

Climate Change; What Does it Mean to the Design Engineer?

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When designing a new facility or an improvement in a process, the engineer follows corporate guidelines and practices regarding financial returns, which typically consider the direct and indirect costs of capital and operating expense. Those costs are then compared with the expected savings or earnings to justify the installation. However, if one follows the developments in the international saga that is the Kyoto Ratification process closely, one begins to recognize a disturbing pattern that inhibits action on greenhouse gas reductions and may result in significant future costs to society and to the company. The pattern cannot be blamed on industry or the pro-fossil fuel politicians in various countries who are in opposition to greenhouse gas emissions reductions. The flaws in the Kyoto process are part of the process itself and they are systemic. Pointing out this fact is not intended to minimize the importance of climate change as a global issue. On the contrary, it is intended to energize thinking about climate change that will more appropriately address the problem. Despite pledges to reduce greenhouse gas emissions, the overall problem continues to grow. The approach that has been used so far has been the wrong approach and has yielded failure and gridlock. A new approach should focus on the systems that produce the emissions, and not the tailpipes or smokestacks. This approach should include:

- 1) Local solutions- Greenhouse gas reduction and adaptation policies that are tailored to an area in question
- 2) Inclusion of developing nations: Dooming other countries to unsustainable fossil fuel development patterns is counter-intuitive.
- 3) Dramatically reducing energy use and increasing energy efficiency.
- 4) A massive change in transportation infrastructure (rather than looking for alternative fuels, we should be looking for alternative transportation)
- 5) Governments to encourage citizens to take personal responsibility for reducing individual carbon footprints
- 6) Eliminating all market distortions and industry entry barriers in energy and transportation markets (fossil fuel subsidies, externalized social costs, direct corporate assistance etc.).
- 7) And, when designing equipment, it means adding a value for global warming into the engineering considerations.

The principle stumbling block in developing a coherent plan to address climate change has been that the problem has been treated as an isolated environmental issue. It is not that. It is a human development and consumption issue. Environmental problems have a cause and direct effect. For climate change the causes are complex, diverse, and in some cases not understood. While most scientists agree that human burning of fossil fuels has some impact on climate, there are a number of other factors that need to be

considered from solar flares to urban heat islands. In addition the “effect” of climate change is likely to vary from region to region and can be extremely difficult to project.

Many actors have attempted to justify either action or inaction on climate change based on costs and benefits of either course. That is, some argue, that the financial impact of reducing emissions is too great to justify the benefits achieved by the reduction. Others contend that the financial impact of inaction will be too great to ignore the financial benefits of investing money today to prevent catastrophe tomorrow. Some in the environmental community have gone so far as estimate these costs in an attempt to build a business case for the financial benefits of reducing greenhouse gases. While there are benefits for companies to calculate a cost of carbon per ton emitted in terms of anticipating future fines and penalties, legal fees, and direct operating costs, the business case for carbon reductions has not yet been argued convincingly.

Despite the fact that details of climate change have altered dramatically over the past several years, the details of international solutions to climate change have become deeply entrenched. One could argue that a Kyoto-groupthink has developed. Solutions that are being discussed at climate conferences are potentially beneficial both environmentally and economically. However, it is important to recognize that they are not the only solutions to reducing anthropogenic greenhouse gases.

The most common method for estimating future CO₂ emissions levels, and the one used by the Intergovernmental Panel on Climate Change (IPCC) is the Kaya Identity. This is based on the work of Prof. Yoichi Kaya of Keio University. The Kaya Identity posits four contributing factors to the growth of greenhouse gas emissions:

Population- the growth rate of the population 1.6%

Per capita GDP- an estimate of standard of living 1.28%

Energy intensity- btu’s per economic unit –1.12%

Carbon intensity- mass of carbon per btu -.45%

These four factors can be used to gain an understanding of the likely growth rate of emissions. According to the 1980-1999 trend projected by the Carbon Sequestration Initiative at MIT estimates that while energy and carbon intensity have both decreased, population and GDP have increased creating a net annual average carbon increase of 1.3%, with marginal increases in the Middle East, South Asia, South America, and East Asia being considerably higher than those in OECD nations.

The two leverage points in the Kaya Identity of greatest concern are energy intensity and carbon intensity. Increasing global mean wealth should be a development goal, and population growth is an issue germane to every sustainability issue that it should not be considered as a means of greenhouse gas reductions but as an end in itself. That leaves policy makers and citizens with the option of reducing energy use and reducing carbon intensity. This is already happening, but the rate at which it is happening must be radically accelerated. The annual global growth rate of 1.3% in carbon emissions is unsustainable.

