FutureGen: Stepping-Stone to Sustainable Fossil-Fuel Power Generation

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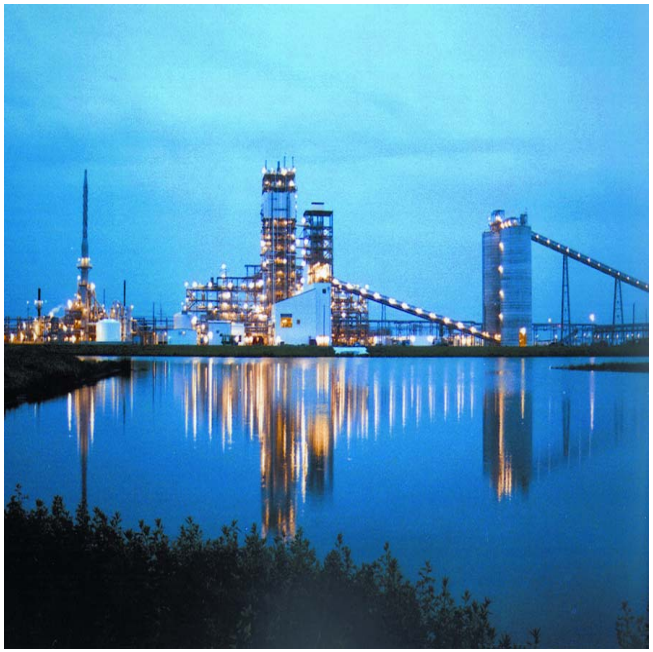
This presentation will highlight the U.S. Department of Energy's FutureGen Initiative. The nearly $1 billion government-industry project is a stepping-stone toward future coal-fired power plants that will produce hydrogen and electricity with zero-emissions, including carbon dioxide. The 275-megawatt FutureGen plant will initiate operations around 2012 and employ advanced coal gasification technology integrated with combined cycle electricity generation, hydrogen production, and carbon capture and sequestration. The initiative is a response to a presidential directive to develop a hydrogen economy by drawing upon the best scientific research to address the issue of global climate change.

The FutureGen plant will be based on cutting-edge power generation technology as well as advanced carbon capture and sequestration systems. The centerpiece of the project will be coal gasification technology that can eliminate common air pollutants such as sulfur dioxide and nitrogen oxides and convert them to useable by-products. Gasification will convert coal into a highly enriched hydrogen gas, which can be burned much more cleanly than directly burning the coal itself. Alternatively, the hydrogen can be used in a fuel cell to produce ultra-clean electricity, or fed to a refinery to help upgrade petroleum products.

Carbon sequestration will also be a key feature that will set the Futuregen plant apart from other electric power plant projects. The initial goal will be to capture 90 percent of the plant's carbon dioxide, but capture of nearly 100 percent may be possible with advanced technologies. Once captured, the carbon dioxide will be injected as a compressed fluid deep underground, perhaps into saline reservoirs. It could even be injected into oil or gas reservoirs, or into unmineable coal seams, to enhance petroleum or coalbed methane recovery.

The ultimate goal for the FutureGen plant is to show how new technology can eliminate environmental concerns over the future use of coal – the most abundant fossil fuel in the United States with supplies projected to last 250 years. FutureGen's co-production of power and hydrogen will also serve as a stepping-stone to an environmentally sustainable energy future.

FutureGen: Stepping-Stone to Sustainable Fossil-Fuel Power Generation



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Topical Conference on Sustainability

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Outline of Presentation

- **DOE Vision for Energy Plants of the Future**
- ***FutureGen* Project**
  - Overview
    - Integrated Gasification Combined Cycle (IGCC)
    - CO_2 Capture and Sequestration
    - Candidate R&D Technologies
  - *FutureGen* Industrial Alliance
    - Recent Activities
    - Schedule and Funding
- **Concluding Remarks**

DOE Vision for Energy Plants of the Future

- Flexible (Feed stocks, co-products, and siting)
- Highly energy efficient
- “Near-zero” emissions (coal as clean as gas)
- CO_2 sequestration-ready
- Industrially ecological (waste into by-products)
- Reduced water requirements
- Affordable (competitive with other energy options)
- Timely deployment of new technology
- Sustainable

