LOW CARBON, CLEAN TRANSPORT

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ABSTRACT

Transport generates a number of adverse environmental effects from both transport infrastructure and vehicles. As well as we want to develop our countries for good infrastructure but while doing so, we forget to protect our environment. This planet is a gift which had been given by our forefathers so it's our responsibility to protect our planet by reducing the harmful gases which are coming from many sources like industries, transportation, domestic ways etc.

Vehicles emit carbon dioxide (CO2), which is a greenhouse gas along with carbon monoxide (CO), nitrogen dioxide (NO2), benzene, and particulate matter which affects people's health also. It is a major source of air pollution. Worldwide motor vehicles currently emit well over 900 million metric tons of CO2 each year. These emissions account for more than 15 percent of global fossil fuel CO2 releases.

The problems of global warming and urban air pollution will almost certainly need to be addressed by making a long-term shift away from oil as the universal energy source for transportation. But designing a new generation of resource-efficient, environmentally friendly vehicles is one of the most challenging technological problems facing the industrialized world. Most of the major automakers are actively developing more efficient conventionally fueled vehicles as well as so-called alternatively fueled vehicles. The latter are variously powered by fossil fuels (called hybrid vehicles), electric batteries, or hydrogen. In all cases, the vehicles have electric drives, meaning they are ultimately driven by electric motors. So by choosing some above types of alternatives we can at least reduce some good amount of harmful gases that are affecting environment. This paper includes how it will be possible to apply such alternatives in country like INDIA where the population is comparatively more than that of others.

INTRODUCTION

The need to control the emissions from automobiles gave rise to the computerization of the automobile. Hydrocarbons, carbon monoxide and oxides of nitrogen are created during the combustion process and are emitted into the atmosphere from the tail pipe. There are also hydrocarbons emitted as a result of vaporization of gasoline and from the crankcase of the automobile. The clean air act of 1977 set limits as to the amount of each of these pollutants that could be emitted from an automobile. The manufacturers answer was the addition of certain pollution control devices and the creation of a self-adjusting engine. 1981 saw the first of these self-adjusting engines. They were called feedback fuel control systems. An oxygen sensor was installed in the exhaust system and would measure the fuel content of the exhaust stream. It then would send a signal to a microprocessor, which would analyze the reading and operate a fuel mixture or air mixture device to create the proper air/fuel ratio. As computer systems progressed, they were able to adjust ignition spark timing as well as operate the other emission controls that were installed on the vehicle. The computer is also capable of monitoring and diagnosing itself. If a fault is seen, the computer will alert the vehicle operator by illuminating a malfunction indicator lamp. The computer will at the same time record the fault in it's memory, so that a technician can at a later date retrieve that fault in the form of a code which will help them determine the proper repair. Some of the more popular emission control devices installed on the automobile are: EGR valve, Catalytic Converter, Air Pump, PCV Valve, Charcol Canitiser etc**.**

Like SI engine CI engines are also major source of emission. Several experiments and technologies are developed and a lot of experiments are going on to reduce emission from CI engine. The main constituents causing diesel emission are smoke, soot, oxides of nitrogen, hydrocarbons, carbon monoxides etc. Unlike SI engine, emission produced by carbon monoxide and hydrocarbon in CI engine is small. In order to give better engine performance the emission must be reduce to a great extend. The emission can be reduced by using smoke suppressant additives, using particulate traps, SCR (Selective Catalytic Reduction) etc.

METHODS TO REDUCE EMISSIONS

CATALYTIC CONVERTER

A **catalytic converter** (colloquially, "cat" or "catcon*")* is a device used to reduce the toxicity of emissions from an internal combustion engine. A catalytic converter works by using a catalyst to stimulate a chemical reaction in which toxic by-products of combustion are converted to less-toxic substances. In automobiles, this typically results in 90% conversion of carbon monoxide, hydrocarbons, and nitrogen oxides into less harmful gases.

First widely introduced on series-production automobiles in the United States market for the 1975 model year to comply with tightening U.S. Environmental Protection Agency regulations on auto exhaust, catalytic converters are still most commonly used in motor vehicle exhaust systems. Catalytic converters are also used on generator sets, forklifts, mining equipment, trucks, buses, trains, airplanes and other engine-equipped machines.

The catalytic converter looks like a muffler. It is located in the exhaust system ahead of the muffler. Inside the converter are pellets or a honeycomb made of platinum or palladium. The platinum or palladiums are used as a catalyst (a catalyst is a substance used to speed up a chemical process). As hydrocarbons or carbon monoxide in the exhaust are passed over the catalyst, it is chemically oxidized or converted to carbon dioxide and water. As the converter works to clean the exhaust, it develops heat. The dirtier the exhaust, the harder the converter works and the more heat that is developed. In some cases the converter can be seen to glow from excessive heat. If the converter works this hard to clean a dirty exhaust it will destroy itself. Also leaded fuel will put a coating on the platinum or palladium and render the converter ineffective.

