FE/NETL
CARBON SEQUESTRATION TECHNOLOGIES PROGRAM

OUTREACH PLAN

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Global climate change is considered to be one of the most pressing environmental concerns of our time. This is due in part to the potential magnitude of the changes it could cause and also to the immense economic, technologic and lifestyle changes that may be necessary to respond to it. Although some uncertainty still clouds the science of climate change, there is strong indication that we may have to significantly reduce anthropogenic emissions of greenhouse gas (GHG) emissions. Carbon sequestration offers a promising set of technologies through which carbon dioxide (CO_2) and potentially other GHGs and criteria pollutants are stored for long periods of time in biologic materials, geologic formations, and possibly other places such as oceans. Scientists are studying various aspects of these technologies and beginning to test them on a small scale in order to determine how carbon sequestration can provide a safe, effective and efficient means of preventing CO_2 from entering our atmosphere.

Responding to global climate change raises a host of questions ranging from the technical to the policy-oriented. The carbon sequestration program at the Office of Fossil Energy and the National Energy Technology Lab's (FE/NETL) is designed to answer technical questions such as: does it work, can it be done cost-effectively, and how much can be sequestered? However, FE/NETL also recognizes that such research and development rarely occurs in a vacuum, especially when it involves fieldwork. Public support is important to the success of the research efforts, and, more importantly, public disapproval will be very difficult to overcome. It is imperative, therefore, for FE/NETL and its research partners to work with the public both to explain the research efforts and to address public environmental, health and safety concerns as they arise. The benefits of this outreach effort will accrue to the research teams, by enabling them to improve their research efforts, and to the public, by providing it with more of a role in addressing climate change.

This document contains an outreach plan for working with the public on carbon sequestration.

- The first section sets the context for this plan.
- The second section presents FE/NETL's outreach plan.
- The third section outlines strategies for evaluating and modifying the communication efforts over time.
- The fourth section includes several appendices.

This document is intended to serve as an initial plan and is being developed at the early stages of field research and deployment of geologic sequestration. As experience with this technology grows, this plan will need to be modified.

PART I. CONTEXT: WHY DO WE CARE ABOUT GLOBAL CLIMATE CHANGE AND WHAT'S BEING DONE TO ADDRESS IT?

Some of the worst-case modeling scenarios describe climate change as a planetary average warming that sets off a chain reaction that makes life as we know it very difficult to maintain. In order to prevent this outcome, scientific models suggest that, over the course of this century, we may need to reduce our global GHG emissions by more than 60% below current levels and over

time we may need to eliminate them altogether. Considering conservative estimates for growth around the world over the next century, such reductions are huge.

In the U.S., roughly 80% of anthropogenic, or man-made, GHG emissions come from burning fossil fuels and are in the form of CO_2. Under existing conditions, the primary options for reducing or eliminating this CO_2 include introducing more efficient and alternate energy production as well as the development of a means to capture CO_2 emissions and store them in biologic material and geologic formations. Given the magnitude of the problem, it is likely that some combination of all of these options will be necessary, as no single solution will mitigate enough CO_2 to make an atmospheric impact. Any option will take years to develop and deploy. Research is critical in developing options that can work in a meaningful timeframe.

A. Overview of Our Scientific Understanding of Global Climate Change

The scientific understanding of climate change has advanced dramatically over the last two decades. Scientists know for certain that certain atmospheric gases including water vapor, carbon dioxide, methane, nitrous oxide and others function like the glass panels of a greenhouse, retaining heat in the earth's atmosphere (hence the term "greenhouse gases"). Without this natural "greenhouse effect," temperatures would be much lower than they are now, and life as known today would not be possible. Scientists are also sure that while some of these gases occur naturally, human activity, including the burning of fossil fuels for energy and transportation, as well as modern agricultural practices, greatly increases the amount of these gases in the atmosphere. Atmospheric models predict this increase of GHG concentrations in the atmosphere should be correlated with higher surface temperatures, which have indeed been monitored, and while scientists are currently unable to prove causation, many scientists are highly confident that this is correlated to human activities.

The primary effect of climate change is that average temperatures are predicted to rise between 2.2°F and 10°F over the next century. This relatively large and rapid increase could severely impact seasonal processes, causing habitat changes. It could also cause the sea level to rise, which could endanger island and coastal communities. This kind of warming could lead to a number of possible outcomes, including changes in precipitation that increase the susceptibility of drought in semi-arid regions and that bring heavy storms and hurricanes to other areas. Preliminary evidence suggests that once hurricanes do form, they would be stronger if the oceans are warmer from global warming. Warmer ocean waters could also cause more frequent and fierce El Niño events. Scientists have identified additional health, agricultural, water resource, forest, and wildlife issues that may be vulnerable to climate changes that global warming may bring. For more information on climate change, see Appendix 1.

The impacts of these changes will be critically dependent on the magnitude of the warming, and the rate with which it occurs. Further, while climate models provide more certainty over large areas, they are much less accurate in determining effects on a local level. While more research is required to determine the real potential for these outcomes, it is also apparent that work needs to be done in parallel to prepare for the possibility of climate change.

B. Sources of CO_2 Emissions

Recognizing the problem of potential global climate change, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988. The role of the IPCC is to assess, in a comprehensive, objective, open and transparent basis, the scientific, technical and socio-economic information relevant to understanding the risk of human-induced climate change, its potential impacts, and options for adaptation and mitigation.[1]

The IPCC Third Assessment Report: Climate Change 2001: Synthesis Report indicates that "there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."[2]

The U.S. EPA compiles the inventory of U.S. GHGs, and the Energy Information Agency at DOE maintains an inventory of GHG emissions through the 1605(b) program. According to the EPA, the U.S. emitted 6,936 MMT of CO_2 equivalent in 2001.[3] Of this amount, more than 80%, or 5,615 MMT, was CO2 emitted as the result of the combustion of fossil fuels, including 32% (2,243 MMT) from coal, natural gas and petroleum combustion by electric utilities, and 25% (1,781 MMT) from the transportation sector.[4] The next largest contributors to U.S. GHG emissions include nitrous oxide from agricultural soil management (4%, or 294MMT) and methane from landfills (3%, or 203 MMT).[5]

Although the science remains somewhat uncertain, many scientists believe that in order to reduce the impacts of climate change the atmospheric concentration of CO_2 needs to be stabilized at levels that can only be achieved by significantly reducing the amount of CO_2 and other GHGs emitted into the atmosphere over time. Indeed, the UN Framework Convention on Climate Change (UNFCCC) requires the stabilization of atmospheric GHG concentrations. Some scientists believe that this amount may need to be held globally at a level that is almost 60% below current global emissions. For the U.S., this could mean reducing emissions by *more than* 60% from where they would have grown over the course of this century. FE/NETL's Carbon Sequestration Technology Roadmap and Program Plan indicates, "for nearly any plausible scenario to [GHG emissions] stabilization, sequestration must account for at least 50% or more of the emission reduction load."[6] The 2004 Update of the Roadmap will contain additional analysis. The combustion of fossil fuel for electricity and transportation represent the two largest sources of CO_2 and thus pose two of the greatest areas for reductions.

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[1] IPCC Worldwide Web Site: "About the IPCC," http://www.ipcc.ch/about/about.htm, September 8, 2003.
[2] IPCC, Summary for Policymakers: A Report of Working Group I of the Intergovernmental Panel on Climate Change, The Scientific Basis, from IPCC Worldwide Web Site: http://www.ipcc.ch/pub/reports.htm, page 10, January, 2001.
[3] U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2001 (April, 2003) EPA 430-R-03-004; Table ES-1, pages ES-2-3. http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2003.html
[4] Ibid., Table ES-8, pages ES-11-12.
[5] Ibid, Table ES-1, pages ES-2-3.
[6] NETL, "Carbon Sequestration Technology Roadmap and Program Plan," 2003.

C. Climate Change Response Options

Three main options for responding to climate change include preventing CO_2 and other GHG emissions from entering the atmosphere, reducing emissions from existing activities and adapting to the changes it may cause. None of these are exclusive of each other and, in fact, it is likely that a combination of all of them will be needed.

Prevention of CO_2 includes precluding the formation of CO_2 by replacing fossil fuel combustion with alternatives such as renewable energy sources including wind and solar power, as well as nuclear energy. Another prevention option is to increase the amount of carbon in biologic systems, thereby removing CO_2 from the atmosphere. This can be done through changes in soil tilling practices or land-use methods such as reforestation of abandoned lands. A third prevention option is to trap emissions before they enter the atmosphere. CO_2 can be captured from the energy system at the smokestack, or through the production of hydrogen in an integrated gasification combined cycle power plant (IGCC). There are opportunities for geologic storage in deep saline formations, unmineable coal seams, depleted oil and natural gas fields, and potentially in the deep ocean, or condensed to a solid mineral carbonate.

Using conservation techniques, such as turning off unused lights, can reduce emissions. Similarly, increasing the efficiency of fossil fuel combustion in power plants, industrial processes, and transportation produces the same amount of energy, but with fewer emissions.

A third type of option is to adapt to a warming climate. Adaptation can be autonomous, that is, reactive to climatic changes, so people may respond by using less energy to heat their homes during mild winters, but may use more energy to cool their homes during periods of extreme heat in the summer. Adaptation can also be driven by government policy that is more proactive, for example, limiting the residential use of water during anticipated periods of drought to ensure that there are sufficient reserves for critical needs.

Each option discussed above is not sufficient on its own to reach the level of reductions that may be required. Instead, many people believe that some combination of all these measure may be required. In other words, it is unlikely that there is a "silver bullet" strategy out there. For a more complete discussion of options to address climate change, please see Appendix 2.

D. Ongoing Efforts to Develop Responses to Climate Change

Efforts are underway around the world to further develop the scientific understanding of climate change and to develop solutions to it. The most prominent of these efforts are connected to the Intergovernmental Panel on Climate Change (IPCC) and the UN Framework Convention on Climate Change (UNFCCC). Based on these efforts, many parties that signed the UNFCCC have also ratified the Kyoto Protocol which pledges participating countries to take action to track, report and reduce their GHG emissions during the period 2008-2013. It remains to be seen whether enough countries participate in the Kyoto Protocol to have the treaty enter into force. .

In addition, many nations have their own efforts underway and a number of companies and individuals are doing their part to study and prevent climate change.

In the U.S., a large number of government agencies are working, often in partnership with NGO and private entities, on various aspects of this issue. This ranges across many different Federal agencies. There have been efforts to coordinate these activities. Among the first, the U.S. Global Change Research Program (USGCRP) began as a presidential initiative in 1989 and was codified by Congress in the Global Change Research Act of 1990. The USGCRP supports research on the interactions of natural and human-induced changes in the global environment and their implications for society. The USGCRP mandates development of a coordinated interagency research program.

In 2001, President Bush announced the Climate Change Research Initiative (CCRI) to focus resources and attention on those elements of the USGCRP that can best support improved public debate and decision-making in the near term. In particular, a goal of the CCRI is to improve the integration of scientific knowledge, including measures of uncertainty, into effective decision-support systems. With that in mind, a new Climate Science and Technology Management Structure was initiated in 2002 to help coordinate the various federal efforts related to climate change.

As Figure 1 on the next page shows, fifteen agencies play a role in overseeing and funding research in a number of different areas. These programs include things like development of renewable energy sources, improved efficiency in fossil combustion, development of new energy sources such as Hydrogen, improvements in our understanding of the science of climate change, improved monitoring and measurement techniques, and a host of other response components. The Office of Fossil Energy and the National Energy Technology Laboratory (FE/NETL) and its carbon sequestration program sit among these programs as part of the overall effort in which the U.S. is engaged.

For more information about specific climate change activities at each specific agency, please see Appendix 3.

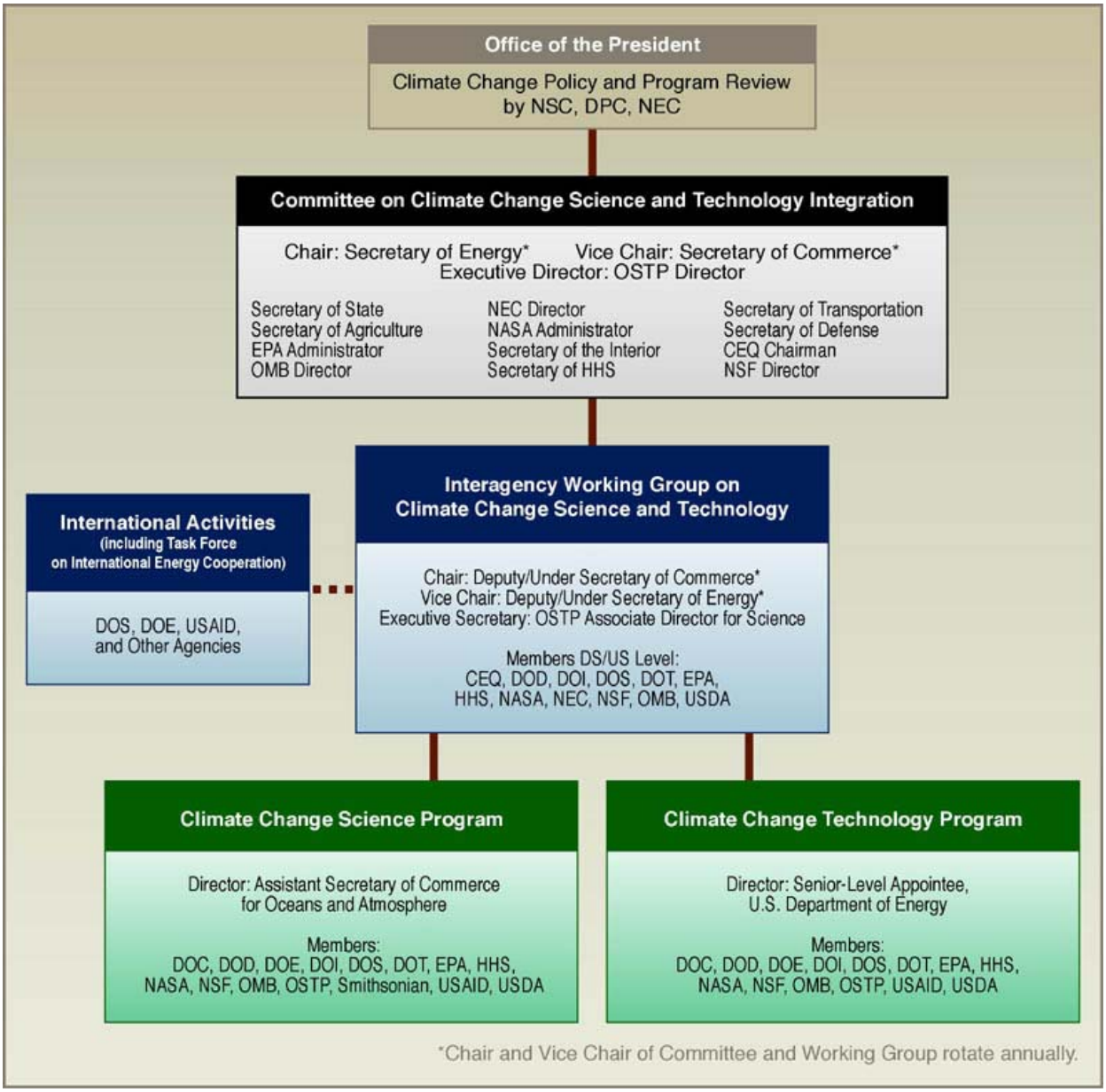


Figure 1: Climate Change Science and Technology Management Structure
(From the U.S. Climate Change Science Program: http://www.climatescience.gov/about/overview-h.htm, and http://www.climatescience.gov/images/cccst-orgchart.jpg)

