

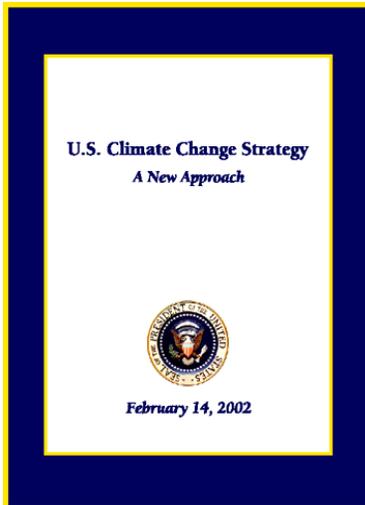
The Carbon Journey: Understanding Global Climate Effects and Advancing Solutions

Climate Change: What is the U.S. Doing About It?

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Boston, MA

U.S. Approach



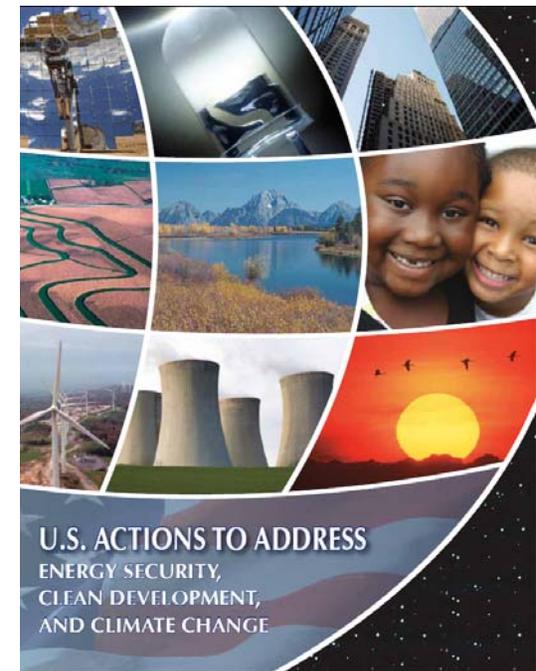
I reaffirm America's commitment to the United Nations Framework Convention and its central goal, to stabilize atmospheric greenhouse gas concentrations at a level that will prevent dangerous human interference with the climate.

President George W. Bush
February 14, 2002

- U.S. Reaffirms its Commitment to the UNFCCC's Ultimate Goal
- Supports the Bali Roadmap (2007) to a post-Kyoto Agreement
- Committed to Working with other Nations to Agree on a Global Outcome that is:
 - **Environmentally Effective**
 - Actions by All the World's Largest Emitters
 - Measurable, Reportable, and Verifiable
 - If all OECD Nations went to ZERO, GHGs Would Still Rise
 - **Economically Sustainable**
 - Must Uphold the Hopes of All Peoples for a Better Life
 - Must Speed Development of Better, Cheaper Technologies
- Places Climate Change in an Integrated Context, including:
 - ❖ Enhancing Energy Security,
 - ❖ Encouraging Economic Growth, and
 - ❖ Reducing Pollution
- Four Basic Elements Are:
 - ❖ Near-term Policies & Measures, including Financial Incentives;
 - ❖ Improved Climate Science;
 - ❖ Advanced Technologies with Lowered Costs; and
 - ❖ International Cooperation

Near-Term Policies and Measures

- **Voluntary Programs**
 - Climate Leaders
 - Climate VISION
 - Energy Star and Natural Gas Star
 - SmartWay Transport Partnership
 - Voluntary GHG Emission Registry “EPACT 1605(b)”
 - Green Power Partnership (EPA)
- **Incentives for Investment**
 - Tax incentives for Conservation, Energy Efficiency, Renewable Energy, & Alternative Fuel Vehicles
 - Incentives for Agricultural GHG Sequestration
 - USAID’s Global Climate Change Program
 - Global Environmental Facility Fund
 - Farm Bill Conservation*
 - Tropical Forest Conservation Act
- **Mandates (EISA 2007)**
- **Executive Orders**
 - Strengthening Federal Government Environmental, Energy, and Transportation Management
- **State Programs**



<http://www.state.gov/goes/climate/>

* Biological sequestration (forests), \$1.6B for energy innovation, and \$2B in loans for advanced biofuel plants

Financial Incentives

Existing Tax Incentives

- **Efficiency & Transportation**
 - Hybrid and Fuel Cell Vehicles (Tax Credit)
 - Clean Fuel Cars, Truck and Refueling Stations
 - Tax Credits for Energy Efficient Building Improvements (Residential and Commercial)
 - Tax Credits for Construction of Energy Efficient Homes
 - Exclusion of Utility Conservation Subsidies
- **Renewable Energy**
 - Renewable Energy Production Credits
 - Residential Solar Energy (Tax Credits)
 - Investment Tax Credits for Solar, Geothermal
 - Hydroelectric, Biomass Elec. (Excl. of Interest on Bonds)
 - Biomass Ethanol (Exemption from Excise Taxes)
- **Low-Carbon Fossil**
 - Coal Bed Methane (Production Credit)
- **Other and Crosscutting**
 - Industry Tax Credits for Landfill Gas and Combined Heat and Power

New Tax Incentives*

- **Efficiency & Transportation**
 - Conservation and Energy Efficiency
 - Tax Credit for Efficient Vehicles
- **Renewable Energy**
 - Extend Renewable Electricity Production Credit (e.g., Home Solar)
 - Renewable Energy Bonds
 - Renewable Content in Gasoline (e.g., Ethanol)
- **Low-Carbon Fossil**
 - Clean Coal Investment Tax Credit
- **Nuclear**
 - Production Credit for Advanced Nuclear,
 - Nuclear Decommissioning,
 - Risk Insurance
- **Other and Crosscutting**
 - Energy Infrastructure (Transmission)
 - Loan Guarantees for Power and Fuels

*EPA05, EISA07, & Omnibus FY08 Appropriation

Recent Mandates

- **Mandatory Renewable Fuel Standard (RFS)**
 - Requires fuel producers to use at least 36 billion gallons of biofuel by 2022.
- **Corporate Average Fuel Economy (CAFE)**
 - Increases the national fuel economy standard to 35 miles per gallon by 2020.
- **Appliance and Lighting Efficiency Standards**
 - Sets energy efficiency standards for light bulbs (phase-out of incandescent lights)
 - Sets standards for residential and commercial appliances (More than 40 appliances).
- **Energy Savings in Buildings and Industry**
 - Increases energy efficiency of residential, commercial, and Federal buildings
 - Increases energy efficiency of industrial equipment and processes
- **State Renewable Portfolio Standards (24 States)**

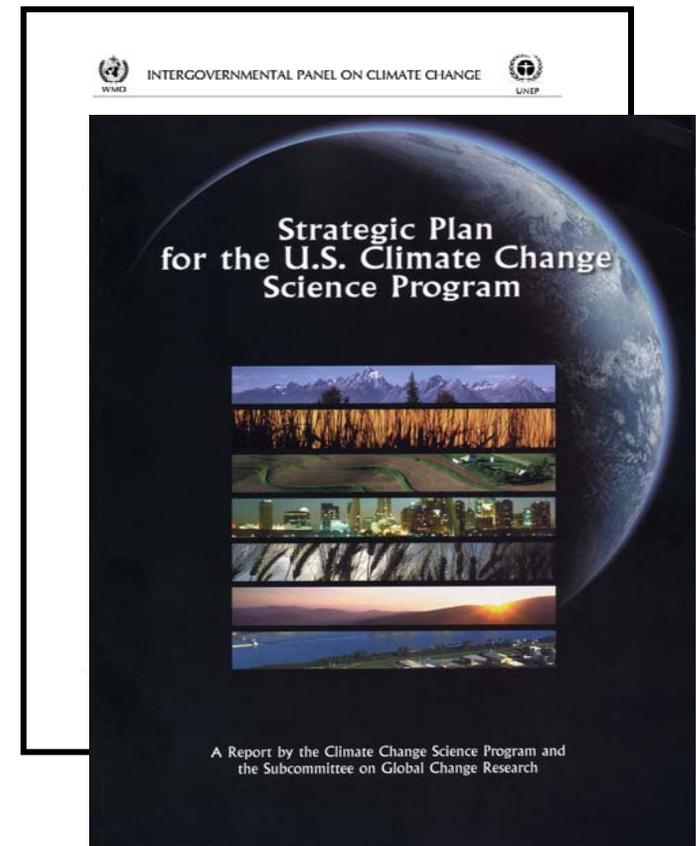
State Programs

States & D.C.	GHG Emissions Targets	Renewable Portfolio Standards	Vehicle GHG Standards	Regional GHG Initiatives	Climate Action Plans	Climate (GHG Reduction) Registries	Public Benefit Funds (Taxes on Energy for R&D, Deployment)	Green Pricing	Biofuels Mandates or Incentives	Energy Efficiency Standards
Alabama					✓			✓		
Alaska				✓		✓			✓	
Arizona	✓	✓	✓	✓	✓	✓	✓	✓		
Arkansas									✓	
California	✓	✓	✓	✓	✓	✓	✓	✓		✓
Colorado		✓		✓	✓	✓		✓	✓	✓
Connecticut	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
D.C.		✓								
Delaware		✓		✓	✓		✓		✓	
Florida								✓		
Georgia						✓		✓		
Hawaii		✓		✓	✓	✓	✓	✓	✓	
Idaho				✓		✓		✓	✓	
Illinois		✓			✓	✓	✓	✓	✓	✓
Indiana					✓	✓		✓	✓	
Iowa		✓		✓	✓	✓		✓	✓	
Kansas				✓					✓	
Kentucky					✓			✓	✓	
Louisiana									✓	
Maine	✓	✓	✓	✓	✓	✓	✓		✓	
Maryland		✓		✓	✓				✓	
Massachusetts	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Michigan						✓	✓	✓	✓	
Minnesota		✓		✓	✓	✓	✓	✓	✓	
Mississippi								✓	✓	