Electricity

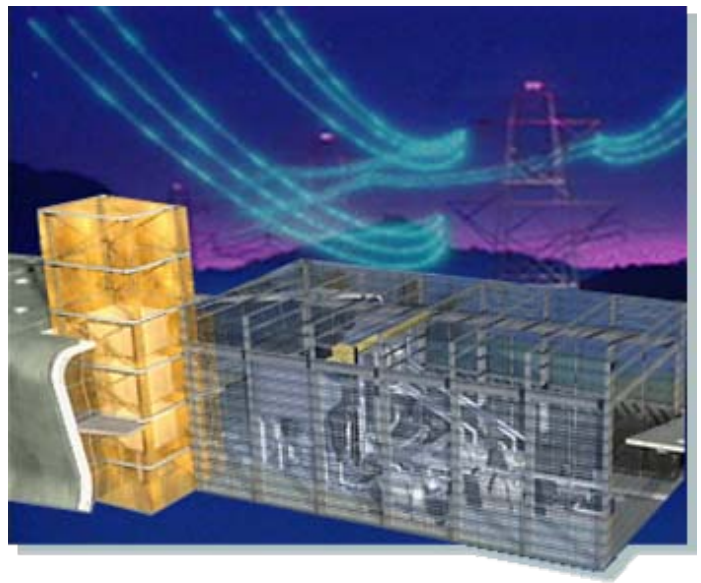
Hydrogen

Chemicals

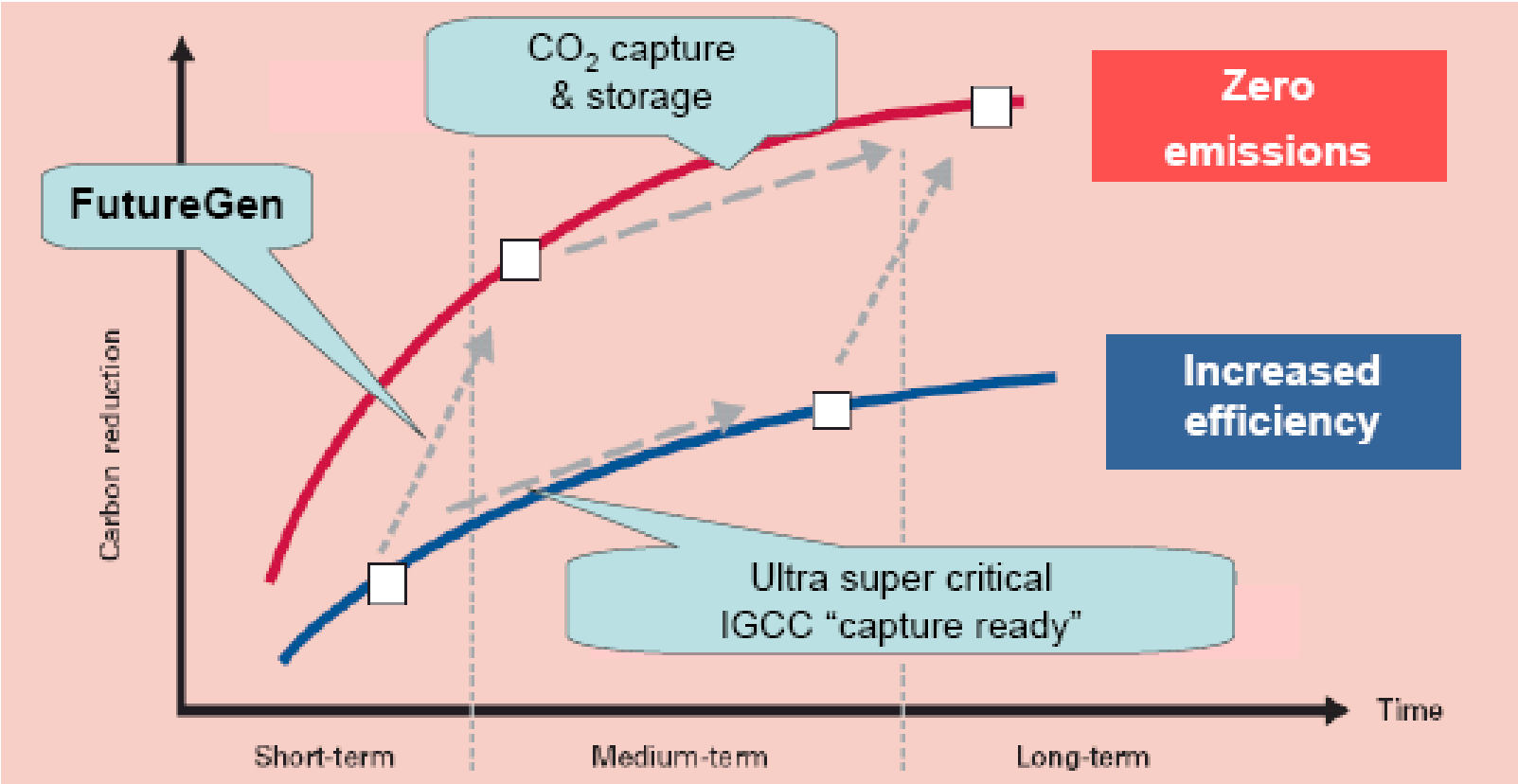
Polygeneration

FutureGen Project Overview

- Commercial-scale 275-MWe Plant
- Design for all U.S. coals (primarily bituminous and sub-bituminous)
- Co-production of H2 and electricity
- Sequester >90% CO2 with potential for ~100%
- Minimum 1-million tons/year CO2 captured and sequestered
- “Living laboratory” to test and validate cutting-edge technologies
- Public-private partnership
- Stakeholder involvement
- International participation
- On-line 2012

