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# **The Babcock & Wilcox Company**

*Generating Powerful Solutions<sup>SM</sup>*

***Oxy-Coal Combustion Process Update for  
Commercial Scale Carbon Capture and Storage***

***Carbon Capture and Sequestration Conference  
Pittsburgh, PA ♦ May 7-10, 2007***

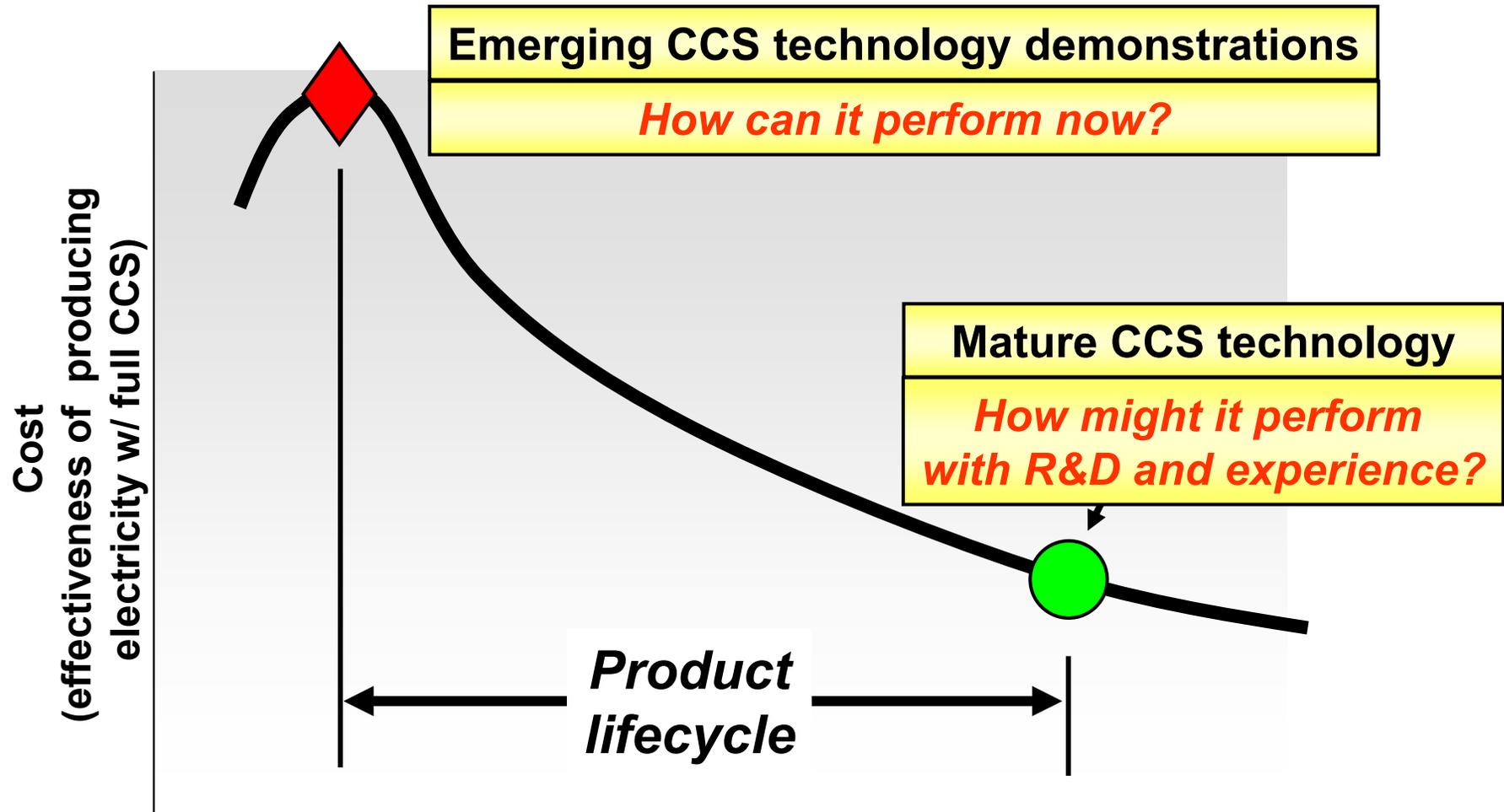
***Kip Alexander  
Senior Technology Manager***

# ***B&W Acknowledges the Need to Meaningfully Manage Carbon Emissions***

-  **CO<sub>2</sub> Capture and Storage (CCS)**  
Technology is near ready for commercial power plant scale demonstrations
-  **Diverse fuel portfolios increase energy security and decrease risk**
-  **Diverse technology portfolios speed deployment of effective CCS solutions (market-driven options)**
-  **Oxy-coal combustion is one of the promising CCS Technology options**