FE/NETL focuses on three primary types of work: core research, infrastructure development and integration of technologies. Core research areas include: separation and capture of CO_2; sequestration through geologic storage and enhanced natural sinks; measurement and verification; non-CO_2 GHG controls; and, breakthrough concepts. In addition, FE/NETL is funding and participating in some crosscutting activities that begin to develop the infrastructure for sequestration (Regional Carbon Sequestration Partnerships) and also integrate sequestration with energy production (FutureGen). These activities are described more fully in the Carbon Sequestration Technology Roadmap and Program Plan available on FE/NETL's website: http://www.netl.doe.gov/coalpower/sequestration/index.html.

PART II. FE/NETL OUTREACH PLAN

FE/NETL is already engaged in public outreach through its website, publication of the technology roadmap, publication of the monthly carbon sequestration newsletter, communication events, its annual technical conference and other activities. In developing this plan, FE/NETL seeks to continuously improve and fine-tune its communication efforts in order to make them more effective. This plan describes where FE/NETL's efforts are today, outlines new activities for 2004 and provides a process for monitoring public response in order to determine when to add new components and how to evaluate effectiveness of existing efforts.

A. Outreach Goals

FE/NETL seeks to:

1. Provide accurate, timely and useful public information regarding the three areas of work it sponsors.
2. Gain information and feedback from its constituents so that FE/NETL can begin to anticipate and respond to environmental, safety and health concerns as they emerge.
3. Maintain the public trust.
4. Achieve the highest community acceptance of the sequestration research program and FE/NETL's efforts.

B. Approach and Guiding Principles

The U.S. Department of Energy works in coordination with the Executive and Legislative Branches to develop and implement energy policy. Policy recommendations often result from careful research conducted at one of DOE's eight program offices. NETL is housed within the Fossil Energy (FE) program office. NETL is primarily a research lab and as such it is not involved in setting or implementing policy. Rather, it is more concerned with the deployment and use of science and research to develop technologies.

The objective of FE/NETL's carbon sequestration program is to identify, demonstrate and deploy safe, effective and broadly acceptable methods for capturing, separating, storing, or sequestering carbon gases generated during combustion of fossil fuels. This objective fits with FE/NETL's overall vision of developing the scientific understanding of carbon sequestration options, in order to provide cost-effective, environmentally sound technology options that ultimately lead to a reduction in greenhouse gas intensity.

Implicit in this set of objectives is the notion that FE/NETL first seeks to determine if carbon sequestration can deliver on its promise. Second, it seeks to determine what safeguards are appropriate to protect the public health and the environment. And third, it seeks to gain the public's approval by demonstrating methods and approaches for carbon sequestration.

FE/NETL is committed to communicating with the public about its research into sequestration and believes it will accrue the following benefits from communication efforts:

- FE/NETL will gain new information that could be helpful in designing requests for research so as to adequately ensure emerging sequestration technologies are safe and broadly acceptable;
- FE/NETL will develop informed constituencies;
- FE/NETL will also build legitimacy and support for its decision decision-making processes; and
- The general public and those located in communities that may host research projects will gain a deeper understanding of the complexity of the issues surrounding climate change and sequestration as well as the trade-offs involved in considering alternatives.

FE/NETL is committed to the proposition that in order to deliver safe, effective and broadly acceptable sequestration technologies, it will need to interact with the public in two-way communication. In general, FE/NETL is approaching this effort with four main messages:

- The reason for research is to find out if the methods and technologies being tested work; there is no presumption of success;
- Research will continue to progress as long as it is safe and controlled;
- Research will continue to progress as long as current results support next steps; and
- FE/NETL seeks public input, and will use it to best structure current and future programs.

C. FE/NETL Carbon Sequestration Program Areas

FE/NETL's Carbon Sequestration Program includes the following components[7]:

1. Core Research
    - Separation & Capture of CO_2
    - Sequestration through geologic storage
    - Sequestration through biologic sinks
    - Measurement, Monitoring & Verification
    - Non-CO_2 Controls
    - Breakthrough Concepts
2. Infrastructure Development
    - Regional Carbon Sequestration Partnerships
    - Carbon Sequestration Leadership Forum
3. Integration of Technologies
    - FutureGen

In combination, these program components will help to answer the questions: Can CO_2 sequestration be used safely and cost-effectively on a broad basis to address climate change, and how?

[7] NETL, "Carbon Sequestration Project Portfolio – FY 2002," 2003

1. Core Research

FE/NETL is directly funding more than 75 research projects across the U.S. and internationally. A brief sample of projects from each of the main categories of Core Research is described below[8]:

a. *Separation & Capture of CO_2:* The research area aims to significantly improve the cost and efficiency performance of CO_2 capture by evaluating specific technologies and exploring system integration possibilities. Sample projects include:
   i. *Connecticut*: Alstrom Power is attempting GHG control by oxygen firing in circulating fluidized bed boilers.
   ii. *District of Columbia*: BP Corporation is part of a collaborative of companies and other governments developing cost effective technologies for CO_2 capture and storage from large combustion sources.
   iii. *Idaho*: INEEL is using a thermally optimized membrane for CO_2 separation.
   iv. *North Carolina*: Research Triangle Institute is using dry regenerable sorbents to capture CO_2 from flue gas.

b. *Sequestration through Geologic Storage*: Through the development of optimized field practices and technologies, the research area seeks to quantify and improve storage capacity of potential reservoirs including depleting oil reserves, unmineable coal seams, sale and shale formations and others. In addition, FE/NETL is building lab facilities in order to simulate extreme environmental conditions and better understand of the fundamental principles of storage. Sample projects include:
   i. *Utah:* University of Utah is studying CO_2 storage in deep saline reservoirs in the Colorado Plateau and Rocky Mountain region.
   ii. *Alabama:* The Geological Survey of Alabama is studying CO_2 storage potential in the Black Warrior coal-bed methane region of Alabama.
   iii. *Ohio:* Battelle Columbus Labs is conducting an experimental evaluation of chemical sequestration of CO_2 in deep saline formations.
   iv. *Oklahoma*: OK State University and PA State University are studying unmineable coal beds and enhancing methane production sequestering CO_2.
   v. *New Mexico*: Sandia National Labs is studying sequestration of CO_2 in depleted oil reservoirs.

c. *Sequestration through Biologic Sinks:* The program is focused on the integration of energy production, conversion and use with land reclamation. Sample projects include:
   i. *Kentucky:* University of Kentucky is studying carbon sequestration on surface mine lands.
   ii. *Texas:* Stephen F. Austin State University is studying the economics of terrestrial carbon sinks through the reclamation of abandoned mine lands.
   iii. *Washington:* Pacific Northwest National Labs is studying the production of soil enhancements from solid wastes.

[8] NETL, "Carbon Sequestration Project Portfolio – FY 2002," State Projects Summary Table, 2003.

d. *Measurement, Monitoring & Verification*: the program seeks to improve the capability to measure the amount of CO_2 stored at a site, to monitor the site for leaks or other deterioration, and to verify that CO_2 stored is not harmful to the host ecosystem. Sample projects include:
   i. *Texas:* Texas Tech University is developing nuclear magnetic resonance well-logging techniques to identify suitable geological formations for long-term CO_2 storage.
   ii. *Kansas:* University of Kansas Center for Research is developing MIDCARB – the interactive digital carbon atlas.
   iii. *North Dakota*: Natural Resources Canada and several private companies are monitoring performance of the Weyburn Carbon Dioxide Sequestration Project.
   iv. *Illinois:* Argonne National Lab is studying CO_2 reservoir improvements.
   v. *Virginia:* The Nature Conservancy is working on the application and development of appropriate tools and technologies for cost-effective carbon sequestration.
   vi. *New Mexico*: Los Alamos National Lab and USDA are working to develop an advanced Laser-Induced Breakdown Spectroscopy (LIBS) device for field-based detection of soil carbon, enabling researchers to obtain accurate measurements in several seconds.

e. *Non-CO_2 Controls*: This program is focused on areas where non-CO_2 GHG gas abatement is integrated with energy production, conversion and use. Sample projects include:
   i. *Pennsylvania:* CONSOL Energy is studying the capture and use of coal mine ventilation air methane.
   ii. *California:* Yolo County is studying a full-scale bioreactor landfill.

f. *Breakthrough Concepts*: this program follows the principle of mimicking and harnessing the potential found in nature that converts CO_2 to other carbonaceous forms like plant energy (photosynthesis) and mollusk shells. The goal is to develop revolutionary approaches with potential for low cost, high permanence and large global capacity. Sample projects include:
   i. *California:* GE Energy is studying fuel-flexible gasification-combustion technology for production of H_2 and sequestration-ready CO_2.
   ii. *Massachusetts:* Physical Sciences, Inc., is studying recovery and sequestration of CO2 from stationary combustion systems by photosynthesis of microalgae.
   iii. *Tennessee:* TVA is studying chemical fixation of CO2 in coal combustion products and recycling through algal biosystems.

2. Infrastructure Development

a. *Regional Carbon Sequestration Partnerships*: FE/NETL also recently announced the selection of seven regional partnerships. In general each partnership will assess the area within its territory to determine potential for both terrestrial and geologic sequestration, to identify priority sites for additional field validation tests and to develop the research agenda for each site. In Phase II of the partnership program, specific areas will be selected for proof-of-concept scale research. As part of their effort, each partnership will identify the potential regulatory and infrastructure

requirements that a region would need should climate science dictate that sequestration be deployed on a wide scale in the future. The selected partnerships are:

i. *West Coast Regional Carbon Sequestration Partnership* is led by the California Energy Commission, Sacramento, CA, and made up of representative organizations from Alaska, Arizona, California, Nevada, Oregon, and Washington.

ii. *Southwest Regional Partnership for Carbon Sequestration* involves the efforts of 21 partners in Texas, New Mexico, Arizona, Oklahoma, Colorado, Kansas Utah, and Wyoming, coordinated by the Western Governors' Association and New Mexico Institute of Mining and Technology, Socorro, NM.

iii. *Northern Rockies and Great Plains Regional Carbon Sequestration Partnership* is headed by Montana State University, Bozeman, MT, and covers Idaho, Montana, and South Dakota.

iv. *Plains CO_2 Reduction Partnership* extends across Minnesota, North Dakota, South Dakota, Montana, Wyoming and two Canadian provinces. It is led by the Energy & Environmental Research Center at the University of North Dakota, Grand Forks, ND.

v. *Midwest Geologic Sequestration Consortium* is evaluating sequestration options in the Illinois Basin of Illinois, western Indiana, and western Kentucky. It is led by the University of Illinois and the Illinois State Geological Survey.

vi. *Southeast Regional Carbon Sequestration Partnership*, headed by Southern States Energy Board, Norcross, GA, and involving Arkansas, Louisiana, Mississippi, Alabama, Tennessee, Georgia, Florida, North Carolina, and South Carolina.

vii. *Midwest Regional Carbon Sequestration Partnership* covers Indiana, Kentucky, Ohio, Pennsylvania, and West Virginia and is coordinated by the Battelle Memorial Institute, Columbus, OH.

b. *Carbon Sequestration Leadership Forum*: The Carbon Sequestration Leadership Forum is an international climate change initiative that will focus on development of carbon capture and storage technologies as a means to accomplishing long-term stabilization of greenhouse gas levels in the atmosphere. This initiative is designed to improve carbon capture and storage technologies through coordinated research and development with international partners and private industry.

3. Integration of Technologies – FutureGen.

FutureGen, DOE's Integrated Sequestration and Hydrogen Research Initiative, is a $1 billion government/industry partnership to design, build and operate a nearly emission-free, coal-fired electric and hydrogen production plant. The 275-megawatt prototype plant will serve as a large scale engineering laboratory for testing new clean power, carbon capture, and coal-to-hydrogen technologies. With respect to sequestration technologies, captured CO_2 will be separated from the hydrogen perhaps by novel membranes currently under development. It would then be permanently sequestered in a geologic formation. Candidate reservoir(s) could

include depleted oil and gas reservoirs, unmineable coal seams, deep saline aquifers, and basalt formations.

FE/NETL's sequestration program provides critical support to FutureGen, which is a separate initiative at DOE.

