



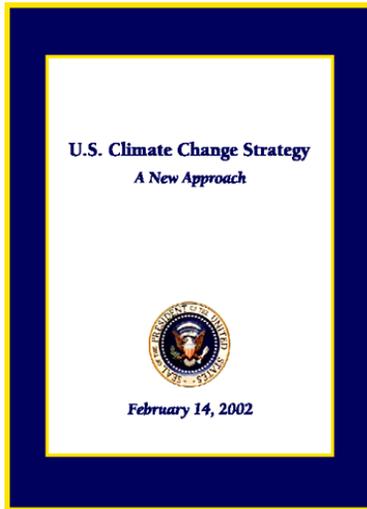
Climate Change Technology – Plans, Programs, and Supporting Policies and Measures

Dr. Robert C. Marlay
Deputy Director, U.S. Climate Change Technology Program
Office of Policy and International Affairs
U.S. Department of Energy
robert.marlay@hq.doe.gov

19 May 2008
Council on Environmental Quality
Washington, DC



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.

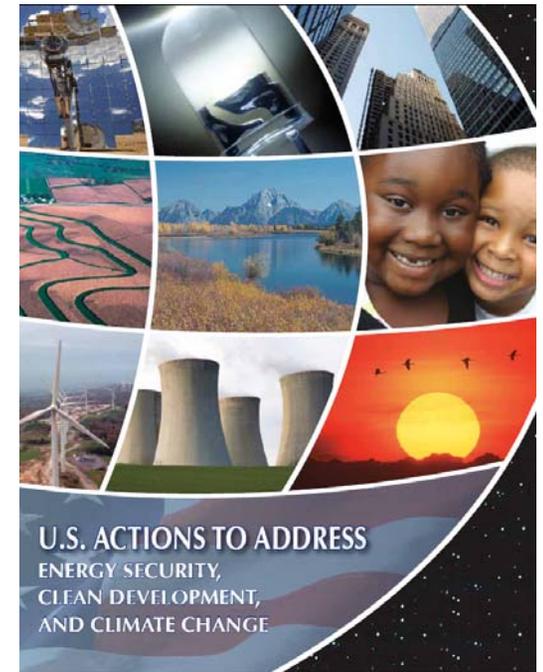
President George W. Bush
February 14, 2002

- Harnesses the Power of Markets and Tech. Innovation, Maintains Economic Growth, and Encourages Global Participation.
- Reaffirms U.S. Commitment to the UNFCCC's Ultimate Goal
- Supports the Bali Roadmap (Dec. 2007) to a post-Kyoto Agreement
- Places Climate Change in an Integrated Context of:
 - ❖ Enhancing Energy Security,
 - ❖ Encouraging Economic Growth, and
 - ❖ Reducing Pollution
- Five Basic Elements Are:
 - ❖ **Near-term Policies & Measures, incl. Financial Incentives;**
 - ❖ Improved Climate Science;
 - ❖ **Advanced Technologies, with Lowered Costs;**
 - ❖ **International S&T Cooperation**
 - ❖ Expanded Financing and Trade in Clean Energy Goods & Services



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

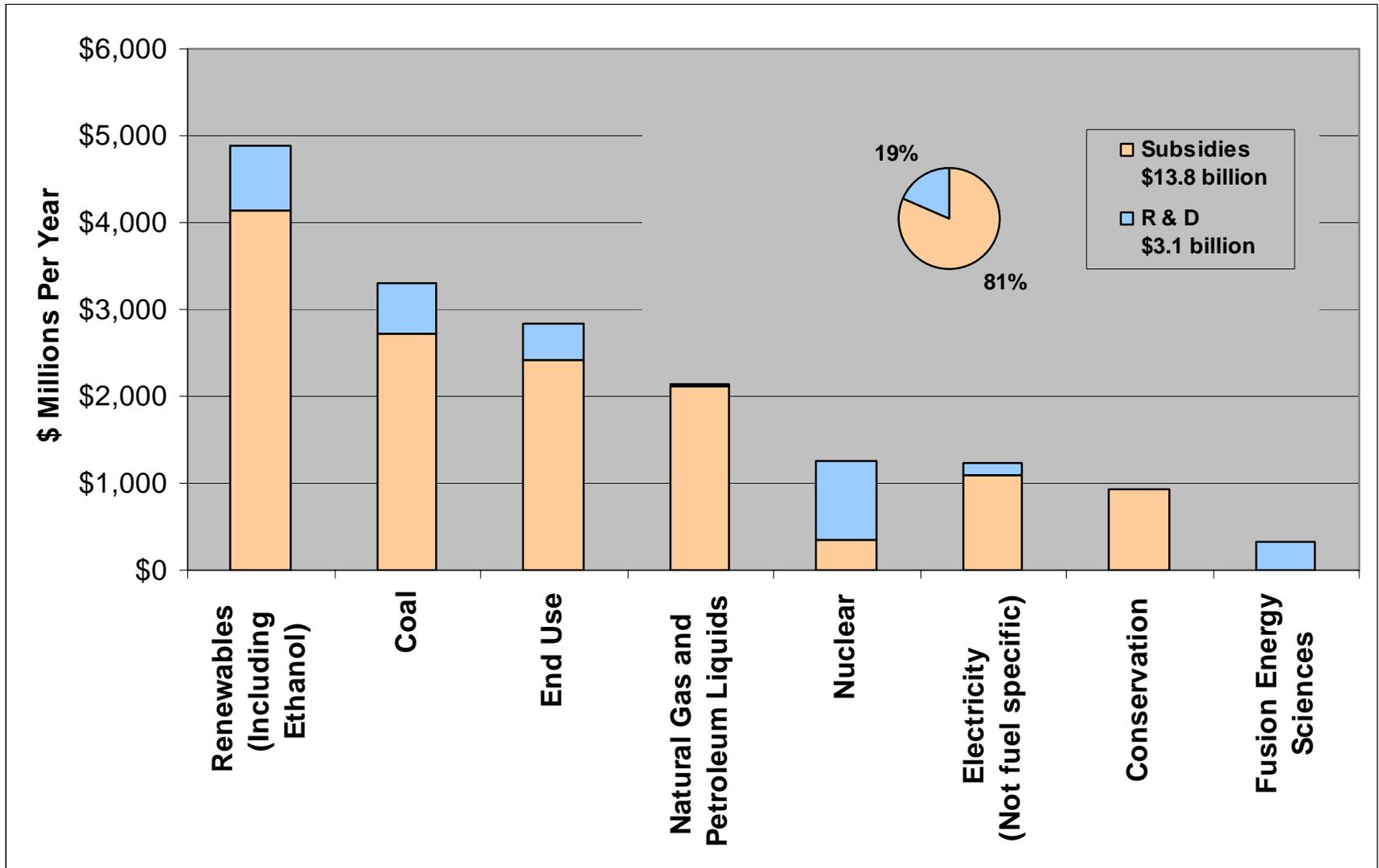
New Tax Incentives*

- **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



Federal Financial Interventions and Subsidies in Energy Markets FY 2007



Source: Energy Information Administration "Federal Financial Interventions and Subsidies in Energy Markets 2007, SR/CNEAF/2008-01, April 2008"



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				✓		✓		✓	✓	



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
- **Via U.S. Climate Change Technology Program**
 - Strengthen Federal R&D Portfolio
 - Prioritize Investments
- **Expand R&D Cooperation with non-Federal Entities**



