



# *Update on the FutureGen Project Pathway Towards Zero Emissions*

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Alliance

Gasification Technology Annual Conference  
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# FutureGen Project Features



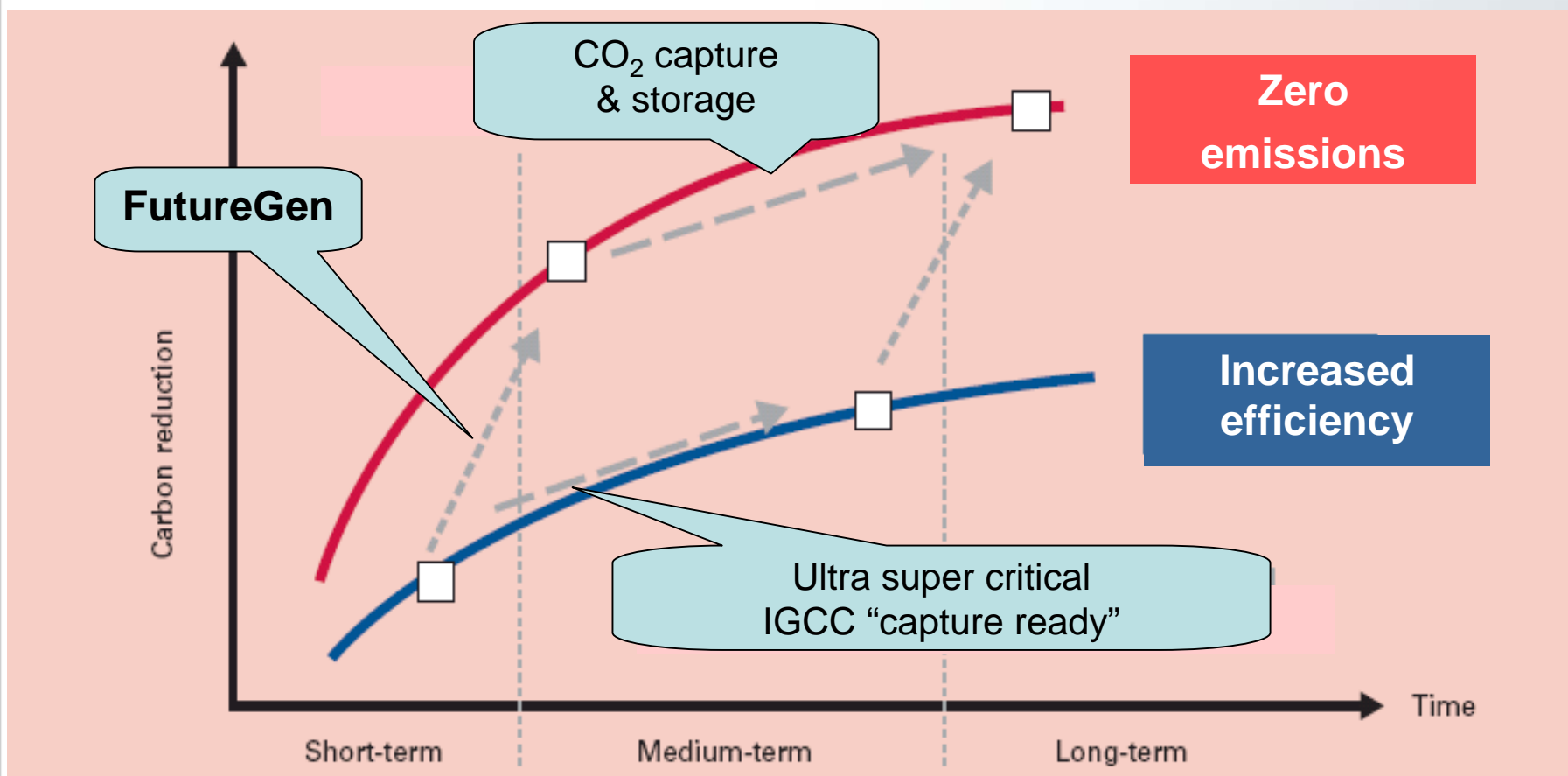
- Commercial-scale 275-MWe Plant
- Minimum 1-million (up to 2.5-million) tons/year CO<sub>2</sub> captured and sequestered
- Co-production of H<sub>2</sub> and electricity
- “Living laboratory” to test and validate cutting-edge technologies
- Public-private partnership
- Stakeholder involvement
- International participation
- On-line 2012

# FutureGen Alliance, Inc.

- **Non-profit, 501(c)3 formed to manage the project**
- **Secured funding**
- **DOE Cooperative Agreement Signed Dec. 2, 2005**
- **10 Members and still growing**



