissions** (and from stationary internal combustion engines), which can also include:

- Crankcase blow-by
- Evaporation of unused gasoline

Motor vehicle emissions contribute to air pollution and are a major ingredient in the creation of smog in some large cities. A 2013 study by MIT indicates that 53,000 early deaths occur per year in the United States alone because of vehicle emissions. According to another study from the same university, traffic fumes alone cause the death of 5,000 people every year just in the United Kingdom.

Exhaust Gas Composition:

The largest part of most combustion gas is nitrogen (N_2), water vapor (H_2O) (except with pure-carbon fuels), and carbon dioxide (CO_2) (except for fuels without carbon); these are not toxic or noxious (although carbon dioxide is a greenhouse gas that contributes to global warming). A relatively small part of combustion gas is undesirable noxious or toxic substances, such as carbon monoxide (CO) from incomplete combustion, hydrocarbons (properly indicated as C_xH_y, but typically shown simply as "HC" on emissions-test slips) from unburnt fuel, nitrogen oxides (NO_x) from excessive combustion temperatures, and particulate matter (mostly soot).

Exhaust Gas Temperature:

Exhaust gas temperature (EGT) is important to the functioning of the catalytic converter of an internal combustion engine. It may be measured by an exhaust gas temperature gauge. EGT is also a measure of engine health in gas-turbine engines (see below).

Cold Engines:

During the first two minutes after starting the engine of a car that has not been operated for several hours, the amount of emissions can be very high. This occurs for two main reasons:

Rich air-fuel ratio requirement in cold engines:

When a cold engine is started, the fuel does not vaporize completely, creating higher emissions of hydrocarbons, nitrogen oxides and carbon monoxide, which diminishes only as the engine reaches operating temperature. The duration of this start-up phase has been reduced by advances in materials and technology, including computer-controlled fuel injection, shorter intake lengths, and pre-heating of fuel and/or inducted air.

Inefficient catalytic converter under cold conditions:

Catalytic converters are very inefficient until up to their operating temperature. This time has been much reduced by moving the converter closer to the exhaust manifold and even more so placing a small yet quick-to-heat-up converter directly at the exhaust manifold. The small converter handles the start-up emissions, which allows enough time for the larger main converter to heat up. Further improvements can be realized in many ways, including electric heating, thermal battery, chemical reaction preheating, flame heating and superinsulation.

Main motor vehicle emissions:

Mono-nitrogen oxides NO and NO_2 (whether produced this way or naturally by lightning) react with ammonia, moisture, and other compounds to form nitric acid vapor and related particles. Small particles can penetrate deeply into sensitive lung tissue and damage it, causing premature death in extreme cases. Inhalation of such particles may cause or worsen respiratory diseases such as emphysema and bronchitis. It may also aggravate

existing heart disease. In a 2005 U.S. EPA study the largest emissions of NOx came from on road motor vehicles, with the second largest contributor being non-road equipment which is mostly gasoline and diesel stations. The resulting nitric acid may be washed into soil, where it becomes nitrate, which is useful to growing plants.

Volatile organic compounds:

When oxides of nitrogen (NOx) and volatile organic compounds (VOCs) react in the presence of sunlight, ground level ozone is formed, a primary ingredient in smog. A 2005 U.S. EPA report gives road vehicles as the second largest source of VOCs in the U.S. at 26% and 19% are from non-road equipment which is mostly gasoline and diesel stations. 27% of VOC emissions are from solvents which are used in the manufacturer of paints and paint thinners and other uses.

Ozone:

Ozone is beneficial in the upper atmosphere, but at ground level, ozone irritates the respiratory system, causing coughing, choking, and reduced lung capacity. It also has many bad effects throughout the ecosystem.

Carbon Monoxide:

Carbon monoxide poisoning is the most common type of fatal air poisoning in many countries. Carbon monoxide is colorless, odorless and tasteless, but highly toxic. It combines with hemoglobin to produce carboxyhemoglobin, which is ineffective for delivering oxygen to bodily tissues. In 2011, 52% of carbon monoxide emissions were created by mobile vehicles in the U.S.

Hazardous air pollutants (toxics):

Chronic (long-term) exposure to benzene (C_6H_6) damages bone marrow. It can also cause excessive bleeding and depress the immune system, increasing the chance of infection. Benzene causes leukemia and is associated with other blood cancers and pre-cancers of the blood.

Particulate matter (PM_{10} and $PM_{2.5}$):

The health effects of inhaling airborne particulate matter have been widely studied in humans and animals and include asthma, lung cancer, cardiovascular issues, and premature death. Because of the size of the particles, they can penetrate the deepest part of the lungs. A 2011 UK study estimates 90 deaths per year due to passenger vehicle PM. In a 2006 publication, the U.S. Federal Highway Administration (FHWA) state that in 2002 about 1 per-cent of all PM_{10} and 2 per-cent of all $PM_{2.5}$ emissions came from the exhaust of on-road motor vehicles (mostly from diesel engines).

Carbon dioxide (CO_2):

Carbon dioxide is a greenhouse gas. Motor vehicle CO_2 emissions are part of the anthropogenic contribution to the growth of CO_2 concentrations in the atmosphere which is causing climate change. Motor vehicles are calculated to generate about 20% of the European Union's man-made CO_2 emissions, with passenger cars contributing about 12%. European emission standards limit the CO_2 emissions of new passenger cars and light vehicles. The European Union average new car CO_2 emissions figure dropped by 5.4% in the year to the first quarter of 2010, down to 145.6 g/km.

Water vapor:

Vehicle exhaust contains much water vapor.

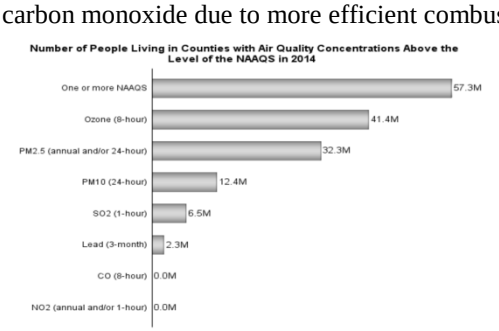
Water recovery:

There has been research into ways that troops in deserts can recover drinkable water from their vehicles' exhaust gases.

Pollution Reduction:

Emission standards focus on reducing pollutants contained in the exhaust gases from vehicles as well as from industrial flue gas stacks and other air pollution exhaust sources in various large-scale industrial facilities such as petroleum refineries, natural gas processing plants, petrochemical plants and chemical production plants. However, these are often referred to as flue gases. Catalytic converters in cars intend to break down the pollution of exhaust gases using a catalyst. Scrubbers in ships intend to remove the sulfur dioxide (SO_2) of marine exhaust gases. The regulations on marine sulfur dioxide emissions are tightening, however only a small number of special areas worldwide have been designated for low sulfur diesel fuel use only.

One of the advantages claimed for advanced steam technology engines is that that they produce smaller quantities of toxic pollutants (e.g. oxides of nitrogen) than petrol and diesel engines of the same power They produce larger quantities of carbon dioxide but less carbon monoxide due to more efficient combustion.



Health Studies:

Researchers from the University of California, Los Angeles School of Public Health say preliminary results of their statistical study of children listed in the California Cancer Registry born between 1998 and 2007 found that traffic pollution may be associated with a 5% to 15% increase in the likelihood of some cancers. A World Health Organization study found that diesel fumes cause an increase in lung cancer.

Types of emissions in vehicles:

Emissions of many air pollutants have been shown to have variety of negative effects on public health and the natural environment. Emissions that are principal pollutants of concern include:

- Hydrocarbons - A class of burned or partially burned fuel, hydrocarbons are toxins. Hydrocarbons are a major contributor to smog, which can be a major problem in urban areas. Prolonged exposure to hydrocarbons contributes to asthma, liver disease, lung disease, and cancer. Regulations governing hydrocarbons vary according to type of engine and jurisdiction; in some cases, "non-methane hydrocarbons" are regulated, while in other cases, "total hydrocarbons" are regulated. Technology for one application (to meet a non-methane hydrocarbon standard) may not be suitable for use in an application that has to meet a total hydrocarbon standard. Methane is not directly toxic, but is more difficult to break down in a catalytic converter, so in effect a "non-methane hydrocarbon" regulation can be considered easier to meet. Since methane is a greenhouse gas, interest is rising in how to eliminate emissions of it.
- **Carbon monoxide (CO)** - A product of incomplete combustion, carbon monoxide reduces the blood's ability to carry oxygen; overexposure (carbon monoxide poisoning) may be fatal. Carbon Monoxide poisoning is a killer in high concentrations.
- **NO_x** - Generated when nitrogen in the air reacts with oxygen at the high temperature and pressure inside the engine. NO_x is a precursor to smog and acid rain. NO_x is the sum of NO and NO_2.[1] NO_2 is extremely reactive. NO_x production is increased when an engine runs at its most efficient (i.e. hottest) part of the cycle.
- **Particulate matter** – Soot or smoke made up of particles in the micrometer size range: Particulate matter causes negative health effects, including but not limited to respiratory disease and cancer.
- **Sulfur oxide (SO_x)** - A general term for oxides of sulfur, which are emitted from motor vehicles burning fuel containing sulfur. Reducing the level of fuel sulfur reduces the level of Sulfur oxide emitted from the tailpipe.
- **Volatile organic compounds (VOCs)** - Organic compounds which typically have a boiling point less than or equal to 250 °C; for example chlorofluorocarbons (CFCs) and formaldehyde. Volatile organic compounds are a subsection of Hydrocarbons that are mentioned separately because of their dangers to public health.

