CLIMATE CHANGE AND GLOBAL WARMING

INTRODUCTION

Climate change and Global warming is one of the most serious problems of environment influences the natural setting on earth. The deforestation, oceanic circulation and the burning of fossil fuels are its main aspects. Here in we shall consider theories about the causes and sources of the atmospheric disturbance and the available evidence to support these theories. Using this as a foundation, we then explore policy responses that have been set in motion by different nations along with the proposals for alternatives. Ultimately our objective is economically evaluating the effectiveness of these policies.

(A) CLIMATE CHANGE

What is it?

Climate change refers to a major alternation in climate measure such as temperature wind, or precipitation that is prolonged, i.e., last decades or longer. This type of response might be associated with natural phenomenon like variances in sun intensity or alterations to oceanic circulation. It might also be linked with human activities such as deforestation or the burning of fossil fuels.

A source of controversy is the predicated response to the increasing production of what are termed *greenhouse gases* (GHGs), what are they? They are gases collectively responsible for the absorption process that naturally warms the earth. On the agenda of the 1992 Rio Summit, the issue of accumulating greenhouse gases and the associated predictions of global temperature changes in one that continues to be discussed and debated. In fact, during 1997, the international community formulated the Kyoto Protocol, which continues the climate change initiative first discussed in Rio. The scientific community is not in complete agreement about climate change and its implication although accumulating information and data have helped improved awareness and understanding. In any case, because of the associated complexity and uncertainty, national and international policy responses to climate change have been somewhat tentative.

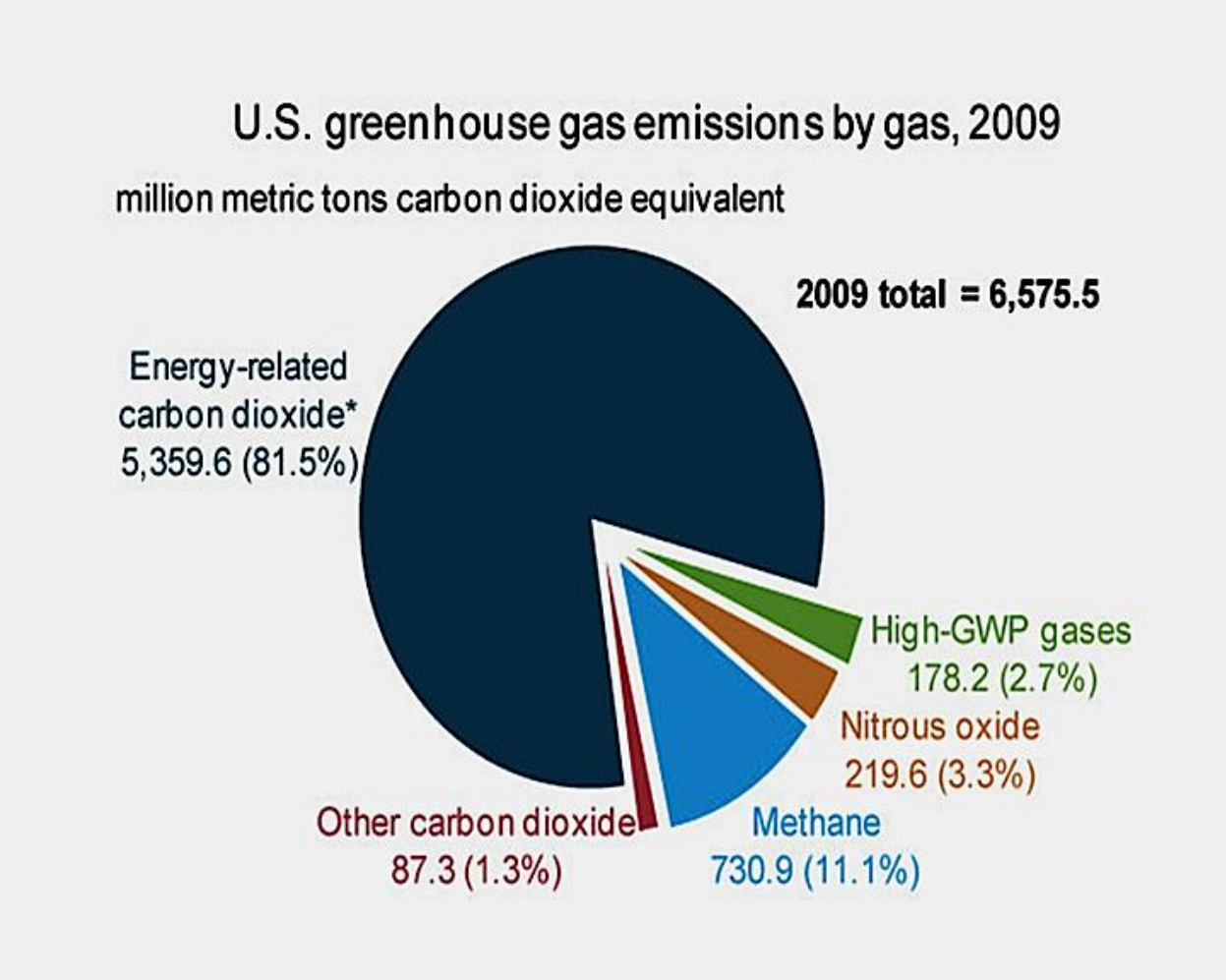
(1) Understanding the Potential of Global Warming