# Pathway towards zero emissions



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

# *FutureGen*

## Push the Technology Envelope

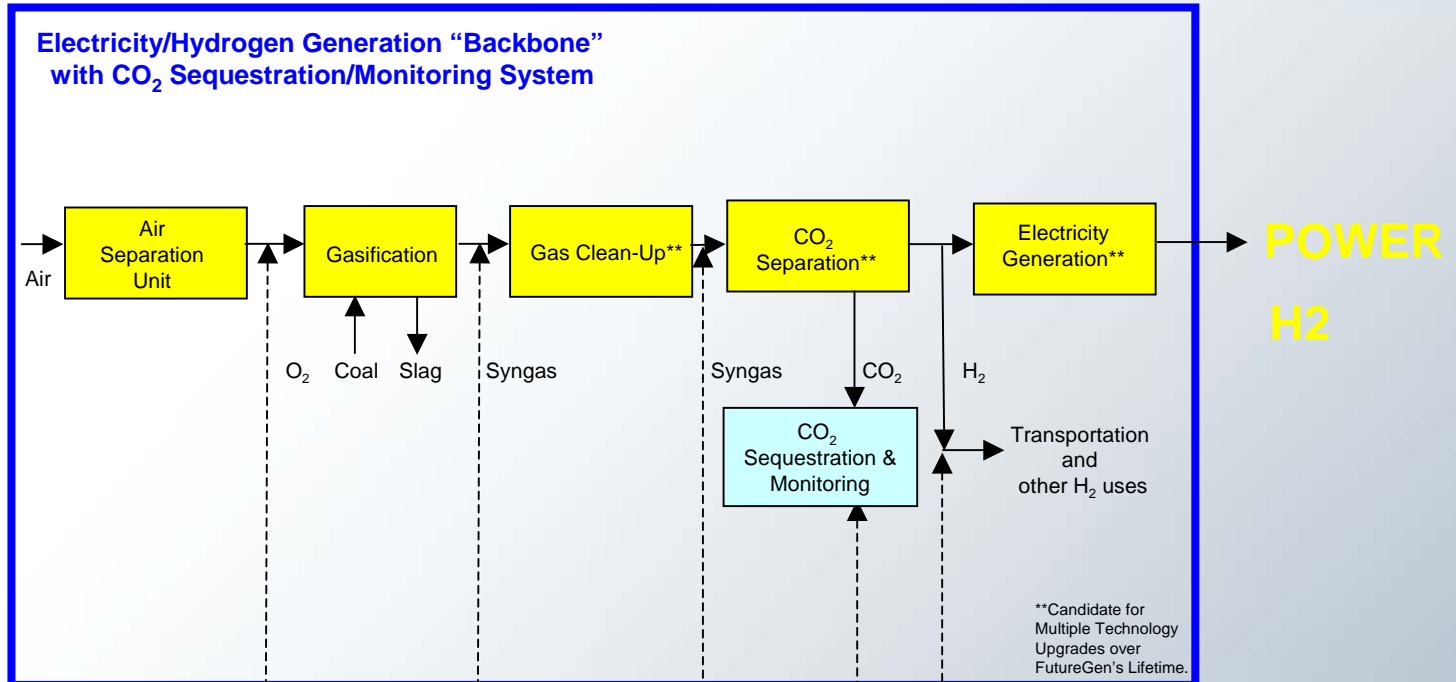
- **Establish the technical, economic, and environmental viability of “zero-emission” coal plants by 2015; thus, creating the option for multiple commercial deployments by 2020**
- **Industry to validate DOE suggested goals:**
  - Sequester >90% CO<sub>2</sub> with potential for ~100%
  - >99% sulfur removal
  - <0.05 lb/MMBtu NO<sub>x</sub>
  - <0.005 lb/MMBtu PM
  - >90% Hg removal
  - With potential for a N<sup>th</sup> plant commercial cost no more than 10% greater than that of a conventional power plant

