

SECA, Coal, and *FutureGen*



8th Annual SECA Workshop

*August 7 - 9, 2007
San Antonio, Texas*

Joseph P. Strakey



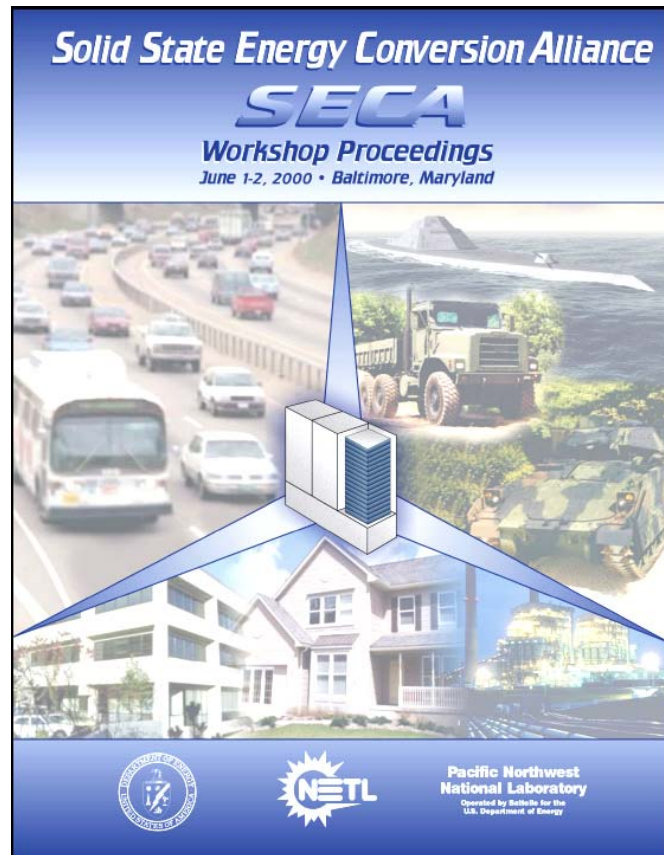
National Energy Technology Laboratory



Office of Fossil Energy



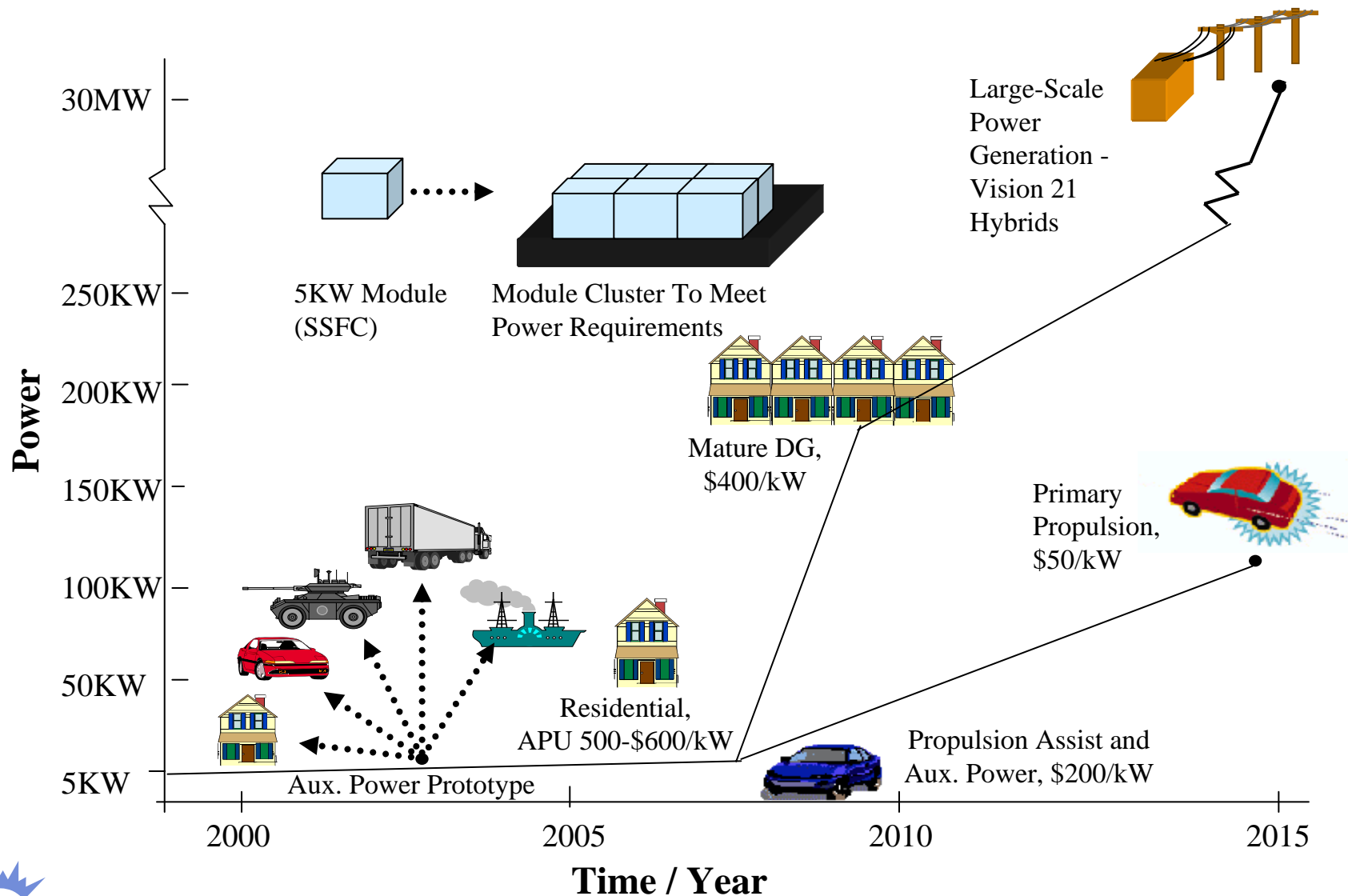
SECA Beginnings



- **NETL-PNNL Strategic Alliance**
 - August, 1999
- **SECA Concept Development: SECA**
 - September – October, 1999
- **1st SECA Annual Workshop, Baltimore, MD**
 - June 1-2, 2000



