The National Council for Science and the Environment (NCSE) thanks the participants for their thoughtful contributions.

Strategies for Stabilization, Mitigation and Adaptation
1. Green Buildings and Building Design
2. Moving Forward: Transportation & Emissions Reduction
3. Animal Agriculture and Climate Change
4. Minimizing Agricultural Impacts on Climate; Minimizing Climate Impacts to Agriculture
5. Mitigating Greenhouse Gases other than CO₂
6. Energy Efficiency and Conservation
7. Biofuel Industry and CO₂ Emissions: Implications for Policy Development
9. How to Ensure Wind Energy is Green Energy
11. Economics: Setting the Price for Carbon
12. Forests and Markets for Ecosystem Services
13. Policy: Challenges of GHG Rulemaking: Where the Rubber Meets the Road
14. Engaging China on a Pathway to Carbon Neutrality
15. Human Population & Demographics: Can Stabilizing Population Help Stabilize Climate?
16. Urban Responses to Climate Change in Coastal Cities
17. Climate Change Adaptation for the Developing World: Expanding Africa’s Climate Change Resilience
18. Coastal Managers and Climate Change
19. Forest Management and Climate Change
20. Climate Change, Wildlife Populations & Disease Dynamics

Guiding and Fostering Multi-Disciplinary Research
21. The US Global Change Research Program – What do we want from the Next Administration?
22. Availability of Technology to Mitigate Climate Change
23. CO₂ Capture and Storage — How Can it Play a Major Role in Mitigating Climate Change?
25. Ocean Fertilization for Carbon Sequestration
26. Geoengineering as Part of a Climate-Change Response Portfolio
27. Looking into the Past to Understand Future Climate Change

Expanding Understanding: Information, Education, and Communication
30. Should There be a National Climate Service? If So, What Should it do and Where Would it be?
31. Communicating Information for Decisionmakers: Climate Change at the Regional Scale
32. Adaptation & Ecosystems: What Information do Managers & Decisionmakers Need?
33. Diverse Perspectives on Climate Change Education – Integrating Across Boundaries
34. Building People’s Capacities for Implementing Mitigation and Adaptation Actions
35. Climate Change and Human Health: Engaging the Public Health Community

Thanks to Lindsey Ehrler for consolidating and organizing these recommendations.
STRATEGIES FOR STABILIZATION, MITIGATION AND ADAPTATION

BREAKOUT SESSION 1: GREEN BUILDINGS AND BUILDING DESIGN
- Create a green building wiki
- Make green buildings accessible to all income groups
- Cultivate education and public awareness on the importance of green buildings among multiple stakeholders
- Introduce energy efficiency into both existing and historical buildings
- Measuring, verifying and modifying systems to reflect increasingly stringent energy standards and improved technologies
- Insurance and codes to facilitate green building measures
- Social marketing for green buildings, based on social science research
- Use green buildings – especially during early education – as an education tool

BREAKOUT SESSION 2: MOVING FORWARD: TRANSPORTATION & EMISSIONS REDUCTION
- Understand transportation market forces to inform pricing or a carbon tax
  - When and where will there be a rebound effect?
  - What behavior is changed and not changed on multi-modal freight and passenger?
  - What are the implications for social justice?
- Study of minimum potential energy intensity w/ tradeoffs for environment, economics and travel time for each transportation mode
  - So that inspirational benchmarks can be set.
  - Setting benchmarks on potential vs. current practices
- Understand implications of federal infrastructure investment for climate change to inform reauthorization formulas and discretionary programs
  - New projects vs. enhancements
  - Life cycle analysis (LCA) -> including tradeoffs
  - Public vs. private transit vehicles
  - Optimizing across modes in metropolitan areas
- Provide information to the public/consumer and understand impact on behavior and greenhouse gas (GHG) emissions reductions
  - GHG implications of shipping options
  - Better public education on GHG emissions & tradeoffs for vehicles
  - Instantaneous miles per gallon (mpg) information for drivers
- Learn from Next Gen w/ Visualization
  - Develop planning tools that integrate strategies, measures, and visualization of tradeoffs between GHG and other environmental impacts at a system-level
- Understand the best pace for advanced technology adoption/investment
  - Strategies and policies to encourage faster turnover and incentives for acceleration of better technologies to increase pace of environmental benefits
- Well-wheels and standardization for vehicles and fuels -> LCA
- Freight repackaging for more efficient shipping.
BREAKOUT SESSION 3: ANIMAL AGRICULTURE AND CLIMATE CHANGE

- Research priority: comparing methane and other GHG emissions (in a life cycle analysis) from pastured animals as compared to animals raised on grain in confinement
- Congress should encourage the U.S. animal agriculture sector to participate in carbon markets, including consideration of soil carbon sequestration (primarily emphasizing the use of pastures)
- Congress should review and analyze the impact of subsidies for various crops on climate change (this analysis has never been done and is necessary for any redirection of subsidies)
- USDA and Congress should revisit animal product labeling laws so that labels allow for identification of the carbon footprint of the product
- Congress should consider how existing infrastructure makes it more difficult for smaller-scale producers to reduce transportation associated with slaughtering and processing
- The media should educate the public more about the issue of animal agriculture and climate change in order to impact individual consumption patterns (similar to calling attention to how our driving habits impact GHGs)
- The National Academy of Sciences should conduct a study, leading to a national science-based dialogue to discuss how meat consumption, processing, packaging, and waste impact GHGs
- Environmental and other organizations (including public health professionals) should bridge work on food/agriculture issues with work on climate change
- Institutions, including universities, should identify the sources of animal products they use in a way that considers the GHGs/carbon footprint, including increasing funding for existing farm-to-institution programs.
- To better assist communities implementing GHG inventories, researchers should evaluate how to best measure and quantify emissions from production of meat, egg, and dairy products
- Researchers should develop sample policies and modeling analysis for local land-use bodies to use to actively preserve land for management-intensive grazing of animals in peri-urban areas