# FutureGen

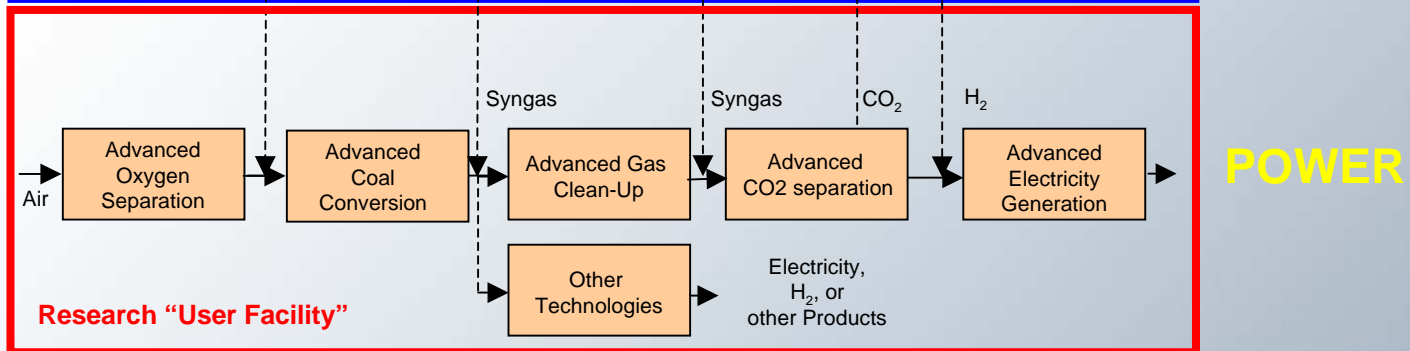
## Industry's View of the Facility

**Full-Scale  
Gasification  
Research  
Platform**

**Sequestration**



**Sub-scale  
Research  
User Facility**



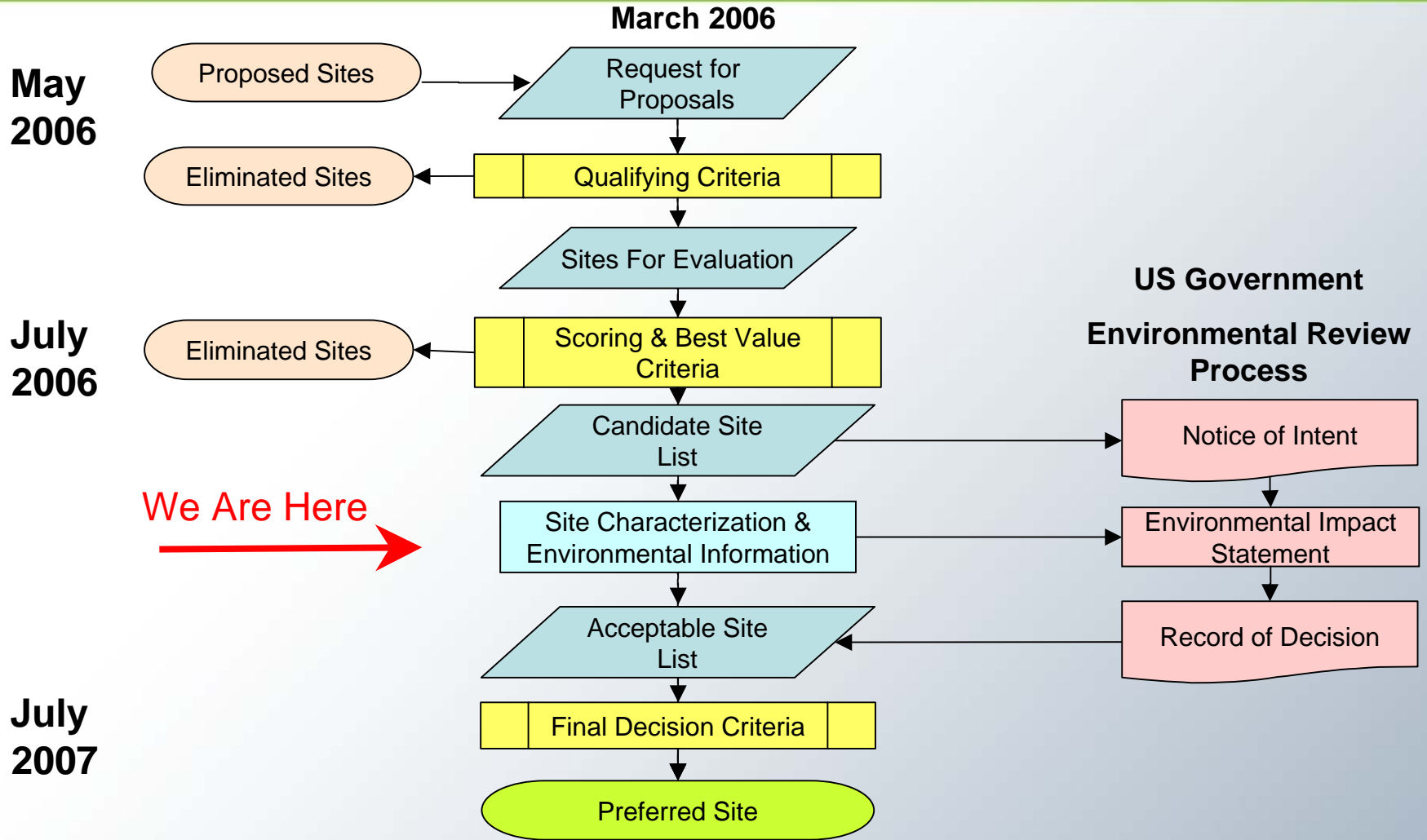
# *FutureGen*

## Current Activities

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- **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