States & D.C.	GHG Emissions Targets	Renewable Portfolio Standards	Vehicle GHG Standards	Regional GHG Initiatives	Climate Action Plans	Climate (GHG Reduction) Registries	Public Benefit Funds (Taxes on Energy for R&D, Deployment)	Green Pricing	Biofuels Mandates or Incentives	Energy Efficiency Standards
Missouri					✓	✓		✓	✓	
Montana		✓		✓	✓	✓	✓	✓	✓	
Nebraska				✓				✓		
Nevada		✓		✓			✓			✓
New Hampshire	✓			✓	✓	✓	✓			
New Jersey		✓	✓	✓	✓	✓	✓			✓
New Mexico	✓	✓	✓	✓	✓	✓	✓	✓		
New York	✓	✓	✓	✓	✓	✓	✓		✓	
North Carolina					✓	✓		✓	✓	
North Dakota				✓		✓		✓	✓	
Ohio						✓	✓	✓	✓	
Oklahoma								✓	✓	
Oregon	✓		✓	✓	✓	✓	✓	✓		
Pennsylvania		✓	✓		✓	✓	✓	✓	✓	✓
Rhode Island	✓	✓	✓	✓	✓	✓	✓		✓	
South Carolina						✓		✓		
South Dakota				✓		✓		✓	✓	
Tennessee					✓			✓		
Texas		✓		✓			✓	✓	✓	✓
Utah				✓	✓	✓		✓	✓	
Vermont	✓	✓	✓	✓	✓	✓	✓	✓		✓
Virginia										
Washington		✓	✓	✓	✓	✓		✓	✓	
West Virginia										
Wisconsin		✓		✓	✓	✓	✓	✓	✓	
Wyoming				✓		✓		✓	✓	

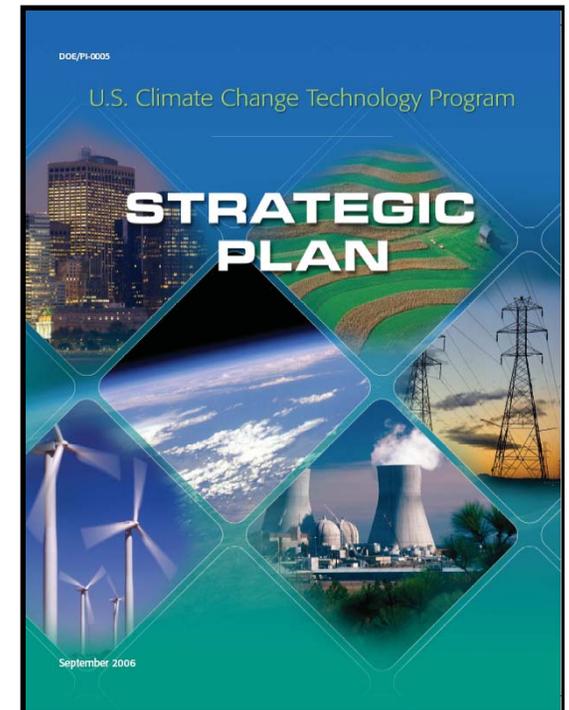
Improved Climate Science

- **U.S. Climate Change Science Program**
 - An Ambitious Program of Research (\$2 B/Year)
- **Science Has Deepened Understanding:**
 - Reduced Uncertainties
 - Helped Identify & Clarify Risks
 - Added Info With Regional Specificity
 - » Water » Big Ice
 - » Coasts » Sea Level Rise
 - » Food » Ecosystems
 - » Health » Ocean Acidification
- **Growing Awareness of Realities:**
 - Uneven Responses Internationally
 - Conditional Participation by Third World
 - Shadow Price of Avoided Emissions High
 - Pros & Cons of EU Trading System
- **Underscored Need for Ambitious Goals for Technology and Accelerated Development**



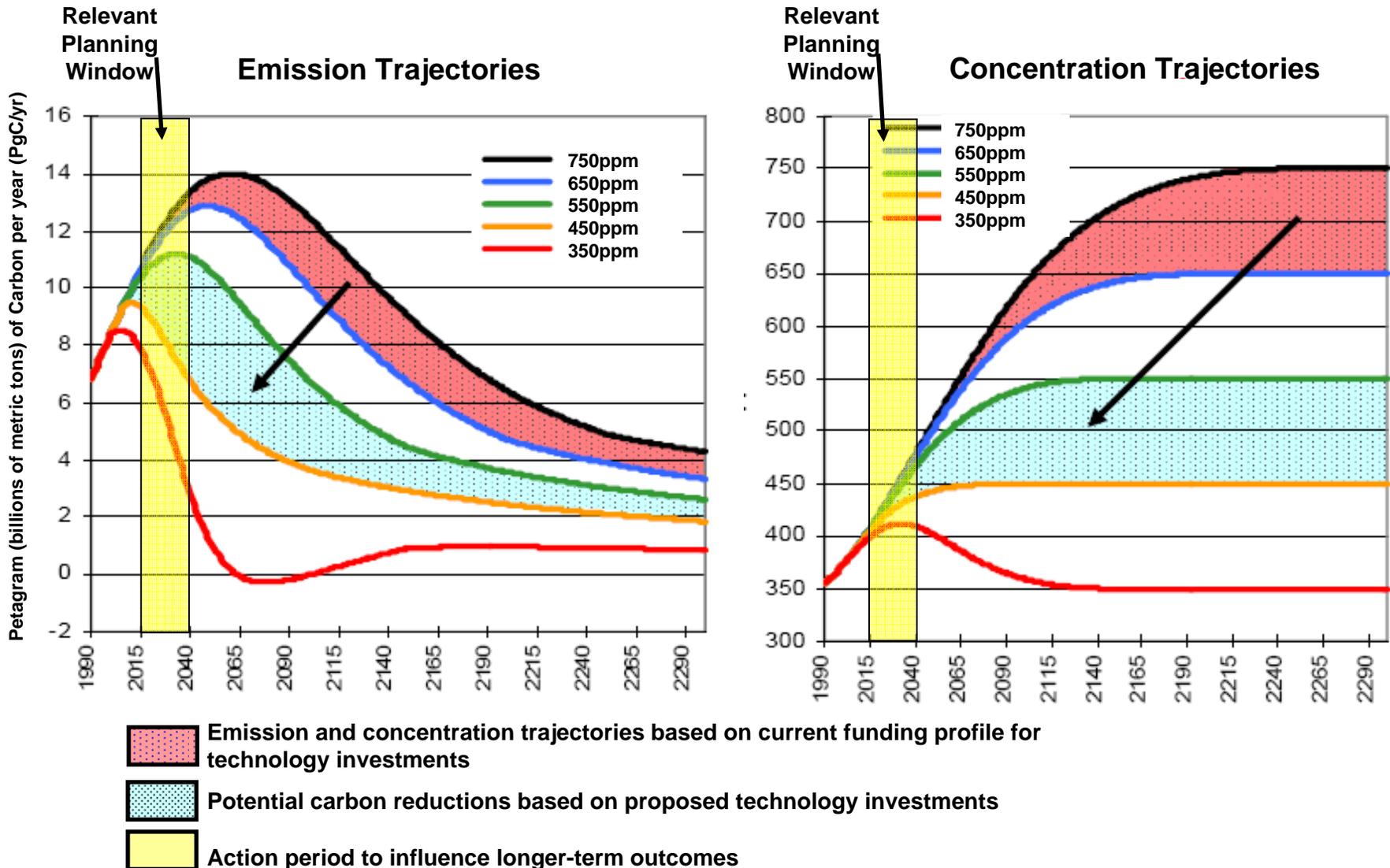
Advanced Technologies: Seeking Better and More Cost-Effective Solutions

- **U.S. Climate Change Technology Program**
 - Authorized in EPAct 2005
 - An Ambitious Program of RDD&D
 - \$4.5 Billion in FY 2009 Budget
- **Climate Technology Goals:**
 1. Reduce Emissions From Energy End Use & Infrastructure
 2. Reduce Emissions From Energy Supply
 3. Capture & Sequester CO₂
 4. Reduce Emissions From Non-CO₂ Gases
 5. Improve Capabilities to Measure & Monitor GHG
 6. Bolster Basic Science



www.climatetechnology.gov

Long-Term Goals Require Near-Term Actions



President's Technology Strategy



“Energy security and climate change are two of the great challenges of our time. These challenges share a common solution: technology.”

President George W. Bush
Major Economies Meeting
September 28, 2007

- **Key Technology Elements**
 - **Coal -- De-Carbonize the Grid**
 - » **Nuclear Power**
 - » **Low-Emission Coal Power**
 - » **Renewable Power**
 - **Cars -- Transform Cars/Trucks Toward New Fuels**
 - » **Hybrid & Electric Vehicles**
 - » **Alternative Fuel Vehicles & Bio-Based Fuels**
 - » **Alternatives, including Other Modes**
 - **Efficiency (All Sectors)**
 - **Other GHGs**
 - **Enablers**
 - » **CO₂ Capture and Storage**
 - » **Modernized Grid**
 - » **Energy Storage, Large and Small Scale**
 - » **Strategic and Exploratory Research**
- **Supporting Policies to Promote Deployment**
 - **Financial Incentives**
 - **Fuel Mandates**
 - **Codes, Standards, Labeling**
 - **Transparent System for Measuring Progress**
- **Establish U.S. Climate Change Technology Program**
 - **Strengthen Federal R&D Portfolio**
 - **Prioritize Investments**
- **Expand R&D Cooperation with non-Federal Entities**

