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Greenhouse Gas Emissions Increase Global Warming

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Abstract: *This paper discusses the greenhouse gas emissions which cause the global warming in the atmosphere. In the 20th century global climate change becomes more sever which is due to greenhouse gas emissions. According to International Energy Agency data, the USA and China are approximately tied and leading global emitters of greenhouse gas emissions. Together they emit approximately 40% of global CO_2 emissions, and about 35% of total greenhouse gases. The developed and developing industrialized countries together emit 90% of the global CO_2 equivalent gases. 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. Hence immediate steps to be taken to reduce greenhouse gas emissions to safe the future generations. The paper emphasizes on the affects of global warming and different ways to reduce greenhouse gas emissions.*

Keywords: Greenhouse gas emissions, Global warming, Climate change.

Introduction

The world has realized that global warming is continually increasing due to greenhouse gas emissions. The living organisms 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 carbon dioxide (CO_2) and other greenhouse gases (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 activity (NAS 2001, 2010). The NAS cites 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.

Scientific research shows that ice losses 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 1.3mm each year and scientists observed that the sea levels are rising by about 3mm per year. By 2006, the Greenland and Antarctic sheets were losing a combined mass of 475Gt (gigatons) of ice per year. If these increases continue water from the two polar ice sheets could have added 15cm to the average global sea level by 2050. So that all the nations

especially developed countries must take immediate steps to reduce GHGs to a substantial level. If GHG emissions can not be controlled then the people of most of the countries will suffer for drinking water, shortage of foods and various heat related diseases. Scientists declared that some plants and animals will extinct in the 21st century due to increase global warming.

According to International Energy Agency (IEA) data (IEA 2007a), the USA and China are approximately tied and leading global emitters of GHG emissions. Together they emit approximately 40% of global CO_2 emissions, and about 35% of total GHGs. The USA is a developed country but China is yet a developing country. In this paper we have described briefly GHG emissions of these two countries.

The aim of this paper is to grow consciousness among the people who are not aware of global warming and its sever effects. The developing and poor nations are suffering from global warming which is due to GHGs and these gases are emitting from industrialized countries. Now it is too late but not yet impossible to control GHG emissions to save the future generations. 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. China shows willingness to the reduction of GHGs but developed countries show opposite opinions. So that the mitigation policies of CO_2 equivalent reduction will not be fruitful in future if all the nations do not consent to the reduction of GHGs emissions (The Prothom Alo 2011b).

Greenhouse Gas Emissions

Every nation in the world has realized that global warming 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

Table 1: The global warming potential of six GHGs, (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

traps different amounts of heat and stays in atmosphere for different lengths of time. So that it is necessary to measures of global warming potential to compare between gases. The following table gives six GHGs global warming potential and atmospheric life in years (Sharma 2007).

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 3km. 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).

Now we illustrate the inventories of six GHGs as follows:

CO_2 is the most significant GHG for its natural high atmospheric concentration and heat-trapping abilities. CO_2 is accumulating in the atmosphere due to human activities. Pre-industrial revolution period CO_2 was at a level of 280ppm and in 2005 it is increased 35% and is reached to a level of 379ppm (IPCC 2007a).

CH_4 is present in the atmosphere very low compared to CO_2 but it is 21 times more potent per unit as a greenhouse gas (EPA 2006). In the pre-industrial period CH_4 was 715ppb (parts per billion) but in 2005 it increased 148% to reach 1774ppb (IPCC 2007a). About half of this increase is due to decomposition of wastes in landfills, natural gas systems, and enteric fermentation (EPA 2006).

N_2O is 300 times more potent than CO_2 as a heat trapping gas (EPA 2006). Pre-industrial period this gas was 270ppb but in 2005 it increases 18% to reach 319ppb (IPCC 2007a). This gas mainly produced from agricultural soil management, mobile combustion, manure management, nitric acid production and human sewage.

