

U.S. DOE Sequestration Program



Sean Plasynski
Sequestration Technology
Manager
Regional Partnerships
Phase II Kick-Off Meeting

October 13, 2005

National Energy Technology Laboratory

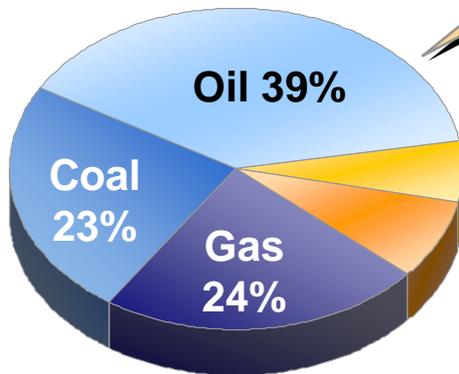


Fossil Energy - America's Energy Foundation

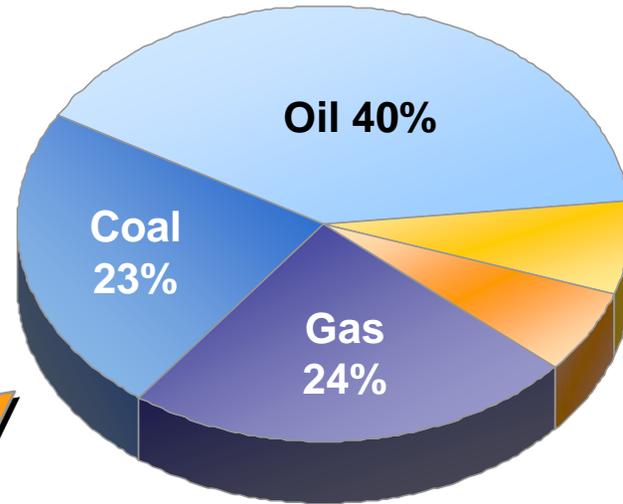
2002

98 Quads

Fossil fuels provide
86% of energy



+ 40%



Renewables
7%
Nuclear 6%

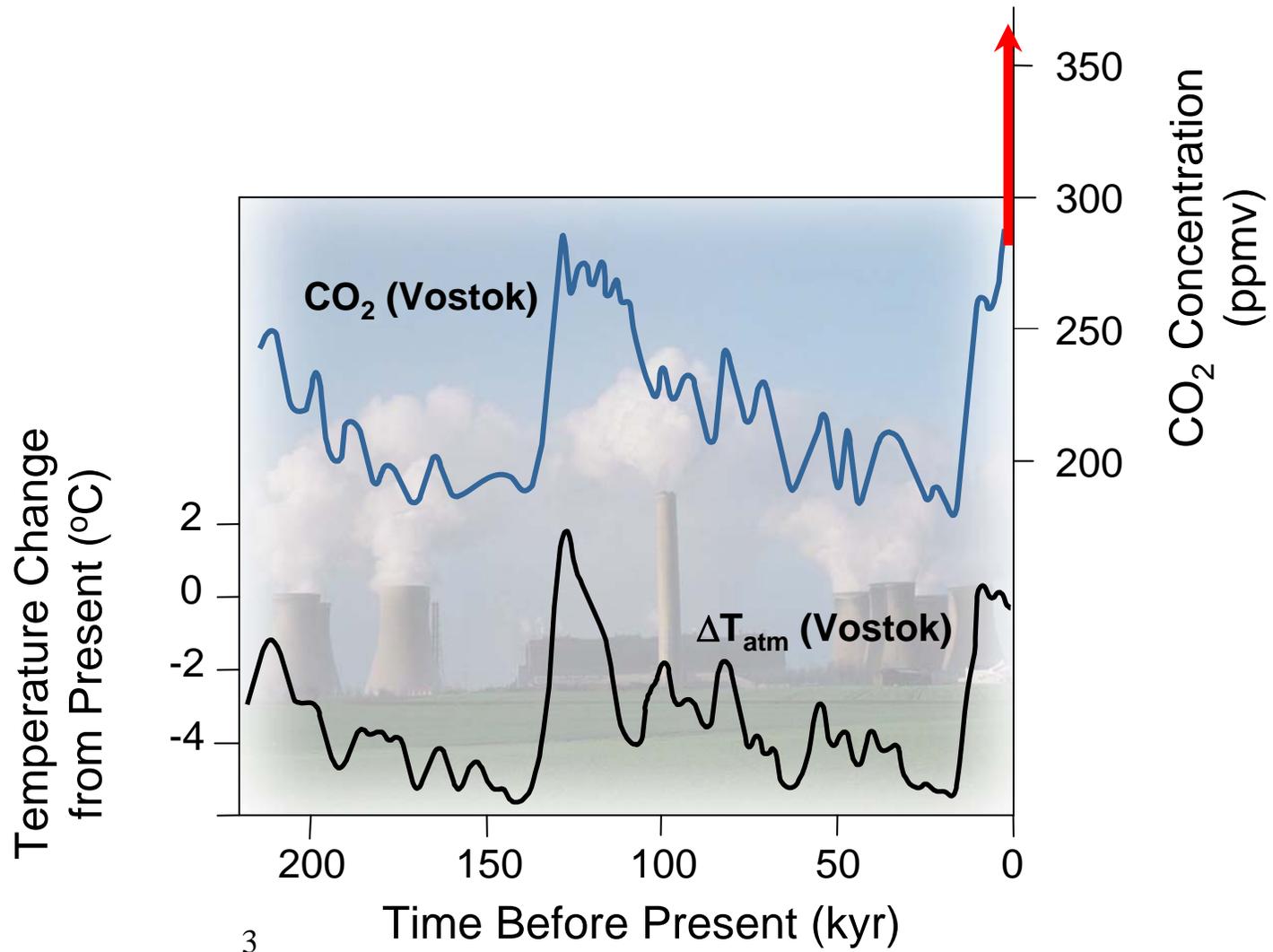
2025

136 Quads

By 2025, reliance on
fossil fuels remains
stable at 87%



CO₂ Concentrations On The Rise (~280 ppm to 370 ppm over last 100 years)



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Drivers for Carbon Sequestration