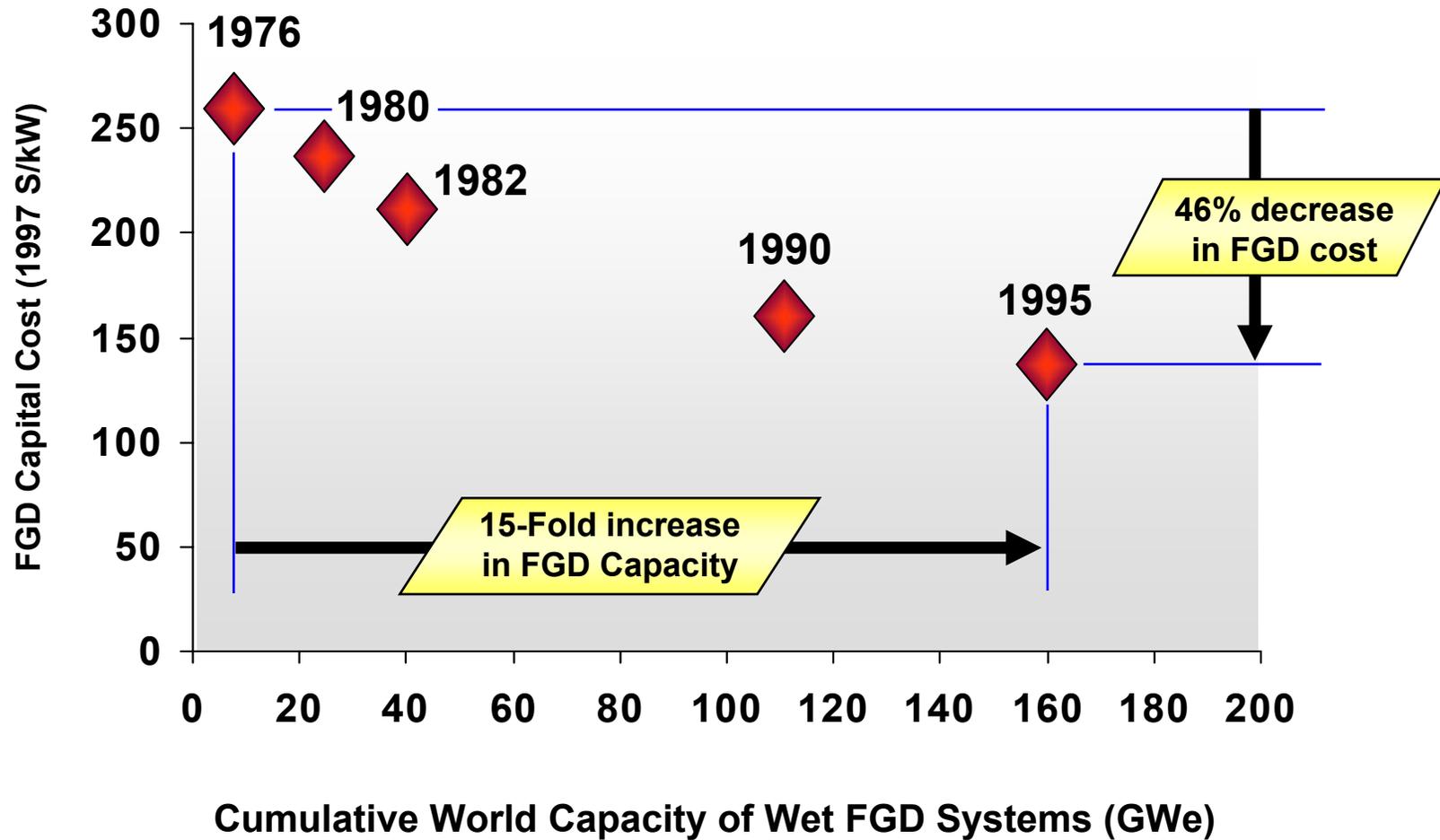
# Performance of Alternative CCS Technologies



## Typical Product Lifecycle Cost Curve



# “Learning by Doing” for Flue Gas DeSO<sub>x</sub> Technology

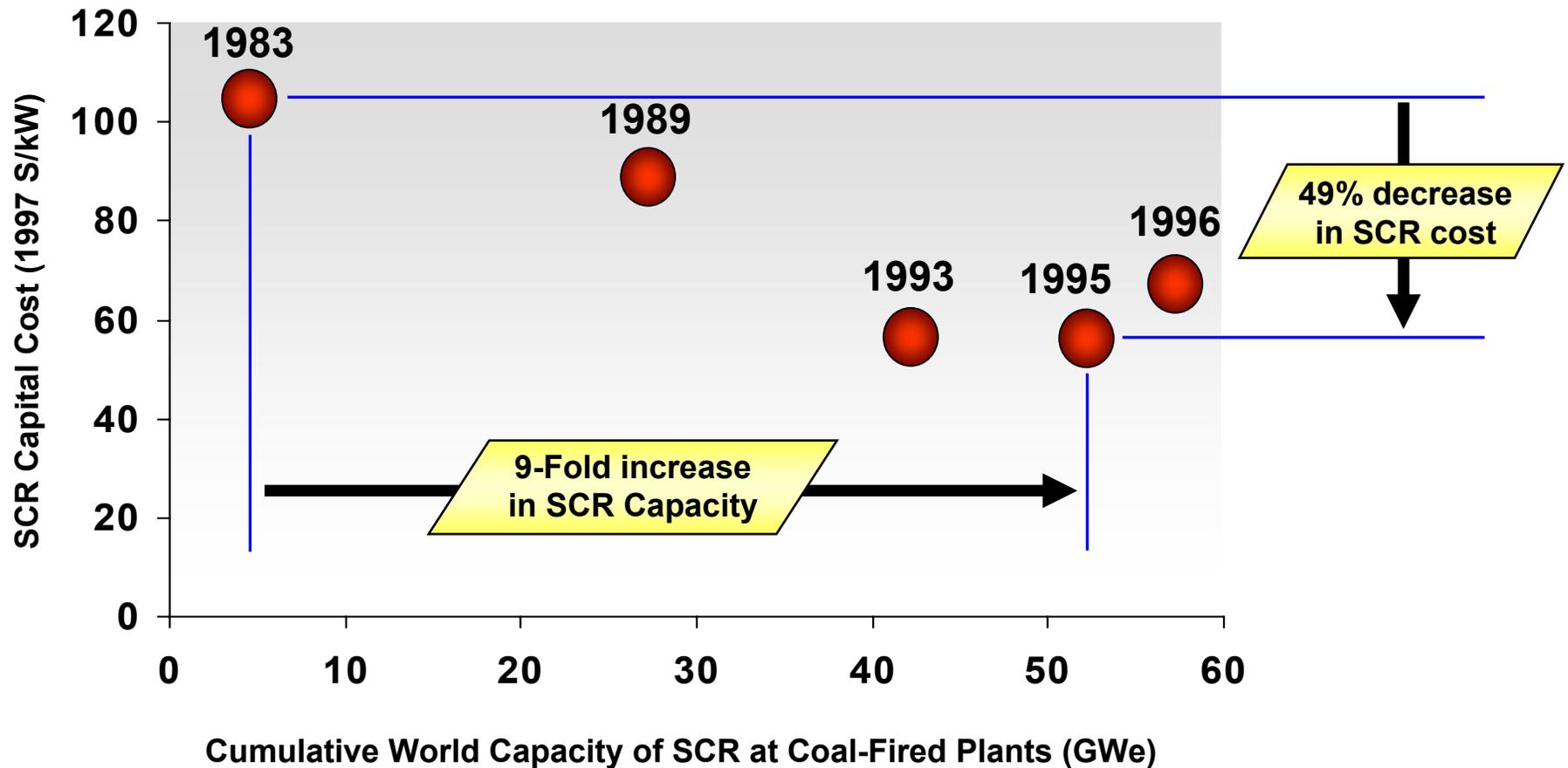


(Based on 90% SO<sub>2</sub> removal, 500 MW plant, 3.5% S coal)

(Source: Edward S. Rubin et al; Experience Curves for Power Plant Emission Control Technologies, 2004).