HFC, PFC and SF_6 group of GHGs are less present in the atmosphere but they are active contributors to climate Change (EPA 2006). These three gases have extremely high global warming potentials, and SF_6 having the highest in power among them. HFC are substitutes of ozone-depleting chemicals such as chlorofluorocarbons (CFC). PFC gases are generated as a byproduct of semi-conductor manufacturing and primary aluminum manufacturing. SF_6 is emitted from electrical transmission and distribution systems. These three gases have increased 58% in atmosphere from 1990 to 2004, due largely to the substitutions away from ozone-depleting chemicals.

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 activity (NAS 2001, 2010). The NAS cites the burning of fossil fuels is the primary source of anthropogenic CO_2 emissions. IPCC (2007a) has expressed its expert opinion that the observed increase in global average temperatures since the mid-20^{th} century is very likely due to the observed increase in anthropogenic GHG concentrations and the temperature has been rising most rapidly since 1970 (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. Warming is larger in the Western Equatorial Pacific than in the Eastern Equatorial Pacific over the past century. The latest report (in 2007) shows that atmospheric concentrations of CO_2 grew 80% from 1970 to 2004, and recently exceeds by far the natural range over the last 650,000 years (IPCC 2007b). 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. Warming occurs over ocean areas, far from direct human effects, with warming over ocean less than over land, an expected result for a forced climate change because of the ocean's great thermal inertia (Hansen et al. 2006). About 100,000 years ago in the last intergalactic period the temperatures were 3^0C to 5^0C higher than the present temperature due to the differences in the orbit of the earth. As a result then the sea level was likely 4m to 6m higher than the 20th century average (IPCC 2007a). NASA and Department of Energy Scientists expressed that emission of CO_2 and other heat-trapping gases have warmed the oceans, and are leading to energy imbalance which is causing, and will continue to cause, significant warming the atmosphere, increasing the urgency of reducing CO_2 emissions. Both NAS (2010) and IPCC (2007b) expressed that humans, largely through the ever-increasing burning of fossils are changing the earth's climate.

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

- 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 1.3mm each year and scientists observed that the sea levels are rising by about 3mm per year. By 2006, the Greenland and Antarctic sheets were losing a combined mass of 475Gt (gigatons) of ice per year. If these increases continue water from the two polar ice sheets could have added 15cm 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 warming 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 Artic 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 380ppm, 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 450ppm 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. 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 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).

Experience of hotter summer days which could increase heat related mortality, ground-level ozone concentrations, storm water runoff, and negative impacts from erosion and invasive species. Rising temperatures may increase air pollution levels, with their attendant increases in respiratory illness and death. GHG emissions and climate change pose a serious threat to the economic well-being, public health, natural resources and environment of the earth. Snowpack in summer stream flows to provide energy, municipal water supply, watershed health and irrigation. The potential rise in sea levels threatens coastal communities, increased vector-borne diseases (EPA 2010).

IPCC and NASA advised that US should target to reduce GHG emissions 20% to 30% below 1990 levels by 2020 to avoid the risks of dangerous impacts of global warming. US president Barack Obama has endorsed two targets as follows (US Climate Action Partnership 2009):

- Reducing US GHG emissions back to 1990 levels by 2020.
- Reducing US GHG emissions to 80% below 1990 levels by 2050.

2009 was actually the fifth warmest year on record as far as global temperatures were concerned. The four warmest years were, in ascending order, 2002, 2003, 2005 and 1998. The last decade was the warmest on record, followed by the 1990s and then the 1980s, so the world is definitely warming up (Betts 2010). The estimated uncertainty of global mean temperature implies that year 2005 was probably the warmest year which is based on the positive polar anomalies, especially the unusual Artic warmth (Hansen et al. 2006).

Scientists monitoring sea ice around the high Arctic and glaciers on the world's highest mountains are detecting ominous new changes linked to the warming global climate. The Arctic's thin and salty seasonal sea ice that freezes and melts in the far north every year actually spread more widely past winters. The team of NASA scientists keeping watch over the ice by satellite expressed that the much thicker perennial ice which normally remains throughout the Arctic summer has grown much thinner and some is already melting and drifting southward as winter ends (NAS 2010).