U.S. Climate Change Technology Program

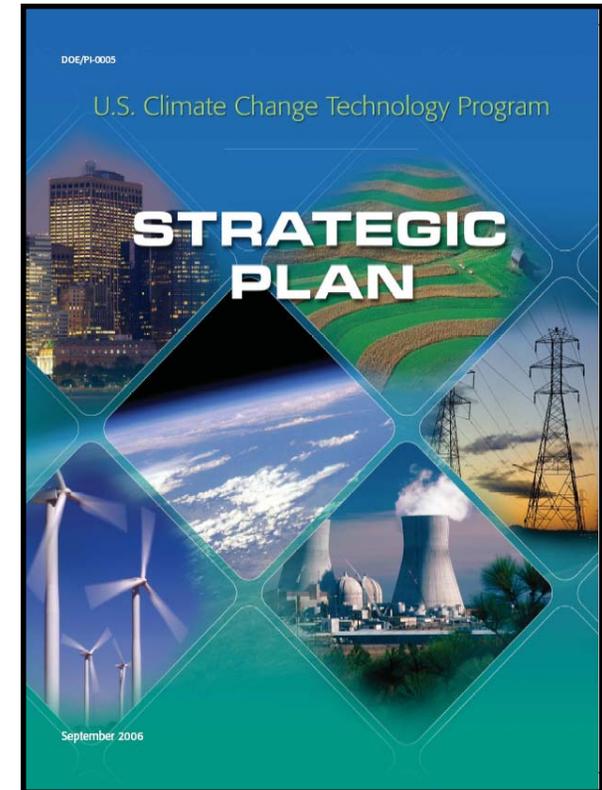
➤ U.S. Climate Change Technology Program

- ❖ Mission – Accelerate R&D on Adv. CC Techs
- ❖ Scope – Ten Federal R&D Agencies
- ❖ Budget -- \$4.4 Billion Requested for FY'09
- ❖ Activities – Coord. R&D Planning & Budgeting

➤ Goals:

- ❖ Four emissions-related strategic goals:
 - ✓ Reduce emissions from energy end use & infrastructure;
 - ✓ Reduce emissions from energy supply;
 - ✓ capture & sequester CO₂; and
 - ✓ Reduce emissions from non-CO₂ gases.
- ❖ Two cross-cutting, supporting strategic goals:
 - ✓ Improve capabilities to measure & monitor GHGs; and
 - ✓ Bolster basic science and strategic research.

➤ **CCTP authorized in *EPA Act 2005*. Led by DOE.**



www.climatetechnology.gov



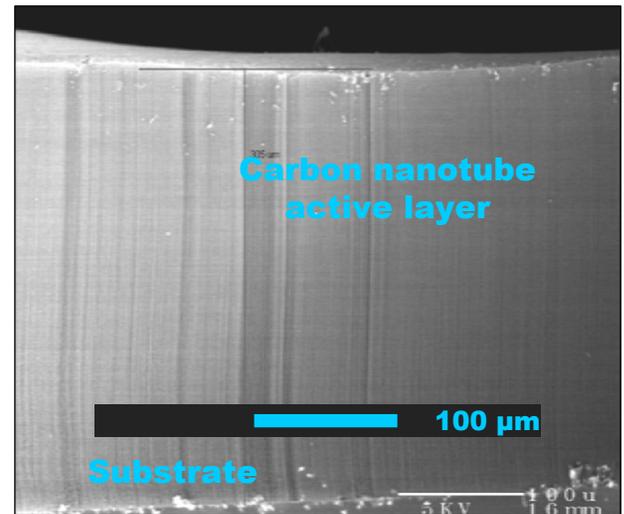
Roadmap for Climate Change Technology Development

	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)



“De-Oil” Transportation

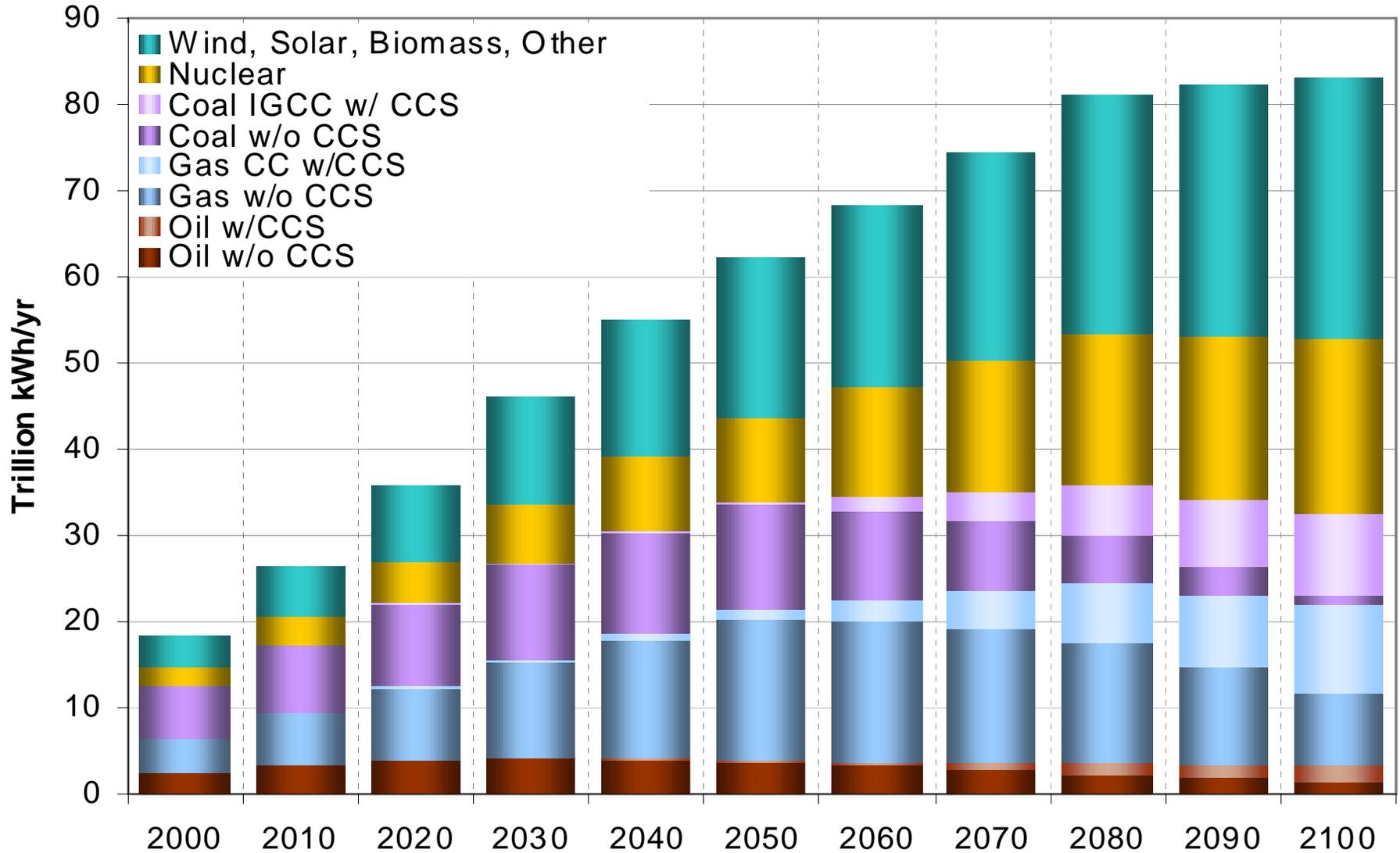
- **Future Transport System**
 - Multi-Modal
 - Regional Choices
 - Coordinated Integrated Land-Use Planning
- **Vehicle Options**
 - Electric Vehicles
 - Hybrid Vehicles
 - Bio-Based Vehicles
 - H₂ & Hydrogenated Molecules
 - Oil & Gas Vehicles



Nanotube-Enhanced Ultracapacitor
[MIT, R. Signorelli – March 2005]



“De-Carbonize” the Electric Grid





Technology Scenarios Explore the Future

Technology Scenario #1: “Closing the Loop on Carbon”

Successful development of carbon capture and storage technologies for use in electricity, as well as in applications such as hydrogen and cement production.

Technology Scenario #2: “A New Energy Backbone”

Additional technological improvement and cost reduction for carbon-free energy sources, such as wind power, solar energy systems, and nuclear power.