# FutureGen Siting Process Flow



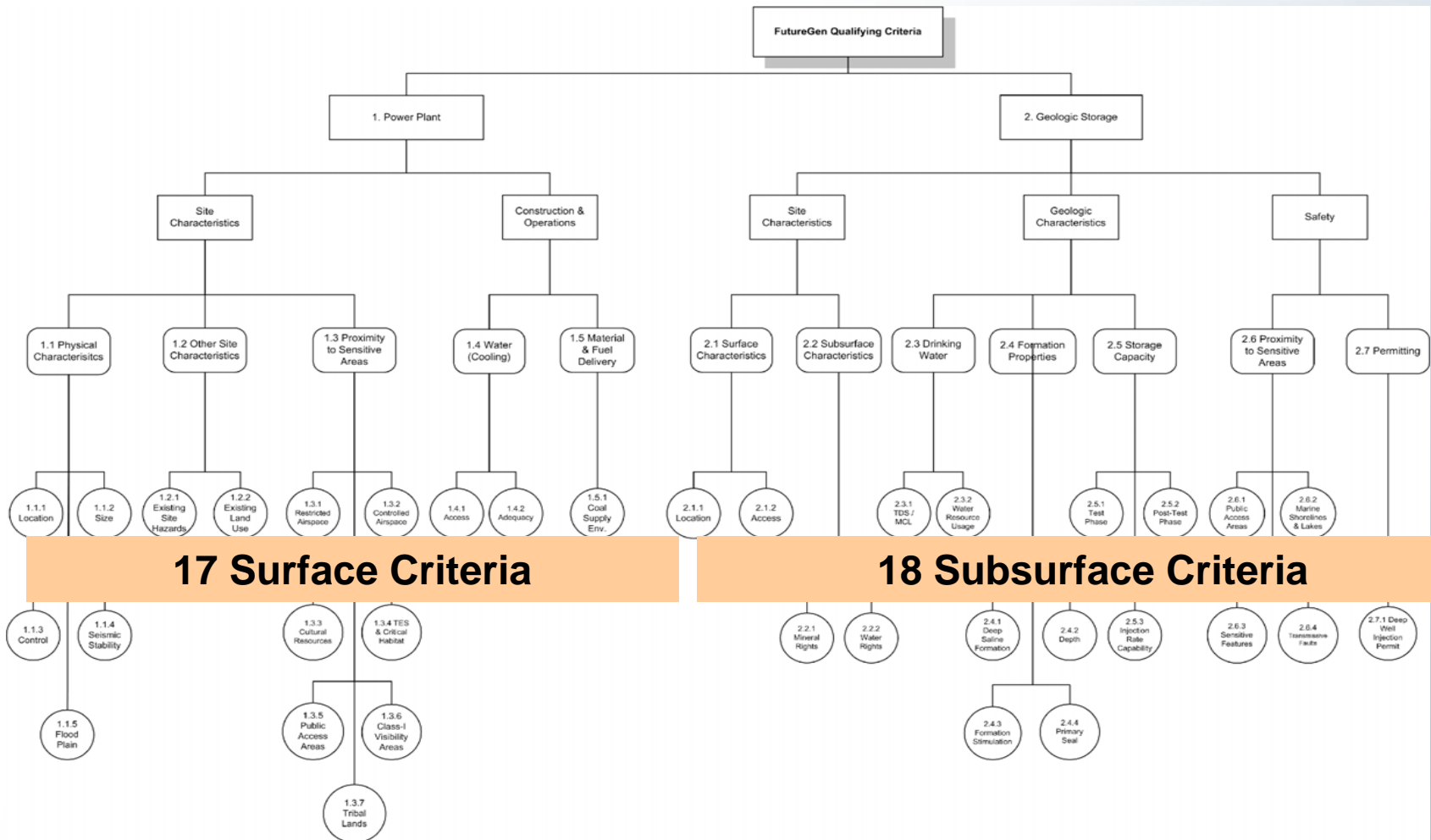
# FutureGen

## Site RFP Criteria

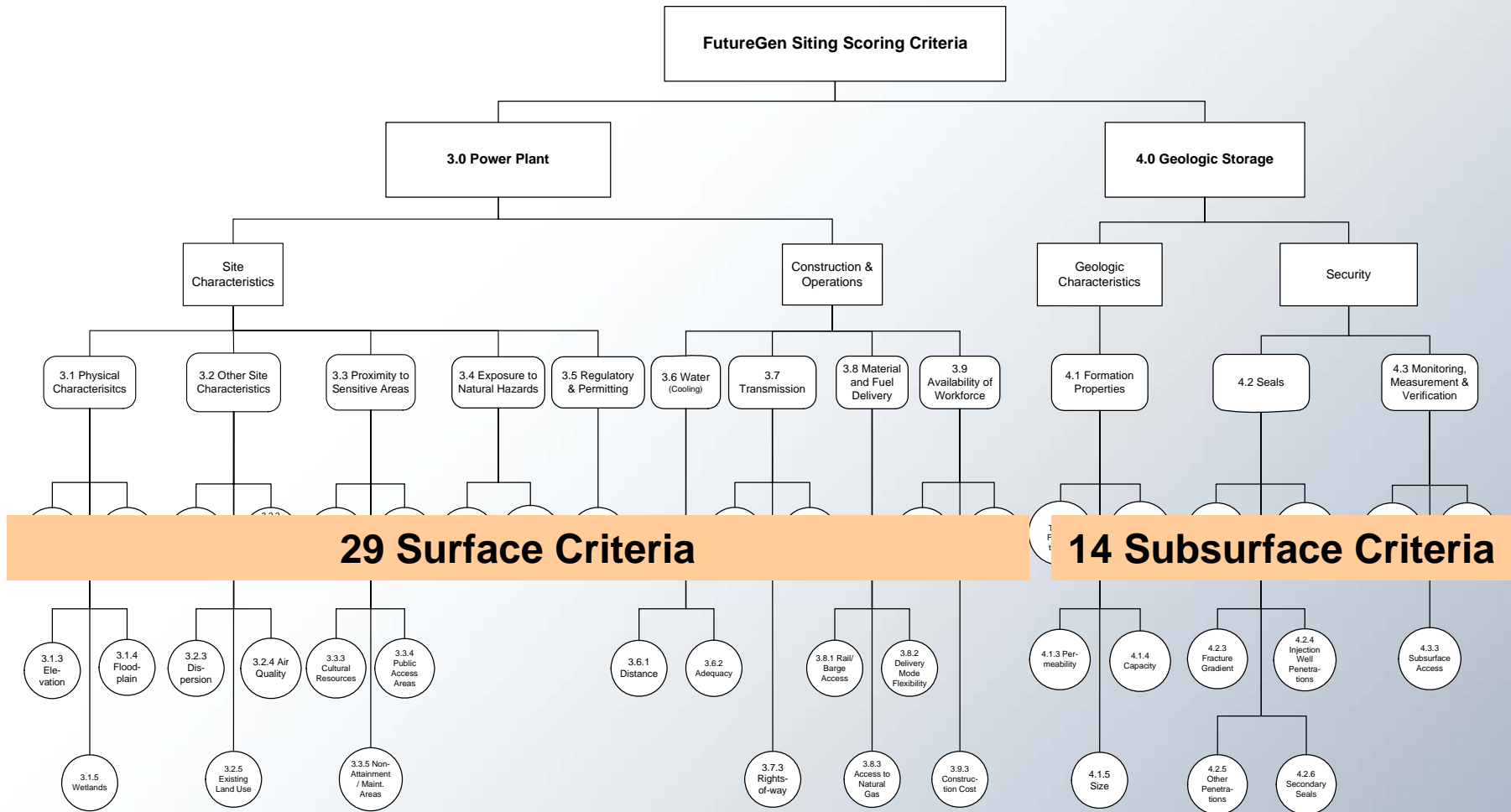
- Qualifying Criteria
  - Each proposal evaluated against certain qualifying criteria (Y/N)
- Scoring Criteria
  - Each proposal scored on each criteria against a predetermined scale
  - Weighting system used to roll-up criteria scores
- Best Value Criteria
  - Each proposal qualitatively evaluated against these criteria

**A report that details the process can be obtained from the FutureGen web site [www.FutureGenAlliance.org](http://www.FutureGenAlliance.org)**

