U.S. Climate Change Technology Program (CCTP) Overview

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Dialogue on Long-Term Cooperative Action to Address Climate Change by Enhancing Implementation of the Convention

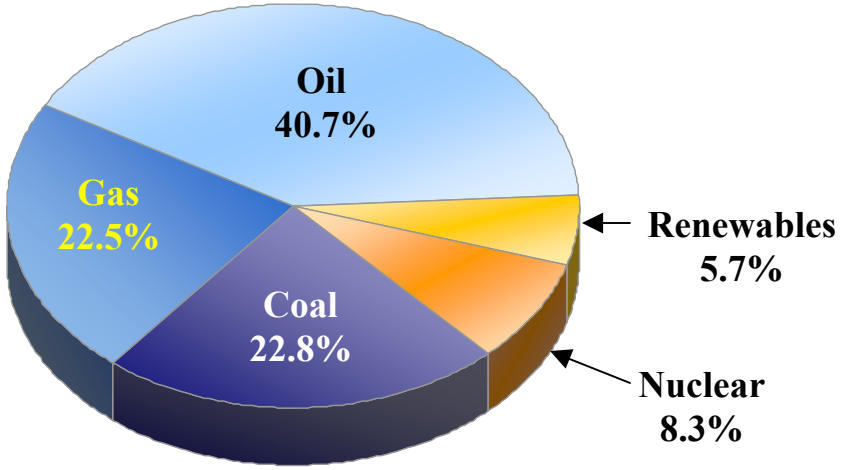
Third Workshop

Bonn, Germany
May 16, 2007

U.S. Energy Consumption and Electricity Generation Profile: 2006

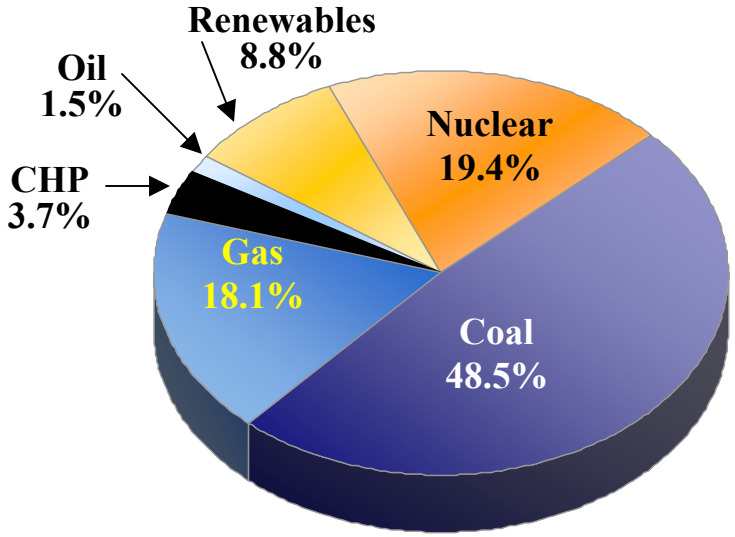
Total U.S. Energy Consumption

98.9 Quadrillion Btus (86.0% Fossil)



Total U.S. Electricity Generation

4,053 TWh (68.0% Fossil)

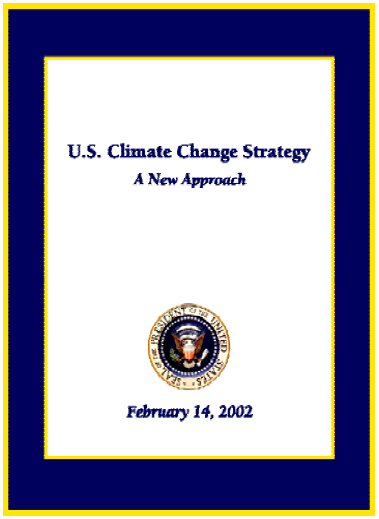


Source: Energy Information Administration (EIA), *Short-Term Energy Outlook*, May 8, 2007. (http://www.eia.doe.gov/emeu/steo/pub/contents.html)

U.S. Approach

I reaffirm America's commitment to the United Nations Framework Convention and its central goal, to stabilize atmospheric greenhouse gas concentrations at a level that will prevent dangerous human interference with the climate.