Roadmap for Climate Change Technology Development

	NEAR-TERM	MID-TERM	LONG-TERM
GOAL #1 Energy End-Use & Infrastructure	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> Fuel Cell Vehicles and H₂ Fuels Low Emission Aircraft Solid-State Lighting Ultra-Efficient HVACR “Smart” Buildings Transformational Technologies for Energy-Intensive Industries Energy Storage for Load Leveling 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> IGCC Commercialization Stationary H₂ Fuel Cells Cost-Competitive Solar PV Demonstrations of Cellulosic Ethanol Distributed Electric Generation Advanced Fission Reactor and Fuel Cycle Technology 	<ul style="list-style-type: none"> FutureGen Scale-Up H₂ Co-Production from Coal/Biomass Low Wind Speed Turbines Advanced Biorefineries Community-Scale Solar Gen IV Nuclear Plants Fusion Pilot Plant Demonstration 	<ul style="list-style-type: none"> Zero-Emission Fossil Energy H₂ & Electric Economy Widespread Renewable Energy Bio-Inspired Energy & Fuels Widespread Nuclear Power Fusion Power Plants
GOAL #3 Capture, Storage & Sequestration	<ul style="list-style-type: none"> CSLF & CSR Post Combustion Capture Oxy-Fuel Combustion Enhanced Hydrocarbon Recovery Geologic Reservoir Characterization Soils Conservation Dilution of Direct Injected CO₂ 	<ul style="list-style-type: none"> Geologic Storage Proven Safe CO₂ Transport Infrastructure Soils Uptake & Land Use Ocean CO₂ Biological Impacts Addressed 	<ul style="list-style-type: none"> Track Record of Successful CO₂ Storage Experience Large-Scale Sequestration Carbon & CO₂ Based Products & Materials Safe Long-Term Ocean Storage
GOAL #4 Other Gases	<ul style="list-style-type: none"> Methane to Markets Precision Agriculture Advanced Refrigeration Technologies PM Control Technologies for Vehicles 	<ul style="list-style-type: none"> Advanced Landfill Gas Utilization Soil Microbial Processes Substitutes for SF₆ Catalysts That Reduce N₂O to Elemental Nitrogen in Diesel Engines 	<ul style="list-style-type: none"> Integrated Waste Management System with Automated Sorting, Processing & Recycle Zero-Emission Agriculture Solid-State Refrigeration/AC Systems
GOAL #5 Measure & Monitor	<ul style="list-style-type: none"> Low-Cost Sensors and Communications 	<ul style="list-style-type: none"> Large Scale, Secure Data Storage System Direct Measurement to Replace Proxies and Estimators 	<ul style="list-style-type: none"> Fully Operational Integrated MM Systems Architecture (Sensors, Indicators, Data Visualization and Storage, Models)

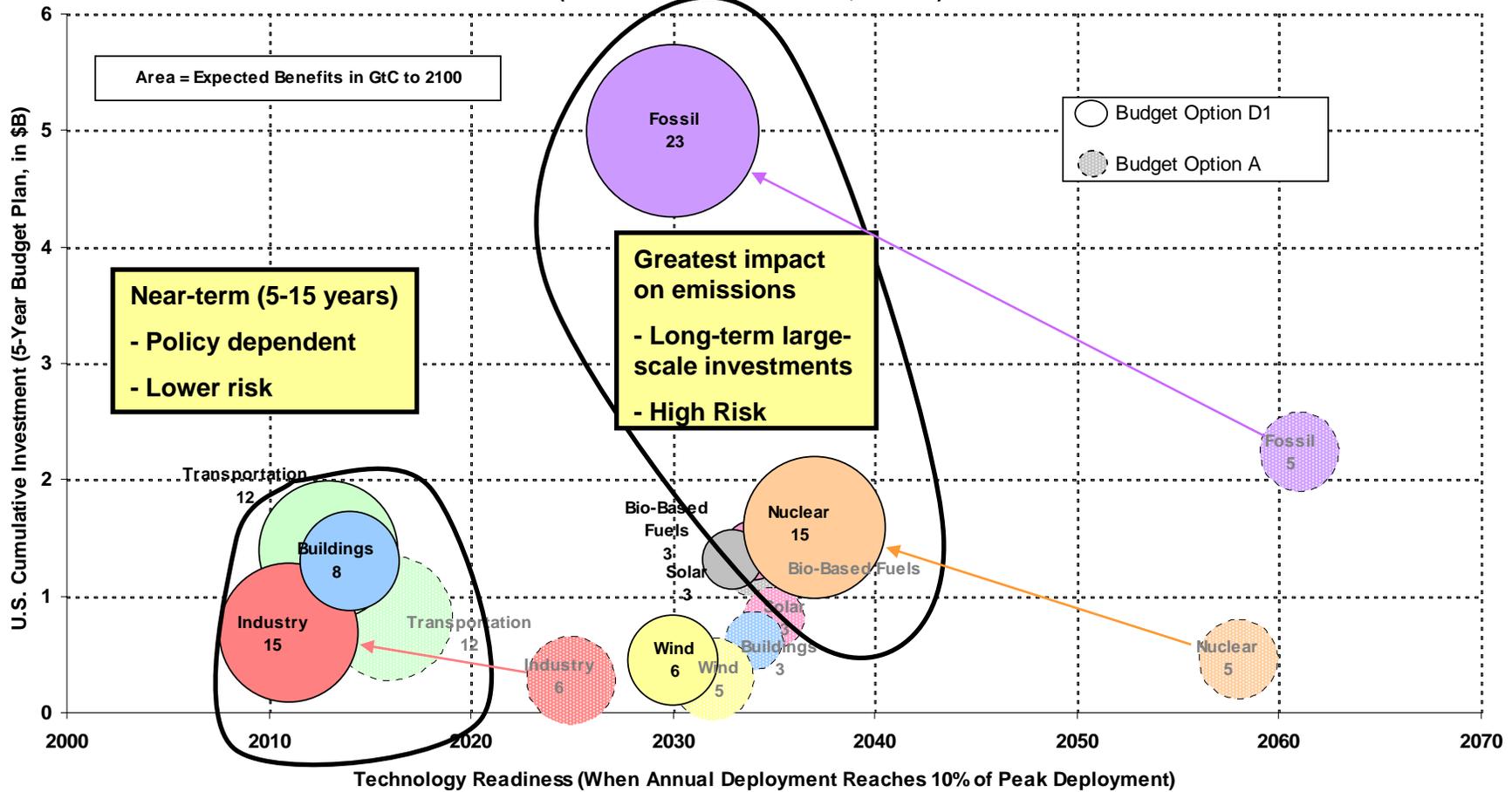
CCTP Portfolio Assessment

CCTP Strategic Goal	Key Element of Strategy		Corresponding Technologies in Portfolio Analysis	Lead	Most Challenging Technical Scenario	Units	Scenarios Years & Quantities -- U.S. Only					Likelihood of CCTP Goal Attainment*				
							2020	2030	2040	2050	2100	Very Unlikely	Unlikely	Maybe	Likely	Very Likely
1 Reducing Emissions from Energy End-Use and Infrastructure	1.1	Transportation	Primary Energy Reduction	EE	BSS 450	GtC/yr	0.10	0.14	0.19	0.23	0.34			✓	✓	
	1.2	Buildings	Primary Energy Reduction	EE	BSS 450	GtC/yr	0.04	0.08	0.11	0.14	0.15			✓		
	1.3	Industry	Primary Energy Reduction	EE	BSS 450	GtC/yr	0.12	0.17	0.21	0.24	0.18		✓			
	1.4	Electric Grid and Infrastructure	Enabling Technology, U.S. Grid Demand	OE	NEB 450	Trillion kWh/yr	6.67	7.35	7.92	8.38	9.49		✓		✓	
2 Reducing Emissions from Energy Supply	2.1	Low-Emission, Fossil-Based Fuels and Power	Electricity: Coal w/CCS	FE	CLC 450	GtC/yr	0.02	0.05	0.11	0.19	0.33		✓		✓	
			Electricity: Natural Gas w/CCS	FE	CLC 450	GtC/yr	0.02	0.04	0.08	0.15	0.26	✓				
	2.2	Hydrogen	Hydrogen Production	EE	CLC 450	Quads	2.40	3.10	4.00	5.10	7.40			✓		
	2.3	Renewable Energy and Fuels	Electricity: Solar Power	EE	NEB 450	GtC/yr	0.00	0.00	0.02	0.04	0.06		✓			
			Electricity: Wind Power	EE	NEB 450	GtC/yr	0.00	0.02	0.06	0.11	0.13		✓			
			Bio-Based Fuels	EE	BSS 450	GtC/yr	0.00	0.00	0.02	0.05	0.06				✓	
	2.4	Nuclear Fission	Electricity: Gen III Reactors	NE	NEB 450	GtC/yr	0.01	0.05	0.13	0.24	0.37			✓	✓	
Electricity: Gen IV Reactors			NE	NEB 450	GtC/yr	0.00	0.00	0.02	0.06	0.15		✓				
Electricity: International Tech. --GNEP			NE	NEB 450-W	Trillion kWh/yr	0.01	0.01	0.02	21.94	39.06		✓				
2.5	Fusion Energy	Electricity: Fusion Energy, Others	SC	BSS 450	GtC/yr	0.00	0.00	0.01	0.04	0.35	✓					
3 Capturing and Sequestering Carbon Dioxide	3.1	Carbon Capture	(Embedded in 2.1)	FE	CLC 450	GtC/yr	0.01	0.01	0.03	21.99	39.41		✓		✓	
	3.2	Geological Storage	Carbon Storage	FE	CLC 450	GtC/yr	0.04	0.09	0.20	0.35	0.61		✓		✓	
	3.3	Terrestrial Sequestration	TBD	USDA	TBD	GtC/yr	TBD									
	3.4	Ocean Sequestration	Not Applicable This Round	DOE	N/A	N/A	TBD									
4 Reducing Emissions of Non-CO ₂ Greenhouse Gases	4.1	Methane Emissions from Energy and Waste	CH ₄ in CO ₂ -Equivalence	DOE/EPA	CLC 450	GtC-Eq./yr	TBD						✓			
	4.2	Methane and Nitrous Oxide Emissions from Agriculture	TBD--CH ₄ (Part)	USDA	CLC 450	GtC-Eq./yr	TBD						✓			
			TBD--N ₂ O (Part)	USDA	CLC 450	GtC-Eq./yr	TBD						✓			
	4.3	Emissions of High Global-Warming Potential Gases	Short-Lived F-Gases in CO ₂ -Equivalence	EPA	CLC 450	GtC-Eq./yr	TBD								✓	
			Long-Lived F-Gases in CO ₂ -Equivalence	EPA	CLC 450	GtC-Eq./yr	TBD								✓	
4.4	Nitrous Oxide Emissions from Combustion and Industrial Sources	N ₂ O in CO ₂ -Equivalence	EPA	CLC 450	GtC-Eq./yr	TBD						✓				
4.5	Emissions of Tropospheric Ozone Precursors and Black Carbon	TBD	EPA	TBD	GtC-Eq./yr	TBD										
5 Enhancing Capabilities to Measure and Monitor Greenhouse Gases	5.2	MM -- Energy Production and Efficiency	N/A	DOE	N/A	N/A	Refer to Strategic Plan, Chapter 8								✓	
	5.3	MM -- CO ₂ Capture and Sequestration	N/A	DOE	N/A	N/A	Refer to Strategic Plan, Chapter 8								✓	
	5.4	MM -- Other Greenhouse Gases	N/A	EPA	N/A	N/A	Refer to Strategic Plan, Chapter 8								✓	
	5.5	MM -- Integrated Systems Architecture	N/A	SC	N/A	N/A	Refer to Strategic Plan, Chapter 8						✓			
6 Bolster Basic Science Contributions to Technology Development	6.1	Strategic Research	N/A	SC	N/A	N/A	Refer to Strategic Plan, Chapter 9								✓	
	6.2	Fundamental Science	N/A	SC	N/A	N/A	Refer to Strategic Plan, Chapter 9									
	6.3	Exploratory Research	N/A	SC	N/A	N/A	Refer to Strategic Plan, Chapter 9					✓				