In a related development, scientists at the World Glacier Monitoring Service, based at the University of Zurich in Switzerland, reported that some 30 major glaciers around the world are shrinking fast, which threatening to increase floods in some regions and to decrease precious water supplies in others. Swiss scientists have been tracking the world's glaciers for more than a century, and the current team is now involved to the U.N. Environment Program. They reported that "data from 30 glaciers in nine mountain ranges from Alaska, the Andes, Antarctica, the Alps and the Himalayas showed that between 2004 and 2006 the average rate of melting and thinning more than doubled". In the survey they observed that the glaciers were melting at an average rate of about a foot a year between 1980 and 1999. The rapid melting of glaciers in every mountain region indicates the serious dangers, from drinking water shortages to flash floods to decreases in available water for irrigation (NAS 2010). A group of scientists of Nepal named International Centre for

Integrated Mountain development (ICIMD) express their research report in UN Climate Change Consensus 2011, Durban, South Africa that the glacier of Himalayas are melting dangerously. The researchers find that about 21% of the glacier in Nepal portion is melted in last 30 years and at the same time 22% of the glacier is melted in Bhutan portion. In 2007 the scientists also expressed that within 2035 all the glaciers of the Himalayas will be melted off (The Prothom Alo 2011b).

The IPCC's (2007b) Synthesis Report "Summary for Policymakers" (Table SPM-6) finds that using the best estimate sensitivity stabilizing at a warming of 2^0C to 2.4^0C requires stabilizing CO_2 emissions in the range of 350-400ppm CO_2 or 445-495ppm CO_2e (IPCC 2007a). For 450ppm CO_2e target developed countries need to reduce their emissions 40% to below 1990 levels in 2020 and reduce the emissions 95% to still lower levels by 2050, even if developing countries make substantial reductions. At the international climate talks in Poland both the Chinese and Indian delegations told that the goal of merely returning to 1990 levels in 2020 is inadequate to fight global warming. In 2007 the EU agreed to "slash GHG emissions by 20% within 13 years unilaterally and pledged to push for an agreement with the US and other industrialized countries to cut by 30% by the same deadline".

IPCC chairman Rajendra K. Pachauri, in an interview with the Prothom Alo expresses his expert opinion about climate change as follows (The Prothom Alo 2010):
"Bangladesh is one of the greatest Δ- islands of the world. Natural calamities like flood, storm, cyclone etc. are in alarming position in this country due to global warming. Within 2050 coastal area of Bangladesh will engulf by the sea which is about two-fifth portion of the country. So Bangladesh can stress the industrialized countries to decrease GHG emissions. The temperature of air and ocean are increasing rapidly, so that ices of the different parts of the world are melting. Within the 21st century the temperature of the world will increase about $+2^0$C. As a result 20% to 30% plants and animals of the world will extinct. In annex-1, 37 developed countries are not yet economically balanced. The developing countries China, India, Brazil and South Africa are in economically backward due to poverty, low per capita income, illiteracy and unskilled human capital. So that they are not taking serious attempts to decrease GHG emissions. These developed and developing countries together emit 90% of the global CO_2e gases. Although these countries are trying to develop their economy but they may or may not success because natural calamities will harm economy much more than their expected development".

According IEA data (IEA 2007a), the USA and China are approximately tied and leading global emitters of GHG emissions. Together they emit approximately 40% of global CO_2 emissions, and about 35% of total GHGs. The USA is a developed country but China is yet a developing country. Now we describe briefly GHG emissions of the USA and China.

Greenhouse Gas Emissions of USA and Mitigation Policies

CO_2 emissions from energy use including transportation calculated for 83% of US GHG emissions in 2005 (EIA 2006). US GHG emissions in 2007 were 16% higher than 1990 levels so that US has to loss much of its credibility in the international community by failing to act already. 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.

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 averting 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).

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 $MMTCO_2e$ in 2012 to 1,732 $MMTCO_2e$ in 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).

In USA N_2O emission reductions could be performing assuming relevant strategies are as follows:

- 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 US in order to meet the Kyoto requirements (McCarl and Schneider 1999).