D. Key Audiences: Initial Familiarity with Sequestration, Perceptions and Concerns

There are wide disparities in the level of familiarity with carbon sequestration among the key audiences. Those actively involved in the research, including universities; some corporations with large amounts of emissions such as energy companies that also invest in research; as well as technology development companies are relatively well informed. The next best informed groups include those who have had some direct experience with sequestration research. These include some regulators in states where field research is taking place, certain government officials, environmental groups and other NGOs that have actively sought information and some others. A larger number is vaguely familiar with the issue of climate change and the concept of sequestration and depending on their background may be more familiar with either terrestrial or geologic sequestration but not necessarily both. The majority of people are barely familiar with the details of climate change and do not know much, if anything, about sequestration.

Some limited work to identify potential perceptions and environmental, health and safety concerns suggest that there is room to constructively engage various audiences within the general public at this early stage in the development of carbon sequestration. Furthermore, that such engagement would be very worthwhile in building public support for the research and the outcomes to which it may lead.

In general, there are a number of reactions that people are going to have to carbon sequestration. They are likely to range from positive support for solutions to climate change and for efforts to protect local economies that also protect the environment, to the more concerned and suspicious. Almost any kind of project that has economic, environmental and social implications is likely to give rise to concerns about public safety, environmental protection, specific concerns about local land-use impacts and impacts on property values. These may be categorized generally as:

- Concerns about the opportunity cost – if resources are spent on sequestration, they may not be spent on renewable energy or other alternatives.
- NIMBY – some people just do not want research conducted in their community
- Concerns about the specific design of the research – perhaps a project would be more acceptable if it were moved 100 yards farther from the fence or included a learning center to teach local kids about the project; and
- Concerns about the research topic in general – some think ocean sequestration should be categorically abandoned.

At the same time that these general categories of concern tend to arise, it has also been found that actively working with audiences in order to first understand their concern and then to develop mutually acceptable means of addressing those concerns can be effective. As the carbon sequestration program grows over time and scope, this kind of engagement will be increasingly important.

Based on initial research, we group the audiences for the carbon sequestration program as follows and offer initial descriptions of the groups and of what we know of them:

1. Regulators and other Government Representatives
2. Elected Government Officials
3. Non-Governmental Organizations (NGOs)
4. Business Leaders
5. The General Public

1. Regulators and Other Government Representatives

Regulators at the federal, state and local level - and possibly other levels as well - are likely to be interested generally in the overall program because they will likely get involved in permitting field sites. An initial debate focuses on the regulatory treatment of sequestration wells – whether they should be regulated as Class I or Class II wells, or some other category. The implications of being regulated as hazardous material are significant in terms of the cost and level of public concern. There are several efforts underway to reach out to regulators. Some of these efforts include work to develop a set of recommendations about how research and ultimately commercial scale sequestration facilities should be regulated.

A second effort involves direct outreach to those regulators overseeing areas where field research is underway. Several projects have negotiated short-term permits. This experience could be shared with others to help determine levels of necessary regulation.
One issue for consideration is the extent to which each state will determine its own regulatory stance towards sequestration versus a common approach set by the federal government.

2. Elected Government Officials

Elected officials tend to care deeply about issues affecting the economy, public safety and the environment. Carbon sequestration potentially impacts all three areas. Engaging elected officials is likely to be very important. Initial research suggests that elected officials have great credibility with a variety of stakeholders and can have a huge impact on framing the topic of carbon sequestration.

It is important to match the engagement with the correct level of government. In addition to federal and state officials, there is also benefit from addressing associations such as the National Governors Association, the Conference of Mayors and the Environmental Council of States, and the National Caucus of Environmental Legislators. These groups provide an effective opportunity to build constituencies and interest in the program.

3. Non-Governmental Organizations (NGOs)

We consider several different types of NGOs including those focused on environmental issues at the national and state level, and on issues including environmental justice, energy, land use and farming. Many of these organizations have a national organization as well as state or local chapters.

a. National Environmental Groups.
Environmental organizations are all unique, and it should be recognized that attempts to categorize them is in no way fully descriptive of the breadth of activities in which these organizations engage. With that caveat in mind, at the national level, there are several types of environmental groups that are active, or potentially could become active in climate change activities.

i. One major set of environmental organizations engage in litigation to strengthen environmental laws. These organizations could become involved if a carbon sequestration project endangered public health, or if there was a strong perception of potential endangerment. Providing data on the safety of proposed and existing projects, and making the data easy to access and disseminate is an important consideration.

ii. A second set of environmental groups includes those who typically achieve their mission by drawing media attention to their activities. They may employ techniques that include civil disobedience, such as creating human chains to stop logging trucks; or misdemeanors, such as hanging large banners from buildings or construction cranes to make their message heard. These groups focus on high impact activities that can focus media attention on a specific issue. Conducting open and honest dialog with concerned citizen groups, including listening and responding to specific environmental, health or safety concerns, will also be of great importance.

iii. A third set of environmental groups is based on large memberships. These groups often have a national professional staff based in one or more major city as well as individual chapters around the country. Information on specific environmental issues of concern is broadcast to members, and members also raise local issues with the national office that can rise to national importance. As a result of their large memberships, these groups often exert political pressure by lobbying state governors, members of Congress, and the Administration.

b. State Based Environmental Groups.
At the state level, many environmental groups focus on more near-term concerns than long-term concerns. For example, in several states local environmental groups are very concerned and active in protecting air quality but do not have resources dedicated to addressing climate change. This is likely to change dramatically as the Regional Sequestration Partnerships get under full swing and as core research advances to increased field-testing. In general it seems that many state-based environmental groups are interested in learning more and in being actively involved in research projects going on in their regions. One important early finding is that the framing of these issues is likely to be quite important to groups at the local level. In general, these groups will become involved in local projects that seek to sequester large amounts of CO_2. Their involvement will be influenced by their familiarity with the project and with their comfort with certain project-specific factors including

project scale, project visibility and location, project safety and project context. Further it seems that proactive outreach could increase familiarity that, while it may lead to more effort in the short term, could make it easier to move projects forward in the long run.

c. Environmental Justice (EJ) Groups.
EJ groups focus on both social and environmental equity. These issues potentially come into play in several ways in relation to carbon sequestration. On the one hand, concern about the impacts of climate change on economically and socially disadvantaged populations could give rise to increased support for carbon sequestration as a means of responding to climate change. On the other hand, concerns about the potential for carbon sequestration to prolong the life of some power plants located in disadvantaged communities could give rise to opposite concerns. An early discussion with EJ groups is important.

d. Energy Groups.
By and large most NGO energy groups are part of environmental groups and they focus on promoting cleaner and more sustainable sources of energy. There is a potential concern that carbon sequestration in effect gives fossil energy a competitive advantage over cleaner energy sources thereby reducing the incentive or the pressure to develop these cleaner energy sources. This could end up being a point of contention for such groups. Providing a more comprehensive view of how the carbon sequestration effort fits into DOE's overall climate program may provide a means of building support in relation to this topic.

e. Land-Use Groups.
Some environmental NGOs are involved primarily in land conservation; frequently they focus on this policy issue and also raise funds to purchase sensitive tracts of land, place conservation easements upon them, and then sell the land to government agencies, or other organizations that manage the lands. These groups would likely be concerned with geologic sequestration projects in areas they are trying to preserve, especially if it meant building a pipeline to a sequestration injection well or building a road that allows tanker trucks to bring in carbon. On the other hand, a biologic sequestration project that attempts to preserve an old-growth forest, or to reforest an area that has been previously logged, and then place an easement on the property, would likely be quite welcome by this constituency of organizations. As project sites are considered, it is important to also consider their proximity to sensitive lands in which conservation groups may have an interest.

f. Farm Bureaus.
The National Farm Bureau and the state chapters provide an important source of information to land-owners as well as feedback to policy makers. It is important to engage them early on regarding efforts to develop biologic sinks.

4. Business Leaders

Another powerful constituency on the national stage is business trade groups. For example, the Edison Electric Institute (EEI), which has almost every major publicly owned electric utility as a member, is a powerful force on energy issues. Other groups such as the National Automobile Manufacturers Association, the American Petroleum Institute, the National Association of Manufacturers, the National Chamber of Commerce and others closely track issues and get involved in order to serve their membership. Many of these organizations are only beginning to get involved in the issue of carbon sequestration.

In addition to these national business trade associations, local business groups and individual companies are likely to have a strong impact on public perceptions of carbon sequestration at the local level. Frequently, carbon sequestration is discussed in the context of the cost of regulatory programs. However, for those companies interested in sustainability or risk management, it holds promise as a benefit by increasing flexibility and creating new options. It is important to understand the different perspectives that business leaders will bring to this effort.

5. The General Public

There are several important forums to interact with the general public to increase their knowledge about sequestration issues, including schools, local clubs and churches. It is also critical to interact with individual citizens who may have special environmental, health or safety concerns, including those whose property adjoins a field site, and other involved citizens.

a. Students Grades K-12.

Today's students will be tomorrow's taxpayers, concerned citizens, and stakeholders. Introducing students to the complex topic of climate change and the options for addressing it in school is one way to help them become engaged constituents as they become older. There are nearly 48 million students in over 94,000 schools across the U.S. [9] This represents an enormous opportunity to reach out to the next generation of global leaders, professionals, and educators who may face growing challenges from climate change. Materials targeted towards students and their teachers needs to be non-biased, easily accessible and consistent with existing standards and requirements – in other words, it needs to be easy for the teachers to add it to their curriculum.

b. Clubs and Churches.

Clubs such as the Rotary Club and 4-H Club, these organizations are often a primary source of information about important business dealings and government efforts. Outreach to the national organizations can help disseminate this information to the local chapters. Information should also likely be distributed to local chapters near project sites, along with presentations at chapter meetings.

c. Abutters.

Special attention needs to be paid to those citizens whose property abuts, or is near, a proposed research facility. In addition to other environmental concerns, these people

[9] National Center for Education Statistics, U.S. Department of Education. Statistics available at http://nces.ed.gov.

are likely to be concerned about the health impacts and safety of research activities, the impact on property values and the long-term implications for property use of the project.

d. Involved Citizens.
People who live in or near areas where research is going to take place may develop an interest in the research project. Much interest may be driven by pure curiosity. It is important to provide information in response to this interest – through newspaper interviews, hand-outs, a web site or a live person answering calls.

E. Outreach Activities and Materials

FE/NETL will work on three main activities:

1. Ensuring that there is sufficient outreach in areas where field work is taking place to build informed and supportive constituencies;
2. Developing materials that continue to synthesize research results and present comprehensive overviews of the program that are accessible to audiences at all levels of knowledge regarding carbon sequestration; and
3. Continuing to monitor public opinion, perceptions and concerns to assess the effectiveness of the outreach program and to determine when additional outreach activities or materials may be needed.

Within these main activities are a number specific actions and materials that are described in further detail below:

1. Ensuring that there is sufficient outreach in areas where fieldwork is taking place to build informed and supportive constituencies.

The Regional Carbon Sequestration Partnerships (RCSPs) present one of the most visible interactions with the public. The seven partnerships are each implementing their own outreach programs and beginning to develop a public infrastructure to support future research efforts. During Phase I of their work, the partnerships will be mapping areas, prioritizing sites and identifying additional research needs. FE/NETL has formed a working group of the outreach coordinators for each partnership. The working group will convene periodically to share ideas, experiences and suggestions. FE/NETL will use this discussion, along with routine progress reports from each RCSP, to assess whether sufficient outreach is being undertaken.

Projects undertaken as part of the core research program typically involve partners and cost sharing. Many of these projects have an outreach component built into the project design. FE/NETL will discuss progress with each project proponent to assess whether sufficient outreach is being undertaken.

FE/NETL will also employ an approach that identifies the key stakeholders for each program area, their environmental, health or safety concerns, and activities and materials

to address those concerns. This matrix approach will be iterative and will allow FE/NETL to identify gaps and priorities in their outreach efforts. The matrix will include key audiences on one axis and program areas on the other. This matrix will be used to optimize the use of outreach resources according to FE/NETL's overall program objectives. As part of this approach, FE/NETL will:

- Review program area priorities. These will include high profile projects, large field tests, and projects that explore an important concern about sequestration;
- Identify the specific audiences or stakeholders relevant to each priority;
- Identify what is known and unknown about the attitudes, concerns and perceptions of those stakeholders regarding sequestration;
- Where necessary conduct some research to determine attitudes, concerns and perceptions;
- Determine appropriate outreach efforts; and,
- Where possible use existing materials and efforts to engage stakeholders and address concerns, or develop new ones as needed.

In addition, FE/NETL will develop an overall sense of the program by developing a second matrix that indicates how existing or planned outreach efforts and materials generally address the broad audience of stakeholders for carbon sequestration. To the extent key materials are relied on heavily, they will be assessed to determine effectiveness in content and dissemination. Improvements will be made as identified. This will be particularly important as the partnerships move to Phase II, where they will be testing sequestration techniques.

2. *Developing materials that continue to synthesize research results and present comprehensive overviews of the program that are accessible to audiences at all levels of knowledge regarding carbon sequestration.*

FE/NETL's current outreach efforts consist of

- The FE/NETL Carbon Sequestration Website including reports, fact sheets and other documents
- The FE/NETL Carbon Sequestration Newsletter
- The Carbon Sequestration Technology Roadmap and Program Plan
- The annual National Conference on Carbon Sequestration
- Select speaking engagements
- FE/NETL has also sponsored the development of a climate change curriculum that is being completed in the fall of 2003 and will be piloted in classrooms in the fall of 2004.

Activities and Materials under consideration:

- Risk communication workshop
- Regional partnership outreach coordination and assistance
- Opinion, perception, concern research
- Development of additional materials

- Development of an agenda for a non-technical informational workshop potentially linked to the EIS process.

These materials and activities are discussed in more detail below:

Website: FE/NETL operates an official website on which it posts news, reports, white papers, announcements and other information (http://www.netl.doe.gov/coalpower/sequestration). This site also enables interested individuals to sign up to receive FE/NETL's Carbon Sequestration Newsletter and to offer comments to FE/NETL. During 2004 an effort will be made to make the website more easily accessible and, if possible, to serve as more of a hub for carbon sequestration information. In addition, measures for encouraging more active use of the website will be developed and implemented.