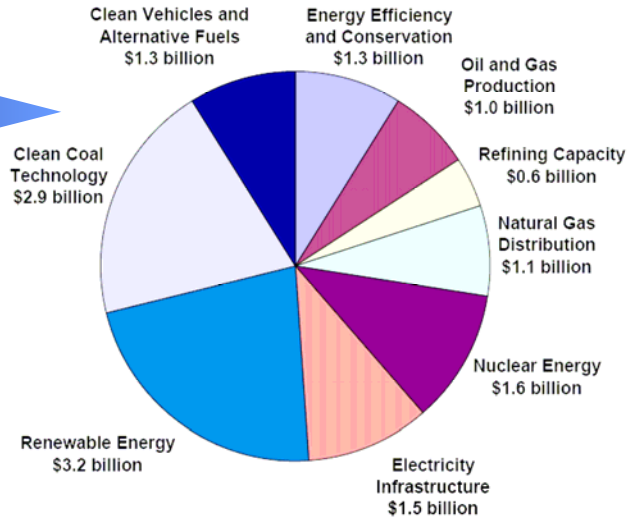
—President George W. Bush
February 14, 2002



- **Harnesses the power of markets and technological innovation, maintains economic growth, and encourages global participation.**
- **Reaffirms U.S. commitment to the UNFCCC.**
- **Integrated into the broader context of development agenda:**
  - Promote Economic Growth
  - Reduce Poverty/Meet Basic Human Needs
  - Good Governance
  - Enhance Energy Security
  - Reduce Pollution
  - Mitigate Greenhouse Gas Emissions
- **Four basic elements:**
  - Near-term policies & measures, including tax incentives
  - Improved climate science ($12.8 Billion 2001-2007)
  - Advanced technologies
  - International cooperation

Domestic Policy

- **Tax Law Changes**
  - Promote investment in new, efficient equipment
- **Energy Policy Act of 2005**
  - $11.5 Billion Clean Technology Tax Incentives.
  - Loan guarantees of up to 80% of project costs to accelerate commercial deployment of advanced energy technologies.
  - Standby coverage for certain regulatory delays for up to 6 r nuclear power plants.
  - $1.65 billion in tax credits for clean coal projects.
  - 7.5 Billion Gallon Ethanol and Biodiesel Mandate by 2012 billion gallons in 2006).
  - Appliance and Building Energy Efficiency Standards.
- **Fuel Economy Improvements**
  - 16% increase in light trucks/SUVs over 6 years (2005-2011)
  - Seeking new legislative authority for passenger cars.
  - On May 14, President Bush ordered four federal agencies to draw up regulations to reduce greenhouse gas emissions from cars and trucks by the end of 2008.



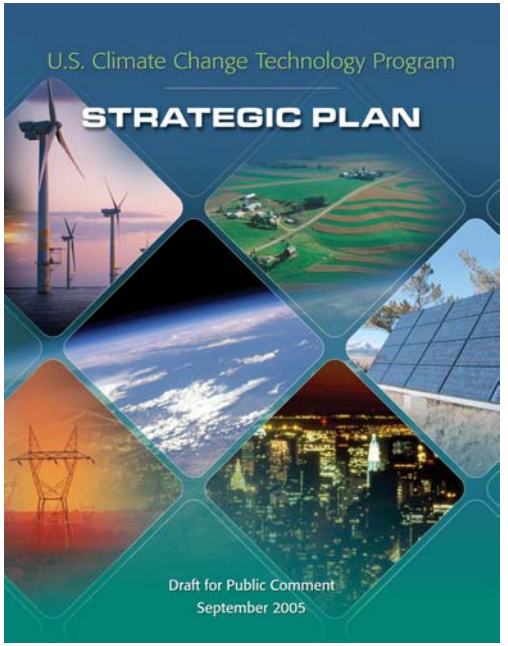
Incentives: $14.5 Billion
Offsets: $3 Billion
Total: $11.5 Billion

Clean Coal Technology

- **Energy Policy Act of 2005 authorized $1.65 billion in tax credits for clean coal projects:**
  - $800 million to support IGCC projects for electricity generation;
  - $500 million to support advanced coal electricity generation projects other than IGCC; and
  - $350 million to gasification projects for other than electricity generation (e.g., production of gases used in chemical production).
- **November 2006: Energy Secretary Samuel Bodman and Treasury Secretary Henry Paulson announced allocation of $1 billion in tax credits to support the construction of nine clean coal and advanced gasification projects in 9 States.**
  - Private investment of more than $10 Billion.
- **Remaining $650 million will be available in 2007.**