Technology Scenario #3: “Beyond the Standard Suite”

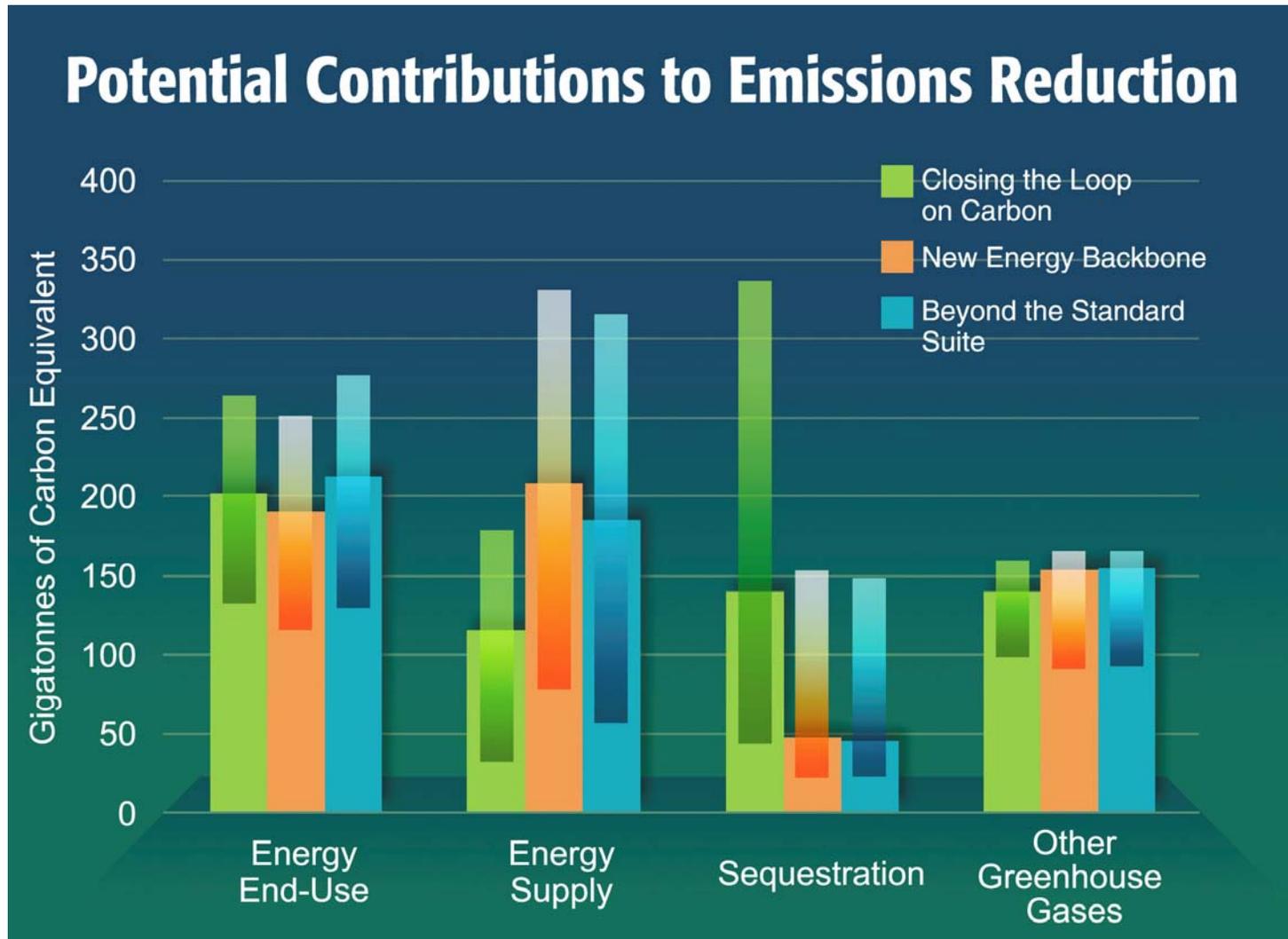
Major advances in fusion energy and/or novel energy applications for solar energy and biotechnology such that they can provide zero-carbon energy at competitive costs in the second half of this century.

Common Characteristics Across Scenarios:

- ✓ *Additional gains in energy efficiency beyond the reference case occur;*
- ✓ *Additional technologies for managing non-CO₂ GHGs become available;*
- ✓ *Terrestrial carbon sequestration increases;*
- ✓ *The full potential of conventional oil and gas is realized; and*
- ✓ *Hydrogen production technology advances.*



Results of An Integrated Assessment

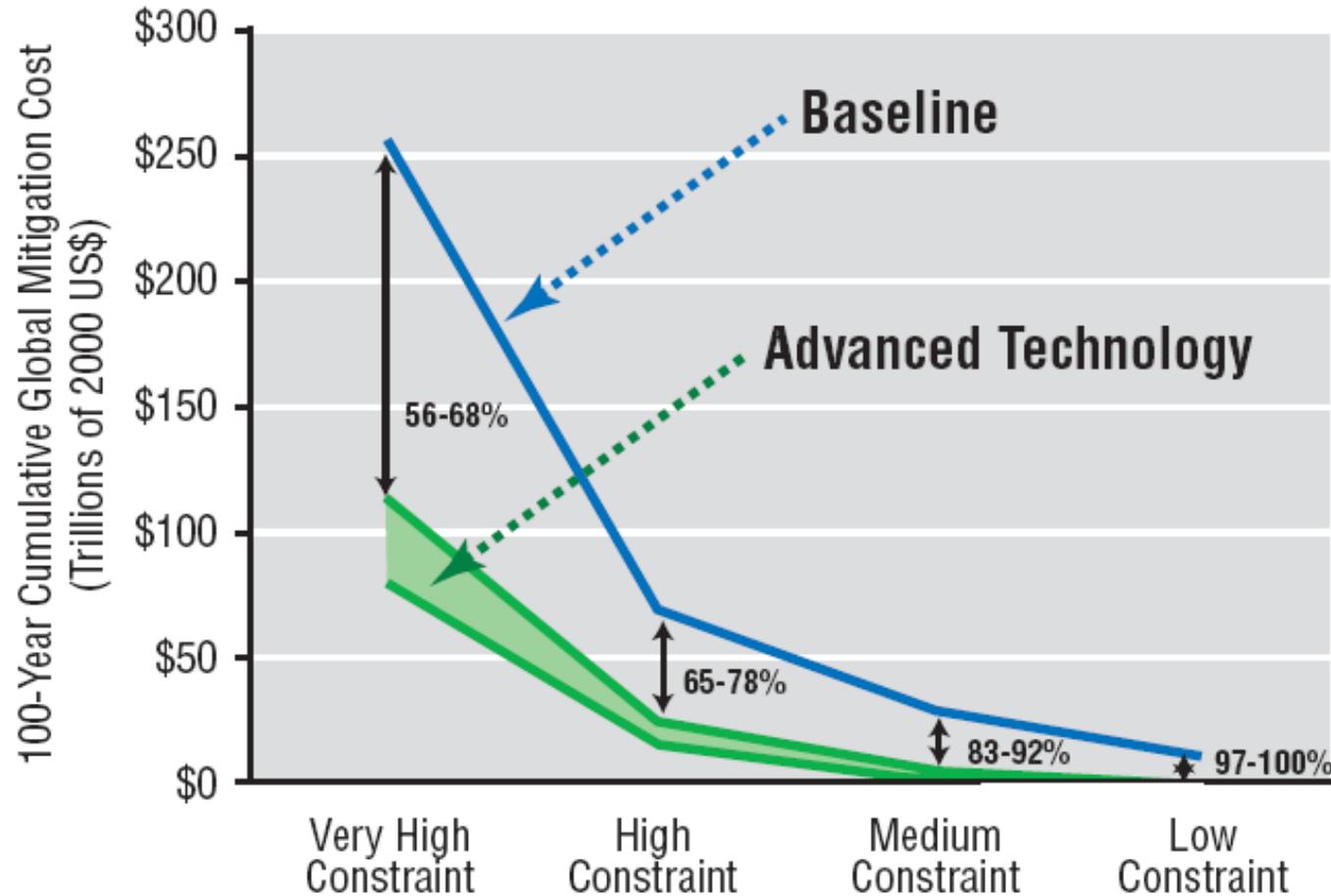


Source: Clarke, L., M. Wise, M. Placet, C. Izaurralde, J. Lurz, S. Kim, S. Smith, and A. Thomson. 2006. Climate Change Mitigation: An Analysis of Advanced Technology Scenarios. Richland, WA: Pacific Northwest National Laboratory.