Carbon Sequestration Newsletter: The monthly newsletter provides an excellent summary of important notices, reports, events and other information about carbon sequestration. Efforts will be made in 2004 to get it more widely distributed and to seek feedback from readers on possible enhancements.

The Carbon Sequestration Technology Roadmap and Program Plan: This document is available on the website[10] and provides detailed information about the overall program. It is currently written in accessible text but is a long document. An updated version will be available in 2004.

Annual Carbon Sequestration Technical Conference: FE/NETL currently sponsors an annual technical conference that covers a variety of research and policy topics. The primary audience is the research and technical community; however, an increasing number of NGO's are attending. In 2004, FE/NETL will actively seek the participation of additional NGO representatives, teachers and local regulators.

Speaking Engagements: Staff from FE/NETL are invited to speak at a number of different conferences, meeting and events. In 2004, a set of talking points will be developed and options for webcasting will be explored to further take advantage of these opportunities.

Curriculum: The Keystone Center is working with FE/NETL to develop a middle school curriculum on climate change that also adheres to National Science Education Standards. By meeting existing teaching requirements, teachers' concerns about adding additional work to tight schedules is allayed, and the curriculum can be seamlessly integrated into existing teaching materials. In 2004, 30 teachers will train on and use the curriculum in their classrooms. Based on their feedback, the curriculum will be finalized and certified and then made available for widespread use in classrooms.

[10] Available at http://fossil.energy.gov/programs/sequestration/publications/program_plans/03/.

Planned Activities and Materials:

Risk Communication Workshop – FE/NETL will conduct a risk communication and messaging workshop with FE/NETL staff and participants from the Regional Carbon Sequestration Partnerships (RCSPs) in Spring 2004. The objective would be to draw on the academic field of risk communication to develop new ways of looking at carbon sequestration and ways of communicating about it to the public. In addition, FE/NETL will develop a paper on risk communication and stakeholding as it relates to the issue of carbon sequestration. This paper will be suitable for sharing with others involved in carbon sequestration projects and with the general public, and will be posted on the FE/NETL website.

Regional Partnership Outreach Coordination and Assistance – As described above, FE/NETL has convened a working group of outreach coordinators. FE/NETL will work with this group to assist in coordinating among the regions and to help in developing outreach materials, sharing lessons learned and best practices. This activity will be designed to fit the needs expressed by the partnerships.

Development of Additional Materials – As indicated throughout, there is likely to be a need for additional outreach materials. FE/NETL will assist others and also develop materials on its own. Some possibilities suitable for different audiences include the following:

- Materials geared towards regulators.
- Relatively non-technical summaries of the carbon sequestration program findings to date.
- Communication materials that describe the full breadth of federal efforts on climate change, and specifically how carbon sequestration fits into this broader research umbrella. (If other federal offices are developing these materials then those will be used here.)

The Department of Energy has many different offices that work either directly or indirectly on issues of carbon sequestration. In addition, several other agencies devote significant resources toward climate change-related activities. Yet, many in the environmental community and in the public at large are not aware of the full breadth of these efforts, and are critical of what appears to be minimal effort and a lack of cohesive strategy. It is crucial that DOE not only work collaboratively with other agencies, as it has done through the U.S. Global Climate Change Program, but also actively communicate these efforts to the public.

Development of an EIS for FE/NETL's overall carbon sequestration program – FE/NETL has initiated an environmental impact statement (EIS) for the carbon sequestration program including research activities and the regional partnerships. FE/NETL has launched a dedicated webpage to the EIS and updates will be posted there routinely (http://www.netl.doe.gov/coalpower/sequestration/eis). During 2004 it is planned that eight public meetings will take place around the country to provide the public with an opportunity to learn more about FE/NETL's program and to voice their comments and concerns.

3. *Continuing to monitor public opinion, perceptions and environment, health and safety concerns to assess the effectiveness of the outreach program and to determine when additional outreach activities or materials may be needed.*

   FE/NETL will conduct its own opinion and concern research and will also work with project proponents and the regions on this research effort. As part of this effort, FE/NETL will explore options for the general public to contact FE/NETL and seek answers to questions about carbon sequestration. This work will include requests for suggestions on improving existing materials and outreach efforts, informal research regarding public support for the outreach efforts, and monitoring of press coverage and other indicators of public opinion. If problems seem to be emerging, FE/NETL will initiate an effort to address those concerns at an early stage.

PART III – EVALUATION AND MODIFICATION

A. Contingency Planning

FE/NETL will monitor press and verbal feedback regarding their overall sequestration program and any specific research projects. FE/NETL will also work with the Regional Partnerships and individual project sponsors to assess if environmental, health or safety concerns about their activities are escalating or becoming enjoined with other controversial interests. Should FE/NETL determine that concerns about the overall sequestration program or research projects are escalating, or becoming enjoined to other controversial issues, FE/NETL will stand ready to modify their activities and may even convene a special workgroup at the national or community level to help FE/NETL better understand the concerns and to work toward mutually agreeable approaches for addressing them. The makeup of these special workgroups would reflect the national stakeholders or the composition of a local community depending on the nature of the concerns. FE/NETL may seek facilitation assistance from a reputable and independent group to assist with the activities of the special workgroup(s).

B. Evaluation of Effectiveness:

As stated above, FE/NETL has established four primary goals for its general outreach efforts:

1. Provide accurate, timely and useful public information regarding the scientific and technical research it sponsors.
2. Gain information and feedback from its constituents so that it can begin to anticipate and respond to environmental, health and safety concerns as they emerge.
3. Maintain the public trust.
4. Achieve the highest community acceptance of the sequestration research program and FE/NETL's efforts.

FE/NETL will use several tools and approaches to assess the effectiveness of its general outreach efforts. These may include:

- Use focus group interviews to assess baseline familiarity with geologic sequestration and attitudes towards the FE/NETL program. Over time, additional focus group interviews can be employed to assess changes in attitude, if any.
- Use informal surveys or interviews to assess the effectiveness of outreach efforts to reach the general public
- Track the number of schools using the climate change curriculum. Rely on independent assessment of the curriculum and the training program to ensure quality is maintained as science progresses.

APPENDIX 1: BACKGROUND ON CLIMATE CHANGE

This section attempts to briefly summarize what we know, think and are trying to answer. The information that follows has been culled from U.S. government websites, including the Environmental Protection Agency, the Department of Energy, as well as the National Academy of Sciences.[11] This information presents a range of information that is known and suspected, and allows readers to draw their own conclusions about the severity of the issue.

Known for Certain

Energy from the sun heats the surface of the Earth, which in turn drives global weather and climate. Some of this heat is radiated back into space, while the rest is trapped by atmospheric GHGs and re-radiated back to the surface. GHGs, including water vapor, carbon dioxide, methane, nitrous oxide and other gases, are so-called because they function like the glass panels of a greenhouse, retaining heat in the earth's atmosphere. Without this natural "greenhouse effect," temperatures would be much lower than they are now, and life as known today would not be possible.

GHGs persist in the atmosphere for much longer periods of time than we are used to dealing with. For example, when conventional pollutants such as sulfur dioxide (SO_2) are emitted in the atmosphere they undergo chemical reactions as they mix with water, sunlight, other gases and things like buffering agents in rock. When some SO_2 is emitted it gets neutralized naturally. If there is too much SO_2, we get acid rain. By simply reducing the amount of SO_2 emitted into the air, we reduce the incidence of acid rain over a period of a couple of years. In comparison, GHGs can take one hundred years or more before it gets "neutralized" naturally or loses its reactivity. When some GHG gets emitted today it takes about 100 years for it to become non-reactive – not just a few years. This time lag related to GHGs means that it is easier to create an imbalance where more is getting emitted to the atmosphere than is rendered non-reactive each year.

Since the beginning of the industrial revolution, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. While these gases occur naturally from plants and animals, there is no doubt this atmospheric buildup of GHGs is the result of increased emissions, largely from human activities, including animal husbandry, modern agricultural practices, and the burning of fossil fuels in factories, power plants and automobiles. By increasing the levels of greenhouse gases in the atmosphere, human activities are strengthening Earth's natural greenhouse effect. The key GHGs emitted by human activities remain in the atmosphere for periods ranging from decades to centuries.

[11] For more information, please see the U.S. Environmental Protection Agency (http://yosemite.epa.gov/oar/globalwarming.nsf/content/climateuncertainties.html), the National Academies of Science (http://books.nap.edu/html/climatechange/climatechange.pdf) and the U.S. Department of Energy (http://www.eia.doe.gov/oiaf/1605/ggccebro/chapter1.html)

Highly Likely[12]

The increase of greenhouse gases should cause surface air temperatures and subsurface ocean temperatures to rise. And temperatures are, indeed, rising. A warming trend of about 1°F has been recorded since the late 19th century. Warming has occurred in both the northern and southern hemispheres, and over the oceans. Confirmation of 20th-century global warming is further substantiated by melting glaciers, decreased snow cover in the northern hemisphere and even warming below ground. The changes observed over the last several decades are likely mostly due to human activities, but some significant part of these changes may be a reflection of natural variability. Knowledge of the effect of these natural factors, including natural climatic variations, changes in the sun's energy, and the cooling effects of pollutant aerosols, all remain incomplete.

Probable Outcomes

Continuing use of fossil fuels and industrial and agricultural processes will likely increase for at least several decades. Thus, human-induced warming and associated sea level rises documented in recent years are expected to continue through the 21st century. This could especially threaten island and coastal communities. In a report in 2001, the National Academy of Sciences concurred with the report by the Intergovernmental Panel on Climate Change (IPCC), noting that a mid-range estimate of warming of 5.4°F by the end of the 21st century is consistent with the assumptions about how clouds and atmospheric relative humidity will react to global warming. The overall range of estimates is that the climate could change by between 2.2°F and 10°F; however, even at the low end of the range, the IPCC notes "would probably be greater than any seen in the last 10,000 years, but the actual annual to decadal changes would include considerable natural variability."

Possible Outcomes

Some simulations indicate a variety of other affects, though whether they will occur, and to what degree, are highly uncertain. Computer model simulations and basic physical reasoning suggest some secondary effects. These include increases in rainfall rates and increased susceptibility of semi-arid regions to drought. There is the possibility that a warmer world could lead to more frequent and intense storms, including hurricanes. Preliminary evidence suggests that, once hurricanes do form, they will be stronger if the oceans are warmer due to global warming. Warmer ocean waters could also cause more frequent and fierce El Niño events. Scientists have identified additional health, agricultural, water resource, forest, and wildlife issues that may be vulnerable to climate changes that global warming may bring. The impacts of these changes will be critically dependent on the magnitude of the warming, and the rate with which it occurs. Further, while climate models provide more certainty over large areas, they are much less accurate in determining affects on a local level. Much more research is required to determine the potential for these outcomes.

[12] The structure of this section, which discusses climate change in decreasing order of certainty, is used by the U.S. EPA. See http://yosemite.epa.gov/oar/globalwarming.nsf/content/climateuncertainties.html for more detail.

Emissions Inventory

The United States is a major source of anthropogenic greenhouse gas emissions, primarily because its economy is the largest in the world. With less than 5 percent of the world's population, but about a quarter of world gross domestic product (GDP), the U.S. produces over 20 percent of total anthropogenic carbon emissions. Current projections show U.S. emissions increasing by 1.2 percent annually between 1995 and 2015 absent any policy interventions. The emissions for the other 28 industrialized nations that are members of the Organization of Economic Cooperation and Development (OECD) are expected to increase at a similar rate. Developing (non-OECD) countries, with 81 percent of the world's population and per capita emission rates that are currently very low, are expected to increase emissions dramatically as nations such as China and India fuel economic development with fossil energy. The Energy Information Administration at the U.S. Department of Energy (EIA) projects that non-OECD carbon emissions will increase at an annual rate of 2.9 percent between 1995 and 2015. This is highly significant, as emissions of carbon dioxide and other gases persist in the atmosphere for decades to centuries. Thus, even if anthropogenic GHG emissions are held at current levels, overall levels in the atmosphere will continue to rise. Put another way, if there is a determination that atmospheric concentrations of greenhouse gases must be stabilized, it will be incumbent on the U.S. and the rest of the world to reduce the rate of emissions below the rate at which these gases naturally degrade.

Carbon dioxide is the most often mentioned greenhouse gas. The most abundant greenhouse gas in the atmosphere is actually water vapor, which varies between 0 and 4 percent. However, it is believed that the impact of anthropogenic water vapor from surface sources such as fuel combustion is minimal on the atmospheric water vapor concentrations. On the other hand, anthropogenic sources of carbon dioxide from the combustion of fossil fuels are believed to be accretive to atmospheric concentrations. Currently, levels of carbon dioxide are approximately 370 parts per million volume (ppmv), up from 280ppmv pre-1750 (prior to the Industrial Revolution).[13] International debate centers not on how to keep CO_2 concentrations at current levels, but rather, considering the lengthy lead times required, have focused broadly on a range of concentrations from 450ppmv to 750ppmv. Certain scientists feel that the probabilities of dramatic climatic effects will increase with increasing concentrations of CO_2.

[13] Blasing, T.J. and S. Jones, "Current Greenhouse Gas Concentrations," Oct. 2002. Carbon Dioxide Information Analysis Center. Available at http://cdiac.esd.ornl.gov/pns/current_ghg.html.

APPENDIX 2. OPTIONS TO RESPOND TO GREENHOUSE GAS EMISSIONS

While there are many variations, there are really only three main options for responding to climate change; they include prevention of GHG emissions, mitigation of emissions, and adaptation to a warming climate. As alluded to above, it is unlikely that there is a "silver bullet" strategy out there. Rather, it is likely that we will use some combination of all of them as time moves forward.