Progressive Development Of SSFC Application



Source: Gary McVay, PNNL, 12/01/1999

SECA Development: Progressive Applications



2005

- \$800/kW
- Prototype (β -Unit)
3 - 10 kW

2010

- \$400/kW
- Commercial

2015

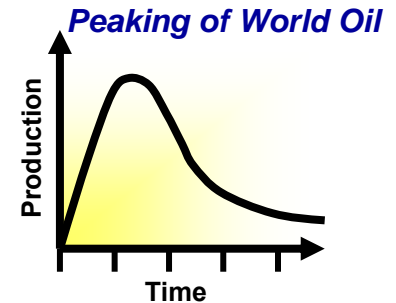
- Vision 21 Power Plants
70-80% efficient plants
- Propulsion <\$200?/kW



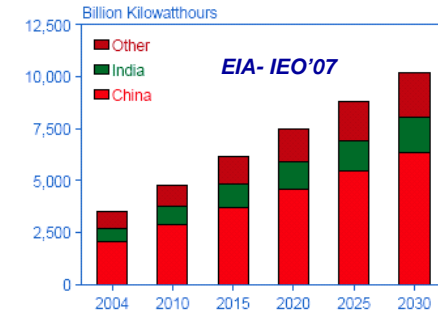
Source: Strakey, 2nd Annual SECA Workshop, 03/29-30/ 2001

So What Changed?

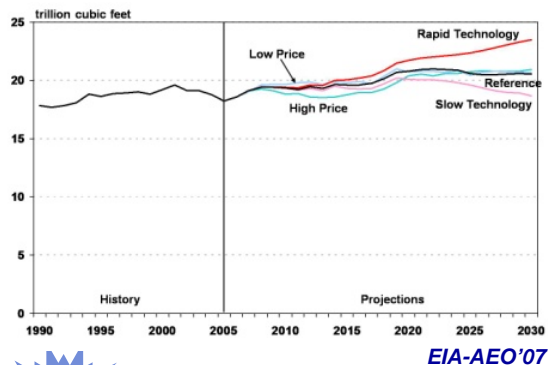
- Terrorist attacks on U.S.
- War in Afghanistan & Iraq
- World oil peaking concerns
- Rapid growth in non-OECD energy use
- Flat domestic gas production
- Global climate change concerns
- Etc., etc.



Net Electricity Generation in Non-OECD Asia



Total U.S. Natural Gas Production

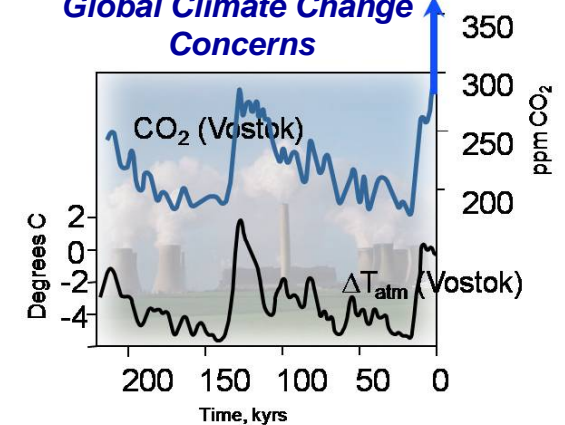


LNG Safety Perceptions



Photo: Boston Globe

Global Climate Change Concerns

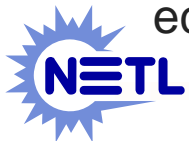
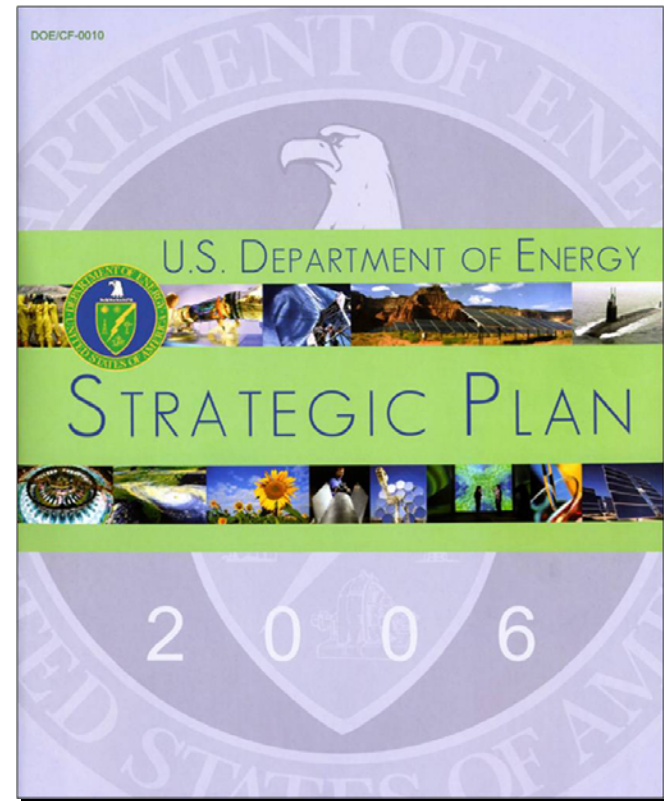


