FutureGen Restructured
A Revised Strategy Towards Achieving Near-Zero Emissions Coal

RITE FutureGen Workshop
Tokyo, Japan
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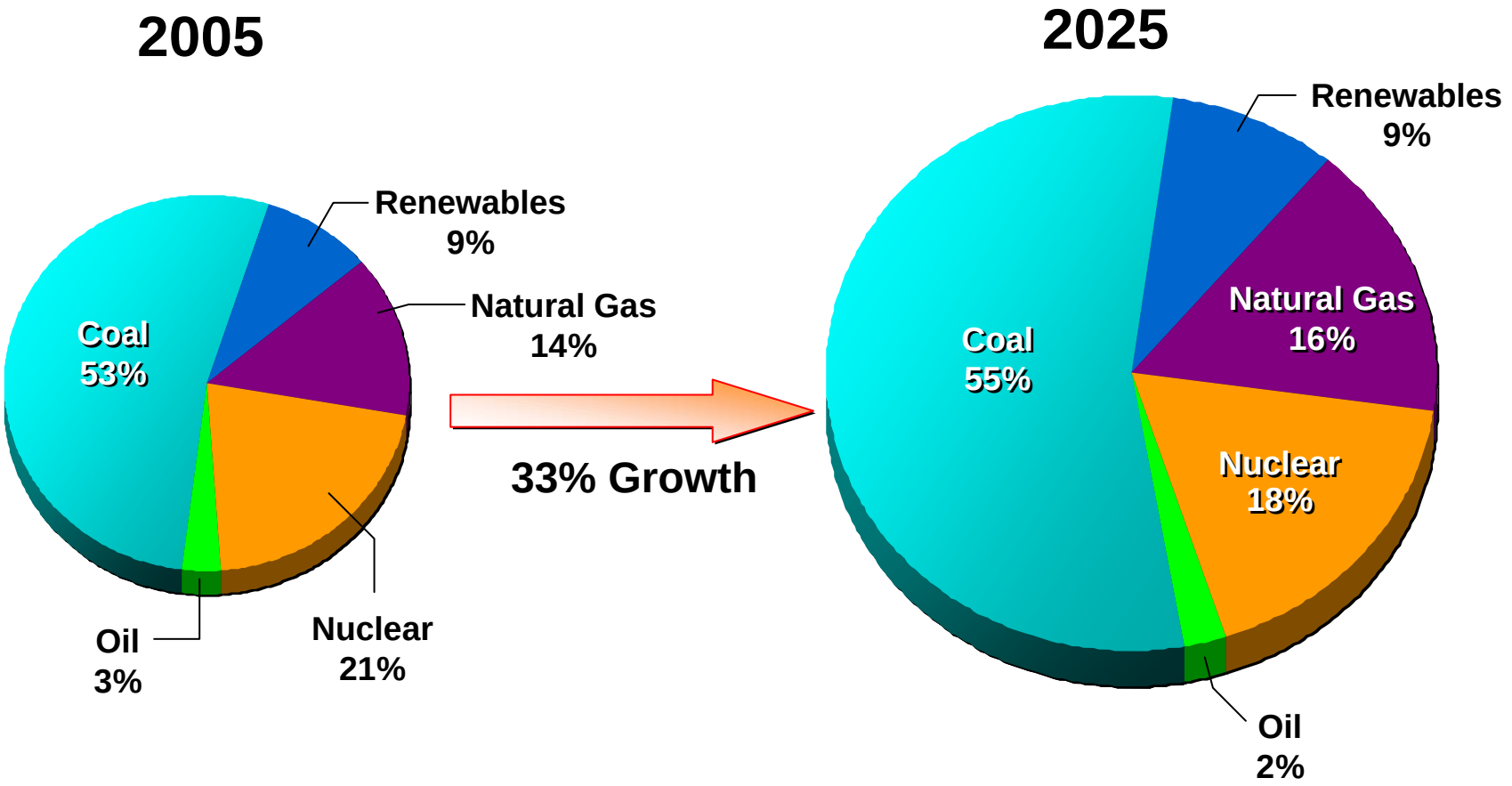
by
Office of Fossil Energy
U.S. Department of Energy

