

ENERGY POLICY TO MITIGATE CLIMATE CHANGE

Ir Otto Poon, BBS, OBE, FHKAAE
President of The Hong Kong Association of Energy Engineers

30 August 2007

Keywords

Climate change, carbon, conservation, efficiency, technology, mitigation

Since time immemorial, human species have been striving to improve their standard of living with increase in consumption of resources and energy. World's population has also grown exponentially to over six billion. This compound growth of population and per capita consumption of energy means fast depletion of resources, particularly fossil fuels, resulting in damage to the natural environment.

Among human being's many environmental sins, nothing is now more serious and urgent than increase in greenhouse gases, global warming and climate change. Global emissions to the atmosphere due to burning of fossil fuels are currently approaching 30 gigatonnes of carbon dioxide per annum and it rising rapidly. According to the Fourth Report published by IPCC (Intergovernmental Panel on Climate Change) published in May 2007, if we carry on business as usual, carbon dioxide (which is the most dominant greenhouse gas) in the atmosphere could increase from 380ppm of the present to reach 550ppm by the end of this century, with average global temperature rise by some 5.0 deg. centigrade, and the mean sea level rise by some 6.0 M This would increase in the acidity of the sea water, threaten water supply and food security, increase in frequency and intensify the intensity of extreme weathers, cause re-emergence of known diseases, incubate new viruses, damage to the animal and plant species. The consequence would be nothing less than Armageddon.

IPCC estimated that we have only a window of thirty years to stabilize the increase in average global temperature to no more than 2.0 deg. centigrade. A more recent estimate by NASA scientist painted a more pessimistic picture. They estimated we have no more than ten years to reverse the trend on greenhouse emission. Otherwise the positive feedback of the global warming will result in a thermal run-away that will tip the balance of nature.

Increase in carbon dioxide is mostly anthropogenic and due mainly to burning of fossil fuels and discharge of carbon dioxide. According to the IPCC Fourth Report, the scientific evidence is now beyond reasonable doubts and warming of the climate system is **UNEQUIVOCAL**

Economically, the consequence of business as usual is equally threatening. Average annual economic lost due to meteorological disasters in China in the 1950's was 40 billion RMB which had increased to over 200 billion RMB in the past ten years. Globally, economic damage in percentage of GDP was estimated by Sir Nicholas Stern to be 5% with two to three deg. C increase in average global temperature, and could reach 20% if we continue business

as usual.

The Stern Review pointed out that one percent of global GDP must be invested immediately to mitigate the effects of climate change; failure could risk a recession worth up to twenty percent of global GDP. Sir Nicholas Stern also said that our actions over the coming few decades could create risks of major disruption to economic and social activity... on a scale similar to those associated with the great wars and the economic depression of the first half of the 20th century.

What we need to do urgently are mitigation and adaptation. Mitigation refers to an anthropogenic intervention to reduce the sources or enhance the sinks of the greenhouse gases. Adaptation means adjustments in natural and human systems in response to actual and expected climate stimuli or their effects, which moderate harm or exploit beneficial opportunities. Mitigation and adaptation measures are complimentary to stabilize the world's climate. As this Forum is a platform to discuss technical matters, I would concentrate this paper on scientific and engineering issues for mitigation.

If we accept the fact that fossil fuel is the culprit in causing climate change, we need to look at ways and means to reduce consumption of fossil fuels, improve the conversion efficiency of energy systems, increase the use of energy from renewable and low carbon sources, develop clean coal technology with carbon capture and storage. We also need to apply the above measures across the entire spectrum of supply and demand sides of the energy portfolio. This will lead to a four layer hierarchy to reduce emission of carbon :

- Energy conservation,
- Energy efficiency,
- Renewable, carbon free and carbon neutral energy sources,
- New technologies

Energy conservation is to use less. This often means we have to change our behavior in how we travel, how we dress and live, what we eat, and to implement a host of house keeping measures.

Energy efficiency is to do more with less. This applies to both supply side and demand. Supply side is to deliver the product and service with most efficient plants and systems. A good example would be generation, transmission and distribution of electricity. On the demand side, there are many things we can do such as water cooled air conditioning system instead of air cooled plants, energy saving lamps to replace incandescent bulbs, green design for buildings, small capacity vehicles instead of SUVs, etc.

There are many proven sources of renewable such as hydro, wind, solar, current, tidal, etc. Carbon free sources will include geothermal and nuclear fission. Carbon neutral energy source could mean waste to energy and biofuels. At the present time, energy from these sources are more expensive than fossil fuels. However, if climate change is the most important consideration, then price shall not be the only factor that we should consider.

Of course, technology will move ahead. New technologies such as carbon sequestration, Pebble Bed reactor, nuclear fusion, thorium reactor, hydrates from the deep ocean floors are at their early stages of development. Given time, these new technologies will be able to provide low carbon or carbon free energy.

The problem is that the carbon in the atmosphere is increasing and increasing rapidly, we do not have the luxury to wait and actions must be taken now based on available technologies to mitigate climate change. We therefore would urgently need to develop new strategy and policy to stabilize the carbon in the atmosphere.

The strategies we can adapt may comprise of :

- Four layer energy hierarchy,
- Establish the cost of carbon,
- Implement carbon trading systems
- Education to change human behavior

As the existing economic model does not take the externalities of fossil fuels into consideration, it is not a level playing field for development and implementation of renewable, carbon free and carbon neutral energy. We need to establish true and realistic prices for carbon which could be applied effectively and equitably to the developed, developing, under-developed and destitute economies to encourage the well off countries to save on energy and to use more carbon free or low carbon energy; as well as to ensure the under-developed and destitute countries will have access to energy to lift them out of poverty.

We also need national and international financial, institutional and legal frameworks to translate the above strategies into government policies to mitigate climate change.

Apart from setting examples in changing our behavior, we energy engineers also have a very important role to play in implementing the four layer energy hierarchy as effective tools to mitigate climate change to save our civilization.

I would like to close by quoting Sir Crispin Tickell who said that if we carry on business as usual, there is a 50% chance that human civilization will not survive by 2050. If civilization is to survive, we need a deep change of mind. This should include reviewing conventional economies and bring in externalities and true costs, looking again at the pattern of economic development, giving governments a new role in establishing incentives and disincentives, and replacement of consumerism as a kind of implicit goal.

Time is not on our side. We need decisive actions and need to take these actions now.

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