Emission control:

Engine efficiency has been steadily improved with improved engine design, more precise ignition timing and electronic ignition, more precise fuel metering, andcomputerized engine management.

Advances in engine and vehicle technology continually reduce the toxicity of exhaust leaving the engine, but these alone have generally been proved insufficient to meet emissions goals. Therefore, technologies to detoxify the exhaust are an essential part of emissions control.

Air Injection:

One of the first-developed exhaust emission control systems is secondary air injection. Originally, this system was used to inject air into the engine's exhaust ports to provide oxygen so unburned and partially burned hydrocarbons in the exhaust would finish burning. Air injection is now used to support the catalytic converter's oxidation reaction, and to reduce emissions when an engine is started from cold. After a cold start, an engine needs an air-fuel mixture richer than what it needs at operating temperature, and the catalytic converter does not function efficiently until it has reached its own operating temperature. The air injected upstream of the converter supports combustion in the exhaust head pipe, which speeds catalyst warm up and reduces the amount of unburned hydrocarbon emitted from the tailpipe.

Exhaust gas recirculation:

In the United States and Canada, many engines in 1973 and newer vehicles (1972 and newer in California) have a system that routes a metered amount of exhaust into the intake tract under particular

operating conditions. Exhaust neither burns nor supports combustion, so it dilutes the air/fuel charge to reduce peak combustion chamber temperatures. This, in turn, reduces the formation of NO_x.

Catalytic converter:

The catalytic converter is a device placed in the exhaust pipe, which converts hydrocarbons, carbon monoxide, and NO_x into less harmful gases by using a combination of platinum, palladium and rhodium as catalysts.

There are two types of catalytic converter, a two-way and a three-way converter. Two-way converters were common until the 1980s, when three-way converters replaced them on most automobile engines. See the catalytic converter article for further details.

Evaporative Emission Control:

Evaporative emissions are the result of gasoline vapors escaping from the vehicle's fuel system. Since 1971, all U.S. vehicles have had fully sealed fuel systems that do not vent directly to the atmosphere; mandates for systems of this type appeared contemporaneously in other jurisdictions. In a typical system, vapors from the fuel tank and carburetor bowl vent (on carbureted vehicles) are ducted to canisters containing activated carbon. The vapors are adsorbed within the canister, and during certain engine operational modes fresh air is drawn through the canister, pulling the vapor into the engine, where it burns.

Remote Sensing Emission testing - Field studies

Some US states are also using a technology developed by Dr. Donald H. Stedman of the University of Denver, which uses infra-red and ultraviolet light to detect emissions while vehicles pass by on public roads, thus eliminating the need for owners to go to a test center. Stedman's invisible light flash detection of exhaust gases is commonly used in metropolitan areas, is offered by the US-Swedish company OPUS Inspection and becoming more broadly known in Europe.

Use of emission test data:

Emission test results from individual vehicles are in many cases compiled to evaluate the emissions performance of various classes of vehicles, the efficacy of the testing program and of various other emission-related regulations (such as changes to fuel formulations) and to model the effects of auto emissions on public health and the environment. For example, the Environmental Working Group used California ASM emissions data to create an "Auto Asthma Index" that rates vehicle models according to emissions of hydrocarbons and nitrogen oxides, chemical precursors to photochemical smog.

Percent Change in Emissions

	1980 vs 2014	1990 vs 2014	2000 vs 2014
Carbon Monoxide (CO)	−69	−62	−46
Lead (Pb)	−99	−80	−50
Nitrogen Oxides (NO_x)	−55	−51	−45
Volatile Organic Compounds (VOC)	−53	−38	−16
Direct PM_{10}	−58	−19	−16
Direct $PM_{2.5}$	---	−25	−33
Sulfur Dioxide (SO_2)	−81	−79	−70

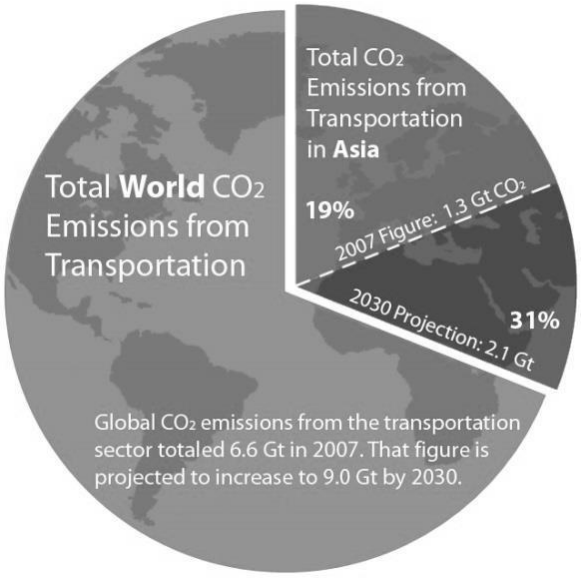
Notes:
1. --- Trend data not available
2. Direct PM10 emissions for 1980 are based on data since 1985
3. Negative numbers indicate reductions in emissions
4. Percent change in emissions based on thousand tons units

SOURCE: Emission statistics PCI

GAS SENSORS:

CO_2 Sensor

NDIR sensors are spectroscopic sensors to detect CO_2 in a gaseous environment by its characteristic absorption. The key components are an infrared source, a light tube, an interference (wavelength) filter, and an infrared detector. The gas is pumped or diffuses into the light tube and the electronics measures the absorption of the characteristic wavelength of light. NDIR sensors are most often used for measuring carbon dioxide. The best of these have sensitivities of 20–50 PPM.**Products: K-30 10,000ppm CO2 Sensor, K-33 ELG 1% CO2 + RH/T Data Logging Sensor:**



SO_2 Sensor

Electrochemical gas sensors are gas detectors that measure the concentration of a target gas by oxidizing or reducing the target gas at an electrode and measuring the resulting current.

Products: 3SP-SO2-20 (upto 20ppm), 4-SO2-2000 gas sensor (0-2000ppm SO2).

CO Sensor

Products: **3SP-CO-1000, IOT-CO-1000.**

NO_2 Sensor

Products: MiCS 2710 NO_2 Sensor, NO2 2E Gas Sensor.

POLLUTION CONTROL SYSTEMS:

Particulate Control Systems

Retrofitting power plants with the EERC's Advanced Hybrid filter technology removes more than 99.99% of fine particles from exhaust gases of coal-fired power plants, incinerators, and mineral-processing facilities as well as recaptures valuable product from process gases in the pharmaceutical and chemical industries. Particulate Test Combustor

Wet Flue Gas Desulfurization System

The EERC's pilot-scale wet flue gas desulfurization system for sulphur control is 7 inches in diameter, with a height of approximately 20 ft. The scrubber is equipped with packing to ensure the scrubber solutions do not run down the walls of the scrubber. The column is made of plastic material, while the spray nozzles are made of stainless steel.

Electrostatic Precipitator (ESP):

A single-wire, tubular ESP, shown schematically in the figure below, provides a specific collection area of 125 at 300°F. Gas velocity through the ESP is 5 ft/min. Plate spacing for the unit is 11 in. The ESP has an electrically isolated plate that is grounded through an ammeter, allowing continuous monitoring of the actual plate current to ensure consistent operation of the ESP. The tubular plate is suspended by a load cell and is used to monitor rapping efficiency. In addition, sight ports are located at the top of the ESP to enable online inspection of electrode alignment; sparking, rapping, and dust build up on the plate. The ESP was designed to facilitate thorough cleaning between tests so that all tests begin on the same basis.

