

Economic Growth, Energy and Environment



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Global Energy Challenges: The Key Role for Business
in Energy Efficiency, Technology Transfer and
Emission Reduction

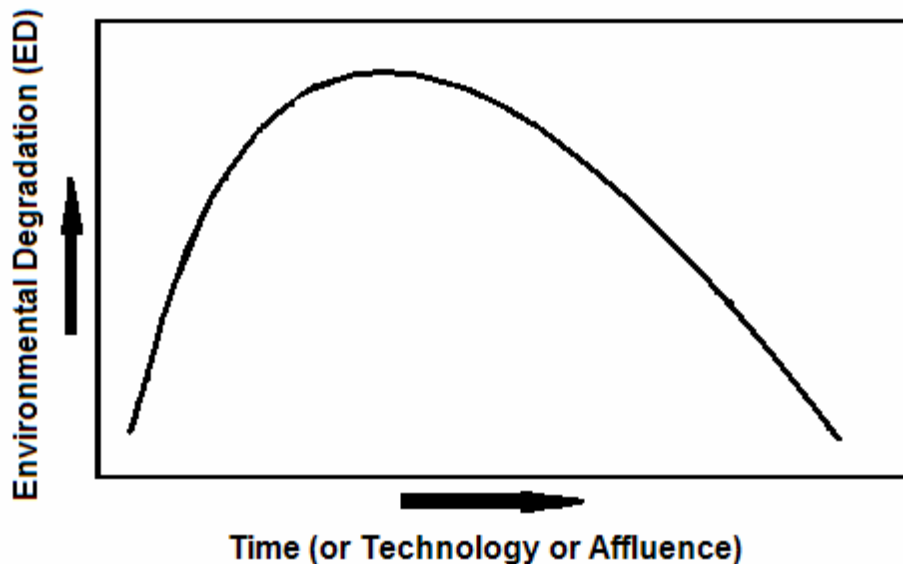
A Workshop Sponsored by the International Council for
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The European Parliament
Brussels, Belgium
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Greenhouse Gas (GHG) Emission Drivers and the Environmental Transition



- **GHG emissions: Driven by population (P), gross domestic product (GDP), and technology (GHG Intensity = GHG/GDP)**
- **Kaya Identity: GHG Emissions \equiv P \times (GDP/P) \times (GHG/GDP)**



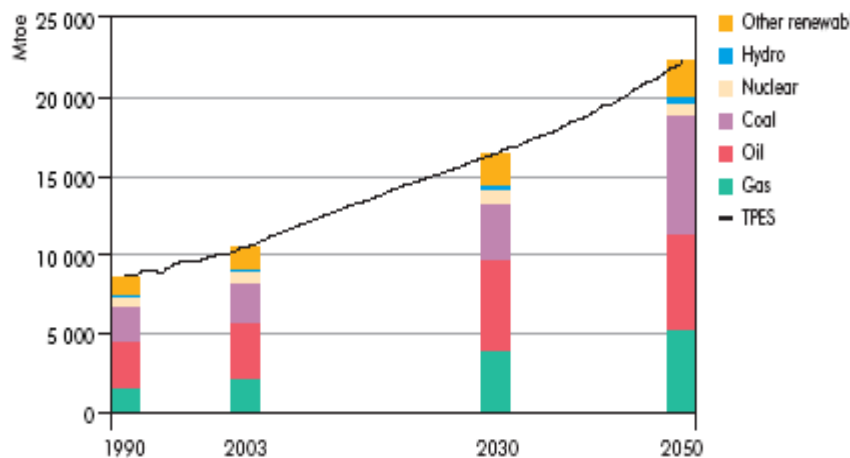
“My approach recognizes that sustained economic growth is the solution, not the problem – because a nation that grows its economy is a nation that can afford investments in efficiency, new technologies, and a cleaner environment.”

**—President Bush,
February 14, 2002**



Reality 1—Fossil Fuels Will Remain Dominant for Decades and Stabilizing GHG Atmospheric Concentrations Is a Long-Term Issue

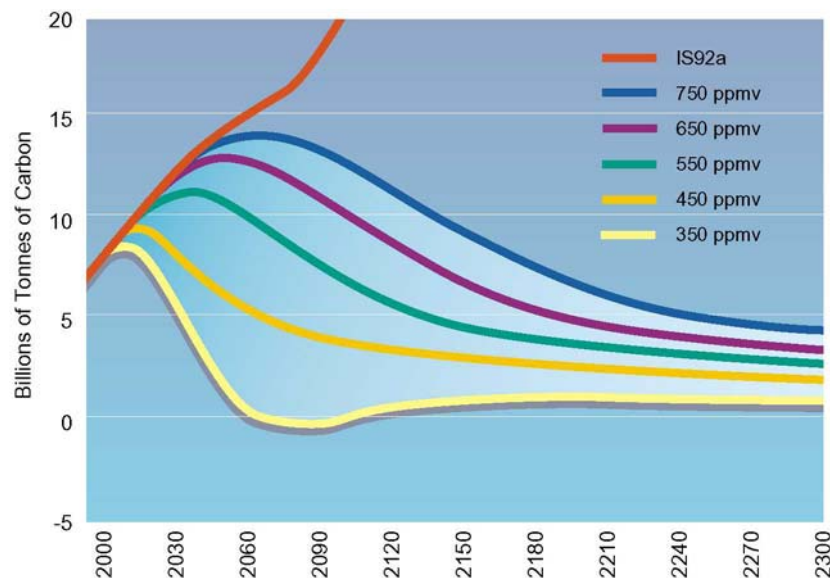
World total primary energy supply by fuel in IEA's Baseline Scenario



Under IEA's Baseline Scenario:

- Primary energy use more than doubles between 2003 and 2050, with a very high reliance on coal.
- CO₂ emissions are almost two and a half times the current level by 2050.

Emissions Trajectories Consistent With Various Atmospheric CO₂ Concentration Ceilings



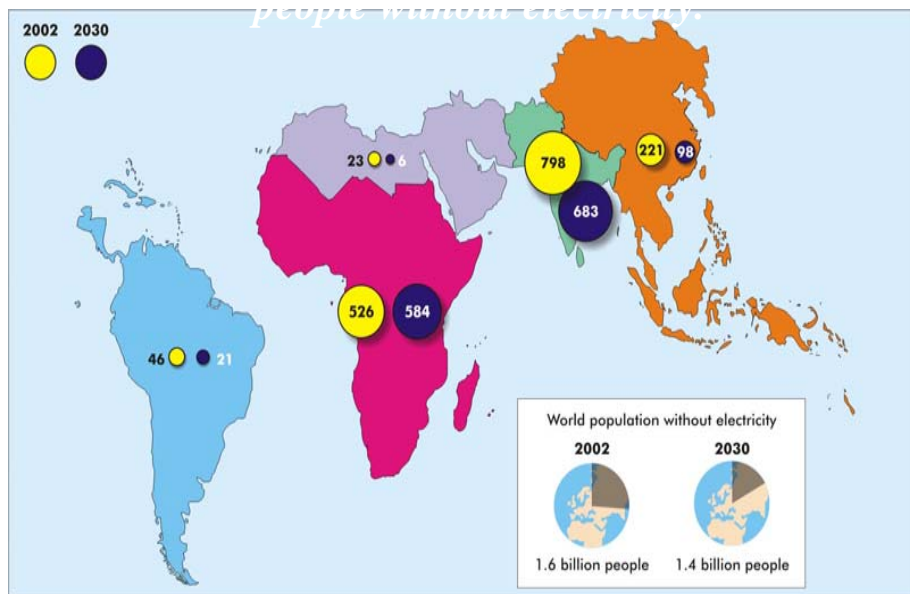
- Stabilizing GHG atmospheric concentrations is a long-term issue—decades to a century or more time scale.
- Stabilization means that GLOBAL emissions must peak in the decades ahead and then decline indefinitely

Reality 2—Can't Expect Developing Countries to Reduce Energy Consumption for the Foreseeable Future

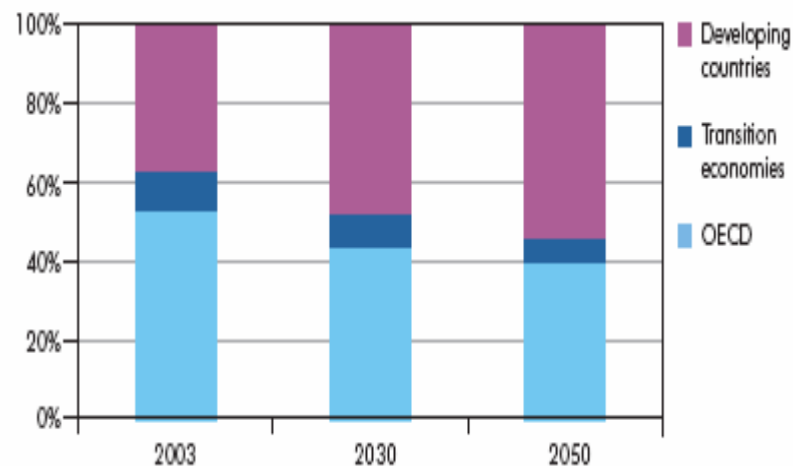


In 2030, if no major new policies are implemented, there will still be 1.4 billion

people without electricity.



