

Environmental and Social Implications/Challenges of Advancing Carbon Capture and Storage (CCS)

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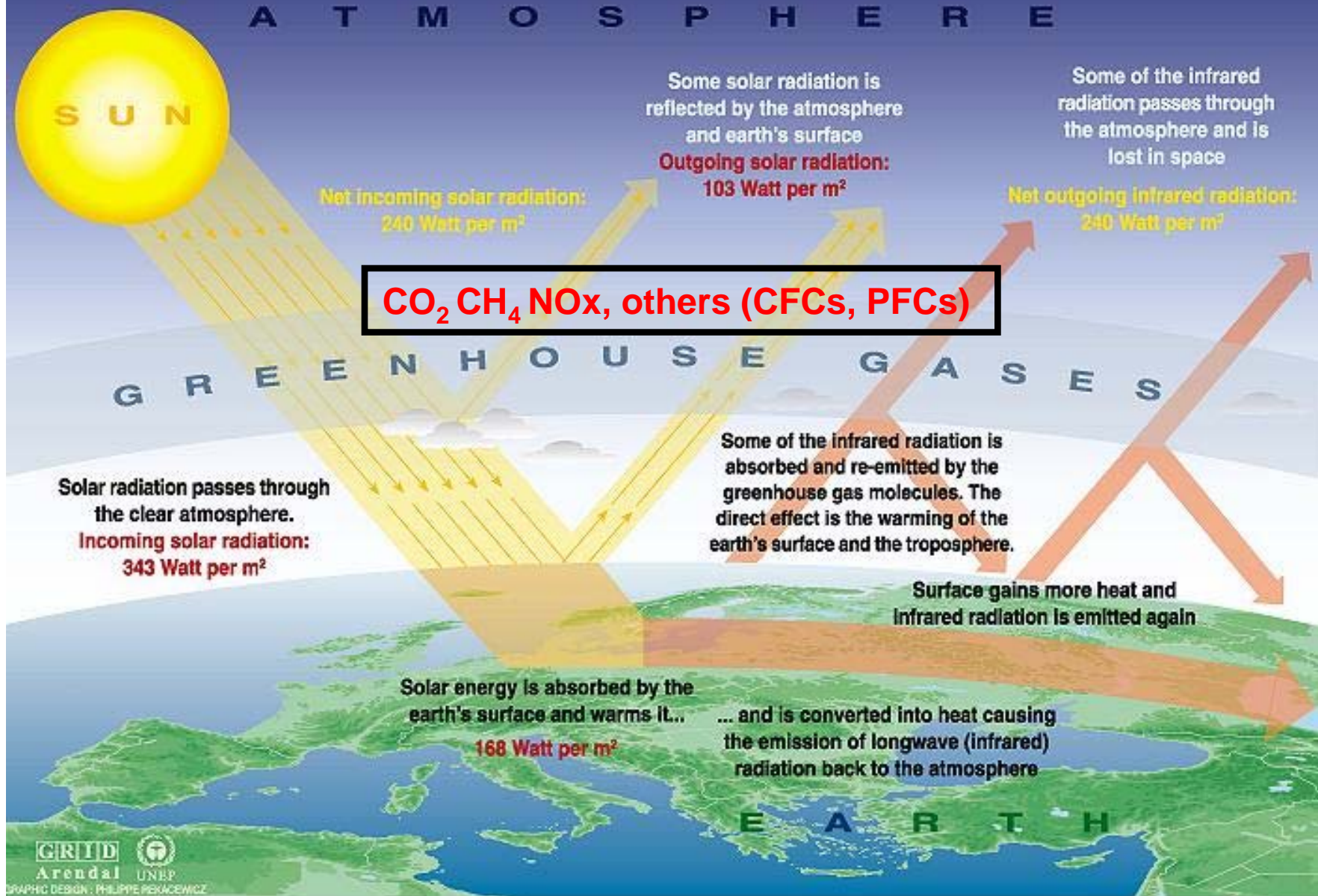
Environmental and Social Implications of Advancing CCS

- Technology with unique potential to reconcile reliance on fossil fuels with reduced CO₂ emissions for climate change mitigation
- Process of Energy Technology Innovation
 - Need for integration and demonstration of the technology
- Does CCS facilitate or slow-down a societal transition away from a reliance on fossil fuels?