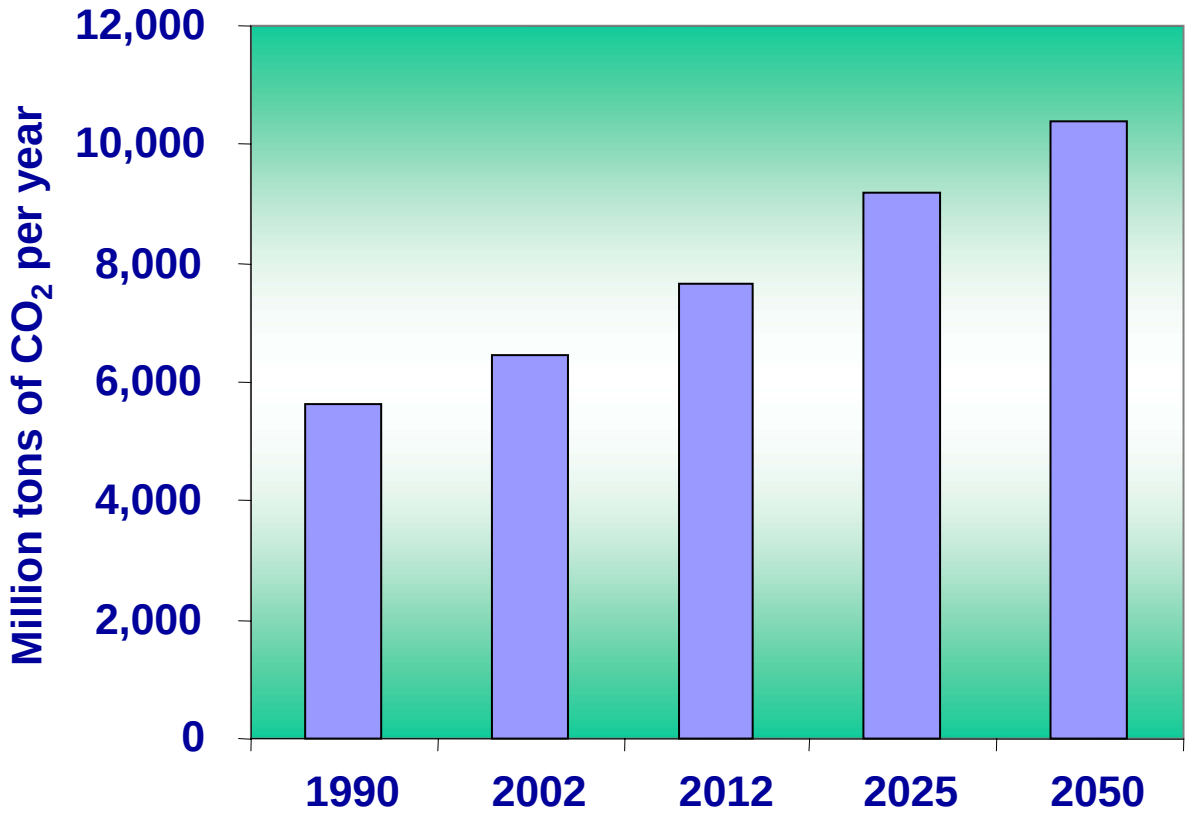
U.S. Electricity Consumption



By 2025, over 356 GW of new generating capacity are expected in the U.S. alone to meet growing demand and to replace retiring units