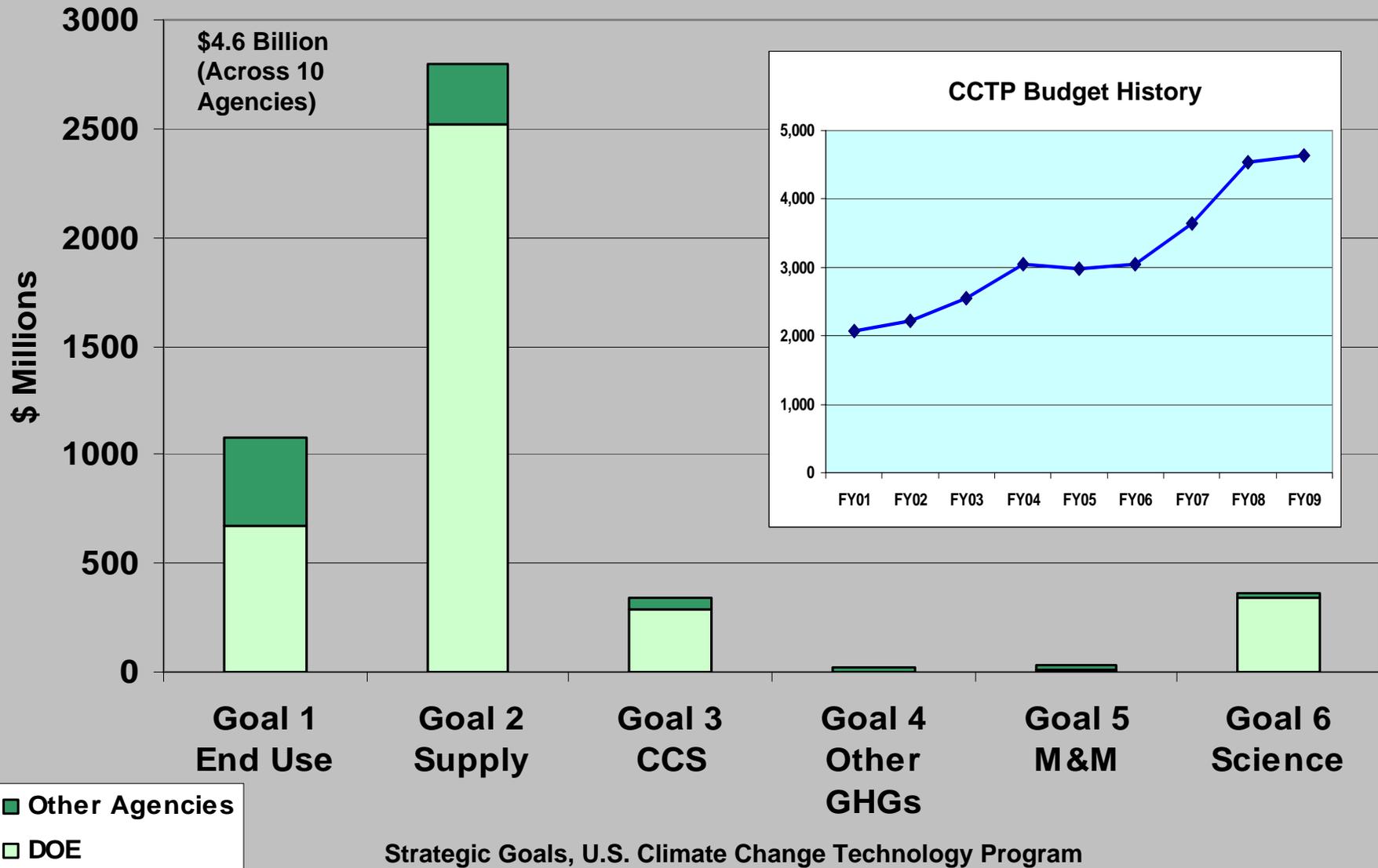
* In view of various hypothetical RD&D portfolios and other factors. Key: Very Likely (90-100%); Likely (60-90%); Maybe (40-60%); Unlikely (10-40%); Very Unlikely (0-10%)

Focus U.S. Federal RD&D Investment on High Return Areas

5-Year RD&D Investment, Technology Readiness Acceleration, and Expected U.S. Climate Change Benefits (CCTP Goals & Risk Factors; to 2100)



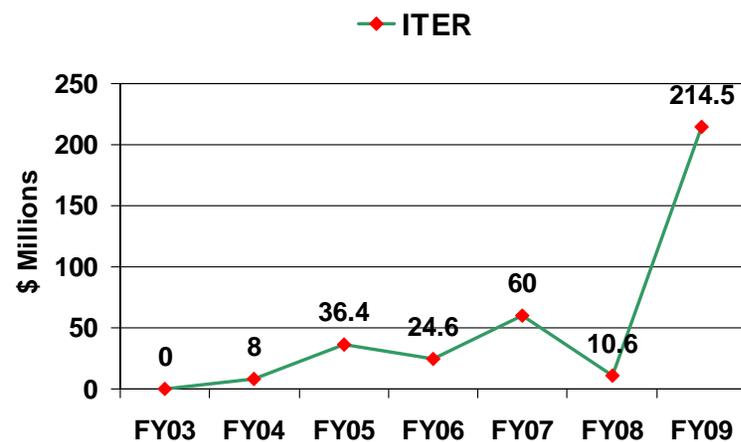
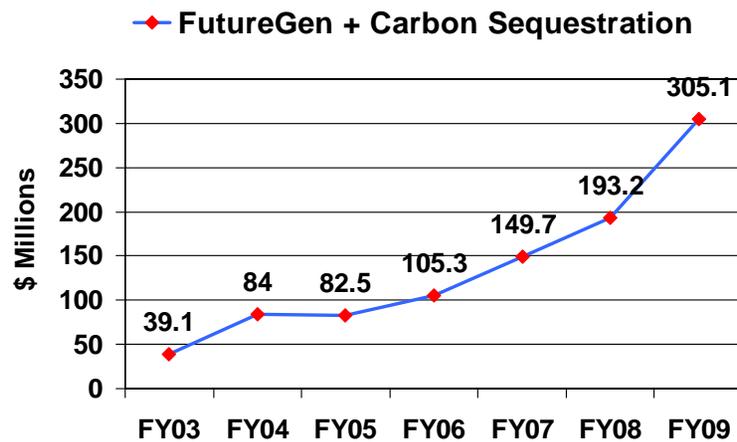
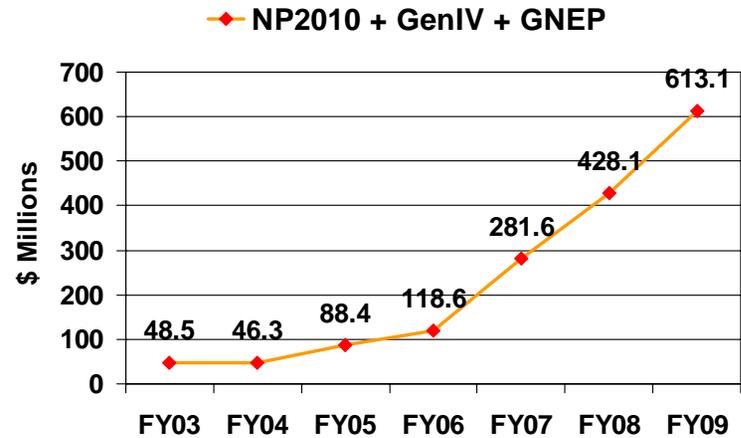
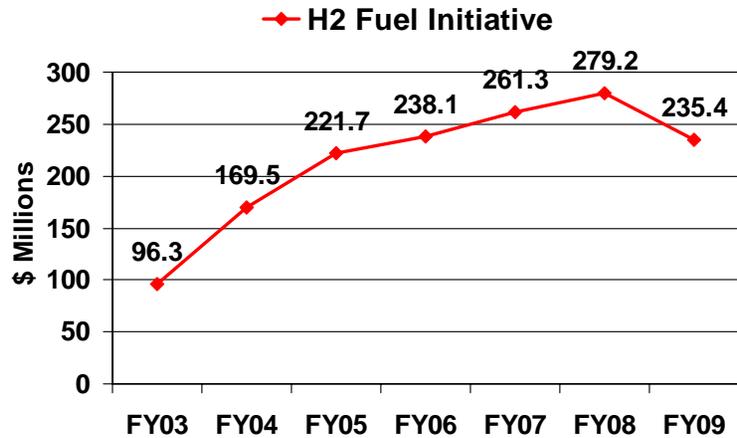
Budget for FY 2009 – Good News for CCTP