Environmental and Social Challenges of Advancing CCS

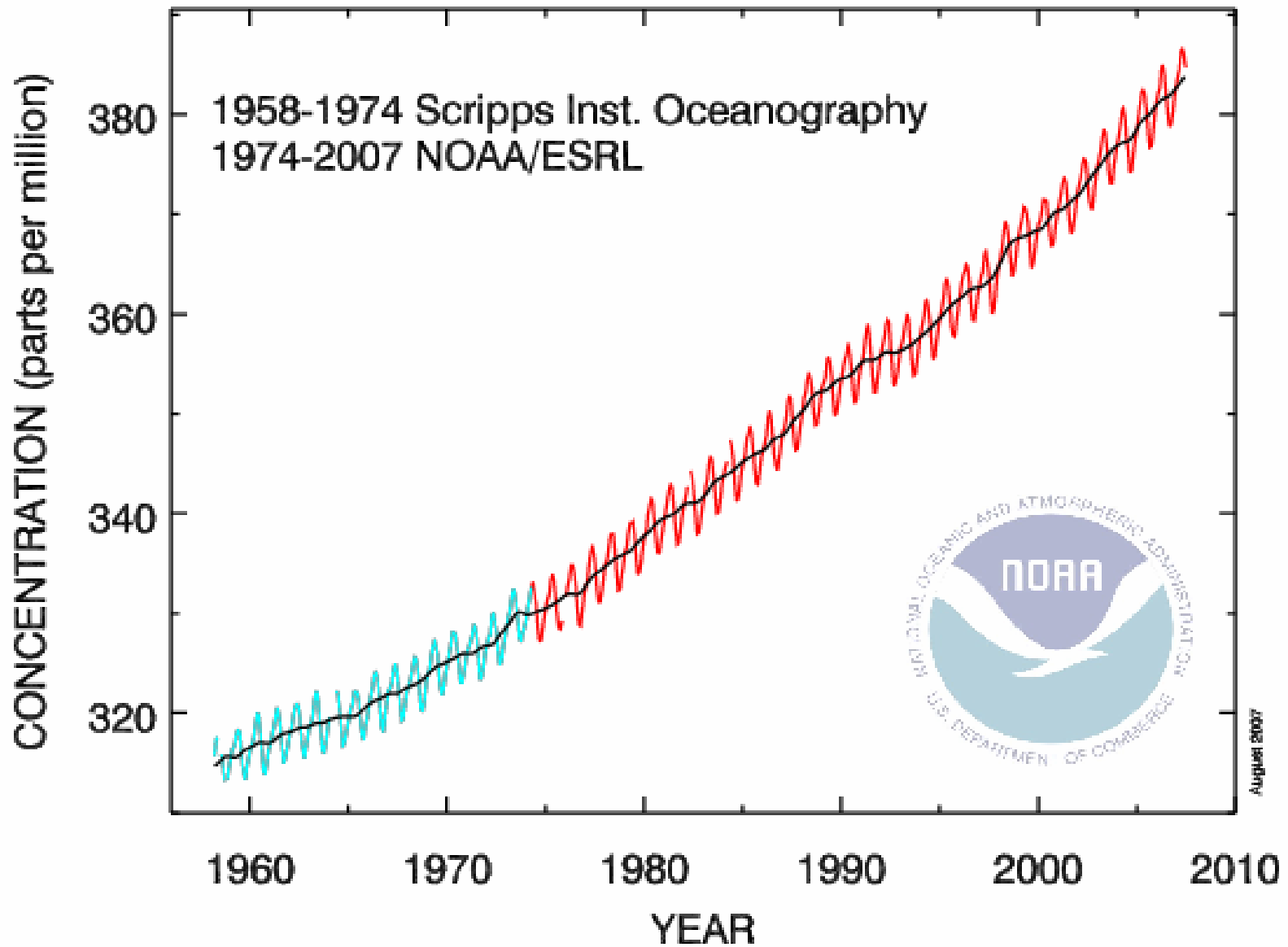
- CO₂ Regulatory Uncertainty
- Risks of CCS
 - Environmental and social risks
 - Local and global risks
- Limited Public Understanding/Awareness
 - Research on public perceptions
- Regulatory and Legal Uncertainty for CCS Projects

The Greenhouse effect

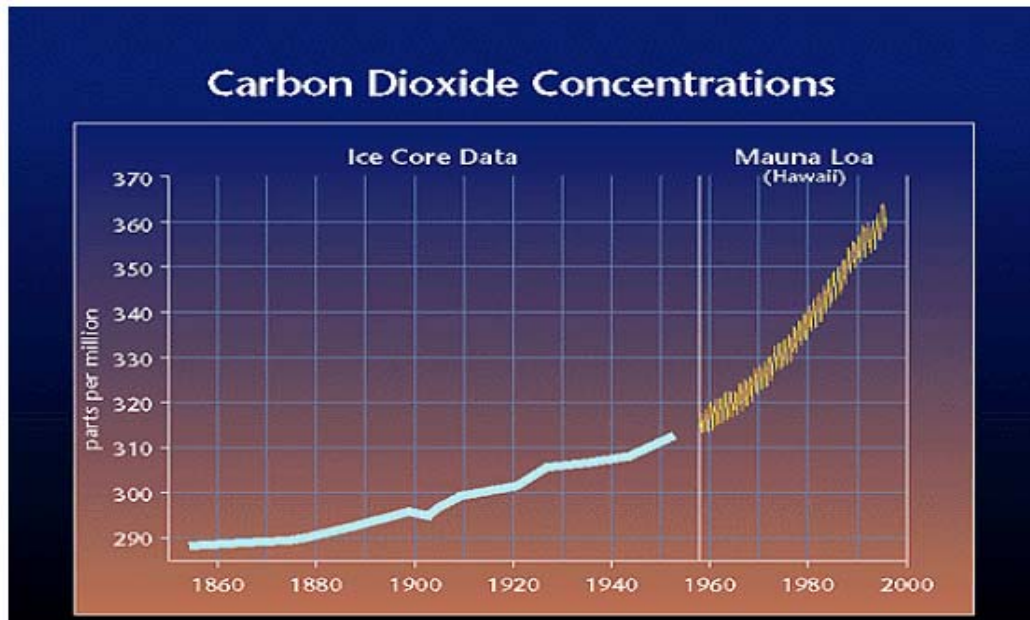


Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

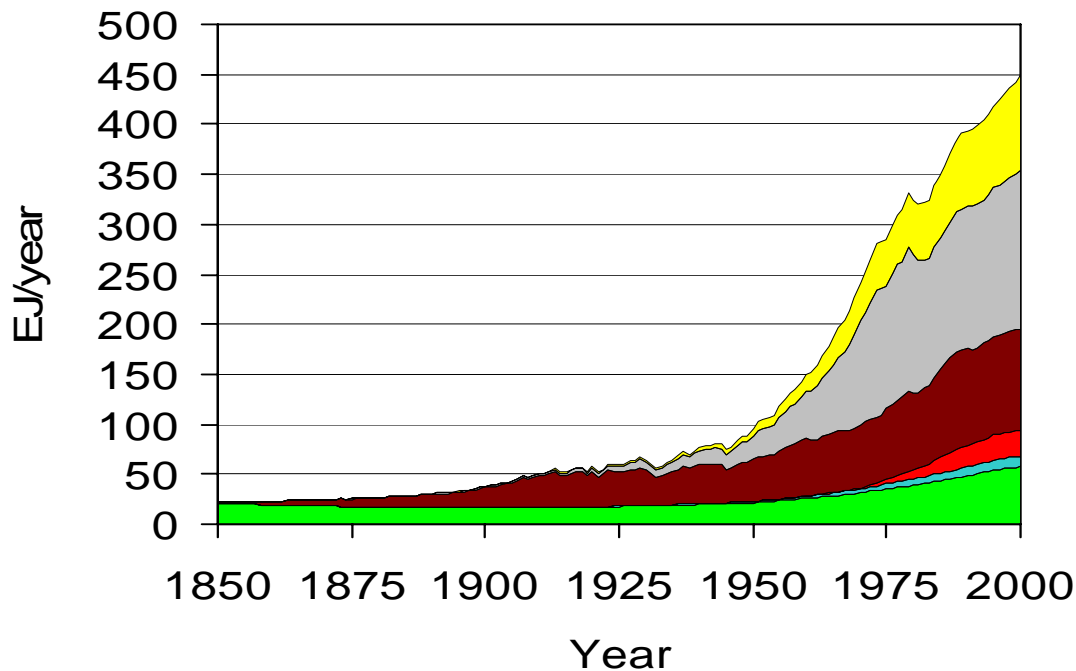
Atmospheric CO₂ at Mauna Loa Observatory