Climate Change Technology Program (CCTP)

- **World's Largest Climate Change Technology Research Program**
  - $17.8 billion 2001-2007; $3.9 Billion requested for 2008.
- **CCTP Goals**
  - Reduce emissions from energy end-use and infrastructure;
  - Reduce emissions from energy supply;
  - Capture and sequester CO_2;
  - Reduce emissions of non-CO_2 greenhouse gases;
  - Improve capabilities to measure and monitor emissions; and
  - Bolster basic science.

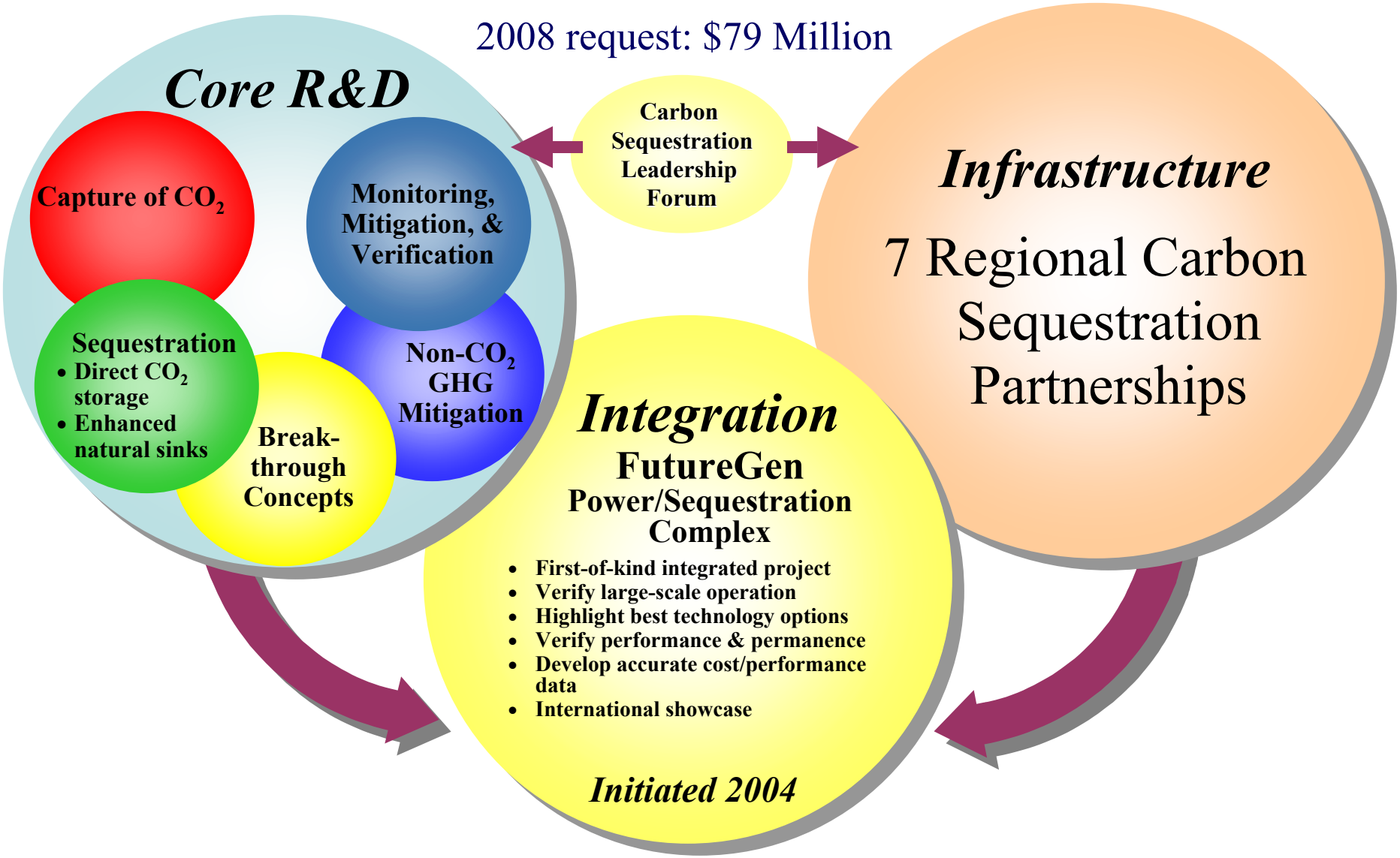


www.climatetechnology.gov

Roadmap for Climate Change Technology Development

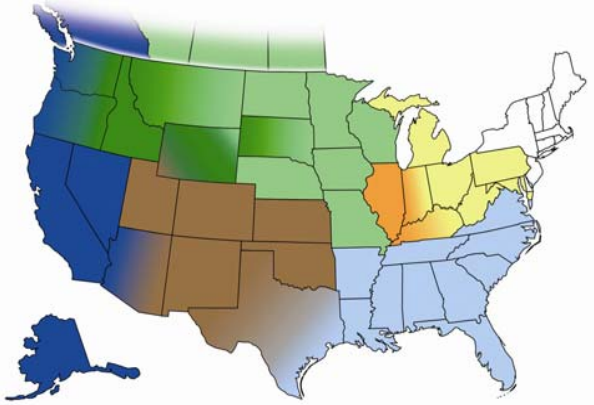
	NEAR-TERM	MID-TERM	LONG-TERM
GOAL #1 Energy End-Use & Infrastructure	• Hybrid & Plug-In Hybrid Electric Vehicles • Engineered Urban Designs • High-Performance Integrated Homes • High Efficiency Appliances • High Efficiency Boilers & Combustion Systems • High-Temperature Superconductivity Demonstrations	• Fuel Cell Vehicles and H_2 Fuels • Low Emission Aircraft • Solid-State Lighting • Ultra-Efficient HVACR • "Smart" Buildings • Transformational Technologies for Energy-Intensive Industries • Energy Storage for Load Leveling	• Widespread Use of Engineered Urban Designs & Regional Planning • Energy Managed Communities • Integration of Industrial Heat, Power, Process, and Techniques • Superconducting Transmission and Equipment