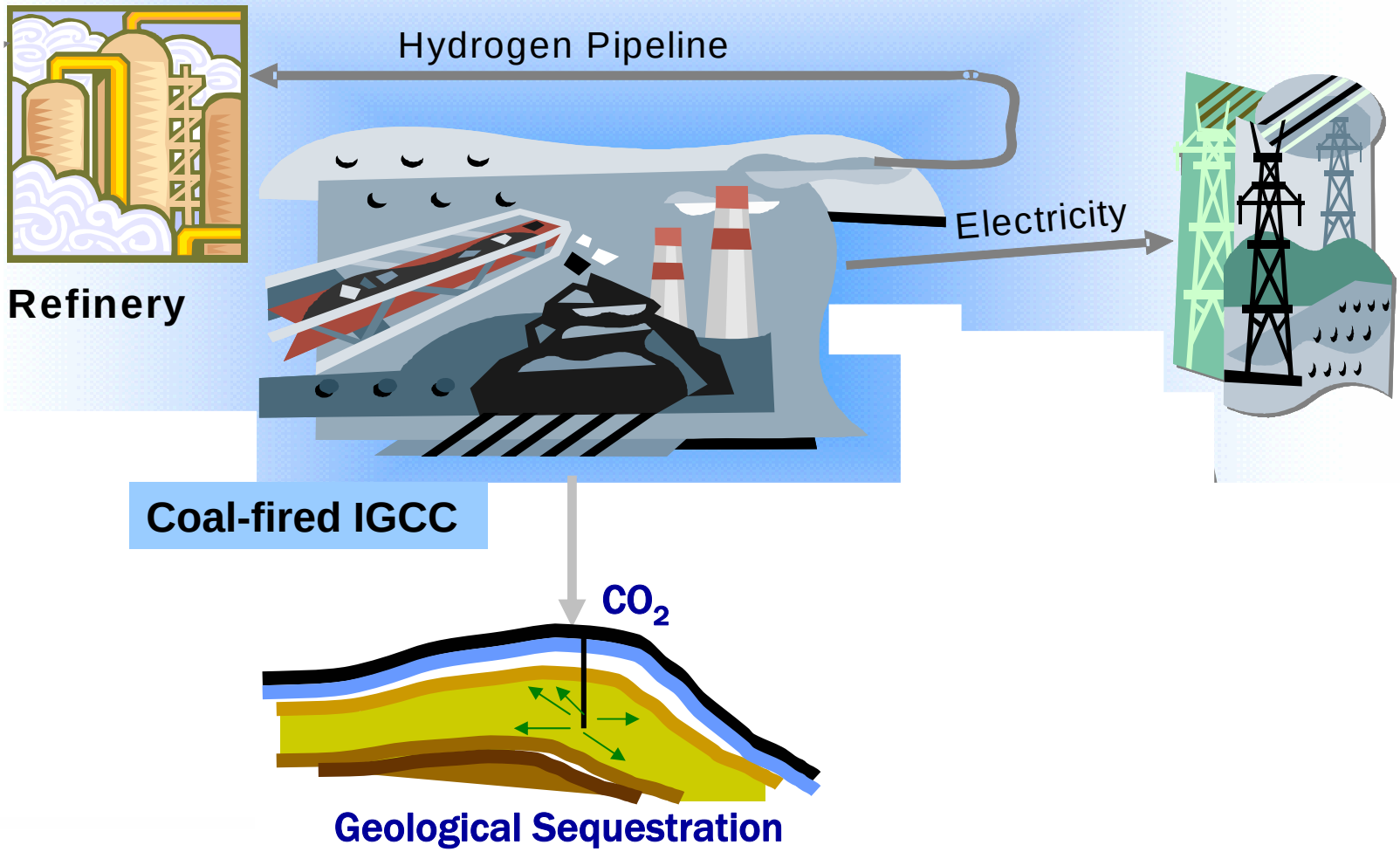


FutureGen: Stepping-Stone to Zero Emissions

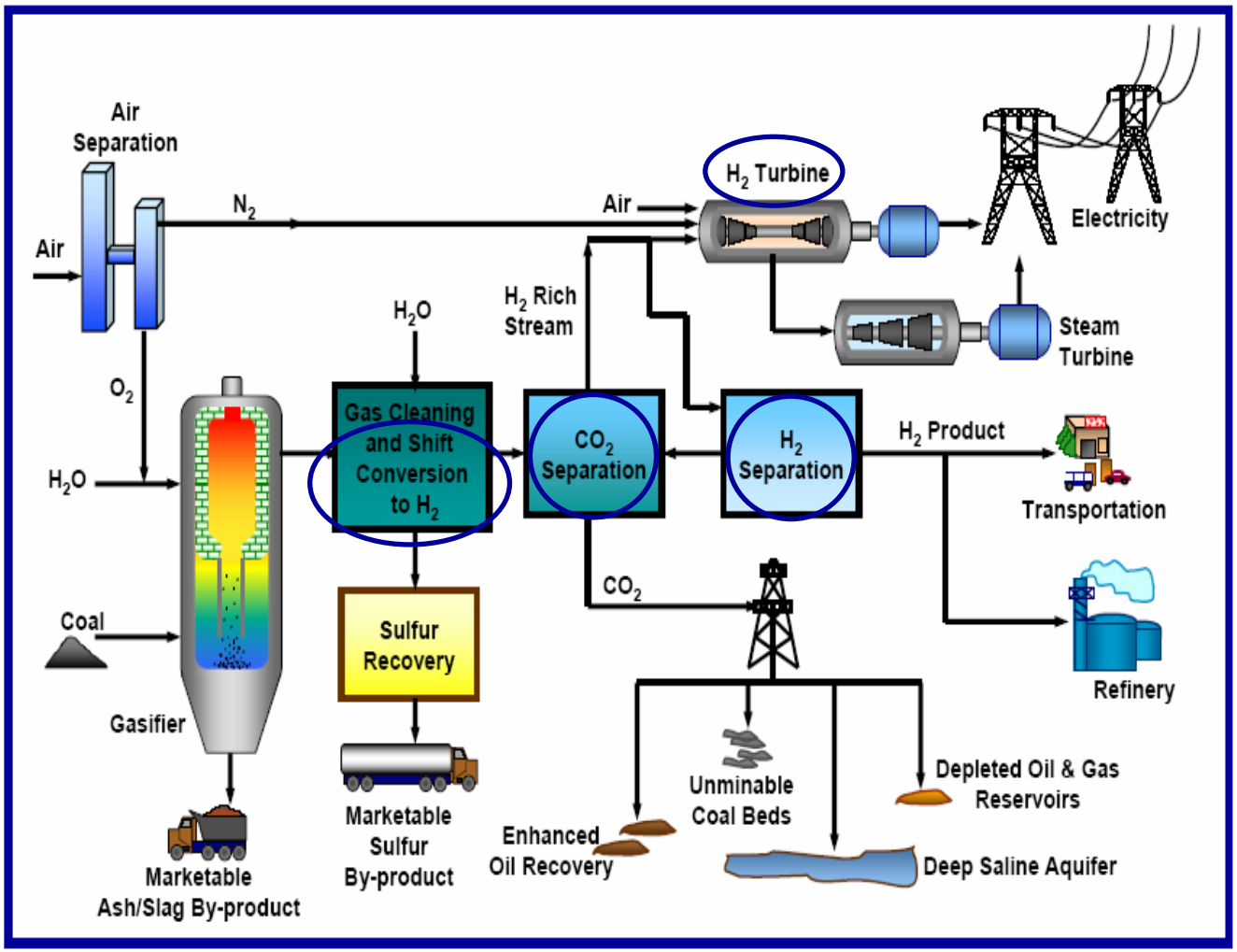


Source : UK Department of Trade & Industry, A Strategy For Developing Carbon Abatement Technologies for Fossil Fuel Use

FutureGen Concept



FutureGen Based on Integrated Gasification Combined-Cycle (IGCC) Technology