Climate Change is Primarily an Energy Problem



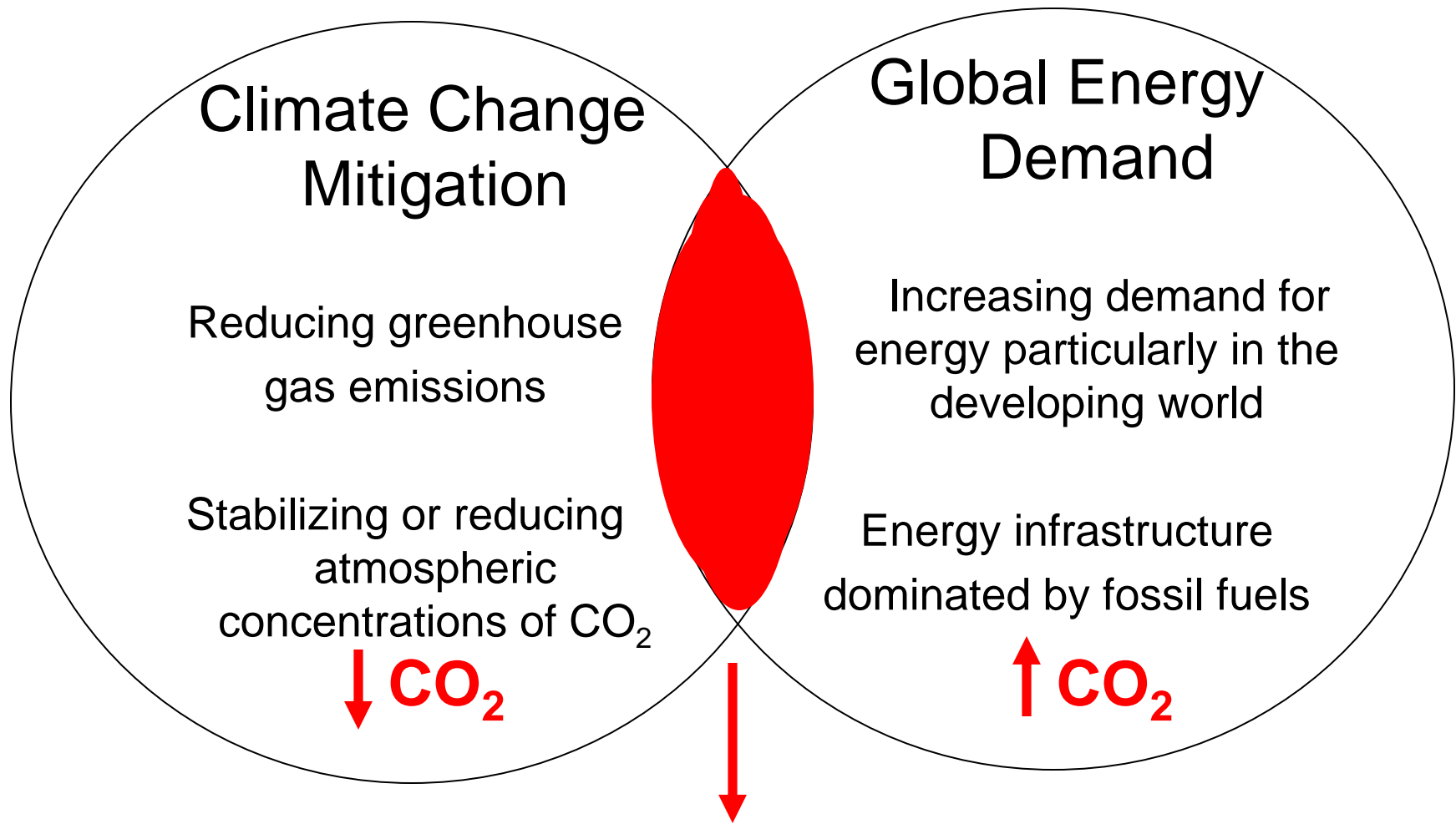
Increasing
CO₂
concentrations



- Gas
- Oil
- Coal
- Nuclear
- Hydro +
- Biomass

Increasing
energy
demand

Holdren, 2004

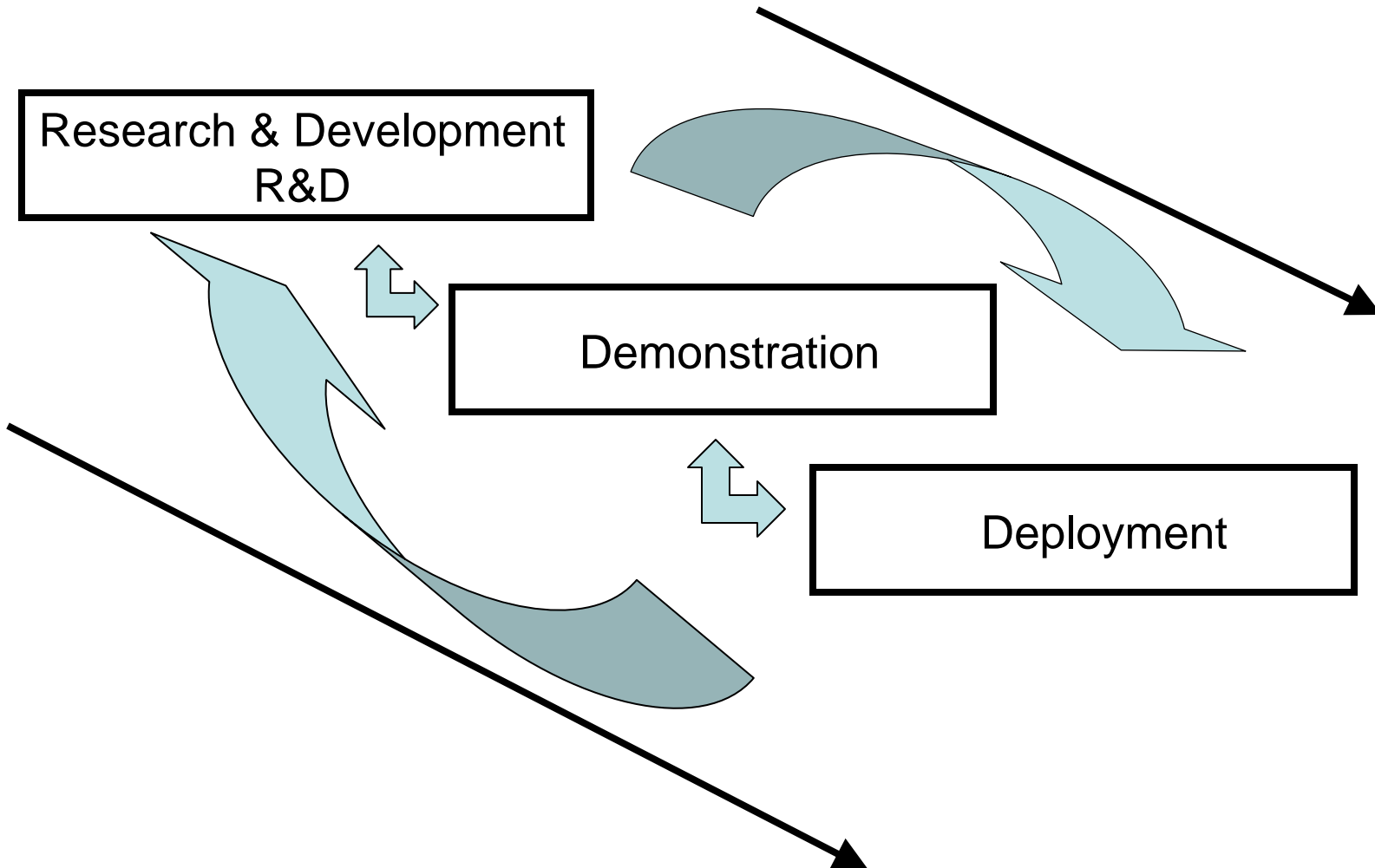


Carbon Management
Technology, Policy, and Strategy
Carbon Capture and Storage - Unique Potential

CO₂ Capture and Storage (CCS) Cleaner Coal Technology

- Coal 34% of global CO₂ emissions, highest CO₂ per kWh