GOAL #2 Energy Supply	• IGCC Commercialization • Stationary H_2 Fuel Cells • Cost-Competitive Solar PV • Demonstrations of Cellulosic Ethanol • Distributed Electric Generation • Advanced Fission Reactor and Fuel Cycle Technology	• FutureGen Scale-Up • H_2 Co-Production from Coal/Biomass • Low Wind Speed Turbines • Advanced Biorefineries • Community-Scale Solar • Gen IV Nuclear Plants • Fusion Pilot Plant Demonstration	• Zero-Emission Fossil Energy • H_2 & Electric Economy • Widespread Renewable Energy • Bio-Inspired Energy & Fuels • Widespread Nuclear Power • Fusion Power Plants
GOAL #3 Capture, Storage & Sequestration	• CSLF & CSRP • Post Combustion Capture • Oxy-Fuel Combustion • Enhanced Hydrocarbon Recovery • Geologic Reservoir Characterization • Soils Conservation • Dilution of Direct Injected CO_2	• Geologic Storage Proven Safe • CO_2 Transport Infrastructure • Soils Uptake & Land Use • Ocean CO_2 Biological Impacts Addressed	• Track Record of Successful CO_2 Storage Experience • Large-Scale Sequestration • Carbon & CO_2 Based Products & Materials • Safe Long-Term Ocean Storage
GOAL #4 Other Gases	• Methane to Markets • Precision Agriculture • Advanced Refrigeration Technologies • PM Control Technologies for Vehicles	• Advanced Landfill Gas Utilization • Soil Microbial Processes • Substitutes for SF_6 • Catalysts That Reduce N_2O to Elemental Nitrogen in Diesel Engines	• Integrated Waste Management System with Automated Sorting, Processing & Recycle • Zero-Emission Agriculture • Solid-State Refrigeration/AC Systems
GOAL #5 Measure & Monitor	• Low-Cost Sensors and Communications	• Large Scale, Secure Data Storage System • Direct Measurement to Replace Proxies and Estimators	• Fully Operational Integrated MM Systems Architecture (Sensors, Indicators, Data Visualization and Storage, Models)