Growing Population and Economy Mean Continued Increases in CO_2 Emissions

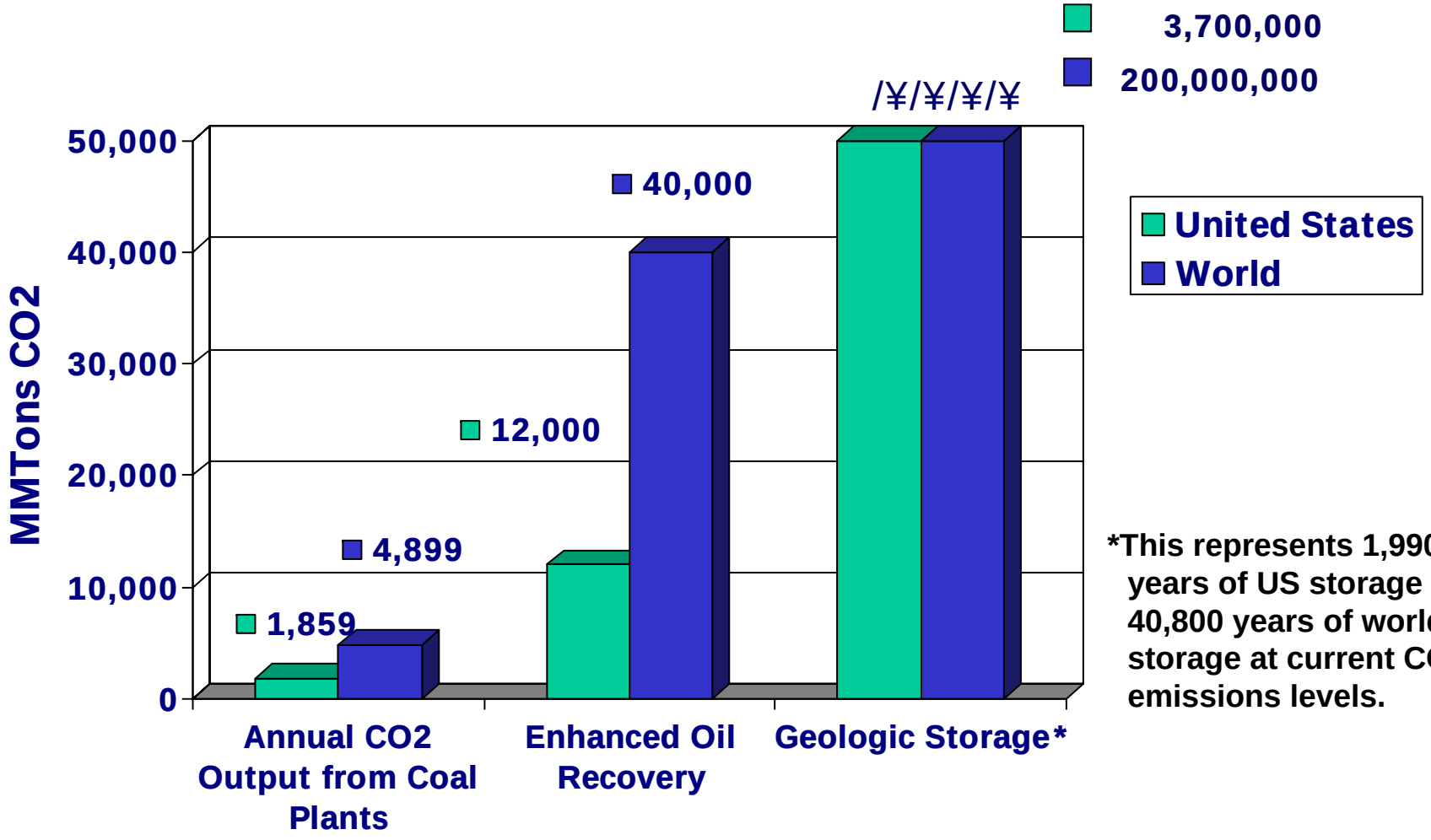
Projected U.S. CO_2 Emissions



Reference case assumes advanced technology but no mandatory CO_2 limits

Data Sources: 1990 - 2025, U.S. DOE Energy Information Administration., historical data and reference case forecast from the AEO 2004. 2050 projection from NETL Carbon Sequestration Program benefits analysis, based on 1.7% annual growth rate of GDP post 2025 and 1.63% reduction in carbon emissions per GDP