DOE Strategic Plan

Theme 1: Energy Security

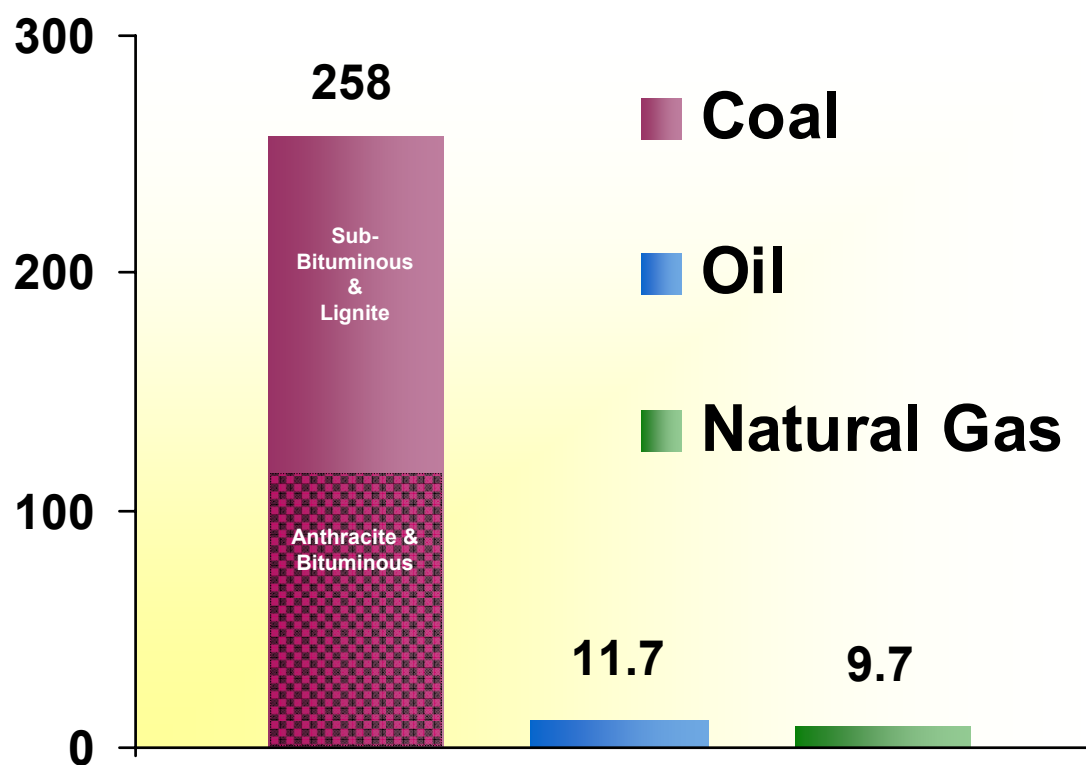
Promoting America's energy security through reliable, clean, and affordable energy.

- 1.1 **Energy Diversity** – Increase our energy options and reduce dependence on oil, thereby reducing vulnerability to disruption and increasing the flexibility of the market to meet U.S. needs.
- 1.2 **Environmental Impacts of Energy**
Improve the quality of the environment by reducing greenhouse gas emissions and environmental impacts to land, water, and air from energy production and use.
- 1.3 **Energy Infrastructure** – Create a more flexible, more reliable, and higher capacity U.S. energy infrastructure.
- 1.4 **Energy Productivity** – Cost-effectively improve the energy efficiency of the U.S. economy.



250 Year Supply at Current Demand Levels !

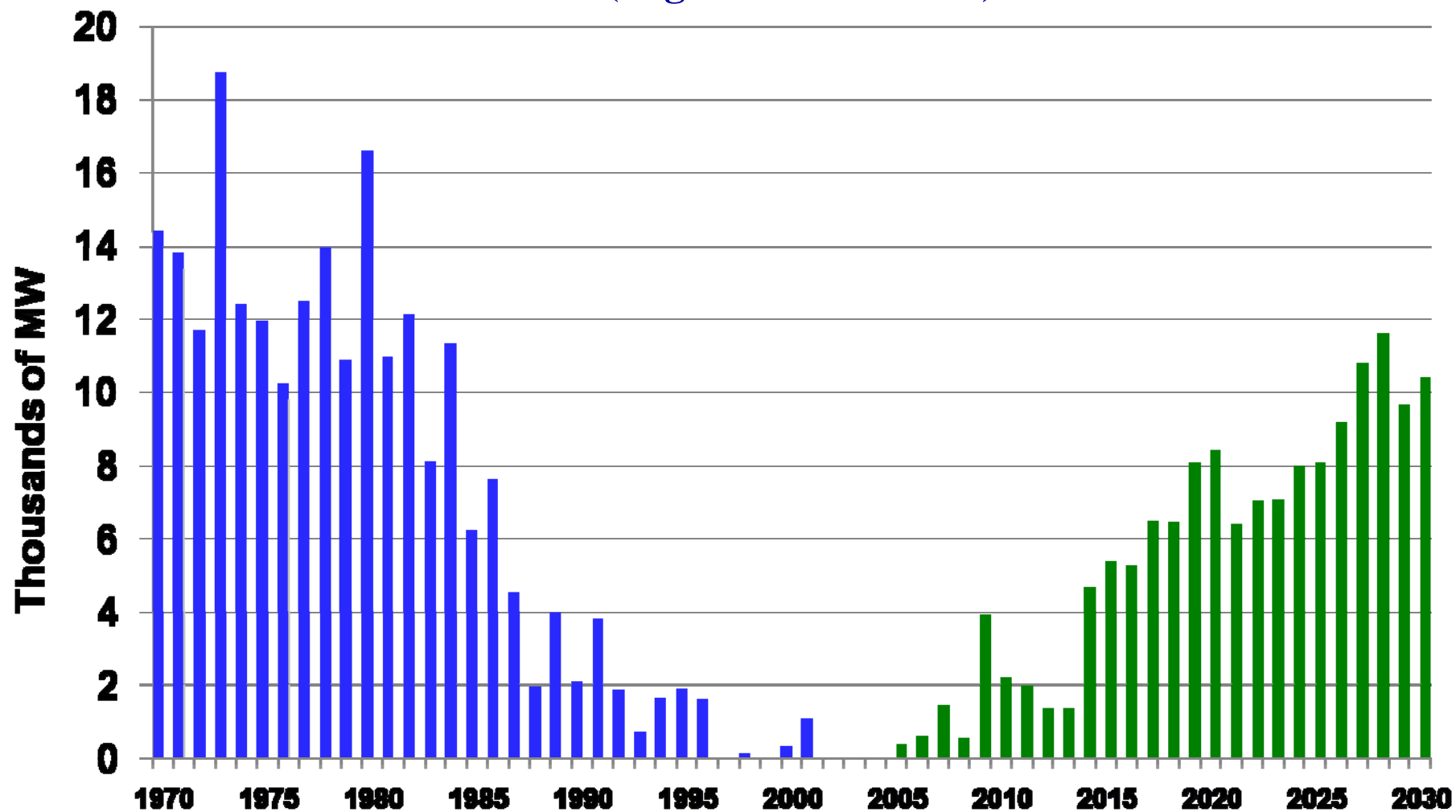
U.S. Fossil Fuel Reserves / Production Ratio



Sources: BP Statistical Review, June 2004, - for coal reserves data - World Energy Council;
EIA, Advance Summary U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves, 2003 Annual Report, September 22, 2004 - for oil and gas reserves data

152 Added GW of Coal Capacity

AEO'07 (High Oil Price Case)