# “Learning by Doing” for Flue Gas DeNO<sub>x</sub> Technology



(Based on 80% NO<sub>x</sub> removal, 500 MW plant, medium S coal)  
(Source: Edward S. Rubin et al; Experience Curves for Power Plant Emission Control Technologies, 2004).



# CCS Deployment – Ideally Seek Two Learning Cycles Before Rollout Urgency Concerns Will Compress the Time Available

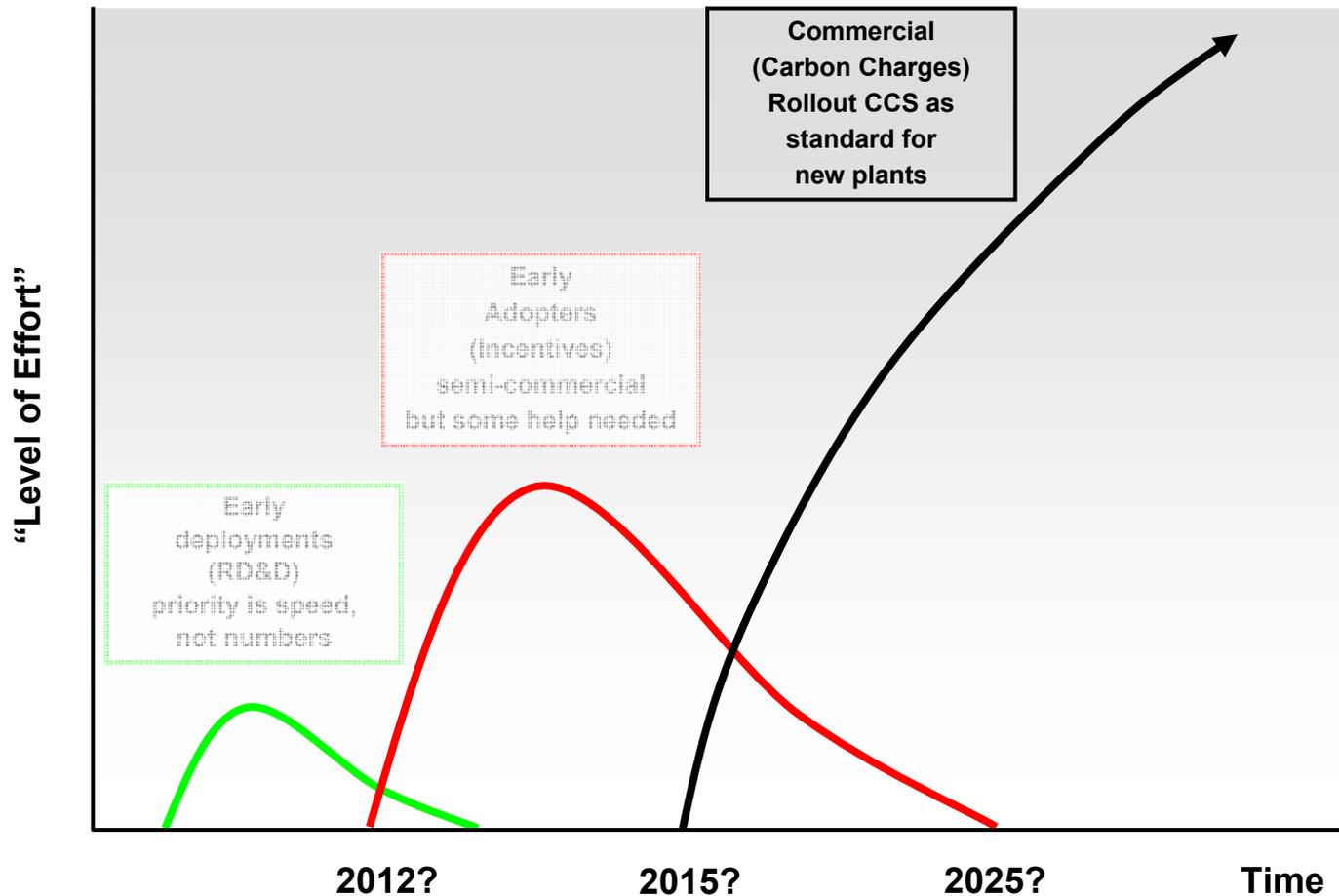


Chart supplied courtesy of  
Dr. Jonathon Gibbins, UK



## CCS Deployment – Ideally Seek Two Learning Cycles Before Rollout Urgency Concerns Will Compress the Time Available

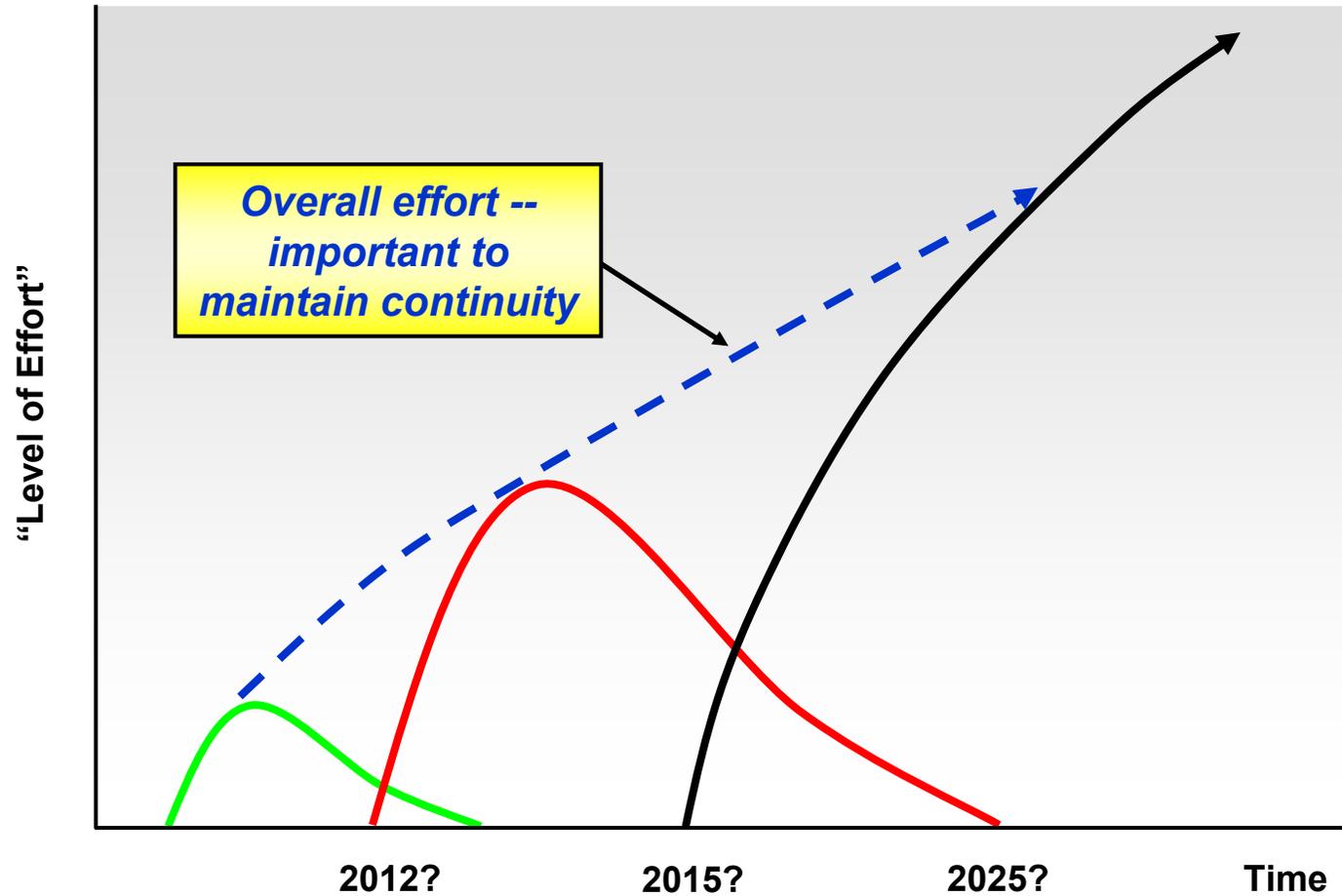


Chart supplied courtesy of  
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# Early Deployments: Largest Injections into Geologic Storage, Ever!