Key Technologies Well Supported

- **Energy Efficiency [\$502M] -- *Accelerated RD&D to Reduce GHG Emissions***
 - Vehicles: \$221M
 - Buildings: \$124M
- **Renewables [\$613M] -- *Increases in Biofuels and Geothermal***
 - Biomass & Biorefinery Systems R&D: \$225M
 - Geothermal Technology: \$30M
 - Solar: \$156M
 - Wind: \$52M
 - Hydrogen: \$235M
- **Coal [\$622M] -- *Largest Budget Request in Over 25 Years***
 - FutureGen: \$156M
 - CCS: \$149M
 - Clean Coal Power Initiative: \$85M
- **Nuclear [\$803M] -- *Increases to Spur First New Plants***
 - Nuclear Power 2010: \$242M
 - Advance Fuel Cycle Initiative: \$302M
- **Electricity Delivery [\$122M] -- *Increases in Energy Storage***
 - Energy Storage & Power Electronics: \$13M
 - Energy Storage R&D: \$34M (Office of Science)
 - Distributed Energy: \$33

Key Initiatives



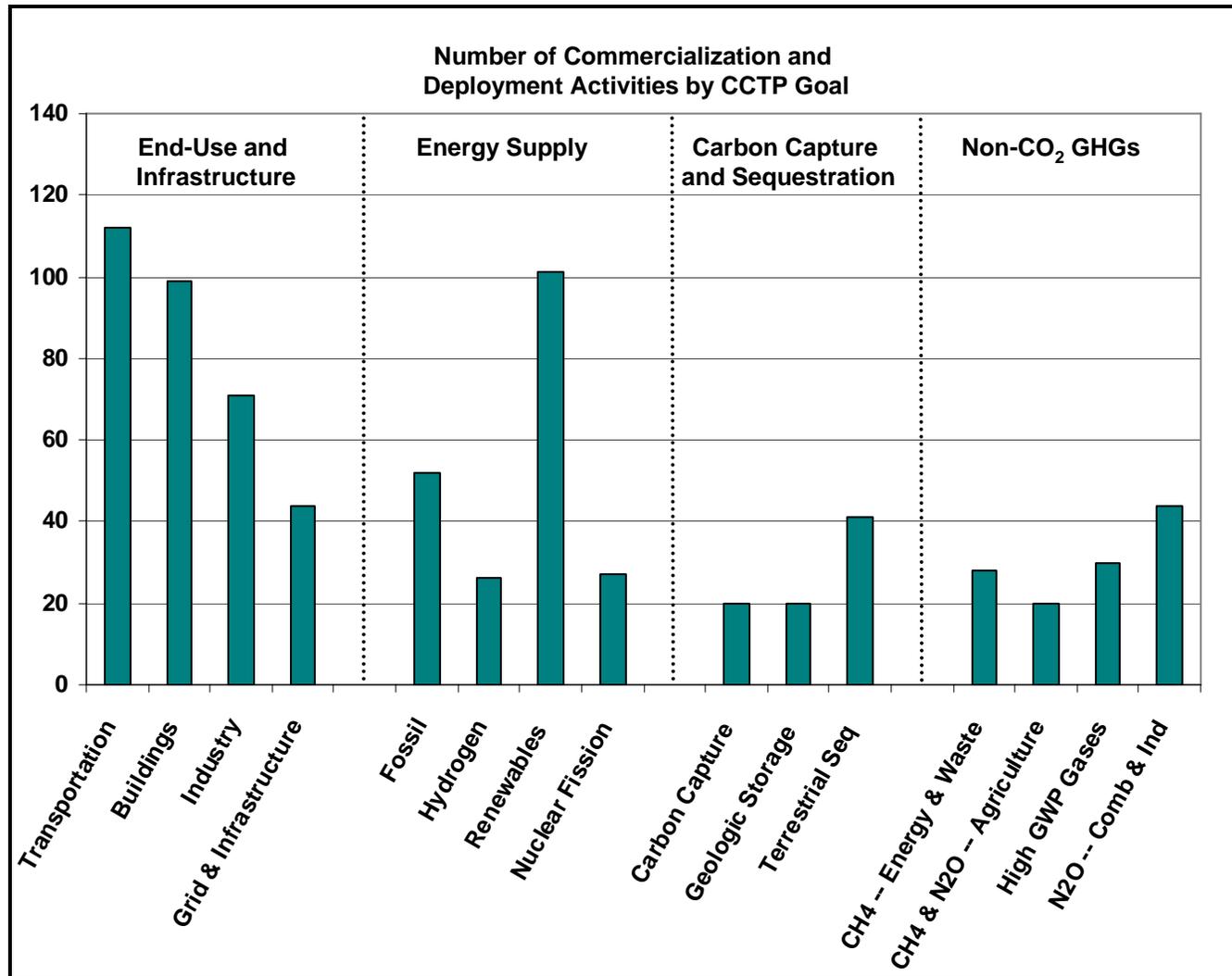
Barriers to Technology Deployment

Cost Effectiveness	Fiscal Barriers	Regulatory Barriers	Statutory Barriers	Intellectual Property Barriers	Other Barriers
High Costs	Unfavorable Fiscal	Unfavorable Regulations	Unfavorable Statutes	IP Transaction Costs	Incomplete and Imperfect Information
Technical Risks	Fiscal Uncertainty	Regulatory Uncertainty	Statutory Uncertainty	Anti-competitive Patent Practices	Infrastructure limitations
Market Risks	Unfavorable tariffs			Weak International Patent Protection	Industry Structure
External Benefits and Costs				University, Industry, Government Perceptions	Misplaced Incentives
Lack of Specialized Knowledge					Policy Uncertainty

6 Barrier Categories
21 Barriers
~50 Detailed Barriers

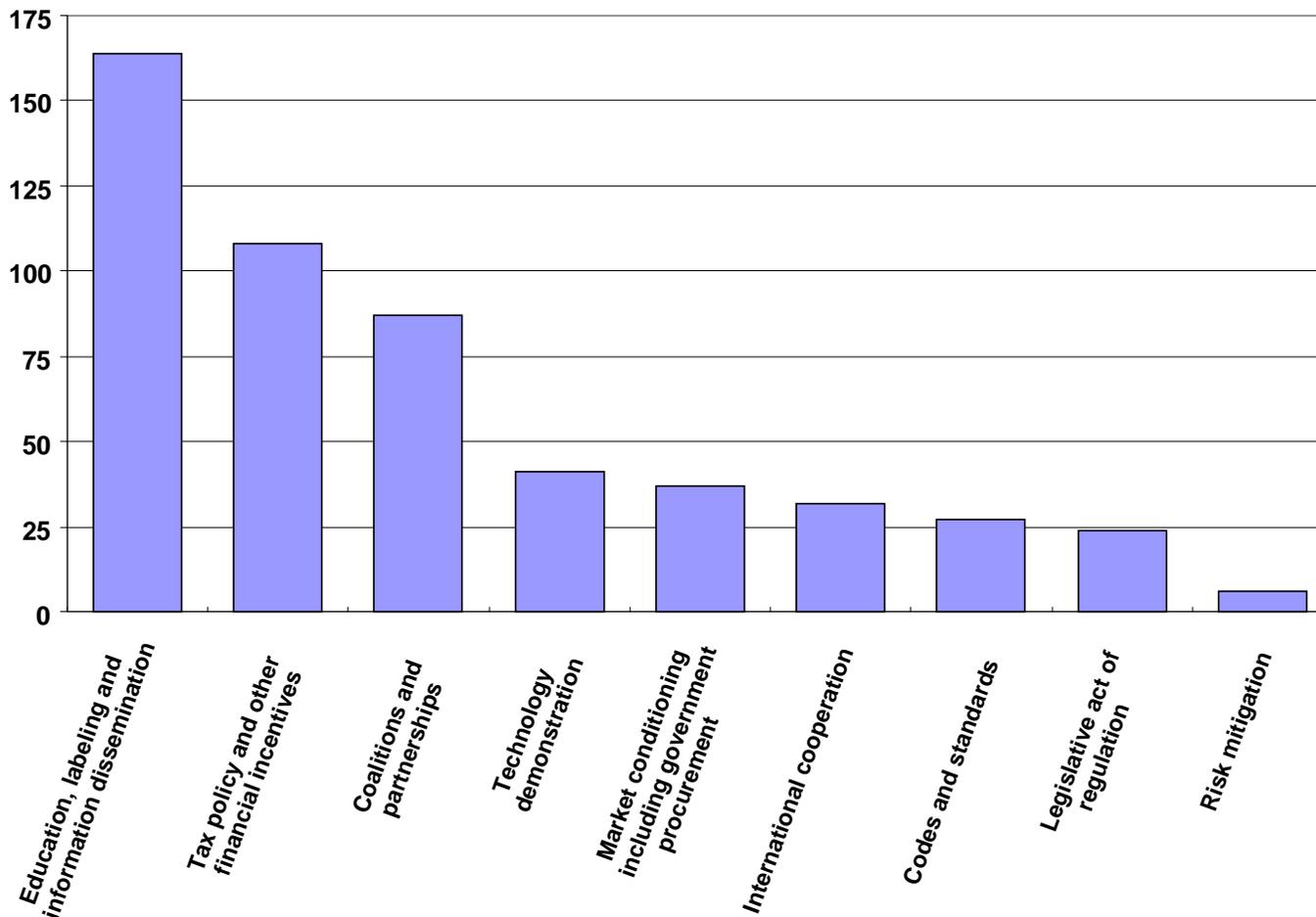
Barriers are organized into six categories consistent with EPO Act 2005 Title XVI.