Coal Plant CO_2 Emissions and CO_2 Storage Capacity



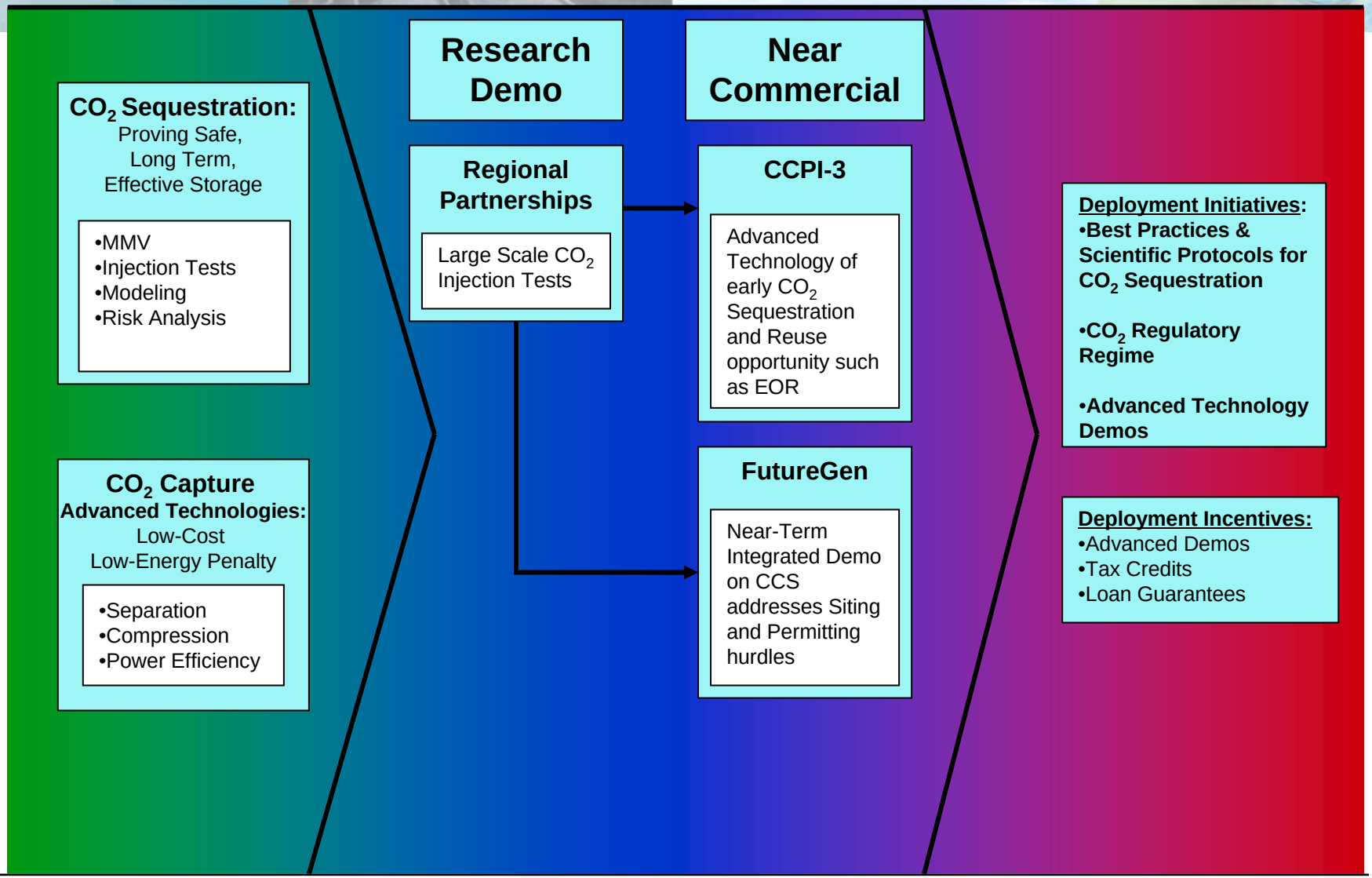
*This represents 1,990 years of US storage and 40,800 years of world storage at current CO_2 emissions levels.