Presidential Direction

Current Drivers for Carbon Sequestration

***National Climate Change Technology Initiative
June 11, 2001***

***Global Climate Change Initiative
February 14, 2002***

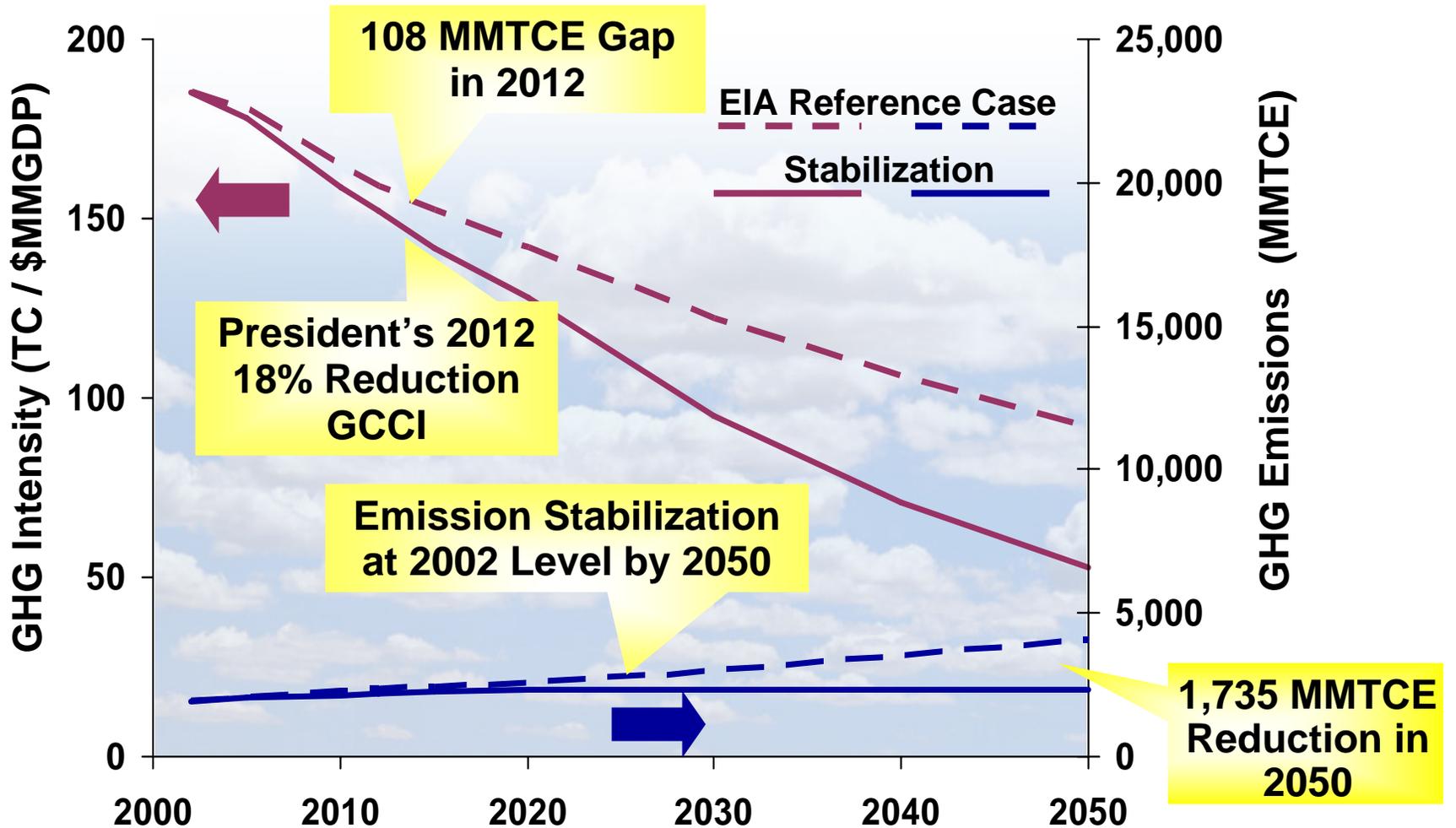
“We all believe technology offers great promise to significantly reduce emissions -- especially carbon capture, storage and sequestration technologies.”

- ***Enables continued use of domestic energy resources and infrastructure***
- ***Sustain economic growth***
- ***Reduce GHG intensity by 18% in next 10 years***
- ***Reevaluate science & path forward in 2012***



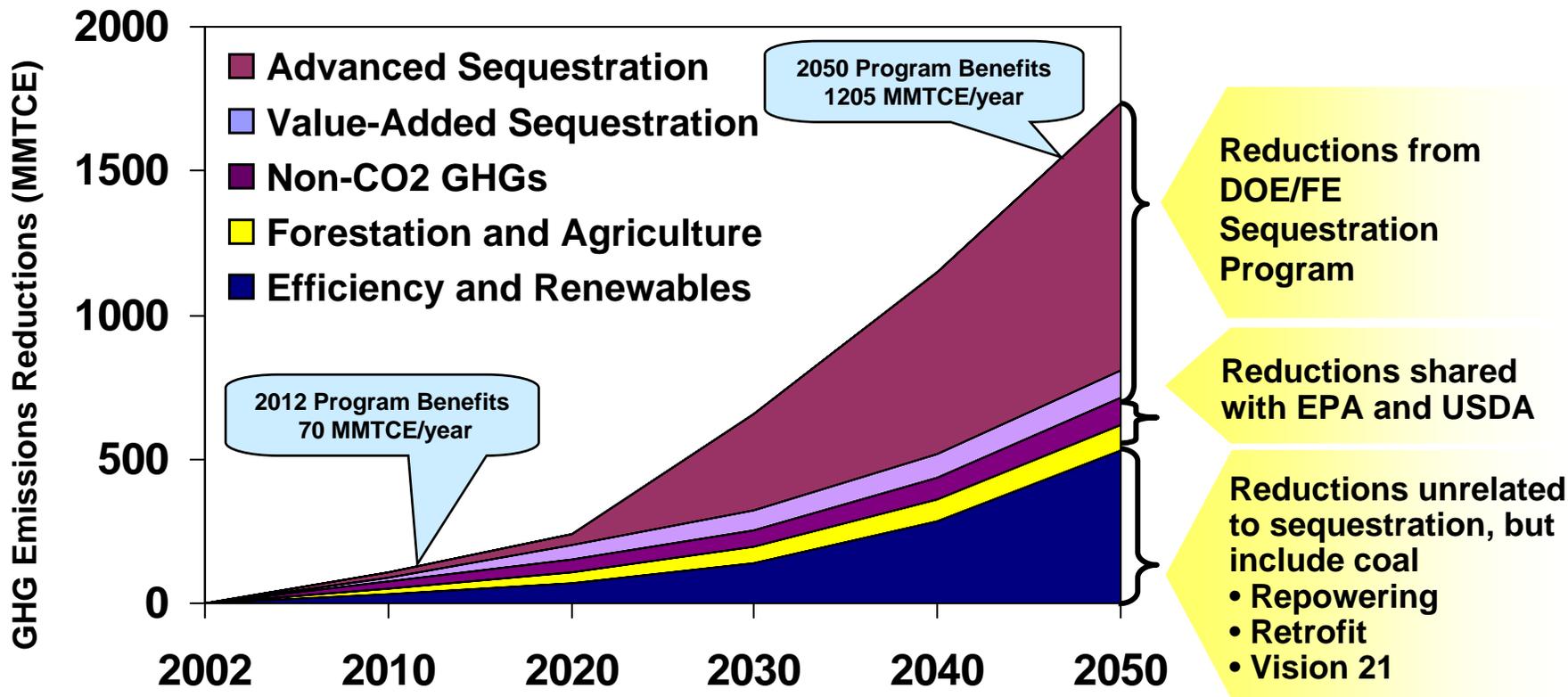
Plausible Pathway to Carbon Stabilization

