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ABSTRACT

This paper discusses the greenhouse gas emissions of the USA which cause the global warming in the atmosphere. In the last of the 20th century and the beginning of the 21st century, global climate change becomes more sever which is due to greenhouse gas emissions. The Kyoto Protocol is introduced in 1997 but developed countries and some developing countries are not implementing this protocol. In December, COP/CMP7, UN Climate Change Consensus 2011, Durban, South Africa, all the nations of UN do not agree to reduce GHGs according to Kyoto Protocol agreement but Kyoto Protocol is extended up to 2015. Due to global warming the ocean levels are increasing, as a result most of the costal areas will submerge by 2050, and some insects and animals will extinct. The USA is searching for the advanced technologies to develop both vehicles and fuels. Recently the USA, Brazil and some other countries are producing biofuels and are using them in vehicles to reduce stress on gasoline and are trying to develop them. This paper emphasizes on the affects of global warming and different ways to reduce greenhouse gas emissions.

JEL. Classification:F64; K23; L16; L24; L65

Keywords: The US greenhouse gas emissions, Global warming, Biofuels, Climate change.

1 INTRODUCTION

The Kyoto Protocol is introduced in 1997 but has activated in 2005. In this Protocol 27 developed countries agreed that they are responsible for greenhouse gas (GHG) emissions but the USA refused to follow that protocol. At last the US government agreed that between 2008 and 2012 it would limit average annual emissions of GHGs to 7% below 1990 levels (Mohajan, 2012a). But the US government have not expressed by which technology will apply to implement Kyoto Protocol. According International Energy Agency (IEA) data (IEA, 2007), the USA and China are approximately tied and leading global emitters of GHG emissions. Together they emit approximately 40% of global carbon dioxide (CO_2) emissions, and about 35% of total GHGs.

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At present it is urgent need to slow the emissions greenhouse gases (GHGs) throughout the world, which have strong and growing evidence of climate change. Because GHGs are responsible for changing global climate is well established. Many governments in developed countries have called for GHG emissions to be cut by up to 80% by 2050 in order to stabilize atmospheric concentrations of GHG. But the USA, Canada and India refuse to reduce of the GHG emissions due to local and global economic crisis in COP/CMP7, UN Climate Change Consensus 2011, Durban, South Africa. The transportation accounts for about one-fifth of global GHG emissions and a higher percentage in industrialized nations. The US transportation sector is the largest GHG emitter among the world's transportation sectors (EIA, 2010). Carbon dioxide (CO_2) emissions from energy use including transportation calculated for 83% of the US GHG emissions in 2005 (EIA, 2006). The US GHG emissions in 2007 were 16% higher than 1990 levels so that the USA has to loss much of its credibility in the international community by failing to act already.

It is well established that the effects of GHGs are extremely dangerous. The living organisms in land and water are in dangerous position and some species has already extinct and will extinct in future if global warming can not be controlled. It is clear to environment experts of all nations that emissions of CO_2 and other GHGs are liable to global warming. The current concentrations of GHG in space have increased since 1750 from a CO_2 equivalent of 280ppm (parts per million) to 430ppm (Stern, 2007). The National Academy of Sciences (NAS) has expressed its expert opinion that concentrations of CO_2 in the atmosphere have increased and continue to increase more rapidly due to human activities (NAS, 2001and 2010). The NAS mentions that the burning of fossil fuels is the primary source of anthropogenic CO_2 emissions. The intergovernmental Panel on Climate Change (IPCC) has expressed its expert opinion that the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations and the temperature has been rising most rapidly since 1970 (IPCC, 2007a and UN Foundation, 2007). After the industrial revolution the global average temperature increases about 0.76^0C. The global surface temperature has increased ≈ 0.2^0C per decade in the past 30 years. Global warming is now $+0.6^0$C in the past three decades and $+0.8^0$C in the past century, and continued warming in the first half of the 21st century is consistent with the recent rate of $+0.2^0$C per decade (Mohajan, 2011).

2 WHAT ARE THE GREENHOUSE GAS EMISSIONS?

Every nation in the world has realized that global worming is due to continuous GHG emissions. The people of the whole world are suffering from the effects of global warming and are projected to suffer much more acute effects as the climate change becomes more severe. The six gases; Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphurhexafluouride (SF_6), hydrofluourocarbon (HFC) and perfluourocarbon (PFC), together constitutes six GHG emissions. These six gases briefly called carbon dioxide equivalents (CO_2e). CO_2e gases covered in the Kyoto Protocol 1997, which is an international agreement linked to the United Nations Framework Convention on Climate Change (UNFCCC). In environment science CO_2e emissions are defined as the sum of the mass emissions of each individual GHG adjusted for its global warming potential (EPA, 2011). These gases are accumulating in the atmosphere then continuously are decreasing the amount of solar radiation which are reflected back into the space, and are warming the earth's climate much like a greenhouse. The GHGs traps heat with shorter wavelength from the sun and radiate back into the space with longer wavelength, as a result the temperature of the earth surface increases continuously. The current concentrations of GHG in space have increased since 1750 from a CO_2e of 280ppm to 430ppm (Stern, 2007). Each GHG traps different amounts of heat and stays in atmosphere for different lengths of time. So that it is necessary to measure of global warming potential to compare between gases. The following table gives six GHGs global warming potential and atmospheric life in years (Sharma, 2007; Mohajan, 2011, 2012a).