Prevention of Emissions

The three largest sources of GHG emissions are from electricity generation (33%), from the combustion of fossil fuels in transportation (27%), and from heavy industry (19%), with the rest from agriculture, and residential and commercial sectors.[14] One method to achieve stabilization of CO_2 in the atmosphere is to prevent these emissions in the first place. This can be accomplished in several ways:

Increase efficiency of combustion. Most coal-fired power plants in existence today are approximately 35% efficient at converting fuel to energy, with the rest lost to heat. Additional efficiencies can be achieved by combining power plants with heated water that can be used for industrial processes, or as steam in greenhouses, e.g. Newer power plants can approach 50+% efficiency. As power plants become more efficient, they are able to use less fuel for each megawatt of electricity, and therefore emit fewer tons of CO_2. According to Los Alamos National Lab, "the U.S. electric power industry has been on a trend toward increased efficiency, but that trend has been very slight in the past two decades."[15] Essentially flat efficiency, coupled with decreasing fuel quality, has led to the slight increase in emissions factor noted earlier.

Alternative fuels and energy sources such as renewable and nuclear. Fossil fuels are, by definition, carbon-based, and as such release carbon dioxide when combusted. On the other hand, renewable energy sources, such as wind and solar power, generate electricity without any fossil-fuel combustion. Similarly, nuclear plants create steam that spins turbines from controlled fission reactions, without any combustion. Therefore, if new power plants are brought online to replace older plants and to meet future demand that do not use fossil fuels, there will be no additional emissions into the atmosphere.

Conservation. In some ways, conservation efforts are almost too cheap to measure.[16] While increasing power plant efficiency or using alternative generation has costs associated with them, conservation efforts can be as simple as asking citizens to voluntarily turn off lights in rooms where they aren't needed, or to change the thermostat a degree or two, particularly when people are away from the house. Similar to efforts by local or state governments to curb water use during periods of drought, which can begin with purely voluntary measures, and perhaps escalate

[14] From Table ES-3: Recent Trends in U.S. Greenhouse Gas Emissions and Sinks, Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2001, April, 2003.
[15] Los Alamos National Lab: "The Products of Coal: Electricity and Carbon Dioxide" from the Clean Coal Compendium website located at: http://www.lanl.gov/projects/cctc/climate/Coal_CO2.html
[16] The Keystone Center Dialogue on Global Climate Change, Final Report. May 2003. Available at: http://www.keystone.org/FINALREPORTGLOBALCLIMATE.pdf

to small penalties for non-compliance, so too can voluntary electricity conservation measures be brought to bear. The result would be a large drop in CO_2 emissions.

Mitigation from Enhanced Biological Systems.
Another response to increasing greenhouse gas emissions is to encourage the sequestration of carbon dioxide through natural systems. This may include changing soil tilling practices, including switching to so-called "no till" systems, which preserve carbon content in soils. Other methods can include land use changes, so that poor agricultural land is left fallow and allowed to become natural grasslands and shrub lands. The term afforestation applies to the practice of planting trees in areas where they did not formerly exist, and reforestation applies to the planting of trees in areas where they were formerly cut down. As plants and trees aspire CO_2 to use for the creation of leaves and wood, these practices can thus serve to take additional carbon dioxide from the atmosphere, offsetting some emissions. A third method that is in the research stage is the application of iron to ocean waters South of the Equator to encourage the growth of, or "fertilize," bacteria and algae that also require CO_2 to grow. All of these programs are limited, however, in that there are constraints on what lands are best-suited to "no till" agriculture, how much marginal agricultural land can be taken out of production, whether forest plantings can exceed timber harvests, and whether application of iron to the ocean is sustainable practice. This adds a level of uncertainty that could be addressed through additional research on the amounts and limits of biological carbon storage. In addition, policy measures would be required that address the environmental, health and safety concerns of the various stakeholders, including property owners, forest product companies, environmental and citizen groups, and a number of Federal and state agencies, including the Department of the Interior, the Environmental Protection Agency, and the Department of Energy.

Mitigation Through Carbon Capture and Storage.
An additional important method for mitigating carbon emissions is through the practice of carbon capture and storage. In a paper by Edmonds et al., the authors note that carbon capture and storage (CC&S) provide a means for deep reductions in CO_2 emissions as the world develops and deploys different energy technologies (such as renewable energy) that are currently more expensive than fossil fuel technologies.[17] Rather than vented to the atmosphere, CO_2 may be captured from the energy system at the smokestack from a traditional power plant, or can be captured through the production of hydrogen in an integrated gasification combined cycle plant (IGCC). As mentioned above, there are opportunities for biological sequestration in soil, trees, and the ocean surface. In addition, there are opportunities for geologic storage in deep saline formations, unmineable coal seams, depleted oil and natural gas fields, as well as the deep ocean, or condensed to a solid mineral carbonate.

In some cases, the costs required to capture and store CO_2 can be offset from new economic activity. For example, in depleted oil and natural gas fields, the injection of carbon dioxide reduces the viscosity of the remaining fuel, allowing more to be extracted. This practice is already in use today. In addition, CO_2 can be used as a flush gas to extract coal-bed methane, while at the same time trapping the injected CO_2. A third example of a potentially positive

[17] Edmonds, J.A., P. Freund, J.J. Dooley. "The Role of Carbon Management Technologies in Addressing Atmospheric Stabilization of Greenhouse Gases." Pacific Northwest National Laboratory and IEA Greenhouse Gas R&D Programme.

economic carbon storage activity is from the production of hydrogen from natural gas or IGCC power plants, where the hydrogen can be used in fuel cells or other technologies, and the CO_2 can be captured and stored. The availability of carbon capture and sequestration technologies greatly reduces the overall cost of achieving carbon limitation and stabilization goals. Thus, these technologies must be researched carefully, as they can provide a useful bridge to a future energy economy.

Adaptation.
One of the options to climate change is through adaptation, which the Intergovernmental Panel on Climate Change refers to as adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts[18]. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change.

Adaptation can be autonomous, that is, reactive to climatic changes, so people may respond by using less energy to heat their homes during mild winters, but may use more energy to cool their homes during periods of extreme heat in the summer. Adaptation can also be driven by government policy that is more proactive, for example, limiting the residential use of water during anticipated periods of drought to ensure that there are sufficient reserves for critical needs. The costs of these proactive adaptation policies are likely to be marginal.

Adaptation has the potential to substantially reduce potential impacts of climate change and to achieve beneficial impacts. For example, some areas that experience warmer winters may be able to alter which crops are grown, and may be able to grow more profitable crops. In developed countries, if climate change is gradual, most sectors of the economy and most communities are reasonably adaptable to changes in average conditions. On the other hand, countries with limited economic resources, low levels of technology, poor information and skills, poor infrastructure, unstable or weak institutions, and inequitable empowerment and access to resources have little capacity to adapt and are highly vulnerable. However, even if climate change is gradual, research suggests that many species of flora and fauna will be unable to adapt to the changes[19]. If climate change is more abrupt, many sectors of the economy and many regions will be vulnerable, both in developed and developing countries, and among even more species of flora and fauna.

[18] "Climate Change 2001: Working Group II: Impacts, Adaptation and Vulnerability" at http://www.grida.no/climate/ipcc_tar/wg2/642.htm
[19] See Schneider, S.H. and T.L. Root. Wildlife Responses to Climate Change: North American Case Studies, Island Press, Washington, DC, 2002.

APPENDIX 3: PROGRAMS TO ASSESS CLIMATE CHANGE AT SPECIFIC FEDERAL GOVERNMENT AGENCIES

The **Department of Energy** has many different offices that work either directly or indirectly on issues of global climate change. This research includes, among other topics, developing a better understanding of climate science, developing alternative energy sources, improving the efficiency of fossil combustion and storing GHG through sequestration. However, most of the direct climate work is centered in two Program Offices: The Office of Fossil Energy and the Office of Science. In addition, several other agencies devote significant resources toward climate change-related activities.

DOE's Office of Fossil Energy is pursuing two major strategies to reduce carbon emissions: (1) making fossil energy systems more efficient, and (2) capturing and sequestering greenhouse gases. The first approach focuses on innovative technologies that boost the fuel-to-energy efficiencies of both coal- and natural gas-fired power plants. More efficient plants use less fuel to generate electric power, and thus release correspondingly fewer greenhouse gas emissions. The second approach may one day significantly reduce concerns over emissions of greenhouse gases from fossil energy systems. Carbon capture and sequestration systems could store, convert, or recycle greenhouse gases, preventing them from building up the atmosphere.

DOE's Office of Science focuses carbon sequestration research at its Office of Biological and Environmental Research (BER). BER is focused on the effects of energy production and use on the global Earth system, primarily through studies of climate response. Research includes climate modeling, atmospheric transport and chemistry, atmospheric properties and processes affecting the Earth's radiation balance, and sources and sinks of energy-related greenhouse gases (primarily CO_2). It also includes research on consequences of climatic and atmospheric changes on ecological systems and resources, and the development of improved methods and models for conducting integrated economic and environmental assessments of climate change and of options for mitigating climate change, and education and training of scientists for climate change research. Research in genomics and biological and environmental research critical to understanding the global carbon cycle are conducted at the universities and national laboratories supported by the Office of Science.

DOE also contributes to the U.S. Global Change Research Program through its Environmental Processes subprogram. A major part of the research is designed to provide the data that will enable an objective assessment of the potential for, and consequences of, global warming. The program is comprehensive with an emphasis on the radiation balance from the surface of the Earth to the top of the atmosphere, including the role of clouds and on improving quantitative models necessary to predict possible climate change at the global and regional levels.

At the **U.S. Department of Agriculture (USDA)**, research is conducted to support long-term studies to improve our understanding of the roles that terrestrial systems play in influencing climate change and the potential effects of global change (including water balance, atmospheric deposition, vegetative quality, and UV-B radiation) on food, fiber, and forestry production in agricultural, forest, and range ecosystems. USDA's research program is strengthening efforts to determine the significance of terrestrial systems in the global carbon cycle, and to identify

agricultural and forestry activities that can contribute to a reduction in greenhouse gas concentrations. USDA's research agencies will support the Department in responding to the President's directive to develop accounting rules and guidelines for carbon sequestration projects. Contributions from the USDA's research program include the development of improved emission and sequestration coefficients, new tools for accurately measuring carbon and other greenhouse gases, and the development of improved methodologies.

At the **Commerce Department, the National Oceanographic and Atmospheric Administration (NOAA)** conducts a great deal of research on the effects of climate change. NOAA's long-term global change efforts are designed to develop a predictive understanding of the variability and change of the global climate system, and to advance the application of this information in climate-sensitive sectors through a suite of process research, observations and modeling, and application and assessment activities. Specifically, NOAA's research program includes ongoing efforts in operational *in situ* and satellite observations with an emphasis on oceanic and atmospheric dynamics, circulation, and chemistry; understanding and predicting ocean-land- atmosphere interactions, the global water cycle, and the role of global transfers of carbon dioxide among the atmosphere, ocean and terrestrial biosphere in climate change; improvements in climate modeling, prediction, and information management capabilities; the projection and assessment of variability across multiple timescales; the study of the relationship between the natural climate system and society and the development of methodologies for applying climate information to problems of social and economic consequences; and archiving, management, and dissemination of data and information useful for global change research.

The **Department of Defense** also plays a research role, as it examines atmospheric composition, including clouds and obscurations, maritime and coastal meteorology, and major storms worldwide. The Naval Research Laboratory's Special Sensor Ultraviolet Limb Imager, launched in late 2001, provides long-term baseline data for investigations of global change in the upper atmosphere. Associated research programs include theoretical studies and observations of solar phenomena, monitoring and modeling of unique features in the middle and upper atmosphere, terrestrial and marine environmental quality research, and energy conservation measures.

At the **Department of Health and Human Services**, within the **National Institutes of Health** (NIH), the **National Institute of Environmental Health Sciences** (NIEHS) supports research related to impacts of global change on human health, including the effects of environmental and occupational exposures to air pollution, agricultural chemicals, and materials used in technologies to mitigate or adapt to climate change. A new inter-disciplinary research program from NIH's Fogarty International Center, entitled Health, Environment and Economic Development, is designed to examine impacts on health of economically-driven environmental change, such as the human health effects of changes in agricultural land use, crop production, and water and land uses for productive purposes expected to derive from climate change in developing countries. The research may also address changes in vector ranges, include evaluations of different mitigation strategies to respond to climate change in developing countries, or explore sustainable livelihood strategies available to developing country populations in order to prevent outbreaks of disease conditions brought on by climate change.

Renewed concern about emerging and reemerging infectious diseases has prompted increased attention to a variety of diseases whose incidence would be affected by environmental change. One area of research, conducted both by NIH and the **Centers for Disease Control and Prevention** (CDC), is the use of remote sensing to study ecologic systems relevant to transmission of specific infectious diseases, especially vector-borne diseases. For example, in cooperation with NASA, NIH National Institute of Allergy and Infectious Diseases (NIAID) grantees have used remote sensing and geographic information system (RS/GIS) technologies to correlate specific ecologic conditions with outbreaks of infectious diseases. Scientists are using RS/GIS to try to predict future disease outbreaks and identify areas where disease prevention programs should be targeted.

The **Smithsonian Institution** also conducts a variety of research on effects of global climate change, from the Smithsonian Astrophysical Observatory, the National Air and Space Museum, the Smithsonian Environmental Research Center, National Museum of Natural History, Smithsonian Tropical Research Institute and National Zoological Park. Research is organized around themes of atmospheric processes, ecosystem dynamics, observing natural and anthropogenic environmental change on daily to decadal time scales, and defining longer-term climate proxies present in the historical artifacts and records of the museums as well as in the geologic record at field sites. The Smithsonian Institution program strives to improve knowledge of the natural processes involved in global climate change, provide a long-term repository of climate-relevant research materials for present and future studies, and to bring this knowledge to various audiences, ranging from scholarly to lay public. The unique contribution of the Smithsonian Institution is a long-term perspective, *e.g.* undertaking investigations that may require extended study before producing useful results and conducting to observations on sufficiently long (*e.g.* decadal) timescales to resolve human-caused modification of natural variability.