Primary energy use share by region in IEA's Baseline Scenario



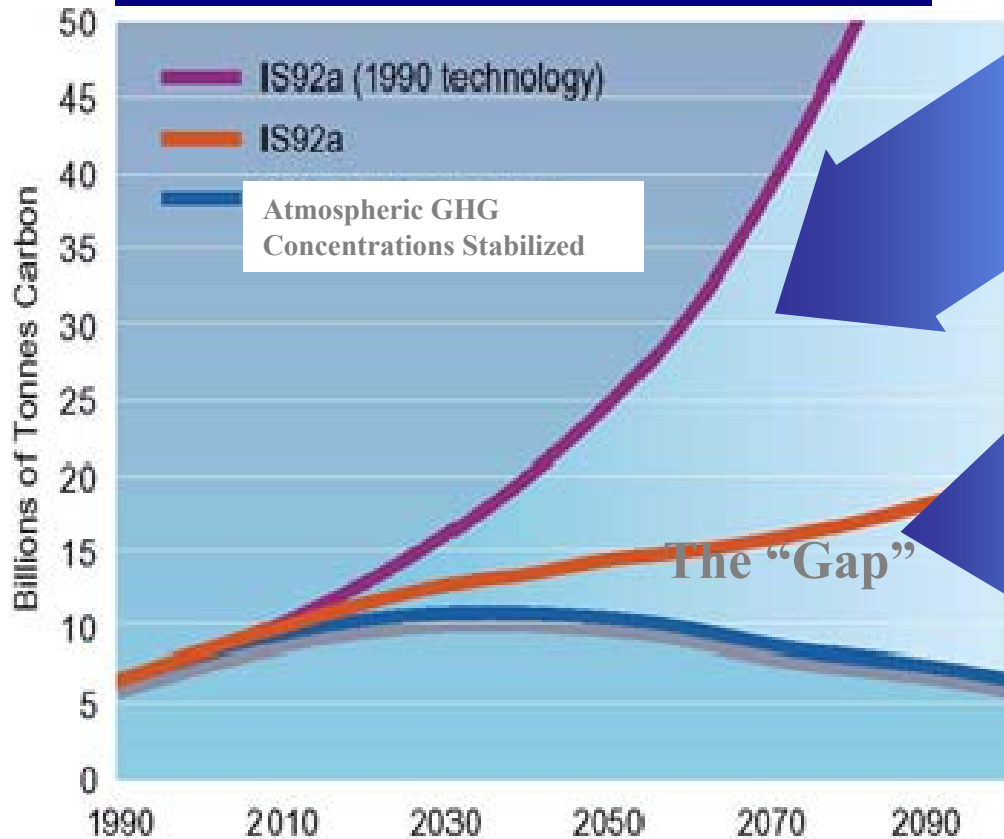
By 2050, 55% of primary energy use is in developing countries.

- **Overriding priority for developing countries, is poverty reduction => Economic growth => Increase in Energy Consumption => Increase in Emissions.**

Reality 3—No “Silver Bullet”: Broad Portfolio of Technologies Required



Global Carbon Emissions



- Assumed Advances In:

- Fossil Fuels
- Energy intensity
- Nuclear
- Renewables

- “Gap” Technologies

- More of All of the Above
- Biological Sequestration
- Carbon Capture and Disposal
- Hydrogen and Advanced Transportation
- Biotechnologies



Reality 4—Challenge is Formidable

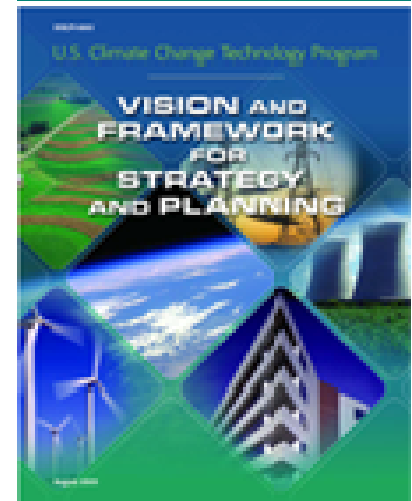
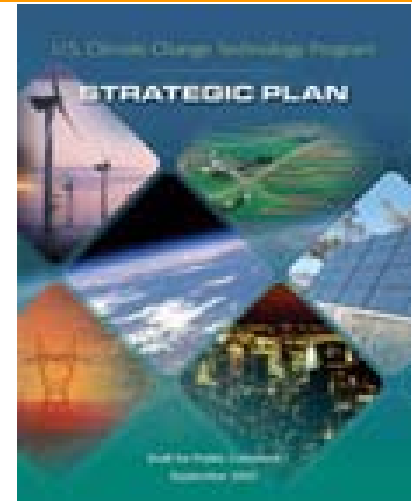
Actions that Provide 1 Gigaton/year of Mitigation

- **Coal:** Carbon capture and storage at 800 1 GW coal power plants.
- **Nuclear:** 700 GW (twice current capacity) displacing coal power
- **Geologic Sequestration:** 3,500 Sleipners @1 MtCO₂/yr (~100 x U.S. CO₂ injection rate for EOR).
- **Biofuels:** Two billion 60 mpg cars running on biofuels; 250 million hectares of high-yield crops (one sixth of world cropland)
- **Efficiency:** 2 billion cars at 60 mpg instead of 30 mpg.
- **Wind:** One million 2-MW windmills displacing coal power. (Today~50,000 MW).
- **Solar PV:** 2000 GW_{peak} (700 times current capacity) and 2 million hectares of land.

Climate Change Technology Program (CCTP)



- **\$2.8 Billion in 2006 (\$14.3 billion 2001-2006); \$3.0 Billion requested for 2007.**
- **Goals**
 - **Reduce Emissions from Energy End-Use and Infrastructure**
 - **Reduce Emissions from Energy Supply**
 - **Capture and Sequester CO₂**
 - **Reduce Emissions of Non- CO₂ GHGs**
 - **Improve Capabilities to Measure and Monitor GHG Emissions**
 - **Bolster Basic Science Contributions to Technology Development.**
- **CCTP Vision & Framework provides:**
 - **Overall Guidance and Strategic Direction**
 - **Vision, Mission, Goals and Approaches**
 - **Groundwork for Portfolio Prioritization**
 - **“Next Steps” for CCTP**
 - **Oversight & Management Controls**



Roadmap for CC Technology Development



Near-Term

Mid-Term

Long-Term

Goal 1: Energy End-Use & Infrastructure

- Hybrid & Plug-In Hybrid Electric Vehicles
- Engineered Urban Designs
- Net-Zero Energy Homes
- High Efficiency Appliances
- High Efficiency Boilers & Combustion Systems
- High-Temperature Superconductivity Demonstrations

- Fuel Cell Vehicles and H₂ Fuels
- Low Emission Aircraft
- Solid-State Lighting
- Ultra-Efficient HVACR
- Net-Zero Energy Buildings
- Transformational Technologies for Energy-Intensive Industries
- Energy Storage for Load Leveling

- Widespread Use of Engineered Urban Designs & Regional Planning
- Net-Zero Energy Communities
- Integration of Industrial Heat, Power, Process, and Techniques
- Superconducting Transmission and Equipment

Goal 2: Energy Supply

- IGCC Commercialization
- Stationary H₂ Fuel Cells
- Cost-Competitive Solar PV
- Demonstrations of Cellulosic Ethanol
- Distributed Electric Generation
- Advanced Fission Reactor and Fuel Cycle Technology

- FutureGen Scale-Up
- H₂ Co-Production from Coal/Biomass
- Low-Speed Wind Power
- Advanced Biorefineries
- Community-Scale Solar
- Gen IV Nuclear Plants

- Zero-Emission Fossil Energy
- H₂ & Electric Economy
- Widespread Renewable Energy
- Bio-Inspired Energy & Fuels
- Widespread Nuclear Power
- Demonstration of 500 MW Fusion Plant

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 CO₂

- Geologic Storage Proven Safe
- CO₂ Transport Infrastructure
- Soils Uptake & Land Use
- Ocean CO₂ Biological Impacts Addressed

- Track Record of Successful CO₂ Storage Experience
- Large-Scale Sequestration
- Carbon & CO₂ 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
- Low-Cost Sensors and Communications

- Advanced LFG Utilization
- Soil Microbial Processes
- Substitutes for SF₆
- Catalysts That Reduce N₂O to Elemental Nitrogen in Diesel Engines

- Integrated WM System with Automated Sorting, Processing & Recycle
- Zero-Emission Agriculture
- Solid-State Refrigeration/AC Systems

Goal 5: Measure & Monitor

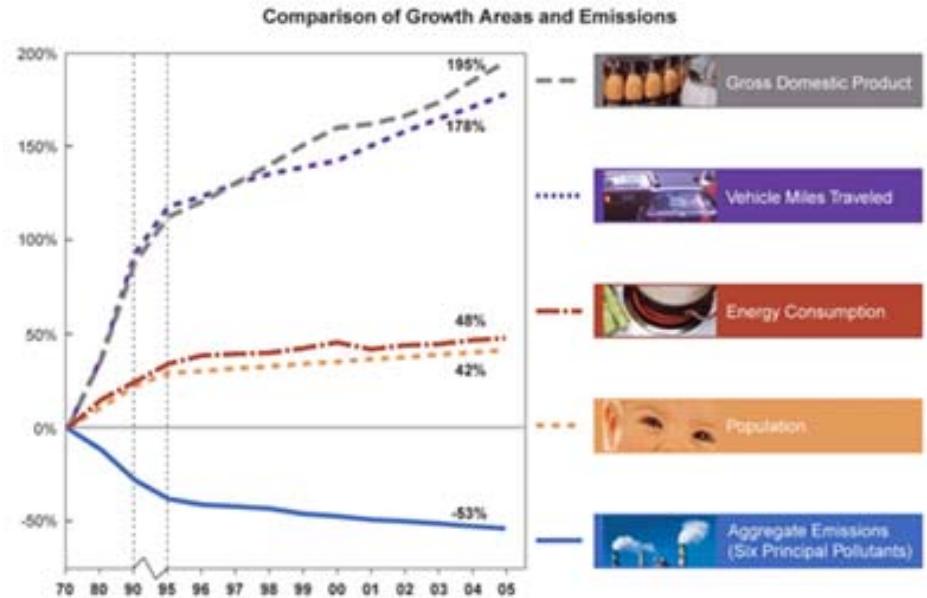
- Large Scale, Secure Data Storage System
- Direct Measurement to Replace Proxies and Estimators

- Fully Operational Integrated MM Systems Architecture (Sensors, Indicators, Data Visualization and Storage, Models)



U.S. Experience

- **Air Pollution Down 54% since 1970:**
 - Down 12% 2000-2005.
 - Economy Up 195%.
 - Vehicle Miles Up 178%.
 - Energy Use Up 48%.
 - Population Up 42%.
- **GHG Emissions up 1.3% 2000-2005:**
 - Population up 11.4 million or 4.1%—nearly equivalent to the combined 2004 population of Greece and Iceland.
 - Real GDP up by \$1.12 trillion or 11.7%—nearly equivalent to the combined 2002 GDP of Brazil and India (in billion 2000 US\$).