The phenomenon of global warming is based on the following scientific facts. Sunlight passing through the atmosphere hits the earth's surface and is radiated back in to the atmosphere, where it is absorbed by naturally present gases such as carbon dioxide (CO_2). This absorption process heats the atmosphere and warms the earth's surface. This is somewhat like a green house that allows sunlight through the glass but prevents the heated air from escaping back outside, thus the phrase "greenhouse effect". This natural phenomenon is responsible for the existence of life on earth as we know it. In fact, without the so-called greenhouse gases, the earth's temperature would be some 30 to 40 Celsius cooler. Global warming falls under the broader heading of climate change. Although the two phrases are often used interchangeably.

If this warming is natural occurrence, what, then is the problem? The issue is that GHG emissions have increased considerable over time, particularly CO_2. This trend is believed to be linked mainly to increasing human activity, such combustion of fossil fuel (i.e., oil, coal and natural gas) and deforestation. Because GHG, affect the earth's temperature, a significant disruption to their natural levels would generate climate changes. A landmark study conducted by the National Academy of Science in 1979 predicted that a doubling of CO_2 would generate a rise in the earth's temperature of 1.5

to 4.5 Celsius (or 2 to 8 Fahrenheit) climate changes in turn would alter agricultural regions, weather conditions, and sea levels.

Although a number of GHGs are responsible for this warming phenomenon, the primary ones are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The relative contributions differ not only because these gases exist in virgin amounts, but also because they have dissimilar capacities to absorb heat. The ability of a GHG to trap heat in the atmosphere is measured relative to CO_2 by its global warming potential (GWP) selected GWPs are in the table. For example, The GWP for methane is 21, which means that one unit of methane has 21 times the capacity for heat absorption as one unit CO_2.



GWP values for selected GHGs

Gas	GWP
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310
Hydro fluorocarbon (HFC - 125)	2800
Tetrofluoro methane (CF_4)	6500
Perfluoro ethane (C_2F_6)	9200
Hydro fluorocarbon - 23(HFC - 23)	11,700
Sulfur hexafluoride (SF_6)	23,900
Source: IPCC (2007b) Table	2.14

Despite growing consensus that rising amounts of CO_2 will change the earth's climate, no one knows with certainly the timing or the extent of the outcome, in part because there are numerous factors to consider. Not the least of these is the influence of feedback effects that can either lesson or intensify the warming phenomenon. For example, volcanic dust acts to filter the sun's warming rays, which would counter some of the influence of accumulating GHGs. Similarly oceans and forests, which act as carbon sinks, are major absorbers of CO_2, although higher temperatures tend to diminish this capacity. Because of factors such as these and the overall inherent uncertainty, scientific research is ongoing in an attempt to settle at least some of the controversy.

Meanwhile, as society has become more aware of climate change issues more attention is being drawn to carbon emissions and the influence of various products and activities on carbon levels in the atmosphere. Measuring this effect referred to as Carbon Foot printing.

What is a carbon footprint ?