- Coal is cheap and abundant
 - in the U.S., China, India and elsewhere
 - it **will** be used to satisfy increasing demand for electricity
- In a GHG constrained world, coal power generation will have to be able to separate and capture CO₂ for storage
- In U.S., anticipated but uncertain future of CO₂ regulations
- In 2005, China building coal power plants at a rate ~1/week - this has since accelerated

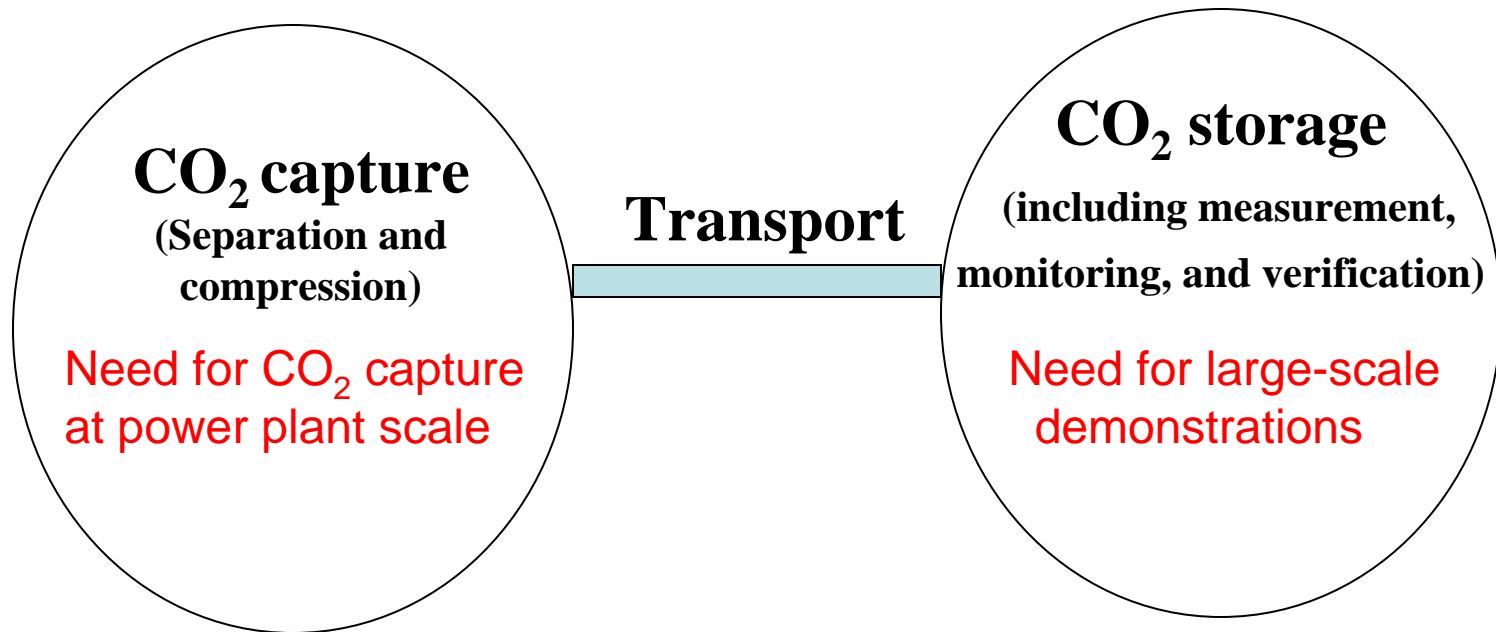
Energy Technology Innovation (R&D³)