Research at the **Department of the Interior's U.S. Geological Survey** (USGS) contributes to the holistic understanding of global change (i.e., the interrelationships among climate, ecological systems, and human behavior). The USGS examines terrestrial and marine processes and the natural history of global change, including the interactions between climate and the hydrologic system. Studies seek to understand the character of past and present environments and the geological, biological, hydrological, and geochemical processes involved in environmental change. The focus of research is on understanding the sensitivity of natural systems and impacts of climate change and variability, surficial processes, and other global change phenomena on the Nation's lands and environments at the regional scale.

DOI also sponsors contributing research programs addressing the collection, maintenance, analysis, and interpretation of short- and long-term land, water, biological, and other geological and biological processes and resources through dispersed observing networks; research in land use and land cover, including creation of maps and digital data products; and inventorying and monitoring of biological habitats, resources, and diversity.

National Science Foundation (NSF) global change research programs support research and related activities to advance the fundamental understanding of physical, chemical, biological, and human systems and the interactions among them. The programs encourage interdisciplinary activities and focus particularly on Earth system processes and the consequences of change. NSF

programs facilitate data acquisition and information management activities necessary for fundamental research on global change, and promote the enhancement of models designed to improve understanding of Earth system processes and interactions and to develop advanced analytic methods to facilitate basic research. NSF also supports fundamental research on the general processes used by organizations to identify and evaluate policies for mitigation, adaptation, and other responses to the challenge of varying environmental conditions.

National Aeronautics and Space Administration, through its **Earth Science Enterprise** (ESE), is working to develop a scientific understanding of the Earth system and its response to natural and human-induced changes to enable improved prediction of climate, weather, and natural hazards for present and future generations. NASA provides the research and technology used by Federal, state, and local agencies that provide these predictive services to the Nation. NASA is launching additional spacecraft designed to yield fresh insight into the global carbon cycle and into how the oceans affect and respond to climate change.

The **U.S. Environmental Protection Agency** (EPA), through its Global Change Research Program is an assessment-oriented program with primary emphasis on understanding the potential consequences of climate variability and change on human health, ecosystems, and socioeconomic systems in the United States. This entails: (1) improving the scientific basis for evaluating effects of global change in the context of other stressors and human dimensions (as humans are catalysts of and respond to global change); (2) conducting assessments of the risks and opportunities presented by global change; and (3) assessing adaptation options to increase resiliency to change and improve society's ability to effectively respond to the risks and opportunities presented by global change.

This includes research and assessment activities focused on the consequences of global change on weather-related morbidity in vulnerable populations (*e.g.*, children, elderly) and vector and water-borne diseases. The ecosystem-based research is designed to understand and predict ecosystem exposure, responses, and vulnerabilities to high-risk chemicals and non-chemical stressors (*e.g.*, invasive species, genetically altered organisms) at multiple scales of biological organization and geographic scales. In addition, assessments are planned that will examine the potential consequences of global change on tropospheric ozone and particulate matter. The program plans assessments of the possible impacts of global change (climate and land use change) on water quality. Also, EPA will investigate and report on alternative fuels and vehicle technology scenarios to determine their influences on emission rates, including the time profile for the market penetration of these technologies.

APPENDIX 4. UNDERSTANDING SEQUESTRATION RESERVOIR TYPES AND LOCATIONS

Not all areas are suitable for either terrestrial or geologic sequestration because of the underlying geology or the nature of the land use in that area. Additionally, many of the areas where carbon sequestration appears viable may prove otherwise after more detailed analysis. . This may be because of cap rock impermeability in some places, or proximity to drinking water aquifers or to seismic faults, for example. Therefore, it is crucial that additional research be conducted to determine the different potentials for sequestration in different geologic formations around the country.

There is tremendous potential for the sequestration of carbon in saline formations, unmineable coal seams, enhanced oil recovery, and basalt formations. Each type of formation raises its own set of research questions and technology implications. However, these formations are not evenly distributed around the nation, making some areas more likely for sequestration projects than others. Furthermore, as the cost of sequestration includes not just injection, but also capture and transport, it seems likely that the most cost-effective projects will be those that are not only near ideal geologic formations, but also are in close proximity to a large source of CO_2 emissions that can be captured, such as at a coal-fired power plant. The Battelle National Lab[20] created a series of maps that generally show areas of potential.

Saline Formations. At a coarse level, it is apparent that saline formations are predominant in two major areas of the country: the upper Midwest, including the Dakotas, Montana and parts of Wyoming and Nebraska; and the Midwest, including Illinois, Indiana, Ohio, West Virginia, and parts of Michigan, New York, Pennsylvania, Virginia and Kentucky. There are also pockets in southern Florida, the Florida panhandle, and other parts of Texas, Oklahoma, the Colorado/Kansas border, and New Mexico. According to the Battelle study, this places 60% of existing plants and 65% of announced new coal-fired power plants within close proximity of a saline formation. Saline formations are located deep beneath the earth's surface and it is likely that they are located near coal mining operations or in areas where there is very little mining activity.

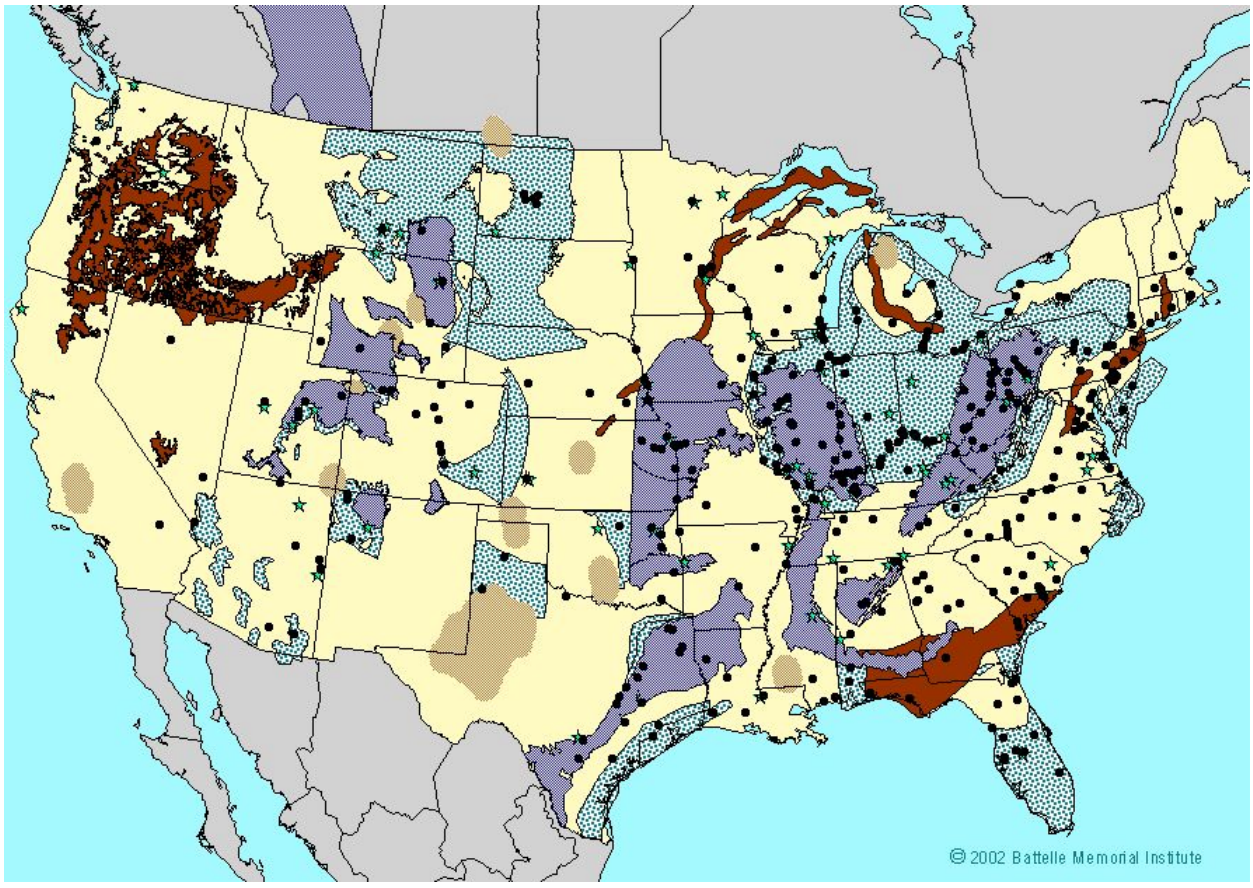
Unmineable Coal Seams. Certain coal seams are too deeply buried under the Earth to make recovery of the coal economic. However, carbon dioxide readily bonds with coal, and in some cases, helps drive off methane gas, which can be economically recovered. Deep, unmineable coal seams are located in several long stretches, including a stretch down the Appalachians from western Pennsylvania and eastern Ohio through West Virginia and into Kentucky and Tennessee. This places 46% of existing and 52% of announced coal-fired power plants within close proximity of a deep coal seam.

Basalt Formations. A third potential site for carbon sequestration lies in basalt formations. These occur in two major areas: the Pacific Northwest, including Washington, Oregon, Idaho and some of northern California. The second lies in a band across southern Alabama and the Florida panhandle through southern Georgia and up to the South Carolina coast. There is also a thin band through Iowa, Minnesota, and bisecting Michigan to Lake Erie. This may prove to be

[20] JJ Dooley. "Clean, Affordable, Secure Energy for a Carbon-Constrained World." Strategic Initiatives for Coal and Power, US Department of Energy, Office of Fossil Energy. Wye Plantation, MD. PNNL-SA-37737. December 2002.

an untapped resource, as only 10% of existing and 7% of announced coal-fired power plants are within close proximity of a basalt formation. However, basalt formations do exist in critical regions that lack other options, including the Pacific Northwest and southern Georgia.

Old Oil Fields. The fourth major site for carbon sequestration lies in areas where enhanced oil recovery (EOR) can occur. This exists in otherwise depleted oil and gas fields, where the injection of carbon dioxide can serve to reduce viscosity, allowing for more fuel to be extracted. This is limited to just a few small pockets around the country, the largest of which is in West Texas, with two spots in Oklahoma, two spots in Wyoming, two along the Colorado Utah border, and one each in southern Mississippi, northern Michigan, and southern California near Santa Barbara. This places just 2% of existing and 4% of announced coal-fired power plants within proximity of these sites.



Source: JJ Dooley. "Clean, Affordable, Secure Energy for a Carbon-Constrained World." Strategic Initiatives for Coal and Power, US Department of Energy, Office of Fossil Energy. Wye Plantation, MD. PNNL-SA-37737. December 2002. On the map, blue is unmineable coal seams, red is basalt formations, purple is saline formations, and tan is enhanced oil recovery.

APPENDIX 5: CLIMATE CHANGE RESOURCE LIST BY TOPIC

I. Agriculture
II. Automobiles and Transportation
III. Calculators
IV. Climate Change
V. Conservation
VI. Emissions Trading
VII. Energy
VIII. Environmental Advocacy Groups
IX. Homes/Housing
X. Industry Advocacy Groups
XI. International Government Sites
XII. Maps and Models
XIII. Oil and Gas Companies
XIV. Sequestration
XV. Statistics
XVI. Take Action and Outreach Activities
XVII. Teaching Guides/Kid Sites
XVIII. Think Tanks
XIX. Wildlife

I. Agriculture

A. **Economic Research Service** at the U.S. Department of Agriculture (USDA) – provides a "briefing room" with global climate change index and Q & A http://ers.usda.gov/briefing/globalclimate/index.htm

B. **Agriculture and Climate Change at USDA** – offers an issue briefing from the perspective of the Soil and Water Resources Conservation Act (RCA), dated October 1995 http://www.nrcs.usda.gov/technical/land/pubs/ib3text.html

C. **American Forests** is a non-profit group focusing on the planting of trees as a way to decrease greenhouse gases. This website has a personal climate change calculator which allows students to easily determine their impact on climate change. The group provides in-depth explanations on how they arrived at those calculations. http://www.americanforests.org/resources/ccc/

II. Automobiles and Transportation

A. **Data on Fuel Economy** http://www.fueleconomy.gov/ and a comparison of different efficiencies of cars at http://www.fueleconomy.gov/feg/findacar.htm

B. **Department of Transportation (DOT), Center for Climate Change and Environmental Forecasting.** The Center is an initiative of the U.S. Department of Transportation, dedicated to fostering awareness of the potential links between transportation and global climate change, and to formulating policy options to deal with the challenges posed by these links. http://climate.volpe.dot.gov/

C. **Emissions per Fuel Type** for transportation by modes of transportation at the EPA: http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/LHOD5MJTKQ/$File/2003-final-inventory_ch2-energy.pdf

III. Calculators:

A. **Bonneville Environmental Foundation**. How much CO2 and other greenhouse gasses (CO2e) do your activities create? Fill in the blanks in our CO2 emissions calculator to find out. https://www.greentagsusa.org/GreenTags/calculator_intro.cfm

B. **Greenhouse Gas Calculator.** Environmental Protection Agency (EPA). http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterToolsGHGCalculator.html

C. **Your Energy Footprint** – worksheets for teachers and individuals, from the York University Faculty of Pure and Applied Science. http://resources.yesican.yorku.ca/energy_flow/energy_menu.html

D. **World Resources Institute** (WRI) has many different spreadsheets on CO_2 emissions. For more on WRI, see below under Think Tanks.