Costs Must Be Lowered Significantly

Comparative Analysis of Estimated Cumulative Costs Over the 21st Century of GHG Mitigation, With and Without Advanced Technology, Across a Range of Hypothesized GHG Emissions Constraints.*



* U.S. Climate Change Technology Program Strategic Plan, September 2006, Figure 10-2



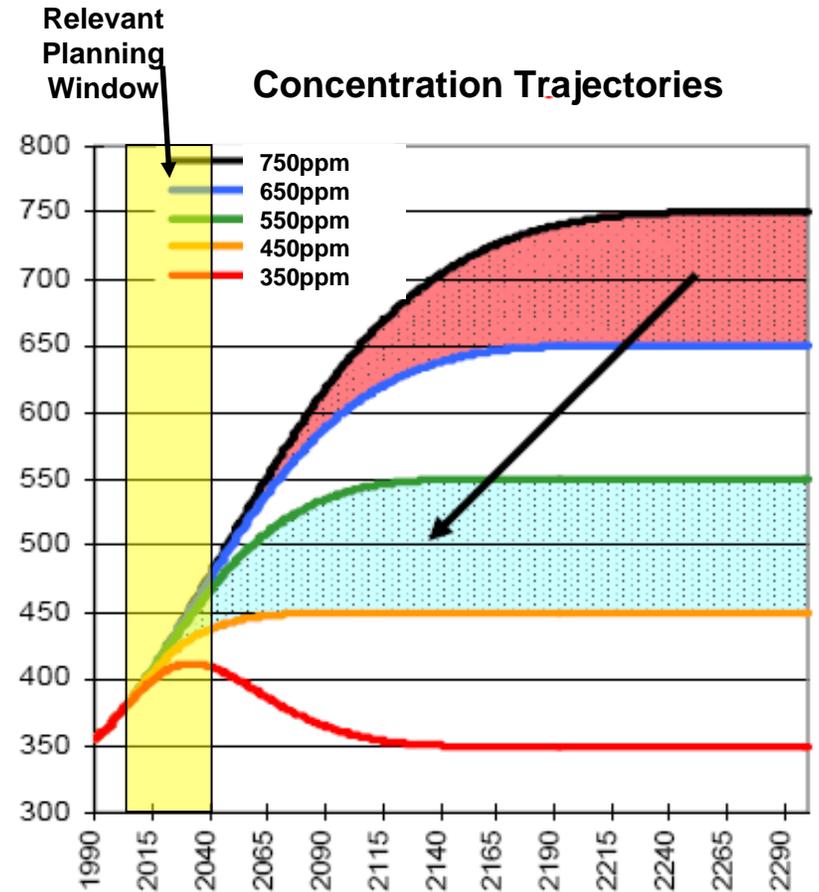
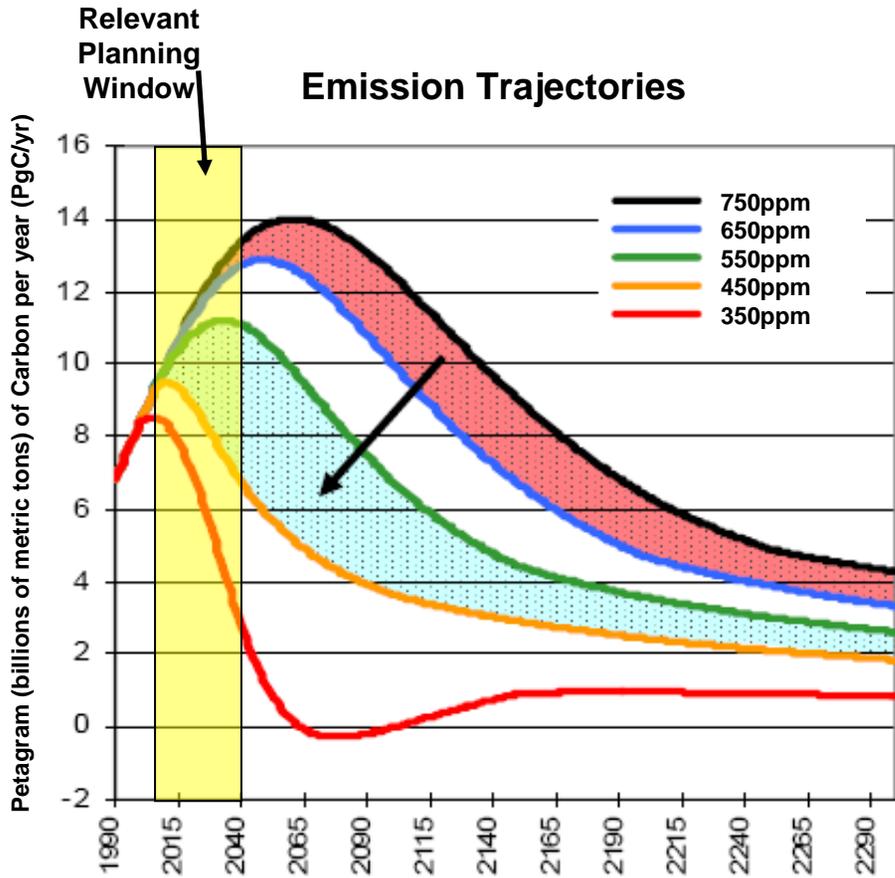
Timing is of the Essence

CCTP Strategic Goal	Very High Constraint	High Constraint	Medium Constraint	Low Constraint
Goal #1: Reduce Emissions from Energy End Use and Infrastructure	2010 - 2020	2030 - 2040	2030 - 2050	2040 - 2060
Goal #2: Reduce Emissions from Energy Supply	2020 - 2040	2040 - 2060	2050 - 2070	2060 - 2100
Goal #3: Capture and Sequester Carbon Dioxide	2020 - 2050	2040 or Later	2060 or Later	Beyond 2100
Goal #4: Reduce Emissions of Non-CO ₂ GHGs	2020 - 2030	2050 - 2060	2050 - 2060	2070 - 2080

Estimated timing of advanced technology market penetrations, as indicated by the first GtC-eq./year of incremental emissions mitigation, by strategic goal, across a range of hypothesized GHG emissions constraints.



Technical Goals Set Within Context of United Nations Framework Convention on Climate Change



- Emission and concentration trajectories based on level of effort for technology investments
- Potential carbon reductions based on more aggressive technology investments
- Relevant planning window to influence longer-term outcomes