GDP Data: World Bank, World Development Indicators (WDI), Online at <https://publications.worldbank.org/subscriptions/WDI/>

Air Emissions Data: U.S. Environmental Protection Agency at <http://www.epa.gov/airtrends/2006/econ-emissions.html>

U.S. GHG Emissions Data: 2006 Common Reporting Format http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/x-zip-compressed/usa_2006_crf_05apr.zip



Climate Change Bilaterals





International 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.
- ***Methane to Markets Partnership***—17 members: Recovery and use of methane from landfills, mines, and oil & gas systems.
- ***ITER***—7 members: Project to demonstrate the scientific and technological feasibility of fusion energy.
- ***Renewable Energy and Energy Efficiency Partnership (REEEP)***—17 countries working to enhance the delivery of clean and secure energy through the use of renewable resources and energy efficiency programs in the developed and developing world.
- ***Global Bioenergy Partnership (GBEP)***—10 countries supporting wider, cost-effective biomass and biofuels development and deployment.

Announced July 2005



“The United States has joined with Australia, China, India, Japan, and South Korea to create a new Asia-Pacific partnership on clean development, energy security, and climate change. This new results-oriented partnership will allow our nations to develop and accelerate deployment of cleaner, more efficient energy technologies to meet national pollution reduction, energy security, and climate change concerns in ways that reduce poverty and promote economic development.”

—President George W. Bush, July 27,
2005



- *Six Partners in 2003 accounted for about half of the world’s GDP, energy use, electricity generation, and carbon dioxide emissions, and nearly two-thirds of world coal consumption.*
- *Eight public-private sector Task Forces (cleaner fossil energy, power production and generation, renewable energy and distributed generation, aluminum, cement, steel, coal mining, buildings and appliances) are preparing action plans.*



Focus

- **Voluntary practical measures** taken by these six countries in the Asia-Pacific region 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
 - Clean Coal
 - Natural Gas
 - Bioenergy
 - Methane Capture/Use
 - Civilian Nuclear Power
 - Geothermal
 - Agriculture/Forestry
 - Rural/Village Energy Systems
 - Advanced Transportation
 - Hydro/Wind/Solar Power
 - Building/Home Construction/Operation
- **Seek opportunities to engage the private sector.**

Principles for Effective International Action



- **Action must focus on broad development agenda, not climate change alone:**
 - **Promote economic growth**
 - **Reduce poverty/meet basic human needs**
 - **Enhance energy security**
 - **Reduce pollution**
 - **Mitigate greenhouse gas emissions**
- **G8 Endorsed Basic Principles in Plan of Action for Climate Change, Clean Energy and Sustainable Development (Gleneagles, June 2005)**
- **Asia-Pacific Partnership on Clean Development and Climate incorporates these principles.**

Background Slides



U.S. Climate Change Policy Overview



- **Integrated into the broader context of development agenda:**
 - **Alleviation of Poverty;**
 - **Rule of Law;**
 - **Investment in People; and**
 - **Stable Economic Institutions.**
- **Reaffirms the U.S. commitment to the United Nations Framework Convention on Climate Change (UNFCCC).**
- **Recognizes the need to take near-term actions, while maintaining economic growth that will improve the world's standard of living.**
- **Grounded in the reality that addressing climate change will require the sustained effort by all nations over many generations.**
- **Promotes advances in climate science and accelerated development of transformational energy technologies.**

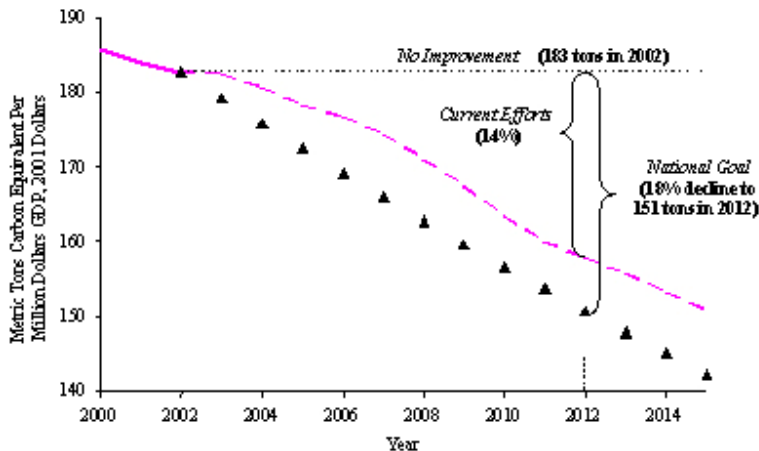
U.S. Climate Change Policy Components



Address climate change within a broader development agenda—one that promotes economic growth, reduces poverty, provides energy security, reduces air pollution, and mitigates greenhouse gas emissions.

- **Slowing the Growth of Net Greenhouse Gas (GHG) Emissions** through near-term policies & measures, including tax incentives:

➤ **National Goal: Reduce GHG Intensity by 18% Over 10-Year Period (2002-2012).**



- **Laying the Groundwork for Current and Future Action: Investments in Science and Technology.**
 - **Climate Change Science Program** (\$1.7 billion in 2006; \$10.7 billion 2001-2006)
 - **Climate Change Technology Program** (\$2.8 billion in 2006; \$14.3 billion 2001-2006)
- **Promoting International Cooperation.**



Near-Term Domestic Actions

- **More than 60 Federal mandatory, incentive-based, and voluntary programs designed to help reduce emissions by more than 500 million metric tons of carbon-equivalent from BAU through 2012. Examples of mandatory and incentive-based programs include:**
 - **Fuel Economy Standards**
 - **Energy Efficiency Standards**
 - **Renewable Energy/CHP Tax Incentives**
 - **Hybrid/Fuel Cell Vehicle Tax Incentives**
 - **Clean Air Rules**
 - **Biological Sequestration**
 - **Nuclear Plant Relicensing**
 - **Nuclear Power 2010**
- **Numerous U.S. Department of Energy (DOE) and U.S. Environmental Protection Agency (EPA) voluntary programs to help consumers and corporations reduce their GHG emissions, such as:**
 - **ENERGY STAR**
 - **CHP* Partnership**
 - **Climate Leaders**
 - **Methane Programs**
 - **SmartWay Transport Partnership**
 - **Climate VISION**
- **U.S. Fiscal Year 2007 budget request of about \$5 billion for climate change programs plus energy tax incentives:**
 - **Supports the near-term objective and future actions through major investments in science and technology.**

*Combined Heat and Power



Domestic Clean Air Policy

- **CLEAR SKIES: Reduce Power Plant Pollution (Sulfur Dioxide, Nitrogen Oxides, and Mercury) by 70% below 2003 levels by 2018**
 - **Market-Based Cap and Trade System**
 - **US Fleet of Coal-Fired Power Plants — 1,300 Nationwide**
 - **Two Phases Provides Regulatory Certainty for Capital Planning Decisions**
 - **Promotes Technology Innovation and Cost Reduction**
 - **Promotes Clean Coal and Relieves Pressure On Natural Gas Usage**
 - **\$50+ Billion in Pollution Controls, Efficiency Upgrades**
 - **\$100+ Billion Health Savings**
 - **High Compliance — Low Bureaucracy**
 - **Minimal electricity price impact (~ 1.7-3%)**
- **CLEAN DIESEL RULES — Reduce Diesel Engine Pollution by 90%+**
 - **Performance Standard — Promotes Innovation**
 - **Fuel Sulfur Dioxide Reduced 99+% in 2007**
 - **New Engine Nitrogen Oxide Reduced 90%**
 - **Large Trucks, Construction and Farm Equipment, Locomotives, Marine Vessels**
 - **Commercially Feasible Timelines**
 - **Assures Reliability and Affordability of New Engines**
 - **Enables Larger U.S. Market in Fuel Efficient Vehicles (up to 30% improved fuel economy)**

Well-Designed Voluntary Programs— Important Part of Solution



- **More than a decade of U.S. experience with many participating agencies:**
 - U.S. Environmental Protection Agency (EPA)
 - U.S. Department of Energy (DOE)
 - U.S. Department of Agriculture (USDA)
 - U.S. Department of Transportation (DOT)
 - Department of Housing and Urban Development (HUD)
- **Many underused/cost-effective technologies/practices offer multiple benefits:**
 - Significant energy savings
 - Reduced air/water pollution
 - Enhance economic growth
 - Sizable GHG reductions
- **Spur investment by identifying cost-effective opportunities:**
 - Assessments of where markets not working
 - Assessments of where largest environmental benefit
- **Focus on action and public/private partnerships:**
 - Provide better information/assistance to make better decisions
 - Reduce transaction costs to better investments

U.S. Voluntary Climate Programs Overview



- **Buildings**

- ENERGY STAR (*EPA, DOE, HUD*)

- **Industry**

- ENERGY STAR (*EPA, DOE*)
- Methane Programs (*EPA, DOE, USDA*)
- High-GWP (*EPA*)

- **Energy Supply**

- CHP (*EPA*)
- Green Power (*EPA*)

- **Transportation**

- SmartWay Transport (*EPA, DOT*)
- Best Workplaces for Commuters (*EPA*)