FutureGen Will Build upon Experience from Four Commercial-Scale Coal-Based IGCC Power Plants

IGCC Advantages

- Fuel and product flexibility
- High efficiency
- Environmentally superior
- Sequestration capable
  - Reduces energy penalty

Current IGCC Issues

- Capital cost 5–20% higher than conventional coal
- Reliability lower

Two Demonstration Plants in U.S.

Wabash River, Indiana
262 MWe, 1995

Tampa, Florida
250 MWe, 1996

Two Demonstration Plants in Europe

Buggenum, Netherlands
253 MWe, 1994

Puertollano, Spain
298 MWe, 1998

FutureGen Will Build on Two Non-Integrated One Million TPY CO_2 Sequestration Projects

Weyburn CO_2 EOR Project

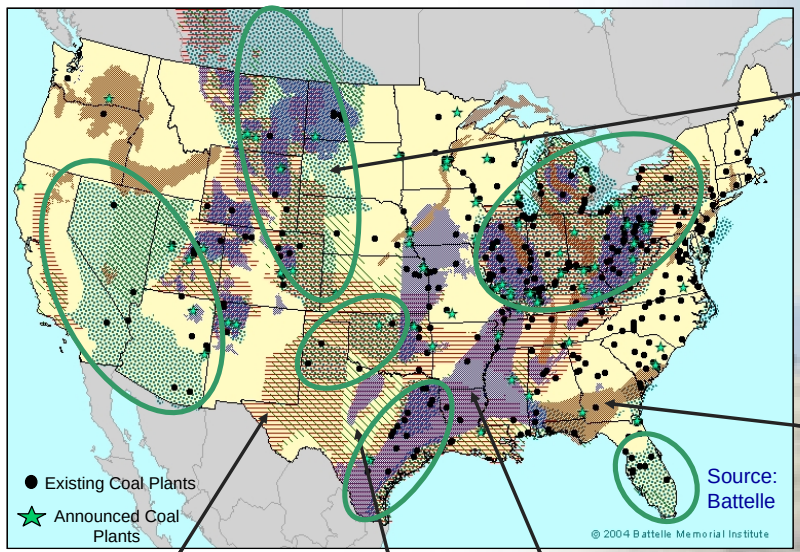
- Pan Canadian Resources
- 200-mile CO_2 pipeline from Dakota Gasification Plant
- Enhanced Oil Recovery in Canada over 20 years