Near Zero Emissions Coal

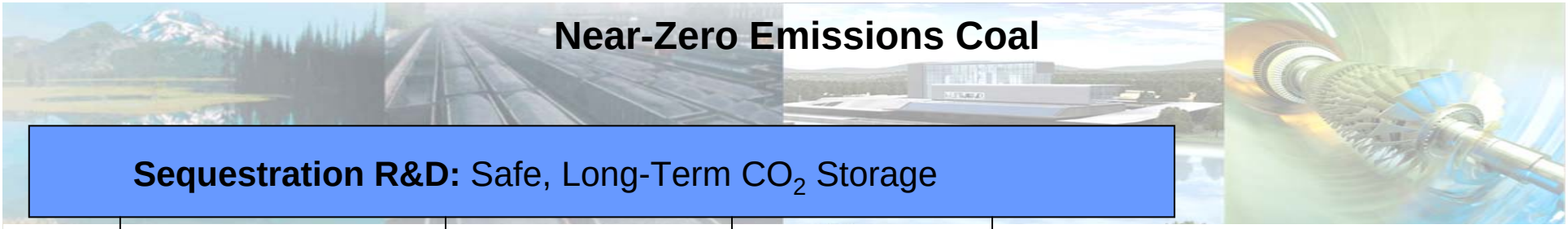
Subscale R&D

Demonstration

Deployment



Near-Zero Emissions Coal



Sequestration R&D: Safe, Long-Term CO_2 Storage

Subscale Field Tests

Regional Partnerships Large Scale CO_2 Injection Demos

1MM Tons/Yr

Data, MMV Modeling Risk Analysis

Best Practices

CCS Integration Demos

CCPI 3 W / CCS

Near-Term Opportunities

FutureGen Integrated IGCC-CCS

Siting / Permitting

Commercial Demos with Promising Advanced Technology

Cost and Energy Penalty Reductions

CO_2 Regulatory Framework

Commercial Deployment

Near Zero-Emissions R&D:

- Advanced Low-cost Capture
- Efficiency Improvements
- Combustion and Gasification

FutureGen Restructured
Why the Change

- **Since the inception of FutureGen five years ago, changes in market realities have altered the energy/power and environmental landscape. These changes include:**
  - **Escalation in material and labor costs for new power plants;**
  - **Growing near-term interest in carbon dioxide regulations; and,**
  - **Several states such as Florida, Kansas, and Minnesota have policies and regulations in place effectively requiring CCS or the flexibility to add CCS for siting/permitting of coal plants.**
- **Changes have prompted DOE to revisit its role to help industry deal with the risk associated with incorporating CCS into IGCC plants that would otherwise have difficulties getting permitted and built without CCS.**

FutureGen Restructured
Why the Restructuring

- **Estimated cost increase in original project and potential for further cost growth led DOE to revisiting original approach.**

- **DOE proposing to restructure FutureGen into commercial demonstrations to address early concerns over GHG emissions from fossil plants, especially coal, as a way to accelerate commercial deployment of CCS in coal plants.**

- **This approach is aimed at providing industry early commercial experience and confidence in adapting CCS systems to coal power plants (addressing technical integration challenges, siting and permitting issues, and shaping regulations on carbon sequestration).**

FutureGen Restructured
The Goal of Near-Zero Emissions Coal Remain the Same

- **FutureGen remains a key, high priority clean coal effort to realize near-zero emissions coal for meeting our energy security and climate change challenges.**

- **The goal remains unchanged:**
  - **Demonstrate the feasibility of near-zero emissions coal energy including carbon capture and storage (CCS),**

FutureGen Restructured
How Different from Original FutureGen

- **Original FutureGen was a single large scale (275MW) test facility serving as a "living laboratory" for integrated testing and validation of innovative technologies to be followed by commercial demonstrations of those technologies.**

- **FutureGen restructured focuses on commercial IGCC-CCS demonstrations as a way to accelerate commercialization of CCS.**

- **Aimed at obtaining reliability data; better defining economic risks and commercial financeability; addressing siting/permitting issues; and helping to shape regulatory framework on carbon sequestration.**

FutureGen Restructured
Emphasizing Commercial Demonstration of IGCC-CCS

- **Will allow for early deployment of near-term IGCC-CCS technology commercial IGCC plants.**
- **Proposes multiple 300-600 MW commercial-scale demonstrations as opposed to a single, 275 MW R&D facility.**
- **Will generating electricity and still aims to capture and safely sequestering at least 1 million tons of CO_2 per year in saline reservoir from each demonstration plant**
- **DOE will help fund the CCS portion of the coal-based IGCC-CCS demonstration while industry funds the IGCC portion (i.e., balance of plant). Anticipate multiple demonstrations of IGCC-CCS at commercial scale.**