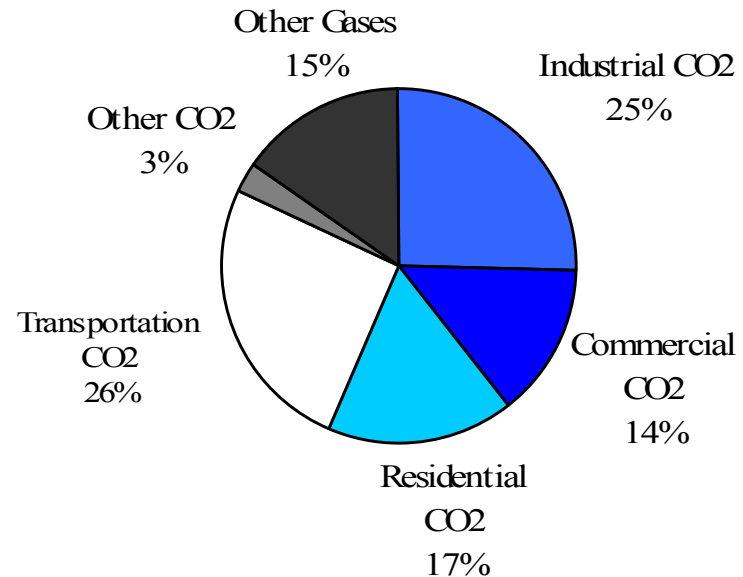
- **Waste**

- Climate and Waste Program (*EPA*)

- **Broad Initiatives**

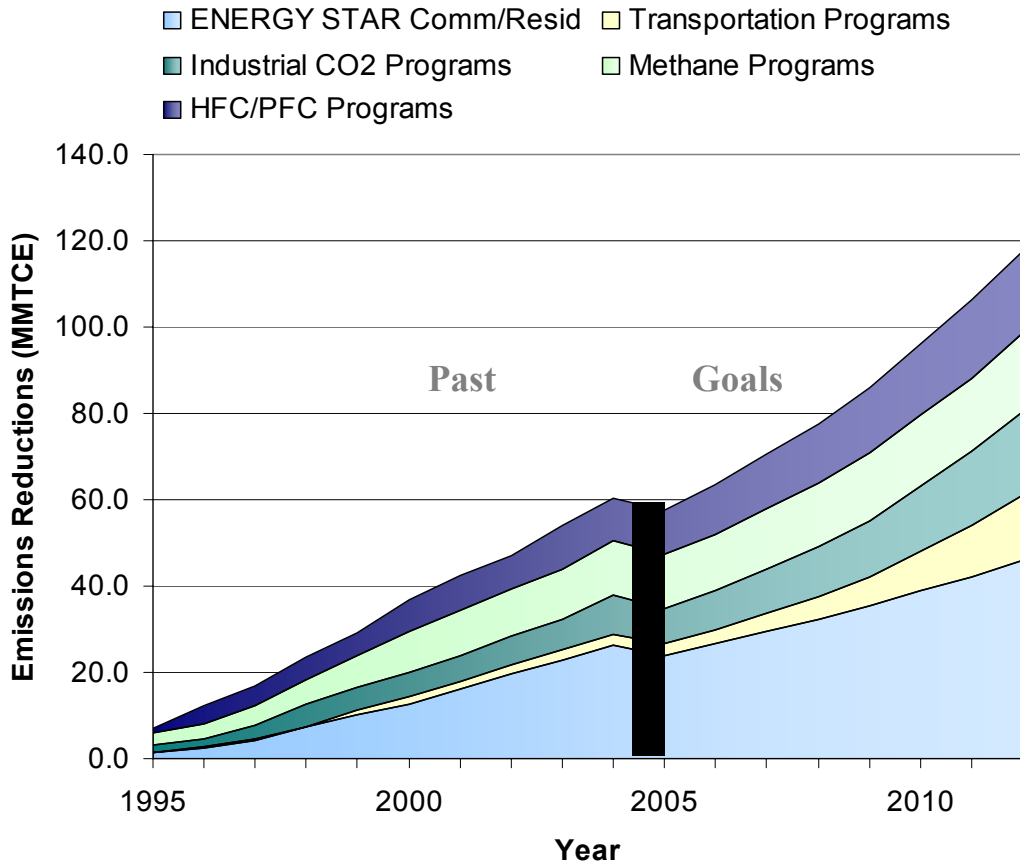
- Climate VISION (*DOE*)
- Climate Leaders (*EPA*)
- State Energy-Environment Partnerships (*EPA*)

U.S. GHG Emissions: 2003



Source: EPA, *U.S. Greenhouse Gas Emissions and Sinks: 1990-2003*, April 2005 at <http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2005.html>

GHG Reductions: Past Accomplishments and Future Goals



- **Partnerships prevented million metric tons (MMTCE) of GHG emissions in 2005—equivalent to the annual emissions from 38 million vehicles.**
- **50 MMTCE per year avoided during the next decade by investments already taken.**
- **Consumers have locked in \$22 billion in investments in energy-efficient technologies.**
- **Estimated net savings of \$9.7 billion in 2004 and \$115 billion through 2014 from ENERGY STAR, Methane, and High-GWP Gas Programs.**

Source: *ENERGY STAR® Overview of 2005 and Other Voluntary Programs, 2004 Annual Report*. U.S. Environmental Protection Agency, September 2005, pp. 3, 49 at http://www.energystar.gov/ia/news/downloads/2005_achievements.pdf



ENERGY STAR

- **Establish in 1992 to promote energy efficiency in homes and businesses, and greatly expanded over the past 5 years:**
 - Covers more than 40 product categories (and thousands of models)
 - Partnerships with more than 8,000 private and public sector organizations.
- **EPA estimates that in 2005 Americans, with the help of ENERGY STAR:**
 - Prevented 35 million metric tons of GHG emissions—equivalent to the annual emissions from 23 million vehicles.
 - Saved about \$12 billion on their utility bills and 150 billion kilowatt hours of energy—4 percent of total 2005 electricity sales.
 - Helped avoid 28,000 megawatts (MW) of peak power—equivalent to the energy required to power about 28 million homes.
- **To date, U.S. consumers have purchased:**
 - More than 2 billion ENERGY STAR qualified products;
 - Almost 10 percent of new housing starts are ENERGY STAR qualified; and
 - Thousands of commercial buildings have been improved.
- **Annual reductions in GHG on track to double again in 10 years to about 60 MMT—equivalent to the annual emissions from 40 million vehicles.**

International

- **ENERGY STAR agreements with:**
 - Australia
 - Canada
 - European Community
 - Japan
 - New Zealand
 - Taiwan.

Methane Programs



- U.S. industries and State and local governments collaborate in several voluntary partnerships to encourage the profitable collection and use of methane that would otherwise be released to the atmosphere:
 - Landfill Methane Outreach Program
 - Natural Gas STAR Program
 - Coalbed Methane Outreach Program
 - AgSTAR Program
- **All follow similar approach:**
 - Provide sound technical, economic, and regulatory information on emissions reductions technologies and practices, as well as tools to help implement methane reduction opportunities.
- **In 2004, these programs, in conjunction with a regulatory program to limit air emissions from the largest landfills, kept methane emission levels to 11.5% below 1990 levels, and they are projected to remain below 1990 levels through 2012.**

International



- **Methane to Markets Partnership:**
 - 17 countries and over 170 project network members working together in a voluntary partnership to advance the recovery and use of methane from landfills, mines, oil & gas systems, and animal waste management systems.

Source: EPA at <http://www.epa.gov/methane/index.html> and associated links, and *INVESTING IN OUR FUTURE: ENERGY STAR® and Other Voluntary Programs, 2004 Annual Report*. U.S. Environmental Protection Agency, September 2005, pp. 33-42 at http://www.energystar.gov/ia/news/downloads/annual_report2004.pdf.

Combined Heating and Power (CHP) Partnership



- Established October 2001 to promote CHP projects, which offer tremendous potential for efficiency improvements (often 75% or higher) by using waste heat produced in many industrial processes as a byproduct of electricity generation.
- Can often be installed in a variety of settings, including large industrial plants, college campuses, hospitals, hotels, and commercial buildings.
- **Multiple benefits:**
 - Cost savings
 - Enhanced electric system reliability
 - Local economic development;
 - Pollution prevention.
- **2001-2005 accomplishments include:**
 - Assisting over 160 projects representing 3,460 Megawatts of new CHP capacity.
 - Preventing annual emissions of over 2.5 million metric tons of CO₂ equivalent—the annual emissions of over 1.6 million cars, or the sequestration from over 2.5 million acres of forest.
 - 177 Partners dedicated to promoting and installing CHP.

Source: EPA at <http://www.epa.gov/chp/> and associated links, and *INVESTING IN OUR FUTURE: ENERGY STAR® and Other Voluntary Programs, 2004 Annual Report*. U.S. Environmental Protection Agency, September 2005, pp. 4, 28 at http://www.energystar.gov/ia/news/downloads/annual_report2004.pdf.



