Global warming: technical solutions

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Evaluate the Technological Solutions Available to Ameliorate Global Warming

Introduction

Global warming has been proven to be the direct result of anthropogenic causes or man-made interventions with nature. Starting with the Industrial Revolution of the late 18 th Century, technologies have been developed that resulted in the accumulation of greenhouse gases in the atmosphere which trap the sun's radiant energy. This enhanced greenhouse effect gradually raises the earth's surface temperatures and is projected to create irregular environmental conditions, namely: the melting of polar ice caps, rising of sea level, profound agricultural changes resulting from climate change, extinction of species, abnormal weather conditions, increased incidence of tropical diseases, disappearance of ecological niches and disruption of drinking water supply, (" Global Warming," 2004).

Since global warming offers a great potential to create catastrophic effects on the environment as a whole, it becomes a global issue, requiring the involvement of the whole international community in finding ways to ameliorate its adverse effects, (Baird, 2006). Global greenhouse gas emissions that are causing global warming come from different sectors. Figure I below shows the global greenhouse gas emissions by sector data: Land use change and forestry contribute the highest greenhouse gas emission rate (19%); followed by electricity (16%); agriculture (14%); transport (13%); other fuel combustion (11%); manufacturing and construction (10%); waste (4%); and industrial (3%) and combined heat and power (3%). The Pew Center on Global Climate Change (Undated, p. 1)

asserts that “ because there are so many sources of these gases, there are also many options for reducing emission.”

This paper evaluates the available technological solutions to ameliorate global warming by presenting the advantages and disadvantages of each option. Moreover, such solutions will be presented on a sectoral basis, starting with land use, forestry and agriculture; followed by electricity, and finally by the transportation sector.

Land Use, Forestry and Agriculture Sector Technology

Land use and forestry technology includes carbon accounting, sequestration, and biofuel production.

1. Carbon Accounting and Sequestration

According to the Intergovernmental Panel on Climate Change or IPCC (2000), carbon stock enhancement from land use, land –use change and forestry activities are reversible and therefore require careful accounting. Carbon accounting technology, which involves land-based accounting and activity based accounting, provides accurate and transparent data on carbon stocks and/or changes in greenhouse gas emissions by sources and removals by sink. These data are required to assess compliance with the commitments under the Kyoto Protocol. Moreover, carbon accounting will help determine relevant carbon pools that can be used in the production of an alternative source of fuel, such as biofuels. Changes in carbon stocks can be technically determined with the use of activity data, remote-sensing techniques, models derived from statistical analysis, flux measurement, soil sampling and ecological surveys. However, the cost of carbon accounting increases as

precision and landscape heterogeneity increases, (IPCC, 2000). As a result of careful carbon accounting, excess carbon can then be captured or sequestered in order to be utilized as fuel source. An example of carbon sequestration technology is the Integrated Gasification and Combined Cycle Process or IGCC, which allows for easy sequestration of carbon for long term storage in underground geological formations. However, the Pew Center on Global Climate Change (Undated), cautions that further research is needed to test the viability of large scale underground storage of carbon in a long term scale.

2. Biofuel Technology

Biofuel production or biomass gasification ensures lower greenhouse gas emission levels by converting waste wood and biomass into biofuels that could replace fossil fuels. The report of the Pew Center on Global Climate Change (Undated, p. 4), maintains that agricultural lands can be planted with carbon-dioxide fixing trees that can be used for fuel production. This will result to land use changes that may have multiple indirect benefits such as improvement of soil, air and water quality; and increase in wildlife habitat. However, study findings suggest that the cultivation of corn and soybeans for biofuel production produces adverse environmental impacts, such as the leaching of pesticides and nitrogen and phosphorus from fertilizers into water resources, (Manuel, 2007). Moreover, biofuels are from two to four times more expensive than fossil fuels and are not believed to compete well in the marketplace. For example, “ a fuel –cost comparison indicates that while gasoline could be refined for 15 to 16 cents per liter (in the late 1980s), the cost of biofuels ranged from an average of about 30 cents per liter (for

methanol derived from biomass) to 63 cents per liter (for ethanol derived from beets in the United Kingdom)", (Barbier et al. 1991, p. 142; cited in Johansen, 2002, p. 266).

Electricity Sector Technology

According to the Pew Center on Global Climate Change Report (Undated), power plants and coal combustion that supply electric power account for the greenhouse gas emissions on the electricity sector. Technological solutions available for this sector to address global warming include:

1. Integrated Gasification and Combined Cycle Process

The Integrated Gasification and Combined Cycle Process or IGCC, is a power generation technology that improves the efficiency of electric power and heat generation with the use of a combination of fossil fuels and renewable energy. It enables clean gas production and the reduction in carbon dioxide emissions with the use of high performance gas turbines, (Abela, et al., 2007). Moreover, air pollutants such as particulate matter, sulphur, nitrogen and mercury are removed from the gasified coal before combustion, (Abela, et al., 2007). However, the major disadvantage of using this technology is its high cost of operation, which is about 20% more than the operating cost of a traditional coal plant, (Wikipedia, undated).