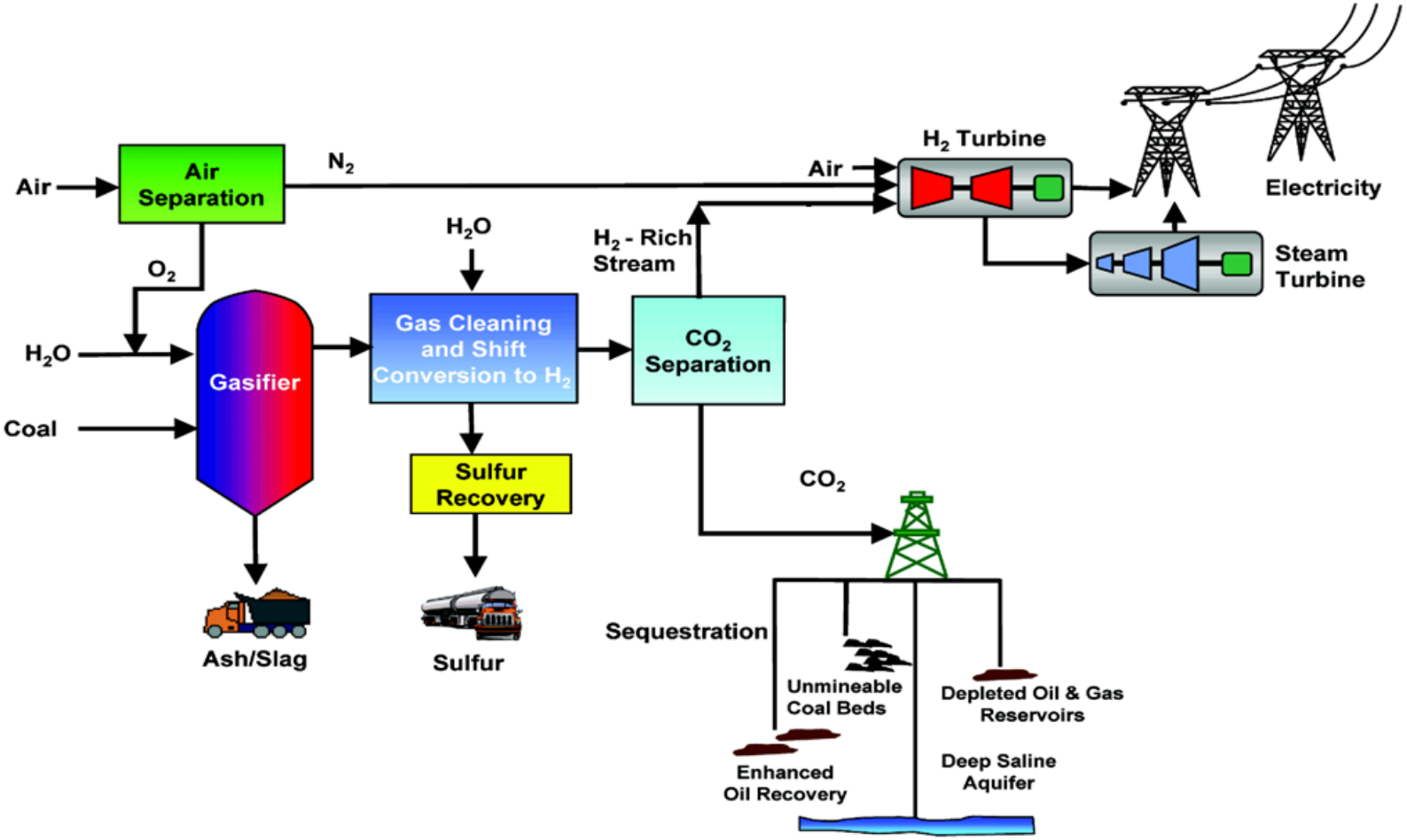
FutureGen Restructured Technical Objectives Remain the Same