More Than 400 Policies & Measures to Address Barriers



Commercialization & Deployment Policies & Measures, by Genre

Number of Government Commercialization and Deployment Activities by Type of Policy and Measure



Policy Process Underway to Address Remaining Barriers

Technology Areas	Tax Policy and Financial Incentives*	Legislative Acts and/or Regulation
Coal w/CCS	Loan Guarantees; Tax Incentives	CO2 Storage – Siting & Permitting; Monitoring; Liability
Nuclear Fission	Loan Guarantees; Tax Incentives	Waste and Fuel Management and Storage
Electric Grid and Infrastructure	Investor Incentives	Rate Structures; Transmission Corridors Renewables & Distributed Generation: Net Metering; Access Rights; Standard Interconnection Policies; Energy Storage Capacity
Transportation	Tax Credit; Manufacturing Credit; Consumer Incentives	National Regulatory Policies; Urban Planning; CAFE; Federal Fleet
Hydrogen	Loan Guarantees; Investor Incentives; Insurance	National Regulatory Policies; Safety, Codes & Standards
Bio-Based Fuels	Loan Guarantees; Production Tax Credit	Stable Subsidies; National Regulatory Policies; Biofuels Tariff; Federal Fleet
Wind Power	Loan Guarantees; Production Tax Credit	Stable Subsidies; Federal RPS; Construction Incentive; Minimum Purchase Price
Industry	Loan Guarantees; Efficiency Tax Credits; CHP Tax Credits; Sector Specific Tax Credits	Equipment Standards; Emissions Regulations; Informational Partnerships (e.g.; MEPs)
Buildings	Manufacturer and Consumer Efficiency Tax Credits; Efficient Residential and Commercial Buildings Tax Credit (builders); CHP Tax Credits	Equipment Standards; Building Codes; Gov't Procurement;
Solar Power	Loan Guarantees; Investment & Manufacturing Tax Credit; Residential & Commercial Installation Tax Credit; Extended Production Tax Credit; Clean Renewable Energy Bonds	Federal RPS; Stable Subsidies; Federal Procurement of Solar Power; Ensured Availability of Public Lands (for concentrating solar power installations)
Other Renewables	Exploration Tax Credit; Extended Production Tax Credit: geothermal, ocean energy; Clean Renewable Energy Bonds	Federal RPS; Ensured Availability of Public Lands; Federal Procurement of Geothermal Power

Green: Existing Policies
Red: Policy Options

International Framework For Addressing Climate Change

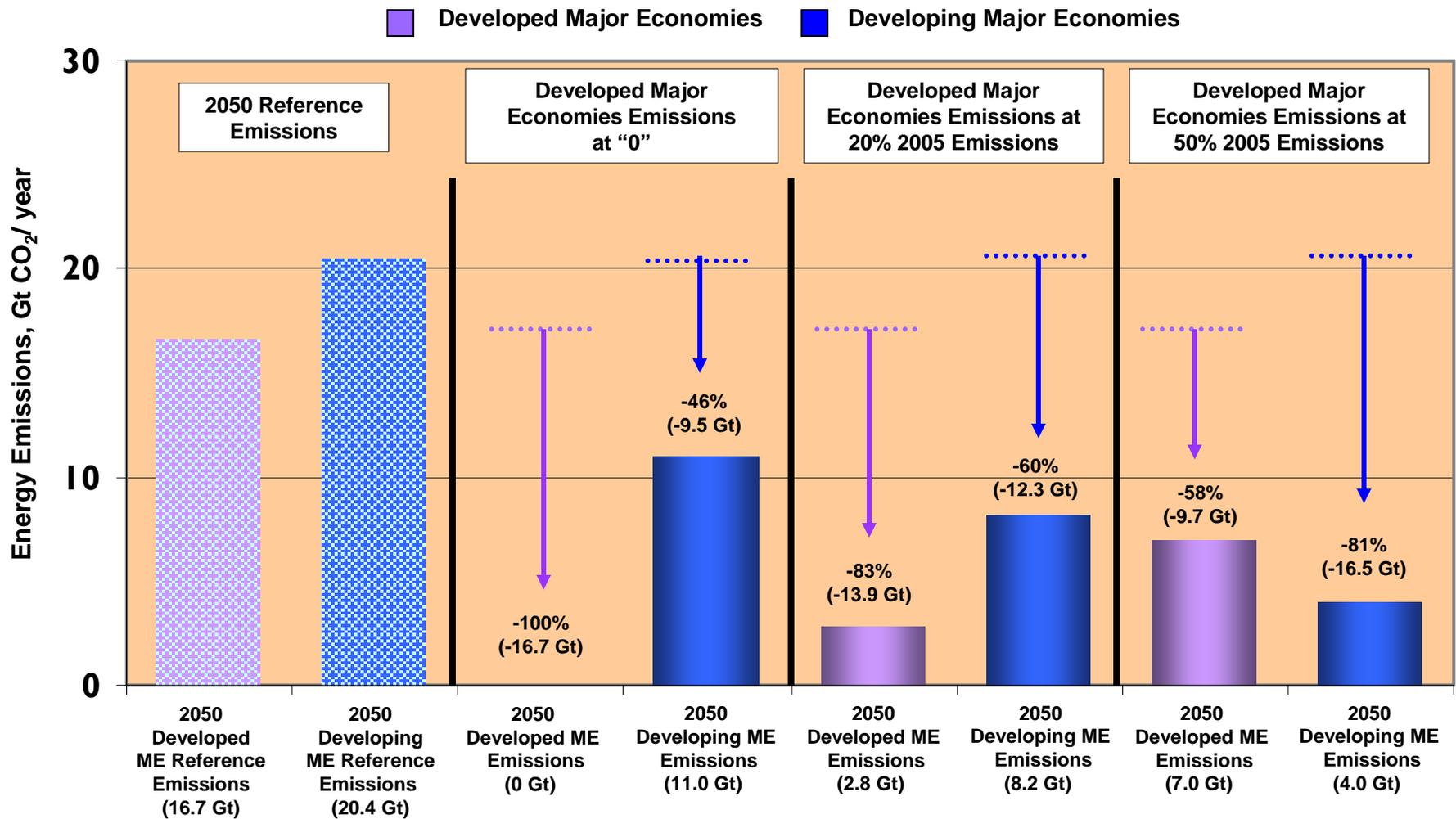
Global Action Programs

- **Asia-Pacific Partnership (7 Nations)**
 - Accounts for 50% of emissions
 - Nearly 100 actions
- **G-8 Dialogue (13-20 Nations)**
 - More than 40 programs
- **Methane to Markets (20 Nations)**
 - 180+ million tons reduced by 2015
- **Renewable Energy and Efficiency (17 Nations)**
- **12+ Bilateral Agreements on Technology and Lower Emissions**
- **Tropical Forest Conservation**
- **Stopping Illegal Logging**
- **Major Economies Process (17 Nations, Including EU)**

Technology Advancement

- **Carbon Capture and Storage (22 Nations)**
- **Future Gen Coal (5 Nations)**
- **Hydrogen (17 Nations)**
- **Global Nuclear Energy Partnership (19 Nations)**
- **Gen IV Nuclear (10 Nations)**
- **Fusion Energy - ITER (7 Nations)**
- **Global Earth Observation (71 Nations)**
 - Recommended by National Academy of Sciences
- **Clean Energy Technology Fund (US, UK and Japan, World Bank)**

Energy CO₂ Emissions Reductions Needed in 2050 for Major Economies¹ to Achieve a Combined 50% Reduction in Emissions Below 2005² Levels



¹ Equals reduction from the 2050 reference case for that ME group (i.e., Developed or Developing). Developed MEs include: U.S., Europe, Russia, Japan, Canada, South Korea, and Australia. Developing MEs include: China, India, South Africa, Mexico, Brazil, and Indonesia.

² 50% of 2005 total Major Economies energy CO₂ emissions equals 11.0 Gt.

Key Elements of Major Economies Process

- Long-term global goal for GHG reduction, consistent with economic growth
- National plans that set mid-term goals
 - Use variety of binding and voluntary policies (mandates, incentives, partnerships)
 - Must be environmentally effective and measurable
- Collaborative technology development and deployment strategies for key sectors
 - Lower carbon fossil power generation, transportation, land use, and near-zero carbon energy (e.g., efficiency, nuclear, wind, and solar)
 - International working groups on key sectors (to advance global and national efforts)
 - Expanded investment in global research and development
- Support adoption of existing clean technologies and the development of new ones
 - Elimination of tariffs and non-tariff barriers for clean energy goods and services
 - Enhanced financing tools (e.g., Clean Energy Technology Fund)
- Improved systems for measurement, reporting, and verification to track more effectively progress
- Robust programs on adaptation, forestry, and technology access for all countries

Int'l Clean Energy Technology Fund

- **Help Developing Countries, Including China and India Accelerate Deployment of Clean Energy Technologies**
- **Encourage Private-Sector Investment in Clean Energy Technology Projects**
- **Joint Effort by U.S., UK and Japan, with Invitation to Others**
 - **U.S. – Pledged \$2B over three years**
 - **UK – Pledged part of its \$1.6B Environmental Transformation Fund**
 - **Japan – Created \$10B Financial Mechanism to Support Developing Countries Committed to Combating Climate Change**
 - **Lift Tariffs on Environmental Equipment and Services**
- **Administered by World Bank**

Summary -- A Path Forward Involves ...