Pulse-Jet Baghouse

The baghouse vessel is a 20-in.-inside diameter chamber that is heat-traced and insulated, with the flue gas introduced near the bottom. Three 13-ft by 5-in. bags provide an air-to-cloth ratio of 4 ft/sec. The air-to-cloth ratio can be increased by removing or adding shorter bags. A variety of bags can and have been used for tests, including 100% GORE-TEX® with a GORE-TEX membrane. These bags provide a particulate collection efficiency that is exceedingly high, >99.995%. Each bag is cleaned separately with its own diaphragm pulse valve.

Selective Catalytic Reduction (SCR) System

In order to control NOx emissions from the CTF, a SCR reactor was installed ahead of the ESP. The reactor contains three catalyst layers and utilizes anhydrous ammonia as the reductant. The system is designed for a face velocity of 5 m/s and an operating temperature of 600° to 800°F, which can be controlled. Sampling ports are available at the inlet, outlet, and between the catalyst layers to facilitate gas sampling. Catalyst can be easily removed and installed to allow the use of any catalyst desired. The reactor can be quickly bypassed to accommodate specific testing needs. This reactor can also be easily moved and installed on the particulate test combustor as well.

CO_2 Capture

Another major focus of the EERC's program is the development of technologies to reduce CO2 emissions into the atmosphere. The EERC's Partnership for CO2 Capture is identifying and commercializing a range of CO2 capture technology systems that can be implemented into the electric utility fleet to meet environmental emission constraints and the requirements of CO2 sequestration. The technologies tested in the pilot-scale systems at the EERC included solvent scrubbing, solid sorbents, and oxygen-fired combustion.

Types of outdoor air pollution:

There are many different types of outdoor air pollution. Measuring them all would be too expensive so regulators focus on a smaller group of common air pollutants, sometimes known as the criteria pollutants. The following is a summary of the main types of outdoor air pollution.

Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a criteria pollutant and contributes to the formation of photochemical smog, with significant impact on human health. Breathing raised levels of NO_2inflames the lining of the lungs and reduces immunity to lung infections. The result is wheezing, coughing, colds, flu and bronchitis, and more frequent and intense asthma attacks. The major source of NO_2 is from combustion of fossil fuels: coal, oil and gas. Most of the nitrogen dioxide in cities comes from motor vehicle exhaust. Other sources of nitrogen dioxide are petrol and metal refining, electricity generation from coal-fired power stations, other manufacturing industries and food processing.

Sulfur Dioxide

Sulfur dioxide (SO_2) is a criteria pollutant. Short-term exposure to SO_2, ranging from 5 minutes to 24 hours, is linked with adverse respiratory effects including bronchoconstriction and increased asthma symptoms. SO_2 is also a major precursor to fine particulate soot and acid rain. Primary sources include fossil fuel combustion at power plants and other industrial facilities. Secondary sources include industrial processes such as extracting metal from ore, and the burning of high sulfur-containing fuels by locomotives, large ships, and off-road equipment.

Carbon Monoxide

Short-term exposure to carbon monoxide (CO) can reduce the oxygen-carrying capacity of the blood, leading to shortness of breath, dizziness and even death. This is especially dangerous for people with heart disease who already have a reduced capacity for carrying oxygenated blood to the heart. The majority of CO emissions in urban environments come from mobile sources e.g. cars, trucks, ships and off-road vehicles. Fossil fuel power stations are another major contributor, as well as fires and biogenic sources in rural areas.

Ozone

In the upper atmosphere ‘good’ ozone (O_3) protects life on Earth from the sun's ultraviolet rays. At ground level ‘bad’ ozone is a criteria pollutant that is a significant health risk, especially for people with asthma. It also damages crops, trees and other vegetation and is the main component of smog. Ground level ozone is not emitted directly; it is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight. Emissions from industrial facilities and electric utilities, vehicle exhaust, gasoline vapors, and chemical solvents are some of the major sources of NOx and VOC.

Particulate Matter

Airborne particulate matter (PM) is categorized into different size fractions. Total Suspended Particulate (TSP) includes all particle sizes and is a good measure of nuisance dust. PM10 (particles $\leq$ 10 microns) is a criteria pollutant and is a serious health risk because PM10 particles can penetrate the lungs. PM2.5 (particles $\leq$ 2.5 microns) is also a criteria pollutant which has even greater health impact due to risk of penetration deeper into the respiratory system. Research has linked particulate pollution to lung and heart disease, strokes, cancer, and reproductive harm. Large particles come from natural sources e.g. soil and organic matter stirred up by wind or human activity. Small particles are by-products of combustion e.g. emissions from vehicles and power stations. Particles from these sources react with other gases in the atmosphere to create particles of various chemical compositions. Gas to particle conversion can also produce fine particulate.

List of pollution sensors for air specifically designed for any particular components-their commercial names and models:

There are various brands and designs of air pollution sensors available today. There are specific indoor and outdoor sensors, as well as universal sensors. Air Casting is one of the popular brands today. Its most popular model is the Air Beam, which is a palm-sized monitor that measures fine particulate matter (PM2.5) in the air. The Air Casting system has an android app available, which connects to its monitors and allows you to share and record data on the go. These mobile sensors can easily be connected to your backpack, and purse. Air casting also gives you the blueprints, and a list of materials and where you can get them from to allow citizens to build their own air monitor.

Air Quality Egg is a sensor system designed to collect very high-resolution readings of nitrogen dioxide and carbon monoxide concentrations outside their home. A small electronic sensing system plugs into a USB and sends data over Wi-Fi. There are about 1228 public and mapped eggs across the world. Speck Sensor is an indoor air quality monitor that detects fine particulate matter in your surrounding environment. It is easily set up and readable. It is a stationary reader and must be plugged in.

TZOA is another popular brand which uses internal sensors to measure air quality, temperature, humidity, atmospheric pressure, ambient light and UV all in one wearable device. They currently have 2 models in the market and both can be connected with smartphone apps.

Future Movement:

The human race is now becoming more conscious about their health, lifestyle, and ecological footprint. With more studies and knowledge about our ecosystems, we are taking prevented measures in order to develop more sustainable ways of living. Having portable and affordable air pollution sensors allows us to be aware of how much pollution exists within our communities and neighborhoods. Through technological advancements this data is now measurable, recordable, and shared across the World Wide Web. This collection of data can help bring about change to our environmental policies. It can track areas of the city that carry higher pollution and risks. This can allow further studies to be conducted and new solutions to be proposed to mitigate these risks. These sensors can also help people guide people with respiratory and health conditions.

IC's available for air pollution control indication (component specific):

Vehicle emissions remain a major contributor to air pollution in cities worldwide. With global vehicle ownership projected to hit 2 billion by 2020, understanding the impact on air quality and human health is fundamental to future urban planning.

Roadside pollution monitoring equipment needs to be compact and real-time

Installing reference air quality monitoring systems based on gas analyzer technology is one way to measure road, motorway and highway emissions. But their cost and size limits the number of monitoring locations. In addition, analyzers log only every 30 or 60 minutes, which is often not sufficient temporal resolution for the measurement of air quality at traffic peaks. This places a heavy emphasis on modelling to complete the picture.

Aeroqual enables roadside networks and targeting of "hotspots"

Our emphasis on smaller, more cost effective monitors enables targeted and denser measurement of roadside emissions. Logging at two minute intervals allows a true picture of pollution at peak exposure. Whether it's measurement of particulate around tunnels, checking NO2 'hotspots', or long-term monitoring, we have a range of solutions for those building and managing roads and highways, as well as for organizations seeking to mitigate the impact of road transport on urban air quality. Dust monitors are used widely in industrial applications like quarries and mines, construction, bulk handling terminals, and waste treatment facilities. They are also used by researchers and consultants in air quality studies and environmental impact assessments. Cities and governments are deploying a network of monitors (e.g. for PM2.5 monitoring) as an alternative to high cost traditional monitoring equipment.

Benefits of continuous real-time monitoring:

Traditional sampling methods like high volume samplers are great for accurate measurement of dust and particulate matter at a fixed point in time or over a 24 hour period, but they cannot indicate exactly when an emissions event occurred. An industrial site needs to know immediately when a problem has occurred so they can put into practice control measures. Researchers and consultants need higher temporal resolution to give meaning to the data. A continuous real-time monitor from Aeroqual can be used in both these applications.

Free web-based data acquisition software

All monitors come with Aeroqual Cloud – web-based data and diagnostics software that connects us to our monitor wherever we may be. We connect to our data by using any web-enabled device simply by opening your web browser and entering your login details. The software allows us to see real-time data in table or chart format, run averages e.g. 1 hr., 8 hr., 24 hr., and download it to your computer. It also gives us access to remote diagnostics. The software is completely secure and we can assign access rights to any number of users. This device is intended to provide the user with a cost-efficient means of determining air quality. The sensor focuses on the five components of the Environmental Protection Agency's Air Quality Index: ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrous oxide. This device detects all of these pollutants except sulfur dioxide. The device also includes a town gas sensor to alert the user to gas leaks or the presence of flammable gases. Furthermore, a temperature and humidity sensor is included as these conditions can impact the performance of the gas sensors. We have yet to fully calibrate our device, but we have extracted data from sensor data sheets to make some preliminary estimation. The sensors used are relatively inexpensive and vary greatly from component to component so they need to be calibrated with known concentrations of the target gasses.

MATHEMATICAL MODEL:

TABLES, PROGRAMS AND SAMPLE APP ANALYSIS

Component Names:

AirBot

WaterBot

Sensordrone

Sensaris

PressureNet

Broadcom Microchip

IGeigie

Control and Power

- Arduino Uno
- 5V power supply
- RGB 16x2 LCD shield

Sensors

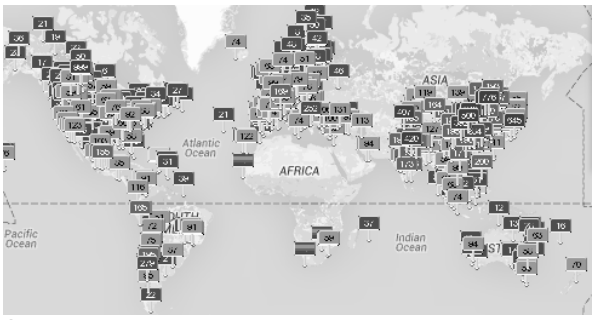
- Shinyei PPD42 Particulate Matter Detector
- MQ-2 Gas Sensor
- MQ-9 Gas Sensor
- MiCS-2714 Gas Sensor (NO2)
- MiSC-2614 Gas Sensor (Ozone)
- Keyes DHT11 Temperature and Humidity Sensor

Box and Assembly

- Access to 3D printer
- Solder Board
- 5V fan
- 10 to 15 wires of gauge 24

Source: Proposed prototype maximized model detailed diagram before input integration.

World vehicular air pollution distribution statistics:



Source: http://aqicn.org/map/world/#@g/6.5363/-529.0956/1z

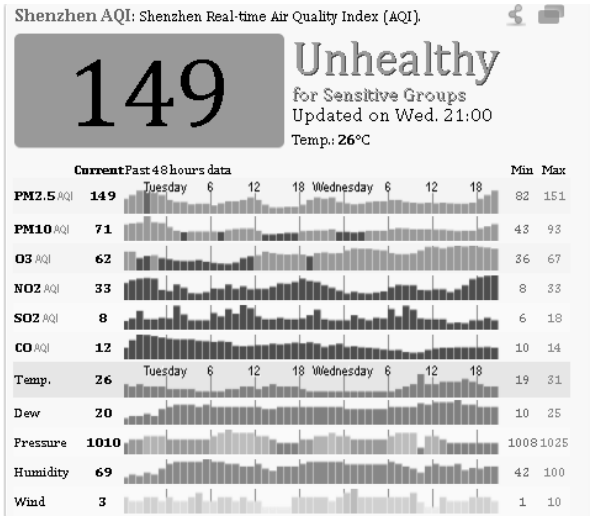
Specific countries as major contributors and under present observation:

Show 25 entries Search:

City	Pollution Index	Exp Pollution Index
Lucknow (Lakhnau), India	111.49	205.61
Kathmandu, Nepal	109.77	202.07
Accra, Ghana	108.10	198.12
Kingston, Jamaica	106.90	196.73
Guatemala City, Guatemala	102.30	187.57
Dhaka, Bangladesh	100.50	182.23
Jakarta, Indonesia	99.34	180.59
Lagos, Nigeria	98.85	189.39
Cairo, Egypt	97.90	180.01
Karachi, Pakistan	97.33	179.45
Faisalabad, Pakistan	96.12	178.22
Guangzhou, China	95.92	175.75
San Salvador, El Salvador	94.83	173.10
Kolkata, India	94.11	171.63
Mashhad, Iran	93.91	174.18
Yangon, Myanmar	93.51	173.93
Meerut, India	93.39	174.54
Ulaanbaatar, Mongolia	92.70	176.74
Bucharest, Romania	92.69	168.92
Tabriz, Iran	92.53	174.16
Mumbai, India	92.02	165.53
Novosibirsk, Russia	91.38	169.57
Moscow, Russia	91.10	164.99
Beirut, Lebanon	91.03	167.97
Tehran, Iran	90.96	170.06

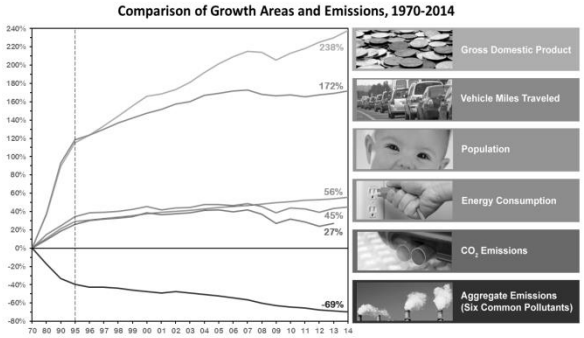
Source: India Today Worldwide Distribution Index

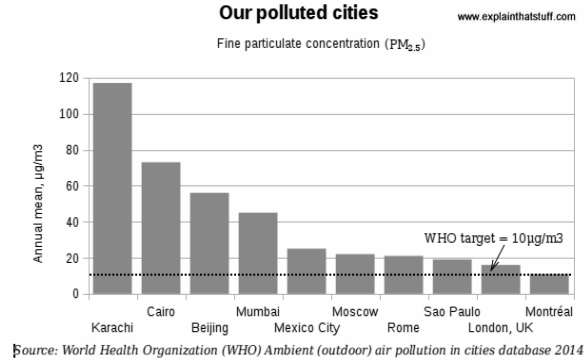
Urban air pollution status:



Source: Sample city pollution survey mapping

Air Pollution contribution percentage and characteristics by vehicles:

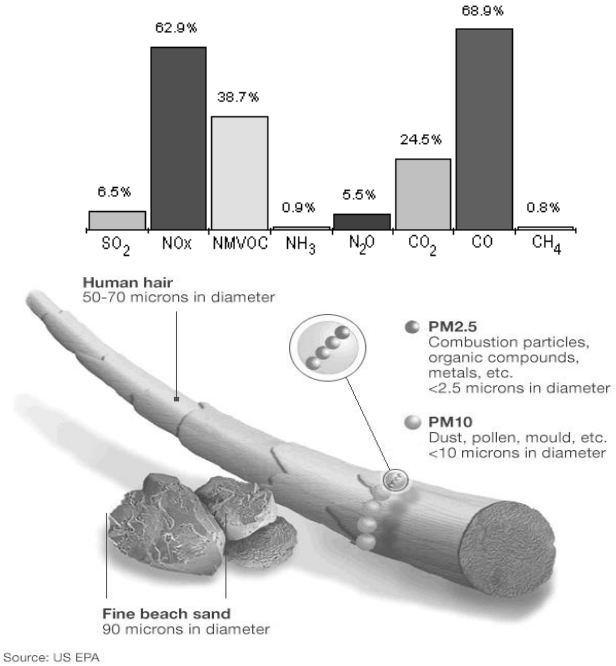




Source: World Health Organization (WHO) Ambient (outdoor) air pollution in cities database 2014

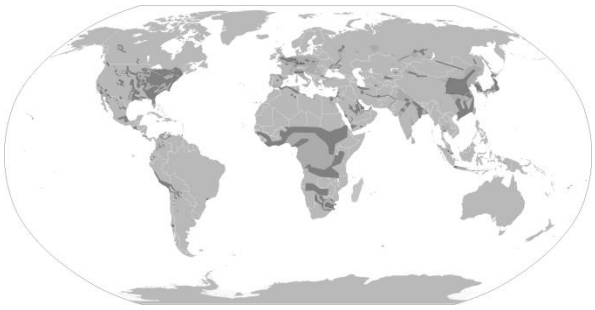
Source: WHO

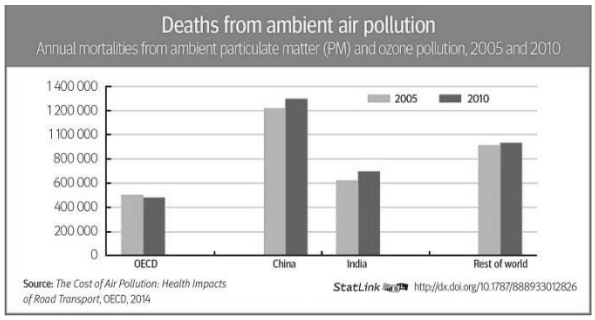
Particular component concentrations, factors, ill-effects and mitigation:



Source: Particulate matter size and contribution

Air pollutant distributions as per varied geographical divisions:



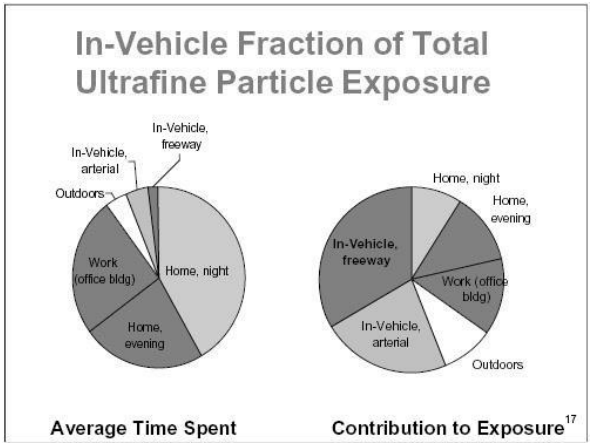


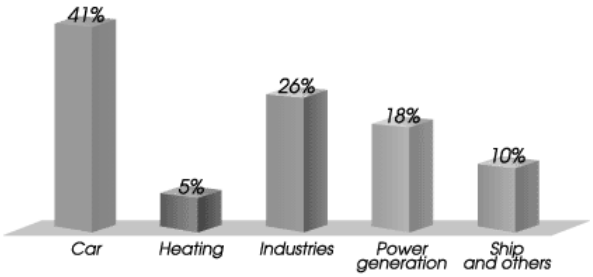
Percent Change in Air Quality

	1980 vs 2014	1990 vs 2014	2000 vs 2014
Carbon Monoxide (CO)	-85	-77	-60
Ozone (O_3) (8-hr)	-33	-23	-18
Lead (Pb)	-98	-97	-87
Nitrogen Dioxide (NO_2) (annual)	-60	-52	-43
Nitrogen Dioxide (NO_2) (1-hour)	-57	-45	-29
PM_{10} (24-hr)	---	-36	-30
$PM_{2.5}$ (annual)	---	---	-35
$PM_{2.5}$ (24-hr)	---	---	-36
Sulfur Dioxide (SO_2) (1-hour)	-80	-76	-62

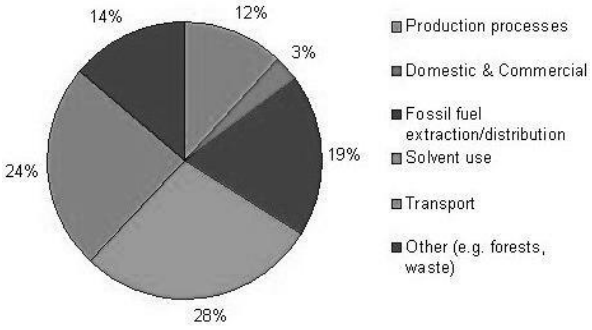
Notes:
1. --- Trend data not available
2. Negative numbers indicate improvements in air quality

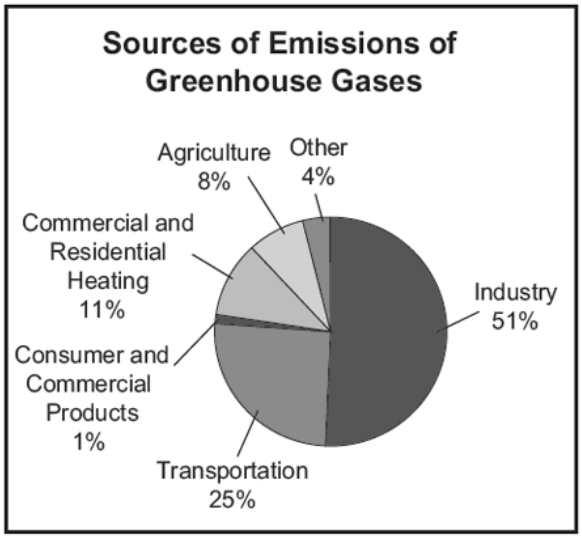
Sources: Air quality index worldwide

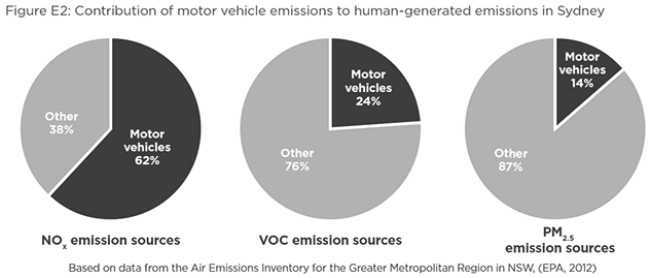




Source: tunza.eco-generation.org







PICD (Pollution Indication and Control Device) components detailed overview:

This proposed device is the vital component and prime part of the pollution control and indication system.

It directly contains the slave IC that consists of an Arduino Atmega8 microcontroller processor and chip which in turn communicates with the vehicle number plate identity verification mechanism stimulated response device RFID also known as the smart CATS protection.

The Near field communication refers to that of the verification of the identity of originality by a initiation sequence that sync. the smart key and remote, smartphone, vehicle dashboard, fuel pump no., engine no., smart number plate and the total info collected is transmitted over to the nearest radio wave receiver placed at traffic signals and radio towers for regular periodic communication governed by:

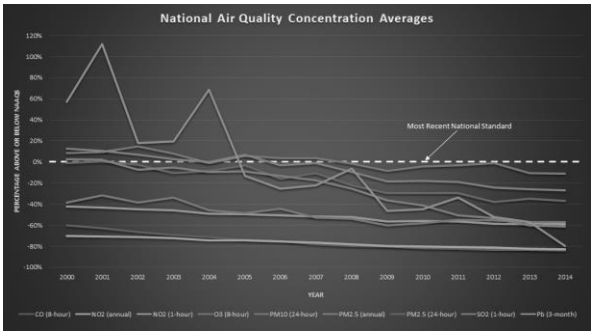
SAMR (Strategically Analytical Modulated Response) Protocol Overview:

Refers to the set of predefined rules for periodic communication and warnings, standard operating procedure and signal sync. and transmission retrieval coupled mechanism.

CHIP LEVEL COMMUNICATION SYSTEM OVERVIEW:

Master-Slave IC Systems:

Microcontroller ATMEGA 8: Here I used a microcontroller ATMEGA 8 in the system. It is an AVR 8 bit microcontroller. AVR stands for auxiliary voltage regulator. It is used to provide a protection from the probability of damage of equipment from over voltage or under voltage. It automatically cut off the power supply which is connected to the equipment for the protection. When I talk about the configuration it is low power and high performance microcontroller. It has 28 ports 23 ports are used for the I/O 4 ports is used for VCC and Ground and last port is used for RF. It has advance RISC architecture in which 130 important powerful instruction and most of them single clock cycle execution. It has 32*8 general purpose register. It has 8 kilobyte flash memory, 512 bytes EEPROM (Electrically Erasable Programmable Read Only Memory) and 1 kilobyte of internal SRAM (Static random Access Memory).



Source: Google pollution index

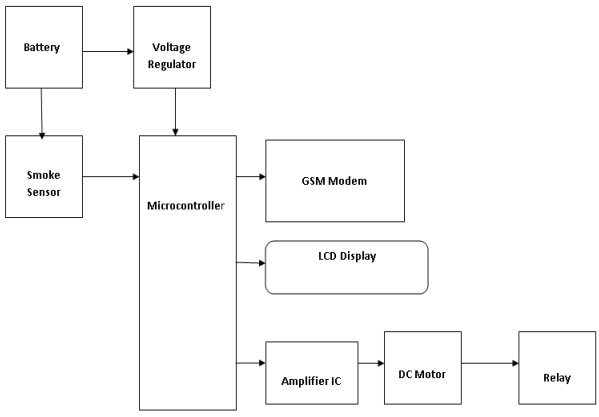
Smoke sensor:

Smoke sensor is a sensor which is used to detect the concentration of the carbon present in the smoke. It has three pin one is grounded and two others pins can call A and B both can be used as either an input and output simultaneously. Input is given across the heating pin to work correctly. A resistance is connected between output pin and ground pin to provide sensitivity to the sensor. When I talk about the inner part of the smoke sensor it contains heater and transducer. Smoke contains some molecule of water

When it released in to the environment so to vaporize the water molecule heater is used. Transducer is basically a transformer of one energy level to another. It converts the ppm (parts per million) into the voltage form.