- Demonstrate commercial integrated operation of coal-based IGCC with CO_2 capture and sequestration;
- Verify the effectiveness, safety, and permanence of CO_2 storage
- Demonstrate approximately 90 percent CO_2 capture on one nominal 300 MW train with 1 million metric tons per year sequestered in a deep saline reservoir;
  - > 99 percent sulfur removal (or alternative minimum)
  - < 0.05 lb/million Btu NO_x emissions
  - < 0.005 lb/million Btu particulate matter emissions
  - > 90 percent mercury removal
- Help establish standardized technologies and protocols for deployment of IGCC –CCS, including CO_2 monitoring, mitigation and verification;

FutureGen Restructured Technical Objectives (cont'd)

- Verify that IGCC with CCS can operate reliably commercially;
- Accurately quantify storage potential of the target geologic formation;
- Detect and monitor surface leakage, if any, and demonstrate the effectiveness of mitigation strategies if leaks occur;
- Develop cost information necessary for future IGCC with CCS;
- Demonstrate the practicality of coal-based IGCC-CCS power plants operations on different coal types and now multiple U.S. locations; and
- Produce the technical and economic data needed for acceptance of IGCC-CCS plants by stakeholders including the coal, electricity, and banking industries; the environmental and international communities; and the public as cost-effective means for producing electric power in a carbon-constrained world.

FutureGen Restructured



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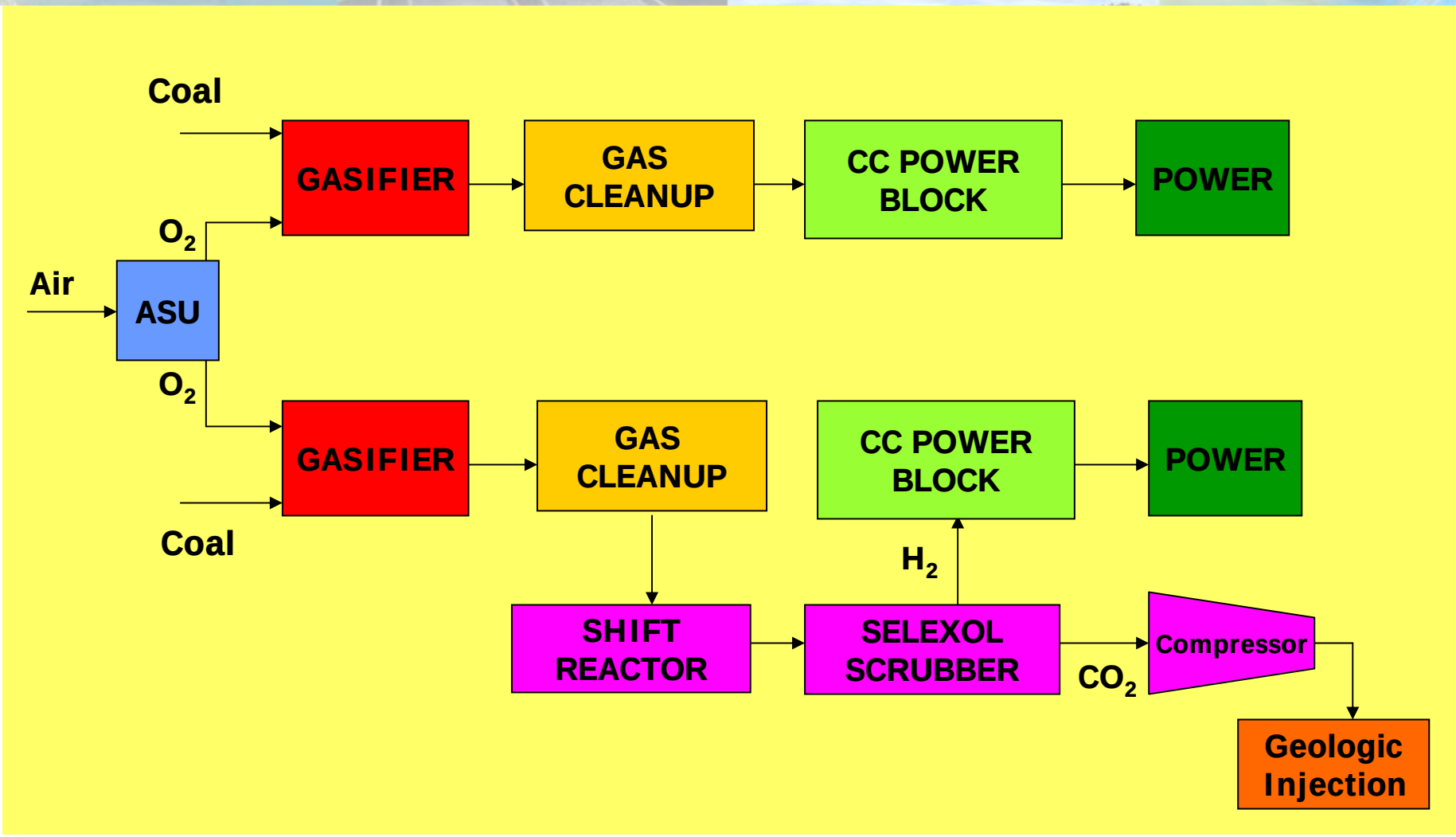