BREAKOUT SESSION 4: MINIMIZING AGRICULTURAL IMPACTS ON CLIMATE; MINIMIZING CLIMATE IMPACTS TO AGRICULTURE

- Develop regionally appropriate management recommendations on mitigation and adaptation in conjunction with producers and include monetary incentives for creative technical approaches.
- Develop stress-resistant varieties and management practices to cope with climate stresses for agriculture and forestry systems.
- Agricultural Extension should make climate change a priority in educational efforts.
- Develop new approaches to spread out producers’ risk over time and space.
- Develop long term data sets at the USDA Agricultural Research Service (ARS) to quantify and understand the impacts of climate on agriculture.
- Perform a life cycle greenhouse gas analysis on all production systems, including controlled environment production systems in northern latitudes.
- Research the effects of climate change on pests and invasive species.
- Rethink agriculture and energy systems so that energy and agricultural waste streams can be utilized, e.g., high value agricultural production coupled with urban waste energy.
- Research the impacts of climate stress on livestock production and identify management practices to alleviate stress.
BREAKOUT SESSION 5: MITIGATING GREENHOUSE GASES OTHER THAN CO₂

- Improve research and understanding regarding co-benefits and the range of environmental impacts associated with the interrelationships between air quality and climate change.
- Future policy discussions should recognize that mitigation costs for non-CO₂ gases are lower than for energy-related CO₂. Additionally, sources of “other gases” are much more diverse – not just energy and land use. The result – a large portfolio of mitigation options and the potential for reduced costs for a given climate policy objective.
  - Where appropriate, we encourage systems approach, integrated thinking across gases and sectors in order to make sure not to create a new problem by addressing another.
  - Mitigation technologies and best management practices exist for many of the non-CO₂ gases and their sources. Industry and others should incorporate and implement these practices as aggressively as possible.
  - Getting to next zero emissions for some of the non-CO₂ sources is not currently technically feasible (i.e., methane from ruminant livestock) and/or to do so may require large-scale societal changes.
  - Work to better articulate the relationship between emissions, concentrations, and radiative forcing for all greenhouse gases, not just carbon dioxide. This will help us better understand the role of non-CO₂ GHG in climate stabilization.

BREAKOUT SESSION 6: ENERGY EFFICIENCY AND CONSERVATION

- Use the social sciences to understand and influence consumer behavior in energy markets
- Focus on plug-loads in developing strategies for energy efficiency
- Increase research on use of heat and energy capture technology
- Increase research on maximum achievable energy cuts to provide a more conclusive projection of the role of energy efficiency in mitigating climate change
- Utilize price signals to create incentives to achieve increased energy efficiency, employ cap and trade systems
- Increase research on energy storage technology in order to increase efficiency
- Integrate energy efficiency into other related policy arenas (e.g. health care, criminology, education, etc.)

BREAKOUT SESSION 7: BIOFUEL INDUSTRY AND CO₂ EMISSIONS: IMPLICATIONS FOR POLICY DEVELOPMENT

- Account for carbon and energy footprint in policy and research climate implications of large-scale biofuel production sequestration strategies.
- Imbed biofuels policy in a comprehensive energy policy, including energy conservation and efficiency.
- Increase research and curricular development (k-12 and up) on current technologies
- Policy should take a life cycle analysis of biofuel systems.
- Remove the $.51 blenders credit
- Maximizing compatibility with existing fuel infrastructure.
- Incentives outcomes, not technologies

Preliminary draft recommendations provided by breakout session participants - subject to review and editing
**BREAKOUT SESSION 8: SOLAR ENERGY: SCALING UP – SCIENCE AND POLICY NEEDS**

- The technology is there; we need implementation.
- Organize the solar industry and its allies (such as community colleges, colleges and universities) to deal with problems unrelated to the technology, such as lack of work force to expand.
- College students serve dual roles of education for the solar workforce and also as a community of activists.
- Encourage legislation that prevents utilities from passing risk of volatile energy resource costs onto the consumers forcing them to explore renewable options like solar and wind.
- Develop strategies to alleviate the financial risk of commercial solar power.

**BREAKOUT SESSION 9: HOW TO ENSURE WIND ENERGY IS GREEN ENERGY**

- Improve state and federal agency involvement and the consistency of requirements and regulation, and discourage policies that reduce research and environmental reviews.
- Ensure that all positive and negative impacts are analyzed in their proper context in relation to other sources of energy generation.
- Define and identify high risk areas that may warrant additional research, mitigation, or avoidance.
- Explore the development of a process to certify wind projects that adequately minimize or mitigate impacts on wildlife and habitat.
- Improve funding for priority monitoring and research and increase agency staffing to address wind permitting issues.
- Account for monitoring, research, and mitigation in upfront planning and permitting of wind projects to improve cost certainty.

**BREAKOUT SESSION 10: NUCLEAR ENERGY: USING SCIENCE TO MAKE HARD CHOICES**

- Policies for energy generation should be based on research showing the need to cap carbon emissions.
- NSF should fund further research in perception and communication of nuclear and climate issues.
- The federal government should increase funding for nuclear engineering and science education at the undergraduate and graduate levels.
- An independent, respected organization should develop a set of appropriate and transparent, life-cycle comparison metrics for all energy technologies, as well as conservation and efficiency.
- An independent, respected organization should fund the development of a complete measure of subsidies, mandates, and market directives associated with all electricity options.
- An independent, respected organization should further develop consensus communication materials (e.g. The Keystone Project [www.keystone.org/spp/energy07_nuclear.html])
BREAKOUT SESSION 11: ECONOMICS: SETTING THE PRICE FOR CARBON

- More economic and policy research on merits or demerits of government oversight, regulation, and management of allowance market. Need to examine both price ceilings and price floors.