Table 1: The global warming potential of six GHGs, Source: IPCC, 2001.

Gas	Global Warming Potential	Atmospheric Life (years)
CO_2	1	5 to 200
CH_4	21	12
N_2O	310	114
HFC	140 to 11,700	1.4 to 260
PFC	6,500 to 9,200	10,000 to 50,000+
SF_6	23,900	3200

The potency of the greenhouse effect is radiative forcing which measures how much the gas affects the balance of heat coming in and going out of the atmosphere. Positive radiative forcing warms the surface of the earth while negative forcing cools it and expressed in watts per square meter, Wm^{-2} (IPCC, 2007a). The combined radiative forcing of CO_2, CH_4 and N_2O is +2.30 Wm^{-2} compared to the radiative forcing of solar irradiance of +0.12 Wm^{-2}. Oceans have warmed from surface of the sea to up to a depth of at least 3 km. It is estimated that absorbed 80% of the additional heat added to the climate. Warmer water taking more spaces of the sea than the colder water, as a result sea level is rising (Sharma, 2007).

3 GLOBAL EFFECTS OF GHG EMISSIONS

Due to global warming some impacts have appeared already and are increasing continuously. Some of them are as follows (Mohajan, 2011):

- The increase of temperature on the surface of the earth, as a result plants are flowering earlier and animals are shifting their ranges due to shortage of food and water.
- The loss of Arctic ice, Antarctic ice, Greenland ice, Himalayan ice etc.
- The increase of hurricane intensity, the earth quake and tsunami in recent years.
- Melting of glaciers at an accelerated rate and related glacial lake outburst flows.
- Heat waves in the oceans and rises in sea level which caused costal flooding.
- Destruction of habitats and extinction of widespread species, and an increasing number of plants and animals species will be at risk of extinction.
- Increase of acid rains destruct forests, insects and create various diseases in the living organisms and ocean will continue to acidify which will harming coral- forming organisms. Due to acidity of the oceans fishes, coral reefs and other living organisms are dying.
- The loss of snowpacks in various parts of the world, as a result ice-bond water supplies will decrease or run off before the usual time.
- Harms of public health such as increased heat-related illness and the irregular smog increased respiratory related diseases.

Scientific research shows that ice loss from Antarctica and Greenland has accelerated over the last 20 years which will raise the sea level. From satellite data and climate models, scientists calculated that the two polar ice sheets are losing enough ice to raise sea levels by 1.3 mm each year and scientists observed that the sea levels are rising by about 3 mm per year. By 2006, the Greenland

and Antarctic sheets were losing a combined mass of 475 Gt (gigatons) of ice per year. If these increases continue water from the two polar ice sheets could have added 15 cm to the average global sea level by 2050. A rise of similar size is expected to come from a combination of melt water from mountain glaciers and thermal expansion of sea water (Black, 2011). The global worming seems to be affecting many glaciers and ice caps have declined in both hemispheres, as a result melting water raise the sea levels. On the other hand the average Arctic Sea ice has melted by 2.7%/decade (Sharma, 2007).

It is estimated that the lower latitudes will bare a disproportionate share of the negative effects of climate change. On the other hand the higher latitudes will have some significant positive effects which may help to balance the negative impacts. Africa is one of the most vulnerable continents due to global warming. It is estimated that water stress will affect between 75 and 250 million people of Africa by 2020. The cultivable land will decrease, the rain-fed agriculture could be cut in half and fisheries must be decline. As a result almost all African countries will seriously affect food security and malnutrition (IPCC, 2007b). Forests will affect by pests, diseases and fire. The citizens of most of the cities will suffer from heat waves, earth quake, tsunami, shortage of water supply and energy supply by 2020. All the countries of the world those depend on rain for cultivation, their production of crops will decrease seriously due to droughts (IPCC, 2007b).

Coral reefs are very important because they act as hatcheries and nurseries for open ocean fish. They protect coastal areas from storms, and provide fish, recreation and tourism money. It is estimated that in Asia coral reef fisheries feed one billion people. The total economic value of coral is estimated about $30 billion. Rising carbon emissions might kill off the ocean's coral reefs by 2050. Burning coal, oil and gas add CO_2 to the atmosphere and the same gas is used to produce soft drinks. As CO_2 is absorbed into the soft drinks and similarly ocean water absorbs it from the air if the air is dense with CO_2. When the CO_2 enters the ocean, it makes the water more acidic. That interferes with the ability of coral to calcify their skeletons. As a result they can no longer grow and they begin to die. The marine scientists said that global warming is seriously threatening that crucial component of the ocean biodiversity. If CO_2 emissions keep stabilize at today's levels of 380 ppm, coral reefs survive mostly intact. Sea water is acidifying as CO_2 from power plants, cars, trucks and other vehicles, and factories mixes into the ocean. Acidified ocean water must be fatal to some fish eggs and larvae. IPCC (2007a) expressed that 450 ppm is regarded by many climate scientists as the "tipping point" to contain rises in average temperatures to around 2^0C. That is still enough to wipe out 20% to 30% of the earth's animal and plant species, and for the world's coral to be bleached, crop product will fall, and millions of people and other creatures suffer from water and food shortages. To decline in global emissions by 2020, it is particularly focused on the energy industry, where $30 trillion of new energy investment is required over the next decade (2^{nd} decade of 21^{st} century). The IPCC (IPCC, 2007a) report was the social cost of carbon. The average estimate is of $12 a ton but the estimates vary widely and up to $90 a ton which means that for every ton of carbon produced and that is roughly equivalent to a ton of coal, which resource companies sell for around $90 and it will cost $12 (EPA, 2010).