A Significant Undertaking



Sequestration = Stabilization

Could Account For > 60% of Reduction Gap in 2050



Carbon Sequestration Program

“Pathways to Greenhouse Gas Stabilization”



Key Research Areas

Monitoring, Mitigation, & Verification

Separation & Capture

Modeling & Assessment

Power Station with CO₂ Capture

Terrestrial Sequestration

Terrestrial

Advanced Concepts

Stable Solids
Fuels
Useful Products

Enhanced Oil Recovery

Unmineable Coal Beds

Geologic Disposal

Depleted Oil or Gas Reserves

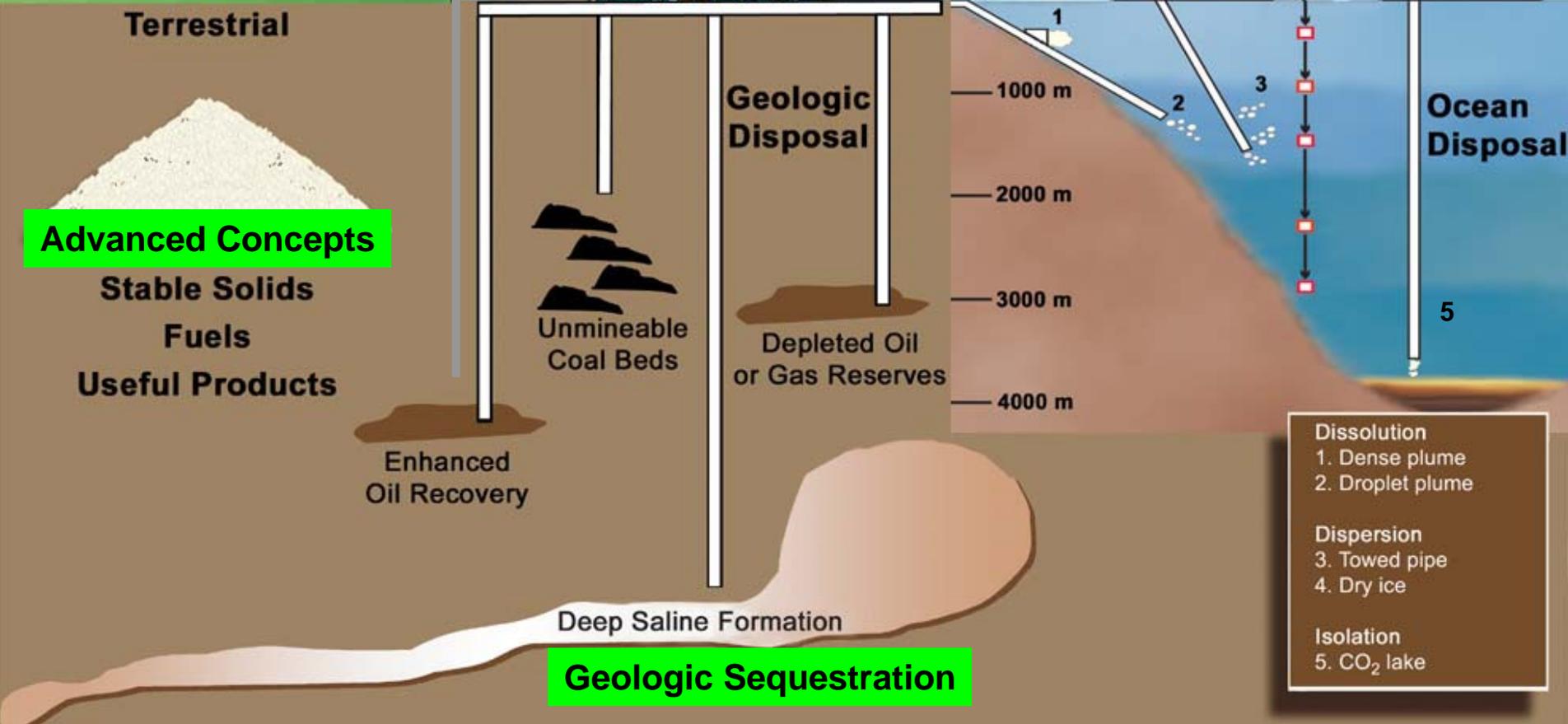
Deep Saline Formation

Geologic Sequestration

Ocean Disposal

1000 m
2000 m
3000 m
4000 m

- Dissolution
- 1. Dense plume
 - 2. Droplet plume
- Dispersion
- 3. Towed pipe
 - 4. Dry ice
- Isolation
- 5. CO₂ lake



Sequestration Program Goals

Develop Technology Options for GHG Management That...