# FutureGen Qualifying Criteria



# FutureGen Site RFP Scoring Criteria

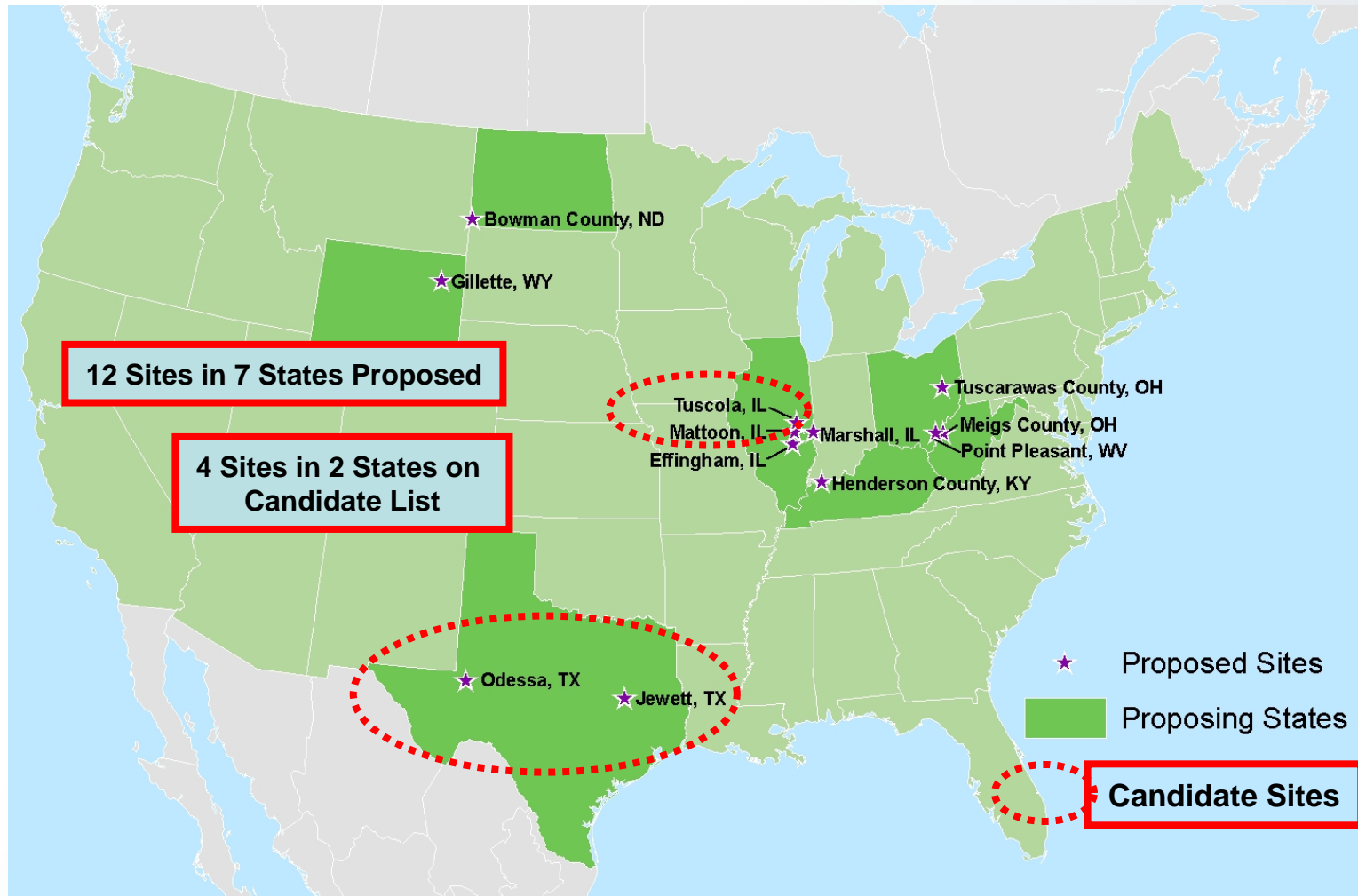


# FutureGen

## Site RFP Best Value Criteria

- Land Cost
- Availability / Quality of Existing Plant and Target Formation Characterization Data
- Land Ownership
- Residences or Sensitive Receptors above Target Formation
- Waste Recycling and Disposal
- Clean Air Act Compliance
- Expedited Permitting
- Transmission Interconnection
- Background CO<sub>2</sub> Data
- Power Sales
- Market for H<sub>2</sub>
- CO<sub>2</sub> Title and Indemnification
- Other Considerations

# FutureGen Site Selection Underway



# *Design and Cost Estimate*

## Facility Goals

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### Key Goals

- Generate 1 to 2.5 million tons per year CO<sub>2</sub>; (target 90% CO<sub>2</sub> capture)
- Design for all U.S. coals (primarily bituminous and sub-bituminous).
  - Maybe other coals.
- Push the technology (“prototype plant of the future”)
- Commercial-scale (275-MW nominal rating)

# Design and Cost Estimate

## Plant Design for Fuel Flexibility

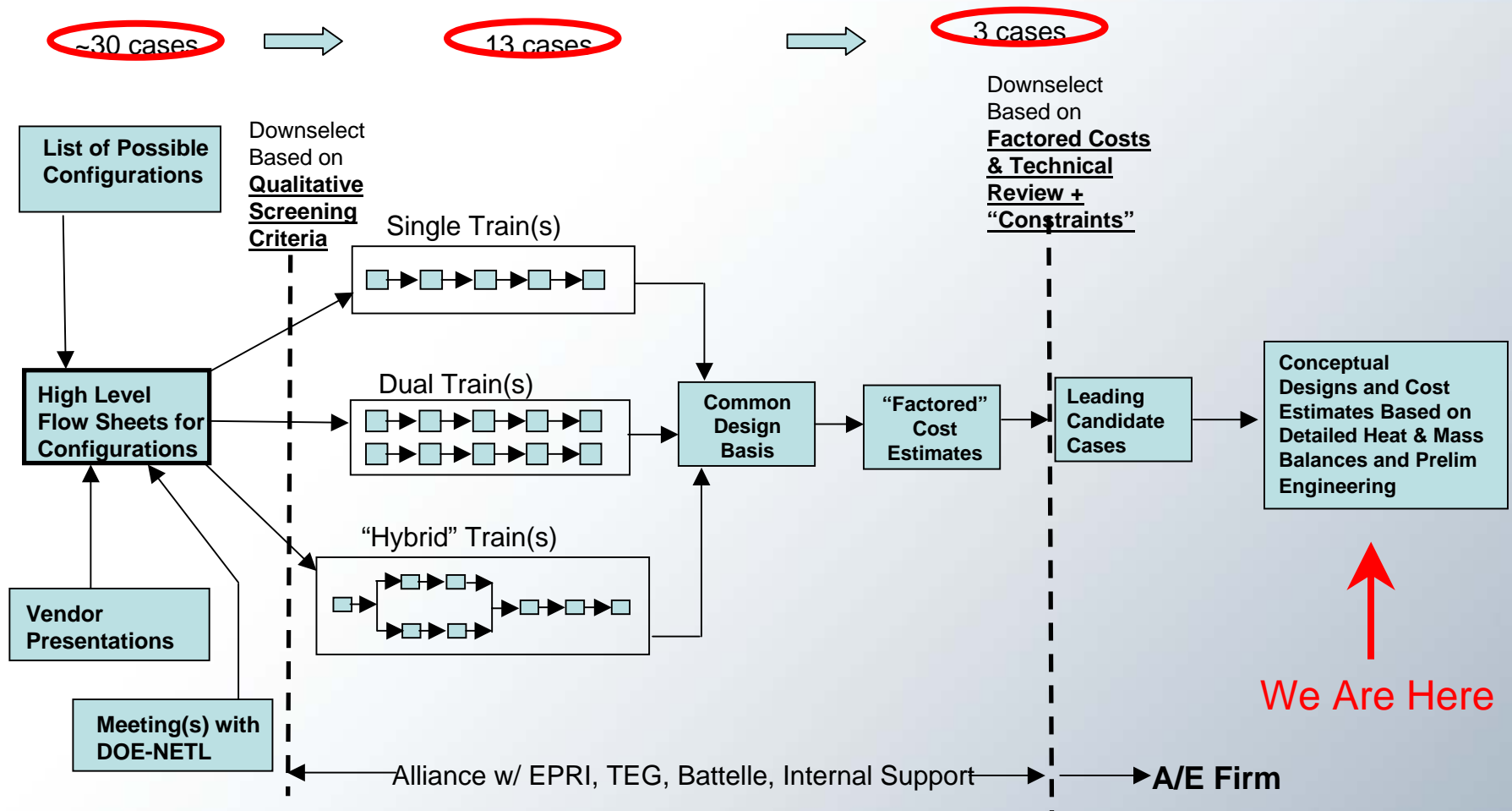
<b>COAL SPECIFICATIONS</b>			
	Mean Property Values		
	Northern Appalachian	Illinois Basin	PRB
<b>AS-RECEIVED (wt%)</b>			
Total Moisture	7	11.5	29
Equilibrium Moisture	2	7.8	27.6
<b>DRY BASIS (wt%)</b>			
Fixed Carbon	53.44	49.3	44.4
Volatile Matter	38.94	40.3	48.9
Ash	7.62	10.4	6.7
<b>DRY BASIS (wt%)</b>			
Ash	7.62	10.4	6.7
Carbon	77.67	71.6	70.3
Hydrogen	5.14	4.9	4.9
Nitrogen	1.47	1.5	0.9
Chlorine	0.1	0.19	0.01
Sulfur	2.49	3.5	0.5
Oxygen	5.51	7.87	17.2
HHV (Dry Basis), Btu/lb	13,980	13,000	12,941