FutureGen Restructured Tentative Implementation Schedule*

*** Budget Driven**

- **Request for Information (RFI) posted Jan 30, 2008, with comments requested back by March 3, 2008.**
- **Planned issuance of competitive solicitation in Spring 2008 with proposals due early Fall 2008; expect Selections in late CY 2008 / early CY2009.**
- **Anticipate negotiation and award in late CY 2009.**
- **Planned first Plant Construction 2012-2015; and first Commercial demo of IGCC-CCS Operations in 2015-2019.**
- **Parallel R&D and CCPI demonstrations to continue with advanced technologies aimed at cost and energy penalty reductions.**

FutureGen Restructured Costs

- **Cost Estimate of FutureGen restructured is expected to be same DOE share as original FutureGen (approximately $1.3B), but DOE investment will be spread among more than one project and capped to help support CCS portion of each demo.**

- **Provides a ceiling on federal contributions limiting taxpayer's financial exposure**

- **Estimates for each demo depends of proposed size and whether there are offsetting cost opportunities for CCS (e.g., EOR) for CO_2 sale above and beyond 1 MM tons / year.**

- **Spending profile will depend on the number and size of projects awarded.**

FutureGen Restructured Rebalances the DOE Investment Aimed at Accelerating Commercial Deployment

- **Leverages DOE's investment across a wide range of projects.**
- **DOE's funding is limited to the CCS component of the power plant.**
- **At least twice as much CO_2 will be sequestered and more clean electricity will be produced.**
- **Accelerates broad public acceptance of CCS via commercial experience validating CCS through multiple demonstrations**
- **Addresses heightened concerns regarding greenhouse gas emissions and helps shape CO_2 regulatory environment**

Restructured FutureGen
Engaging the International Community

International engagement in the FutureGen concept and CCS remains an important component to gaining broad global acceptance of near-zero emissions coal as a viable means of providing energy security and addressing climate change.

DOE is exploring ways to engage governments in deploying Near-Zero Emission Coal plants with CCS for deployment around the world, including FutureGen.

FutureGen Restructured
Engaging the International Community

- **Need exists for information exchange (non-proprietary) and cooperation among participating countries on plants with CCS through proven mechanisms such as:**

- **Government sponsored workshops on: advanced designs and analyses of plant concepts and barriers and solutions encountered by power plant projects with CCS around the world.**

- **Sponsored symposia comparing status and design philosophies based on non-proprietary information of planned and ongoing large-scale plants with CCS.**

- **Developing global outreach strategies for acceptance of near-zero emissions coal and CCS to accelerate early global deployment of these technologies.**

FutureGen Restructured Summary

- **Goal of FutureGen restructured remains the same: To achieve near-zero emissions technology for coal to meet our energy security and climate change challenges.**

- **In response to growing climate change concerns that have created hurdles to siting coal-based power plants, restructured approach addresses these concerns earlier rather than later by accelerating demonstrations of integrated IGCC-CCS technology.**

- **Commercial utility experience with IGCC-CCS demonstrations can:**
  - **identify and resolve IGCC-CCS technical integration issues;**
  - **address siting and permitting process/issues with CCS;**
  - **help shape regulatory framework for carbon storage**

- **Strong continued commitment to Clean Coal RD&D to support deployment -- FY 2009 Coal Budget Request is highest in 25 years.**