Volume of CO₂ Produced

- **1 million metric tons of CO₂:**
 - Every year would fill a volume of 32 million cubic feet
 - *Close to the volume of the Empire State Building*
- **U.S. emits roughly 6 billion tons (gigatons) of CO₂ per year**
 - Under an EIA reference case scenario cumulative CO₂ emissions 2004-2100 are expected to be 1 trillion tons
 - *Enough to fill Lake Erie with liquid CO₂ almost twice*



Regional Carbon Sequestration Partnerships

- 350 organizations
- 41 states (NY recently joined)
- 4 Canadian provinces
- 3 Indian nations
- Total of 34% cost share



Developing the Infrastructure for Wide-Scale Deployment

Regional Carbon Sequestration Partnerships

“Developing the Infrastructure for Wide Scale Deployment”

Characterization Phase

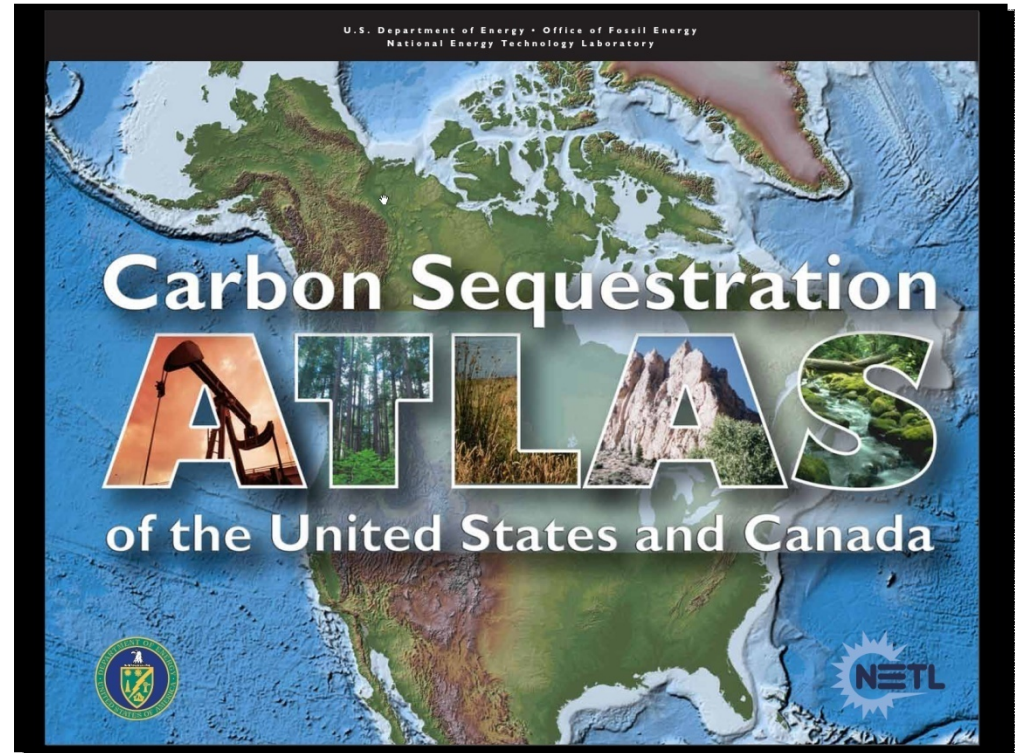
- 24 months (2003-2005)
- \$16M DOE funds

Validation Phase

- 4 years (2005 - 2009)
- Field validation tests
 - 25 Geologic
 - 11 Terrestrial
- \$100M DOE funds