Wigley, Richels, Edmonds, Nature, 1996

R&D

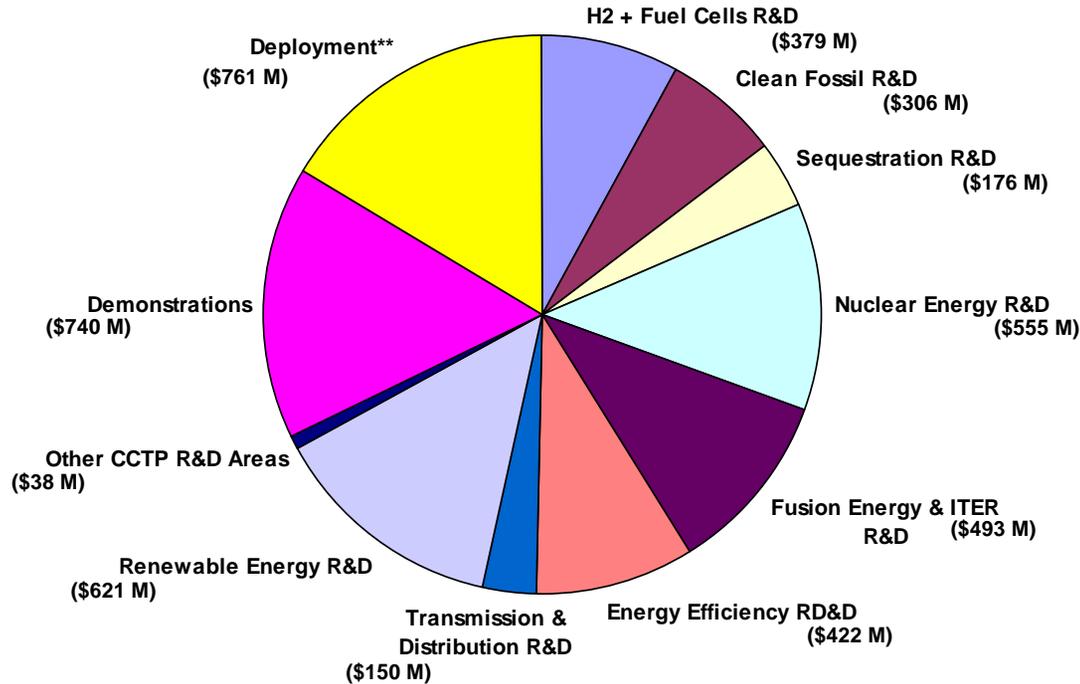
CCTP Strategic Goal	Key Element of Strategy		CCTP Strategic Plan -- Corresponding Technologies in Scenarios Analysis	Lead	Most Challenging Technical Scenario	Units	Scenarios Years & Quantities -- U.S. Only				
							2020	2030	2040	2050	2100
1 Reducing Emissions from Energy End-Use and Infrastructure	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	N/A	N/A	TBD				
	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 Gasses	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 Gasses	5.2	MM -- Energy Production and Efficiency	N/A	DOE		Refer to Strategic Plan, Chapter 8					
	5.3	MM -- CO ₂ Capture and Sequestration	N/A	DOE		Refer to Strategic Plan, Chapter 8					
	5.4	MM -- Other Greenhouse Gases	N/A	EPA		Refer to Strategic Plan, Chapter 8					
	5.5	MM -- Integrated Systems Architecture	N/A	SC		Refer to Strategic Plan, Chapter 8					
6 Bolster Basic Science Contributions to Technology Development	6.1	Strategic Research	N/A	SC		Refer to Strategic Plan, Chapter 9					
	6.2	Fundamental Science	N/A	SC		Refer to Strategic Plan, Chapter 9					
	6.3	Exploratory Research	N/A	SC		Refer to Strategic Plan, Chapter 9					



FY 2009 Budget Request -- CCTP Portfolio

CCTP FY09 Budget Request* Portfolio of R&D, Demonstration and Deployment

**Total Multi-Agency
FY09 Budget Request:
\$ 4,641 Million**



* All CCTP Federal Agencies FY09 Budget Request (inc: USAID & STATE)

** Deployment is 70% Energy Efficiency

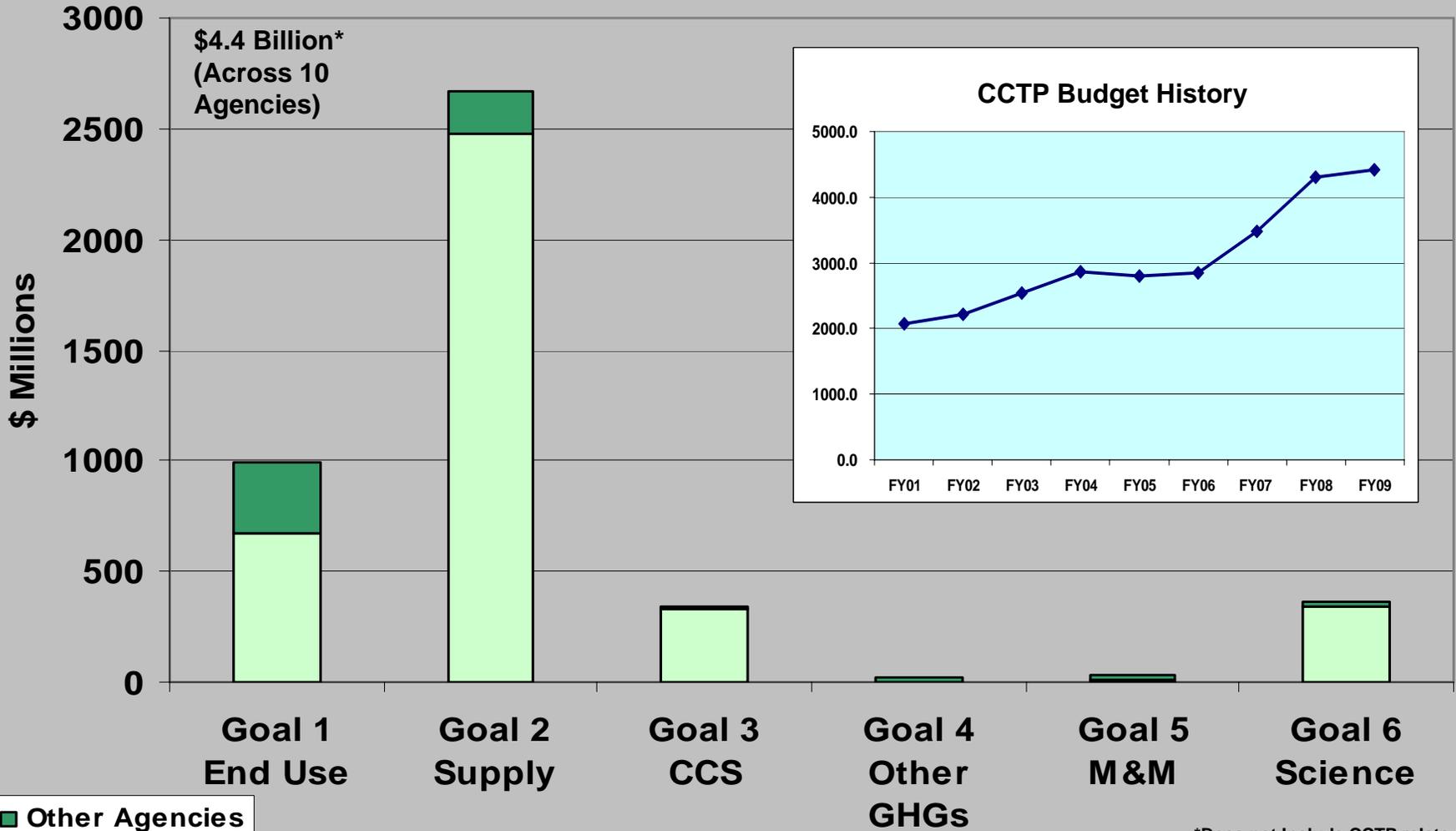


Technology Area Highlights

- **Energy Efficiency [\$550M] -- *Accelerated R&D to Reduce GHG Emissions***
 - Vehicles: \$221M
 - Buildings: \$124M
- **Renewables [\$705M] -- *Increases in Biofuels and Geothermal***
 - Biomass & Biorefinery Systems R&D: \$225M
 - Geothermal Technology: \$30M
 - Solar: \$156M
 - Wind: \$53M
 - Hydrogen Fuel Initiative: \$265M
- **Coal [\$744M] -- *Largest Budget Request in Over 25 Years***
 - FutureGen: \$156M
 - CCS: \$149M
 - Clean Coal Power Initiative: \$85M
- **Nuclear [\$879M] -- *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



Federal Budget Request for FY 2009 – Good News for CCTP



\$4.4 Billion*
(Across 10 Agencies)

\$ Millions

■ Other Agencies
□ DOE

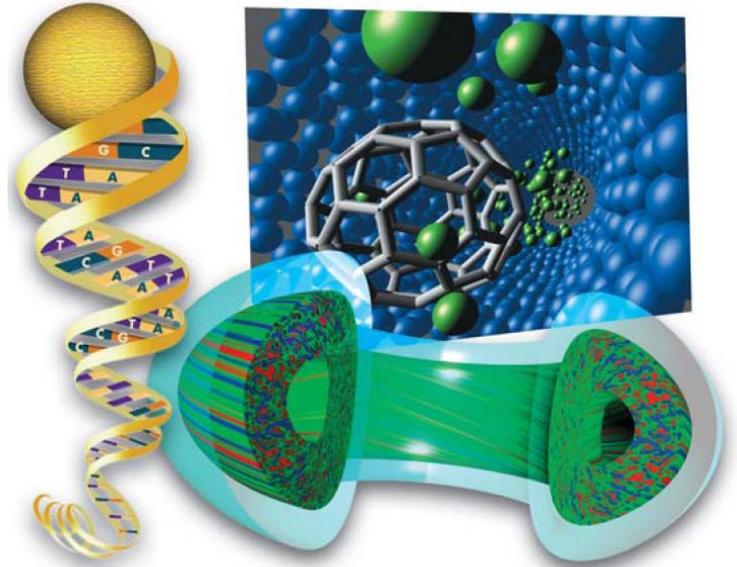
Strategic Goals, U.S. Climate Change Technology Program

*Does not include CCTP related funding from STATE (\$36M) and USAID deployment activities (\$189M).



