Welcome to *Greenhouse Gases: Science and Technology*

Editorial

Curtis M. Oldenburg Editors-in-Chief,

M. Mercedes Maroto-Valer Editors-in-Chief

Curtis M. Oldenburg
Lawrence Berkeley National Laboratory
One Cyclotron Road
Berkeley, CA 94720
CMOldenburg@lbl.gov, (510) 486-7419

Welcome to *Greenhouse Gases: Science and Technology*. Through the publication of articles ranging from peer-reviewed research papers and short communications, to editorials and interviews on greenhouse gas emissions science and technology, this journal will disseminate research results and information that address the global crisis of anthropogenic climate change. The scope of the journal includes the full spectrum of research areas from capture and separation of greenhouse gases from flue gases and ambient air, to beneficial utilization, and to sequestration in deep geologic formations and terrestrial (plant and soil) systems, as well as policy and technoeconomic analyses of these approaches. Our aim is to share findings that are critical to mitigating anthropogenic climate change caused by greenhouse gases and to accelerate the transfer of knowledge from researchers to government decisionmakers who can implement policies that will lead to actual reductions in emissions.

The need for accelerating progress in reducing greenhouse gas emissions is urgent. Anthropogenic greenhouse gas emissions are exceeding the uptake ability of terrestrial and marine ecosystems, the result of which is increasing atmospheric concentrations of gases such as CO_2, CH_4, and N_2O and warming of the atmosphere. This is a crisis with no end in sight. First, CO_2, the main greenhouse gas causing warming, once emitted into the atmosphere remains there for millenia[1] which means we are effectively locking-in a certain amount of global warming with our current and past emissions. Sober projections suggest energy consumption and related greenhouse gas emissions will increase by approximately 50 and 40%, respectively, in the next 25 years[2]. Second, mankind has obtained most of its energy since the Industrial Revolution from fossil fuels, which are the main source of increased CO_2 in the atmosphere, and projections are that fossil fuels will remain the dominant source of primary energy for many decades, particularly in developing countries. Third, even if very effective energy conservation and efficiency measures are widely implemented, the growing human population and the associated increase in standards of living and land-use requirements for food production mean that effective greenhouse gas emissions will continue to increase for at least the next 50 years as the global population swells to 9 billion people. The greenhouse gas problem appears to be here to stay, and the search for economical and low-risk approaches to address this problem must and will continue for the foreseeable future.

Progress is being made in addressing greenhouse-gas emissions, but whether it is the increased use of renewable energy sources, energy efficiency and conservation, nuclear power, or biofuels, each of these approaches has its own reason for not growing sufficiently to contribute to solving the crisis. For example, renewables such as geothermal, wind, and solar have made huge strides in the last five years but still provide only around 1% of primary energy supply[3]. The hydroelectric and biomass components of renewable energy bring the total renewable contribution up to 10% of primary energy supply with projections of growth to 13% by 2020[2]. The main reason for this limited penetration is cost; it currently places renewables at a disadvantage relative to fossil fuels which provide over 80% of the world's primary energy supply[3]. As for energy efficiency and conservation, growth in population and standards of living threaten to exceed whatever gains in greenhouse gas emission reductions can be achieved today. Growth in nuclear power, which currently provides approximately 6% of world energy needs[3], offers large opportunities for low-carbon electricity production but brings with it challenges of public acceptance, nuclear non-proliferation, and nuclear waste disposal. Finally, biofuels can be a way of producing low-carbon energy, but they bring with them the challenge of large-scale production in the face of increasing need for water and land for food production. Until such time as these approaches can and do provide a greater share of primary energy, mankind needs to reduce greenhouse gas emissions from the existing available global energy supply mix so that large-scale climate change can be avoided.

Carbon Dioxide Capture and Storage (CCS) is one approach that accommodates the continued use of fossil fuels while also addressing associated CO_2 emissions. CCS can potentially bridge the gap between today's energy sources and future increased reliance on greater efficiency, renewables, nuclear power, and biofuels. A great deal of research is underway to find effective ways of capturing CO_2 from flue-gas and ambient-air sources, and to safely store CO_2 in the deep subsurface. With respect to capture, there are very significant energy requirements for adding capture to traditional fossil-fuel combustion and industrial systems, including cement production. These extra energy expenditures, referred to as the ‘energy penalty’, are likely around 30%[4] of the energy produced for use by the end-user. Research is underway to reduce this energy penalty, to find better ways to capture CO_2 from a variety of sources including ambient air, and to find ways to utilize CO_2 on large scales that also keeps it out of the atmosphere. As for the storage part of CCS, there are many questions around capacity, injectivity, storage integrity, monitoring, and environmental impacts. CCS has its own costs and risks, but these must be compared to the cost and risk of doing nothing and standing by as greenhouse gases disrupt Earth's climate and ecosystems.

While the main focus will be on CO_2, other greenhouse gases such as CH_4 and N_2O, will also be covered. It will be apparent through the collective articles in the journal that the energy and climate systems are interlinked. For example, the 30% energy penalty mentioned earlier means that, somewhat paradoxically, more fossil fuel will need to be consumed in order to reduce fossil-fuel CO_2 emissions. In addition, there are environmental impacts to producing fossil fuel and these must be considered in whatever policies are chosen. Clearly, there are multiple linkages in energy systems and these linkages will be prominent in the papers published.

With this introduction, we welcome you as readers and contributors to the journal, joining with us to address one of the most important and persistent problems facing the world.

Acknowledgment

This work was partially supported by the Assistant Secretary for Fossil Energy, Office of Sequestration, Hydrogen, and Clean Coal Fuels, through the National Energy Technology Laboratory, U.S. Department of Energy, under Contract No. DE-AC02-05CH11231.

References

1. Inman M, Carbon is forever, Nature Reports: Climate Change [Online]. Available at: http://www.nature.com/climate/2008/0812/full/climate.2008.122.html [January 14, 2011].

2. US Energy Information Administration, International Energy Outlook, 2010. [Online]. Available at: www.eia.gov/oiaf/ieo/index.html [January 14, 2011].

3. International Energy Agency, World Energy Outlook 2009. IEA: Paris, France. Available at: http://www.worldenergyoutlook.org/2009.asp [January 14, 2011].

4. House KZ, Harvey CF, Aziz MJ and Schrag DP, The energy penalty of post-combustion CO2 capture & storage and its implications for retrofitting the U.S. installed base. Energy Environ Sci. 2:193–205 (2009).