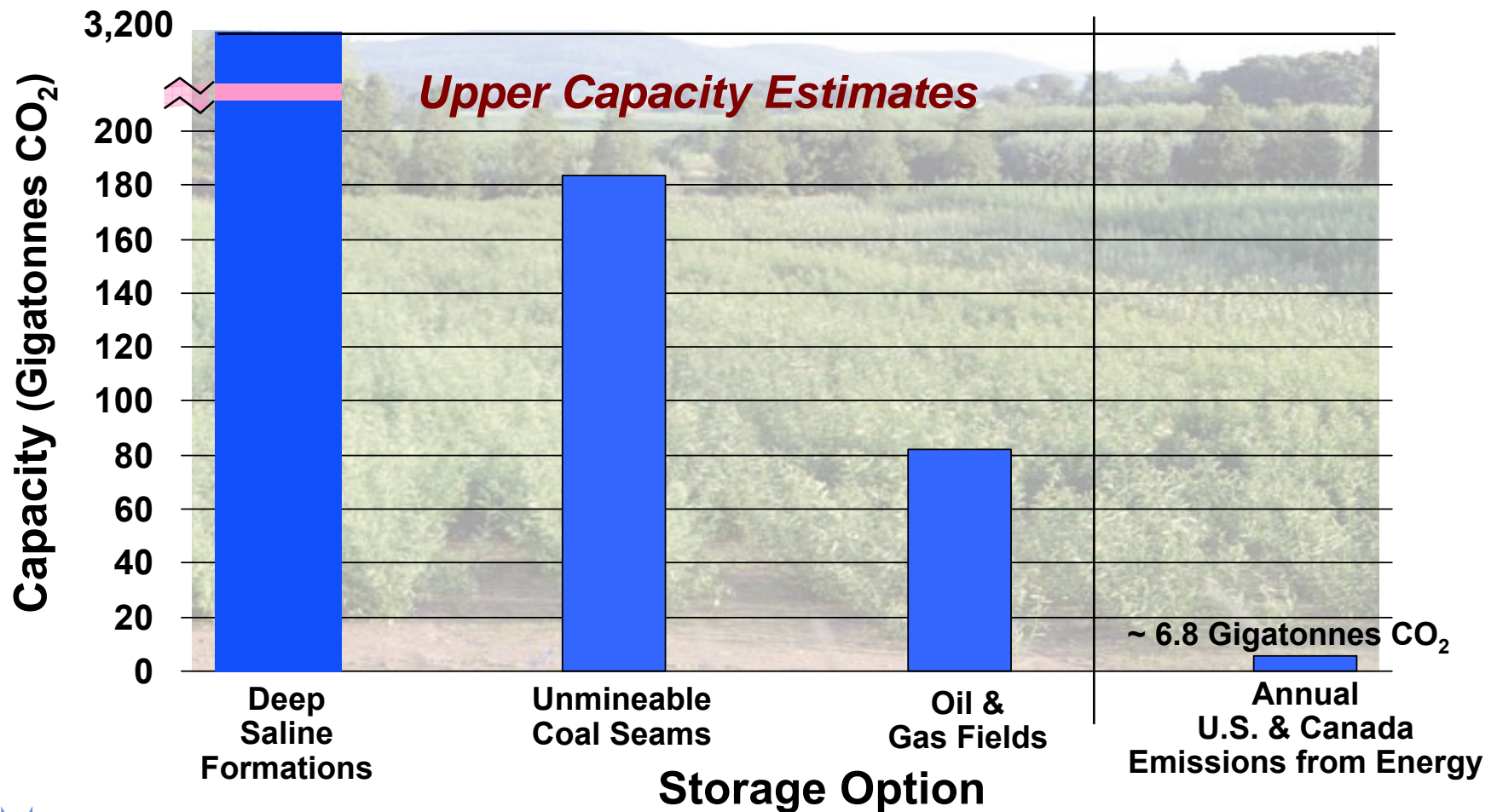
Deployment Phase

- 10 years (2008-2017)
- Seven large volume injection tests
- ~\$470M DOE funds



North America Geologic Storage Capacity

(> 500 Year Potential Storage Capacity for U.S. & Canada)

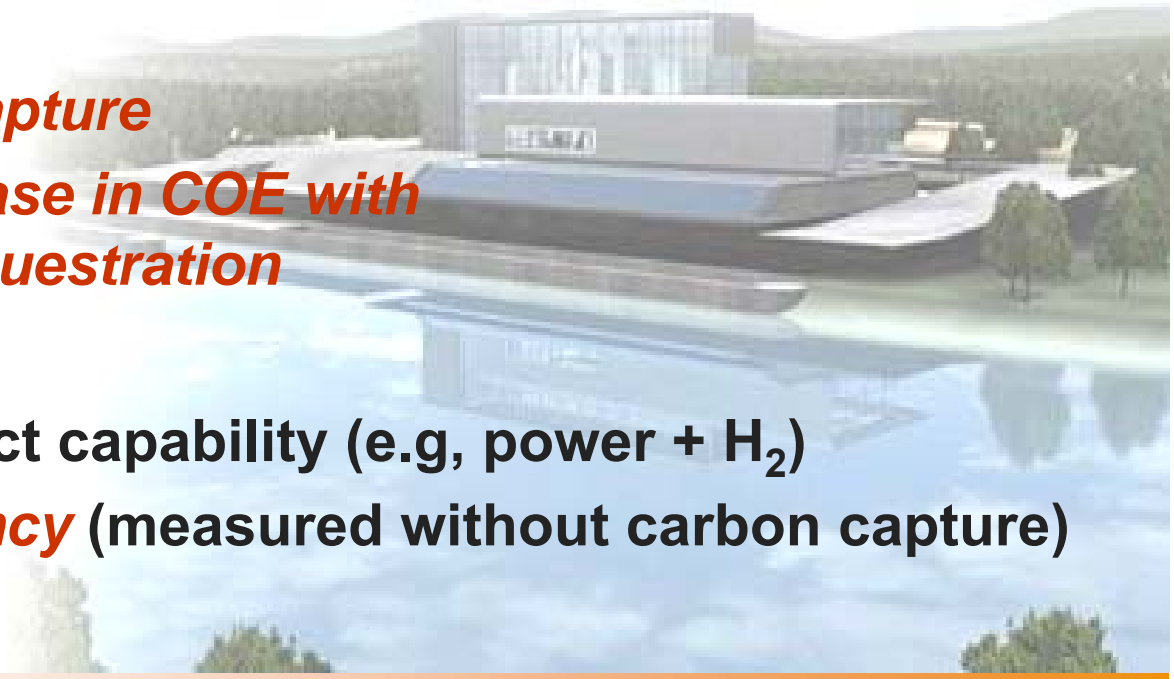


Capacity Data from Carbon Sequestration Atlas of the United States and Canada, DOE-NETL, Feb 2007
Emissions Data from EIA, "International Carbon Dioxide Emissions and Carbon Intensity" extrapolated to mid-2007