Steep reductions in carbon emissions will require a dramatic reduction in energy use regardless of the source. Increasing both energy efficiency and energy conservation in the transportation and electricity generation sectors is vital to a more sustainable future. Efficiency and conservation are often lumped together as one approach, when in fact they should be presented separately. Energy efficiency is a genuine energy substitute. It consists of the suite of products, materials, and services that reduce the amount of energy needed to perform the same task. Insulation is an example of one of these products. Conservation is the personal choice to use less energy in our daily lives. It is, some would say, the personal virtue that leads to driving less, turning off lights in unoccupied rooms, and setting the thermostat a few degrees higher in the summer. Serious action on these two fronts will have a tremendous effect, not only in reducing greenhouse gas emissions- but in improving air quality, reducing SO₂ emissions, reducing energy costs for individuals and the private sector, increasing national security, and protecting resources and habitats.

The exciting thing about conservation and efficiency is that the US and many other countries have explored these two options in the past- with the discovery that they work. Last year, Californians avoided a serious energy crisis, by reducing demand. No new power plants were brought online at the time, no elaborate permit trading schemes, and the perceived caps were short-lived. Energy efficiency lowers energy costs, reduces pollution, and without question will reduce the amount of greenhouse gases emitted to the atmosphere. Another exciting aspect of this approach is that despite our past efforts, there remains considerable prospect for improvement. Greenhouse gas emissions could be viewed as a measure of energy waste. More efficient use of energy is in our best national security, economic, and environmental interests. Eliminating this waste is not simply a path of austerity; it is a fertile industry waiting to be consolidated, and the expertise to capitalize on this opportunity exists within this room and this conference. Industry and government could dramatically reduce greenhouse gas emissions, not necessarily by caps and trading, but by promoting:

- New building designs and materials that over their life cycles have lower impacts than those they are replacing.
- The radical redesign of national transportation infrastructure. Investment in regional train systems, public transport, inner city development, and the removal of sections of urban interstates should all be considered.
- The expansion of combined cooling heat and power technologies and cogeneration to the private sector and to individual homes
- Decentralized energy generation technology, so that the inefficiencies associated with transmission of electricity are a thing of the past
- The materials, engineering, and technology for a modernized national energy grid
- Lighter, stronger, materials for transportation
- More energy efficient processes and reduction of energy intensive materials in manufacturing
- Innovations of new products and processes in static industries

- Technologies that require less energy throughout the supply chain, and can be constructed with less energy intensive materials
- Subsidy transfer from supply side fossil fuel subsidies to demand management: energy efficiency and conservation promotion

Technology exists to make power plants, homes and transportation considerably more efficient than they are today. If the political will exists to promote this technology, there is also a promising industry of energy efficiency and reductions waiting to flourish. However, no energy source has ever developed without the assistance and guidance of the public sector. From whale oil to nuclear plants, government has strongly influenced the energy industry and continues to do so even in this age of deregulation. The notion that our current state of energy over consumption is somehow the result of free markets is both false and deceptive in a nation where fossil fuel subsidies, energy efficiency, and conservation could reduce greenhouse gas emissions far below anything proposed in the Kyoto Protocol at a cost savings.

Energy efficiency and conservation hold tremendous promise, but they must be integrated into a plan for a more sustainable future. Rethinking urban development patterns in the United States is critical to addressing some of our most pressing social and environmental issues including climate change, but also loss of biodiversity, traffic congestion, and ground level ozone pollution. This will require a new way of thinking about transportation substitutes and the way that we design our cities and our homes. It is a formidable task, and one that requires industry and government engagement with the public.

Most scientific research indicates that climate change is already occurring, that it is essentially irreversible, that, in the short-term, reductions will have little effect, and that those who will suffer the most as a consequence of these changes will be the very poor- mostly those who live in the tropic zone. Amid the diplomatic drama of the Kyoto process some economists and the IPCC have been trying to come to grips with these grim facts. In developed nations, adaptation will be relatively painless and the benefits of climate change may even outweigh the negatives. However, in Africa, the South Pacific, and tropical Asia the prospects are not nearly as benign. It is particularly in these areas, where per capita greenhouse gas emissions are typically orders of magnitude smaller than those of the average European, North American, or Australian, that impacts will be the most severe. Climate change is a flashpoint in the debate between the north and south, between the G8 and the G77.

The solution presented in the Kyoto Protocol is to exempt countries that are viewed as less wealthy, by traditional economic indicators, from having to reduce their emissions. However, it is particularly with these nations that diplomatic engagement with the industrialized world is most critical. Our development pattern with respect to fossil fuels has been correctly deemed unsustainable, and to condemn those countries to the same development errors that we have had would be a serious mistake. The often inferred notion that “economic prosperity will drive environmental improvements” has not proven true in the past. Nations in the twenty-first century should not be doomed to

the same fossil fuel intensive patterns of the twentieth century. However, no one would argue that a Tanzanian who emits virtually no greenhouse gases relative to his or her American counterpart should have to further reduce his or her emissions, or do so by the same amount required by our society. The solution is twofold: 1) Smart economic development and international policy that incorporates the lessons that we have learned, so that the same mistakes are not repeated, and 2) Increasing the adaptive capacity of the nations most at risk.