Basic Science Research

- **Fundamental Science:**
 - Fundamental science is basic research that provides the underlying foundation of scientific knowledge that can lead to fundamental new discoveries.
- **Strategic Research:**
 - Strategic research is basic research that is inspired by technical challenges in the applied research and development programs.
- **Exploratory Research:**
 - Exploratory research is basic research, or early and exploratory study of application-inspired concepts, undertaken in the pursuit of high-risk, novel, emergent, integrative or enabling approaches, not elsewhere covered.



Fundamental science is critically important in the creation of new knowledge and improved understanding of technological innovation.



Science to Technology Workshops

Basic Research Needs from 2005 CCTP Portfolio Review:

- Electric grid challenges – system architecture, control systems, and power electronics
- Thermoelectrics by application (e.g., refrigeration, power generation)
- Solid state lighting
- Bio-X – combination of nanoscience and genomics
- Plant genetic engineering
- Measuring and monitoring of climate change mitigation – international focus
- Sensors, controls, communication
- Energy storage – basic science and requirements of integrated systems
- Batteries – power & energy (basic chemistry)
- Heat Transfer – material insulation, cryogenics, thermal conducting coolants
- Ocean sequestration & methane hydrates

BES/BER “BRN” Workshops To Date:

- **Catalysis for Energy**
August 6-8, 2007
- **Electric Energy Storage**
April 2-4, 2007
- **Clean and Efficient Combustion of 21st Century Transportation Fuels**
October 29–November 1, 2006
- **Advanced Nuclear Energy Systems**
July 31 - August 3, 2006
- **Solid-State Lighting**
May 22 - 24, 2006
- **Superconductivity**
May 8-11, 2006
- **Breaking the Biological Barriers to Cellulosic Ethanol**
December 2005
- **Genomics: GTL Roadmap**
August 2005
- **The Path to Sustainable Nuclear Energy**
September 2005
- **Solar Energy Utilization**
April 18-21, 2005
- **Advanced Computational Materials Science: Application to Fusion and Generation IV Fission Reactors**
March 31-April 2, 2004
- **Nanoscience Research for Energy Needs**
March 16-18, 2004
- **Hydrogen Economy**
May 13-15, 2003
- **Assure a Secure Energy Future**
October 21-25, 2002
- **Opportunities for Catalysis**
2002

BRN = Basic Research Needs



Energy Frontier Research Centers

- **A New Era for Science --**
 - *Innovative Basic Research to Accelerate Scientific Breakthroughs Needed to Create Advanced Energy Technologies for the 21st Century Awards to be \$2M - \$5M per Year for an Initial 5-Year Period (~\$100M/Yr)*

- **Centers Will Pursue Fundamental Basic Research in Areas Such as:**
 - Solar Energy Utilization
 - Catalysis for Energy
 - Electrical Energy Storage
 - Solid State Lighting
 - Superconductivity
 - Geosciences for Nuclear Waste and CO₂ Storage
 - Advanced Nuclear Energy Systems
 - Combustion of 21st Century Transportation Fuels
 - Hydrogen Production, Storage, and Use
 - Materials Under Extreme Environments

- **FY 2009 Budget Proposal --**
 - *The Office of Science seeks to engage the Nation's intellectual and creative talent to tackle the scientific grand challenges associated with determining how nature works, leading the scientific community to direct and control matter at the quantum, atomic, and molecular levels, and harness this new knowledge and capability for some of our most critical real-world challenges.*

- **U.S. Universities, DOE Laboratories, and Other Institutions are Eligible**



Supporting Policies and Measures



Barriers Typology

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

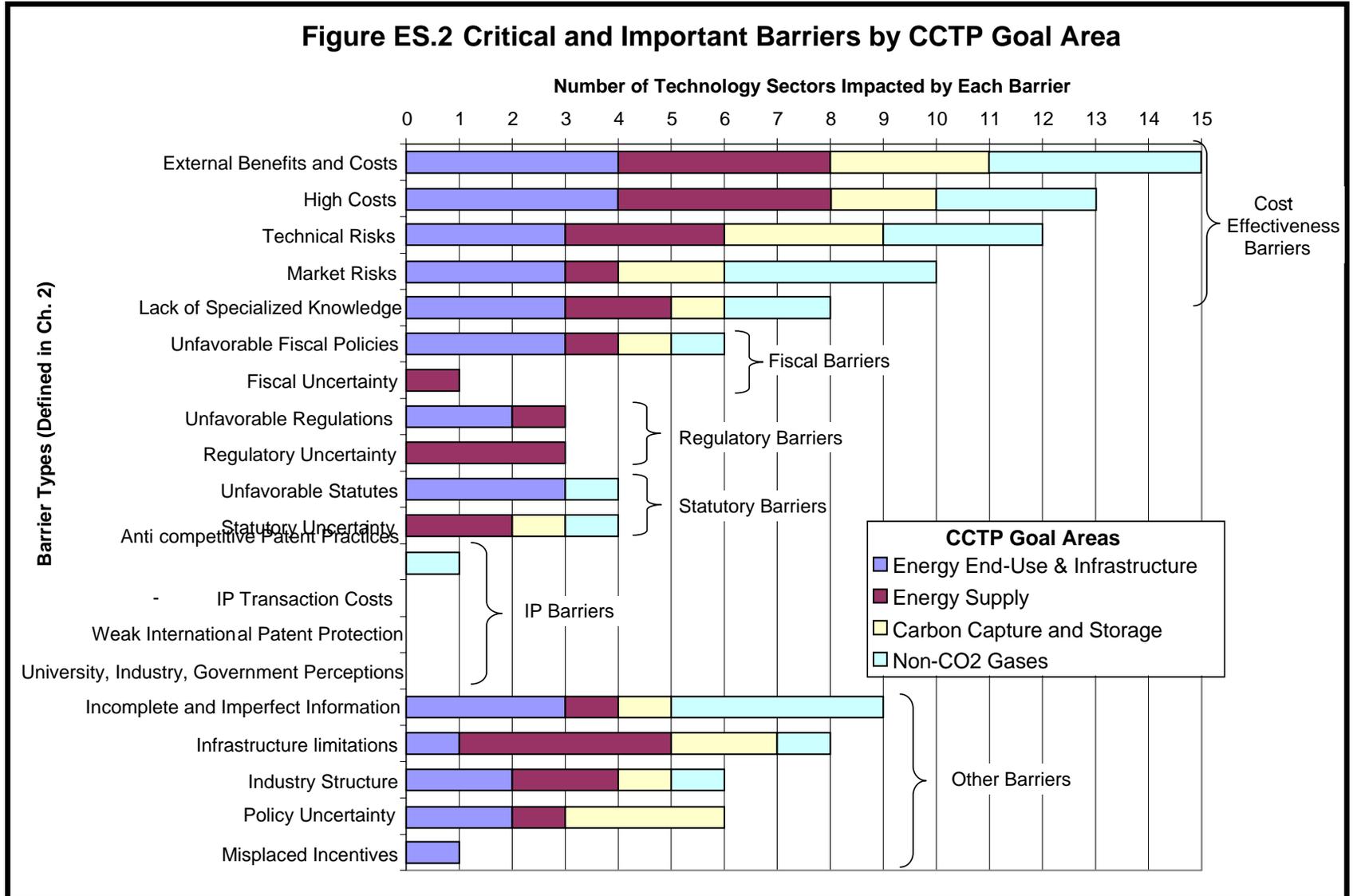
6 Barrier Categories
21 Barriers
~50 Detailed Barriers