# *Design and Cost Estimate* Screening Criteria

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- **Economic Criteria**
  - **Capex Overrun Potential**
  - **COE Reduction Potential**
- **Technical Criteria**
  - **Coal Flexibility**
  - **Step-Outs**
  - **Schedule Risk**
  - **Mission Risk**
  - **Technical Risk**
- **Programmatic Criteria**
  - **Vendor Alignment**
  - **DOE-Developed Backbone Technologies**

# Design and Cost Estimate Conceptual Design Decision Process



# *Design and Cost Estimate*

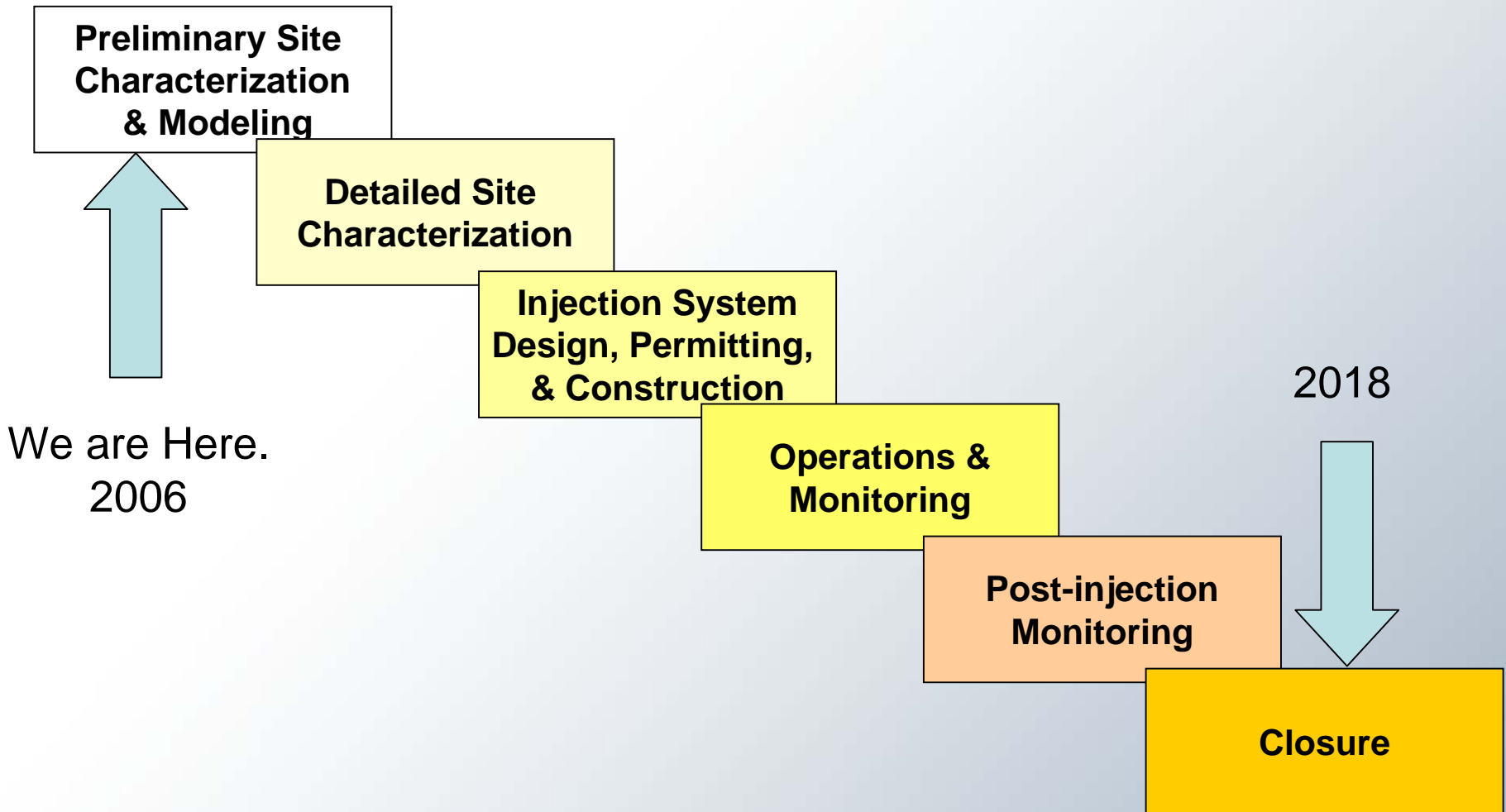
## Design Cases

- **Two Single Trains:**
  - Slurry feed water quench
  - Dry feed water quench
- **One Multiple Stream Hybrid:**
  - 100% full slurry quench
  - 30% transport gasifier with ITM air separation
- **Three coal types:**
  - Northern Appalachian
  - Illinois Basin
  - PRB

**These are design configurations for the conceptual design and cost estimate, not the final designs. The actual designs will be established through competitive bids in 2007.**