## Cumulative CO<sub>2</sub> Storage Accelerated Each Deployment Period

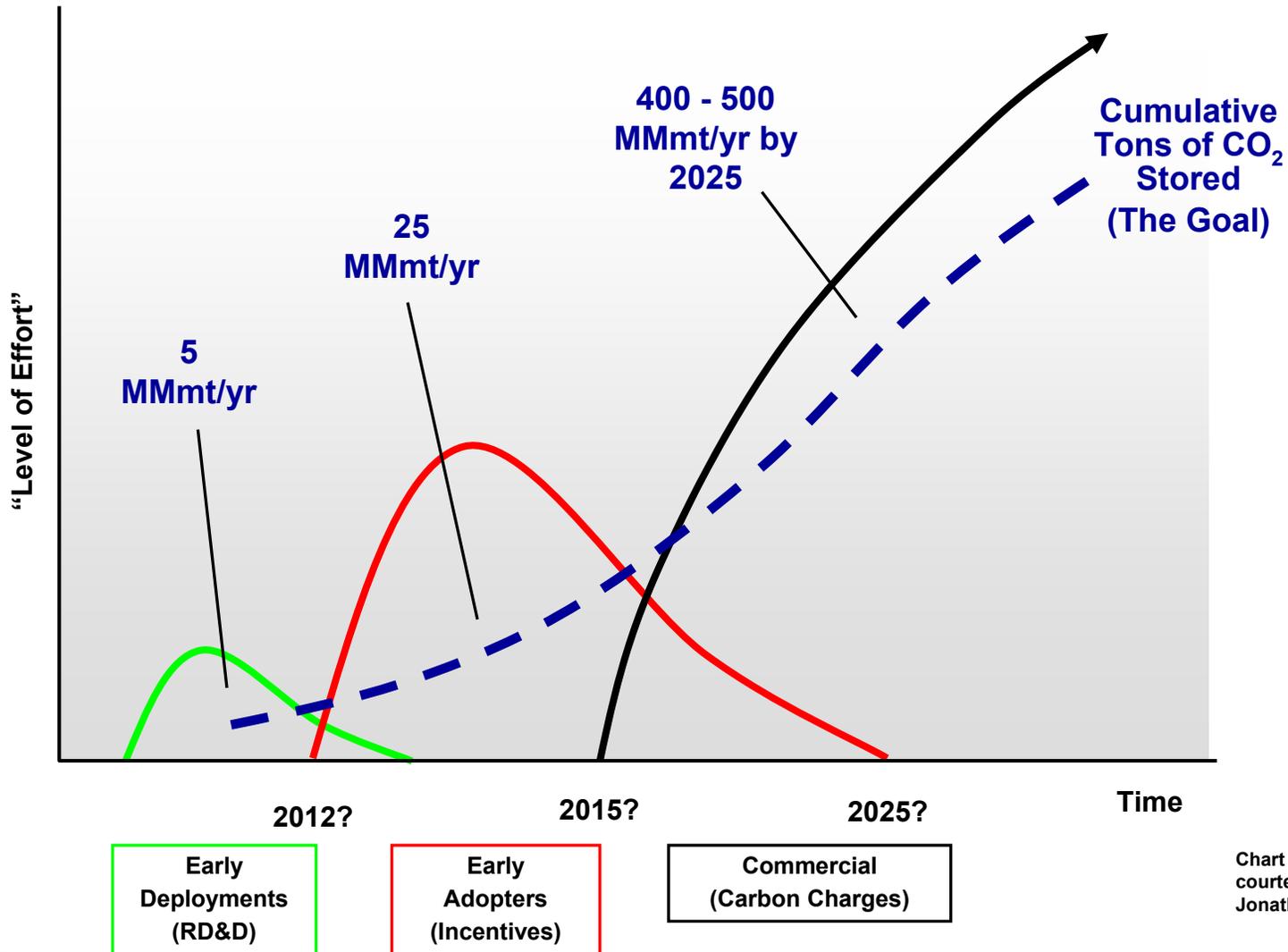


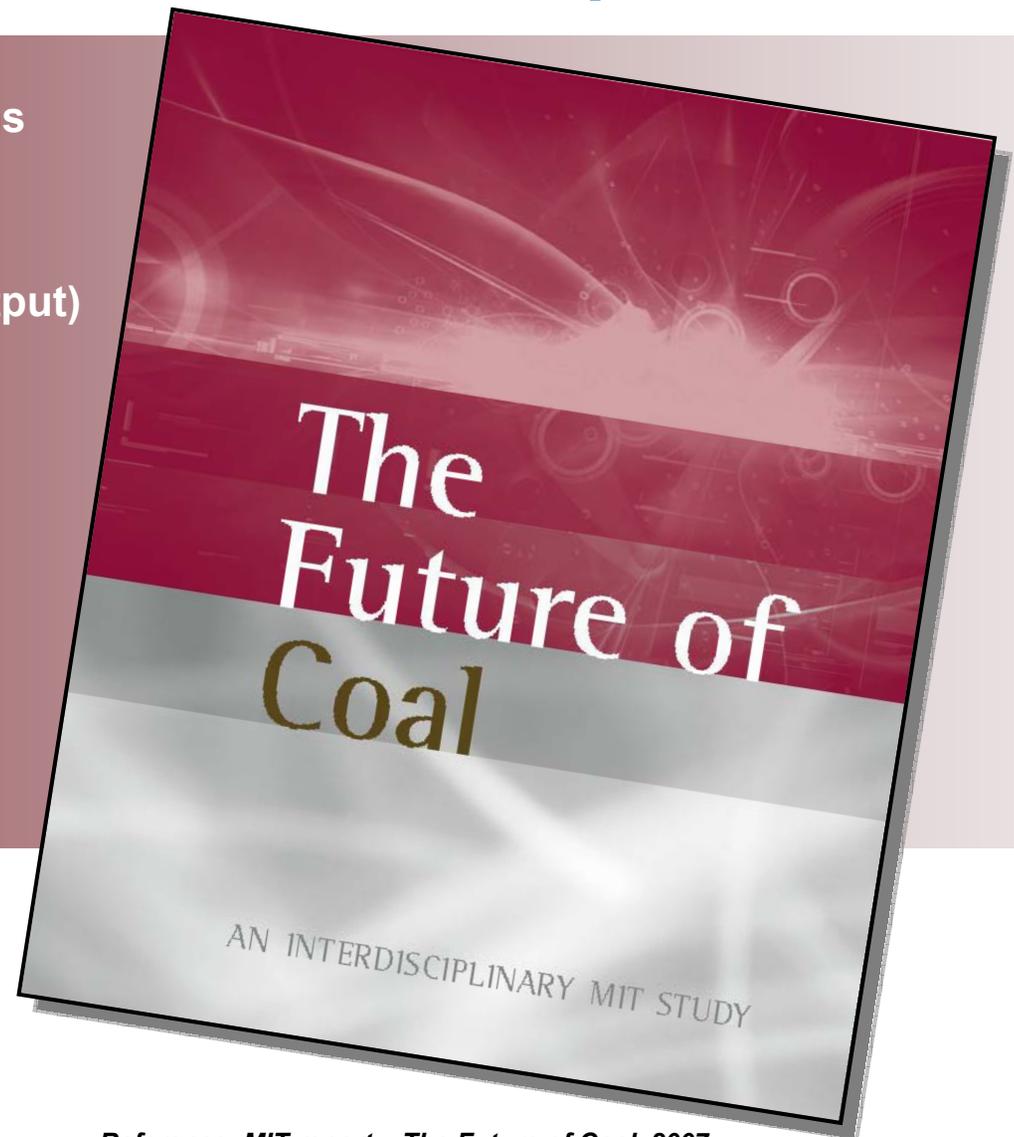
Chart supplied  
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# ***B&W's Carbon Management Policy Position Aligns with Recent MIT "The Future of Coal" Report***

## **Begin with "at scale" CCS demonstrations**

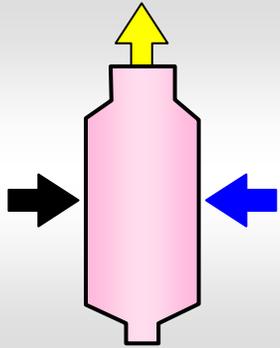
- ◆ **\$300M/year program – Up to five (5) demonstrations at 1 million metric tons/year CO<sub>2</sub> (about 200MW plant output)**
- ◆ **Integrate capture and storage to learn from the entire process**
- ◆ **Large geologic injections needed to affirm technology, regulatory needs, public confidence**
- ◆ **Demonstrate across technologies, fuels, new and retrofit sites**



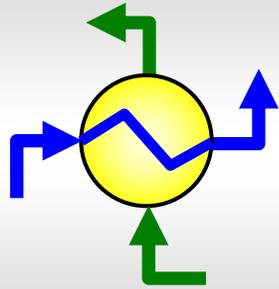
**Reference: MIT report – The Future of Coal, 2007**