1. CO2 emissions from fuel used for heating and transportation, (http://docs.wri.com/direct_emissions.xls)
2. CO2 emissions from purchased electricity (http://docs.wri.com/indirect_emissions.xls)
3. CO2 emissions from business travel by air, train, bus and car (http://docs.wri.com/business_travel_emissions.xls)
4. CO2 emissions from employee commuting (http://docs.wri.com/commuting_emissions.xls)

IV. Climate Change

A. **Climate Change Policy Support**. Developing flexible, market-based protocols as low-cost solutions for achieving global reductions of GHG emissions. http://www.netl.doe.gov/products/ccps/index.html

B. **Climate Change Research Division** at the Office of Science at the Department of Energy. http://www.science.doe.gov/ober/CCRD_top.html

C. **Climate Services** is a central resource for national and international research on climate change. www.climateservices.gov

D. **Current research and activities by U.S. government agencies** are listed at the following site: "*U.S. Climate Change Technology Program - Research and Current Activities*." Available at: http://www.climatetechnology.gov/library/2003/tech-options/index.htm

E. **Defense Environmental Network and Information Exchange (DENIX).** DENIX is the central platform and information clearinghouse for environment, safety and occupational health (ESOH) news, information, policy, and guidance. Serving the worldwide greater Department of Defense (DoD) community. Information on Climate Change available at: https://www.denix.osd.mil/denix/Public/Library/Climate/climate.html

F. **Global Warming**. Information on global warming at the EPA website. http://www.epa.gov/globalwarming

G. **US Global Change Research Information Office.** Provides access to educational resources and data on preventive technologies. http://www.gcrio.org

H. **MIT Joint Program on the Science and Policy of Global Change.** Founded in 1991 as an interdisciplinary organization that conducts research, independent policy analysis, and public communication on issues of global environmental change. http://web.mit.edu/globalchange/www

I. **National Position Papers.** Explain official positions of the U.S. government on climate change and global warming. http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsPositionPapers.html

J. **Smithsonian Institute (SI).** The Smithsonian offers a variety of sources of information on climate. Links can be found at the Biodiversity, Global Climate Change, Understanding Ecosystems site. http://www.si.edu/resource/faq/nmnh/ecology.htm

K. **The Center for the Study of Carbon Dioxide and Global Change** website offers an interesting perspective on Global Climate Change, essentially that there is not a global warming problem. The Center is dedicated to discovering and disseminating scientific information pertaining to the effects of atmospheric CO2 enrichment on climate and the biosphere. The website features a very useful dictionary of terms related to Global Climate Change. http://www.co2science.org/dictionary/define.htm

L. **US Global Change Research Information Office** website offers vast amounts of information on topics related to Global Climate Change. It also has a component, "Dr. Global Change", a reference service that assists researchers, students, educators, resource managers, decision makers and the general public in finding information and data relevant to global environmental change. Answers are prepared by GCRIO staff along with staff from U.S. Government agencies. http://www.usgcrp.gov/usgcrp/education/default.htm

M. **White House Policy** on climate change is outlined at: http://www.whitehouse.gov/news/releases/2002/02/climatechange.html

V. Conservation

A. **Energy Savers**: A Consumer Guide to Energy Efficiency and Renewable Energy, at the Department of Energy: http://www.eere.energy.gov/consumerinfo/

B. **Energy Star** -- Energy Saving Product Information. ENERGY STAR is a government-backed program helping businesses and individuals protect the environment through superior energy efficiency. http://www.energystar.gov

C. **Science.gov** is a gateway to authoritative selected science information provided by U.S. Government agencies, including research and development results. Information on energy and energy conservation at http://www.science.gov/browse/w_121.htm

VI. Emissions Trading

A. **Cash for Carbon** article regarding carbon credits http://www.emagazine.com/january-february_2001/0101curr_carbon.html

B. **Emissions Marketing Association (EMA)** promotes market-based trading solutions for environmental management and to serve its membership. http://www.emissions.org/

C. **Emissions Trading Handbook** provides a resource of first reference and practical guide to environmental-based trading programs. http://www.etei.org

D. **Environmental Resources Trust (ERT)** pioneers the use of market forces to protect and improve the global environment. Founded in 1996, with the help of Environmental Defense, ERT is focused exclusively on building markets that

encourage private parties to serve their own best interests and the best interests of the environment. The GHG Registry[SM] records validated greenhouse gas ("GHG") emissions profiles to help create a market that will enable efficient emissions reductions. http://www.ert.net/ghg/index.html

E. **Greenhouse Gas Emission Reduction Trading Pilot (GERT)** is a Canadian collaboration between the federal government, six provinces, industry associations and environmental groups. http://www.gert.org

F. **International Emissions Trading Association** is an independent, non-profit organization dedicated to the establishment of effective systems for trading emissions. http://www.ieta.org

G. **Natsource**. A world-leader in institutional energy brokering, Natsource provides brokerage and advisory services for natural gas, coal, and electricity, as well as weather hedging and environmental issues. "Natsource Reports GHG Trading Doubled in The Past Year" http://www.natsource.com/news/index.asp?n=427

VII. Energy

A. **White House policy** on "Ensuring Reliable, Affordable and Environmentally-Sound Energy" at http://www.whitehouse.gov/energy

B. **Department of Energy** (DOE) (http://www.energy.gov)

VIII. Environmental Groups

A. **Environmental Defense** - Environmental Defense is dedicated to protecting the environmental rights of all people, including future generations. Among these rights are clean air and water, healthy and nourishing food, and a flourishing ecosystem. Information on climate at: http://www.environmentaldefense.org/system/templates/page/focus.cfm?focus=3

B. **National Environmental Trust (NET)** - The National Environmental Trust is a non-profit, non-partisan membership group established in 1994 to inform citizens about environmental problems and how they affect our health and quality of life. Information on climate at: http://environet.policy.net/warming

C. **National Wildlife Federation (NWF)** - The mission of the National Wildlife Federation is to educate, inspire and assist individuals and organizations of diverse cultures to conserve wildlife and other natural resources and to protect the Earth's environment in order to achieve a peaceful, equitable and sustainable future. Information on climate at: http://www.nwf.org/climate/programHomepage.cfm

D. **Natural Resources Defense Council (NRDC)** - The Natural Resources Defense Council's purpose is to safeguard the Earth: its people, its plants and animals and the natural systems on which all life depends. Information on climate at: http://www.nrdc.org/globalWarming/default.asp

E. **PewClimate** - The Pew Center on Global Climate Change was established in 1998 as a non-profit, non-partisan and independent organization. The Center's mission is to provide credible information, straight answers, and innovative solutions in the effort to address global climate change. Information on climate at: http://www.pewclimate.org/ A GHG market has begun to emerge over the past 5 years, driven by global climate change treaty negotiations likely to impose limitations

on GHG emissions. The report looks at GHG trading and policy development, and its market characteristics and future. http://www.pewclimate.org./projects/trading.cfm

F. **Sierra Club** - The Sierra Club is America's oldest and largest grassroots environmental organization with over 700,000 members today. Inspired by nature, Club members work together to protect our communities and the planet. Information on climate at: http://www.sierraclub.org/globalwarming/

G. **U.S. Public Interest Research Group (U.S. PIRG)** - U.S. PIRG is an advocate for the public interest. When consumers are cheated, or our natural environment is threatened, or the voices of ordinary citizens are drowned out by special interest lobbyists, U.S. PIRG speaks up and takes action. Information on climate at: http://uspirg.org/uspirg.asp?id2=5235

H. **Union of Concerned Scientists (UCS)** - UCS is a nonprofit partnership of scientists and citizens combining rigorous scientific analysis, innovative policy development, and effective citizen advocacy to achieve practical environmental solutions. Information on climate at: http://www.ucsusa.org/global_environment/global_warming/index.cfm

I. **Winrock International -** International is a nonprofit organization that works with people around the world to increase economic opportunity, sustain natural resources, and protect the environment. Winrock matches innovative approaches in agriculture, natural resources management, clean energy, and leadership development with the unique needs of its partners. (http://www.winrock.org/Winrock). Projects related to carbon sequestration can be found at:

1. "Opportunities for Mitigating Carbon Emissions through Forestry Activities," by Sandra Brown. http://www.winrock.org/reep/Opportun_carbon.html
2. Carbon Sequestration and Sustainable Coffee Project. Develop a carbon inventory and monitoring plan in the Lake Atitlan Region of Guatemala where farmers produce shade-grown coffee, and determine the potential carbon accumulation or sequestration benefits of this agricultural activity. http://www.winrock.org/fact/facts.cfm?BU=9058&CC=5146

IX. Homes/Housing

A. **Energy Savings in the Home**. The first web-based do-it-yourself energy audit tool, sponsored by DOE and EPA http://homeenergysaver.lbl.gov/

B. **Life Cycle Assessment Tools** to measure Environmental Impacts – reports on results of a forum regarding the application of life cycle assessment tools to homebuilding. Section III addresses climate change factors. At the Department of Housing and Urban Development (HUD) http://www.huduser.org/publications/pdf/lifecycle.pdf

X. Industry Groups

A. **Global Climate Coalition (GCC)** http://www.globalclimate.org. This organization of industries opposed to climate change regulations is inactive, but its website still contains active links.

B. **U.S. Chamber of Commerce** (http://www.uschamber.com) When it comes to representing American business -- strength and reputation matter. That's why 3 million companies of all sizes look to us to advance their interests before Congress,

government agencies, and the courts. Climate Change Eye-Openers http://www.uschamber.com/government/issues/environment/climatechangeapril.htm

C. **Alliance of Automobile Manufacturers** (http://www.autoalliance.org) The Alliance of Automobile Manufacturers is a trade association of 9 car and light truck manufacturers. One out of every 10 jobs in the U.S. is dependent on the automotive industry. No other industry is linked to so much U.S. manufacturing or generates more retail business and employment. Position on Climate Change http://www.autoalliance.org/pressreleases/mediastatement021203.htm

D. **National Association of Manufacturers** (http://www.nam.org) The NAM's mission is to enhance the competitiveness of manufacturers and to improve American living standards by shaping a legislative and regulatory environment conducive to U.S. economic growth, and to increase understanding among policymakers, the media and the public about the importance of manufacturing to America's economic strength. Climate Change Science Articles http://www.nam.org/secondary.asp?TrackID=&CategoryID=1161

E. **National Mining Association** http://www.nma.org. The National Mining Association (NMA) is the voice of the American mining industry in Washington, D.C. NMA is the only national trade organization that represents the interests of mining before Congress, the Administration, federal agencies, the judiciary and the media. Our membership includes more than 325 corporations involved in all aspects of the mining industry including coal, metal and industrial mineral producers, mineral processors, equipment manufacturers, state associations, bulk transporters, engineering firms, consultants, financial institutions and other companies that supply goods and services to the mining industry. NMA provides a forum for all the diverse segments of the mining industry to come together and advocate public policies designed to protect and expand opportunities for domestic mining. See their article: "CO_2: A Pollutant?" at http://www.nma.org/about_us/publications/pub_co2_pollutant.asp.

F. **Edison Electric Institute** (http://www.eei.org) EEI is the premier trade association for U.S. shareholder-owned electric companies. Our U.S. members serve nearly 70 percent of all electric utility ultimate customers in the nation, and generate almost 70 percent of the electricity produced by U.S. electric utilities. Climate Actions available at http://www.eei.org/industry_issues/environment/climate/index.htm

G. **American Petroleum Institute** (http://www.api.org)

1. Air Quality Improvements and Climate Change Partnerships http://api-ec.api.org/environ/index.cfm?bitmask=001003001001003000
2. A report entitled "Key Uncertainties, Milestones and Issues in the CCSP: An Assessment of the Strategic Plan of the U.S. Climate Change Science Program" http://api-ec.api.org/filelibrary/Wojick_CCSP_ReportFINAL04Dec03.pdf.

H. **American Gas Association** (http://www.aga.org) The American Gas Association represents 187 local energy utility companies that deliver natural gas to more than 52 million homes, businesses and industries throughout the United States. Environmental Benefits of Natural Gas available at http://www.aga.org/Content/NavigationMenu/About_Natural_Gas/Natural_Gas_Background/Environmental_Benefits/Default228.htm

I. **Partnership for Climate Action.** http://www.pca-online.org/ PCA is dedicated to climate protection, and its members are committed to limiting and reducing their greenhouse gas emissions. This unique effort is a collaboration of forward-looking companies across different industrial sectors and Environmental Defense, a leading nongovernmental organization with a distinct approach to engaging the business community

XI. International Government Sites

A. **International Energy Agency**, based in Paris, is an autonomous agency linked with the Organisation for Economic Co-operation and Development (OECD). http://www.iea.org

B. **International Governmental Panel on Climate Change (IPCC).** The Intergovernmental Panel on Climate Change (IPCC) has been established to assess scientific, technical and socio- economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation. http://www.ipcc.ch/

C. **World Energy Council**. http://www.worldenergy.org/wec-geis/wec_info/about_wec/about_wec.asp. The World Energy Council (WEC) is the foremost global multi-energy organization in the world today. WEC has Member Committees in over 90 countries, including most of the largest energy producing and energy consuming countries. The 80-year-old organization covers all types of energy, including peat, wood, coal, oil, natural gas, nuclear, hydro, and renewables, and is UN-accredited, non-governmental, non-commercial and non-aligned. WEC is a UK-registered charity headquartered in London.