Signal Control mechanisms:

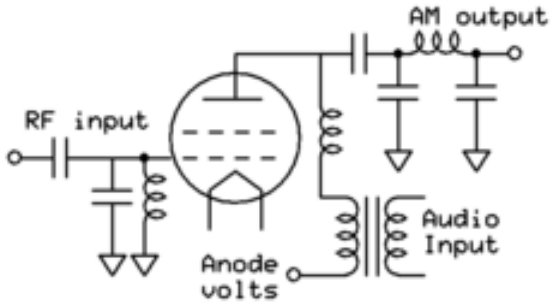
BLOCK DIAGRAM:



Radio-frequency identification (RFID) is the wireless use of electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects. The tags contain electronically stored information.

An RFID reader is a network connected device (fixed or mobile) with an antenna that sends power as well as data and commands to the tags. The RFID reader acts like an access point for RFID tagged items so that the tags' data can be made available to business applications.

For many applications, such as tracking parts for just-in-time manufacturing, companies could justify the cost of tags—a dollar or more per tag—by the savings an RFID system could generate. And when RFID was used to track assets or reusable containers within a company's own four walls, the tags could be reused.



Base station, RFID, and Tower Control Communication Systems:

Materials:

at first let's take a look for what we need :

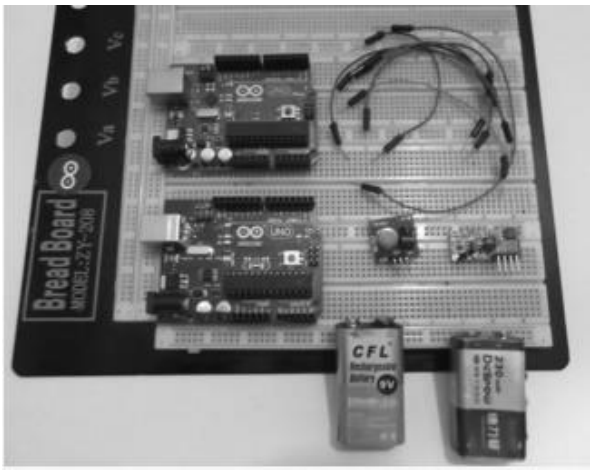
1) 2 Arduino Board "I used Uno"

2) RF 315MHz or 433MHz transmitter-receiver module .

3) jumper wire .

4) BreadBoard .

5)External Power supply (9V Battery *2) "Optional" .



This module has a specification for:

Transmitter:

Working voltage: 3V - 12V for max. power use 12V
Working current: max Less than 40mA max , and min 9mA
Resonance mode: (SAW)
Modulation mode: ASK
Working frequency: Eve 315MHz Or 433MHz
Transmission power: 25mW (315MHz at 12V)
Frequency error: +150kHz (max)
Velocity : less than 10Kbps
So this module will transmit up to 90m in open area .

Receiver:

Working voltage: 5.0VDC +0.5V
Working current: ≤5.5mA max
Working method: OOK/ASK
Working frequency: 315MHz-433.92MHz
Bandwidth: 2MHz
Sensitivity: excel –100dBm (50Ω)
Transmitting velocity: <9.6Kbps (at 315MHz and -95dBm)
the use of an optional antenna will increase the effectiveness of your wireless communication. A simple wire will do the trick.

Vehicle registration and identification strategies availabilities with suggested improvements:

Regional Transport office: RTO

The simple idea is the widening of the vehicle registration and the driving license database that meets international standards making it capable enough of handling big data over cloud servers that keeps track record of all above mentioned vehicular data into the sync and allowing its access into two means, one handled by the administrator and the other as a personal user account secured by a password token.

VUIDN (Vehicle Unique Identification number) with integrated chip provisioning:

The benefits would be manifold as:

Pollution control and management database

-control using devises

-data transmission using sensors

-periodic warnings

Vehicle added security features against theft and crime:

-any discrepancy observed in the sync data would lead to formation of a doubtful red token calling for immediate identification and tracking to curtail any criminal activities relating to stolen or misuse of vehicles

SMART SYNCHRONIZATION:

A voltage regulator is used to provide the pulsating nature of DC to the microcontroller because microcontroller doesn't work on variable DC. Smoke sensor detects the carbon pollutants which are exhausted or released from the vehicle into the environment. The smoke contains carbon pollutants which affect the quality of the air and cause the air pollution. The output of the smoke sensor is in the form of analog voltage so there is need of analog to digital convertor to convert analog voltage into the digital voltage. The process of the system is very simple. The output of the smoke sensor then will go to the microcontroller. Microcontroller checks the condition if vehicle attains the maximize threshold level , DC motor will go to on state and relay which is connected between ignition wire and lock of vehicle will be activated by which engine go to the off state and a SMS through GSM modem go to registered mobile no by which we can get an alert notification.

Communication between PCID and SMART LICENSE PLATES:

It will be governed by the near field communication of nearby present slave systems.

SLAVE Transmission of Pollution response update:

The signal received from the smoke sensor is now compared with the pre-defined threshold pollution

level in the smoke released from the vehicle. As the microcontroller attains the value of the output greater than the value of maximum level of carbon present in the smoke the microcontroller triggers the system, as the system triggers the relay which is connected between the lock and the spark plug is activated due to this the close path is formed between lock and spark plug. As the close path is formed the engine goes to the off state. The main motive of the system to control the emission from the vehicle is now achieved. There are three level of indicator in which there LED is used to indicate the level of emission. The LEDs are Green, Yellow and Red. Green led indicates that the level of emission from the motor vehicle is in under. The yellow LED is used to indicate that the level of emission is now increasing. The Red LED is used to indicate that the level of emission is now beyond the standardized value. As the Red LED glows the system is trigged and the engine goes to off state.

National Level and City Level DBMS creation and advantages:

- **Criminal record database with broader information acceptance and access for access, control and permissions**
- **Personal Vehicle Id No VUIDN coupled with engine no. and (Driving License) DL NO. in online database**
- **Personal Vehicular Carbon Footprint Account (with Login and periodic Remainders)**
- **Personalized remote tracking, tracing, GPS locater and Remote locking access systems**

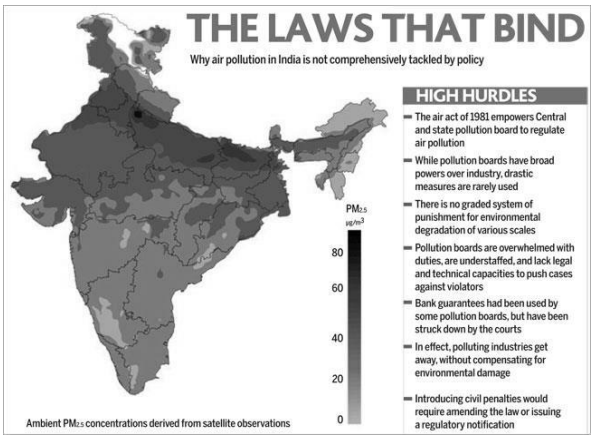
3steps Remainder and Warning System:

As the vehicle achieved the value of emission greater than the value of the maximum threshold pollution level GSM modem send the notification alert to the owner's registered mobile no via SMS. There are three levels Level 0, Level 1, Level 2. At level 0 no notification will send to the owner. At level 1 the notification will send to the owner that the emission level of the vehicle is increasing so there is a need to check your vehicle's pollution level as soon as possible via message on to the mobile. The second step would refer to imposing a fine with a deadline for adsorbents refill and emission check. The third level will have as strict enforcement as offence under vehicle possession laws and the Driving License will get invalidated automatically.

All these attempts could only be made possible with:

NETWORKING, ORGANIZATION AND MANAGEMENT OF CLOUD SERVERS INVOLVING BIG DATA ANALYTICS.

GOVERNMENT STANDARDS AND LEGISLATIVE PROVISIONS:



Source: Indian Legislature

Summary on Air Prevention and Control of Pollution Act (1981) of India

It is also a comprehensive legislation with more than fifty sections. It makes provisions, interalia, for Central and State Boards, power to declare pollution control areas, restrictions on certain industrial units, authority of the Boards to limit emission of air pollutants, power of entry, inspection, taking samples and analysis, penalties, offences by companies and Government and cognizance of offences etc..

The Act specifically empowers State Government to designate air pollution areas and to prescribe the type of fuel to be used in these designated areas. According to this Act, no person can operate certain types of industries including the asbestos, cement, fertilizer and petroleum industries without consent of the State Board.