- State-level regulation of electric utilities varies widely between traditional cost-of-service regulation and varying degrees of deregulation at the generation level (coupled with continued regulation at the distribution level). There should be more economic and policy research on the complex interactions between state-level utility regulation and state and national climate change policy that are likely to occur. State legislators, Public Utility Commission (PUC) officials, and stakeholders should have a credible and accessible set of research findings to guide them in future regulatory decisions that interact with climate policy.

- More research into the optimal combination of “carrots and sticks” that can accelerate the commercialization of carbon capture and sequestration. Issues of liability should also be addressed along with other legal/regulatory issues.

- More economic and policy research into how nations could make “border adjustments” to account for imports from countries that do not control GHG emissions. This is relatively easy in the case of carbon taxes, but problematic in the case of cap-and-trade. Topics would include how World Trade Organization (WTO) policy should treat such border adjustments.

BREAKOUT SESSION 12: FORESTS AND MARKETS FOR ECOSYSTEM SERVICES (ES)

- Develop better methods to measure, map, model and value ecosystem services at multiple spatial & temporal scales:
  - Technology/tools needed:
    - International Global Land Use Observatory (built with the following tools)
    - Landsat Data Continuity Mission
    - LIDAR systems
    - Streamlined clearinghouse for remote sensing data with broad international access
  - Science:
    - Methods for modeling carbon storage & how to modify existing models
    - Dealing with scaling factors & relating different measurement techniques to relate datasets, models and projections across regions

- Valuation science (i.e., monetizing ecosystem services):
  - How to improve spatial targeting mechanisms for identifying and valuing ecosystem services?
  - How to balance demand & supply of ecosystem services?
  - Need explicit models for the demand side of ES (a set of models & tools with standardized measures of ecosystem service demand & value)

- How do management activities (e.g., thinning, cutting, burning) affect provision of ecosystem services individually and bundled?
  - How does the area, type and condition of a forested area affect the quantity and quality
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- How well do our models predict carbon storage & what modifications are needed?
- How to detect and prevent “leakage” of forest ecosystem services?
- Standardize language, develop registries of ecosystem services, develop verification standards across regions.
- Improve our understanding of ecosystem bundling:
  - How do we best add value to carbon sequestration?
  - Under what circumstances is it best to bundle multiple ecosystem services (climate regulation, water provision, biodiversity, etc.) and what are the implications/tradeoffs of doing so?
  - How to market and price bundled services, understand relationship between resilience and bundled ecosystem services (ecosystem functioning)?
  - Develop a systems approach to understanding ecosystem service bundling and processes.
  - Solve conflicts between bundling and additionally
- Improve the connections between social and natural sciences within ecosystem services research.

**BREAKOUT SESSION 13: POLICY: CHALLENGES OF GHG RULEMAKING: WHERE THE RUBBER MEETS THE ROAD (NOTE THAT THIS SESSION SPECIFICALLY FOCUSED ON DEVELOPMENT AND IMPLEMENTATION OF POLICY)**

- Not enough is known about climate change (CC) mitigation to adopt a comprehensive GHG reduction program.
- However, the risks of CC are so significant that strong GHG mitigation action needs to begin immediately.
- A regulatory and legislative scheme must lead to an 80% reduction by 2050
- Strong presidential leadership is essential. The presidential message must identify what we need to do now and where we need to be headed. This will
  - Decrease the chaos and make the regulatory process more linear
  - Give clear marching order to the agencies and bureaucracy,
  - Create a firm political position from which to work with Congress.
- Congress must draft appropriate legislation.
- Leadership, both in Congress and by the President, can be stimulated by national industrial and business leaders demanding government action to
  - Pre-empt the Clean Air Act (CAA)
  - Avoid a patchwork of state approaches
- Congress must clarify the linkages between a GHG reduction scheme and the CAA
- Technology:
  - President must include funding for R&D and pilot projects in budget
  - Congress must appropriate money for R&D and pilot projects
- We must compromise quickly
- Legislation should incorporate deadlines
- Maintaining constituent pressure on both Congress and the White House is important
- In the short term, a patchwork approach may be inevitable
• We must specify the nexus between CC, air, and water regulation; perhaps beginning with existing regulation
• We should utilize information/reports from already existing advisory groups to inform policy/regulation

OUR CONSENSUS:
• Leadership must come from the top
• Congress must pass new legislation

BREAKOUT SESSION 14: ENGAGING CHINA ON A PATHWAY TO CARBON NEUTRALITY
• There should be a joint China-US governmental study on tracking embedded carbon flows and funding options (Department of Commerce and Ministry of Commerce)
• Joint China-US governmental task force to deal with climate security in Pacific Rim countries
• Massive cultural business-based educational exchange to build a base of understanding
• US universities that offer green MBA’s in China to include sustainable development
• Congress and US administration leadership role in limiting GHG domestically and re-engaging in international negotiations
• Continue and expand work to reduce trade barriers for green technology
• Associations of mayors and governors should establish climate sister cities/province/state relations with counterparts in China
• Increase efforts to build capacity for emission inventories and monitoring and identification of carbon sinks
• Support capacity building to help bring locally-appropriate technology to scale in China

BREAKOUT SESSION 15: HUMAN POPULATION & DEMOGRAPHICS: CAN STABILIZING POPULATION HELP STABILIZE CLIMATE?
• Climate science should fully integrate demography and population dynamics—including fertility, mortality, migration, geographic distribution, age structure—into climate change models and research.
• The IPCC should be more explicit, transparent and communicative about how human population projections fit into models of greenhouse gas emissions growth and human vulnerability to climate change impacts.
• Climate modelers should conduct sensitivity analyses of the ways in which changes in fertility are likely to impact climate change
• To facilitate full integration, funding should be increased for research on the demographic dimensions of climate change mitigation and adaptation.
• More research into the nexus of food security, biofuels, and population dynamics in a time of changing climate
• More research on linkage between demographics, household income, consumption, and other socioeconomic factors in the context of climate change.
• Clarify and strengthen the contribution of achieving the United Nations’ low population growth projection to reducing growth in greenhouse gas emissions
• Research into the costs of providing universal access to voluntary family planning/reproductive health (FP/RH) services as a means to slow population growth,
reduce future greenhouse gas emissions and human vulnerability to climate change impacts.