Carbon Sequestration



Regional Sequestration Partnerships: A Phased Approach

- **Phase I (Characterization)**
  - 7 Regional Partnerships (>240 organizations spanning 40 states, 3 Indian nations & 4 Canadian provinces)
  - 24 months (2003-2005)



Regional CCS Partnerships

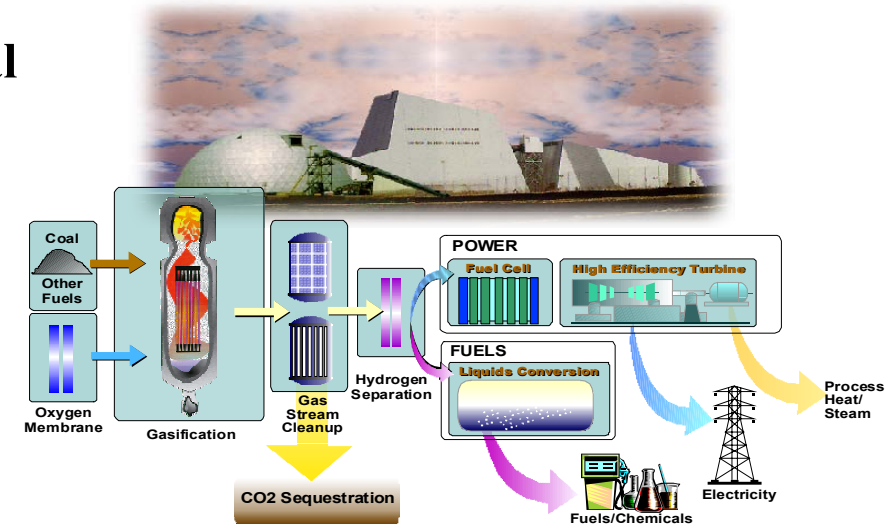
- **Phase II (Field Validation Tests)**
  - 4 years (2006 - 2009)
  - All seven Phase I partnerships continued
  - November 2005 – solicitation for up to $100 million in federal funds
  - $45 million in cost share

- **Phase III (Measurement, Monitoring &Validation & Integration)**
  - 2008-2017
  - Significance to FutureGen and public policy

FutureGen

- **A U.S.-led, 10-year, approximately $1 billion international public-private partnership to pioneer coal-to-hydrogen and carbon management technologies for coal.**

- **FutureGen will be the world's first zero-emission power plant and an international test facility that:**
  - Pioneers advanced hydrogen production from coal;
  - Emits virtually no air pollutants; and
  - Captures and permanently sequesters carbon dioxide.