The Board can predicate its consent upon the fulfillment of certain conditions. The Air Act

apparently adopts an industry wide "best available technology" requirement. As in the Water Act, courts may hear complaints under the Act only at the instigation of, or with the sanction of, the State Board.

The Government passed this Act in 1981 to clean up our air by controlling pollution. It states that sources of air pollution such as industry, vehicles, power plants, etc., are not permitted to release particulate matter, lead, carbon monoxide, sulphur dioxide, nitrogen oxide, volatile organic compounds (VOCs) or other toxic substances beyond a prescribed level.

To ensure this, Pollution Control Boards (PCBs) have been set up by Government to measure pollution levels in the atmosphere and at certain sources by testing the air. This is measured in parts per million or in milligrams or micrograms per cubic meter.

The particulate matter and gases that are released by industry and by cars, buses and two wheelers is measured by using air-sampling equipment. However, the most important aspect is for people themselves to appreciate the dangers of air pollution and reduce their own potential as polluters by seeing that their own vehicles or the industry they work in reduces levels of emissions.

This Act is created to take appropriate steps for the preservation of the natural resources of the Earth which among other things includes the preservation of high quality air and ensures controlling the level of air pollution

INDIAN ACTION PLAN 2015-2016:

Control of Vehicular Emissions:

Sl. No.	Action Points	Time Frame for implementation
i)	Launch extensive awareness drive against polluting vehicles;	Immediate
ii)	Ensure Strict action against visibly polluting vehicles;	Immediate
iii)	Install weigh in motion bridges at Delhi borders to prevent overloading;	Immediate
iv)	Take steps to prevent parking of vehicles in the non-designated areas;	Immediate
v)	Introduce early alarm system for benefit of commuters related to traffic congestion on major routes for route diversion ;	Immediate
vi)	Consider introducing plan for Flexi/staggered timings to minimize peak movement of vehicles on the road;	Immediate
vii)	Take steps for retrofitting of diesel vehicles with Particulate Filters;	Immediate
viii)	De-congest pathways;	Immediate
ix)	Synchronize traffic movements / Introduce intelligent traffic systems for lane-driving;	30 days
x)	Install vapor recovery system in fueling stations	30 days
xi)	Take steps for installation of remote sensor based PUC system etc.;	90 days
xii)	Formulate action plan for controlling decongestion of fuel stations including increasing number of dispensing machines;	90 days
xiii)	Prepare action plan to check fuel adulteration and random monitoring of fuel quality data;	90 days
xiv)	Prepare action plan for public transport on CNG mode;	90 days
xv)	Undertake road widening and improvement of infrastructure for decongestion of road;	90 days
xvi)	Promote battery operated vehicles;	90 days
xvii)	Take steps to expedite early completion of Western and Eastern Peripheral expressway and submit completion schedule	60 days

(B) Control of Road Dust/Re-suspension of dust and other fugitive emission:

Sl. No.	Action Points	Time Frame for implementation
i)	Formulate action plan for creation of green buffers along the traffic corridors;	Immediate
ii)	Introduce wet/ mechanized vacuum sweeping of roads;	30 days
iii)	Maintain pot holes free roads for free-flow of traffic to reduce emissions and dust;	60 days
iv)	Introduce water fountains at major traffic intersection, wherever feasible;	90 days
v)	Undertake greening of open areas, gardens, community places, schools and housing societies.	90 days
vi)	Take steps for blacktopping / pavement of road shoulders to avoid road dust;	180 days

(C) Control of Air Pollution from Bio-Mass Burning:

Sl. No.	Action Points	Time Frame for implementation
i)	Take stringent action against open burning of bio-mass/leaves/tyres etc to control such activities and submit periodic status reports;	Immediate
ii)	Ensure proper collection of horticulture waste (bio-mass) and composting–cum-gardening approach;	Immediate
iii)	Ensure strict enforcement of ban on burning of agriculture waste and crop residues	Immediate
iv)	Prohibit use of coal in hotels and restaurants and eliminate use of kerosene for cooking in Delhi;	60 days

Sl. No.	Action Points	Time Frame for implementation
i)	Set-up helpline in States/UT for taking action against reported non-compliance;	Immediate
ii)	Evolve a system of reporting of garbage /municipal solid waste burning through mobile based applications and other social media platform linked with Central and State level Control Rooms ;	30 days
iii)	Establish Standard Operating Procedure to provide quick and effective response to complaints	30 days
iv)	Take steps for maximizing coverage of LPG / PNG for domestic cooking purposes with intention of achieving 100%;	90 days
v)	Ensure DG sets meeting the standards only be allowed to operate	30 days
vi)	Promote use of LPG instead of coal in restaurants/ dhabas/ road side eateries;	90 days
vii)	Undertake Satellite based monitoring for tracking and enforcing agriculture waste burning;	90 days
viii)	Take steps for setting up of bio-mass based power generation units to avoid bio-mass burning.	One year

SOURCE:
http://pib.nic.in/newsite/PrintRelease.aspx?relid=134044

The main functions of the Central Board, as specified in Section 16 of the Act.
To improve the quality of air and to prevent, control or abate air pollution in the country; and in particular, and without prejudice to the generality of the foregoing functions, the Central Board, may

- Advise the Central Government on any matter concerning the improvement of the quality of air and the prevention, control or abatement of air pollution
- Plan and cause to be executed a nation wide programme for the prevention, control or abatement of air pollution
- Coordinate the activities of the State Boards and resolve disputes among them
- Provide technical assistance and guidance to the State Boards, carry out and sponsor investigations and research relating to problems of air pollution and prevention, control or abatement of air pollution
- Plan and organize the training of persons engaged or to be engaged in programmes for the Can

prevention, control or abatement of air pollution on such terms and conditions as the Central Board may specify

- Organise through mass media a comprehensive programme regarding the prevention, control or abatement of air pollution
- Collect, compile and publish technical and statistical data relating to air pollution and the measures devised for its effective prevention, control or abatement and prepare manuals, codes, or guides relating to prevention, control or abatement of air pollution
- Lay down standards for the quality of air
- Collect and disseminate information in respect of matters relating to air pollution
- Perform such other functions as may be prescribed, under Rules or under an Order.

In addition to the above functions, the Central Board may establish or recognize a laboratory or laboratories to enable the Central Board to perform its functions under this Section efficiently, and it may
a) delegate any of its functions under the Act generally or specially to any of the Committees appointed by it; and
b) do such other things and perform such other acts as it may think necessary for the proper discharge of its functions and generally for the purpose of carrying into effect the purposes of the Act.

What are the functions of the State Boards under the Air Act 1981?
The functions of the State Board, as specified in Section 17, shall be:

- To plan a comprehensive programme for the prevention, control or abatement of air pollution and to secure the execution thereof
- To advise the State Government on any matter concerning the prevention, control or abatement of air pollution
- To collect and disseminate information relating to air pollution
- To collaborate with the Central Board in organizing the training of persons engaged or to be engaged in programmes relating to prevention, control or abatement of air pollution and to organize mass education programme relating thereto
- To inspect, at all reasonable times, any control equipment, industrial plant or manufacturing process and to give by order, such directions to such persons as it may consider necessary to take steps for the prevention, control or abatement of air pollution
- To inspect air pollution control areas at such intervals as it may think necessary, assess the quality of air therein and take steps for the prevention, control or abatement of air pollution in such areas
- To lay down, in consultation with the Central Board and having regard to the standards for the quality of air laid down by the Central Board, standards for emission of air pollutants into the atmosphere from industrial plants and automobiles or for the discharge of any air pollutant into the atmosphere from any other source whatsoever not being a ship or an aircraft
- Provided that different standards for emission may be laid down under this clause for different industrial plants having regard to the quantity and composition of emission of air pollutants into the atmosphere from such industrial plants
- To advise the State Government with respect to the suitability of any premises or location for carrying on any industry which is likely to cause air pollution
- To perform such other functions as may be prescribed or as may, from time to time, be entrusted to it by the Central Board or the State Government
- To do such other things and to perform such other acts as it may think necessary for the proper discharge of its functions and generally for the purpose of carrying into effect the purposes of the Act.
- In addition to the above functions, the State Board may establish or recognize a laboratory or laboratories to enable the State Board to perform its above functions efficiently.