Climate Leaders



- Launched February 2002 to challenge individual companies to develop climate change strategies. Companies implement their strategies by setting aggressive GHG reduction targets and reporting progress to EPA.
- **Currently, 89 participants whose U.S. emissions represent an estimated ten percent of total U.S. GHG emissions.**
- **As of June 28, 2006, 46 have set GHG reduction goals and the rest are in the process of setting goals.**
- **EPA estimates that meeting the goals will prevent more than 8 million metric tons of carbon emissions equivalents per year—equal to the emissions of 5 million cars annually**



Climate VISION



- **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 Commitments

- **Alliance of Automobile Manufacturers:** 10% reduction in GHG per vehicle produced from 2002-2012.
- **Aluminum Association:** 53% carbon equivalent reduction in PFC and CO₂ emissions from carbon anode per ton of Al from 1990-2010.
- **American Chemistry Council:** 18% reduction in GHG emissions per pound of production from 1990 to 2012.
- **American Forest & Paper Association:** 12% reduction in GHG intensity from 2000-2012.
- **American Iron & Steel Institute:** 10% improvement in energy efficiency from 1998 to 2012.
- **American Petroleum Institute:** 10% improvement in energy efficiency of refinery operations from 2002-2012.
- **Association of American Railroads:** 18% reduction in GHG intensity per ton mile from 2002-2012.
- **The Business Roundtable:** 100% participation by BRT members in voluntary actions to reduce, avoid, offset, or sequester GHGs.
- **Industrial Minerals Association:** Soda ash, borates, and sodium silicate company members committed to 4.2% reduction in GHG emissions from fuel combustion per ton of product between 2000 and 2012.
- **International Magnesium Association:** Eliminate sulfur hexafluoride emissions from magnesium production by the end of 2010.
- **National Lime Association:** 8% reduction greenhouse gas emissions from fuel combustion per ton of product between 2002 and 2012
- **National Mining Association:** 10% improvement in energy efficiency of mining operations from 2002-2012.
- **Portland Cement Association:** 10% reduction in CO₂ emissions per ton of cementitious product produced or sold from 1990 to 2020.
- **Power Partners:** 3%-5% reduction in GHG emissions per unit of electricity produced from a 2000-2002 base period to 2010-2012.
- **Semiconductor Industry Association:** 10% reduction in absolute perfluorocompound emissions from 1995 to 2010.



Domestic Energy Policy

- **Tax Law Changes**

- **Promotes Investment in New, Efficient Equipment**
- **Improve Productivity, Reduce Pollution and GHG**

- **Energy Policy Act of 2005**

- **\$11.5 Billion Clean Technology Tax Incentives**
- **7.5 Billion Gallon Ethanol and Biodiesel Mandate**
- **Appliance and Building Energy Efficiency Standards**
- **Regulatory Reform: Renewables, Nuclear, Electricity Markets**

- **Fuel Economy Improvements**

- **15% increase in light trucks/SUVs over 6 years**
- **Sensible reforms to save fuel, save lives, save jobs**

Energy Policy Act of 2005 Tax Incentives



Incentives: \$14.5 billion

Offsets: \$3 billion

Total: \$11.5 billion

Energy Policy Act of 2005

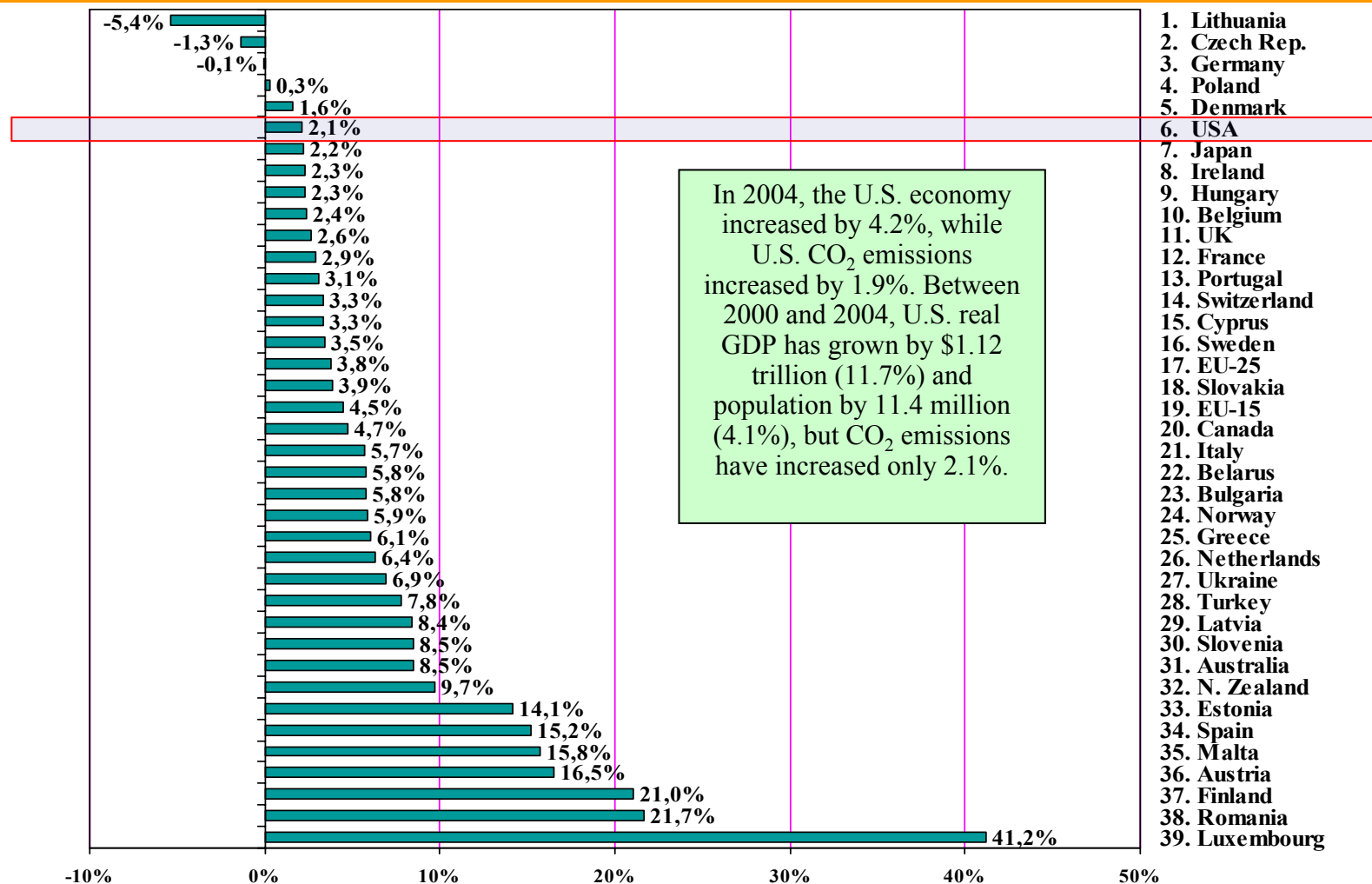
Technology Incentives



- **Title VI provides standby support coverage for certain regulatory delays for up to 6 new nuclear plants.**
- **Title XV increases the amount of the renewable content of gasoline from 4.0 billion gallons in 2006 to 7.5 billion gallons in 2012**
- **Title XVII authorizes DOE to issue loan guarantees of up to 80% of project costs to accelerate commercial deployment of advanced energy technologies.**
 - **Eligible technologies must:**
 - ✓ **Avoid, reduce or sequester GHG or air pollutants**
 - ✓ **Employ new or significantly improved technology**
 - **Technology categories include:**
 - ✓ **Renewables**
 - ✓ **Carbon capture & storage**
 - ✓ **Hydrogen fuel cells**
 - ✓ **Advanced nuclear energy**
 - ✓ **Coal gasification**
 - ✓ **Energy efficiency**
 - ✓ **Efficient generation and T&D**
 - ✓ **Production facilities for fuel efficient vehicles**