- Promote strategies to slow population growth, promote resilience, and build capacity for adaptation in regions most vulnerable to climate change impacts.
- Highlight the need for universal access to family planning, especially in areas where slowing population growth can be most effective in reducing greenhouse gas emissions, now and in the future.
- Conduct research examining the role of migration, both internationally and internally, on vulnerability to climate change impacts and greenhouse gas emissions.

**BREAKOUT SESSION 16: URBAN RESPONSES TO CLIMATE CHANGE IN COASTAL CITIES**

- University accreditation boards and professional accreditation boards in planning, architecture and civil engineering should include climate change in criteria for accreditation. This will require the development of education programs for professionals.
- The National Flood Insurance Program should take into account the risks posed by climate change in urban areas.
- Project and program review criteria at federal, state, and local levels should include climate change impacts and vulnerabilities.
- Climate change scientists, professionals and advocates must improve the way we communicate climate change and its urgency to make it locally relevant to schools, engineers, planners, and communities.
- The IPCC needs to develop user-friendly tools to improve access to information in the PCMDI website so planners can incorporate climate scenario information into their decisionmaking tools.
- Funding agencies should support the scientific community in the incorporation of the socioeconomic side of local impacts to adaptation issues associated with climate change.
- The appropriate agencies should establish climate change-triggered threshold levels for existing critical infrastructure.
- Elected officials who make land use decisions need to base these decisions on a long-term land use plan, design standards, and building codes that includes vulnerability analysis, certified by a planner.
- We encourage city officials, planners, and decision-makers to meet together regularly in informal social settings to exchange information and opinions on climate change as related to their responsibilities.

**BREAKOUT SESSION 17: CLIMATE CHANGE ADAPTATION FOR THE DEVELOPING WORLD: EXPANDING AFRICA’S CLIMATE CHANGE RESILIENCE**

- Expand training of African climate change scientists.
- Support clean energy research and development at the regional level to expand energy access in Africa, specifically solar, geothermal, and biofuel generation.
- Develop an international scientific research program to which governments, private entities, NGOs and academics both in and out of Africa can contribute to develop fundamental natural science understanding for sustainable development (surficial geology, soil science, mineral resources, geochemistry, surface and groundwater, land cover, ecology, biodiversity conservation, etc) and develop greater understanding of climate
change at the regional to local scale, including observations, models, and verification of models.

- Research climate change impacts on water resources and infrastructure for water systems.
- Support appropriate national educational programs to promote understanding of climate change and impacts on natural and human systems at multiple levels and promote career opportunities in solutions and sustainability.
- Research relationships among population growth, demographic movements, urbanization and available agricultural land base and carrying capacity with multiple climate change scenarios to climate change adaptation and technology.
- Promote outcome research to influence climate change adaptation, and efficiency of projects based on African priorities.
- Explore policy mechanisms to bridge the competition between short-term relief of food crises and longer-term rural development assistance for in drought-prone countries.
- Support research into spread of non-native agricultural products.
- Conduct research to understand how implement microcredit programs in Africa with large and growing informal economies and other credit vehicles.

**BREAKOUT SESSION 18: COASTAL MANAGERS AND CLIMATE CHANGE**

- States and federal agencies should collaborate with regional associations /regionally to create data inventory to identify data gaps and strategies to fill gaps and disseminate data through a portal.
- The federal Climate Change Science Program (CCSP) and the Union of Concerned Scientists (UCS) should synthesize IPCC information into more relevant format for regions.
- Home buyers, homeowners and renters should be given information about adverse effects and consequences of sea level rise and natural hazards through printed and web resources.
- Coastal management agencies should translate climate scenarios into management criteria for regulation, engineering, and planning.
- NOAA, USGS, Army Corps of Engineers, FEMA and other federal agencies should develop integrated models that link climate to ocean and coastal processes and impacts.
- Academia should assist coastal managers in determining scenarios for land use planning, infrastructure and habitat impacts.
- Congress and state governments should increase coastal habitat restoration funding and address the long-term sustainability of restoration projects.
- The Coastal States Organization and state coastal management programs should initiate regional adaptation planning.
- Congress should fund education programs supporting integrated natural science and public policy to develop and acquire curricula specific to regional climate impacts at K-12 through university levels.
- States should set up scientists and managers “speed dating-like” interfaces to facilitate needs and research.
BREAKOUT SESSION 19: FOREST MANAGEMENT AND CLIMATE CHANGE

- Communication & Education
  - Develop and implement a communications strategy and an educational strategy to engage all stakeholders in dialogue and action about the consequences of current land management and societal behaviors in the context of climate change.

- Management Response
  - Coordinate landowners and land management agencies on joint decision-making about adaptation actions to address fragmentation of habitats and management.
  - Federal agencies should incorporate all forest management field / monitoring data into publicly available, web-accessible databases.