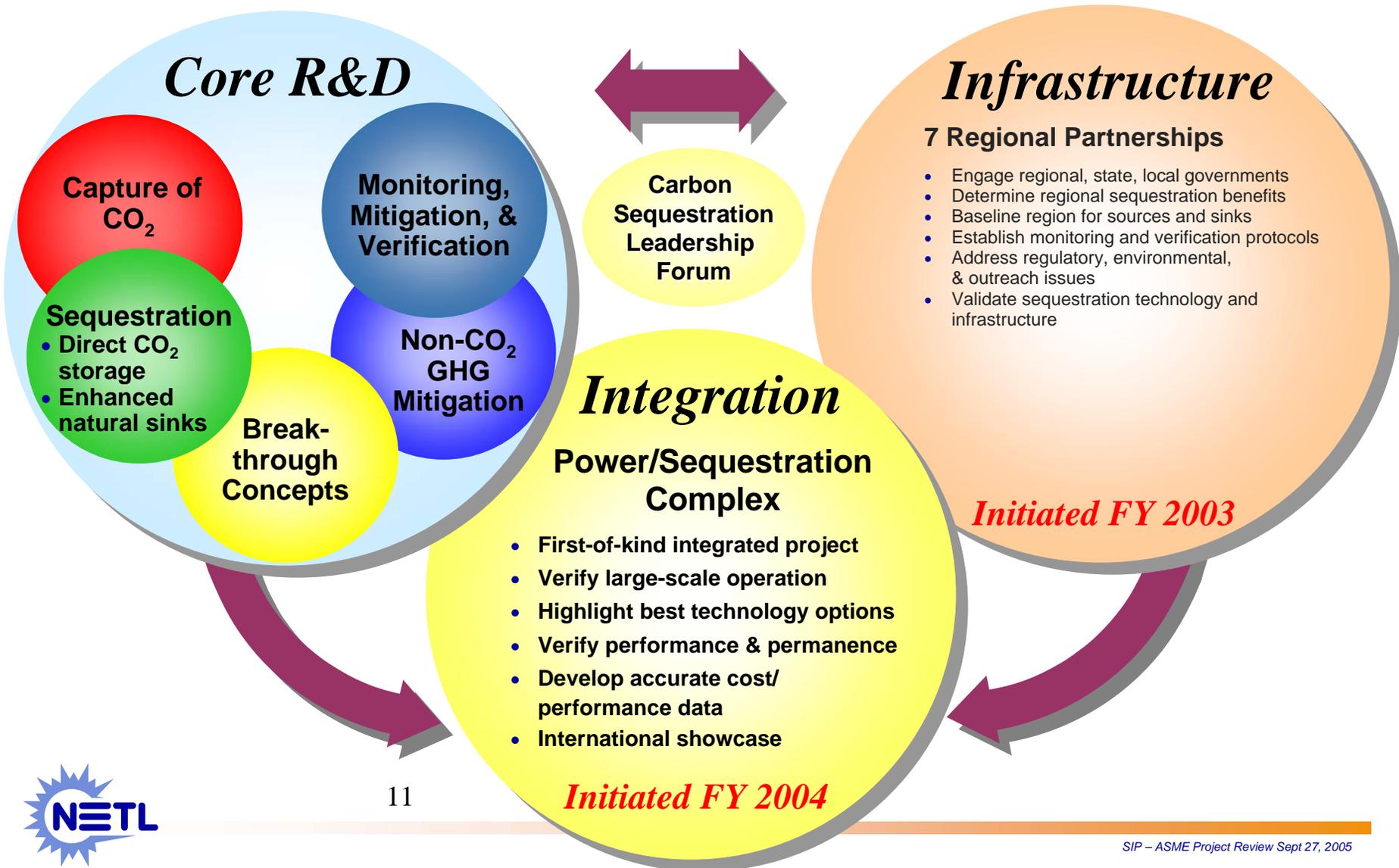
- Are safe and environmentally acceptable
- Result in
 - < 10% increase in cost of energy services (< \$10/tonne CO₂ avoided) for capture, transport, & storage
 - Monitoring, Mitigation & Verification protocols for assurance of permanent storage
- **Global Climate Change Initiative**
 - Contribute to reducing carbon intensity by 18% by 2012
 - Provide portfolio of commercially ready technologies for 2012 assessment

Cost Performance Goals

Year	COE Penalty IGCC Plants (% Increase)	COE Penalty PC Plants (% Increase)
2002	30	80
2007	20	45
2012	10	20
2015	<10	10
2018*	0	0

*Cost/Energy offset from sequestering CO₂ with criteria pollutants NO_x, SO_x, H₂S (gasification)