GHG Emission in 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 U.S. transportation sector is by far the largest GHG emitter among the world's transportation sectors. It is estimated that CO_2 emissions in transportation sector of USA grow by about 10% by 2035 (EIA 2010).

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 instead of 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.
- 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).

The US 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 2009). To buy gasoline US loss hundreds of billions of dollars each year which effects 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 U.S. transportation sector's energy consumption and CO_2 emissions (EIA 2009). In an EIA study shows that 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 falls emissions from the electric utility sector by 60% while transportation emissions fall by only 5% (EIA 2009).

The US consumes more than 10 million barrels of oil per day only moving people and goods on roads and rail 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):

- Research need to develop energy-efficient vehicles (natural gas transit buses). Encourage users to purchase and use energy efficient vehicles. It is need 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 55mph (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.

Greenhouse Gas Emissions of China

The emissions of CO_2 of China are very high due to the large population, inefficient strong capital investment, heavy reliance on coal and inefficient planed urbanization. The per capita income of USA is very high but that of China is very low. The GHG emissions of China are higher than the USA (Leggett, Logan and Mockey 2008). China produces about 80% of its electricity by the fossil fuel-fired technologies and it emits one-fifth of world's GHG emissions from power generation. In 2006 it has becoming the world's largest GHGs emitter. The potential investors of China are confronted with uncertainty in the design of China's future climate policy. IEA (2007b) expects that power generation in China will grow with an average 4.9% p.a. It is estimate that the installed capacity will reach 1775 GW by 2030, which is nearly as high as the current installed capacity of the US and the EU combined (Schenker 2011).

Within the period of 1979 to 2007, the Chinese economy grew at an average 9.8% p. a. China acquired $1.5 trillion in foreign exchange resources by the end of 2007 and $3.2 trillion foreign reserve at the end of 2011, which is the world's largest foreign reserve (The Prothom Alo 2011b). So that citizens have improved their standards of living. In 2011 some economic experts claim that China is now a developed country, but yet China is a developing country. World Bank in 2005 estimated that up to 200 million people in China lived on less than $1.25 per day. Hallding, Han and Olsson (2009) indicate that although China has large foreign reserve and rich economic development, but about half of the populations live on less than $2 per day. So that China has not eradicated poverty and can not create field to increase per capita income which is a drawback to overcome poverty of the citizens of China. In most parts of China environ pollution has become so worst that social and political stability are at risk. In 2007 World Bank and the government of China estimated that the cost of outdoor air and water pollution to China's economy totaled around $100 billion per annum which is 5.8% of China's GDP (World Bank 2007). Due to GHG emission China realized the effect of warming of Climate. Recently China has

observed that impacts of storm intensity, rising sea levels, decrease in agricultural productivity, shifting water availability already affecting the people of China.

Coal is the relatively cheap natural fossil energy source for China. In China Coal-fired power plants produce over 2500 TWh (terawatt-hours) electricity per year. Because of heavy reliance on coal, the electricity and heat sector is responsible for about 50% of China's CO_2 emissions from fuel combustion (IEA 2010b). In 2007, it is estimated that China coal contribution is about 70%, in petroleum is 20%, in gas is 3%, and hydroelectric and nuclear contribute 7% for its total energy needs. While the USA used petroleum about 40%, coal and natural gas provide about 25%, and nuclear and hydroelectric contributing 10% for its total energy needs. Hence China in 2007 consumed about twice as much coal each year as the USA. On the other hand China is the world's largest producer of hydroelectricity generating over 397 TWh per year, which is 16% to the total annual electricity production. China estimated in 2004 that its total GHG emissions in 2007 would be about 6100 $MMTCO_2e$ which is a growth of 50% in one decade. This estimation is 83% from CO_2, 12% from CH_4, 5% from N_2O, and 1% from SF_6, HFC and PFC.

