CARBON SEQUESTRATION

cience for the 21st Century

Cradle to grave carbon managment will allow continued economic prosperity

There is growing concern about the potential worldwide environmental impacts from the vast amounts of carbon dioxide that are released from the combustion of fossil fuels. Possible impacts range from global warming to acidification of the ocean. Unless action is taken, future carbon dioxide emissions will dwarf those to date. Los Alamos National Laboratory leads a number of scientific efforts to isolate and dispose of carbon dioxide before it ever reaches the air, and also to directly remove carbon dioxide from the atmosphere.

The stability of the world's economy depends on abundant energy. For economic reasons, the energy supply has been, and in all likelihood will continue to be, dominated by fossil fuels, which are still plentiful. Limiting energy use to curtail carbon dioxide emissions would stifle economies and leave the majority of the world impoverished, as energy use is the enabling agent for wealth. Left unchecked, however, the atmospheric concentration of carbon dioxide will double in the next 50 years, as poorer nations of the world seek the standard of living enjoyed by today's richer nations. This doubling will take atmospheric carbon dioxide levels well beyond the highest levels recorded in geologic strata dating back 10 million years, with the potential for severe global impacts.

Los Alamos is actively engaged in research and development to achieve carbon sequestration, the capture and secure storage of carbon dioxide emitted from the combustion of fossil fuels. Los Alamos' scientists have developed a number of innovative concepts combining expertise in earth sciences, chemistry and biology.

Los Alamos scientists are investigating the use of reactors for achieving low-cost, high-efficiency hydrogen production from natural gas. Hydrogen fuels release no carbon dioxide and can be used in fuel cells to produce electricity. In another effort, scientists are investigating a zero-emission, coal-fueled power plant, which involves a carbon dioxide acceptor process for hydrogen production coupled with high-temperature, solid oxide fuel cells. Others at Los Alamos are developing hydrogen separation membranes to yield pure hydrogen streams. To deal with diffuse carbon dioxide emissions such as those from cars, trucks and aircraft, Los Alamos scientists are investigating the direct chemical extraction of carbon dioxide from the atmosphere. Other Los Alamos scientists are addressing the same issue by improving the natural process by which the earth's biomass takes carbon dioxide from the atmosphere. They are investigating how to enhance plant growth and soil retention of carbon.

For permanent sequestration of carbon dioxide, Los Alamos proposes enhanced mineral carbonation. This is an accelerated version of the natural process that has maintained the atmospheric carbon dioxide levels on geological time scales. Los Alamos has pioneered the research to react carbon dioxide with naturally occurring magnesium and calcium silicates to form stable carbonates, either by an industrial, above-ground process or the injection of supercritical carbon dioxide into appropriate geological strata. Enormous deposits of such silicates in the form of serpentinite rocks are found in a number of locations, notably near the high-energy-using coasts of the United States. Future power plants could be located near these deposits, allowing for immediate, permanent disposal of their carbon dioxide emissions.

In the 21st century, all these methods used in some combination could enable human-dominated systems to continue to grow while maintaining the natural environmental balance of the planet.

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