Methane is 21 times more powerful than CO_2 to trapping heat. A vast expanse of permafrost in Siberia and Alaska has started to melt for the first time since it formed 11,000 years ago. It is caused by the recent 3°C rise in local temperature over the past 40 years (since 1970) which is more than four times the global average. Peat bogs cover an area of a million square miles (or almost a quarter of the earth's land surface) to a depth of 25 meters. This has the capacity to release billions of tons of methane trapped by ice below the surface. The whole world peat bogs store at least two trillion tons of CO_2 which is equivalent to a century of emissions from fossil fuels.

It is estimated that the west Siberian bog alone contains about 70 billion tons of CH_4, a quarter of all the CH_4 stored on the land surface of the world. This is equivalent to emitting 1.7 trillion tons of CO_2, which is more GHG than has been emitted by humans in the past 200 years. Vast areas of wet peat land forests are being drained and logged in Indonesia and Malaysia. Along with the ensuing peat fires this contributes 2 billion tons of CO_2, making South-East Asia the third largest polluter in the world behind the US and China. We can easily reduce our CO_2 emissions from fossil fuels if we try but we could not reduce methane emissions once if they started to emit (NAS, 2010).

4 GHG GAS EMISSIONS OF THE USA ONLY

The USA emits a number of different GHGs through a wide variety of activities in households and businesses. The EPA estimates that, in 2006 (EPA, 2008), US emissions of GHGs amounted about 7.1 BMTCO_2e (billions metric tons CO_2e) which is 85% in the form of CO_2, 8% in the form of CH_4, 5% in the form of N_2O, and 2% in the form of other three GHGs. About 86% of those emissions were directly related to the generation and consumption of energy but the remaining 14% came from industrial and agricultural processes as diverse as the production of cement and the management of landfills, wastewater and agricultural soils. About 94% of the CO_2 was emitted directly through the combustion of fossil fuels, 40% from petroleum products, 35% from coal and 19% from natural gas (Mohajan, 2011).

These emissions were partially offset by the net absorption of roughly 900 MMTCO_2 (million metric tons CO_2) by the nation's forests and soils. Experts generally consider that a cap-and-trade system or a tax, both of which would give businesses and households economic incentives to reduce the production and consumption of such emissions. Experts also generally agree that because of the uncertainties that society faces about the marginal benefits and marginal costs of preventing climate change, a tax on emissions would have several economic advantages over a cap-and-trade approach. All US emissions of GHGs would not be manage easily because CO_2 emissions from the combustion of fossil fuels, a significant share of the remaining 20% of US emissions, which come from a variety of relatively minor sources, which are much more difficult to monitor and would be difficult to control under either a cap-and-trade system or a carbon tax (CBO, 2009, and Mohajan, 2012c).

Stolaroff (2009) shows that by considering only emissions that are released within US borders, the total share of US GHG emissions associated with products and packaging is 37%. He also shows that if we include emissions from producing goods imported into and consumed in the US products and packaging gives 44% of GHG emissions.

In Kyoto Protocol the US government agreed that between 2008 and 2012 it would limit average annual emissions of GHGs to 7% below 1990 levels. But the US government have not expressed by which technology will apply to implement Kyoto Protocol. S. 2191, the Lieberman-Warner bill, provides a useful illustration of the mechanics of a cap-and-trade system, which would have required the EPA to establish two cap-and-trade programs aimed at reducing the emission of GHGs in the US over the 2010–2050 periods. Under S. 2191, consumers of gasoline would not have needed to submit allowances for the CO_2 emitted by their cars and trucks but importers and refiners could not produce and sell the gasoline to consumers without submitting allowances, effectively bringing the consumers, the ultimate emitters increase the scarcity of gasoline, as a result raises its price. In the case of S. 2191, the number of allowances allocated under the main program would have declined from 5,775 MMTCO_2e by 2012 to 1,732 MMTCO_2e by 2050, at which point the number of allowances would be equal to about 28% of 2005 emissions in sectors covered by the program. The Low Carbon Economy Act of 2007, S. 1766, would have established a technology accelerator payment starting at $12 per metric ton of CO_2e in 2012 and rising by 5% annually thereafter (McCarl and Schneider, 1999, and Mohajan, 2011).

In the USA N_2O emission reductions could be performing assuming relevant strategies are as follows (Mohajan, 2011):

- reduced nitrogen fertilizer applications,
- use of nitrification inhibitors,
- improved nitrogen nutrient management, and
- reduced nitrogen content of animal feeds.

Scientists estimated that about 0.13 MMTs of N_2O emissions need to be reduced in the USA in order to meet the Kyoto requirements (McCarl and Schneider, 1999).