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ENVIRONMENTAL IMPACT

Catalytic converters have proven to be reliable and effective in reducing noxious tailpipe emissions. However, they may have some adverse environmental impacts in use:

- The requirement for a rich-burn engine to run at the stoichiometric point means it uses more fuel than a lean-burn engine running at a mixture of 20:1 or less. This increases the amount of fossil fuel consumed and the carbon-dioxide emissions of the vehicle. However, NO_x control on lean-burn engines is problematic.

- Although catalytic converters are effective at removing hydrocarbons and other harmful emissions, they do not solve the fundamental problem created by burning a fossil fuel. In addition to water, the main combustion product in exhaust gas leaving the engine — through a catalytic converter or not — is carbon dioxide (CO_2) Carbon dioxide produced from fossil fuels is one of the greenhouse gases indicated by the Intergovernmental Panel on Climate Change (IPCC) to be a "most likely" cause of global warming. Additionally, the U.S. EPA has stated catalytic converters are a significant and growing cause of global warming, because of their release of nitrous oxide (N_2O), a greenhouse gas over three hundred times more potent than carbon dioxide.

- Catalytic converter production requires palladium or platinum; part of the world supply of these precious metals is produced near Norilsk, Russia, where the industry (among others) has caused Norilsk to be added to Time magazine's list of most-polluted places.

Fig. Catalytic converter on a 1996 Dodge Ram Van (2004)

EMISSION CONTROL NORMS IN SI ENGINE

The first Indian emission regulations were idle emission limits which became effective in 1989. These idle emission regulations were soon replaced by mass emission limits for both gasoline (1991) and diesel (1992) vehicles, which were gradually tightened during the 1990's. Since the year 2000, India started adopting European emission and fuel regulations for four-wheeled light-duty and for heavy-duty vehicles. Indian own emission regulations still apply to two- and three-wheeled vehicles

Level of Emission Norms	2/3 Wheelers ##		4 Wheelers
	2-Stroke	4-Stroke	4-Stroke
Euro I /India 2000	* Intake, exhaust, combustion optimization * Catalytic converter	* 4-Stroke engine technology	* Intake, exhaust, combustion optimization *Carburetor optimization
Euro II / Bharat Stage II	* Secondary air injection * Catalytic converter * CNG / LPG (3 wheelers only)	* Hot tube * Secondary air injection * CNG / LPG (3 wheelers only)	* Fuel injection * Catalytic converter * Fixed EGR * Multi-valve * CNG/LPG
Euro III/ Bharat Stage III	* Fuel injection * Catalytic converter	* Fuel injection * Carburetor+ catalytic converter	* Fuel injection +catalytic converter * Variable EGR * Variable valve timing * Multi-valve * On-board diagnostics system * CNG/LPG
Euro IV / Bharat Stage IV	*Developed recently	* Lean burn * Fuel injection+ catalytic converter	* Direct cylinder injection * Multi-brick catalytic converter * On-board diagnostics system

Level Of Emission Norms	Technology Options
Euro I / India 2000	· Retarded injection timing · Open/re-entrant bowl, · Intake, exhaust and combustion optimisation · FIP~700-800 bar, low sac injectors · High swirl · Naturally aspirated
Euro II / Bharat Stage II	· Turbocharging · Injection pressure > 800 bar, moderate swirl · High pressure inline / rotary pumps, injection rate control · VO nozzles · Re-entrant combustion chamber · Lube oil consumption control · Inter-cooling (optional, depends on specific power), · EGR (may be required for high speed car engines) · Conversion to CNG with catalytic converter

Euro III / Bharat Stage III	· Multi valve, · Low swirl – high injection pressure > 120 bar · Rotary pumps, pilot injection rate shaping · Electronic fuel injection · Critical lube oil consumption control · Variable geometry turbocharger (VGT) · Inter-cooling · Oxycat & EGR · CNG/LPG · High specific power output
Euro IV / Bharat Stage IV	· Particulate trap · NOx trap · On board Diagnostics system · Common rail injection-injection pressure>1600 bar · Fuel Cell · CNG/LPG

THE CHALLENGE

While transportation is crucial to the economy and individuals, as a sector it is also a significant source of greenhouse gas (GHG) emissions and can affect human welfare negatively. Transport is currently responsible for 13% of all world greenhouse gas emissions and 23% of global carbon dioxide emissions (CO2) from fuel combustion are transport related. Transport related CO2 emissions are expected to increase by 57% worldwide in the period 2005 – 2030, much more than emissions from any other sector. But there is consensus in science and politics that global GHG emissions must be reduced by more than 80% by 2050 from 1990 levels in order to avoid catastrophic global warming. Contrasting the current growth rate of transport-related emissions with aspired reduction targets, it is clear that the transport sector needs to start contributing to mitigation efforts now.