Recently the society has become increasingly aware of climate change and global warming perhaps even more so when the Nobel Peace Prize was awarded jointly to the inter governmental panel on climate change (IPCC) and former U.S. vice president Al Gore in 2007. Concerns about the potential risks of climate change prompted a grassroots interest in reducing emissions of GHGs, including CO_2. Along the way, the notion of a carbon footprint evolved as a way to communicate the contribution to carbon release generated by an individual a house hold a product or an activity.

As this trend has emerged, both public and private sectors have begun to respond. The tools estimate a household's GHG annual emissions based on user-provided information such as place of residence, vehicles driven, fuel used and recycling practices. However the foot print calculators are using different methods of estimates but use the some information restricts the possibility of exactness in estimation. But the intent is to educate society about energy use and to promote energy conservation and environmentalism.

(2) Predicting the Potential Effects

National Assessment Synthesis Team

Scientists are working on, doing research and constantly debating on the issue of climate change and global warming. But there has been a symmetric lack of substantive information on what the eventual outcome of accumulated GHGs might be. However the use of computer simulation models, researchers have been able to assimilate some information about the expected implications. A comprehensive study was conducted as a part of the U.S. Global change Research Program, and the findings were published in a 2001 report by the National Assessment Synthesis Team. Estimates include predictions about forest ranges, biodiversity, the Earth's sea levels, agricultural productivity, water and air quality, and health risks. A subsequent report was published in 2009, which integrates findings from the U.S. Global Change Research Program with research results from other nations around the world.

Rising sea levels are considered to be one of the more probable outcomes of global warming, arising from thermal expansion of the earth's waters and melting of glaciers. As per its estimation the report cited the increase in sea levels ranging 5 to 37 inches. According to one study of the 2009 report the sea level would rise by 3 feet which may cause trouble for the coastal areas, e.g. losses of coastal wet lands, regional flooding, and beach erosion.

However the research findings have some positive side that there is some evidence to support the possibility of a beneficial fertilization effect from increased levels of CO_2, since it is a necessary component of photosynthesis. Furthermore, certain parts of the world such as Canada, Russia and Northern Europe would profit from the northward shift to viable agricultural land that may occur with a warming trend. Conversely, other areas such as the southern United States may suffer losses with such shift. Hence some regions would gain while others lose; most global warming models predict that the net economic effect on agriculture would be relatively minor.

(3) Intergovernmental Panel on Climate Change (IPCC)

In 2007, the intergovernmental Panel on climate change (IPCC) completed its fourth Assessment Report (AR4), on earth's climate. The Fifth Assessment Report (AR5), Comprising Three Working Group Report and a Synthesis Report is in progress. The IPCC was established in 1988 by the world Meteorological Association and United Nations Environment Program. The report is published every five or six years, is a compilation of in depth research by three working groups: Working Group I on "The Physical Science basis", Working Group II on "Impacts adaptation and vulnerability" and Working Group III on "Mitigation of climate change."

The findings of this assessment are comprehensive, complex and highly detailed but at a high level, the chief conclusions of the IPCC are:

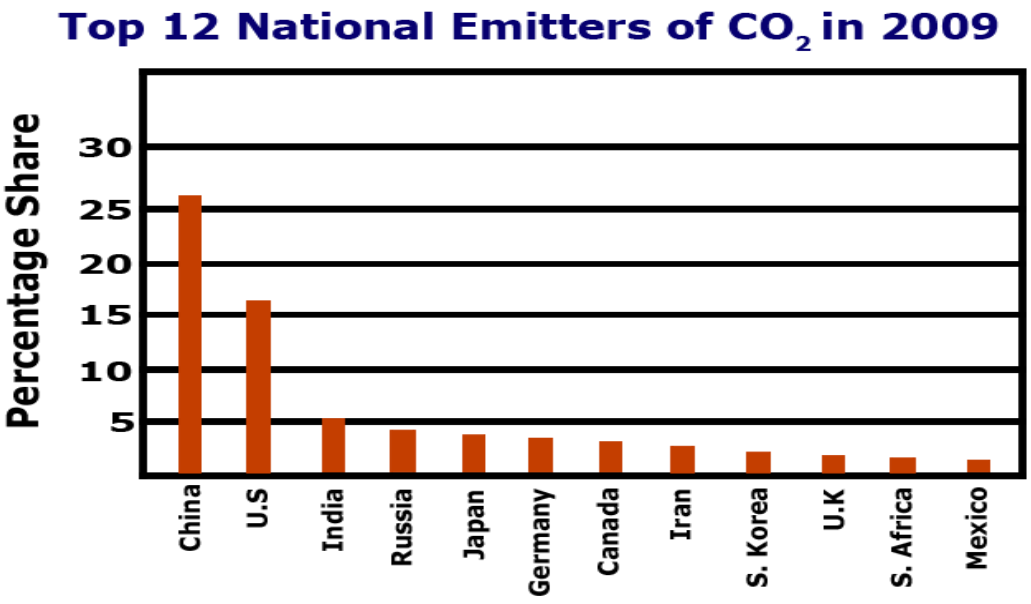
- Global Warming is unequivocal based on observed increases in air and ocean temperature snow and ice melting and rising sea levels.