Need for integration and demonstration of CCS technology

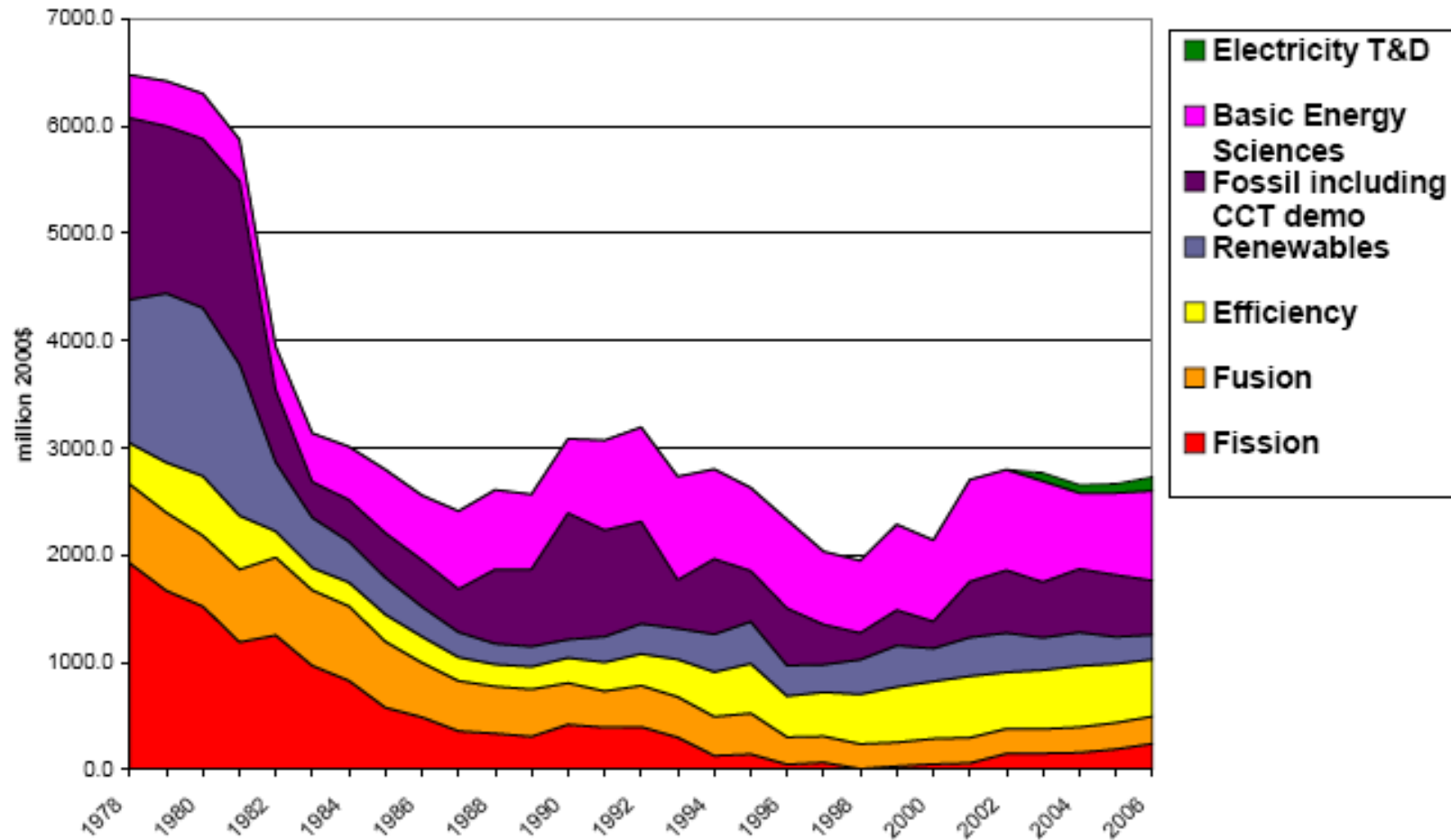
Technically feasible

technologies for each step in commercial use for other applications
but, not yet integrated or demonstrated at appropriate scale