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



Barriers – Summary of Findings

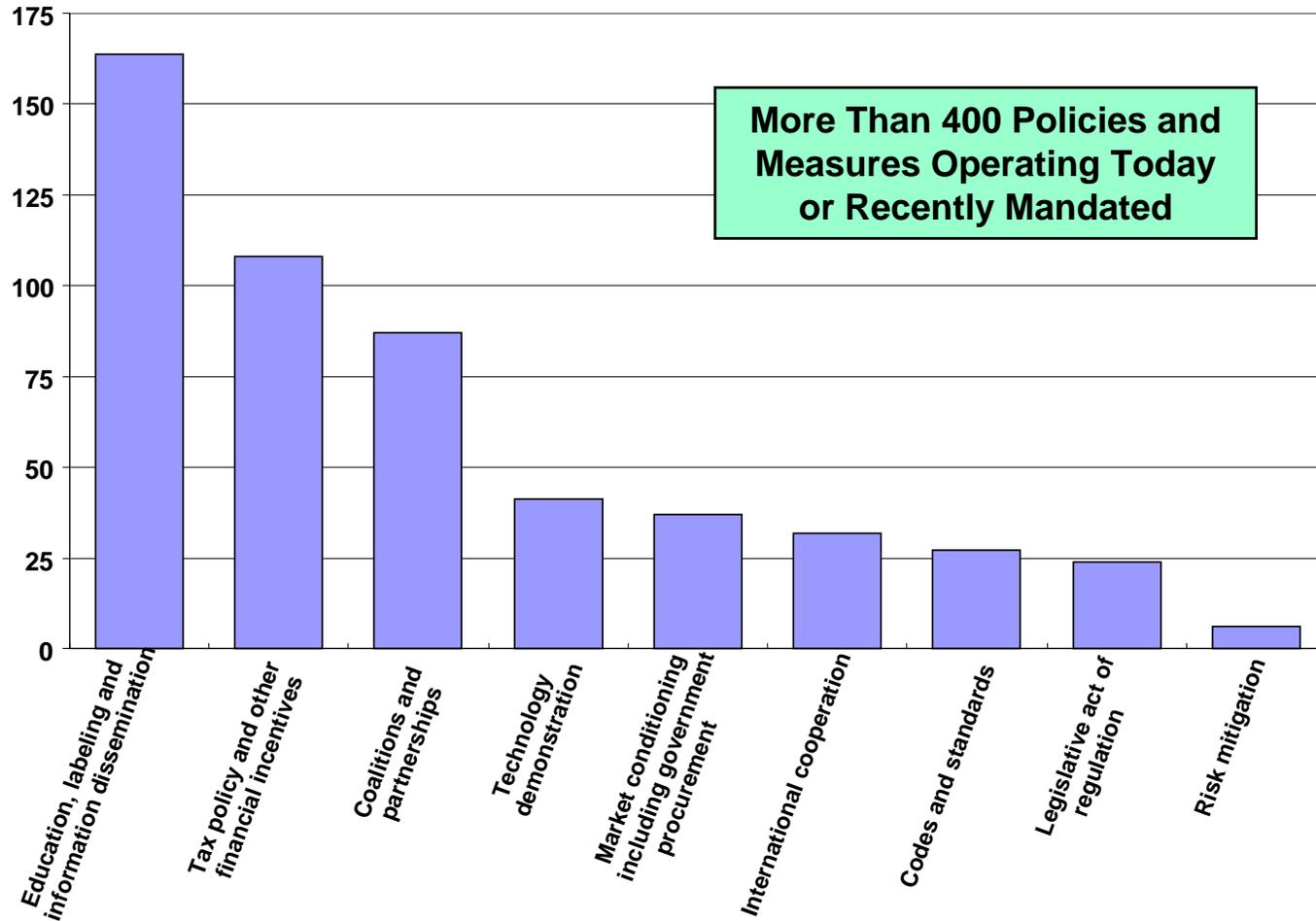
Figure ES.2 Critical and Important Barriers by CCTP Goal Area





Commercialization & Deployment Activities, by Category or Genre

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





Continuing Process of Policy Assessment and Improvement -- by Technology Area

Technology Areas	Tax Policy and Financial Incentives	Legislative Acts and/or Regulation
Coal w/CCS	Loan Guarantees; Tax Incentives; Cost-Shared Partnerships	CO ₂ Storage – Siting & Permitting; Monitoring and Verification ; Liability Indemnification ; New Source Review Revisions ; Access to Public Lands ; Property Rights for Subsurface Areas
Nuclear Fission	Loan Guarantees; Production Tax Credit; Standby Support for Certain Delays	Liability Indemnification; Standard Design Certifications; Early Site Permits; Combined Construction & Operating License; Waste and Fuel Management and Storage
Electric Grid and Infrastructure	Loan Guarantee Program, Waste Energy Recovery Incentive Grants*; SmartGrid Investments Matching Grants*; Additional Incentives for Investments (including Cost Recovery Mechanisms)	Public Utilities Regulatory Policies; Renewable and Distributed Generation Code and Standards; Transmission Pricing (Rate Structures); National Transmission Corridors; SmartGrid Code and Standards*; Utility Energy Efficiency Programs*; Standard Net Metering and Interconnection Policies ; Siting Access Rights ; Access to Meter and Other Data ;
Transportation	Tax Credit ; Manufacturing Credit ; Consumer Incentives , Manufacturing Incentives*	National Regulatory Policies ; Urban and Land Use Planning ; CAFÉ* ; Federal Fleet*
Hydrogen	Loan Guarantees; Alternative Motor Vehicle and Alternative Fuel Infrastructure Tax Credits; Investor Incentives ; Insurance	Safety, Codes & Standards; Stationary Fuel Cell Permitting
Bio-Based Fuels	Credit for installing alternative fuel refueling; Loan Guarantees; Production Tax Credit; Development Grants*	Stable Financial Incentives ; National Regulatory Policies ; Biofuels Tariff ; Federal Fleet* , Standard specifications for fuels*
Wind Power	Loan Guarantees; Production Tax Credit; Clean Renewable Energy Bonds; Development Grants*;	Manufacturing Partnerships* ; Stable Financial Incentives ; Mandated Federal Procurement of Wind Power ;
Industry	Loan Guarantees; Efficiency Tax Credits; Sector Specific Tax Credits	Equipment Standards; Emissions Regulations ; Informational Partnerships (e.g.; Manufacturing Extension Partnership), Energy-intensive industries program*
Buildings	Manufacturer and Consumer Efficiency Tax Credits , Tax Deductions for Commercial Buildings; Accelerated Depreciation	Federal appliance and equipment standards; Building Codes* ; Government Procurement, Federal Buildings Standards*
Solar Power	Loan Guarantees; Business Energy Tax Credit; Residential & Business Solar Investment Tax Credit; Clean Renewable Energy Bonds; Development Grants*; Production Tax Credit	Manufacturing Partnerships* ; Stable Financial Incentives ; Access to Public Lands (for concentrating solar power installations) ; Mandated Federal Procurement of Solar Power