Country	GHG Emissions (1995) kilotons	Population (000's)	Per Capita Emissions kilotons
United States	5,161,953	267,115	19.3
China	3,212,515	1,220,224	2.6
Russia	1,708,289	148,460	11.5
Japan	1,136,892	125,068	9.1
Germany	834,696	81,594	10.2
Saudi Arabia	254,798	18,255	14
Brazil	250,270	159,015	1.5
<i>Nigeria</i>	90,999	111,721	.81
Pakistan	85,192	136,257	.63
Greece	76,241	10,454	7.3
Norway	63,354	4,332	14.6
Austria	59,229	8,045	7.3
<i>Bangladesh</i>	20,932	118,229	.2
<i>Tanzania</i>	2,440	30,026	.08
<i>Fiji</i>	744	784	.9
<i>Maldives</i>	286	254	1.1

A uniquely troubling issue that is generally ignored in climate negotiations: countries that are predicted to be hardest hit by changing climates generally have low per capita emissions. There is a significant social element to climate change, and it could have a major impact on private companies. Therefore, wealthier nations have a moral obligation to concern themselves not only with reducing the amount of greenhouse gases that they emit they also need to look at the impacts of a changing climate. This has been done, to an extent, for risk, but not for opportunity. Developing products and materials that can help people minimize the projected impacts of climate irregularities is a business opportunity that is not being addressed in many quarters. Reducing emissions alone will not be enough.

Companies need to infuse the international debate on climate change with creative thinking. Scientific certainty should be replaced with scenario planning. Analyzing ways to reduce point source CO₂ need to be replaced with mechanisms to reduce greenhouse gases over the full life-cycle of products and services. Perhaps most importantly, the adaptive capacity of nations on the front line of climate change needs to be developed. Corporate leadership on the issue will have two derived benefits. First those companies taking a leadership role will be viewed as the best environmental performers in their industry. Second, those companies will also be able to shape the mechanisms by which countries achieve future emissions reductions

Investing in communities is important, and it will require a coordinated effort from industry, governments, NGOs, and international bodies like the World Bank, IMF, and UN. The role of industry goes beyond simply investing money in communities, but investing intellectual capital in developing innovative products and services that will help people cope with the specific damages from climate change that they will encounter. Companies need to think beyond greenhouse gas emissions, and consider how to provide governments and communities with the materials, goods, and services that are needed in this changing global landscape. These materials, products, and services will need to be less greenhouse gas intensive than those that they are replacing to avoid the perception and real possibility that profiteering on climate change is taking place. The sustainable development perspective incorporates these concerns, and is the best available approach for reducing not only emissions and ecological but providing solutions for the problems that these emissions cause.

As the leaders of over one hundred nations gather in Johannesburg for the World Summit on Sustainable Development, there is growing frustration with inaction on climate change since the first commitments were made to reduce greenhouse gases in 1992 Earth Summit in Rio. The problem of increased atmospheric carbon dioxide, first identified in 1896, has not been addressed despite increased media and governmental attention. It's important to understand why this is before projecting a new path forward. In the ten years since the first pledges to reduce greenhouse gasses, the emissions of greenhouse gases have increased steeply around the world. There have been some programs implemented that have had some success, but the big picture for reductions is grim. Quoting sources and statistics to bolster one side or another has led to gridlock in the debate about climate change. This is not necessarily accidental:

The weight of impressions on the public must be balanced so people will have doubts and lack motivation to take action. Accordingly, means are needed to get balancing information into the stream from sources that the public will find credible. There is no need for a clear-cut `victory.'...Nurturing public doubts by demonstrating that this is not a clear-cut situation in support of the opponents usually is all that is necessary. (Philip Lesly, 1992).

Business has been following Lesly's advice: actively, in the form of corporate front groups and think tanks, and passively in the form of sustainable development. The end result is the same: inaction on climate change. If the inertia of the climate debate is going to be broken, there needs to be agreement not on impacts and costs, but on the moral imperative for action and the best approach for reshaping infrastructure to combat climate change and reduce greenhouse gas emissions.

Philip Lesly, 'Coping with Opposition Groups', *Public Relations Review*, Vol. 18, No. 4 (1992), p. 331.

MIT Carbon Sequestration Initiative. http://sequestration.mit.edu/carbon_emissions_data/