Sleipner North Sea Project

- Statoil
- CO_2 sequestered (1996-2000)
- Currently monitoring CO_2 migration
- Separates CO_2 from natural gas
- $36–50 / tonne CO_2 tax

Geologic Carbon Sequestration

- Coal Seams and Shales: ~18 GT
  - 126 TCF of CBM from unmineable coal seams
- Oil and Gas Reservoirs: ~27 GT
  - 16 billion barrels of oil from favorable fields
- Saline Formations: >5,000 GT



Saline-Filled Sedimentary Formations

Saline-Filled Basalt Formations

Depleting Gas Basins

Depleting Oil Fields

Major Bituminous and Sub-bituminous Coal Basins

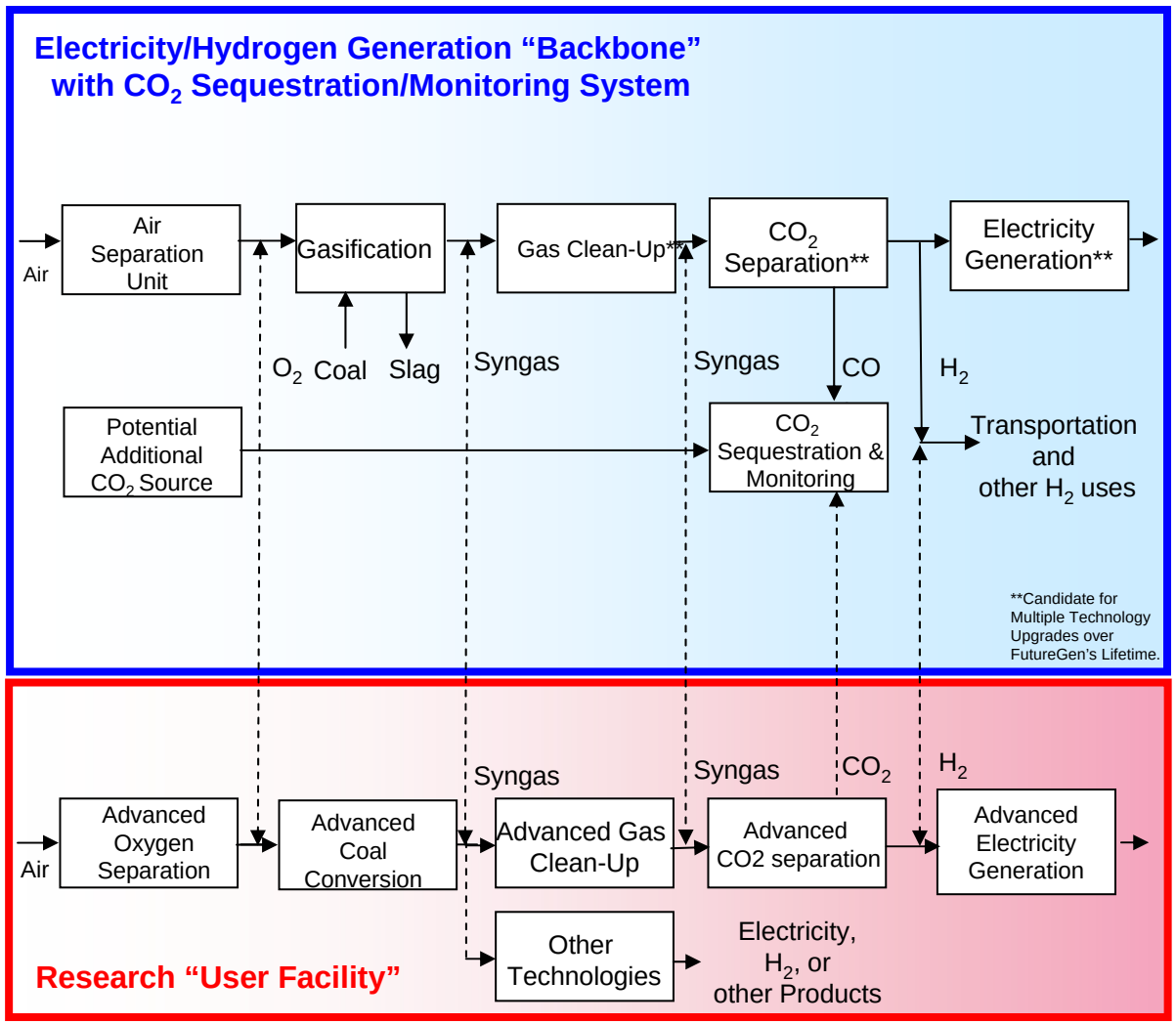
Thousands of Years of Storage Capacity in Promising Sinks across the U.S.