D. United Nations

1. Framework Convention on Climate Change (UNFCCC). The main website for international work on climate change, including information on various treaties. http://unfccc.int/index.html.
2. Food and Agriculture Organization (UNFAO). http://www.fao.org. The FAO was founded in 1945 with a mandate to raise levels of nutrition and standards of living, to improve agricultural productivity, and to better the condition of rural populations. They report on "Harvesting Carbon Sequestration Through Land-use Change: A Way Out of Rural Poverty?" available at: http://www.fao.org/english/newsroom/news/2002/9040-en.html
3. Conference on Trade and Development (UNCTAD). Established in 1964, UNCTAD aims at the development-friendly integration of developing countries into the world economy. "A pilot greenhouse gas trading system." Includes rules for emissions trading. Available at: http://r0.unctad.org/ghg/publications/pilot_ghg.pdf

E. **World Business Council for Sustainable Development (WBCSD)** http://www.wbcsd.ch is a coalition of 170 international companies united by a shared commitment to sustainable development via the three pillars of economic growth, ecological balance and social progress. Information on Energy and Climate available at http://www.wbcsd.ch/templates/TemplateWBCSD4/layout.asp?type=p&MenuId=NjY&doOpen=1&ClickMenu=LeftMenu

F. **Center for International Climate and Environmental Research-Oslo (Cicero)** mandate is to both conduct research and provide information about issues of climate change. http://www.cicero.uio.no/index_e.asp

XII. Maps and Models

A. **Department of Commerce** (DOC) organizations section offers link to Climate Monitoring & Diagnostics Laboratory, which includes some info on global warming http://www.cmdl.noaa.gov/ccgg/faq.html#1

B. **National Geologic Map Database**, at the U.S. Geological Survey. http://ngmdb.usgs.gov/

C. **National Climatic Data Center** at the National Oceanographic and Atmospheric Administration at the Department of Commerce. http://lwf.ncdc.noaa.gov/oa/climate/climateextremes.html

D. **Naval Research Laboratory**, Ocean Dynamics and Prediction Branch, offers satellite information on the interactions of the ocean and the atmosphere, computer modeling on ocean circulation, and ice dynamics. http://www7320.nrlssc.navy.mil/html/7320-home.html

XIII. Oil and Gas Companies

A. **ChevronTexaco** position on climate change: One of the environmental concerns we all share is global climate change. We recognize that the use of fossil fuels has contributed to an increase in greenhouse gases - mainly carbon dioxide and methane - in the earth's atmosphere. http://www.chevrontexaco.com/cr%5Freport/environmental%5Fissues/climate%5Fchange.asp

B. **ConocoPhillips** position on climate change: ConocoPhillips recognizes that human activity, including the burning of fossil fuels, is contributing to increased concentrations of greenhouse gases in the atmosphere that can lead to adverse changes in global climate. http://www.conocophillips.com/sustainable/content/climate-position.asp

C. **ExxonMobil** publishes its views on climate change: Stating that the risk of long-term climate change needs to be addressed in a sound way, the company calls for moving beyond the highly-politicized Kyoto Protocol to an effective international climate policy. http://www2.exxonmobil.com/Corporate/Newsroom/Newsreleases/Corp_xom_nr_170401_2.asp

D. **BP.** In 1997, was the first company in our industry to accept that, while the scientific understanding of climate change is still emerging, precautionary action is justified. Information on climate change available at http://www.bp.com/subsection.do?categoryId=55&contentId=2000032**.** Information on emissions trading available at http://www.bp.com/genericarticle.do?categoryId=55&contentId=2006476

E. **Shell Oil** position on climate change: Sir Philip Watts, Chairman of the Committee of Managing Directors of the Royal Dutch/Shell Group of Companies, Speaking on the subject of climate change, Sir Philip said there is evidence that climate change is a real threat - greenhouse gases from human activity, largely produced by burning

fossil fuels bring about long lasting atmospheric changes likely to affect the climate. He said that we should take action now and that can be done economically and action need not affect prosperity. http://www.shelloil.com/news/press_releases/2003/press-031203.htm

XIV. Sequestration

A. **National Energy Technology Lab (NETL).** Our vision is to possess the scientific understanding of carbon sequestration options, providing cost-effective, environmentally sound technology options that ultimately lead to a reduction in greenhouse gas intensity. http://www.netl.doe.gov/coalpower/sequestration/index.html

B. **Defense Environmental Network and Information Exchange (DENIX).** Information on Carbon Sequestration at: https://www.denix.osd.mil/denix/Public/Library/Climate/cseq.html

C. **Carbon Sequestration program** at the Department of Energy, Office of Fossil Energy. http://fossil.energy.gov/programs/sequestration

D. **Carbon Sequestration in Terrestrial Ecosystems (CSiTE),** a research consortium, to perform fundamental research that will lead to acceptable methods to enhance carbon sequestration in terrestrial ecosystems as one component of a carbon management strategy. http://csite.esd.ornl.gov/index.html

E. **CO_2 Capture Project.** The CO2 Capture Project is an international effort funded by seven of the world's leading energy companies. This project intends to address the issue of reducing emissions in a manner that will contribute to an environmentally acceptable and competitively priced continuous energy supply for the world. http://www.co2captureproject.com.

F. **MIT Carbon Sequestration Initiative.** A consortium of industry and academia to provide an objective source of assessment and information about carbon sequestration, link industry and government efforts, and educate a wide audience. http://sequestration.mit.edu.

XV. Statistics

A. **About.com's Environmental Issues** site tracks climate change and global warming issues. http://environment.about.com

B. **Carbon Dioxide Information Analysis Center (CDIAC)** is the primary global-change data and information analysis center at DOE. http://cdiac.ornl.gov/ and http://cdiac2.esd.ornl.gov/index.html

C. **Energy Information Administration**. A primary source of energy statistics at DOE www.eia.doe.gov.

D. **Envirofacts:** Maps and Information at the EPA http://www.epa.gov/enviro/index_java.html

E. **FirstGov,** the U.S. Government's Official Web Portal.

1. Facts For You: Environment Statistics. Available at http://www.firstgov.com/Citizen/Facts/Facts_Environment.shtml

2. A long list of different websites on a variety of environmental and agricultural topics (http://www.firstgov.com/Citizen/Topics/Environment_Agriculture.shtml)

F. **Report on "Emissions of Greenhouse Gases in the United States 2002"** available at ftp://ftp.eia.doe.gov/pub/oiaf/1605/cdrom/pdf/ggrpt/057302.pdf

G. **Where You Live.** Data about environmental issues in your zip code at the EPA. http://www.epa.gov/epahome/whereyoulive.htm

XVI. Take Action and Outreach Activities

A. **Army Corps of Engineers**, Climate Change and Variability. Describes what city water managers can do to prepare for possible climate change. http://www.iwr.usace.army.mil/iwr/climatechange/cvcw.htm

B. **Cities for Climate Protection** (CCP) is a campaign of the International Council for Local Environmental Initiatives (ICLEI). The CCP is a performance-oriented campaign that offers a framework for local governments to develop a strategic agenda to reduce global warming and air pollution emissions , with the benefit of improving community livability. Five hundred local governments are participating the Campaign, representing 8% of global greenhouse gas emissions, and the numbers are growing. Information available at http://www.iclei.org/co2/. Ten things local governments can do to reduce emissions at: http://www.iclei.org/us/10_Things.pdf

C. **Natsource's Environmental Action Desk** engages businesses, associations, and individuals to offset their impact on the environment through the purchase of Environmental Action Certificates -- which represent 'environmentally friendly' projects. http://www.enviroactiondesk.com

D. **State and Local Outreach Kit at EPA.** This page provides outreach material designed to inform the public about global warming, with a primary focus on voluntary greenhouse gas reduction strategies that help states, communities, and individuals save money, improve air quality, and lower risks to human health. Available at: http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsOutreachMaterialStateKit.html

XVII. Teaching Guides/Kid Sites

A. **California Energy Commission: Energy Quest.** http://www.energyquest.ca.gov/index.html

B. **Energy information for kids** at the Energy Information Administration at DOE http://www.eia.doe.gov/kids/

C. **Exploring the Environment** website provides general, simple information on a variety of topics, including Global Climate Change. The students are given a scenario and as environmental consultants are asked to help a potential wheat farmer sort through the problems around Global Climate Change. The website is easy to use for both teachers and students. The glossary is an excellent resource. http://davem2.cotf.edu/ete/modules/climate/GCglossary.html

D. **GE Lighting Audit for Your School:** This website allows students to complete a lighting audit of the school (which could be applied to home or any other location) to determine which light bulbs are the most energy efficient. This could be an action

project that students undertake for the community.
http://www.gelighting.com/gelauditor/school

E. **Global Warming.** Information on global warming at the EPA website. http://www.epa.gov/globalwarming/kids.

F. **Journey to Planet Earth** is a website partnering PBS and Johns Hopkins. "This chapter gives you the basics of global warming and discusses potential consequences for our weather, our world, and ourselves." It is enlightening and appropriate for student audiences.
http://www.pbs.org/journeytoplanetearth/johnshopkins/temperature/index.html

G. **Louisiana Earth Science Teacher Professional Development:**
Thinking Graphically About Energy Sources
http://www.leeric.lsu.edu/bgbb/7/ecep/math/r/r.htm

H. **National Science Teachers Association: Stored Energy and Fuels**
http://www.nsta.org/Energy/find/primer/primer3_1.html

I. **Woodrow Wilson Leadership Program in Environmental Science**
http://www.woodrow.org/teachers/esi/1998/p/energy

XVIII. Think Tanks

A. **Heritage Foundation**. Founded in 1973, The Heritage Foundation is a research and educational institute - a think tank - whose mission is to formulate and promote conservative public policies based on the principles of free enterprise, limited government, individual freedom, traditional American values, and a strong national defense. Energy policy is a national priority. Lawmakers should implement a long-term energy plan that balances supply and demand, ensures reliable and affordable supplies of energy for the future, and provides responsible stewardship of the nation's resources. http://www.heritage.org/Research/EnergyandEnvironment/index.cfm

B. **American Enterprise Institute.** The American Enterprise Institute for Public Policy Research is dedicated to preserving and strengthening the foundations of freedom—limited government, private enterprise, vital cultural and political institutions, and a strong foreign policy and national defense—through scholarly research, open debate, and publications. Founded in 1943 and located in Washington, D.C., AEI is one of America's largest and most respected "think tanks." They offer a book entitled "Reconstructing Climate Policy: Beyond Kyoto," by Richard B. Stewart, Jonathan B. Wiener at http://www.aei.org/publications/bookID.211/book_detail.asp

C. **Brookings Institute**. The Brookings Institution is an independent, nonpartisan organization devoted to research, analysis, education, and publication focused on public policy issues in the areas of economics, foreign policy, and governance.

1. Article published in the Financial Times, "Power of the market can meet global warming challenge," December 5, 2003. David B. Sandalow, *Guest Scholar*, Foreign Policy Studies and Stuart E. Eizenstat ,*Head of the International Practice* ,Covington & Burling. Available at http://www.brookings.org/views/op-ed/fellows/sandalow20031205.htm
2. National Issues Forum Energy's Future: What Should Americans Know? Sources, Dependency, Conservation, Alternatives, Environment
http://www.brookings.org/comm/transcripts/20020621.htm

D. **Resources for the Future**. As the premier independent institute dedicated exclusively to analyzing environmental, energy, and natural resource topics, RFF gathers under one roof a unique community of scholars conducting impartial research to enable policymakers to make sound choices. Work specifically on climate change can be found at http://www.rff.org/rff/Climate.cfm

E. **World Resources Institute**. World Resources Institute (WRI) is an environmental think tank that goes beyond research to find practical ways to protect the earth and improve people's lives. Work on climate can be found at http://climate.wri.org

1. A report "Working 9 to 5 on Climate Change" details calculation tools to determine CO2 emissions, and how to reduce them. Tools include CO2 emissions from fuel used for heating and transportation, (http://docs.wri.com/direct_emissions.xls); CO2 emissions from purchased electricity (http://docs.wri.com/indirect_emissions.xls); CO2 emissions from business travel by air, train, bus and car (http://docs.wri.com/business_travel_emissions.xls); CO2 emissions from employee commuting (http://docs.wri.com/commuting_emissions.xls)
2. Climate Analysis and Indicators Tool CAIT is an information and analysis tool on global climate change, and can be used to analyze a wide range of climate-related data questions and to help support future policy decisions made under the Climate Convention and in other fora. Available at http://cait.wri.org.
3. EarthTrends. An online collection of information regarding the environmental, social, and economic trends that shape our world. Committed to the principle that accurate information drives responsible decisions by governments and individuals, EarthTrends offers the public a large breadth of statistical, graphic, and analytical data in easily accessible formats. Offers detailed data tables and maps about resource consumption and emissions around the globe. Available at http://earthtrends.wri.org.
    a. Carbon emissions per capita map http://earthtrends.wri.org/text/CLI/maps/185.htm
    b. Atmosphere and Climate Overview http://earthtrends.wri.org/text/CLI/data_tables/data_table1.htm also available at Excel and Adobe downloads.

F. **Worldwatch Institute**. The Worldwatch Institute offers a unique blend of interdisciplinary research, global focus, and accessible writing that has made it a leading source of information on the interactions among key environmental, social, and economic trends. Our work revolves around the transition to an environmentally sustainable and socially just society—and how to achieve it. Worldwatch produces two annual books "Vital Signs" and "State of the World" available for purchase from the website, that detail various environmental indicators around the globe. General research topics can be found at: http://www.worldwatch.org/topics/

1. Climate Change: http://www.worldwatch.org/topics/energy/climate/
2. Energy Sources http://www.worldwatch.org/topics/energy/energy/
3. Materials http://www.worldwatch.org/topics/energy/materials
4. Transportation http://www.worldwatch.org/topics/energy/transportation

G. **Earth Policy Institute**. Dedicated to providing a vision of an environmentally sustainable economy—an eco-economy—as well as a roadmap of how to get from here to there. http://www.earth-policy.org. Books available for free download include:

1. "Plan B: Rescuing a Planet Under Stress and a Civilization in Trouble," by Lester R. Brown http://www.earth-policy.org/Books/PlanB_contents.htm
2. "Eco-Economy: Building an Economy for the Earth," by Lester R. Brown http://www.earth-policy.org/Books/Eco_contents.htm

H. **Coalition for Environmentally Responsible Economies (CERES)**. The leading U.S. coalition of environmental, investor, and advocacy groups working together for a sustainable future. (www.ceres.org). Reports on climate change, including "Corporate Governance and Climate Change: Making the Connection" and "Electric Power, Investors, and Climate Change: A Call to Action" available at http://www.ceres.org/reports/main.htm.

XIX. Wildlife

A. **Climate Change, Wildlife, and Wildlands**. The U.S. EPA, in partnership with the National Park Service and with input from the U.S. Fish and Wildlife Service, developed a kit for use when talking with the public about how climate change is affecting our nation's wildlife and public lands. http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsOutreachMaterialORWKit.html