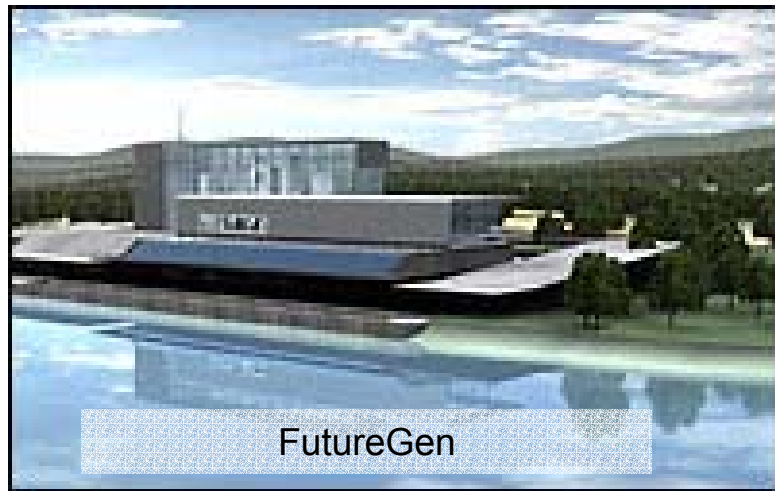


# **Role of Sequestration and Technology in Reducing Greenhouse Gas Emissions**



FutureGen



No-till planter

March 2004

## Failure of the Kyoto Protocol

- Based primarily on mandatory CO2 emission rollbacks from fossil fuels.
- Would drive up energy prices.
- Would cause one million job loss in the US according to Clinton Administration study.
- Job loss of 2-3 million according to other studies.
- No significant impact on greenhouse gas concentrations in the atmosphere.

## Alternative to mandatory CO2 emission rollbacks

- Rapid development of new technologies
  - Wind, solar and other renewables
  - Hydrogen economy
- Soil sequestration (terrestrial) – storing carbon by managing forests, croplands and grazing lands.

## Hydrogen economy

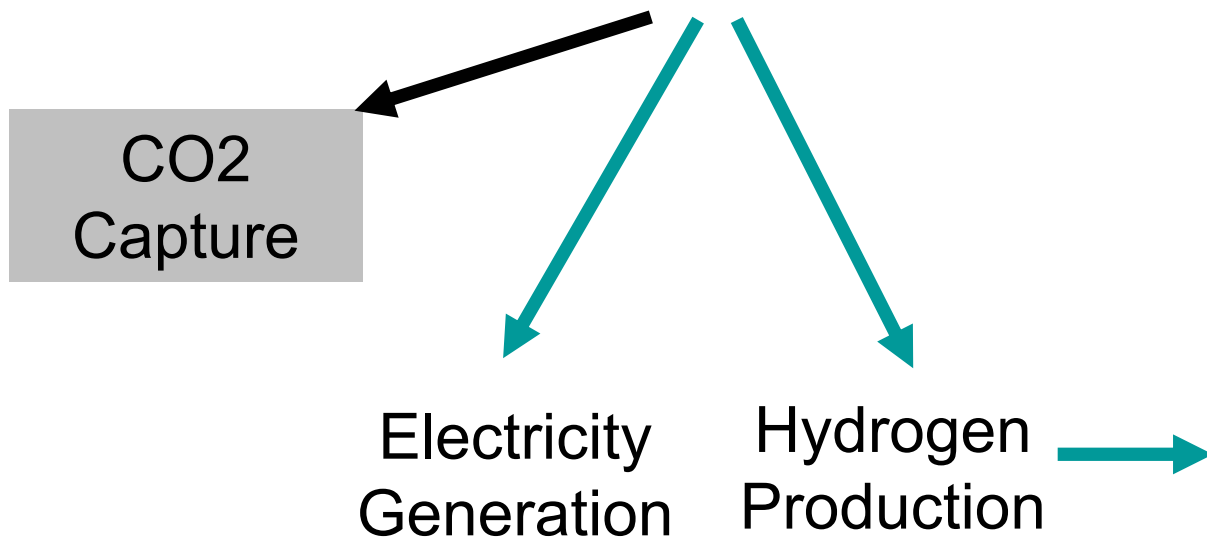
- Program began in the Clinton Administration, continued under Bush as FutureGen. Coal appears to be the lowest cost source of hydrogen.\*
- Goals
  - Build a 275 megawatt power plant that produces its hydrogen fuel from coal.
  - Sequester 90% of CO<sub>2</sub> emissions and produce zero emissions of pollutants including SO<sub>2</sub>, NO<sub>x</sub>, and mercury.
  - Produce electricity with at 10% greater cost than non-sequestered systems.
  - Produce hydrogen at equivalent to 48 cents per gallon of gasoline that can be used in transportation.

\*Natural gas is a source of hydrogen, but natural gas is already in high demand.

Source: Department of Energy

## Removal of carbon before the fuel is burned

Coal Gassification



Hydrogen / Fuel Cell Powered Vehicles

## Technology issues

- Hydrogen technology and is a decade away.
- It will take more time for new hydrogen technologies to displace older technologies once they are developed.
- Solar and wind technologies are promising but slowed by cost and siting.

 A sequestration bridge is needed to get to a greenhouse gas stabilization path

## What is Sequestration?

- The capture of CO<sub>2</sub> before or after fossil fuels are burned.
- Kinds of sequestration
  - **Soil sequestration** – capturing CO<sub>2</sub> in trees, plants and the soil. Managing crop lands, pasture lands and forests.
  - **Geological sequestration** – piping CO<sub>2</sub> into the oceans or geological formations as the fuel is burned.