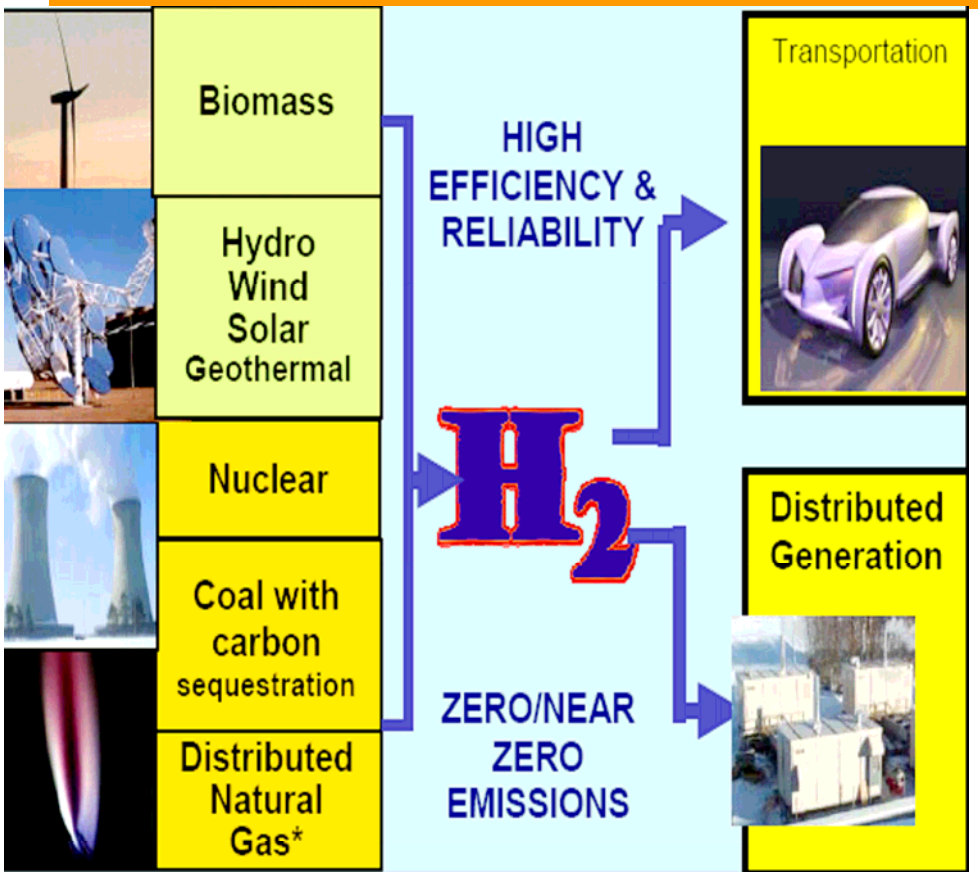


- **U.S. Department of Energy (DOE) requesting $108 million for 2008.**

- **DOE to share project costs with the private sector FutureGen Alliance (11 large coal and power producers from Australia, China, UK, and U.S.), which has pledged $250 million.**

- **Governments of India and South Korea have pledged $10 million each; China has announced it will join.**

Hydrogen Fuel Initiative



- **Integrating technologies for:**
  - Hydrogen production **from fossil, nuclear, and renewable resources.**
  - Infrastructure development**, including delivery and storage.**
  - Fuel cells **for stationary and transportation applications.**
- **Goal: Go-no decision by business in 2015; deployment beginning 2020.**

Biofuels Initiative

- **Goal: Make production of cellulosic ethanol from corn and other organic materials available as a competitive energy alternative by 2012.**
- **Next generation biorefineries will be fully integrated facilities that can process grain or biomass crops into a full range of commodity and consumer products.**
- **2008 request: $179 Million.**
- **February 2007: DOE announced up to $385 Million for 6 biorefinery projects expected to produce more than 130 million gallons of cellulosic ethanol per year.**

Biorefinery Concept

"Twenty in Ten"

- **President Bush announced the "Twenty in Ten" plan to reduce U.S. gasoline usage by 20 percent in 10 years in his 2007 State of the Union Address.**

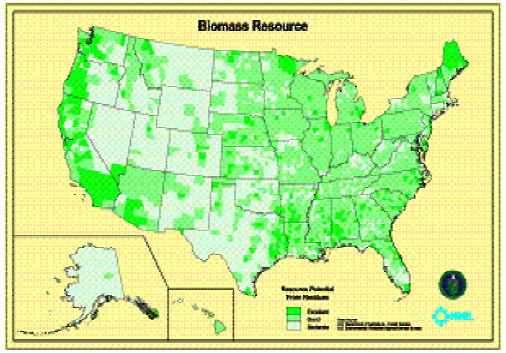
- **America will reach President's goal in 2017 by:**

  - Increasing the required renewable and alternative fuel content of gasoline to 35 billion gallons; and
  - Reforming CAFE fuel economy standards for cars and extending the current rule for light trucks**.**

- **Plan will help:**

  - Increase U.S. energy security; and
  - Address climate change concerns by significantly reducing and potentially stopping the growth in GHG emissions from cars and light trucks, potentially avoiding up to 170 million metric tonnes of CO2-equivalent in 2017**.**

- **President Bush also directed the Federal Government to reduce oil consumption in fleet vehicles, increase use of renewables/alternative fuels and power, and reduce GHG emissions.**



It's in our vital interest to diversify America's energy supply—the way forward is through technology. We must continue changing the way America generates electric power, by even greater use of clean coal technology, solar and wind energy, and clean, safe nuclear power. We need to press on with battery research for plug-in and hybrid vehicles, and expand the use of clean diesel vehicles and biodiesel fuel. We must continue investing in new methods of producing ethanol, using everything from wood chips to grasses, to agricultural wastes.