# Emerging Carbon Capture Technologies



*Pre-Combustion: IGCC*



*Post-Combustion: Solvent Scrubbing*

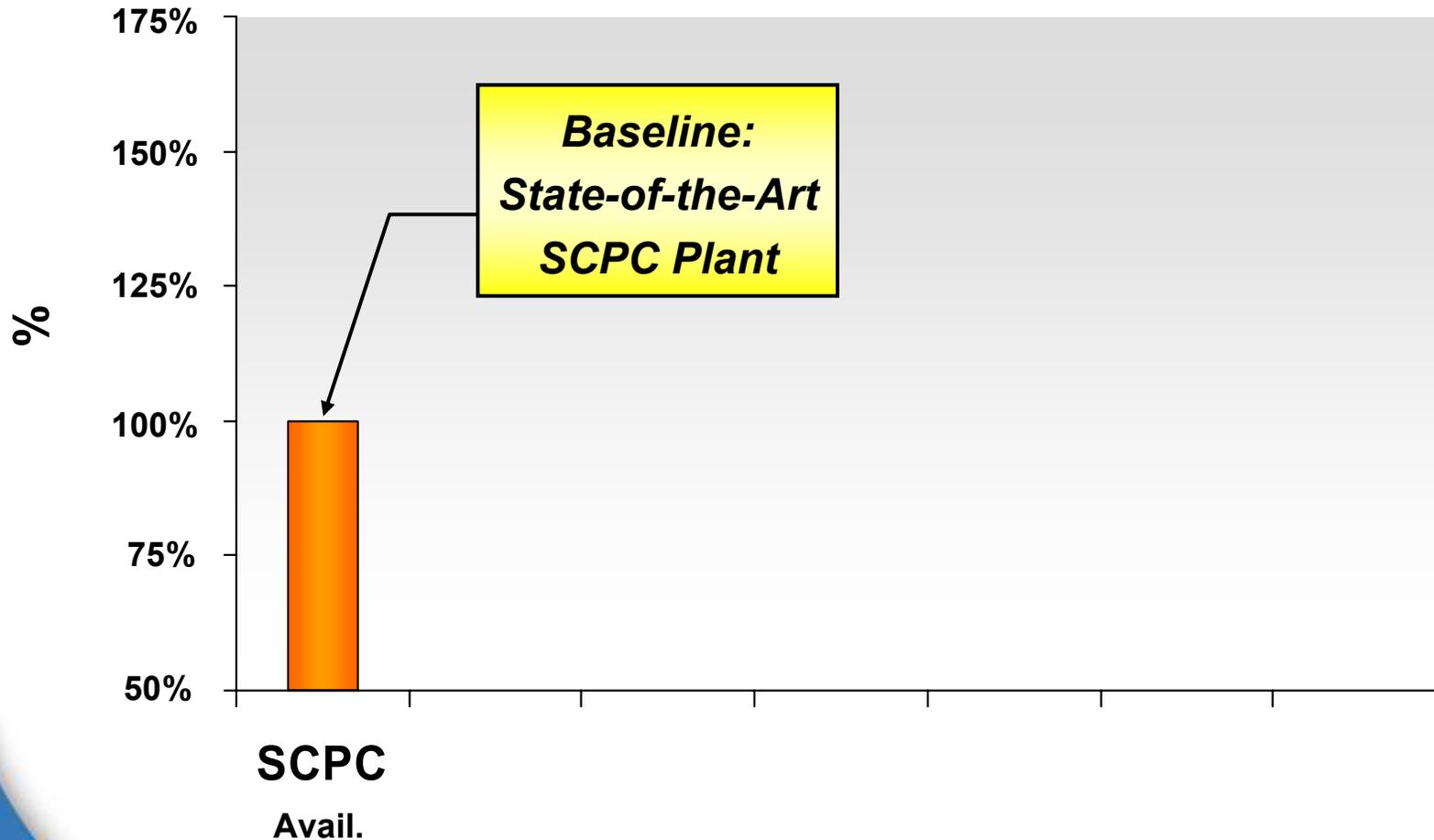


*Combustion: Oxy-Coal*



# Carbon Capture Technology Costs as Compared to State-of-the-Art Supercritical PC Boiler Plant Costs

Cost of Electricity, Percent of Base SCPC\*

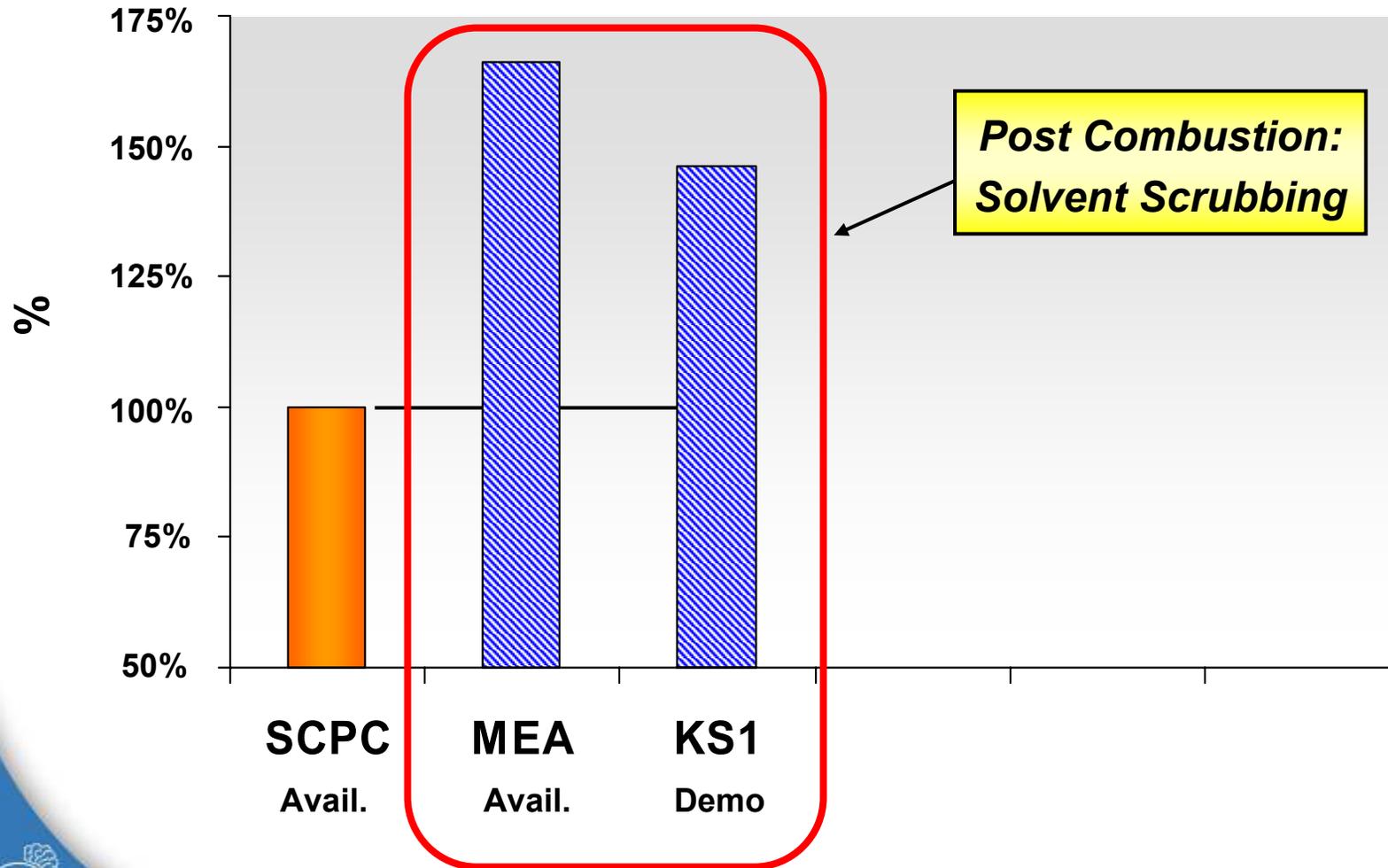


\* SCPC = Supercritical Pulverized Coal; Data obtained from various sources.