5 GHG EMISSIONS DUE TO GLOBAL TRANSPORTATION

In China, India, Brazil, Brazil, Indonesia, Malaysia and other developing countries, rapidly increasing wealth and a rising middle class, rapid urbanization, and massive additions to road infrastructure are creating enormous demands for personal vehicles, public transportation and freight transportation. Personal vehicles are widely increasing as status symbols as well as being faster, more flexible and convenient, and more comfortable than public transportation . As a result, the world auto fleet increased from about 50 million vehicles to 580 million vehicles between 1950 and 1997, which is five times faster than the growth in population (Barker et al., 2007). Apart from travel within metropolitan areas, intercity and international travel is also growing rapidly.

In Europe and Japan, high-speed trains are a part of the inter-city travel with other vehicles. On the other hand bus and lower speed rail dominate inter-city travel in the developing countries. Freight transportation, driven by globalization and the rapid development of industry in China, India and the other developing countries, is also a major consumer of energy, which is two-fifths of global transportation energy use (World Business Council for Sustainable Development, WBCSD, 2004).

Forecasts to 2030 confirm that the rapid growth in transportation demand, oil use, and GHG emissions over the past few decades is expected to continue. International Energy Outlook 2009, states that without changes in ongoing trends, the transportation energy demand of the nations outside of the Organization for Economic Cooperation and Development (OECD) will grow by about 90% from 2006 to 2030, which is an annual growth rate of 2.7% (EIA, 2009a). Most of this new consumption of 36 to 46 quadrillion Btus (quads) in 2030 is expected to be oil, placing pressure on the world's oil supply capacity. If conventional sources fail to meet this demand, the most likely alternatives will be heavy oil, oil sands, oil shale, biofuels and liquids from natural gas and coal which are carbon-intensive fuels that would increase GHG emissions. The IEA forecast a move to high-carbon fuels after 2030, and its estimated transportation GHG emissions for 2050 (16 GT) are about 113% higher than those in 2007 (7.5 GT).

6 GHG EMISSIONS IN THE US TRANSPORTATION SECTOR

The 2010 US Climate Choices report by the US National Academy of Sciences (NAS 2010) makes it clear that the earth's climate is changing due to human activity. Many governments in developed countries have agreed for GHG emissions to be reduced 80% by 2050 in order to stabilize atmospheric concentrations of GHG (Greene and Plotkin, 2011). The transportation creates about one-fifth of global GHG emissions. The industrialized countries emit more than developing countries. So that reducing emissions from this sector must be a key part of a global strategy to combat climate change. The US transportation sector is the largest GHG emitter among the world's transportation sectors. It was accountable for 31% of global transportation energy use and GHG emissions in 2006. In 2030, the US transportation sector is expected to use one-fourth of global transportation energy. It is also estimated that CO_2 emissions of the USA grow by about 10% by 2035 (EIA, 2010). In 2006, Americans traveled 5.2 trillion person-miles in vehicles and moved 4.6 trillion ton-miles of freight (BTS, 2009), which consumed 28.6 quads of energy (EIA, 2009b).

The US transportation sector faces following three major challenges to take any attempt to reduce higher GHG emissions:

- The vehicle manufacturers want to make larger and more powerful vehicles which will be fuel economy.
- Any attempt to shift from petroleum fuels to lower-carbon alternatives such as hydrogen or electricity is failed, because the motorists want to use high-carbon fuels which give them excellent characteristics for transportation. Past attempts to bring new fuels and new technologies into the US marketplace have failed seriously. Also the cost and performance of current technologies and fuels against which these new options must change over time, creating a moving target which effect viability and adoption of new fuels.
- The US population and economy are expected to continue to grow, increasing both freight and personal travel. The real Gross Domestic Product (GDP) to be doubled for growing populations additional 85 million by 2035 compared to 2008 (EIA, 2010).

A strong research, development, demonstration, and deployment program will be crucial to the reduction of GHGs in the US transportation sector. There are enough alternative pathways that one can be reasonably assured of success if the US government commits to a strong effort to reduce GHG emissions (Mohajan, 2011).

The USA must reduce GHG emissions from the transportation sector substantially within 2050. So that the US transportation to be more energy efficient and less carbon-intensive, which reduce its GHG emissions from transportation sector. The dependence on petroleum the US transportation system makes the US economy vulnerable to significant excess economic costs on the order of hundreds of billions of dollars per year (Greene, 2010). Mitigating transportation's GHG emissions can save about 70% US petroleum use (EIA, 2009a). To buy gasoline US losses hundreds of billions of dollars each year that effect in economic development. In only 2008 the estimated economic cost of oil dependence was half a trillion dollars ($350 billion in wealth transfer, $150 billion in lost GDP) (Greene and Hopson, 2009). All kinds of light-, medium-, and heavy-duty highway vehicles dominate the US transportation sector's energy consumption and CO_2 emissions. In 2007, they emitted 78% of total transportation CO_2 emissions of the USA and accounted for 80% of the sector's energy use. Air transportation was second with about 9.5% of energy use. But emissions from air transportation effect on global warming are overstated by the warming effect of jet engine contrails (EIA, 2009a).