We have seen that China is a leading GHG emitter, its GHG emission per capita is below than that of the USA, other industrialized countries and World average. In 2005 Chinese emission per capita were about 6 tons compare to the USA at 25 tons and Russia at 15 tons. Even China's emissions per capita are also below the world average which is 7 tons. It is observed that China's emissions per capita are lower than world average but the GHG emission intensity is highest in the world. China's emissions are about 1.4 $MMTCO_2e$ per billion US dollars of purchasing power parities (GNI_{ppp}), Russia is about 1.33, India is at 0.98 and the USA is 0.9 MMT CO_2 e/ GNI_{ppp}. Hence China's GHG intensity is about twice the world average. As China wanting to increase per capita income so that it will increase GHG emissions. These emissions can be reduced by using efficient technologies in the industrial sectors. The World Bank's World Development indicators observed that China's GHG emission intensity fell more than 66% from 1990 to 2005, the USA dropped 48% and the world average declined by 43% (Leggett, Logan and Mockey 2008).

The year 2010 marked two important milestones for China which are as follows (IEA 2010a):

- In July, 2010 the IEA reported that the energy demand of China surpassed US and become the world's largest energy consumer.
- In August, 2010 China overtakes Japan as the world's second largest economy.

GHG Mitigation Policies of China

The 1992 UNFCCC supported 192 countries including China and USA to stabilize "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". In the UNFCCC all the countries unanimously agrees to GHG concentrations (Leggett, Logan and Mockey 2008). In Copenhagen climate change summit in December 2009, China pledged to cut carbon intensity by 40% to 45% relative to 2005 level by 2020. This commitment stressed that renewable and nuclear energy would increase up to 15% by 2020 and it would expand forest cover by 40 million hectares and forest volume by 1.3 billion cubic meters compared to 2005 (Mochizuki and Zhong 2011)

According to IEA estimations of GHG emissions of China from 1990 to 2005 the total amount of CO_2 increased from 2545 $MMTCO_2$ (144%) but total GHG emissions increased

from 3905 $MMTCO_2e$ to 7527 $MMTCO_2e$ (152%), (IEA 2008). From 2006 to 2007 CO_2 emissions of China increased up to 8%. In 2005 the growth rate of population was 0.6% compared to 1.1% in 1990s which is a positive attempt to decrease GHG emissions. On the other hand from 1991 to 2005 its real GDP grew at an average 10.2% per annum and its energy growth rate was 5.6% per annum (National Bureau of Statistics China 2007). These progresses came from economic restructuring and energy efficiency improvements. Recently China has wanted to decrease electricity production from coal to control GHG emissions (Leggett, Logan and Mockey 2008). The Chinese government hopes that more than 50% energy will come from nuclear and renewable energy sources (wind, biomass, solar and hydro-electric energy) by 2050 (China Climate Change Info-Net 2008).

The Pew Centre on Global Climate Change estimated that, in 2003, the GHG emissions of China release 42% from electricity and heat made up, 21% from industry, 20% from agriculture, 9% from household and services, 5% from transportation and 3% from waste (Pew Centre on Global Climate Change 2007). China's target is 20% reduction in energy intensity between 2005 and 2010. This mandate expresses that the reductions in each year be 4%. Accordingly expected GHG emissions reduction would be 700 $MMTCO_2$ by 2010.

China takes an attempt to produce 16% of all energy from renewable resources by 2020. It expects that wind, solar, geothermal and tidal energy will reduce 60 $MMTCO_2$, biomass will reduce 30 $MMTCO_2$ and hydroelectricity will reduce 30 $MMTCO_2$ (Global Wind Energy Council 2007 and NDRC 2008).

Recently China started to build energy saving buildings and announced that new buildings constructed from 2006 to 2010, the buildings should be design in standard to energy conservation by 50%. The government of China estimated that the standards and levels for refrigerators, air conditioners, washing machines and color televisions will save 33.5 TWh and reduce greenhouse gas emissions by 11.3 $MMTCO_2$ by 2020 (Zhou 2008). China joins Post-Kyoto agreement and promises to stabilize CO_2 emissions on the 450ppm level to reach the two degree goal. So it has to reduce emissions until 2020 by 22% compared to the baseline. To reach the target it must reduce the share of coal-fired power plants quickly and hydro-electricity, nuclear and wind power increases their share (Schenker 2011). To develop renewable energy China invested $36 billion in renewable energy in 2009. Its target is to produce at least 300 GW in hydropower, 180 GW in wind power and 30 GW for bio-power and to produce 10 MTs of ethanol and 2 MTs of bio-diesel by 2020 (Zang 2011).

China, in 2004, set passenger vehicle fuel economy standards in step by step whose average speed will be 36 miles per gallon (mpg) in 2008. It also emphasis same conditions on trucks and agricultural vehicles. After implementation of these standards China could reduce 488 $MMTCO_2$ by 2030. The Chinese Ministry of finance adopted taxes on vehicles taxes on vehicles which is affected September1, 2008. This law doubled taxes on large vehicles and reduced taxes on small vehicles. Purchasers of cars with engines above 4 liter capacity will pay a rise tax of 40%, the vehicles with engine capacity between 3 and 4 liters will rise 15% to 25%. On the other hand engines with one liter capacity will reduced from 3% to 1% (Leggett, Logan and Mockey 2008). In 2007 China has become world's largest CO_2 emitter despite its effort to scale up energy efficiency and aggressively promote renewable energy use (IEA 2007b)

GHG Emissions Due to Global Transportation

In China, India, Brazil 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).

In Europe and Japan, high-speed trains are a part of the intercity travel with other vehicles. On the other hand bus and lower speed rail dominate intercity 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 (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 2009).

GHG Emissions from Non-road Vehicles and Engines

According to the Clean Air Act (CAA), a non-road engine is “an internal combustion engine that is not used in a motor vehicle or a vehicle used solely for competition...”. EPA’s definition of non-road vehicles and engines includes outdoor power equipment, recreational vehicles, farm and construction machinery, lawn and garden equipment, logging equipment, marine vessels, locomotives, and aircraft (EPA 2003).

Table 2: Nationwide Non-road CO_2 Emissions in 2007. Calculated by Western Environmental Law Center using EPA’s non-road emissions model.

2007 U.S. Emissions: Non-road Sector	CO_2 tons/year	Percent Total
Agricultural Equipment	43,627,556	19.8%
Airport Equipment	1,068,325	0.5%
Commercial Equipment	18,046,747	8.2%
Construction and Mining Equipment	70,413,126	32.0%
Industrial Equipment	30,645,516	13.9%
Lawn and Garden Equipment	26,212,514	11.9%
Logging Equipment	2,117,651	1.0%
Pleasure Craft	17,399,940	7.9%
Railroad Equipment	266,237	0.1%
Recreational Equipment	10,347,620	4.7%
Total: All Categories	220,145,231	100%

EPA also employs the term "non-transportation mobile sources" to refer to a subset of non-road vehicles and engines that are mobile but not used on a traditional road system. This category includes snowmobiles, golf carts, riding lawn movers, agricultural equipment and off-road trucks and vehicles, and excludes aircraft, rail and watercraft. According to EPA, in 2007, CO_2 emissions from the non-road sector totaled 220,145,231 tons/year (table-2) in the USA.

The recent new researches demonstrate that due to the thermal inertia of the ocean and ice sheets, the climate will continue to warm for several decades, even if greenhouse gas emissions are held constant. The Bali Action Plan (2007) adopted United Nations climate conference recognizes that "deep cuts in global emissions" will be required to avoid dangerous climate change. Specifically, it acknowledges the need for industrialized nations to GHG emissions by 25% to 40% below 1990 levels by 2020.

Concluding Remarks

In this paper we have shown that GHG emissions increase global warming gradually which results global climate change. To keep the earth living place for all creatures we have to take immediate steps for reducing GHG emissions efficiently. We also show that the USA and China must reduce GHG emissions to create pressure other nations to follow them. Both the countries have taken various steps immediately to decrease GHG emissions and will take new efficient policies in future to make the earth livable peacefully for all.

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