- Research
  - Economists should incorporate linkages between energy supply, demand, and policy with forest-sector models for carbon management.
  - Government /academia should develop predictive tools and models for land managers that are designed to predict:
    - Climate change at regional / local scales
    - Species shifts at regional / local scales
    - The GHG implications of alternative forest management activities & strategies including “no active management”.
  - **Note: Different groups will need different types of tactical and strategic info.
  - Researchers should develop and evaluate options for facilitated adaptations so ecosystems are resilient to climate change.
  - Climate impact modelers should develop hot-spot analyses so that this information can be used by decision-makers and stakeholders to prioritize adaptation opportunities.
  - Interdisciplinary science should work with local communities to assess vulnerabilities, impacts, and strategies for adaptation.
  - Scientists should work across disciplines and with local communities to assess vulnerabilities, impacts and integrated adaptation and mitigation strategies within local communities.

BREAKOUT SESSION 20: CLIMATE CHANGE, WILDLIFE POPULATIONS & DISEASE DYNAMICS

- Science
  - We believe the following areas are critical knowledge gaps in our understanding of climate change and wildlife diseases:
    - Effects of invasive species
    - Vector-borne diseases
    - Rapid evolution of pathogens
    - Host-species movement patterns
    - Ecosystem fragmentation
    - Seasonality of wildlife disease events
    - Ecosystem dynamics

  - We propose that these gaps could be filled through:
    - Development and implementation of standardized data collection systems to detect ecosystem change(s).
Development of models explaining observed data trends and for forecasting future events.  
- These data and models will then allow for development of risk assessment models.  
- Existing scientific expertise is probably sufficient for organizing and analyzing data, and defining data needs, but dramatically more capacity is needed for data collection.  

We propose this capacity could be expanded with the:  
- Training citizen-scientists  
- Engaging citizen-based organizations (i.e. Audubon societies, Ducks Unlimited, etc.).  
- Engaging traditional and other local communities  

- **Education and Awareness**  
  In the interests of building data collection capacity, we propose to enhance the education and awareness of the public on wildlife and climate change; by:  
  - Providing information for curriculum development in the nation’s schools  
  - Developing curriculum based on information from professional societies (e.g. The Wildlife Society and Wildlife Disease Association)  
  - Engaging state and tribal wildlife agencies to provide public programs on wildlife and climate change.  
  - Engaging local media and organizations to provide a format for increased awareness.  

- **Economics and Policy**  
  - We wish to reinforce the critical necessity of resources to support research and management of wildlife in the face of climate change.  
  - Sources of funding can include:  
    - Federal and state governments  
    - Science foundations  
    - Private industry  
  - On a global scale, financial institutions like the World Bank and World Health Organization (WHO) should be sources of funds.  
  - Establish economic metrics for the values of ecosystems and habitats  
  - Establish a global ecosystem assessment based on these economic metrics.  This information could be used by national policymakers around the world.  

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**GUIDING AND FOSTERING MULTI-DISCIPLINARY RESEARCH**  

**BREAKOUT SESSION 21: THE US GLOBAL CHANGE RESEARCH PROGRAM (USGCRP)-- WHAT DO WE WANT FROM THE NEXT ADMINISTRATION?**  

- Reframe the USGCRP to better address the 21st Century opportunities and challenges  
  - Focus on adaptation research and response strategies  
  - Enhanced focus on mitigation research and response strategies  
  - Enhanced support for international, national, and regional-scale climate and global change assessments and related analyses  
  - Enhanced support for observations and monitoring of essential climate and global change variables  
  - Enhanced effectiveness of decision support and communication activities  

- Implement the recommendations of the National Academy of Sciences  

Preliminary draft recommendations provided by breakout session participants - subject to review and editing
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- Enhance research, assessment, and communication activities at regional-to-local scales
- Enhance and broaden the social science research agenda
- Enhance implementation of the statutory mandate for the USGCRP
- Invest in and amplify the use of the collaborative capabilities of web-based systems
- The federal budgetary process should more effectively reflect the needs of the nation to address the issues of climate and global change
- Reform the management of the USGCRP

**BREAKOUT SESSION 22: AVAILABILITY OF TECHNOLOGY TO MITIGATE CLIMATE CHANGE**

- Given the crisis facing global climate there is a need for action by the Administration and Congress to greatly increase the funding, at least a doubling, to implement technologies that are commercial or near commercial to reduce the carbon emissions at the fastest possible rate. This would include nuclear energy, energy efficiency (transportation, buildings, and appliances), renewables, and carbon capture and sequestration. The U.S. Climate Change Technology Program (CCTP) should take the lead in setting up priorities for the implementation of technologies. Priority should be given to projects that address more than one issue, e.g., carbon free power production supports carbon-free transportation and simultaneous production of biomass energy with carbon capture, or that use the oceans that cover 70% of the earth’s surface.

- The high levels of reduction of carbon emissions needed to meet the goals for 2100 cannot be achieved with existing technology. The Administration and Congress needs to triple the level of funding for strategic research to develop the next generation of end-use and production energy technologies with efficiencies to meet the goal at a cost that will enable their adoption by lesser developed economies. Emphasis should be on renewable energy. The CCTP should provide the roadmap for providing the balance of funding technologies at the fundamental, strategic, and demonstration levels and to provide the correct mix of participation by government, industry, and academia.

- Energy efficiency is the low-hanging fruit that can lead to the greatest reduction in CO₂ at least cost. The goal should be a decrease emissions in energy use of 1 to 2% per year are needed. Government at the federal and state level should develop new incentives (and remove disincentives), regulations, and change in public behavior to achieve this goal.

- The DOE should develop regional Climate Change Commercialization Centers that can adapt mitigation technologies to local climates and demographics.

- A new private funding mechanism should be explored by the Administration and Congress. One example would be to develop an environmental security account that would place a price on carbon with the revenue going exclusively to the payer’s account, either individual or corporate, for the purpose of furthering the goals of environmental security.

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Preliminary draft recommendations provided by breakout session participants - subject to review and editing

**BREAKOUT SESSION 23: CO2 CAPTURE AND STORAGE (CCS) — HOW CAN IT PLAY A MAJOR ROLE IN MITIGATING CLIMATE CHANGE?**
- Conduct multiple commercial scale projects of integrated CCS at power plants with storage in saline aquifers to validate large-scale performance and reliability. Projects should span a range of plant/capture types (e.g. combustion, gasification systems), new and retrofit applications, and range of geological formations. Develop financing for the above.
- Education and dialogue is needed to facilitate public awareness/acceptance of CCS
- Educate policy makers and regulators about CCS (e.g. what are the risks, etc)
- Conduct risk assessment of geologic sequestration to identify data needed by insurance industry and regulatory agencies regarding risks, etc.
- Significantly increase funding for basic and applied R&D to develop new and advanced (lower cost) capture and storage technologies
- Life cycle assessment tools for full CCS projects - from resource requirements through storage including object, such as mixed gases.

**BREAKOUT SESSION 24: COUNTING CARBON: TRACKING AND COMMUNICATING Emitted AND EMBODIED GREENHOUSE GASES IN PRODUCTS, SERVICES, CORPORATIONS AND CONSUMERS**
- As corporations, countries, consumers and communities attempt to measure and report their greenhouse gas footprints, they face many daunting challenges, particularly in the United States where awareness lags and emissions (sometimes imported embedded in products from abroad) soar. Representatives from government, business, academia and non-governmental organizations discussed the challenges and opportunities of measuring and conveying to stakeholders the quantities of greenhouse gases emitted into the atmosphere, sometimes hidden in the life cycle of various products or services. The discussants explored how such information can assist individuals, companies, communities and nations in meeting specific goals and fostering more energy efficient and climatically savvy societies. Following are their general recommendations:
  - Problem: Lack of awareness
    - Solution: Training and education, supported with coordinated, multi-disciplinary efforts to convey the contribution of a product or service life cycle to greenhouse gas emissions
  - Problem: Lack of expertise
    - Solution: Even more training
  - Problem: Lack of consistency
    - Solution: Standardize the measurement and ensure transparency, using techniques and strategies such as those developed by the World Resources Institute and the Carbon Disclosure Project.
  - Problem: Lack of data and difficulty in assessing the quality of data
    - Solution: Use existing and emerging tools and technology, such as “smart metering” in homes, the NIST BEES tool, and highlight case studies of particular products to build.
  - Problem: Too many measurements and/or surveys
    - Solution: Standardize and simplify data gathering without sacrificing quality and integrity.
  - Problem: Variety and scale of factors can be overwhelming
    - Solution: Keep an eye on the big picture or high magnitude solutions, and don’t be distracted by noise and minutia.
  - Problem: Lack of connectedness (individuals and corporations lack understanding)
Solution: Provide opportunities for connectivity, including a clearinghouse of information and resources.

**BREAKOUT SESSION 25: OCEAN FERTILIZATION FOR CARBON SEQUESTRATION**
- Any commercial or experimental international regulations should be based on the environmental impact
- Keep in mind the pathogens, fungus and the development and the impact on species
- The scientific community should evaluate potential sites before proceeding with an experiment
- Workshop of institutions (e.g. Oceana) where concerns may be expressed
- Scientifically determine what standards are adequate: depth, length of time, tools, all the parameters necessary
- Possibly using large areas and experimenting and observing for several years to better understand the changes that occur
- Not only considering the surface of water, but also take into account the movement of water at various depths of the ocean in evaluating an experiment.
- Transparency is critical both for independent observers and data -if the funding comes from commercial sources rather than government, than transparency is even more critical
- Countries should reach a consensus to come together and gather data and information rather than using small experiments

**BREAKOUT SESSION 26: GEOENGINEERING AS PART OF A CLIMATE-CHANGE RESPONSE PORTFOLIO**
- Geoengineering (solar radiation management) is not now well enough understood to be considered as an option that is complementary to mitigation and adaptation for dealing with global warming.
- More research on the efficacy, effectiveness, and ethical considerations of geoengineering is needed. This research should be multidisciplinary, including the climate system, biological and ecosystem aspects. An additional research program into the governance and ethical aspects needs to be set up. A well-managed, multi-agency program focused on geoengineering should be established.
- A geoengineering research program should not be at the expense of a much larger increase in research needed into mitigation and adaptation. Geoengineering should only be considered in emergencies if those larger programs are inadequate.
- Large-scale field experiments should not be carried out until detailed theoretical assessments of how they would work and the possible consequences are conducted.
- The capability for long-term monitoring the climate system, particularly by satellites, needs to be maintained and enhanced, so that climate change, and the effects of any geoengineering approaches, can be measured and detected in an accurate and robust manner.
- So as to be accepted and monitored by the people of the world, the research needs to be published in the peer-reviewed, open literature, and the research program should be internationally sponsored.
- Beyond solar radiation management, other novel approaches to counterbalancing climate change and its impacts should be explored.
BREAKOUT SESSION 27: LOOKING INTO THE PAST TO UNDERSTAND FUTURE CLIMATE CHANGE

- Develop integrated land-based (e.g., ice cores and lake cores) and ocean-based (e.g., sediments from scientific ocean drilling, corals) paleoclimatic data sets
- Train and encourage the scientific community to communicate paleoclimate research to policymakers, educators, and the public at large.
- Create funding mechanisms and institutional arrangements to encourage climate/ocean dynamists and paleoclimate observationalists to collaborate to improve climate models
- Incorporate paleoclimate research into environmental science textbooks
- Increase scientific society funding of Congressional Science Fellowships
- Understand the sensitivity of ice sheets to climate change and their impact on sea level

BREAKOUT SESSION 28: A NATIONAL STRATEGY FOR WILDLIFE ADAPTATION TO CLIMATE CHANGE: WHAT SHOULD IT INCLUDE?

- Protect biodiversity and the ecological and evolutionary processes that produce and maintain it.
- Employ a transparent process that is iterative and adaptive, supported by research and monitoring of ecosystem structure and functioning.
- Ensure early action to invest in habitat conservation, including buying land.
- Include a quick response mechanism for ecological catastrophes and other episodes.
- Ensure coordination with all stakeholders, including Mexico, Canada and other countries, and be integrated with strategies to address the impacts of climate change on public health and the built environment.
- Create an unbiased, IPCC-like commission to identify the best available science.
- Develop a strategy for education, communication, and public outreach
- Focus on a broad range of stresses on wildlife (non-climate as well) to promote resilience.
- Be integrated with and implemented through planning and management for federal lands.
- Consider international biological diversity and opportunities to provide assistance to other countries.

EXPANDING UNDERSTANDING: INFORMATION, EDUCATION AND COMMUNICATION

BREAKOUT SESSION 29: MASS ACTION: HOW SCIENTISTS CAN ENGAGE THE PUBLIC IN GLOBAL DIALOGUE TOWARD SHARED POLICY & BEHAVIOR CHANGE SOLUTIONS FOR GLOBAL CLIMATE CHANGE

Given the pressing issue of climate change, NCSE should issue a public statement calling for collaborative action by the NCSE stakeholders:

- Foundations/Philanthropic Organizations
- Corporation numbers
- Education members
- Educators
- Students
- NGOs
- Scientists

All NCSE stakeholders should come together to take action.
- Establish a working group to communicate to scientists how to share data with the lay public.
Preliminary draft recommendations provided by breakout session participants - subject to review and editing

- For instance, the working group would create a protocol for communication (climate literacy) and common language, to include terminology.
- The working group would design standardized training for scientists that encompass the protocol, and media techniques regarding basic communication.

- NCSE should work with youth organizations and media organizations to reach youth and popular segments through “new media.”
- Scientists working with the NCSE should select articles that are most important for public awareness. These articles should be edited in such a way that the lay public can comprehend. (note NCSE’s online Encyclopedia of the Earth does this and welcomes authors). NCSE can work through journalists such as science writers who would publish the information in popular journals.
- Climate change should be included in college and educational curriculum.
- Partnerships/coalitions should be built across:
  - Audiences
  - Sectors
  - Issues
- Mobilize community leaders for community action using appropriate messengers.

**BREAKOUT SESSION 30: SHOULD THERE BE A NATIONAL CLIMATE SERVICE? IF SO, WHAT SHOULD IT DO AND WHERE WOULD IT BE?**

- The Office of Science and Technology Policy, the Office of Management and Budget, and the Department of Commerce, with the advice and consent of Congress, should move quickly to establish a National Climate Service and in parallel establish an advisory committee of non-Federal representatives (information providers and users) to define a mission and responsibilities, identify priorities, estimate required resources, and propose an organizational structure.
- The Office of Science and Technology Policy and the Office of Management and Budget should undertake a Federal interagency initiative to mobilize the nation’s vast resources to better understand, mitigate, and adapt to the changing climate.
- The National Climate Service should bring together the best and brightest from government, industry, academia, and the non-governmental sector to tackle the urgent and unprecedented information challenges associated with climate change.
- To ensure an informed citizenry, the National Climate Service should be the Federal focal point for climate change communications and education.
- The National Climate Service should work in an ongoing, close partnership with the broad user community—within and outside government—to define needs and continually develop products to meet them.
- The National Climate Service should specify scientific and technical needs and requirements, and work with the science and technology community to deliver improved products and services.
- To ensure continued public awareness, the National Climate Service should effectively communicate to society the risks and adverse consequences of climate change.
- The National Climate Service should ensure the scientific integrity, transparency and accuracy of its products and services.
BREAKOUT SESSION 31: COMMUNICATING INFORMATION FOR DECISIONMAKERS: CLIMATE CHANGE AT THE REGIONAL SCALE

• The should be proactive, early and frequent, meaningful and purposeful dialogue between the scientific community and the intended audience.

• Regional projects should be facilitated by professionals with expertise in communications, decision-making, and conflict-resolution.

• Institutional structures, such as interdisciplinary teams & extension services, need to be encouraged and embedded in projects.

• Utilize more ensemble models.

• Framing and pitching information for specific intended audience.

• Increase climate science and technical literacy among decision-makers and community-at-large.

BREAKOUT SESSION 32: ADAPTATION & ECOSYSTEMS: WHAT INFORMATION DO MANAGERS & DECISIONMAKERS NEED?

Increased communication and education about ecosystem information is essential for policy makers to make meaningful and correct decisions. Local and regional networks of smart monitoring must communicate with larger networks to achieve a greater overall picture. Data must be standardized so that they are fit for analysis. Data must be crafted into information that is capable of being understood quickly by policymakers.

Consolidated Priorities:

• Greater assessment of end user needs (the needs of policymakers to understand complex and dynamic data in order to make informed decisions).

• Develop a National Climate Effects Network (a national and consolidated authority for information analysis and dissemination).

• Invest in the human dimension portion of the global climate control arena. Develop science translators for decisionmakers at the local, federal, and state levels.

• How do projections and downscaling inform ecosystem definitions?

  – An assessment and redefinition of thinking from separate thinking to ‘whole systems’ thinking.

• The Climate Service (Effects Network??) should include all branches of government.

• There should be a transition to thinking about whole systems, the development of a systems approach and from static to dynamic policymaking decisions.

• Frame the global climate control problem in terms of sustainability instead of a ‘reactive model’.

• Long term maintenance of ecosystem monitoring systems. Results displayed and accessible over the long term, so that data trends may be understood over time.

• Make the consequences of reactive leadership transparent to everyone.

• Greater focus on risk communication issues.

  – Facilitate researchers to communicate information to decision makers.

  – Long-term investments in ‘science integrators’ – those who can communicate palatable and specific data to decision makers.

BREAKOUT SESSION 33: DIVERSE PERSPECTIVES ON CLIMATE CHANGE EDUCATION – INTEGRATING ACROSS BOUNDARIES

• Inter-sectoral recommendations
The US Climate Change Science Program should coordinate with NSF (multiple directorates), NOAA, EPA, Department of Interior (DoE, National Parks), NASA, and USDA (Forest Service and land grants), to support and guide the development of a national-level strategic plan for climate change education that includes specific mechanisms for working with a wide range of non-governmental partners (including formal, informal and nonformal education, corporations, foundations, NGO’s).

The US Climate Change Science Program and its federal partners should work closely with (i.e. co-convene a workshop with) the Coalition for Climate Literacy and other non-governmental partners during 2008 to ensure multi-sectoral and diverse stakeholder input into the design of a climate change education strategic plan.

This coordinated effort and strategic plan should include outreach to and collaboration with both governmental and non-governmental funding sources (i.e. private foundations) to initiate and support multidisciplinary research to benchmark and assess the effectiveness of existing climate change education programs and to identify and evaluate promising integrative approaches (“best-practices”).

To infuse popular culture with accurate and appropriate climate change science, educational NGOs and their university, community, and business partners should facilitate opportunities for scientists and engineers to partner with artists, fashion-designers, novelists, game designers and other conduits to the public.

The Coalition for Climate Literacy (CCL) should cross-link key high-traffic web resources (i.e., Windows to the Universe, Encyclopedia of Earth, Keystone Center) to make them visible and accessible and connect relevant groups.

In its first year of office, the next US presidential administration should deliver and support a clear compelling national call for citizens and leaders in all sectors to take well-informed action in response to current climate change science in their workplace and home life.

With the assistance of federal, educational, business and NGO coalitions, the American Association for Retired Persons (AARP) should develop and implement a climate change education campaign for their constituency (adults over 50).

**Education Sector Recommendations:**

Textbook publishers should integrate climate change into the long term development of textbooks across the range of academic disciplines. In the short term, these publishers should provide multidisciplinary climate change information to supplement existing publications.

All climate change educators (instructors and curriculum developers for K-16, non-formal, and informal education) should:

- Utilize pedagogical strategies that are responsive to target audiences, (i.e. use localized examples of climate change impact incorporate financial implications of climate change).
- adopt an adaptive management approach (recognize that climate change science will continue to evolve)
Preliminary draft recommendations provided by breakout session participants - subject to review and editing

- use IPCC and other reliable sources as a framework to build trust among the public (particularly important for informal educators).
- incorporate existing and emerging social science research on framing messages.

**BREAKOUT SESSION 34: BUILDING PEOPLE’S CAPACITIES FOR IMPLEMENTING MITIGATION AND ADAPTATION ACTIONS**

- Tailor message to audience (appropriately research target audience, use appropriate messenger with appropriate target audience)
  - Communicating with Individuals – connect climate change solutions to every-day actions/decisions, explain it to people using things they understand in their everyday life, gradually build social norms and trends towards climate change solutions, utilize status symbols to drive initial changes, use funny messages/cartoons to convey information, make it personal, focus on one message at a time, use analogies, focus on addressing people's motivation to act, skill sets, and permission to act
  - Educating Community – provide/encourage community activities/involvement,
  - Mass Education - use multiple media pathways (school curriculum, wiki, commercials, gyms, collect personal stories of “Why I care about Climate Change” like PostSecret), train teachers
- measure effectiveness of communication strategies and continually improve
- address paradoxical issues and false beliefs
- provide empowerment, opportunity to get involved
- tap into positive motivators, focus on immediate benefits of climate mitigation
- frame issue as a generational problem
- encourage innovative behavior
- reduce barriers, make it easy for people to do something
- use school system (standardized state-level curriculum in schools) to improve science literacy, spread climate change solutions
- create youth-produced advertisements to publicize awareness/solutions (maybe funded by wealthy)

**BREAKOUT SESSION 35: CLIMATE CHANGE AND HUMAN HEALTH: ENGAGING THE PUBLIC HEALTH COMMUNITY**

- Research
  - Congress should substantially increase funding for research on health impacts of climate change.
  - CCSP should create a working group to review and coordinate all federal research related to health impacts of climate change.
  - Policymakers should include life-cycle analysis of the potential health, environmental, economic, and social consequences and co-benefits when considering proposed technologies or practices to mitigate or adapt to climate change. This analysis is especially important for energy technologies and practices.
- Legislative

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Preliminary draft recommendations provided by breakout session participants - subject to review and editing
Congress should support an increase in surveillance, monitoring, and response capacity for climate change related health impacts in local, state, and federal public health agencies, with an emphasis on defining and protecting vulnerable populations.

Congress should include assessment of health impacts, positive and negative, of all technologies and policies related to climate change adaptation and mitigation in relevant legislation.

- Education
  - A national campaign should be initiated to educate the general public about the local and broader health implications of climate change.
  - Curricula on climate change and health should be incorporated at all levels of education with a special emphasis on programs in health and environmental studies.

- Collaboration Development
  - Local, state, and federal public health departments should institutionalize collaborative relationships with a broader array of other governmental and non-governmental organizations responsible for policies and projects about climate change and health.

- Global Outreach
  - The United States should collaborate with international organizations to help the poorest and most vulnerable countries and populations develop sustainable economies and increase their adaptive capacity to negative impacts of climate change.

In addition, we endorse the recommendations on emerging infectious diseases and other health implications of climate change published in the 2007 Report on the Seventh National Conference on Science, Policy, and the Environment.