FutureGen: Industry's View of the Facility

"State-of-the-Art Gasification Technology Platform"

"Sequestration Platform"

"Stakeholder Involvement & Research Platform"



FutureGen: Candidate R&D Technologies

Transport Gasifier

FutureGen

Carbon Sequestration

Hydrogen Production

Ultra-Low NOx H_2 Turbine

SECA Fuel Cell ($400/kW)

Membrane Separators

FutureGen Industrial Alliance

- **Membership**
  - American Electric Power
  - AngloAmerican
  - BHP Billiton
  - China Huaneng Group
  - CONSOL Energy
  - Foundation Coal
  - Kennecott Energy
  - Peabody Energy
  - Rio Tinto
  - Southern Company
- **DOE Cooperative Agreement signed Dec. 2, 2005**
- **10 Members and still growing**

- **Characteristics**
  - >45% of U.S. coal production
  - >20% coal-fueled electricity production
  - Operations in >30 States
  - Represent all major coal types

FutureGen Industrial Alliance

- **DOE Cooperative Agreement**
  - Signed Dec. 2, 2005
- **Site Selection**
  - "Final Four" announced July 25
  - Final site to be announced summer 2007
- **Conceptual Plant Design**
  - Reviews with major technology suppliers
  - Three alternative facility configurations
  - Conceptual design and cost estimate underway
- ***FutureGen* Plant**
  - On-line 2012
  - "Living R&D laboratory" for cutting-edge technologies

- **Membership**
  - Leading coal mining and coal-fueled power companies
  - >45% of U.S. coal production
  - >20% coal-fueled electricity production
  - Operations in >30 States
  - Represent all major coal types