The US consumes more than 10 million barrels of oil per day only moving people and goods on roads and rails throughout the country which generates more than 23% of US anthropogenic GHG emissions. In 2010, Americans drove about 3 trillion miles (Burbank and Nigro, 2011). In January 2011, the Pew Center on Global Climate Change issued a report on all of the actions that can be taken by the US government across the transportation sector to save oil and reduce GHG emissions (Greene and Plotkin, 2011). There are many ways to save oil and to reduce GHG emissions from transportation as follows (Burbank and Nigro, 2011, and Mohajan, 2011):

- Research need to develop energy-efficient vehicles (natural gas transit buses). Encourage users to purchase and use energy efficient vehicles. It is needed to impose federal gasoline tax and other transportation user fees to reduce GHG emissions.
- It is essential to increase of low-carbon fuels and installation of electric plug-in facilities and other infrastructure to support use of low-carbon fuels. It also necessary to ethanol tax exemption and encourage purchasing of natural gas transit buses.
- Operational efficiency such as congestion reduction strategies, speed reduction, promotion of eco-driving, traveler information systems, real-time traffic management centers, adaptive traffic management etc. need to save fuel. Moreover if maximum speed is fixed in 55 mph (miles per hour) then GHG emissions will decrease.
- Infrastructure Construction such as light emitting diodes traffic lights, low-carbon pavements, other low-carbon materials, energy-efficient construction practices, construction and maintenance equipment need to reduce black carbon and other emissions.

The use of oils develops the US current and future economy but GHG emissions decrease the flow of the economy. For the last three decades, the US transportation has grown to the highest rate in energy consumption and GHG emissions, because the other sectors were more successful in improving their energy efficiency. Some of the main reasons for the rapid growth of the US transportation being as follows (Greene and Plotkin, 2011):

- Automakers used technologies that could have improved fuel economy instead of providing better acceleration, greater safety, larger size, and other features.
- *Just-in-time* manufacturing and distribution technologies favored truck freight transportation than rail and demanded frequent deliveries, encouraging the growth of heavy-duty truck transportation.
- The fuel economy standards in place from 1975 to 2008 had more relaxed standards for light-duty trucks than for passenger cars. That is why sales of the less efficient trucks increases, which grew from 17% sales in 1980 to about 50% in 2008 (EPA, 2009).
- Deregulation of passenger air travel provides lower fares and more options, expanding demand.

The new Annual Energy Outlook of EIA (EIA, 2010) forecasted that the transportation sector's energy consumption will grow by about 21% from 2008 to 2035, compared to growth of about 33% for the commercial sector. At the same time the EIA (2010) forecasts that growth in CO_2 emissions to be about 10% over the same period compared to 24% for the commercial sector. The forecast also anticipates that US oil imports will shrink dramatically, from 60% of total consumption in 2006 to 45% in 2035.

7 MITIGATION ATTEMPTS OF TRANSPORTATION IN THE USA

In the USA the GHG emissions in transportation will have to be reduced marginally by 2050 to mitigate the effects of climate change. The different combinations of policies, technologies and behaviors could reduce transportation's CO_2 emissions by anywhere from 15 to 65% below 2010 levels by 2050. But at present it is not possible to determine with confidently and precisely how great a reduction the transportation sector can make by 2050.

Market-based policies such as CO_2 tax or a cap-and-trade system allowed the market to determine the price of allowances to emit CO_2 which would be true if transportation markets were perfectly competitive and efficient. They are affected by political decisions about highways, ports, and other infrastructure, as well as by government regulations and patterns of land development.

Some experts suggest that market-based policies alone cannot achieve significant reductions in transportation emissions. In an EIA study of an economy-wide carbon cap-and-trade system a carbon price that rises from $20 per ton of CO_2 in 2012 to $65 per ton in 2030 reduces emissions from the electric utility sector by 60% but transportation emissions fall by only 5% (EIA, 2009c). On the other hand, bottom-up analyses of transportation options have claimed that emission reductions of 12% to 50% compared to projected levels in 2030, at costs of less than $50 per ton of CO_2 (Greene and Schafer, 2003, and Creyts et al., 2007).

Now we will discuss that the GHG emissions can be reduced by improving vehicle and system efficiencies, substituting lower-carbon fuels for petroleum, shifting traffic among modes, and changing the pricing of transportation.

Passenger Cars and Light-Duty Trucks Efficiency

Passenger cars and light-duty trucks account for about 60% of the energy used for US transportation and their energy use has grown by 1.4%/ year over the past several decades (Davis et al., 2009). The efficiency of these vehicles can be improved by adopting the following ways (Greene and Plotkin, 2011):

- reducing the energy needed to move the vehicle, by reducing weight, the resisting force of air(aerodynamic drag), and resisting force between tires and the road (rolling resistance),
- improving the efficiency of the engine and transmission,
- improving the efficiency of accessories such as air conditioning and lights, and
- reducing the need for heating and air conditioning by improved insulation, changing in window glass, and reducing more weight of the vehicles.