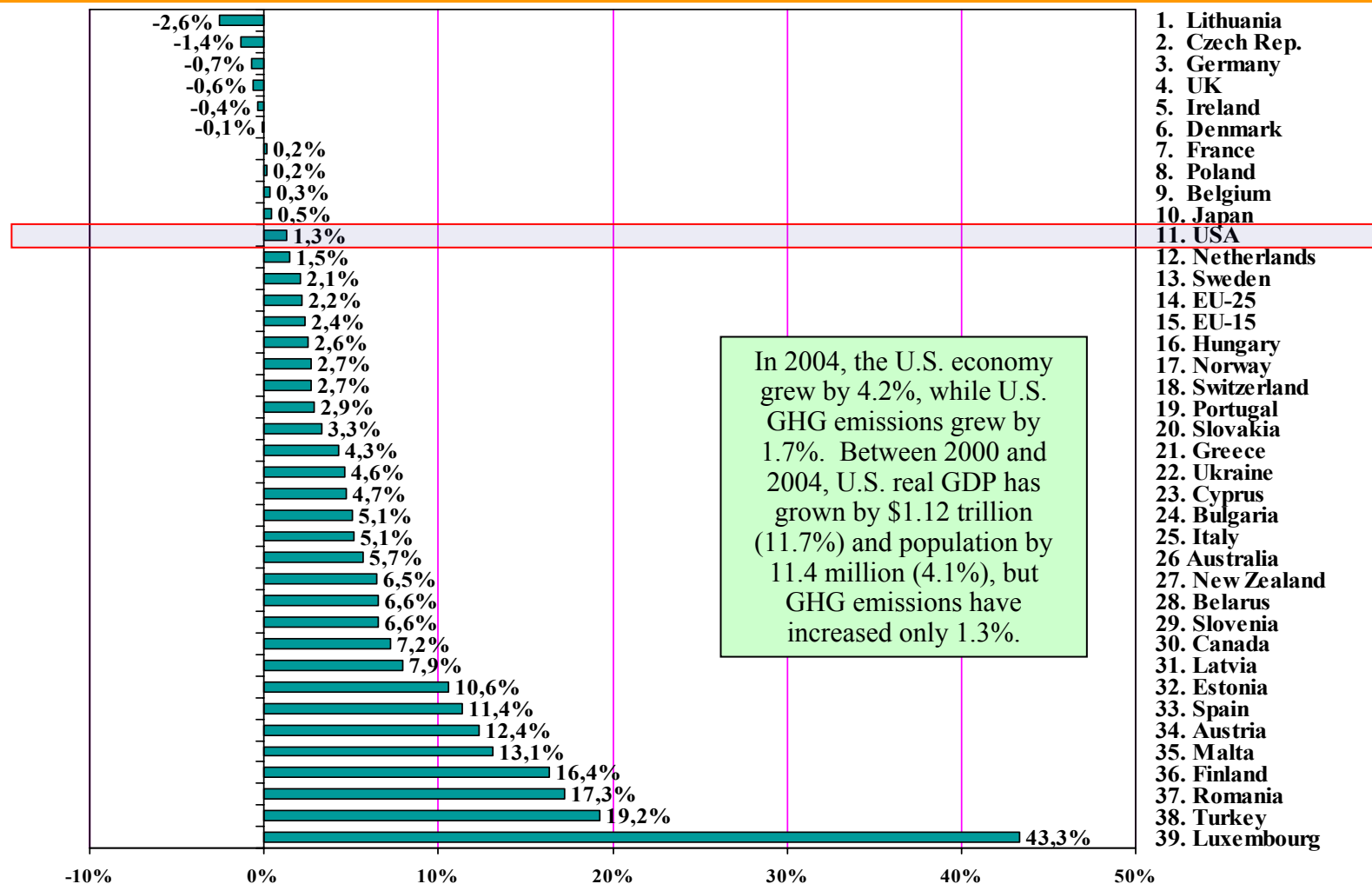


Trends in CO₂ Emissions: 2000-2004

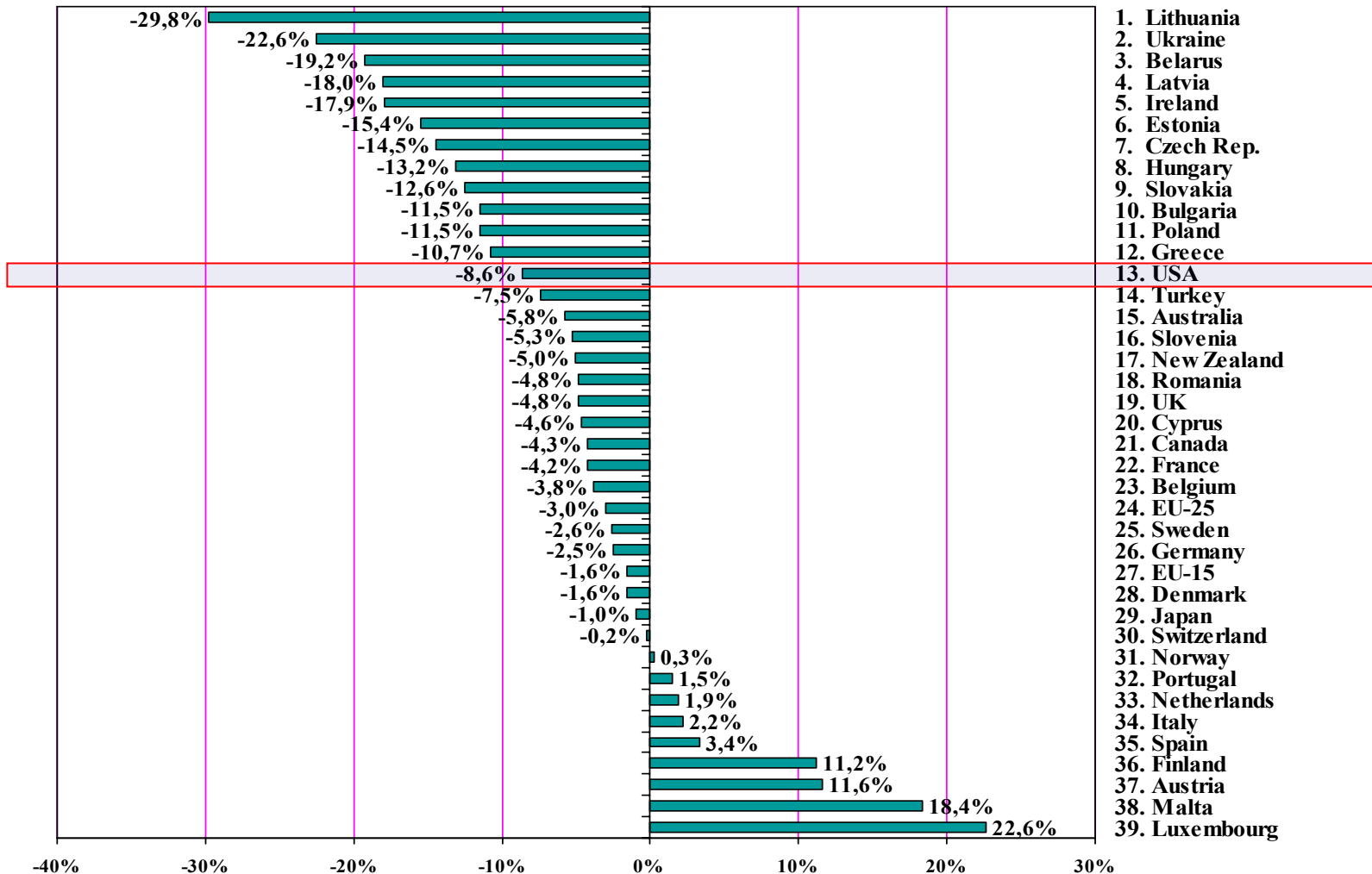




Trends in GHG Emissions: 2000-2004



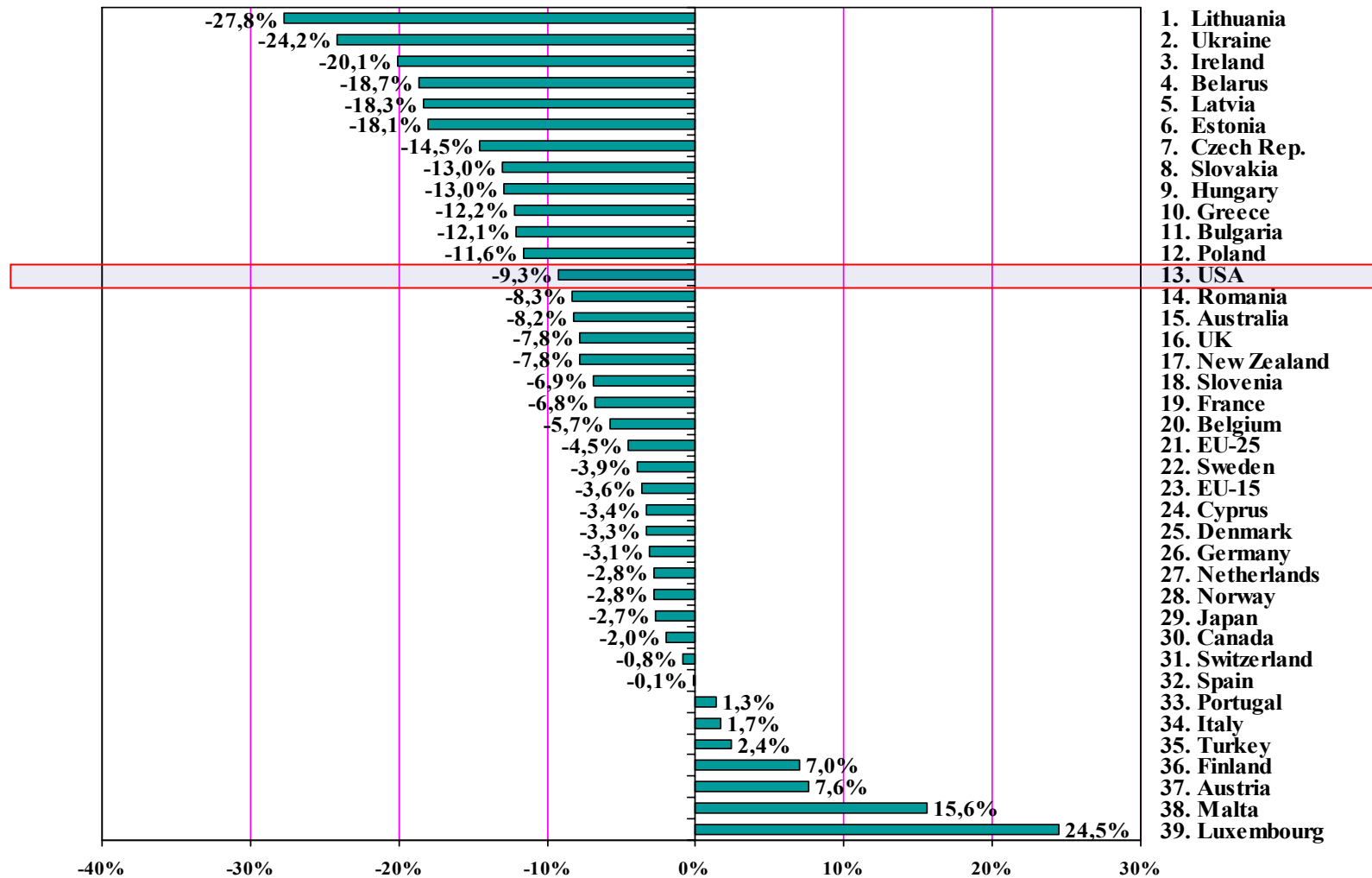
Trends in CO₂ Emissions Intensity: 2000-2004



GDP Data: World Bank, World Development Indicators (WDI),
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Emissions Data: 2006 National Inventory Reports and Common Reporting Formats at http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/2761.php.