*FutureGen*

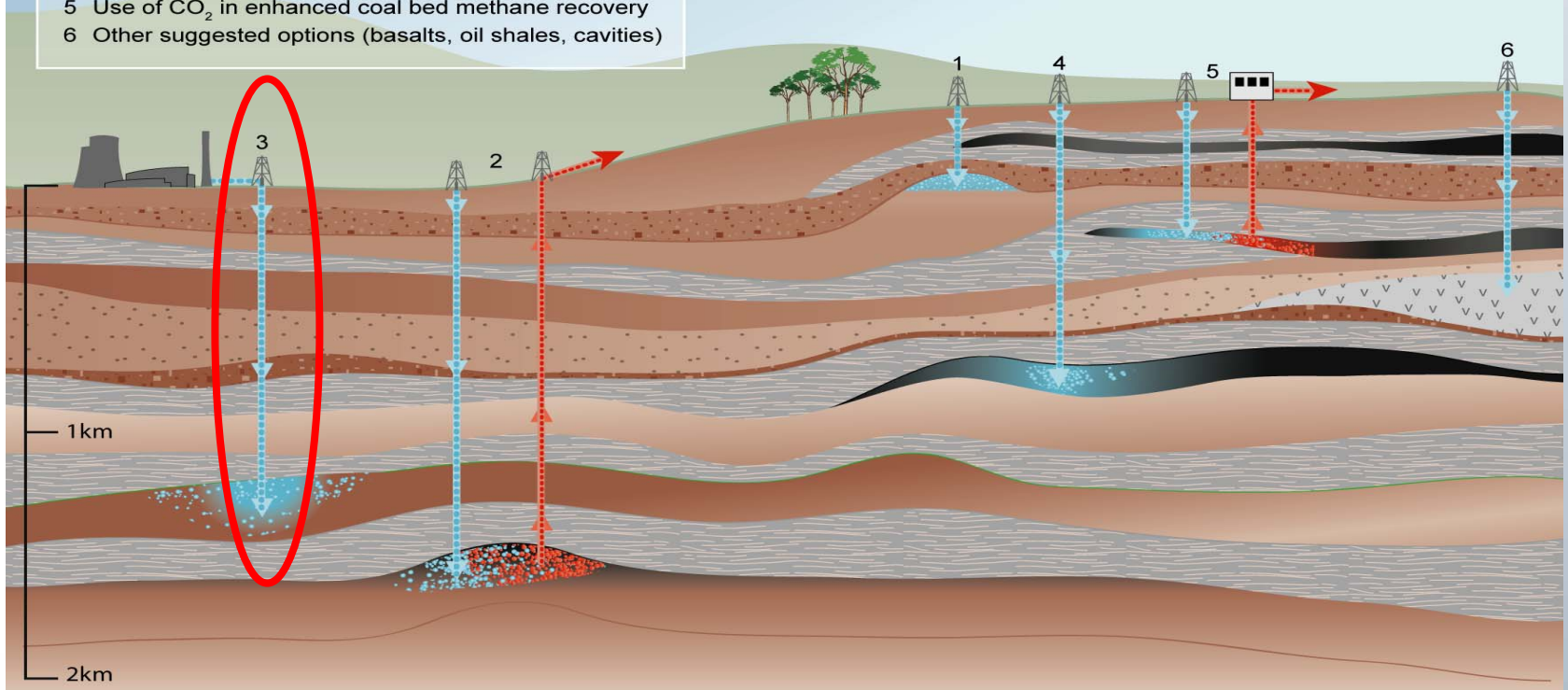
# Phases of Sequestration



# CO<sub>2</sub> Storage Variety of Reservoir Types

## Geological Storage Options for CO<sub>2</sub>

- 1 Depleted oil and gas reservoirs
- 2 Use of CO<sub>2</sub> in enhanced oil recovery
- 3 Deep unused saline water-saturated reservoir rocks
- 4 Deep unmineable coal seams
- 5 Use of CO<sub>2</sub> in enhanced coal bed methane recovery
- 6 Other suggested options (basalts, oil shales, cavities)

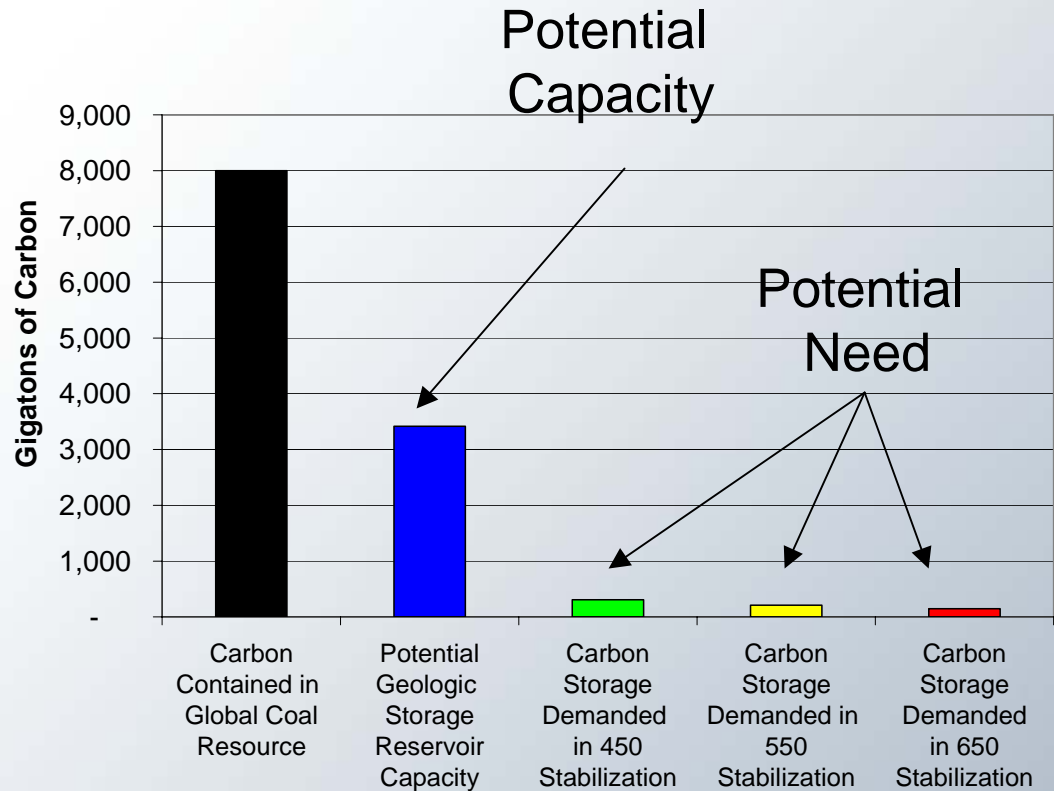


Courtesy of Peter Cook, CO<sub>2</sub>CRC

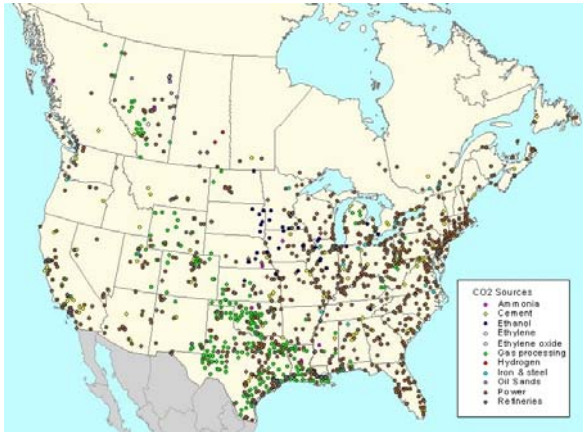
# Sequestration Capacity: Is there enough?

## Global Capacity Exceeds the Need

- Published estimates of potential storage capacity are approximately 3,000 GtC (11,000 GtCO<sub>2</sub>).
- In total this capacity exceeds the global need in ALL CO<sub>2</sub> management regimes commonly discussed.