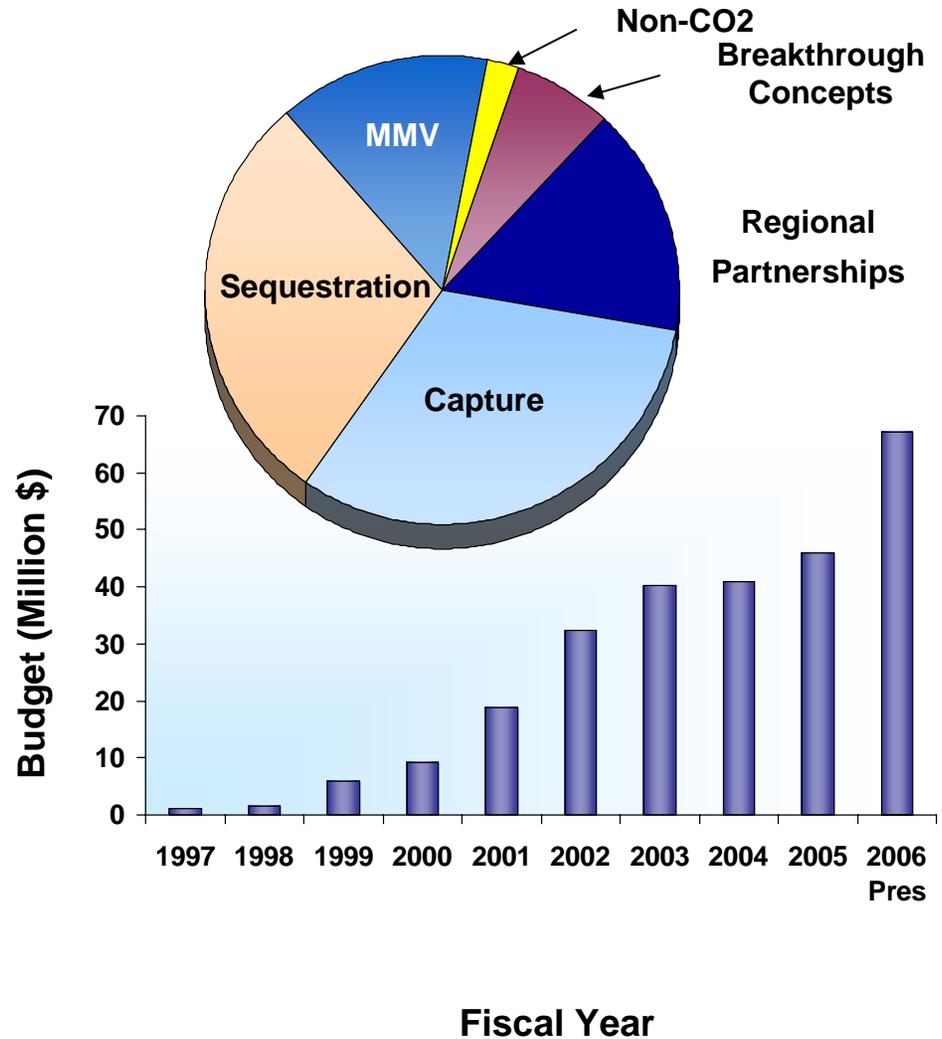
Carbon Sequestration Program Structure



Sequestration: A Dynamic Program

Portfolio Overview – FY2005

- **Diverse research portfolio**
 - ~ 60 R&D Projects
 - IEA & CCP consortia
- **Strong industry support**
 - ~ 36% cost share
- **Federal Investment to Date ~ \$200 Mil**
- **Administration Priority**
 - ~ 50% increase in 2006 budget request
 - House \$50 MM
 - Senate \$74.2MM



Carbon Sequestration Program Structure

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 Partnerships

- Engage regional, state, local governments
- Determine regional sequestration benefits
- Baseline region for sources and sinks
- Establish monitoring and verification protocols
- Address regulatory, environmental, & outreach issues
- Validate sequestration technology and infrastructure

Initiated FY 2003

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

Initiated FY 2004

Regional Carbon Sequestration Partnerships

Developing Infrastructure for Wide Scale Deployment

- **All Seven (7) Regional Partnerships Continued into Phase II**
 - Big Sky Regional Carbon Sequestration Partnership
 - West Coast Regional Carbon Sequestration Partnership
 - Midwest Regional Carbon Sequestration Partnership (MRCSP)
 - Southeast Regional Carbon Sequestration Partnership (SECARB)
 - Southwest Regional Partnership on Carbon Sequestration
 - Illinois Basin Regional Partnership
 - Plains CO2 Reduction Partnership
- **Validating sequestration technology & infrastructure**
 - Phase 1 - design
 - Phase 2 - testing

Announcement of Phase II Selections

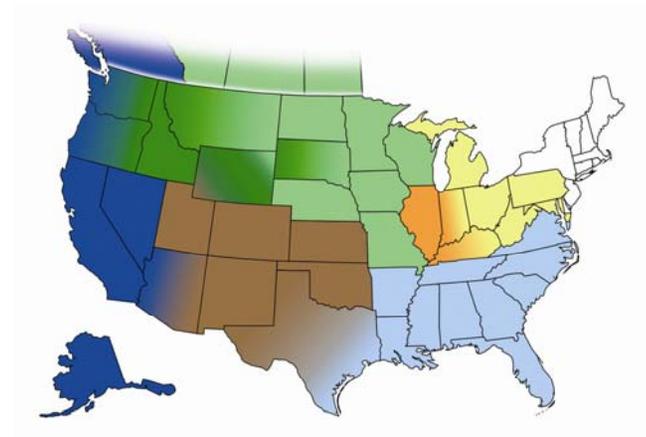
By moving carbon sequestration technology from the laboratory to the field...we are another step closer to significantly reducing greenhouse gas emissions while maintaining the important role coal plays in America's energy mix.