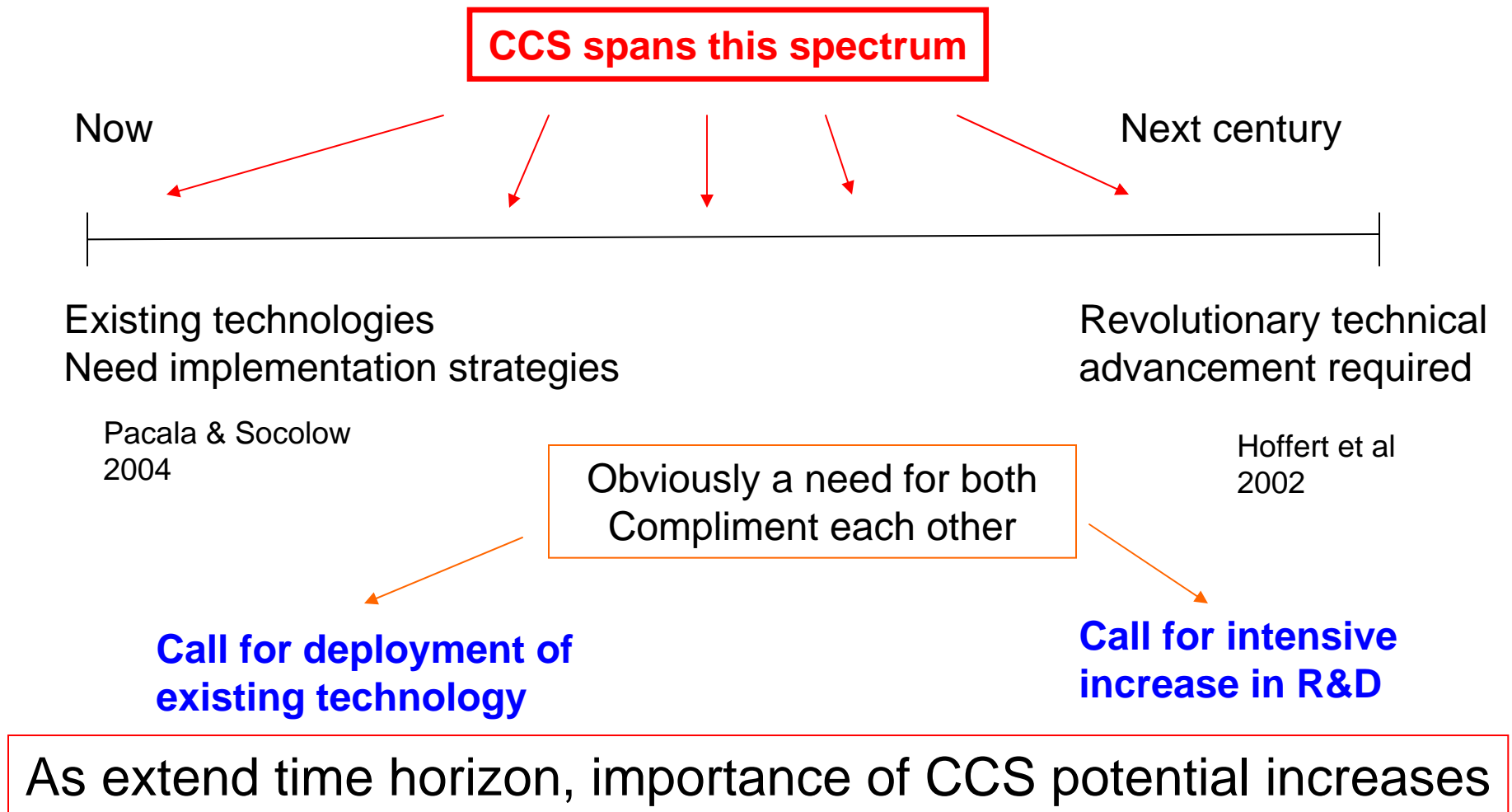
Different technologies involved are associated with different organizations/sectors with different expertise and interests

U.S. DOE Energy RD&D FY1978-FY2006



Gallagher, 2006

Perceptions of climate-mitigation-technology readiness linked to timeframe



Concern about Incremental Deployment of “Cleaner Coal Technologies”

- Should we build coal-fired power plants now without carbon capture and storage?
- If so, can we build “CCS-ready” coal-fired power plants?
 - Costs and inefficiencies associated with retrofitting a power-plant at a later date.
 - But regulatory and economic incentives to encourage incorporating CCS not yet in place

Environmental and Social Challenges of Advancing CCS

- Regulatory Uncertainty Related to CO₂
 - U.S. greenhouse gas regulation anticipated but uncertain
 - Lack of policy complicates risks of energy-technology decisions
- Risks of CCS
 - Global and local risks of geological storage
 - Environmental and social risks of CCS technology
- Limited Public Perception of Risks and Benefits of CCS
 - Awareness about climate change and CCS linked
- Regulatory and legal Uncertainty Related to CCS Projects

