Rationale and Potential for Zero Emission Carbon Technologies

Alan Johnson
(Zero Emission Coal Alliance)
Hans Ziock
(Los Alamos National Laboratory)

In a world in which energy security is of critical importance, it is essential that we clearly identify and deal directly with real environmental threats. 'Climate Change' is the political and public face of the threat of a massive carbon imbalance in the global ecosystem brought about by the world's enormous consumption of fossil fuels. The focus on climate change, one possible, but unproven impact of carbon overloading in the atmosphere, risks diverting attention from the real challenge of carbon management.

Given the low cost, reliability, and convenience of fossil fuels, it is virtually certain that they will need to be used to meet the world's insatiable appetite for energy for centuries to come. In fact, in the next few years, intense efforts can be expected to further utilize coal in particular to ensure less reliance on politically unstable sources of oil supply.

The scale of the issue needs to be understood. Fossil carbon available for consumption dwarfs the amount of carbon currently found in the atmosphere by well over a factor of 10 and a similar factor for all the carbon in the world's standing biomass. The vastness of these reserves implies that the goal of carbon management must go well beyond the limits called for by the Kyoto Protocol: the target must be essentially ZERO CO_2 emissions. Advances in technology make this doable for only a small fractional increase in energy costs. A number of different approaches are capable of achieving this objective. Any solution requires two processes: one that separates the energy (in the form of electricity or hydrogen) from the carbon and yields a pure stream of CO_2, and another that permanently sequesters the CO_2.

Los Alamos National Laboratory's Zero Emission Carbon Technology (ZECT) is one such concept. This approach is a chemical process that avoids any combustion. In an energy neutral process, coal (or a carbon fuel) and water are chemically converted into separate hydrogen and CO_2 streams. The hydrogen is subsequently converted to electricity (and back to water) via solid oxide fuel cells, with the 'waste' heat released from the fuel cells being recycled and used to produce more hydrogen. The CO_2 is subsequently reacted with extremely abundant ultra-mafic rocks to yield safe, stable, solid mineral carbonate: a process by which Nature itself has already sequestered vast quantities of CO_2. A recent analysis of the concept by Nexant, a Bechtel Company, indicates that electric power could not only be produced for a competitive price but also with extraordinarily high process efficiency. This efficiency gain, by itself, effectively doubles the lifetime of the world's fossil fuel supply. Even without sequestration, it would halve the amount of CO_2 produced for each unit of power.

This is not the only contribution that ZECT can make to environmental and energy security. Because the process produces hydrogen before it makes electricity, a whole range of synfuels possibilities open up: going all the way from synthetic fuels production from coal, through bitumen and heavy oil upgrading, to syngas production, biomass conversions and even the direct use of hydrogen as a transportation fuel or for distributed power generation. It is indeed possible to achieve energy security by relying on fossil fuels while at the same time preserving the environment.