Samuel W. Bodman
Secretary of Energy
June 9, 2005

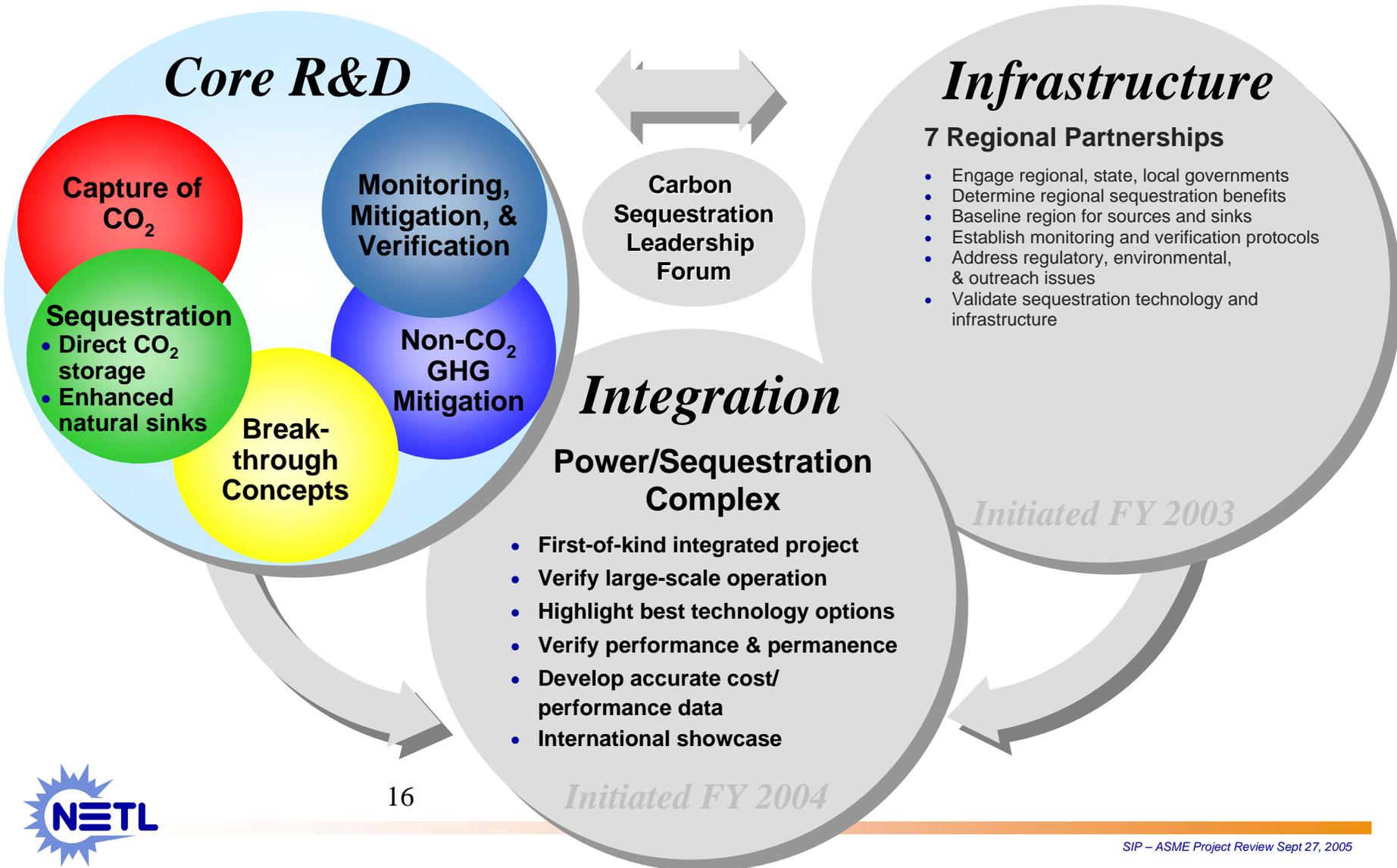


Details of Regional Partnerships *Phase II*

- **Selections of Phase II announced June 2005**
 - Total DOE Contribution \$100 MM over 4-years
 - Cost-Sharing \$45 MM (31% cost-share total project costs)
 - Significant involvement from utilities
 - Every Partnership has utility partners
 - Cost-Share from Utilities/Energy Co. over \$11M
- **Summary of Field Projects Proposed**
 - 25 Geologic Injection Tests
 - 4 EOR/Saline
 - 6 Saline reservoirs
 - 7 ECBM/EGR
 - 8 depleted oil field sequestration tests with EOR
 - Injecting between 1,000-450,000 tons of CO₂
 - 10 Terrestrial Tests
 - 4 Forestry
 - 4 Agriculture no-till
 - 1 Mineland restoration
 - 1 Westland/Prairie Restoration



Carbon Sequestration Program Structure



Separation & Capture R&D

Technology Goals

- 2007 have two technologies < 20% increase in Cost of Energy
- 2012 developed two technologies < 10% increase Cost of Energy

Issue

- Demonstrated technology is costly
- Scale-up (Lab scale to Commercial Plant)

Pathways

- Pre-combustion capture
- Post-combustion capture
- Oxygen-fired combustion
 - Chemical looping
- Optimized engineering



Sequestration/Storage R&D

Technology Goals

- 2012 – predict CO₂ storage capacity with +/- 30% accuracy
- Develop best practice reservoir management strategies that maximize CO₂ trapping

Issues

- Health, safety, and environmental risks
- Uncertain regulatory framework
- Site selection

Pathways

- Field experiments / demos
- Protocols for identifying amenable storage sites
- Capacity evaluation studies

- Underlying science



Monitoring, Mitigation & Verification

Technology Goals

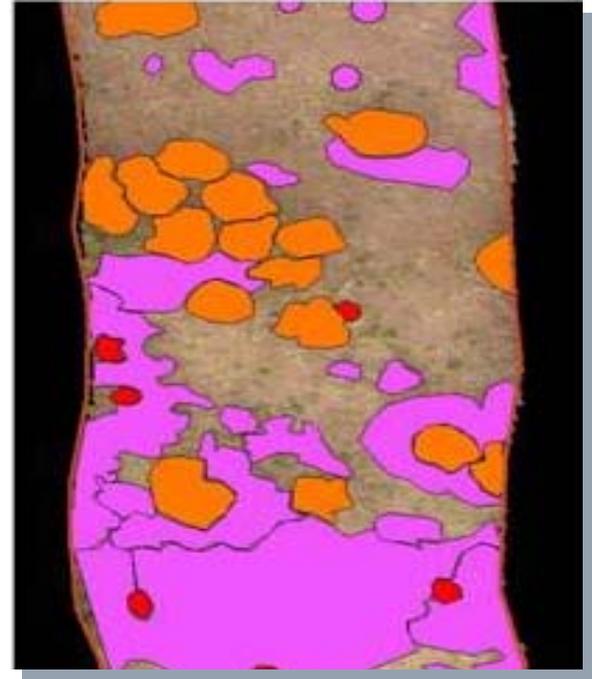
- 2012 – ability to verify 95% of stored CO₂ for credits (1605b)
- CO₂ material balance to >99%

Issue

- Proving CO₂ fate

Pathways

- Surface and subsurface CO₂ leak detection and mitigation tools
- Atmospheric detection systems
- CO₂ fate and transport studies
- Protocols for accounting and permanence



*Digital Aerial Imagery
to Estimate Carbon
Stocks in Above-
Ground Vegetation*

Breakthrough Concepts

Issue

- Need revolutionary approaches to meet DOE cost goals

Pathways

- CO₂ conversion to benign, solid forms
- Advanced capture concepts
- Biogeochemical processes



Non-CO₂ Greenhouse Gas Mitigation

Issue

- Methane a powerful GHG

Pathways

- Technologies to mitigate large fugitive releases
 - Coalbeds
 - Landfill gas
- Collaboration with EPA on best-practice mitigation options