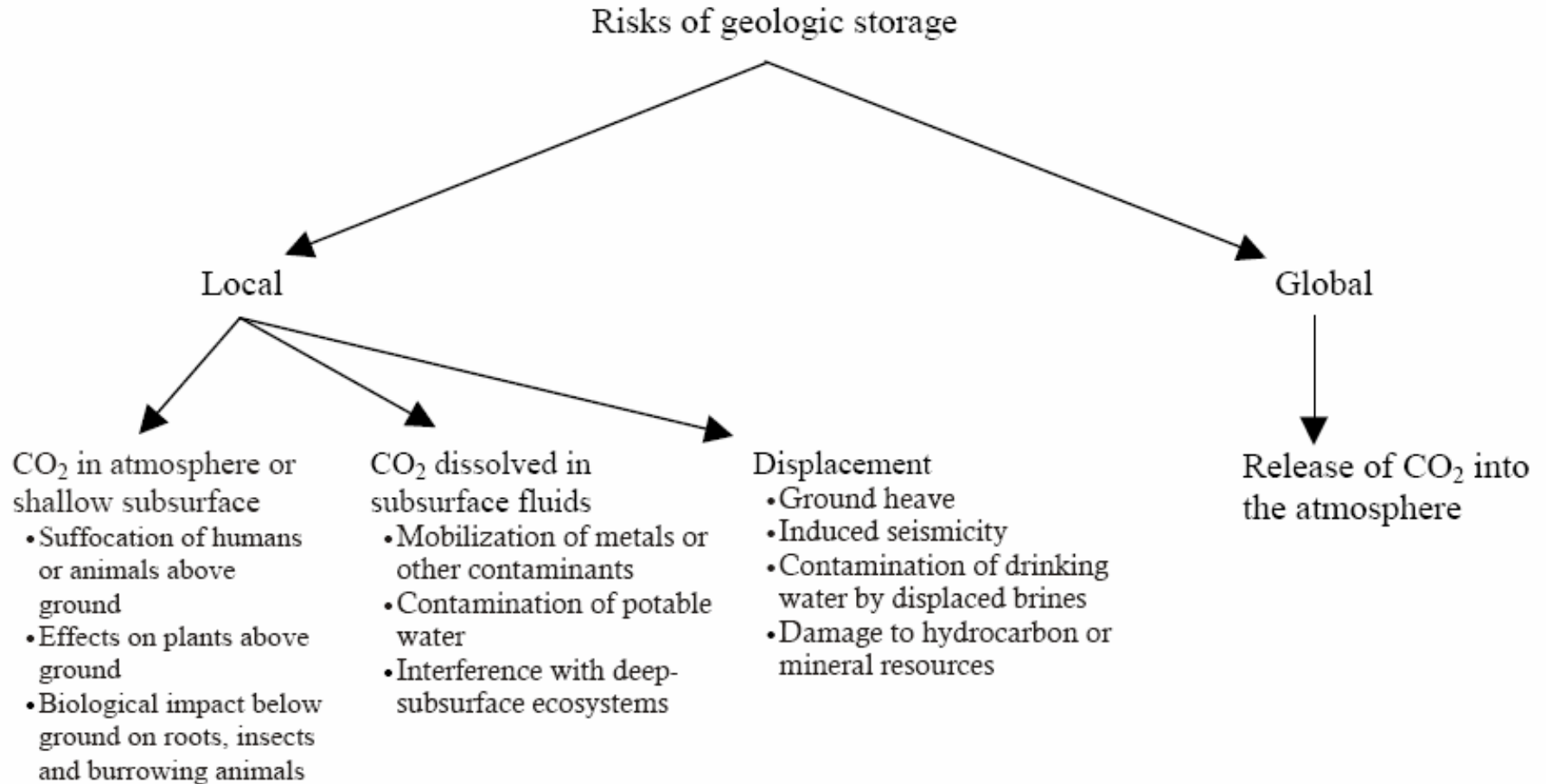
CO₂ Regulatory Uncertainty

- U.S. greenhouse gas regulation anticipated but uncertain
- Lack of policy complicates risks of energy-technology decisions

Relevant Recent News

- Last week Kansas Department of Health and Environment was the first U.S. government agency to cite CO₂ emissions as the reason to reject an air permit for a proposed coal-fired electricity generating plant
- Supreme Court decision in April asserted that greenhouse gases should be considered pollutants under the Clean Air Act.
- Power shortages and rolling blackouts predicted in recent study (North American Electric Reliability Corp – NERC, 2007).
 - Growing energy demand but limited new electricity generation due in large part to GHG regulatory uncertainty

Global and Local Risks of Leakage from Geologic Storage of CO₂



From Keith & Wilson, 2002

Environmental/Social Risks and Concerns

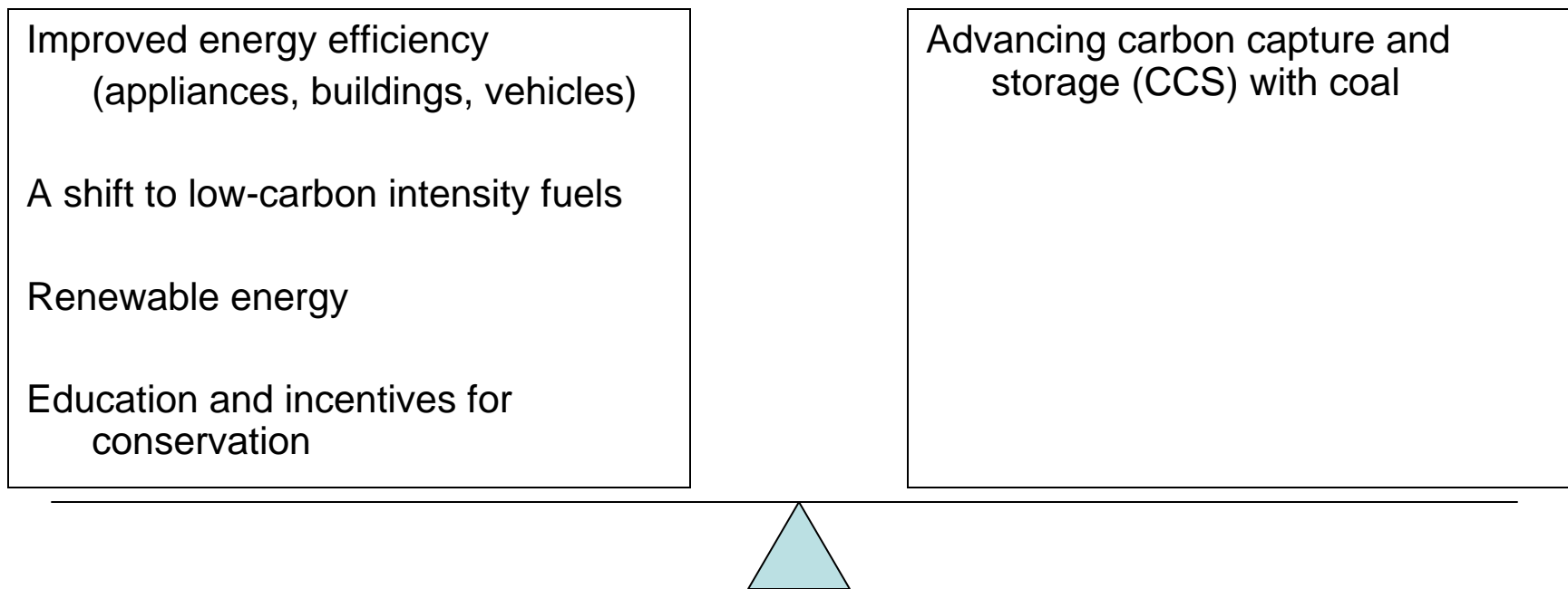
- Support for CCS could detract from efforts to promote conservation, efficiency, and renewables
- Current U.S. government focus on technology rather than policy has not been effective in reducing CO₂ emissions

"Ultimately, we must develop and bring to market new energy technologies that transcend the current system of fossil fuels, carbon emissions and economic activity. Put simply, the world needs a technological revolution,"

Condoleezza Rice speaking to delegates at a special U.N. conference on climate change, September 24, 2007

- Focus on CCS could slow down rather than accelerate a transition away from fossil fuel reliance

Uncertainty and division about CCS among environmental advocacy groups



Risk of promoting the continued use of coal – if CCS is not deployed on large-scale, efforts could increase CO₂ emissions by supporting coal.