Weight reduction of the vehicles can be achieved by design changes and the use of stronger, lighter materials, such as high green qualities plastics, polymer composites, and lighter metals. A lighter vehicle can use a smaller, lighter, and cheaper engine, with less support structure and lighter suspension and brakes. Reducing aerodynamic drag by 10% can yield a fuel economy improvement of about 2% (EEA, 2006). Aerodynamic drag force increases with the square of speed; hence it can be the dominant force on the vehicle at highway speeds. Drag reduction can be obtained by reducing a vehicle's cross-sectional area, improving the fit of body parts, changing the vehicle's shape, smoothing the vehicle's underbody, and other measures. A recent MIT study 'On the Road in 2035', projects that the new car fleet could attain about a 30% reduction in aerodynamic drag by 2035 (Bandivadekar et al., 2008). For example, at present the average coefficient of aerodynamic drag C_D (drag force = $C_D \times \text{velocity}^2 \times$ cross-sectional area) of the new US passenger car fleet is about 0.30, with the best at about 0.25. The aerodynamic drag coefficient of the Toyota Prius is 0.25 (Toyota, 2009). A European version of the Mercedes E-Class Coupe is 0.24 (Daimler, 2009).

There are substantial opportunities to improve drivetrain efficiencies even for conventional drivetrains and gasoline-fueled engines. For gasoline engines some key technologies are as follows:

- Direct injection of fuel into the cylinder, but at present it is done in modern diesel engines.
- Turbocharging with substantial engine downsizing. An exhaust turbocharger uses the engine's exhaust to drive a turbine which pushes extra air into the cylinders, increasing power and torque. 1.4-liter turbocharged engines could replace 2.3 to 2.5 liter four-cylinder engines (SAE International, 2010).
- A variety of other measures, including improved lubricants, lighter weight valve trains, more precise control of the timing and opening of intake and exhaust valves.

The improved transmissions can be increased drivetrain efficiency by reducing internal losses and by enabling the engine to operate more at its most efficient speed. A new generation of six, seven, and eight speed automatic transmissions with fewer parts and lower internal losses have made substantial inroads in the luxury car fleet and will roll into the overall fleet over the next few years. The fuel economy gains from these technologies would be about 4 to 5%.

'On the Road in 2035' examines efficiency upgrades to a midsize car and a pickup truck, and extrapolates these upgrades to the overall fleet. The baseline midsize car is the 2005 Toyota Camry sedan with a 2.5-liter 4-cylinder engine. The study concludes that average midsize new cars in 2035 could achieve a 20% reduction in curb weight, a 25% improvement in aerodynamics, and a 33% reduction in tire rolling resistance. The study then looked at the potential impact of seven different drivetrain combinations, ranging from advanced conventional spark ignition (SI) drivetrains to battery electric and fuel cell drivetrains. Even the 2035 conventional drivetrain car with SI gasoline engine attains a 62% improvement in fuel economy, saving nearly 2200 gallons of gasoline over a 150,000-mile lifetime. The estimated increase in retail price is $2,000, or $0.92 per gallon saved. However, applying a discount rate of 20% to fuel savings, better reflecting consumer behavior, the cost rises to $2.55 per gallon saved.

The 2035 hybrid-electric vehicle (HEV) attains a 65% reduction in fuel use compared to the baseline 2005 vehicle, but only 44% compared to the advanced spark-ignition engine (SIE) saving an additional 1,500 or so gallons over its lifetime, but at a price increase of $2,500 over that of the 2035 SIE. This is a marginal cost of about $1.64 per additional gallon save or $4.54 at a 20% discount rate.

Attaining the 'On the Road in 2035' efficiencies would have substantial effects. The AEO2010 Reference Case (EIA, 2010) projects that light-duty vehicle (LDV) energy use will increase by about 7% from 2007 to 2035; CO_2 emissions would increase by a similar amount. In this case, new car on-road fuel economy will be 36 miles per gallon (mpg) and light-duty trucks will achieve 27.3 mpg by 2035. Extending these trends to 2050 would achieve a stock fleet of about 33 mpg.

In contrast, new passenger cars with 'On the Road' technology would attain 42.8 mpg for gasoline-fueled engines with conventional drivetrains; 48 mpg with turbocharging; and nearly 76 mpg with hybrid drivetrains. Equivalent values for light-duty trucks are 27.3 mpg, 32.2 mpg, and 49 mpg, respectively.

8 IMPROVEMENT OF NON-PETROLEUM-BASED FUELS

Alternative fuels such as biomass liquids, electricity, hydrogen, and other low carbon fuels can also play a major role in reducing both oil use and GHG emissions, improving the efficiency of gasoline- and diesel-fueled vehicles can greatly reduce oil use and GHG emissions by up to 29% per vehicle for the LDV stock fleet from business-as-usual levels by 2035, and 44% by 2050. But additional measures should be required to attain a large absolute reduction in transportation's GHG emissions. A primary option is the use of low-carbon fuels to replace petroleum-based fuels.

In the future, successful penetration of large numbers of alternative fuel vehicles, and substitution of significant quantities of gasoline and diesel fuels, will depend on several factors as follows:

- most importantly, cost-competitive vehicles and fuels,
- a sustained and vigorous R&D program,
- avoidance vehicle breakdowns and safety problems, and toxic emissions from fuel production on the part of both vehicle designers and fuel providers,
- a major commitment from government and/or industry to subsidize elements of the new fuel system including early development of refueling infrastructure, and
- sustained high oil prices or government's willingness to use taxes or other pricing policies to keep petroleum-based fuel prices higher than the alternatives.