Between 1990 and 2005, transport energy consumption increased by 37%, and was the fastest growing end-use sector. The associated CO2 emissions rose broadly in line with this increased energy use to reach 5.3 Gt. Within transportation, road transport is by far the largest energy user and accounted for 89% of total transport energy use in 2005 (IEA, 2008). Road transport is also the main contributor to increased transport energy use. While non-road modes increased their energy consumption by 13% between 1990 and 2005, road transport energy use rose by 41%. In Figure the increasing amount of the different transport sub-sectors over the years is presented.

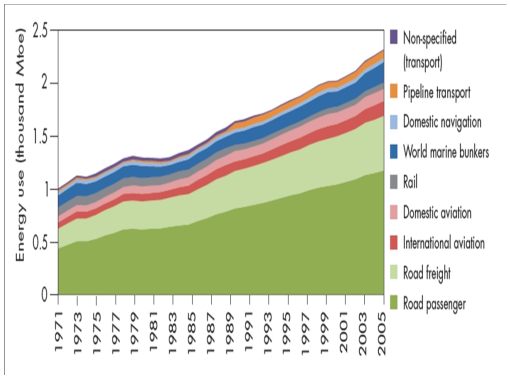

Fig. World Transport Energy Use by Mode, 1971-2006

To meet long-term climate targets, developed countries should reduce greenhouse gas emissions by 80 to 95% until 2050 compared to 2000 levels. But also non-OECD countries need to reduce their GHG emissions significantly by 2050. It is also clear that OECD countries have a bigger responsibility and need to support the developing world in this undertaking.

Low-carbon transport is confronted with a number of barriers that need to be encountered by strategic action. These barriers are:

1. **Time-lag between decisions and effects**: Some measures require a long-term approach that only takes effect when continuity in political decision-making is achieved.
2. **Cross-cutting** nature of transport: Many decisions in other sectors influence transport demand. Integrated decision-making is needed.
3. **Fragmented target group**: Everybody and all social groups have mobility needs. The sources of emissions are rather small, so there is a need to bundle measures.

At the moment, many industrialized countries struggle to overcome the automobile dependence and face strong difficulties to turn back, while an increasing number of industrialized cities are in the process of breaking the trend. In light of this experience, it becomes even more important for developing countries to not end up in the same trap but choose a more sustainable path – not only to combat climate change but to develop a reliable and convenient transport system, and to improve the local environment.

VISION & OPPURTINITIES

Low-carbon transportation is not a burden but increases liveability and well-being, providing many other advantages as well. Low-carbon strategies or roadmaps are thus providing an avenue for a modern, sustainable and stable society.

A low-carbon transportation infrastructure that follows the principles of sustainable development not only mitigates climate change but also realizes the following co benefits:

1. Increases energy security as less oil needs to be imported. Resource conflicts can be avoided and transport users won't have to suffer from fuel price shocks;
2. Reduces traffic congestion, and consequently air pollution and noise are reduced, having a positive impact on the environment and human health.
3. Reduces land demand by preventing urban sprawl and preferring semi-dense mixed-use neighborhoods.
4. provides visibility and acknowledgement of cities that demonstrate leadership: sustainable and modern low-carbon transportation systems increase the

competetiveness and attractiveness of cities and attract top companies, highly qualified workers and employees into then country (see Mercer Liveability Index);

5. pending on future climate change agreements - cities and countries that achieve mitigation beyond baseline scenarios gain access to emission certificates and carbon related funding schemes.

Fig. Freiburg, Germany, is an Example of a liveable City

Elements of a vision for a low carbon transport system are:

1. Dense but green and mixed used cities that allow white collar jobs, shopping and leisure facilities close to people's living quarters.
2. Modern, high quality links between the centers and good integration of long-distance hubs with local transportation.
3. High quality alternatives to individual car-use, especially efficient public transport and good non-motorized transport infrastructure and its proper integration.
4. Efficient, inter-modal freight transport and smart urban logistics that also includes clean vehicles.
5. Advanced technologies such as electric/gasoline hybrid engines, alternative fuels or even electric motorbikes and cars.

There is a high need to manage transport demand in order to make the best and most Cost-efficient use out of valuable land and infrastructure. Examples like Zurich, Vienna, London, Paris, New York, Hong Kong, Singapore and many others demonstrate that economic success is directly linked to advanced sustainable transport systems. Moreover, a higher share of alternative transport modes is directly related to less pollution from cars and less CO2 emissions. This has a positive impact on air quality and reduces the contribution of transport related emissions to climate change.