Trends in GHG Emissions Intensity: 2000-2004



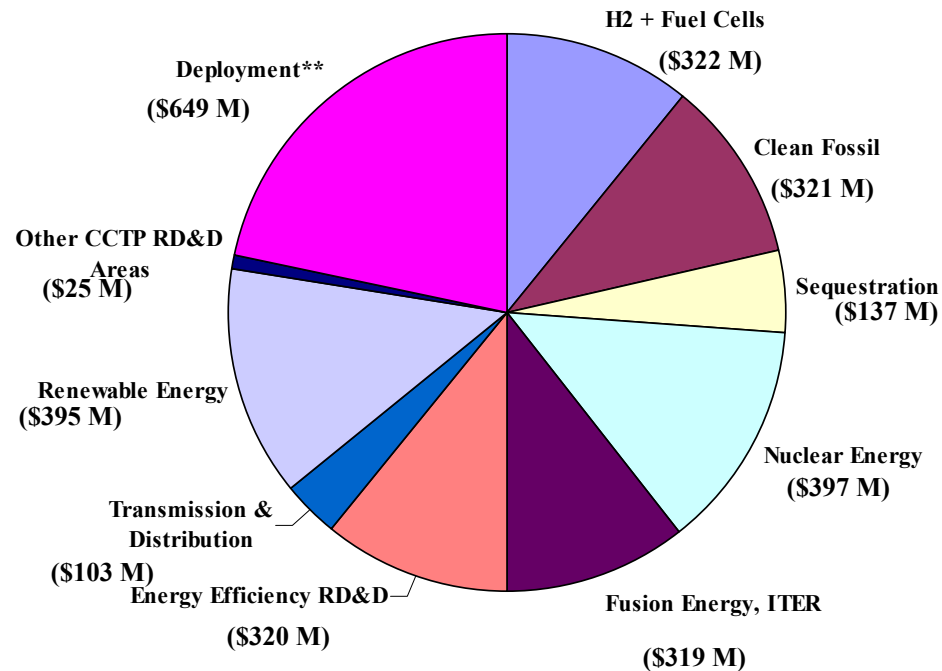
GDP Data: World Bank, World Development Indicators (WDI),
 Online at <https://publications.worldbank.org/subscriptions/WDI/>.

Emissions Data: 2006 National Inventory Reports and Common Reporting Formats
 at http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/2761.php.

Fiscal Year 2007 Budget Request: CCTP Portfolio



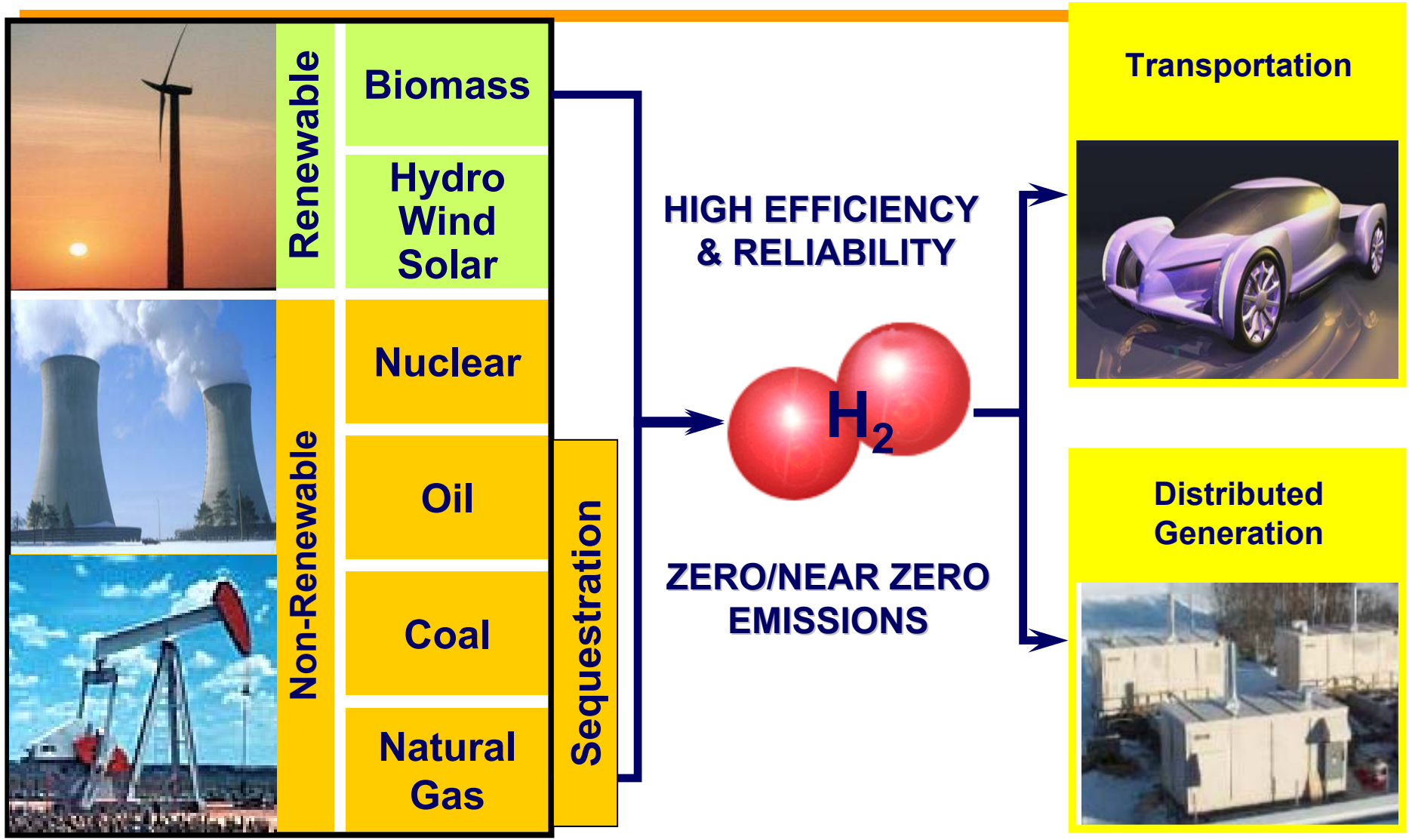
CCTP Fiscal Year 2007 Budget Request* Portfolio of RD&D and Deployment: \$2.987 Billion



*All CCTP Federal Agencies Fiscal Year 2007 Budget Request

** Deployment is 79% Energy Efficiency

Hydrogen Fuel Initiative—1



Hydrogen Fuel Initiative—2



- Hydrogen R&D activities: Focused hydrogen program.

➤ Will integrate technologies for:

- ✓ Hydrogen production from fossil, nuclear, and renewable resources
- ✓ Infrastructure development, including delivery and storage.



- Goal: **Fuel cells for stationary and transportation applications.** Go-no go decision by business in 2015; deployment beginning 2020.

Next Generation Biorefineries



Will be fully integrated facilities that can process grain or biomass crops into a full range of commodity and consumer



Carbon Sequestration



Core R&D

Capture of CO₂

Monitoring, Mitigation, & Verification

Sequestration
• Direct CO₂ storage
• Enhanced natural sinks

Break-through Concepts

Non-CO₂ GHG Mitigation



Carbon Sequestration Leadership Forum

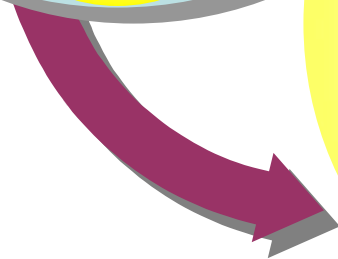
Infrastructure

7 Regional Carbon Sequestration Partnerships

Integration Power/Sequestration Complex

- First-of-kind integrated project
- Verify large-scale operation
- Highlight best technology options
- Verify performance & permanence
- Develop accurate cost/performance data
- International showcase

Initiated FY 2004

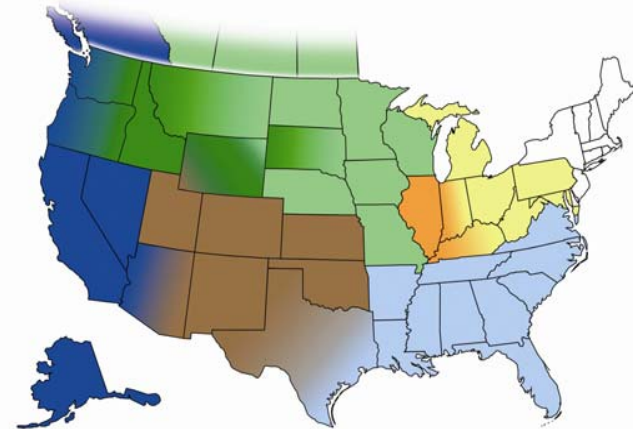


Regional Sequestration Partnerships: A Phased Approach



Phase I (Characterization)

- **7 Regional Partnerships (40 states & over 200 organizations)**
- **24 months (2003-2005)**



Regional Partnerships

Phase II (Field Validation Tests)

- 4 years (2005 - 2009)
- All seven Phase I partnerships continued
- \$100 million federal funds
- \$45 million in cost share

Phase III (MMV & Integration)

- 2009-2013
- Significance to FutureGen and public policy



Nuclear Power



Nuclear Power 2010: Goals are to:

- identify sites for new nuclear power plants;
- develop and bring to market advanced nuclear plant technologies;
- evaluate the business case for building new nuclear power plants; and
- demonstrate untested regulatory processes.

Advanced Fuel Cycle Initiative: Develop advanced, proliferation resistant nuclear fuel technologies that maximize the energy produced from nuclear fuel while minimizing wastes.