Another factor that should be considered in developing programs to replace petroleum fuels with alternatives is the overall robustness of any new fuel system. Since gasoline and diesel fuel are energy dense and easily transported, petroleum-based systems tend to be quite robust in the face of local emergencies. In contrast, some alternative fuel sources, such as electricity and hydrogen, are vulnerable to local emergencies such as damage to the electricity grid or the break of pipelines from earthquakes or other causes and significant re-supply may be difficult because of these fuels' low energy density.

The current major candidates for significant displacement of gasoline and other petroleum-based fuels are hydrogen in fuel cell vehicles, liquid fuels from biomass, electricity, compressed and liquefied natural gas, and liquid fuels from coal and natural gas. For liquid fuels from coal or natural gas, carbon capture and storage will be required to avoid increases in GHG emissions. Liquefied petroleum gas (LPG) is also a viable substitute for petroleum fuels, but its supply is quite limited.

Electricity

The combination of major improvements in electric drivetrains both improved performance and reduced costs stimulated partly by the production and sale of millions of gasoline-electric hybrids and growing interest in electricity as a transportation fuel. Despite major improvements in batteries, pure electric vehicles remain extremely range-limited. Because most LDVs are driven for relatively short distances on most days, a PHEV with 40 miles of electric range (PHEV40) can electrify about 60% of vehicle miles driven. Even cheaper PHEVs with a 10-mile electric range (PHEV10) should be able to electrify about 20% of miles driven. The NAS recently accomplished that current PHEV battery packs would cost well over $1,000 per kilowatt-hour (kWh), dropping over the next 10 years to about $400 kWh (NRC, 2010). Nelson, Santini, and Barnes (2009) estimate that, in mass production of 100,000 battery packs per year, PHEV20 battery packs would cost $255 per kWh and

PHEV40 battery packs would cost $210 per kWh. A key difference in battery cost estimates seems to be disagreement about the level of maturity of automotive-scale Lithium-ion batteries and thus the potential for further improvements and cost reductions. But at least four new Lithium-ion chemistries are currently being developed for near-term PHEVs (Santini, 2010) with the potential for lower cost and higher available specific energy. Further, the NAS assumes that only 50% of the energy stored in PHEV batteries will be accessible, to assure the needed battery longevity. Although first generation PHEVs appear to be adopting this limitation on battery availability, this is almost certainly a conservative approach and it seems likely that the NAS estimates will prove to be overly pessimistic. The NAS assessment developed two scenarios for PHEV deployment a maximum practical scenario yielding 40 million PHEVs on the road by 2030 out of a total fleet of 300 million, rising to nearly 250 million PHEVs by 2050, and a more probable case yielding 13 million PHEVs by 2030 and about 100 million by 2050 (NRC, 2010). Both of these scenarios appear to be quite optimistic, conditioned at a minimum on substantial cost reductions in PHEV batteries, strong incentives to potential purchasers, and major infrastructure investments in charging stations and electricity distribution networks.

The GHG emission reduction potential of PHEVs depends on the source of the electricity used for recharging. 'On the Road in 2035' (Bandivadekar et al., 2008) estimates that in 2035, PHEV30s would emit about the same GHG emissions as hybrids without plug-in capability if the electricity used in recharging was identical to current US average generation. Obtaining substantial reductions past this level would require, considerable progress decarbonizing the US electrical grid. Pure battery electric vehicles seem unlikely to significantly replace internal combustion engine-based vehicles in the near future because of high costs and energy storage challenges. Recent analyses have found that vehicles with ranges of 200 miles and above will be significantly heavier than competing vehicles, reducing overall efficiency.

'On the Road in 2035' (Bandivadekar et al., 2008) assumes that, in 2035, the Lithium-ion batteries in an EV with 200-mile range would have a specific energy of 150 watt-hours (Wh) of useable energy per kg. A midsize EV passenger car would weigh nearly 3,600 pounds compared to about 2,800 for a comparable 2035 car with a gasoline engine. The EV would cost $14,400 more than the competing 2035 gasoline fueled car, and $11,900 more than a 2035 gasoline fueled HEV. The EV's lifecycle GHG emissions would be higher than those of a gasoline fueled HEV unless the carbon intensity of the power sector is reduced.

An additional concern about EVs is charging time, estimated to be 7 to 30 hours for a 200-mile range vehicle depending on whether 240V current or regular 120V household current is used.

A more optimistic view of EVs' future exists, but it will take heroic progress in battery development to achieve much higher specific energy and much lower cost and even then EVs with high mileage range would likely still be heavy and expensive. Nissan has introduced the Leaf, a subcompact EV with a 100 mile announced range, with an initial price of $32,800. These vehicles enjoy the benefits of being able to recharge at home and cheaper fuel. However, the potential market for these vehicles is highly uncertain at this time.

Coal-to-Liquid Fuels

Coal is also a viable source of liquid fuels, and the NAS estimates that such fuels could compete with gasoline at oil prices as low as $60 per barrel (NRC, 2009). However, such fuels would provide few or no GHG benefits with CCS used in their production and would cause large increases in CO_2 emissions if CCS were not used (EPA, 2007; Wang, 2007 and DOT, 2010).