- **A Visionary Long-Term Approach, Aimed at the UNFCCC Goal, Based on Innovation, Growth and International Cooperation**
- **Continued U.S. Leadership on Tech. Solutions & Int'l Dialogue**
- **Near-Term Actions – Voluntary, Financial Incentives & Mandates**
- **Progress in Climate Change Science Will:**
 - **Reduce Uncertainty and Illuminate Risks and Benefits**
 - **Add Relevance and Specificity to Assist Decision-Makers**
- **Progress in Climate Change Technology Will:**
 - **Create New, Better, and More Affordable Solutions**
 - **Facilitate Means for Transformational Change**
 - **Enable Broadened Consensus on Policy Formulation**
- **Expand Opportunities for Cooperation Among:**
 - **Business, Industry, States and NGOs**
 - **Research Institutions and Academia**
 - **Major Economies, Under G8 Leadership**
 - **Cooperative Frameworks with S&T Actions Abroad**
- **Build a Bridge to Low-Emissions Future with Broad Public Support**

Links and Contact

- CCTP Strategic Plan: www.climatetechnology.gov
- CCTP Scenarios:
http://www.pnl.gov/main/publications/external/technical_reports/PNNL-16078.pdf
- CCSP Integrated Assessment Modeling Comparison:
<http://www.climate-science.gov/Library/sap/sap2-1/finalreport/default.htm>
- Oak Ridge “Carbon Lock-In” Report incorporating CCTP deployment report barrier typology:
http://www.ornl.gov/sci/eere/PDFs/Carbon_Lock_In_Report.pdf

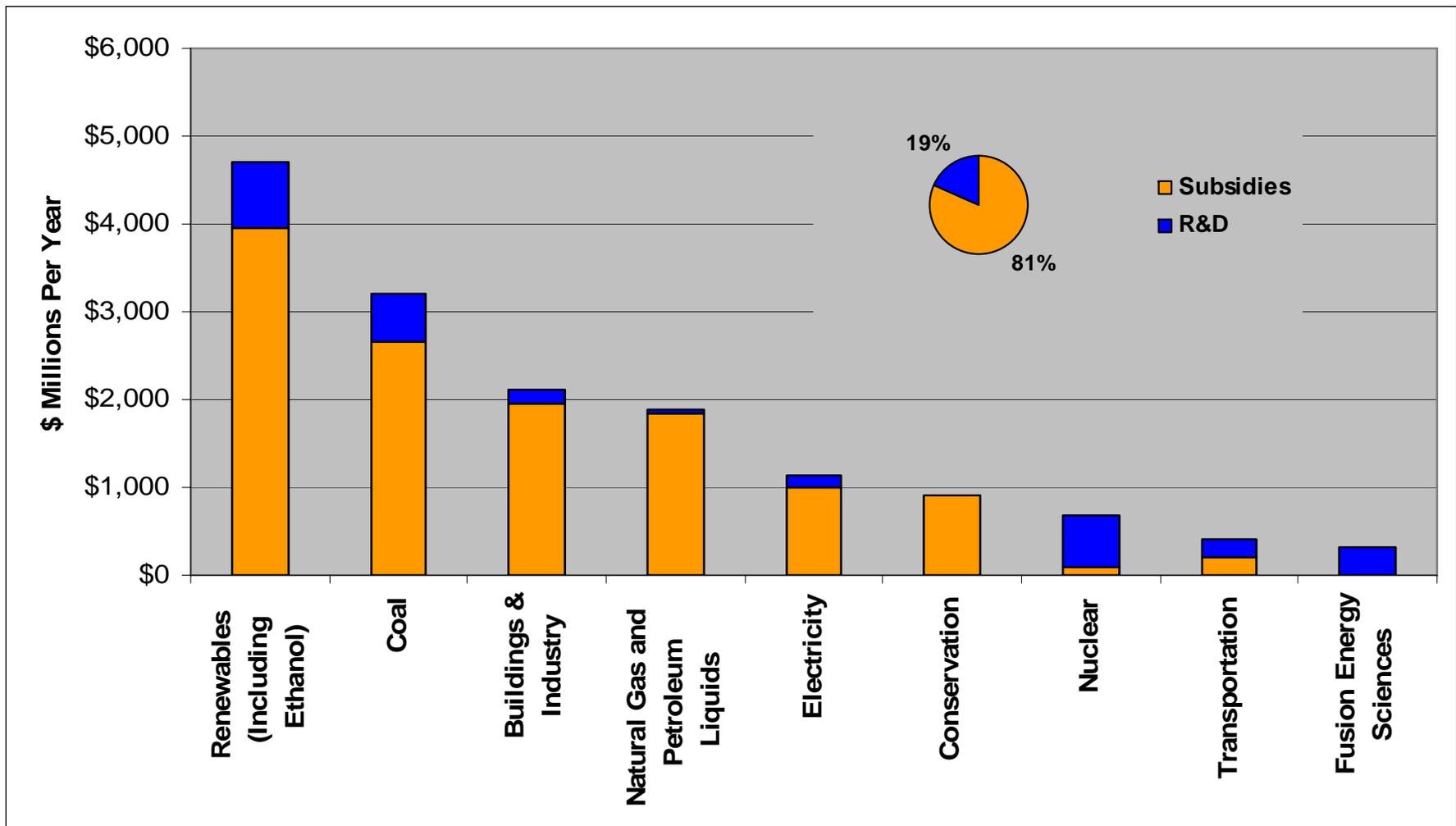
robert.marlay@hq.doe.gov, 202-586-3949

BACK-UP

How Big is a Gigaton? Using U.S. Technology,* These Actions Can Cut Emissions by 1 GtC/Year

Today's Technology	Actions that Provide 1 Gigaton / Year of Mitigation
Coal-Fired Power Plants	Build 1,200 "zero-emission" 500-MW coal-fired power plants (in lieu of coal-fired plants without CO ₂ capture and storage) (73% CF)
Geologic Sequestration	Install 3,700 sequestration sites like Norway's Sleipner project (0.27 MtC/year)
Nuclear	Build 500 new nuclear power plants, each 1 GW in size (in lieu of new coal-fired power plants without CO ₂ capture and storage) (90% CF)
Electricity from Landfill Gas Projects	Install 28,000 "typical" landfill gas electricity projects (typical size being 3 MW projects at non-regulated landfills) that collect landfill methane emissions and use them as fuel for electric generation.
Efficiency	Deploy 1 billion new cars at 40 miles per gallon (mpg) instead of new cars at 20 mpg (12,000 miles per year)
Wind Energy	Install 650,000 wind turbines (1.5 MW each, operating at 0.45 capacity factor) in lieu of coal-fired power plants without CO ₂ capture and storage.
Solar Photovoltaics	Install 6 million acres of solar photovoltaics to supplant coal-fired power plants without CO ₂ capture and storage (assuming 10% cell DC efficiency, 1700 kWh/m ² solar radiance, and 90% DC-AC conversion efficiency).
Biomass fuels from plantations	Convert to biomass crop production a barren area about 20 times the total land area of Iowa (about 700 million acres)
CO ₂ Storage in New Forest.	Convert to new forest a barren area about 9 times the total land area of the State of Washington (nearly 400 million acres) (Assumes Douglas Fir on Pacific Coast)