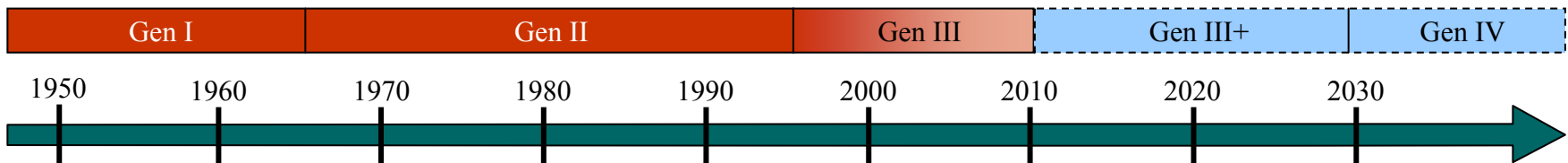
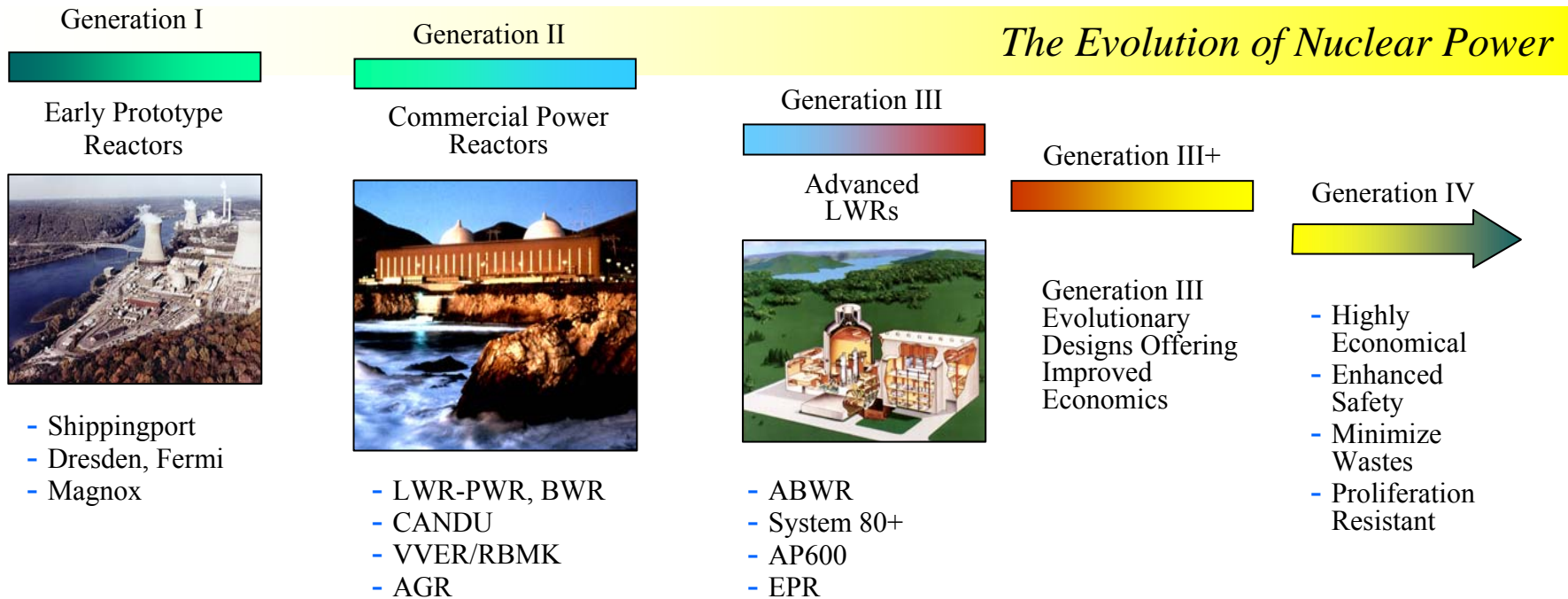
Generation IV Nuclear Energy Systems Initiative: R&D into the next generation of nuclear power plants that are safe, economical, secure, and proliferation resistant. Commercialization goal of 2030.

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.

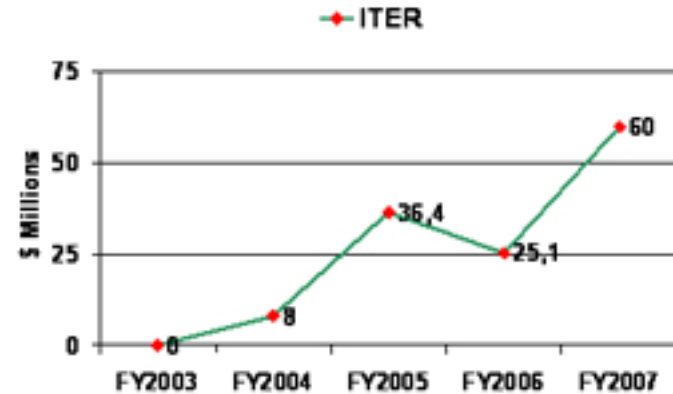
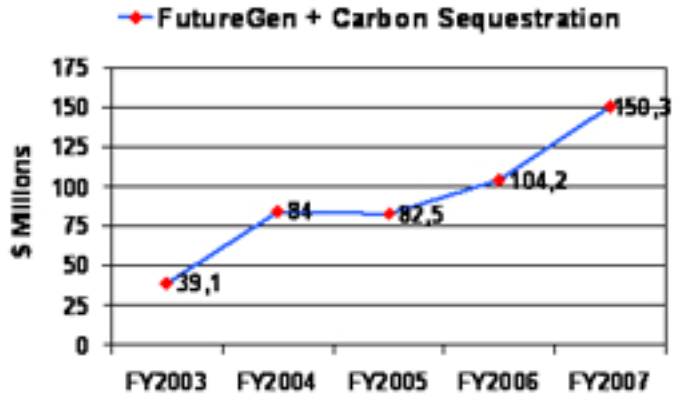
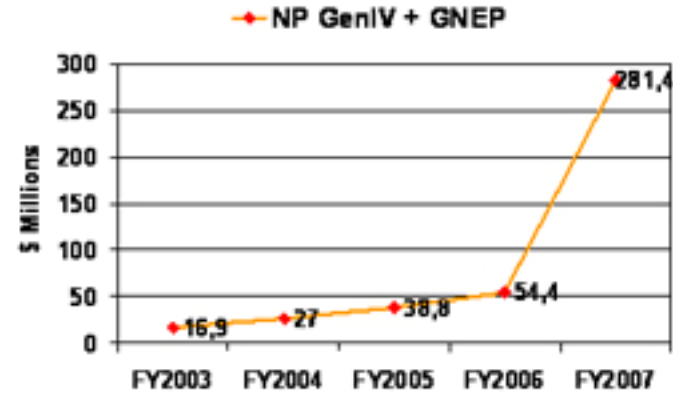
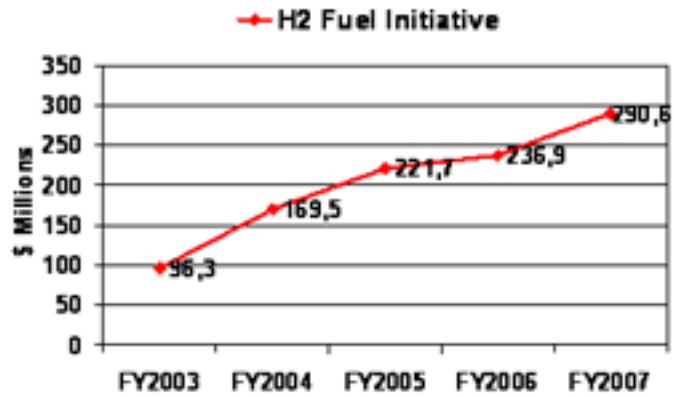
Generation IV Nuclear Power



Goal: Generation IV nuclear energy systems deployable no later than 2030 for generation of electricity and other energy products.



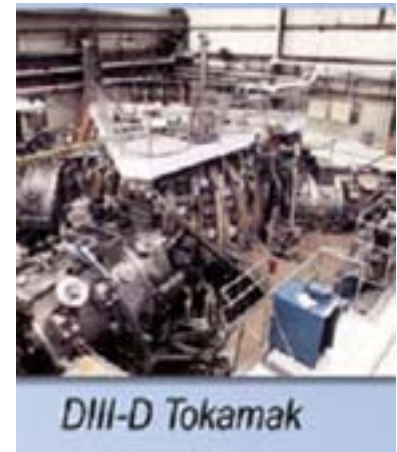
FY 2007 Budget Request — Key Initiatives



Fusion



- **Fusion of deuterium and tritium fuels to generate heat that can be used to produce electricity and possibly hydrogen.**
- **Fusion energy has attractive environmental and safety features:**
 - **No greenhouse gas emissions**
 - **No long-lived radioactive products**
 - **Abundant and widely distributed sources of fuel (seawater and lithium)**
 - **Inherent safety features**
 - **Continuous mode of operation to meet demand**
- **Goals:**
 - **500 MW for 500-2,500 seconds**
 - **Commercialization by 2050**

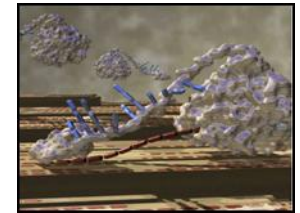
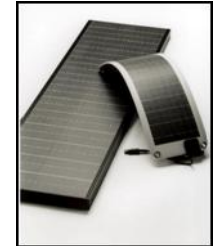


New Initiatives for FY 2007



Advanced Energy Initiative

- **Alter the way we power our homes and automobiles within 20 years.**
- **DOE request includes:**
 - **Solar America Initiative, \$148 Million (+\$65 Million)**
 - **Biomass/Biofuels Initiative, \$150 Million (+\$59 Million)**
 - **Hydrogen Fuel Initiative, \$289 Million (+\$53 Million)**
 - **FutureGen (\$54 Million in FY 2007; \$203 Million in FY 2008)**
 - **Nuclear Power 2010 (\$54 Million in FY 2007)**



Global Nuclear Energy Partnership

- **Responds to the challenges of:**
 - **Global terrorism – threat of nuclear proliferation**
 - **Anticipated 50% growth in energy demand by 2025**
 - **Nuclear waste**
- **DOE request includes \$250 Million for this initiative.**



American Competitiveness Initiative

- **President's commitment to double Federal spending on science over the next 10 years**
- **DOE request includes \$4.1 billion (+\$505 Million) for the Office of Science**