FutureGen Current Activities

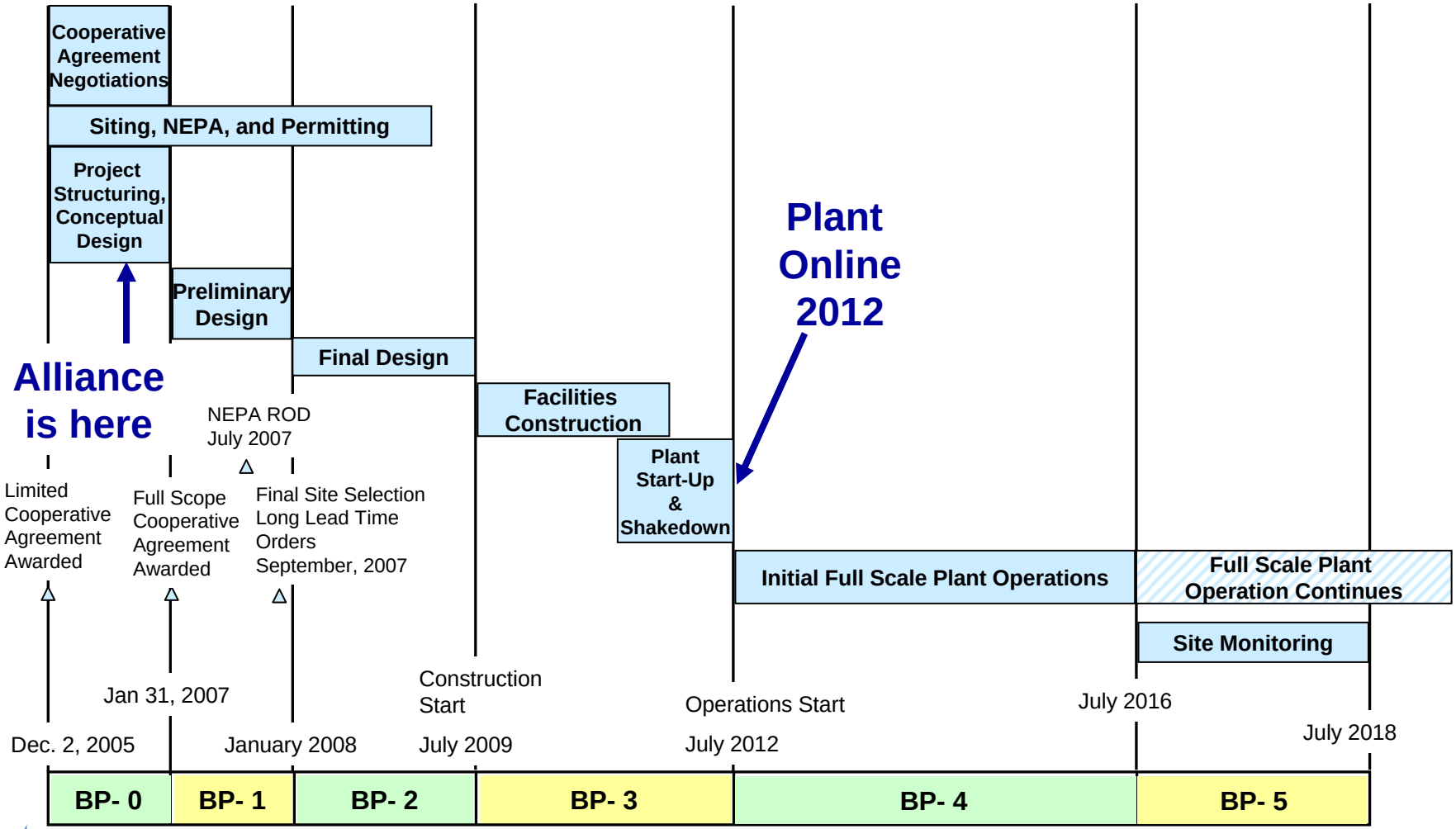
- Site Selection
  - "Final Four" announced July 25
  - NEPA process underway
  - Final site announced summer 2007
- Conceptual Plant Design
  - Reviews with major technology suppliers
  - Three alternative facility configurations
  - Conceptual design and cost estimate underway
- Conceptual Sequestration Design
  - Reservoir modeling for each site

Proposed Sites for *FutureGen*

1	Effingham, Illinois
2	Marshall, Illinois
3	Mattoon, Illinois
4	Tuscola, Illinois
5	Henderson County, Kentucky
6	Bowman County, North Dakota
7	Meigs County, Ohio
8	Tuscarawas County, Ohio
9	Odessa, Texas
10	Jewett, Texas
11	Point Pleasant, West Virginia
12	Gillette, Wyoming

Candidate Sites

FutureGen Project Schedule



FutureGen Funds / Costs

Cost Elements	$ Million
Plant Definition, Baselining & NEPA	81
Plant Procurement & Construction	480
Shakedown & Full-Scale Operation	188
Sequestration (Design & Construction)	191
Site Monitoring	10
TOTAL	$950

International Participation

- DOE has invited other nations to join
- Governments of India and South Korea have pledged $10 Million each

DOE	620
Industry	250
International	80

Summary

- **FutureGen is *moving forward fast***
- **FutureGen is a stepping-stone to *sustainable fossil-fuel power generation***
  - Supports a technology-based, climate change mitigation strategy, which reduces the risk of climate change while protecting the environment
  - Validates the cost and performance of an integrated "zero emissions" coal-fueled power plant
  - Creates the technical basis to retain coal in global energy mix with long-term goal of zero emissions
- **FutureGen is an opportunity for public and private sectors to *share cost and risk* of "zero emissions" technology development**

Visit the NETL Website at http://www.netl.doe.gov/

- **Coal & Power Systems**
  - Web page for each Coal/Power R&D Program, including FutureGen
  - Background info, Project fact sheets, Reference materials

- **NETL FutureGen Project Director: thomas.sarkus@netl.doe.gov**

- **Also, visit www.FutureGenAlliance.org**

Questions/Discussion