DOE's Office of Fossil Energy

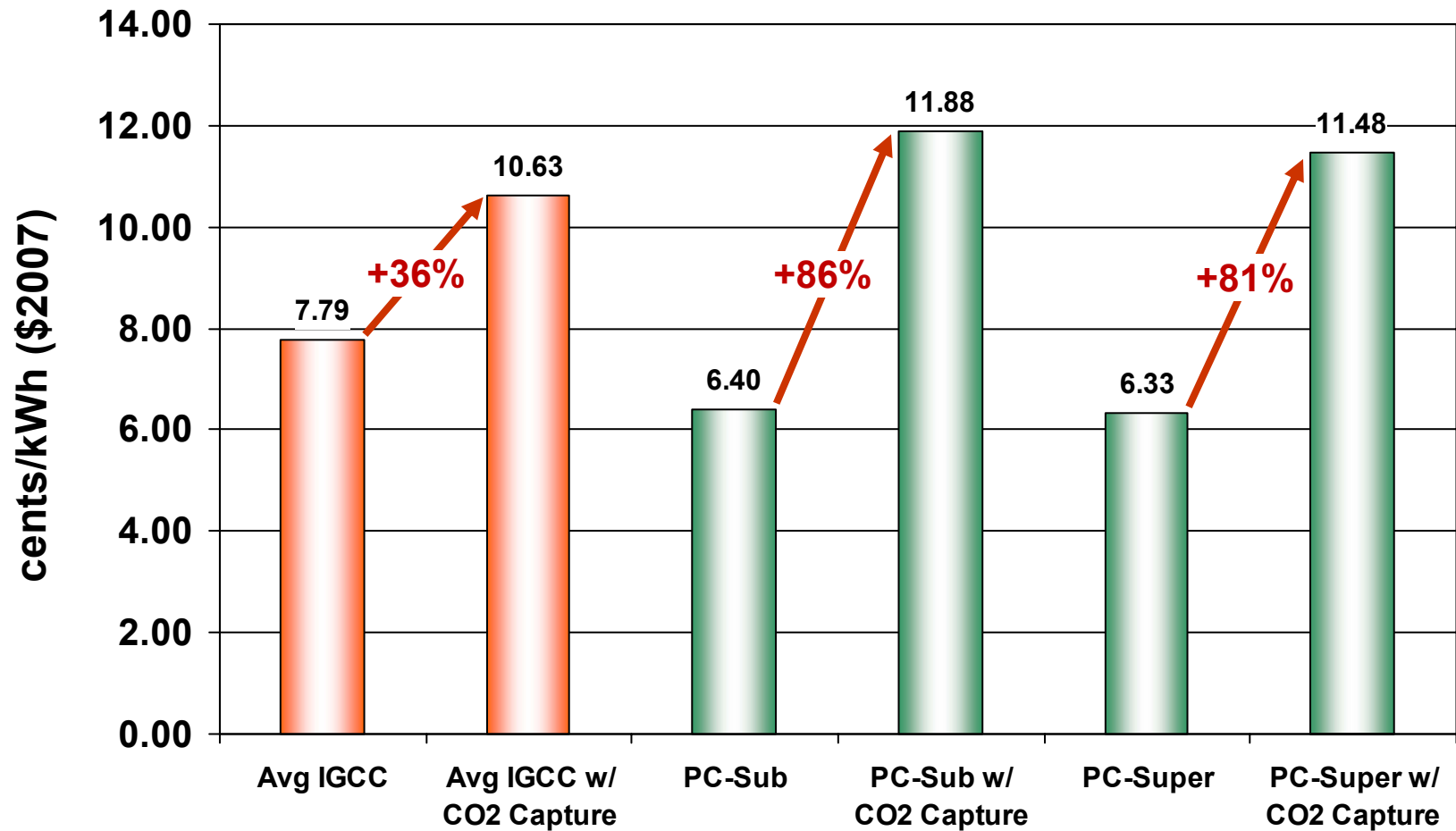
Advanced (Coal) Power Systems Goals

- **2010:**
 - 45-50% Efficiency (HHV)
 - 99% SO₂ removal
 - NO_x < 0.01 lb/MM Btu
 - 90% Hg removal
- **2012:**
 - **90% CO₂ capture**
 - **<10% increase in COE with carbon sequestration**
- **2015**
 - Multi-product capability (e.g, power + H₂)
 - **60% efficiency** (measured without carbon capture)



Capturing CO₂ with Today's Technology is Expensive

Cost of Electricity Comparison



January 2007 Dollars, Coal cost \$1.80/10⁶ Btu

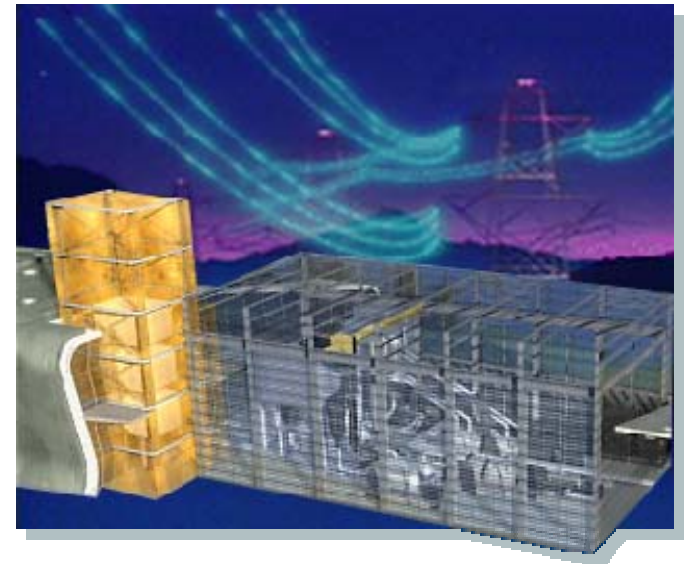


DOE/NETL Report: "Cost and Performance Baseline for Fossil Energy Plants", May 2007

FutureGen Objectives

**World's first near zero-emission,
full-scale coal-based power plant to:**

- **Co-produce electricity & H₂
from coal**
- **Emit virtually no air pollutants**
- **Capture & permanently
sequester CO₂
(1 million tonnes/yr)**
- **Integrate operations at full-
scale (275 MWe) – a key step**



FutureGen Project

Supporting FutureGen is a Major Goal of the R&D Programs

- A billion-dollar, 10-year project to create the world's first coal-based, near-zero emission electricity plant with carbon capture and sequestration
- Industry-led project with government oversight & international participation
 - Signed Cooperative Agreement with DOE on Dec. 2, 2005
 - Project structuring to Jan. 2007
 - Design to July 2009
 - Construction to July 2012
 - Operations to July 2016
 - Site monitoring to July 2018
- Industry will choose project site & backbone technologies
 - Down-selected to four potential sites



FutureGen Candidate Site Features

Conceptual Sequestration Design

Mattoon



- Injection on-site
- ~8,000 ft deep
- Mt. Simon sandstone formation

Tuscola



- Injection off-site (~10 miles)
- New pipeline to be constructed
- ~8,000 ft deep
- Mt. Simon sandstone formation

Brazos



- Injection at two sites (~25 and 33 miles)
- New pipeline to be constructed
- ~6,000 ft deep in the Woodbine formation
- ~11,000 ft deep in the Travis Peak formation

Odessa



- Injection off-site (~56 miles)
- Potential to use existing pipeline with minor upgrades
- ~6,000 ft deep
- Guadeloupe Sands