Section 37. Failure to comply with the provisions of section 21 or section 22 or with the directions issued under section 31-A.

a.
b. Whoever fails to comply with the provisions of section 21 or section 22 or directions issued under section 31-A, shall, in respect of each such failure, be punishable with imprisonment for a term which shall not be less than one year and six months but which may extend to six years and with fine, and in case the failure continues, with an additional fine which may extend to five thousand rupees for every day during which such failure continues after the conviction for the first such failure.
c. If the failure referred to in sub-section(1) continues beyond a period of one year after the date of conviction, the offender shall be punishable with imprisonment with a term which shall not be less than

two years but which may extend to seven years and with fine.
"Automobile" means any vehicle powered either by internal combustion engine or by any method of generating power to drive such vehicle by burning fuel.

Power to give instructions for ensuring standards for emission from automobiles.

The State Government shall, in consultation with the State Board, give such instructions as may be deemed necessary to the concerned authority in charge of registration of motor vehicles under the Motor Vehicles Act, 1988, and such authority shall notwithstanding anything contained in that Act or the rules made there under be bound to comply with such instructions.

Source: POLLUTION CONTROL BOARD OF INDIA

COST EFFECTIVENESS, PHASE-IN STATUS AND BENEFITS OF INSTALLATION:

The concept of detecting and controlling the emission level of the motor vehicle is implemented. The emission level from the vehicle can be controlled at the commercial level if it is implemented due to this the air pollution from the motor vehicle definitely be controlled with the help of detection process. If we talk about the air pollution from motor vehicle, motor vehicles are reasonable for the two third of air pollution in the urban area so we have to control the level of emission from the motor vehicle we have to control. Give our best efforts to control so from our prospective there is need of this system at the commercial level to control air pollution.

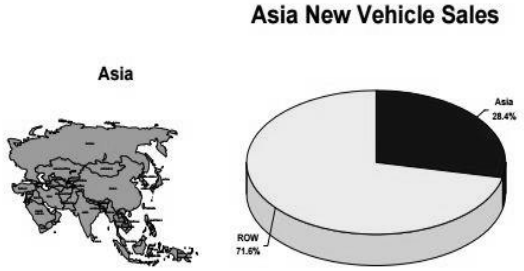
GLOBAL UTILITY FACTOR:

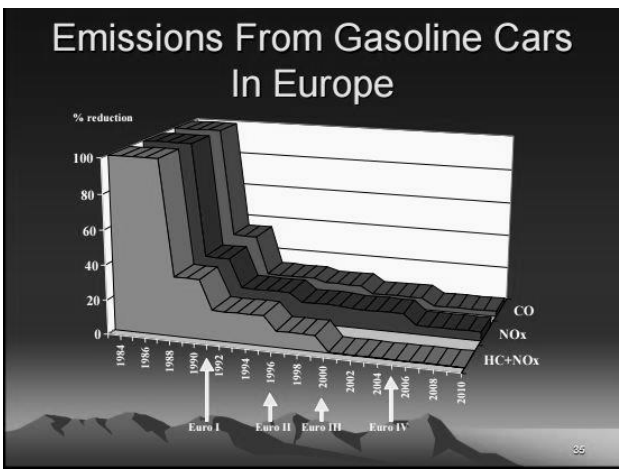
We see that the air pollution from motor vehicle is one of the main causes of the pullulated air. In Delhi the quality of air is not good means the air contains carbon pollutants is much higher than the standardized vale of air quality. To have a breath in the air of Delhi approximately equal to the smokes 30 cigarettes per day. If we regulate or control the output of the emission from motor vehicle then the quality of the air will be improved. Environmental issues like climate changes, global warning and human health's are affected by the internal combustion of fuel in the engine of the motor vehicle. Therefore reduce in the emission of the motor vehicle will reduce the number of diseases due to poor quality of air and the environmental problems will be reduced. If we check up our motor vehicle pollution level at regular period of time then the internal combustion will be decreased and the mileage of the vehicle will be increased definitely.

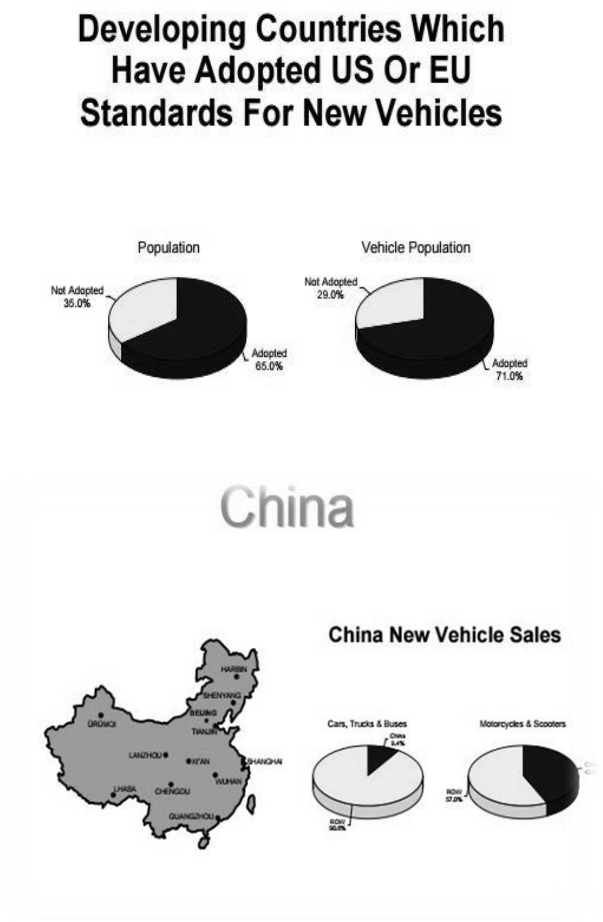
MATHEMATICAL MODEL:

TABLES, GRAPHS AND PIE CHARTS

World vehicular air pollution distribution statistics:







Source: Air pollution analytics, UN

PRESENT FEASIBILITY:

This model can be made on an experimental level and after all clearance demo and testing are done in the workshops they can be tested on road conditions at several flagged cities. Experimental voluntary implementation drives needs to be carried out to test functioning and adjustments specific to country landscape.

The feasibility would be high as all technologies used in the system at present in a primary level at wide distributed systems , the only problem is that the conceptualized integration, proper compatible pairing up , an static price adjustment with compulsory law implementation is missing that keeps all the present components apart.

FUTURE HOPES:

They need to be brought together in a large scale and after the requisite system has been fabricated and tested can be phased out into each vehicle systems in all cities of the country, and with suitable adjustments in conditions and progressive improvements can be elaborated into all road vehicular transports all over the world.

We live in a world in which finding clean air has become a great feat. We have reached a stage in which our children inherit respiratory ailments instead of fortunes. Homo sapiens have always been an adaptive species. To that end, we have introduced numerous measures to tackle our immediate predicament that is pollution. Legislators, scientists and engineers have been at the forefront of these adaptive measures. The PICD is a revolutionary device which serves both purposes of detection and abatement. In the grand scheme of things, the PICD is likely to be a key contributor to vehicular pollution control.

References:

[1] http://aqicn.org/map/world/
[2] http://www.treehugger.com/clean-technology/environmental-sensors.html
[3] https://www.google.co.in/#hl=en&q=radio+transmitter+receiver+arduino
[4] http://www.sas.com/en_us/insights/analytics/big-data-analytics.html
[5] http://axibase.com/environmental-monitoring-using-big-data/
[6] http://www.webopedia.com/TERM/C/cloud_computing.html
[7] https://www.founder2be.com/ideas/smart-license-plates-for-vehicles
[8] https://en.wikipedia.org/wiki/Carbon_dioxide_sensor
[9] http://euro-gasman.com/gas-sensors/sulphur-dioxide-so2/gas-sensors/sulphur-dioxide-so2-4-so2-2000-gas-sensor.html
[10] http://www.spec-sensors.com/product/so2-sensor/
[11] http://www.spec-sensors.com/product/iot-co-1000-digital-gas-sensor-module/
[12] http://www.spec-sensors.com/product/so2-sensor/
[13] http://euro-gasman.com/nitrogen-dioxide-no2-2e-gas-sensor.html
[14] http://www.datasciencecentral.com/profiles/blogs/environmental-monitoring-using-big-data
[15] https://www.cdiweb.com/datasheets/e2v/mics-2710.pdf
[16] http://www.undeerc.org/Equipment/Combustion-Systems/Full-Suite-of-Air-Pollution-Control-Devices.aspx
[17] http://pib.nic.in/newsite/PrintRelease.aspx?relid=134044
[18] http://www.moef.nic.in/sites/default/files/No%2014%20%201981.pdf
[19] http://envfor.nic.in/division/air-pollution
[20] http://www.yourarticlelibrary.com/law/acts/summary-on-air-prevention-and-control-of-pollution-act-1981-of-india/30191/