President George W. Bush
2007 State of the Union Address

Nuclear Power

- **Nuclear Power 2010:** $1.1 Billion government/private sector partnership to license new reactors and for private industry to obtain licenses for new designs that could result in new power plants ordered by 2009 and operating by 2014:
  - 2008 request: $114 Million.
- **Advanced Fuel Cycle Initiative:** Develop advanced, proliferation resistant nuclear fuel technologies that maximize the energy produced from nuclear fuel while minimizing wastes.
  - 2008 request: $395 Million.
- **Generation IV Nuclear Energy Systems Initiative:** R&D into the next generation of nuclear power plants that are safe, economical, secure, and proliferation resistant.
  - 2008 request: $36 Million.
- **Nuclear Hydrogen Initiative:** R&D into technologies that use nuclear reactors to produce hydrogen, including thermochemical water-splitting cycles, high-temperature electrolysis, and alternative technologies.

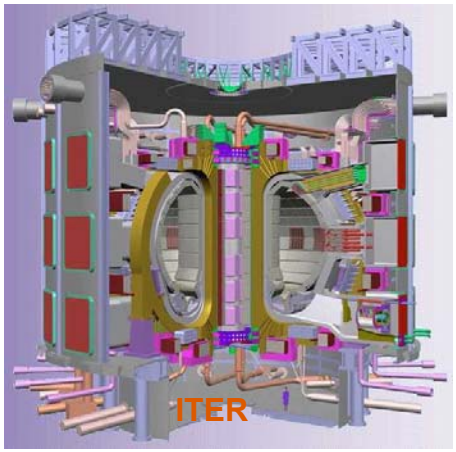
ITER Fusion Energy Project

- A multilateral collaborative project among the U.S., China, E.U., India, Japan, Russia, and South Korea to design and demonstrate a fusion energy production system.

- Fusion power has many advantages:
  - Produces zero GHG emissions.
  - Reactors cannot "melt down" and do not generate high-level radioactive waste.
  - Plentiful Fuel: Lithium and deuterium fuels are both readily available natural resources.

- Cadarache, France selected as ITER site.

- November 2006: Partners signed an agreement to construct the project.
  - Scheduled for completion in 2015.
  - 2008 request: $160 Million.
  - Total value of the U.S. contribution: $1.122 Billion



http://www.iter.org

Advanced Energy Initiative

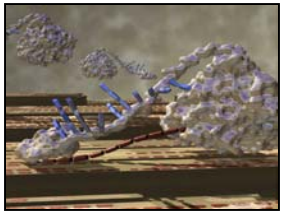
- **Goal: Alter the way we power our homes, automobiles & businesses within 20 years.**

- **President's 2008 budget will request a 26% increase in AEI above 2007, including:**

  - Clean Coal Initiative: $385 Million
  - Solar America Initiative: $148 Million
  - Biofuels Initiative: $179 Million
  - Hydrogen Fuel Initiative: $309 Million
  - Advanced Battery Research: $42 Million
  - FutureGen: $108 Million
  - Nuclear Power 2010: $114 Million
  - Global Nuclear Energy Partnership: $405 Million

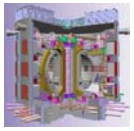
    ✓ Responds to the challenges of:

    – Global terrorism – threat of nuclear proliferation;
    – Anticipated 50% growth in energy demand by 2025; and
    – Nuclear waste.



International Technology Partnerships

- ***Carbon Sequestration Leadership Forum (CSLF)*** — 22 members: Focused on CO2 capture & storage technologies.
- ***International Partnership for the Hydrogen Economy (IPHE)*** — 17 members: Organizes, coordinates, and leverages hydrogen RD&D programs
- ***Generation IV International Forum (GIF)*** — 11 members: Devoted to R&D of next generation of nuclear systems.



- ***ITER*** — 7 members: Project to demonstrate the scientific and technological feasibility of fusion energy.
- ***Methane to Markets Partnership*** — 20 members: Recovery and use of methane from landfills, mines, agriculture, and natural gas production systems. Aims to capture 50 million metric tons CO2 equivalent by 2015.
- ***Asia-Pacific Partnership on Clean Development & Climate*** — 6 members; focuses on accelerating deployment of technologies to address energy security, air pollution, and climate change.
- ***Global Nuclear Energy Partnership*** — Seeks worldwide consensus on enabling expanded use of nuclear energy using a nuclear fuel cycle that enhances energy security, while promoting non-proliferation.