FutureGen: Cutting-Edge Technologies

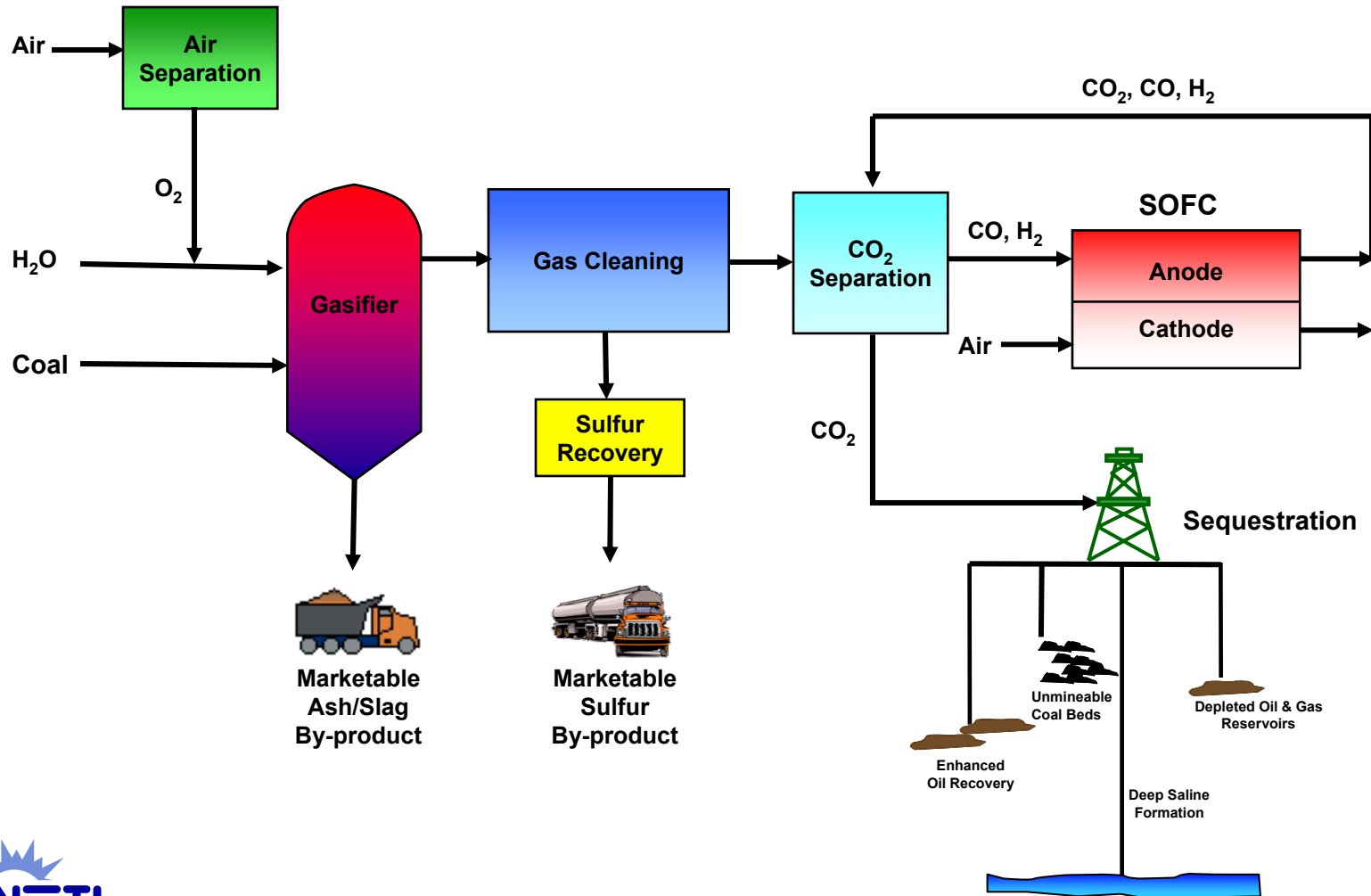
- **Can accommodate technology innovations with minimal modifications**
 - Emerging from national or international R&D pipelines
 - Slipstream or full-scale tests
 - Over life of project
- **Some emerging new technologies**
 - Membrane-based O₂ and H₂ separation
 - High-efficiency hydrogen turbines
 - High-throughput gasifiers
 - Monitoring systems
 - ***Fuel cells***

FutureGen will be a global showcase of very best technology options for coal-based systems with near-zero carbon emissions