TOWARDS LOW-CARBON TRANSPORT: AVOID/REDUCE – SHIFT –IMPROVE

To achieve significant emission reductions and realize a sustainable and attractive infrastructure, novel and innovative approaches are required. In general, greenhouse gas emissions in the transport sector can be reduced through a number of measures and approaches which will be discussed below. Ambitious emission reduction targets can best be reached when all factors simultaneously contribute to mitigation.

Fig. Low-Carbon Transport Modes in Hangzhou, China

According to current projections, the carbon content will be reduced and energy efficiency will improve only marginally, while travel demand further explodes in developing countries. A low-carbon transportation system needs more than a piecemeal approach and requires improvement in all dimensions – travel demand, mode choice, and technology – simultaneously to quickly gain traction.

Fig. Infrastructure for Plug-In Vehicles in San Francisco

A main framework for strategic action is the so-called Avoid/Reduce-Shift-Improve approach (GTZ, 2007), where infrastructure is provided in such a way that:

1. Future travel demand is reduced or avoided.
2. Travel is shifted to more economic & environmentally-friendly modes.
3. Technological measures improve the vehicle fleet & fuels.

Avoid/Reduce-Shift-Improve are an important and innovative agenda for OECD and non-OECD countries. Developing countries often have the opportunity to develop sustainable infrastructure in growing cities, maintain high shares of traditional, low-carbon modes, while at the same time "leapfrog" to environmentally-friendly technologies. In contrast to particularly North America, transport infrastructure is often newly constructed and car ownership is in many cases relatively low. By enabling a less car-dependant mobility, developing countries can successfully avoid the high-level of car-dependency and carbon-lock-in syndromes in politics and society.

THE LOW CARBON CITY

The developing world's urban population will double by 2030 (UN, 2004). Most of the additional travel activity in the next decades, hence, will be produced in the growing cities of the developing world. The inertia of such a trajectory holds danger but also promise: If the current development continues towards automobile dependency and concrete miles maximization, GHG emissions will be fixed for half a century or longer. However, if an alternative low-carbon development gains traction, a fundamental lower emission trajectory can be achieved. As a basic principle on city level, urban development planners should aim at **achieving density**. The aim must be to retain or achieve medium to high urban density profiles. A minimal urban density is a precondition for efficient and convenient accessibility by walking and cycling, and for making public transit profitable.

Fig. In Amsterdam, Non-Motorized Transport has one of the highest Modal Shares among other European Cities.

Clearly, it is not enough to just have good ideas, they also must be implemented. Specific integrated planning agencies can foster sustainable transport concepts, whereas others constitute barriers. If institutions are fragmented and work in ignorance of each other and without a coherent perspective, no integrated, high efficient.

Fig. Three Elements of Low-Carbon Urban Development

development approach can be achieved. And it is possible! Even in previously notorious car based cities such as Athens a change towards a higher use of non-car based transport was achieved.

BENEFITS

- ☐ Reduces traffic congestion.
- ☐ Reduces vehicle operating costs.
- ☐ Reduced HG emission & air emission.
- ☐ Reduced noise levels.
- ☐ Improved equity, safety.
- ☐ Reduced health costs due to air pollution.
- ☐ Reduced other pollution (soil & water contamination)

LATEST PROJECTS

HEART4EV-This project seeks to increase the efficiency of the gas turbines used to power hybrid vehicles.

HERO-This project is investigating the application of parallel hybrid drivetrain technology in an off-road 4x4 vehicle.

LAMTRAK-This project is supporting another innovation – an infinitely variable ratio transmission device for use in vehicles - known as the Torotrak rolling traction variator - to increase fuel efficiency and reduce pollution.

RHOLAB-The RHOLAB project aims to develop a novel lead acid battery incorporating thermal management, fault tolerance and safety features as a traction battery for hybrid vehicles.

CHOICE-This project will design, build and evaluate a diesel series hybrid city bus incorporating vehicle & passenger information systems

CONCLUSION

Efforts are being made to reduce the consumption of fossil fuels and maximize the utilization of environment-friendly energy sources and fuels for meeting energy needs. In India, the demand for oil for the transport sector is estimated to increase over the next decade. This sector is the largest consumer of petroleum products. Government is providing policy support, fiscal incentives and regulatory measures for development of alternative energy vehicles and fuels. Battery operated vehicles, fuel cell vehicles, hydrogen powered vehicles and bio-fuel powered vehicles have been identified in this context. The development activities of such fuels and vehicles need to be further encouraged particularly in view of their potential to protect the environment. Hybrid Electric Vehicles (HEVs) use the combination of engine of a conventional vehicle with electric motor powered by traction batteries and/or fuel cell. This combination helps in achieving both the energy and environmental goals. The deployment of a large number of this type of vehicles would help us in terms of environmental benefits, reduction of oil consumption and reduction in emissions.

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