Natural Gas

As with coal, natural gas can be transformed into liquid fuels using Fischer-Tropsch technology, but with only modest GHG benefits if CCS is used in making the fuels (Wang, 2007). However, vehicles fueled directly by compressed or liquefied natural gas (NGVs) do offer reductions in GHG emissions compared to gasoline and diesel fueled vehicles. DOE estimates that a dedicated compressed natural gas (CNG) vehicle will obtain about the same fuel economy, on a gasoline-equivalent basis, as an otherwise-identical gasoline-fueled vehicle (DOE, 2010). Using Argonne National Laboratory's GREET model to estimate lifecycle GHG emissions, this implies that the CNG vehicle has 15% lower lifecycle GHG emissions than a similar gasoline-fueled vehicle. New engine designs may allow bi-fuel engines (primarily natural gas and gasoline) to obtain substantial CO_2 reductions burning natural gas while providing fueling flexibility to overcome natural gas's refueling infrastructure issues. For example, Volkswagen's Passat Ecofuel sedan uses both a supercharger and a turbocharger to get maximum performance and efficiency when operating either on gasoline or natural gas, with 23% lower GHG emissions operating on CNG than on gasoline (Volkswagen AG, 2009). Worldwide, there are more than 9.5 million NGVs on the road, and their numbers have been growing by 30% annually since 2000 (IANGV, 2010). While there are only a little over 100,000 NGVs deployed in the USA (Yborra, 2008), about one-fifth of full-size transit buses are fueled by natural gas, and there are thousands of natural-gas fueled airport shuttles, delivery vans, trash haulers, and other vehicles. NGVs could be part of a US strategy to reduce GHG emissions and increase energy security. Given recent shale gas discoveries, they could be fueled by domestic gas. They also provide significant reductions in emissions of particulate matter, oxides of nitrogen NO_x, and hydrocarbons. However, use of natural gas to replace coal in the electricity sector would provide a bigger GHG benefit than using natural gas in vehicles.

9 LONG-TERM TRANSPORTATION FUTURE TECHNOLOGIES OF THE USA

Lithium Air Batteries

This type of batteries might be higher energy densities is crucial to developing electric vehicles with longer ranges. Gasoline's energy density is about 13,000 Watt-hour (Wh) per kg compared to current Lithium-ion batteries' 100 to 200 Wh per kg, nickel metal hydrides' 60 to 120 Wh per kg, and lead acid's 25 to 40 Wh per kg. A number of research organizations are trying to develop practical lithium metal-air batteries. The anode is made of lithium metal, while the surrounding air acts as a cathode.

Potential energy densities are 5,000 Wh per kg and higher, enough to allow EVs to attain ranges equal to those of internal combustion engine (ICE) vehicles. These batteries could also be used to store electricity for the power grid, improving penetration of intermittent electricity sources such as wind and solar.

Third Generation Biofuels

Current biofuel efforts are focused on relatively conventional crops ranging from corn to fast growing grasses. All are limited by large acreage requirements; fuel yields per acre per year range from 50 gallons of biodiesel from soybeans to about 440 gallons of ethanol from corn (ExxonMobil, 2010, and Argonne National Laboratory, 2010). So-called third generation biofuels offer much larger benefits. Obtaining oils from algae grown in open ponds or in closed-system bioreactors offers yields at least an order of magnitude larger than conventional crops, with yield estimates well over 5,000 gallons per acre per year. Algae fuel (oilgae) is a biofuel from algae and denoted as a third-generation biofuel (IEA, 2008). Algae has the advantage of producing oils that can be converted into biodiesel, biogasoline, or jet fuel, and carbohydrates that can be fermented into bioethanol and biobutanol; there also is the potential for algae to directly produce hydrogen. Production also does not require fertile land or high quality water, avoiding conflicts with food and feed production. Algae grow quickly, especially if fed with concentrated CO_2, such as exhaust streams of fossil power plants. The challenges to algae-based fuel production include finding strains that have both high oil content and resistance to viral infection, and reducing the costs of growing, harvesting, and fuel processing. Third generation biofuels are called advanced biofuels (Mohajan, 2012b).

Automated Highways

By 2050 it is plausible that portions of the nation's highway system could operate in an automated mode, allowing vehicles to "drive themselves" in coordination with other vehicles and interacting with the highway system (Shladover, 2000). The potential benefits include reduced accidents, increased capacity, and 10 to 20% reductions in GHG emissions. Fully automated highways face social and institutional as well as technical difficulties, the most important of which is representing reliability.

10 CONCLUDING REMARKS

In this paper we have shown that GHG emissions of the USA is increase gradually which results global climate change. Thinking this the USA is taking various steps to reduce GHG emissions. The USA must reduce GHG emissions to create pressure other nations to follow them. To keep the earth living place for all creatures we have to take immediate steps for reducing GHG emissions efficiently. The biofuels can be a substitute alternative of petroleum, which can reduce GHG emissions but it creates food crisis. We have also discussed future long-term technologies of the USA in transportation sector to reduce GHG emissions.

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