Is CCS a technology that helps in a transition to a more sustainable energy system or will it slow down that transition?

Limited Awareness/Understanding

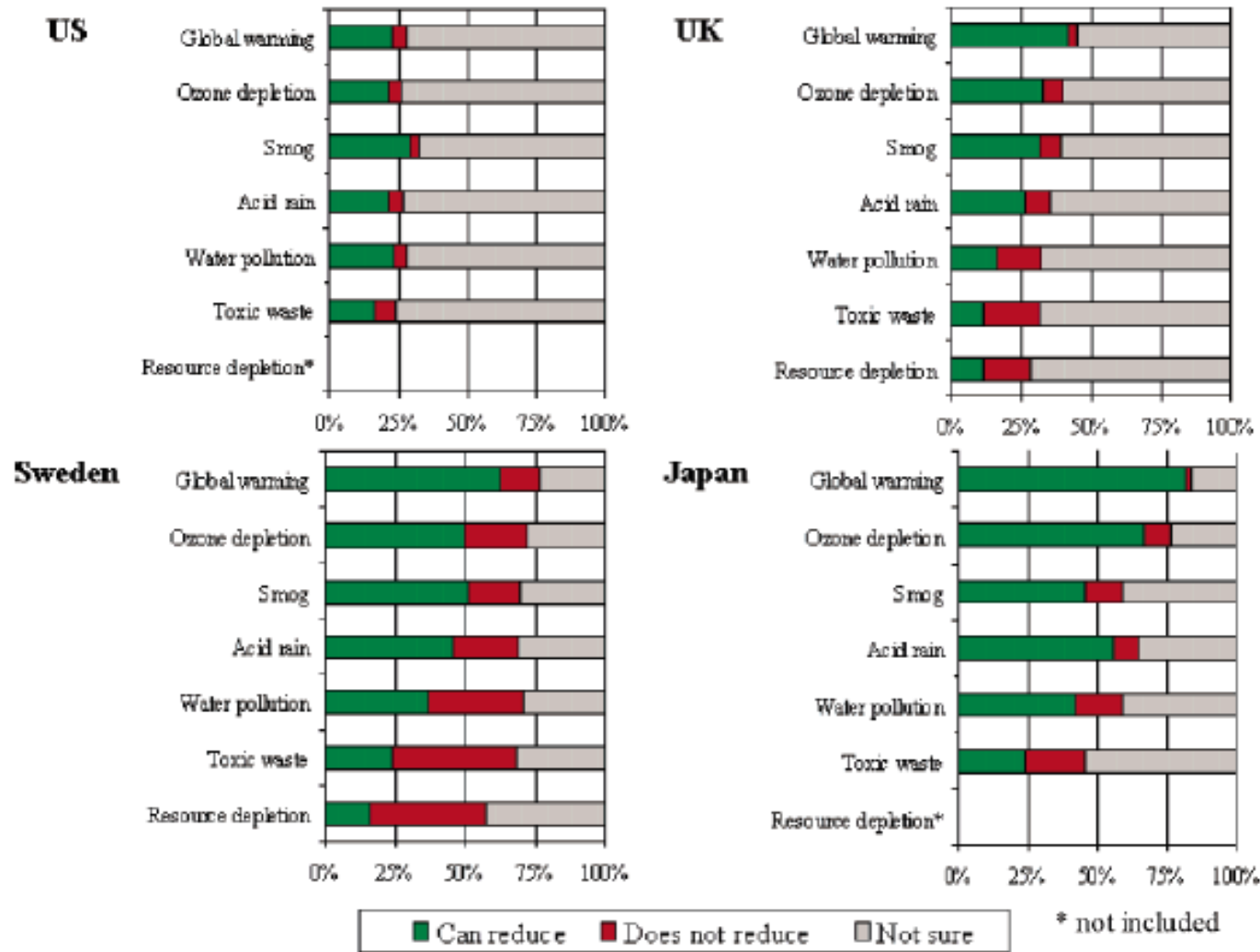


FIGURE 2. Responses to "Please select if "carbon sequestration" or "carbon capture and storage" can reduce each of the following environmental concerns."

Public Perceptions of CCS Technology

- Recognition that public acceptance of CCS technology very important
- More information does not necessarily facilitate greater acceptance or less skepticism in the technology
- Level of understanding of risks of climate change integrally linked to perceptions of CCS
- Level of trust in the source of information critical
- Public concern about CCS different in communities where CO₂ storage has been proposed
 - Much of the concern linked to general mistrust of government and industry, rather than technology-specific issues

Regulatory and Legal Uncertainty Related to CCS Projects

- Unresolved issues:
 - What kind of regulatory framework should be developed to guide CCS projects?
 - Modifications of existing regulations or development of new regulations?
 - Who has responsibility/liability over the long-term for ensuring stored CO₂ stays out of the atmosphere?

Broader Issues

Without carbon dioxide regulation, difficult to effectively advance technological progress with complex interdependent sets of technologies

Challenge of how to gain technological experience for new technologies with global (rather than local) benefits

Technological decisions in the U.S. related to coal-fired power plants and CCS have global impact

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