- GHGs associated with human activity have risen 70 percent between 1970 and 2004, and carbon dioxide (CO_2) increased by 80 percent during that period. Much of the observed rise in global average temperatures since the middle of the twentieth century is very likely linked to the observed rise in anthropogenic GHG concentrations.
- Based on current climate change policies and practices, GHG emissions are projected to grow over the next 30 years, and effects on the climate are very likely to be greater than what was observed during the twentieth century.
- A broad range of adaptation options are available, but more are needed to lessen vulnerability to climate change. Also there are barriers, and limits that are not completely understood.
- Reasons for concern identified in the prior IPCC report remain important to defining vulnerabilities and some are assessed as stronger than originally believed.

Taken together, scientific predictions about the effects of global warming are not conclusive. Given the complexity of the science as well as the long-range nature of the forecasts, it is understandable that there is a complete argument about which of the conjectured events may occur, the degree of impact, and the timing of any associated outcome. However, scientists are achieving greater clarity and the research continues. In the interim, policy makers must decide how to respond to rising CO2 levels and other GHGs even in the face of uncertainty about the implications.

(B) POLICY RESPONSE TO CLIMATE CHANGE

Setting policy in response to climate change is difficult for two reasons: (1) global warming and climate variations are complex issues, and there is some degree of uncertainty associated with them. (2) Both the source of the problem and the predicted effects are global in scope, any effective policy solution relies on international agreement. Many nations contribute significantly to the aggregate level of GHG emissions. The top 12 national emitters of primary GHG, CO_2, are shown in figure here.



(a) International Response

(1) U.N. Framework Convention on Climate Change (UNFCCC)

It the 1992 Rio Summit, global climate change was an important agenda item for the many national representatives who gathered at the 12 day worldwide conference. Among the major agreements produced at the summit was U.N. Frame work convention on climate change (UNFCCC), which deals with global warming and other air quality issues. Among its major provisions are:

- Countries must implement national strategies to limit GHG emissions with the objective of reducing emissions to their 1990 levels by 2000.
- Differences in political and economic conditions among nations are to be accommodated by avoiding uniform emission targets and timetable for only one GHG.
- Signatories are encouraged to recognize climate change in the formulation of economic, social and environmental policies.
- Industrialized nations will assist developing countries in obtaining data and in limiting emissions.

(2) Kyoto Protocol To the UNFCCC

Conference of the Parties (COP) held in Kyoto, Japan, in 1997, agreed on establishing emission limit for developed countries. It was decided that the developed countries are responsible for at least 55 percent of CO_2 emissions for 1990, and to see that the limits of emission has to be accomplished in part through emission trading.

However there were certain limitations with regard to fixing the limit of emission in the sense that there is limited scientific evidence of global warming and the emissions limits world negatively affects industry and the U.S. economy. More over U.S. resisted ratified the treaty until developing countries made commitment to meet binding emission targets along with developed nations. Moreover President Bush announced his opposition to the Kyoto Protocol and took the U.S. out of the agreement in March 2001. Bush administration promised to deliver a domestic initiative to combat global warming. However the United States would remain involved in negotiations and funding for the UNFCCC.

In 2001, 178 nations reached an agreement without U.S. and the accord called for 38 industrialized countries to cut their GHG emissions to 5.2 percent below 1990 levels by 2012, leaving developing countries without any emissions requirements. It was decided that the emissions targets were to be achieved during the so called commitment phase from 2008 to 2012, using several market-based instruments, referred to as flexible mechanisms, chief among these is a cap and trade system of GHG allowances for participating developed nations.

Major Elements of the Kyoto Protocol to the UNFCCC

- Developed nations must reduce overall greenhouse gas (GHG) emissions by at least 5.2 percent below 1990 levels in the first commitment period, 2008-12, by meeting individual emissions targets assigned to each country. Negotiations for subsequent commitment periods will follow.
- Emissions targets cover the primary GHGs: Carbon dioxide (CO_2), methane (CH_4) nitrous oxide (N_2O), hydro fluorocarbons (HFCs) per fluorocarbons (PFCs) and sulfur hexafluoride (SF6).
- Emissions targets are to be achieved by international emissions trading of GHG allowances.
- Carbon absorbing activities, such as reforestation, can be used to offset emissions targets. Any GHGs removed through such activities earn credits called removal units (RMUs)
- Under the Clean Development Mechanism (CDM), a developed nation can enter into emissions reducing projects in a developing nation and use the resulting certified emissions reductions (CERs) to meet its own emission targets.
- Using Joint Implementation, a developed nation can implement an emissions reducing project in another developed nation and use the resulting emissions reduction units (ERUs) against its own emission target.
- Participants failing to meet their emissions targets must resolve the difference in the second commitment period plus a 30 percent penalty.

(3) United Nations Climate Change Conferences.

The conference of the parties (COP) was held successively in Copenhagen and Cancun in 2009 and 2010, respectively referred as COP15 and COP16. The agreement collectively known as the Copenhagen Accord. There were pledges by individual member nations to reduce GHG emissions, but unlike Kyoto's these were not binding. The overall consensus was that the COP15 did not meet expectations.

The lack of progress in Copenhagen was problematic because the attends understood that Kyoto's first commitment phase would officially expire in 2012 and that replacing or extending the Kyoto protocol would not be easy, given the large number of countries involved and their differences in terms of their economic development, access to economic resources, governance structure, and positions on climate change.

In Mexico at the COP16, known as Cancun agreement emphasized a long term goal to reduce GHG emissions to assure that the rise in average global temperature would be less than 2 Celsius above pre industrial levels. The member nations also agreed to establish the Green Climate Fund, originally announced in Copenhagen to support developing nations' projects, policies and other activities. A technology Mechanism also was launched to support innovations that would facilitate GHG mitigation and to transfer needed technologies to developing countries.

Since China being a developing nation was under emission caps, and the United States did not ratify the treaty, the establishment of binding GHG reduction commitment was difficult. Though the two nations are the largest emitters of GHGs, jointly responsible for over 40 percent of the world's releases. Consequently industries within participating developed countries must face the potential disadvantage of facing emissions limits that their competitors within two world powers do not.

(4) European Union (EU) Response

Following the Kyoto Protocol European Union launched its own GHG trading program in 2005, for member states. This system is called as the European Union Emissions Trading Scheme (EU ETs), is a true cap and trade program designed to help the EU achieve its emissions reduction commitment under the Kyoto Protocol of 8 percent below 1990 levels for the 2008-2012 period. It shows that Europe is the only world power to establish and use a carbon market. Exchanges located all over Europe facilitate trade among the member countries, and allowance prices are market determined. Allowances are not printed but instead are exchanged through electronic registries.

The allowances are determined by market and their prices fluctuate. More over the European Union has proposed a Carbon Tax for all EU members, and it was believed that the Carbon tax is necessary in order to achieve the emissions reduction target set for 2020, which is 20 percent below 1990 levels.

(b) U.S. National Response

After withdrawing from Kyoto agreement in 2001, the U.S. it formed a climate change working group which in turn, requested a report from the National Academy of Sciences (NAS) on what was known about the science of climate change. Both the working group's report and the NAS report were released in June 2001. President Bush, then formulated his climate change plan to act as the U.S. alternative to Kyoto protocol According to this plan, the overall objective for the nation was to reduce green house gas (GHG) intensity by 18 percent by 2012, where GHG intensity refers to the ratio of GHG emission to economic output. President Obama committed the U.S. to a 17 percent reduction in GHG emissions from 2005 level by 2020 as part of the Copenhagen accord and the subsequent Cancun Agreements although again this pledge is unbinding. Domestically the commitment to decrease GHG releases by 17 percent has been included in various bills submitted through congress, some of which called for a cap and trade approach to achieve this objective but none became law.

Despite the failure to legislate a national GHG emissions limit or launch a cap and trade program, other regulations for both mobile and stationary sources have been put in place or are under development to address climate change. They are:

1. Court Ruling and EPA Finding on Controlling GHGs
2. California's Role in National GHG Regulation
3. U.S. GHG Control on Mobile Sources.
4. U.S. GHG Control on Stationary Sources.
5. U.S. Regional Response
    a. Regional Green house Gas Initiative (RGGI)
    b. Western Climate Initiative (WCI)

(c) ECONOMIC ANALYSIS OF CLIMATE CHANGE POLICIES

The prime aim of environmental policy is to give efficient allocation of resources or to give the Social Marginal Benefits (SMB) greater than the Social Marginal Cost (SMC). However the assessment is difficult for global warming because of the gray areas that weaken scientific predictions. Hence there is always a dilemma of estimating the potential benefits from any initiate designed to control climate change.

Estimating the Benefits

OECD Environment committee estimates, the benefits of controlling global warming based on conventional prediction would be $ 61.6 billion or approximately 1.1 percent of GDP, and as high as $ 338.6 billion, or at least 6 percent of GDP, over the very long-run of 250-300 years.

Economist Wilfred Beckerman (1990) estimates the net effect of global warming on U.S. agriculture to be within a range of a net gain of $ 710 billion and a net loss of 10 billion. However this loss of $ 10 billion is only about 0.2 percent of U.S. GDP.

More recent studies conducted by Mendelssohn and Neumann (1999) and Nordau's and Boyer (2000) present benefit estimates that align more closely with those shown by Beckerman Specifically, Mendelssohn and Neumann estimate that the net benefit to U.S. from climate change control would be 0.1 percent of GDP, while Nordau's and Boyer estimate the comparable value at approximately -0.5 percent of GDP or a net cost to society. Sir Nicholas Stern (2007) argues that without a policy response, the costs of climate change, and hence the benefits of responding, are likely to be 5 percent of global GDP per year, but that the costs of responding to the problem by controlling GHG can be limited to about 1 percent of GDP each year.

Although these studies share a common perspective that benefits assessment is critical to developing climate change policy, the implications are different. In any case, these analysts suggest the need for more research and help to explain in challenge policy makers face in deciding how to respond to global warming concerns.

Economic Model of the Market Failure

We can understand this model by following figure.

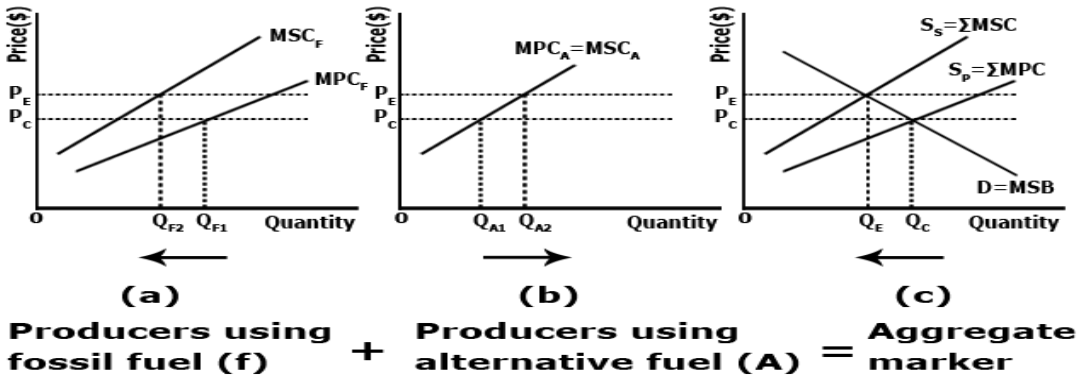


Figure (a) depicts the marginal private cost of fossil fuel users (MPCf) and the associated marginal social cost (MSCf). By definition, MSCf is the vertical sum of the MPCf and the marginal external cost (MECf) of electricity production, where the MECf is capturing the negative production externality. This means that MECf is implicitly shown as the vertical distance between MSCf and MPCf and represents the cost of health and property damages associated with CO_2 emissions. figure (b) shows the marginal social cost of alternative fuel users (MSCa). For simplicity, it is assumed that this segment of the market does not generate any negative externalities. Thus MSCa is exactly equal to MPCa.