2. Renewable Energy Sources

Renewable energy sources such as the wind, solar and water can produce electricity without releasing greenhouse gases and are thus important in the amelioration of global warming.

a. Wind Power

Wind power technology harnesses the power of the wind which is an indirect form of solar power, to supply energy. Some have propeller type devices, while others have vertical axis designs, which possess the ability to accept wind from any direction. According to Elliott (2003), wind power is already an essential source of energy; and that in 2002, the total generating capacity has reached 24, 000 megawatts, with costs decreasing significantly with technology development. However, this technology often has large space requirements, due to the need of the wind turbines to be grouped together in wind farms, in order to facilitate sharing of connections to the power grid. Moreover, there should be a separation of about 5 to 15 blade diameters between individual wind turbines, in order to “ prevent turbulent interactions in wind farm arrays” , (Elliott, 2003, p. 135).

b. Solar Power

Radiant energy can be captured and utilized to generate electricity which may be used to operate solar batteries or may be transmitted along normal transmission lines. Radiant energy is collected in a photovoltaic cell, which is a bimetallic unit that allows direct conversion of sunlight to electricity. The only drawback of utilizing photovoltaic cells is its high cost. However, recent “ developments in the semiconductor industry have significantly brought down prices”, (Elliott, 2003, p. 132). Electric power generation has also been accomplished with the use of big solar heat-concentrating mirrors and parabolic troughs and dishes that track the sun across the sky and focus its rays so as to raise steam, (Elliott, 2003, p130), and consequently produce

electricity. One major disadvantage of using solar power technology is that it works only during the day and requires electrical storage mechanisms at night. Additionally, radiant heat is insufficient in cold regions and in areas with extensive cloudy periods, resulting in low amount of energy collection.

c. Water Power

Hydropower is the world’s biggest renewable source of energy. It is deemed as one of the most acceptable and cleanest technologies whereby a unit of water produces hydropower cumulatively by passing through the turbines of many dams along the descent of a river”, (Gibbons, 1986, p. 86). According to Elliott (2003, p. 151), “ there is around 650 GW of installed capacity in place, mostly in 300 large projects. However, in recent years, there have been social and environmental concerns about large hydros, and some new projects have met with opposition”. Its adverse environmental impacts include the destruction of large areas of natural vegetation and agricultural land for water storage; biodiversity loss, flooding and displacement of population, (Elliott, 2003).

3. Geothermal Power

Geothermal power is not considered a renewable resource when used at rates of extraction greater than their natural replenishment. With sustainable use, however, geothermal power can be effectively harnessed to provide electricity. Geothermal energy comes from the heat of the earth and can be categorized into geopressured, magma, hydrothermal and hot dry rock, (Wright, 2002, p. 362). According to Hobbs (1995, cited in Wright, 2002, p. 362), commercial operations are mostly in the form of hydrothermal systems

“ where wells are about 2000 metres deep with reservoir temperatures of 180 to 270°C.” Although geothermal systems produce less than 0. 2 percent of the carbon dioxide produced by coal or oil-fired plant, they also emit non-condensable gases such as small quantities of sulphur dioxide, methane, hydrogen sulphide, nitrogen and hydrogen. Additionally, such systems cause induced seismicity and ground subsidence. They are also capital-intensive investments that require financial and technical assistance, (Wright, 2002, p. 362).

Transport System Technology

The transportation sector has one of the highest greenhouse gas emissions rate, after land use and forestry, electricity and agriculture sectors. The Pew Center on Global Climate Change (Undated), recommends the use of “ off the shell” technologies that are currently available in the market, which significantly reduce greenhouse gas emissions of conventional cars and trucks. These “ off the shell” technologies focus on increasing energy efficiency, fuel blending and the use of advanced diesels and hybrids. Additionally, long term technological options to reduce greenhouse gas emissions are now gradually being developed which include the use of biofuels, electric vehicles and hydrogen fuel cells.

a. Fuel Blending

Fuel blending involves the mixing of ethanol and other biofuels with gasoline to produce more-environment friendly fuels. The Pew Center on Global Climate Change (Undated, p. 4), asserts that corn-based ethanol can reduce

greenhouse emissions to at least 30% “ for each gallon of regular gasoline that it replaces”.

b. Diesels and Hybrids

Diesel and hybrid engines offer excellent fuel economy and overall fuel efficiency. However, they also emit air pollutants such as nitrogen oxides and particulates. Newer diesel engine models, however, “ use very sophisticated fuel-injection systems, which result in vehicles that have better acceleration with reduced emissions, vibration, and noise”, (Doyle, 2000, p. 383). Moreover, because diesels and hybrids afford excellent fuel economy, they use less gas on a per mile basis, thereby producing less greenhouse gas emissions compared to conventional cars and trucks. “ When both technologies are combined in a diesel hybrid vehicle, it can yield a 65-percent reduction in greenhouse gas emissions per mile”, (Green and Schafer, 2003; cited in The Pew Center on Global Climate Change Undated, p. 6).