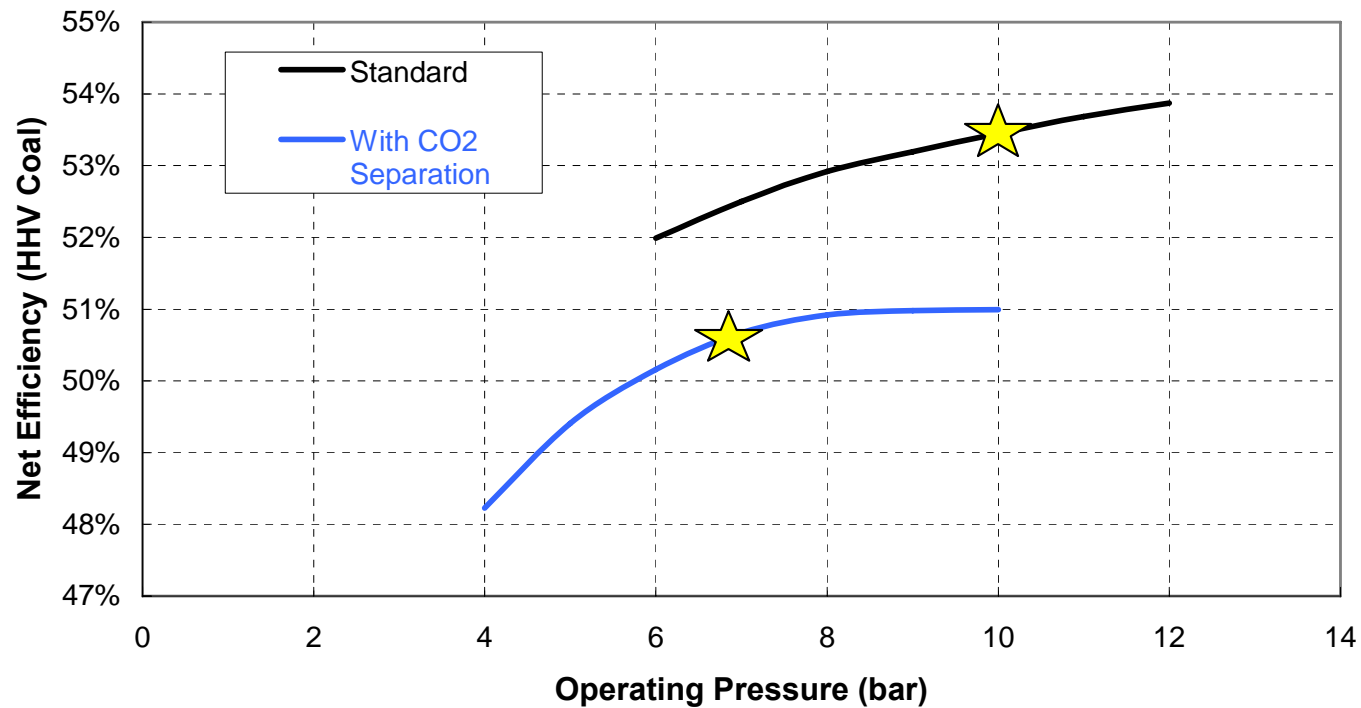
FutureGen

IGCC Fuel Cell with Sequestration



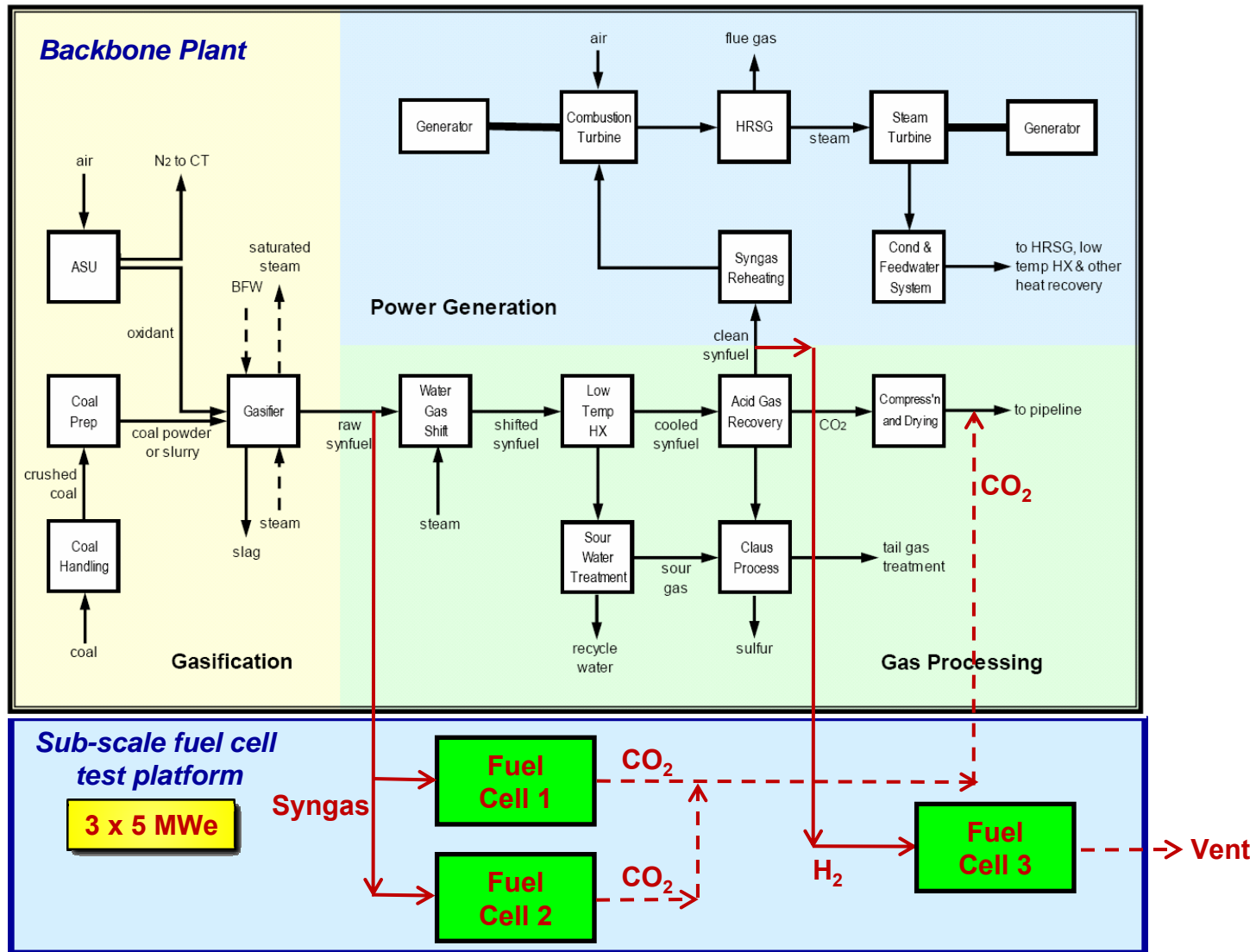
GE IGFC Study

Performance Summary



- **53.4% (HHV) Possible with IGFC**
- **CO₂ Separation penalty 2.7 points**

FutureGen Fuel Cell Test Configuration



SECA Coal-Based Systems Draft FOA

**FINANCIAL ASSISTANCE
FUNDING OPPORTUNITY ANNOUNCEMENT**



**U.S. Department of Energy
Office of Fossil Energy**

**Solid State Energy Conversion Alliance (SECA)
Coal-Based Systems**

Funding Opportunity Number: DE-PS26-07NT43136

Announcement Type: Draft

CFDA Number: 81.089

Issue Date (DRAFT): JULY 17, 2007

Public Comments Deadline: JULY 31, 2007

Application Due Date: SEPTEMBER 10, 2007

This is a draft announcement issued for public comment only. The period of public comment will close 14 (fourteen) days after the issue date of this draft. The final announcement will be issued on or about 08/07/2007. The anticipated due date for applications submitted in response to the final Funding Opportunity Announcement is 9/10/07 at 8:00:00 PM Eastern Time.

<http://www.netl.doe.gov/>

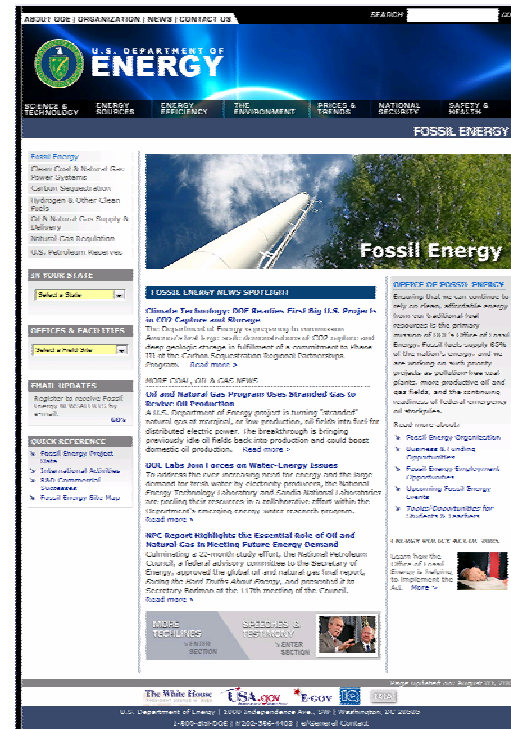


For Additional Information

Joe Strakey

412-386-6124

joseph.strakey@netl.doe.gov



Office of Fossil Energy
www.fe.doe.gov

NETL
www.netl.doe.gov