Figure (c) presents the aggregate market for electricity, shown with a demand curve (d) measuring the marginal social benefit of electricity usage (MSB) and two distinct supply curves, Sp and Ss. The Sp is the private market supply of electricity, found as the horizontal sum of MPcf and MPca, and the Ss is the social market supply, found as the horizontal sum of MScf and MSCa.

In the absence of CO_2 emission controls, equilibrium is determined by the intersection of market demand (d) and private market supply (Sp). The competitive equilibrium quantity and price are Qc and Pc respectively. At Pc fossil fuel utilities are willing to supply Qf1, where the alternative fuel users supply much smaller amount, Qa. Notice that fossil fuel users can supply most of the electricity to the market at price Pc because their MPcf is relatively low without policy controls, these utilities do not consider the external costs of their CO_2 emissions. This results in private market incentives allocating too many resources to their production processes and too few resources to alternative fuel users.. Consequently, Pc is sending a false signal about how to efficiently allocate productive inputs, and the market fails.

To correct the market failure, the external cost of fossil fuel emissions must be brought in to the market transaction. As shown in figure (c), this means that market price must be determined by market demand (d) and the social market supply (Ss), which includes both external and private costs. Notice that the efficient equilibrium price (Pc) is higher than what the private market determines, because electricity demanders are now paying the full cost of their consumption activity. That is, the per unit price (Pc) paid for electricity is exactly equal to the marginal social cost incurred to produce it.

At this higher price level, the quantity of electricity has been, reduced to its efficient level (Qe). This new price level corrects the mix of fossil and alternative fuels used to produce electricity. At Pe, fossil fuel based production appropriately has declined from Qf1 to Qf2, effectively reducing the emissions of CO_2. At the same time, the higher price provides an incentive to alternative fuel users to supply more electricity, shown as the increase from Qa1, to Qa2.

It should be noted that his model explains that how the output of, or consumption of CO_2 creating energy source is reduced and increase the out of alternative resource causing less emission and equilibrium is attained at Qe. However if worth noting that Qe still include some fossil fuel based production i.e. CO_2 emissions are not totally eliminated but they are reduced to the level that society accepts, based on trade - off between the MSB of electricity usage and the MSC.

Pollution charges

It has been seen that pollution charges reduce the CO_2 emission. Though it has been a subject of debate but generally three types of pollution charges are proposed, namely:

- A gasoline tax - tax imposed on each gallon of gasoline consumption
- A But tax - tax levied on heat content of energy source
- A Carbon tax - tax imposed on the Carbon content of fuel

Tradeable Allowance System

It is a market instrument used to control global warming. The tradable allowance system for GHGs establishes a market for GHG permits where each allows the release of some amount of GHGs. within the Kyoto Protocol; the international GHG allowance market is the primary means by which developed nations are to achieve their emissions targets.

CONCLUSION

In this module we have examined one of the most serious problems of environment i.e. the climate change and global warming, we have analyzed the political global warming and GHGs have effect on our planet and its natural endowment, and on health of human beings. The politician, economists, scientists and researchers have shown serious concern and put effort to reduce the Co2 emissions and bring it to tolerable and safe level. On this front we have several achievements, which include the Montreal protocol and its subsequent amendments to control ozone depletion and the ratification of the Kyoto protocol to limit GHG emissions, along with the Durban platform, which extends the protocol. However there are still important issues to be worked out, including the participation of developing countries in a successor's agreement to the Kyoto pact. These countries lack the financial resources and the technology to innovate around the causes of global air pollution. Yet their co operation is critical given the expected rate of industrial and economic growth in these nations and the associated ramifications for global environment.