## Advantages of Sequestration

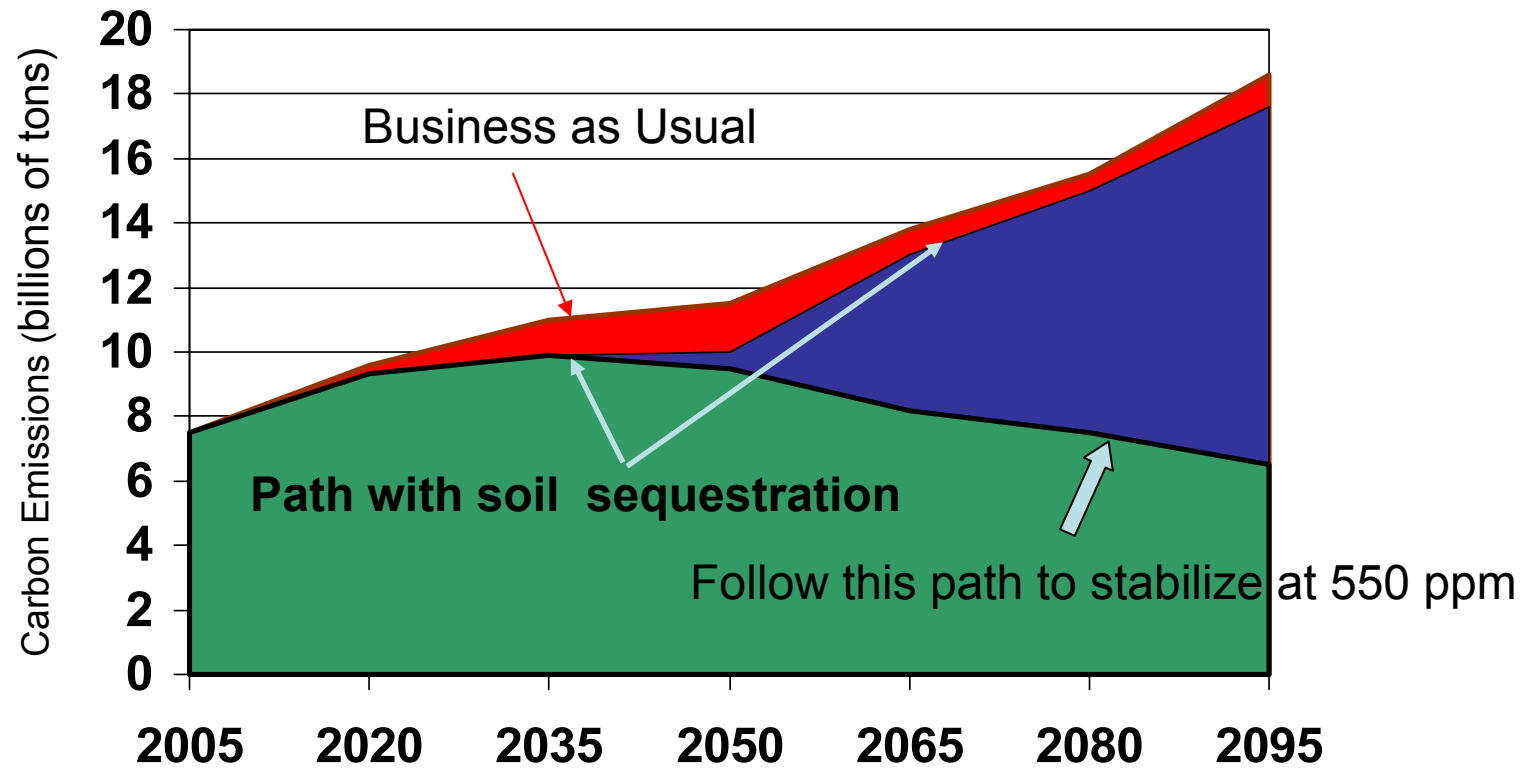
- Sequestration allows continued use of fossil fuels, particularly coal.
- Technology can be transferred to developing countries for more effective worldwide emission reductions.
- Sequestration creates jobs.
- Emission limitations can create very high prices and shift away from coal to more scarce natural gas and imported oil.

## Soil Sequestration

- Soil sequestration alone can put globe on a path to maintain 550 ppm target until 2035, allowing time for advanced energy technologies to mature.
- Soil sequestration technology is already available at low cost.

Note: Improvements in conservation and energy efficiency (not shown on next chart) can take you further into the future than soil sequestration alone.

Policy of Soil Sequestration ***by itself*** can put the **US and World** on a path to stabilize greenhouse gases at 550 ppm out to 2035



Source: Top line IPCC (1990); Bottom line Wigley-Richels-Edmonds scenario (Wigley et al., 1996); Soil sequestration path, Wigley, Richels, and Edmonds 1996, Economic and environmental choices in the stabilization of atmospheric CO2 concentrations. Nature 379.

## Conclusion

- Begin rapid development of technologies for fuels that do not produce greenhouse gases.
- Research and develop technologies for geological storage of carbon.
- Immediately begin soil sequestration programs
  - Create incentives for an aggressive soil sequestration program in the U.S.
  - Create incentives for developing nations to use soil sequestration.
- Continue to develop voluntary programs for the reduction of greenhouse gases.