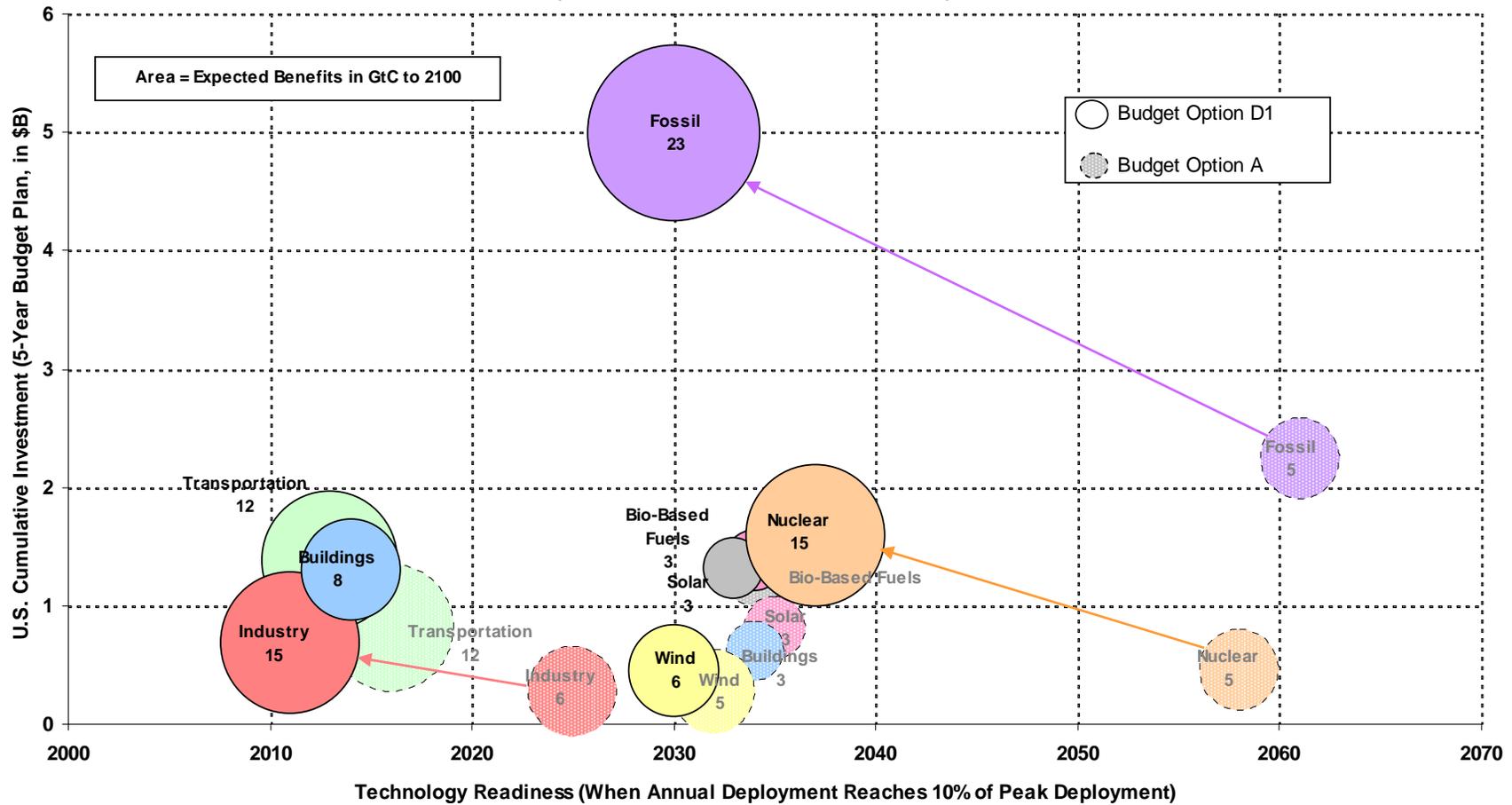
Federal Subsidies on Energy, FY 2007



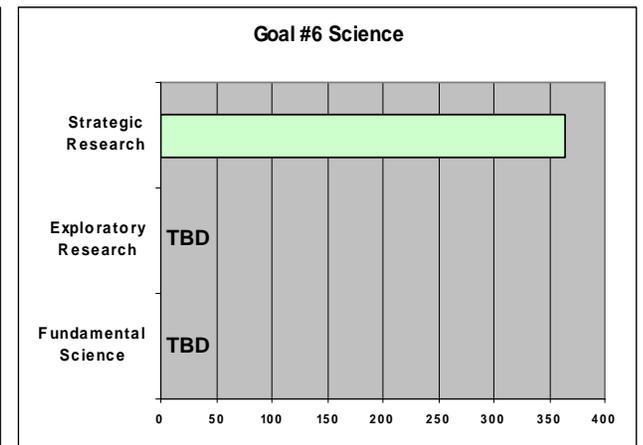
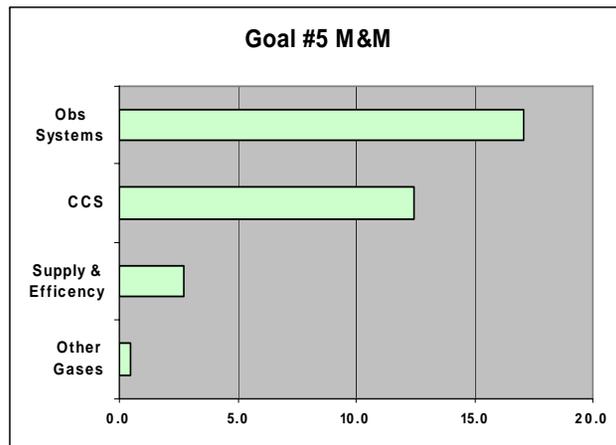
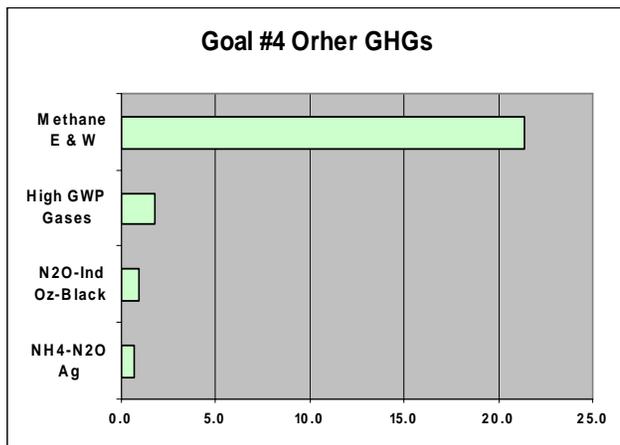
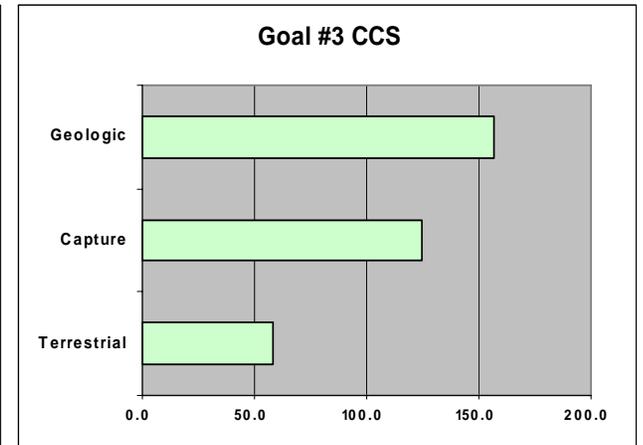
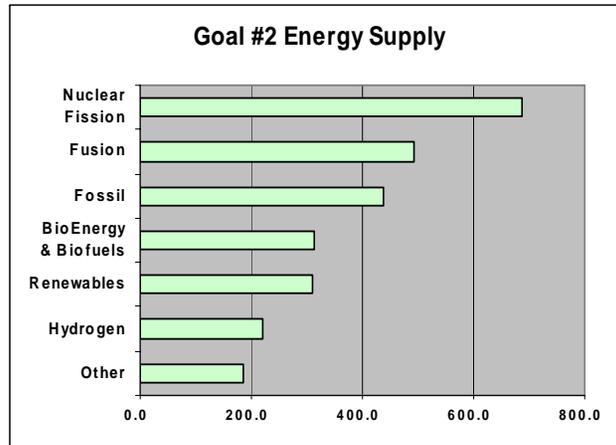
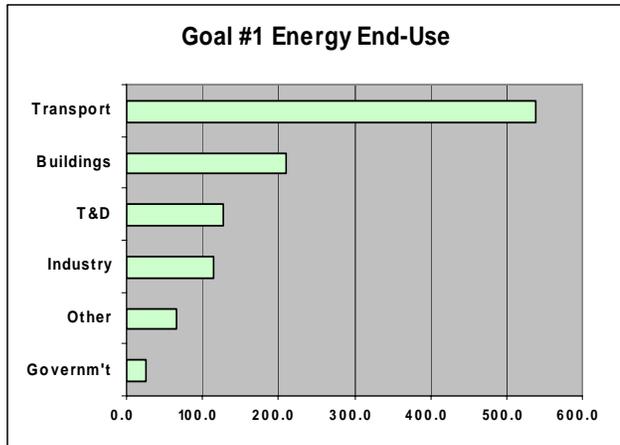
Sources: R&D data are from the Federal Climate Change Expenditures Report (2007). Subsidy data are from the Energy Information Administration analysis of tax expenditures, U.S. Treasury (2007).

Investment Analysis

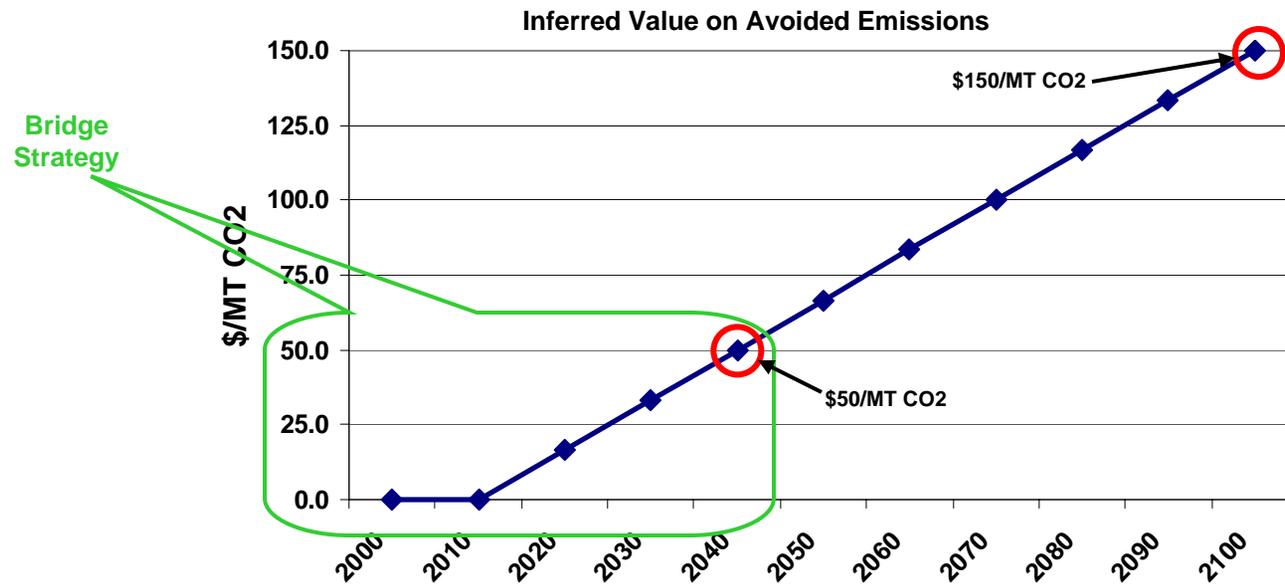
5-Year RD&D Investment, Technology Readiness Acceleration, and Expected U.S. Climate Change Benefits (CTTP Goals & Risk Factors; to 2100)



R&D Priorities, FY 2009 (Proposed)



What Price for Carbon ?



Incremental % Price Increase

	2004 Price	% Increase at: \$10/ MT-CO2	% Increase at \$50/ MT-CO2
Electricity (kwh)	\$0.076	2.3%	8.2%
Gasoline (Gal)	\$1.90	1.3%	4.6%
Coal (S-Ton)	\$27.30	19%	70%
Natural Gas (mcf)	\$10.74	1.4%	5.1%

Climate VISION Sectors



Alliance of Automobile Manufacturers



Aluminum Association



American Chemistry Council



American Forest & Paper Association



American Iron & Steel Institute



American Petroleum Institute



Association of American Railroads



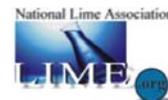
The Business Roundtable



Industrial Minerals Association - North America



International Magnesium Association



National Lime Association



National Mining Association



Portland Cement Association



Power Partners



Semiconductor Industry Association



Climate Vision Progress Report 2008
<<http://www.climatevision.gov/>>

Innovative International Partnerships



Group on Earth Observations: 65 governments and 40+ organizations members; designing and implementing a new Global Earth Observation System of Systems.



Carbon Sequestration Leadership Forum: 22 members; focused on CO₂ capture & storage.



International Partnership for the Hydrogen Economy: 17 members; organizes, coordinates, and leverages hydrogen RD&D programs.



Generation IV International Forum: 10 members; devoted to R&D on next generation of nuclear systems.



ITER: 7 members; project to develop fusion as a commercial energy source.



Methane to Markets: 17 members; recovery and use of methane from landfills, mines, oil & gas systems, and agriculture.

Asia-Pacific Partnership

- Undertake voluntary practical measures to create new investment opportunities, build local capacity, and remove barriers to the introduction of clean, more efficient technologies.
- Help each country meet nationally designed strategies for improving energy security, reducing pollution, and addressing the long-term challenge of climate change.
- Promote the development and deployment of existing and emerging cleaner, more efficient technologies and practices that will achieve practical results in areas such as:



- | | | |
|---------------------|--------------------------|--------------------------------|
| • Energy Efficiency | • Methane Capture/Use | • Rural/Village Energy Systems |
| • Clean Coal | • Civilian Nuclear Power | • Advanced Transportation |
| • Natural Gas | • Geothermal | • Hydro/Wind/Solar Power |
| • Bioenergy | • Agriculture/Forestry | • Building & Home Construction |