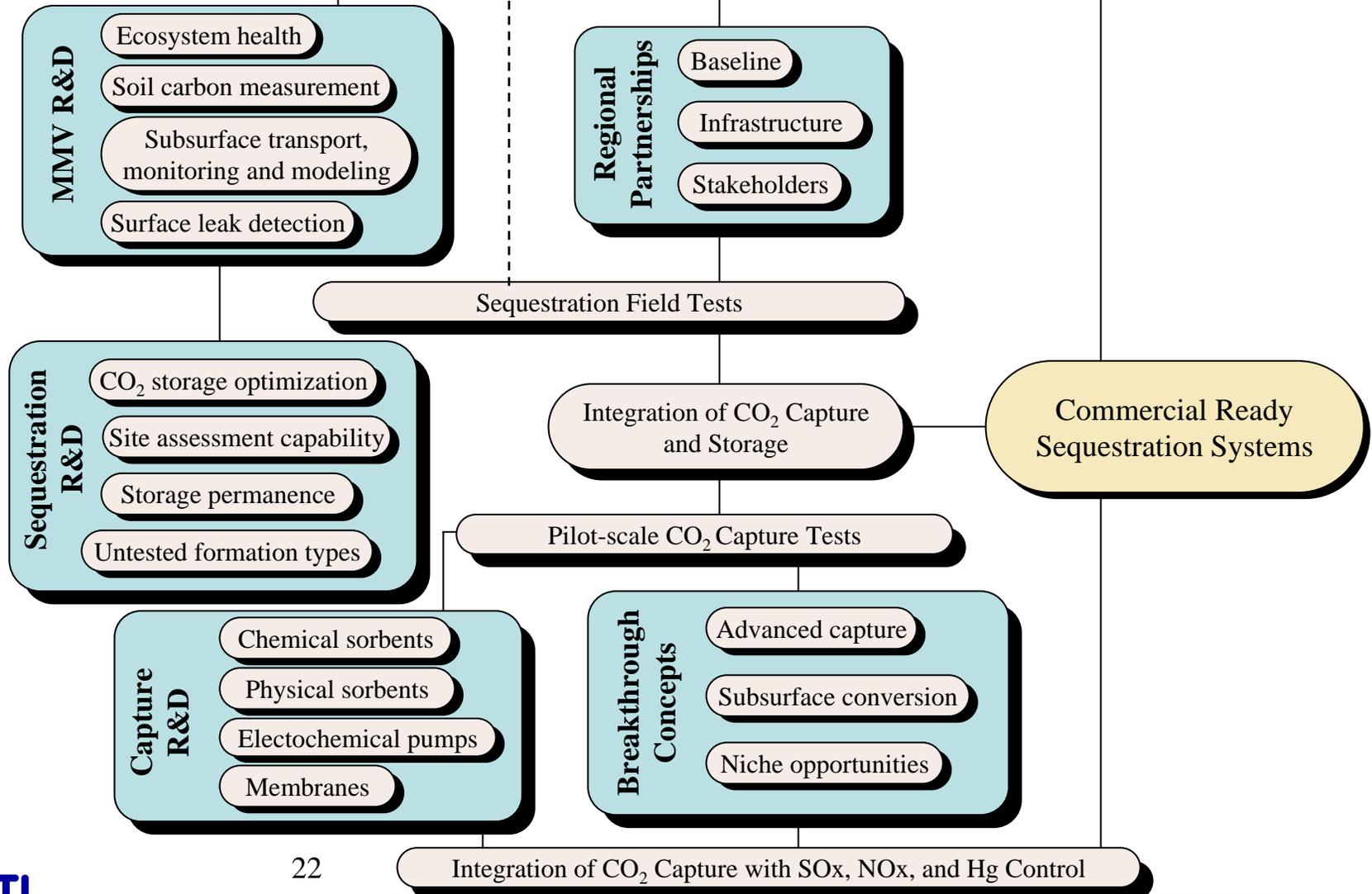
Projects

- Mine mouth Ventilation Methane Mitigation
- Landfill Methane Projects (covers, bioreactors, ECBM)