# Commercial Amine Systems are Available and Expensive Many New Solvents being Developed to Reduce Costs

Cost of Electricity, Percent of Base SCPC\*

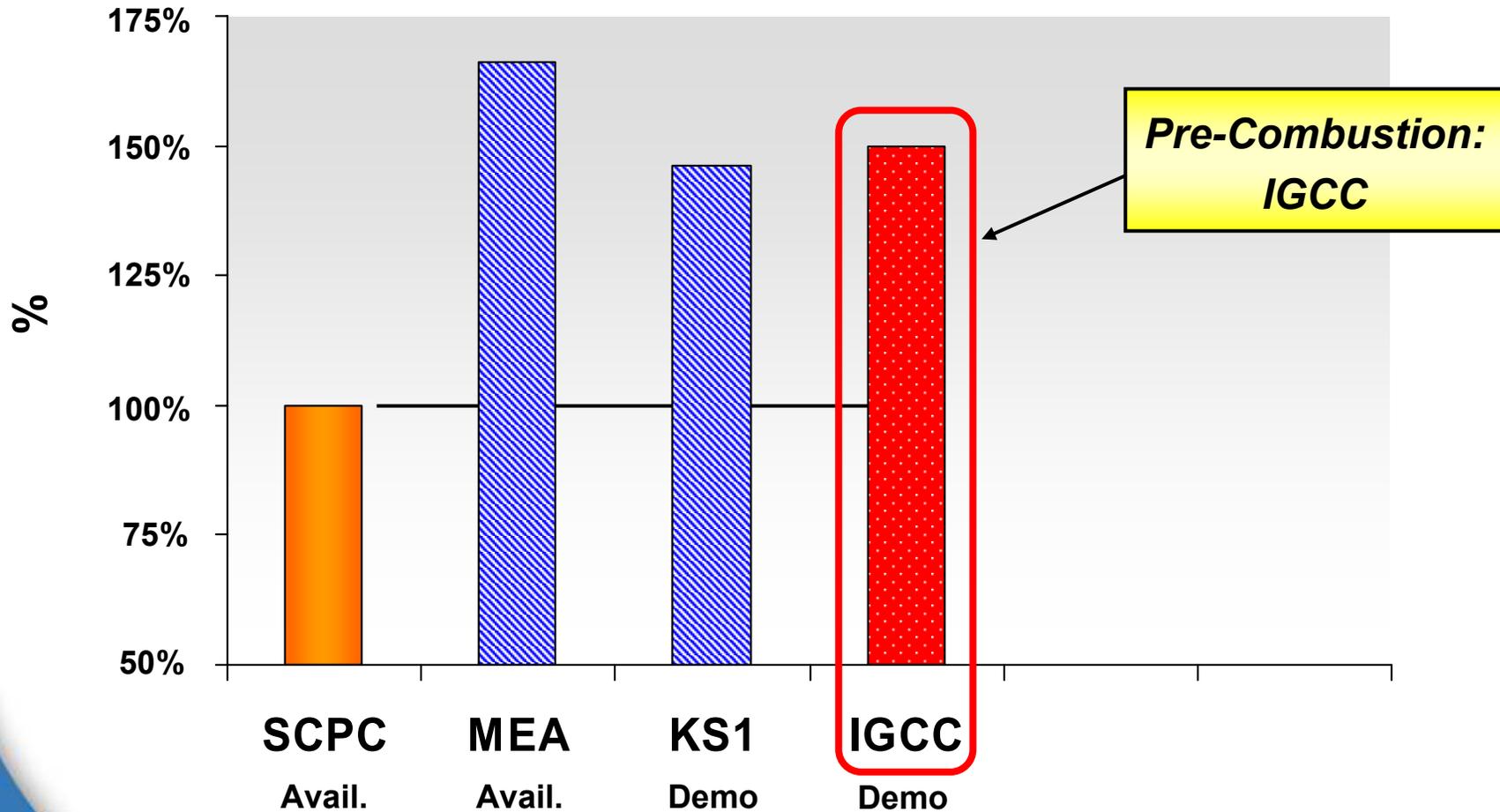


\* SCPC = Supercritical Pulverized Coal; Data obtained from various sources.