c. Biofuels

As previously mentioned, biofuels offer cleaner emissions than regular gasoline. Agricultural and forest products can be processed to produce ethanol that may be combined with gasoline and enable significant reductions in greenhouse gas emissions. Corn-based, cellulosic and sugar-cane-based ethanols have been proven to significantly reduce emissions, (The Pew Center on Global Climate Change, Undated).

d. Electric Vehicles

Electric vehicles offer cleaner emissions by reducing the amount of pollutant and greenhouse gas release in the air. They release “ 30 percent less hydrocarbons and 15 percent less nitrogen oxides” than conventional vehicles, (Doyle, 2000, p. 289). In the past, electric cars needed advances in battery storage. Thus, the “ plug-in” hybrid was developed in order to solve the battery storage problem. The “ plug-in” hybrid “ is a gas- electric vehicle that can be charged at home overnight”, (The Pew Center on Global Climate Change, Undated).

e. Hydrogen Fuel Cells

Hydrogen fuel cells “ produce power by combining oxygen with hydrogen to create water”, (The Pew Center on Global Climate Change, Undated, p. 6). Hydrogen is obtained from natural gas by reforming and is combined with oxygen that is readily available in the air, which generates electricity continuously. The fuel cells replace combustion turbines in integrated cycles, resulting in increased fuel efficiency of 46-55 percent. However, there is a need to find ways to produce hydrogen with minimal emissions, (The Pew Center on Global Climate Change, Undated).

Conclusion

A careful analysis of the global greenhouse gas emissions by sector is essential in identifying the needed technological solutions to help curb or reduce gas emissions. By focusing the effort to reduce emissions of the higher contributing sectors, the overall efforts to address global warming effects can be effectively channeled. Thus, it is imperative to focus on the available technologies that address the adverse effects of global warming on

the following sectors: land use and forestry, electricity, agriculture and transport. In its comprehensive report on technological solutions for climate change amelioration, the Pew Center on Global Climate Change (Undated, p. 2), claims that “ there is no single, silver bullet technology that will deliver the reductions in emissions that are needed to protect the climate”. It further recommends the integration of a portfolio of solutions wherein the identification of useful technologies should be based on the analysis of key economic sectors. Moreover, it suggests that policy makers should prioritize the creation of incentives that will release the power of the marketplace in developing solutions. In the final analysis, further research and development of more exact and cost-effective portfolio of technologies that ameliorate global warming effects must be advocated.

References:

1. Abela, M., Bonavita, N., Martini, R., 2007. Advanced process control at an integrated gasification combined cycle plant. Available from: http://library. abb. com/GLOBAL/SCOT/scot267. nsf/VerityDisplay/62CF14177B1A39D2852572FB004B4EB3/$File/AC2% 20ISAB_ABB. pdf. [Accessed: 11 August 2007].
2. Baird, S. L., 2006. Climate Change: A Runaway Train? The Human Species Has Reshaped Earth’s Landscapes on an Ever-Larger and Lasting Scale. The Technology Teacher, 66(4), 14+
3. Doyle, J. 2000. Taken for a Ride: Detroit’s Big Three and the Politics of Pollution. New York: Four Walls Eight Windows.
4. Elliott, D., 2003. Energy, Society & Environment. New York: Routledge.

5. Gibbons, D. C., 1986. The Economic Value of Water. Washington, DC: Resources for the Future.

6. Global Warming. 2004. In the Columbia Encyclopedia (6th Ed.). New York: Columbia University Press

7. Intergovernmental Panel on Climate Change (IPCC), 2000. IPCC Special Report: Land Use, Land Use Change and Forestry. Summary for Policy Makers. Available from: http://www. grida. no/climate/ipcc/spmpdf/srl-e. pdf. [Accessed: 10 August 2007}.

8. Johansen, B. E., 2002. The Global Warming Desk Reference. Westport, CT: Greenwood Press.

9. Manuel, J., 2007. Battle of the Biofuels. Environmental Health Perspectives, 115(2), 92+.

10. The Pew Center on Global Climate Change. Undated. Climate Data: A Sect oral Perspective. Climate Change 101: Understanding and Responding to Global Climate Change. Available from: http://www. pewtrusts. org/pdf/pew_climate_101_techsolutions. pdf. [Accessed: 10 August, 2007].

11. Wikipedia. Undated. Combined Cycle. Available from: http://en. wikipedia. org/wiki/Combined_cycle#_note-0. [Accessed: 11 August 2007].

12. Wright, R. M., 2002. Energy and Sustainable Development. In Natural Resource Management for Sustainable Development in the Caribbean, Goodbody, I. & Thomas-Hope, E. (Eds.) (pp. 307-385). Barbados: Canoe Press.