Re-cap of Technology R&D Pathways

Regulatory Approval and Compliance, Acceptance in GHG Trading Context



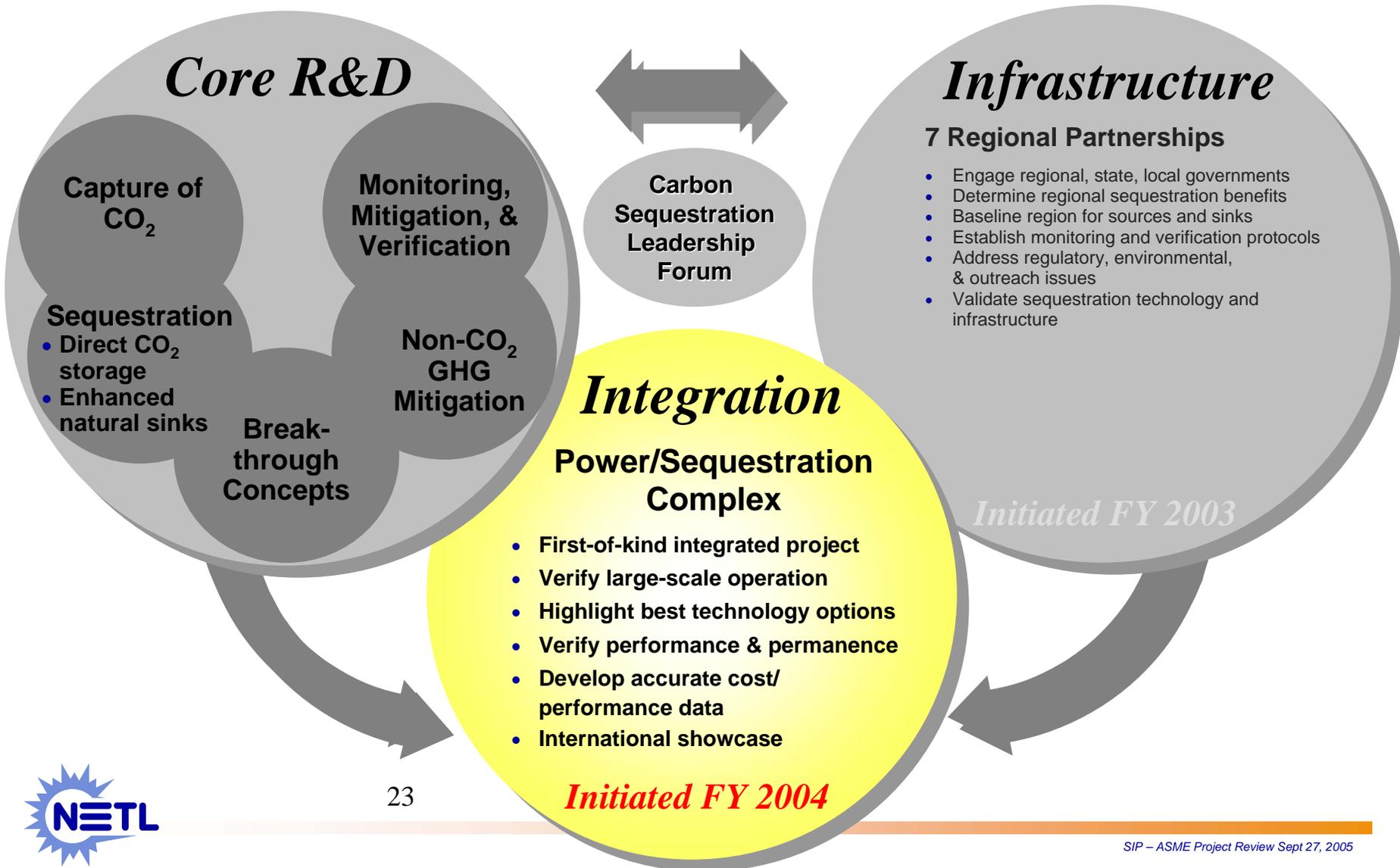
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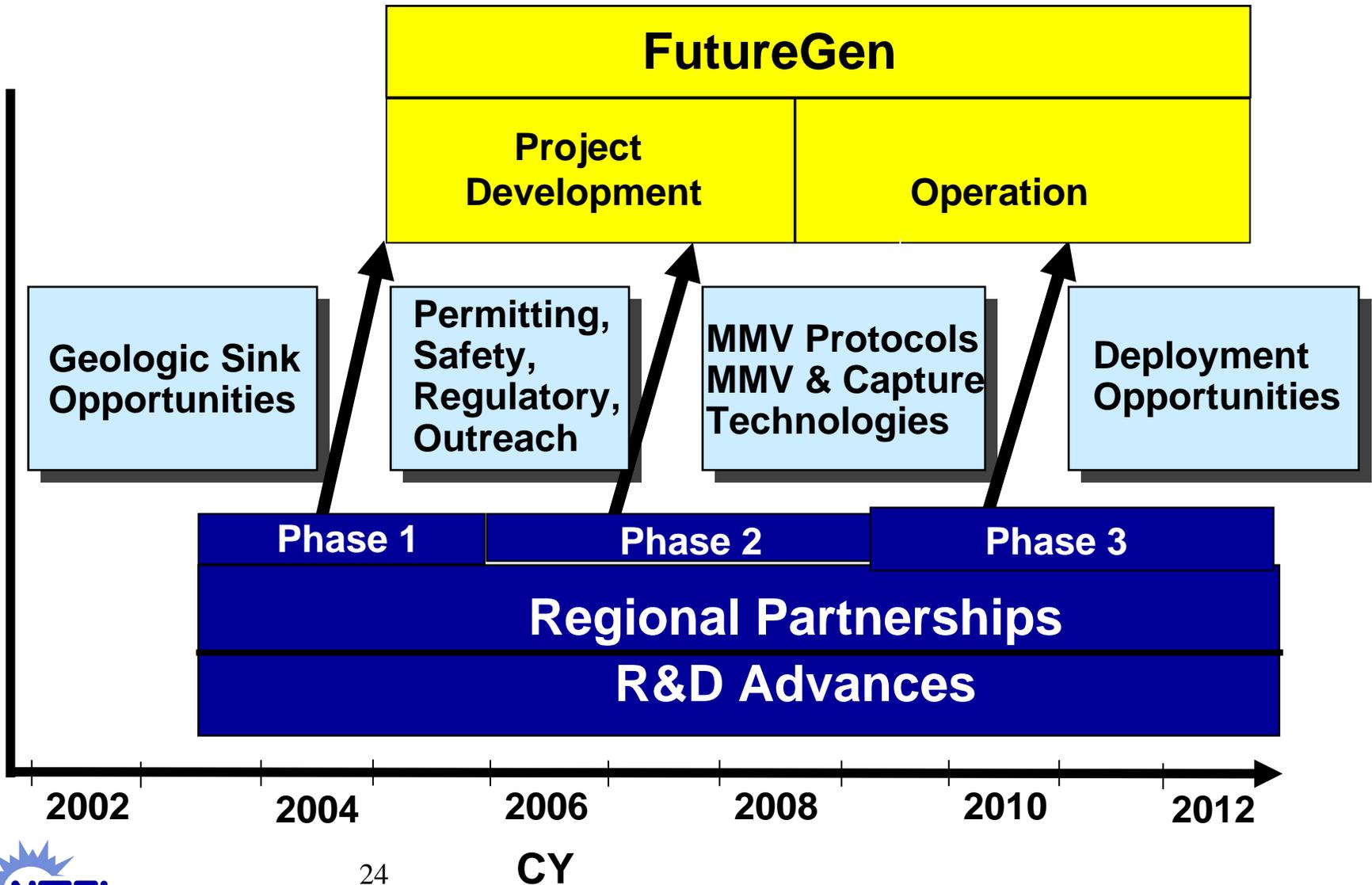
2002

2015

Carbon Sequestration Program Structure



Critical FutureGen Connection





Funding for NLs

- **E-government corporate R&D Portfolio Management Environment (ePME)**
- **Each lab has a Site Administration Manager (SAM)**
- **\$ submitted = \$ we have listed**