# Sequestration Capacity: In Right Places? Adequate Capacity in U.S.



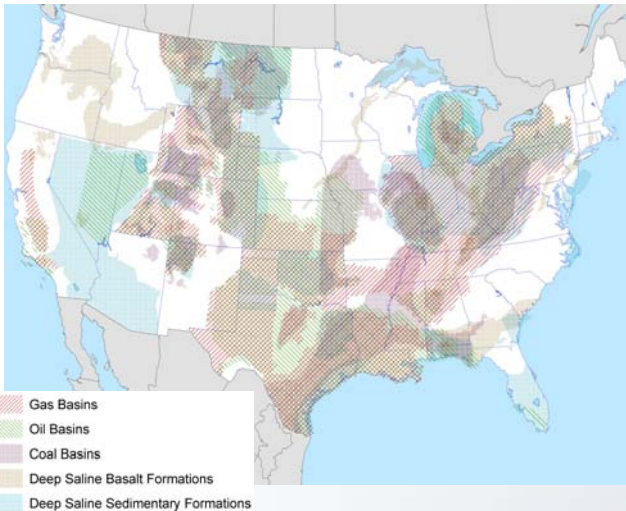
**2,082 Large Sources (100+ ktCO<sub>2</sub>/yr)  
with Total Annual Emissions = 3.8 GtCO<sub>2</sub>/yr**

- 1,185 electric power plants
- 447 natural gas processing facilities
- 154 petroleum refineries
- 53 iron & steel foundries
- 124 cement kilns
- 43 ethylene plants
- 9 oil sands production areas
- 40 hydrogen production
- 25 ammonia refineries
- 47 ethanol production plants
- 8 ethylene oxide plants

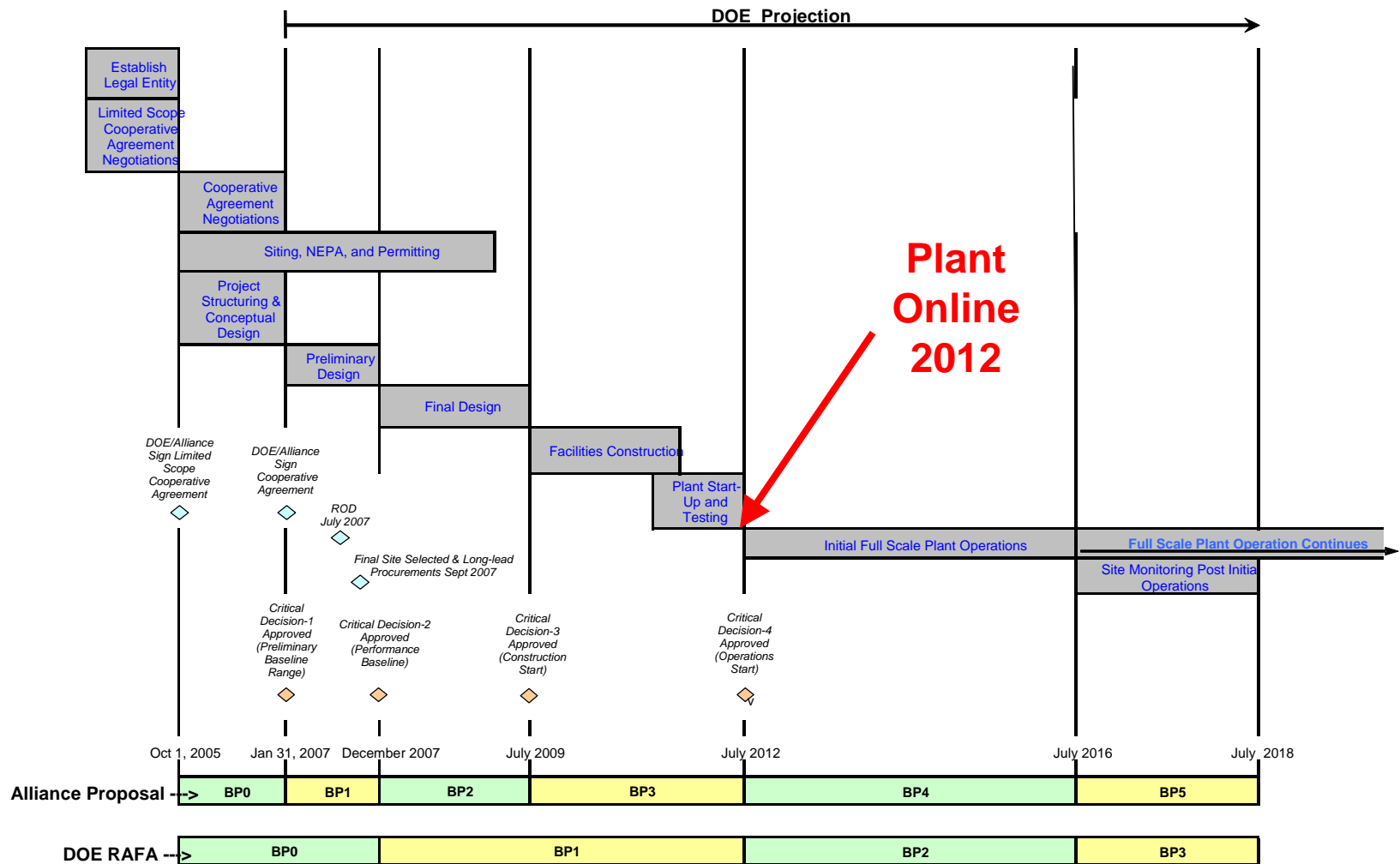
**~ 100 Years**

**3,800+ GtCO<sub>2</sub> Capacity within 330 US and Canadian  
Candidate Geologic CO<sub>2</sub> Storage Reservoirs**

- **3,730 GtCO<sub>2</sub> in deep saline formations (DSF)**
- 65 GtCO<sub>2</sub> in deep unmineable coal seams with potential for enhanced coalbed methane (ECBM) recovery
- 40 GtCO<sub>2</sub> in depleted gas fields
- **13 GtCO<sub>2</sub> in depleted oil fields with potential for enhanced oil recovery (EOR)**



# FutureGen Schedule



- **DOE to provide \$700M**
  - \$620M from Federal Appropriations
  - \$80M from Foreign Governments
    - India and South Korea are on International Steering Committee
- **Industry to provide \$250M**
  - Expect to share between 10 to 14 full members

# Summary

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- **FutureGen is real and *moving forward fast***
- **FutureGen *creates significant value***
  - Supports a technology-based climate change strategy, which mitigates the financial risk of climate change while protecting the environment
  - Validates the cost and performance of an integrated “zero-emission” coal-fueled power plant
  - Creates the technical basis to retain coal in global energy mix with a long-term goal of zero emissions.
- **FutureGen is an opportunity to *share the cost and risk* of “zero emissions” technology development**



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