Green: Existing Policies
Red: Policy Options



International Frameworks for Cooperation and R&D Collaboration



International Cooperation

Benefits

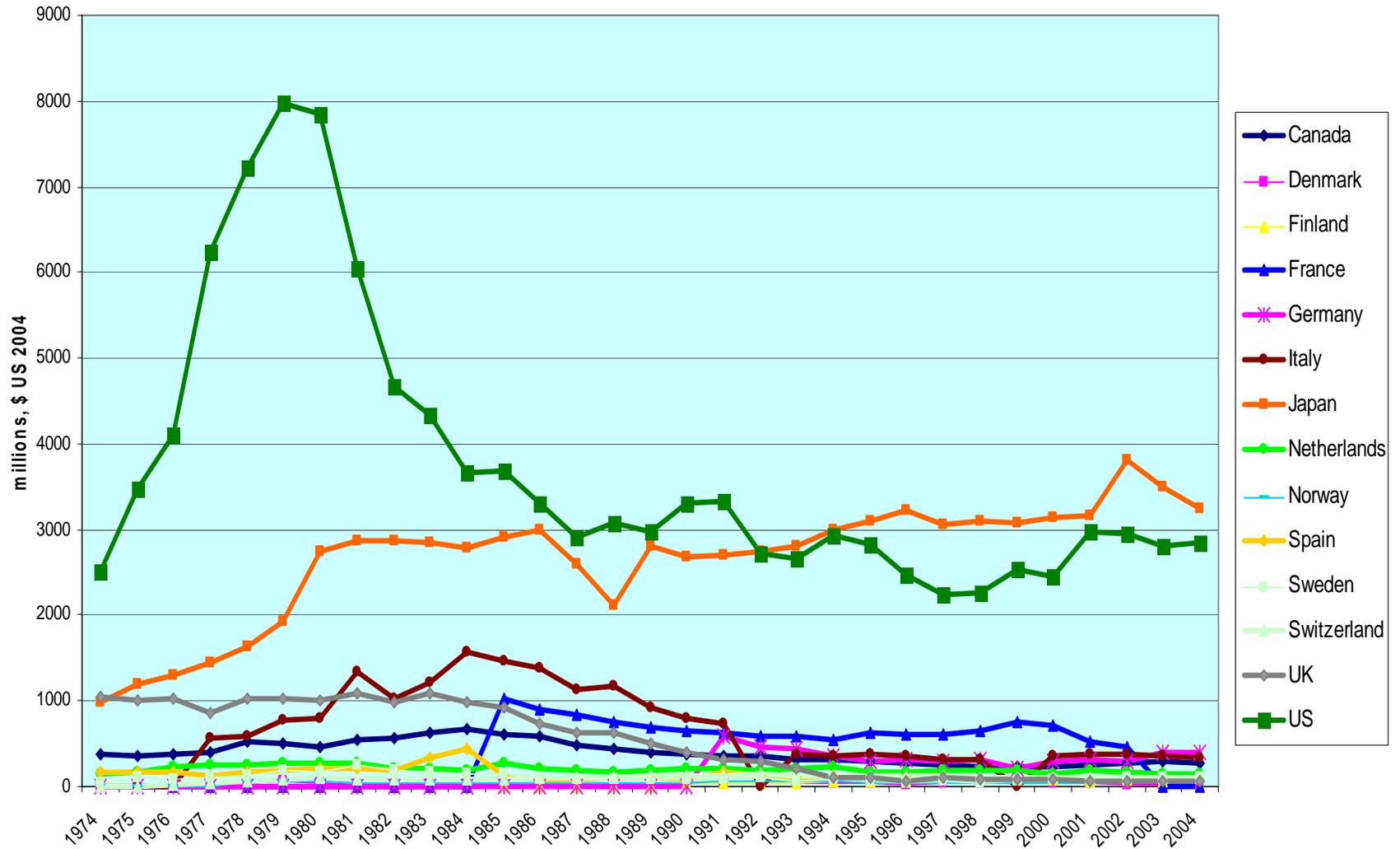
- **Raise Overall Global Level of Effort**
- **Accelerate Technology Development**
- **Pool Technical Resources**
- **Gain Access to Privileged Facilities**
- **Broaden Knowledge Base**
- **Facilitate Exchange of Information**
- **Enable Multi-Path Approaches**
- **Harmonize Technical Standards**
- **Reduce Partner Costs & Risks**
- **Increase Likelihood of Success**

Challenges

- **Diverse National R&D Funding Motivations, Schemes and Priorities**
- **Lack of Common, Shared Vision**
- **Heterogeneous Program Designs**
- **Patents & Intellectual Property Issues**
- **Other Barriers (e.g., National Security)**
- **Administrative Complexity and Cost**
- **Travel and Coordination Costs**
- **Management & Accountability Issues**
- **Technical Support (e.g. IPCC/TSU)**
- **Need for Strong Central Leadership**



History of Int'l Energy R&D





Key Technologies & International Cooperation

Key Technologies

- **Advanced Lighting**
- **Building & Home Construction**
- **Advanced Transportation**
- **Grid (Power Electronics)**
- **Clean Coal**
- **Advanced IGCC**
- **Geothermal**
- **Hydro/Wind/Solar Power**
- **Rural/Village Energy Systems**
- **Bioenergy**
- **Civilian Nuclear Power**
- **Methane Capture/Use**
- **Agriculture/Forestry**

International Cooperation

- **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
- **Asia Pacific Partnership (6 Nations)**



Potential Areas for Int'l Collaboration

Energy End-Use Technologies	Energy Supply Technologies	Capture CO ₂ Directly from Atmosphere
Zero-Emission Vehicle Systems	Stationary Fuel Cells	Geologic Storage: Safety, Health, and Environmental Risk Assessment
Multi-Modal Intercity & Freight Transport	Zero-Emission Fossil Energy	Geologic Storage: Large-Scale Demonstration
Engineered Urban Designs & Regional Planning	Hydrogen Zero-Emission Fossil Energy	Terrestrial Sequestration: Reforestation
Low Aviation Emissions	Low-Cost H ₂ Storage & Delivery	Terrestrial Sequestration: Soils Conservation
Ultra-Efficient HVACR	Cost-Competitive Solar PV	Carbon & CO ₂ Based Products & Materials
Intelligent Building Systems	Cellulosic Biofuels	Ocean CO ₂ Biological Impacts Addressed
Energy Managed Communities	Photolytic Water Splitting	Non CO₂ GHGs
C&CO ₂ Managed Industries	Advanced Fission Reactor and Fuel Cycle Technology	Precision Agriculture
Water and Energy System Optimization	Proliferation-Resistant Fuel Cycles	Zero-Emission Agriculture
Industrial Heat, Power, Processes	Advanced Concepts for Waste Reduction	Solid-State Refrigeration/AC Systems
High-Efficiency, All-Electric Manufacturing	Demonstration of Burning Plasmas	Catalytic Reduction of N ₂ O
Closed-Cycle Products & Materials	Fusion Power Plants	M&M
Energy Storage for Load Leveling	CCS	Fully Operational Sensor and Satellite Networks
Advanced Controls and Power Electronics	Post Combustion Capture	Low-Cost Sensors and Communications
Wireless Transmission	Oxygen Separation Technologies	MM Systems Architecture



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)**



Major Economies Process

- The U.S. is working with other “Major Economies” to establish a new post-2012 framework on GHG emissions.
- Endorsed by UN, G8 & APEC leaders
- New framework by Dec. 2008 will help lead to an international agreement by the end of 2009.
- Six elements:
 1. A **long-term global goal** for GHG reduction, consistent with economic development & energy security objectives;
 2. **National plans** that advance the long-term global goal and that set mid-term goals that are effective and measurable;
 3. Collaborative **technology development and deployment strategies for key sectors**, including lower carbon fossil power generation, transportation, land use, and near zero carbon energy (e.g., efficiency, nuclear, wind, and solar);
 4. Improved entity-level **measurement and accounting** systems;
 5. Support accelerated adoption of clean technologies by **innovative financing and lowering/eliminating tariffs** and non-tariff barriers; and
 6. Robust programs to address **adaptation, forestry, and technology access** for all UN member states.
- Treasury seeking \$2 billion over 3 years for Clean Energy Technology Fund.
- Second meeting held in Hawaii January 30-31.
- Third held in April in France.



"Energy security and climate change are two of the great challenges of our time. The United States takes these challenges seriously. The world's response will help shape the future of the global economy and the condition of our environment for future generations. The nations in this room have special responsibilities."

President George W. Bush
September 28, 2007

Major Economies Represented		
Australia	Germany	Mexico
Brazil	India	Russia
Canada	Indonesia	South Africa
China	Italy	UK
EU / EC	Japan	United States
France	Korea	UNFCCC*

* Observer