# Gasification System Technology with CSS being developed

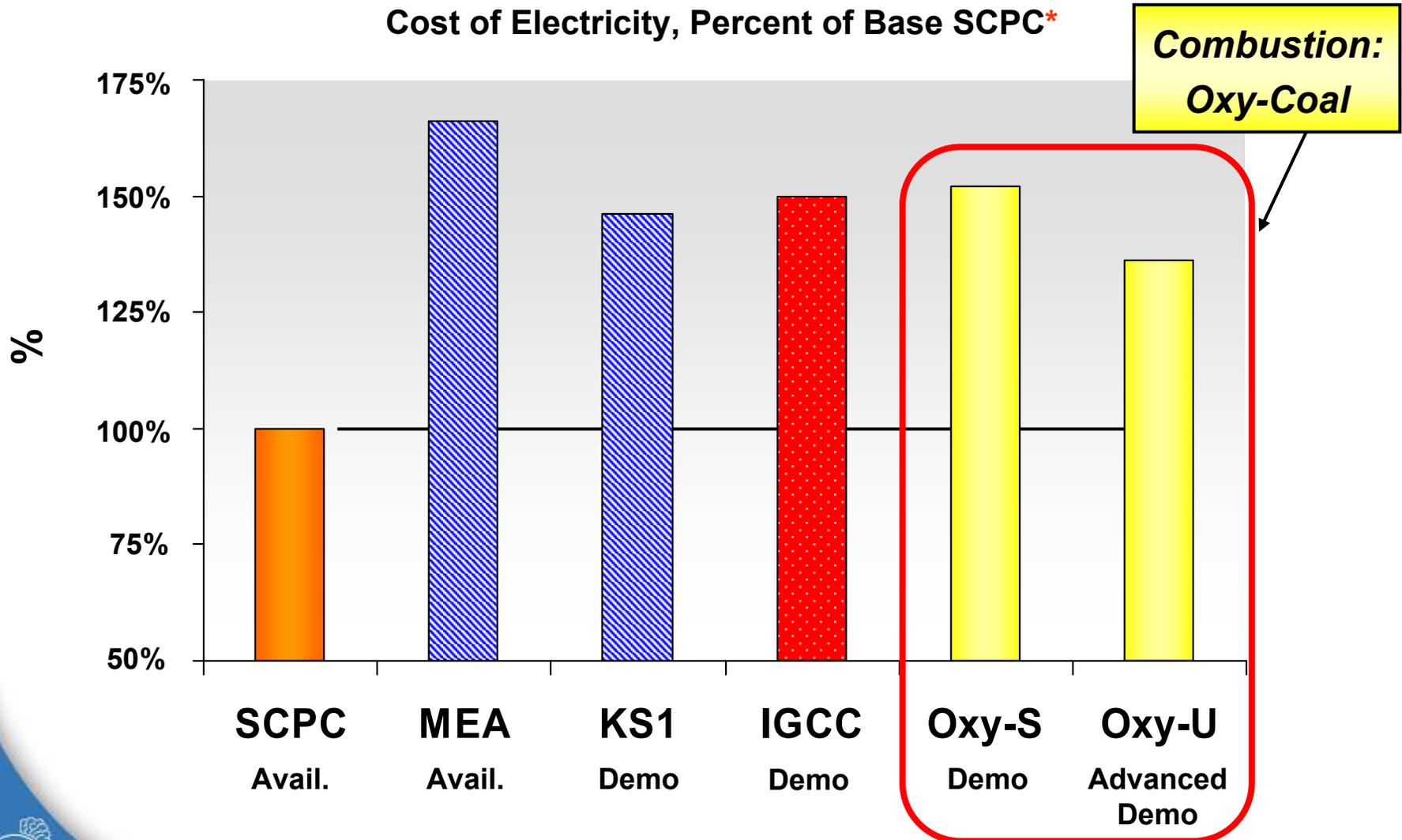
Cost of Electricity, Percent of Base SCPC\*



\* SCPC = Supercritical Pulverized Coal; Data obtained from various sources.



# Oxy-Coal SCPC Technology is being developed Ultra-SCPC Technology being Developed to Reduce Costs

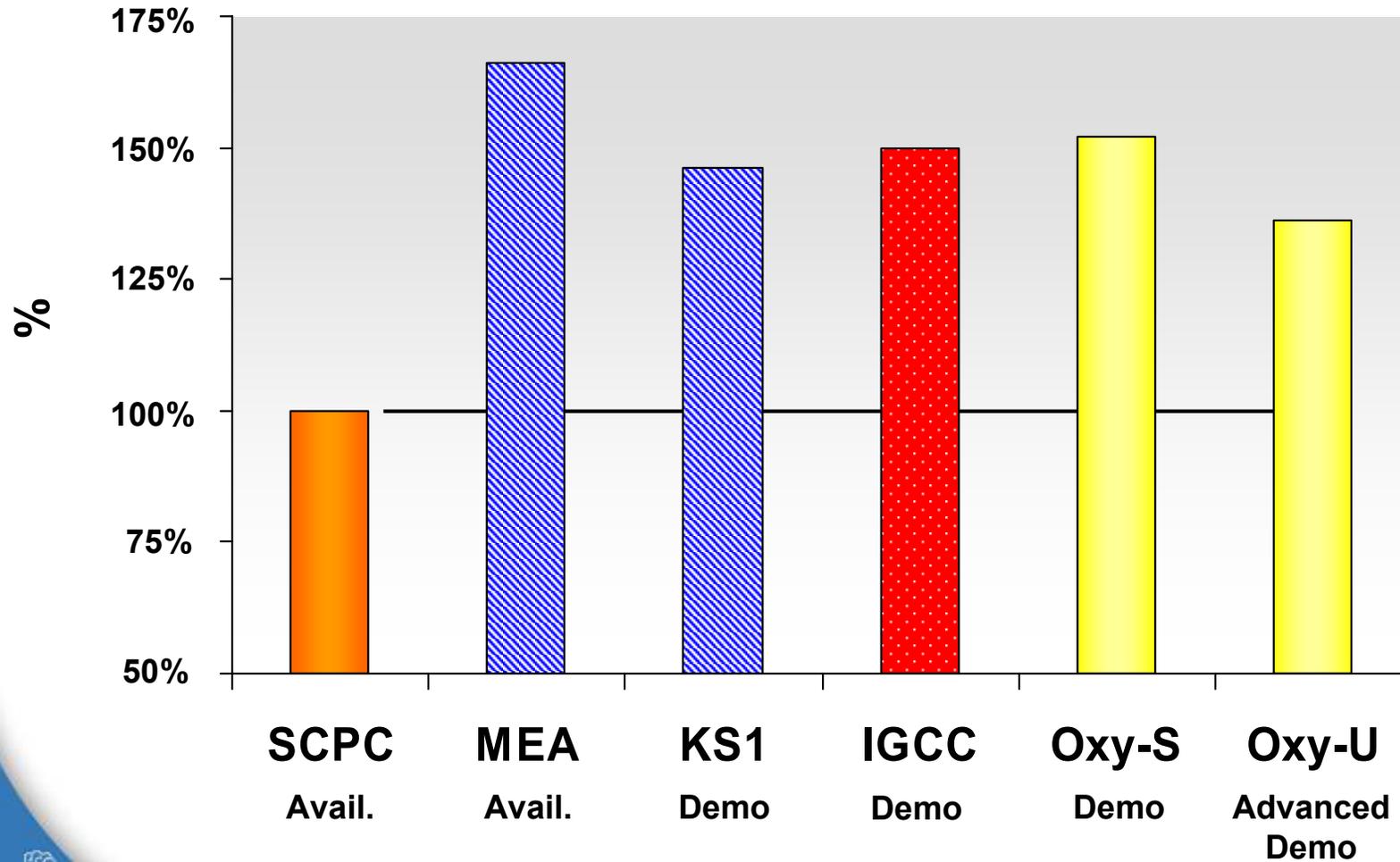


\* SCPC = Supercritical Pulverized Coal; Data obtained from various sources.



# Carbon Capture Technology Costs Generally Uncertain Today Comparative Range indicates Options of Similar Cost

Cost of Electricity, Percent of Base SCPC\*

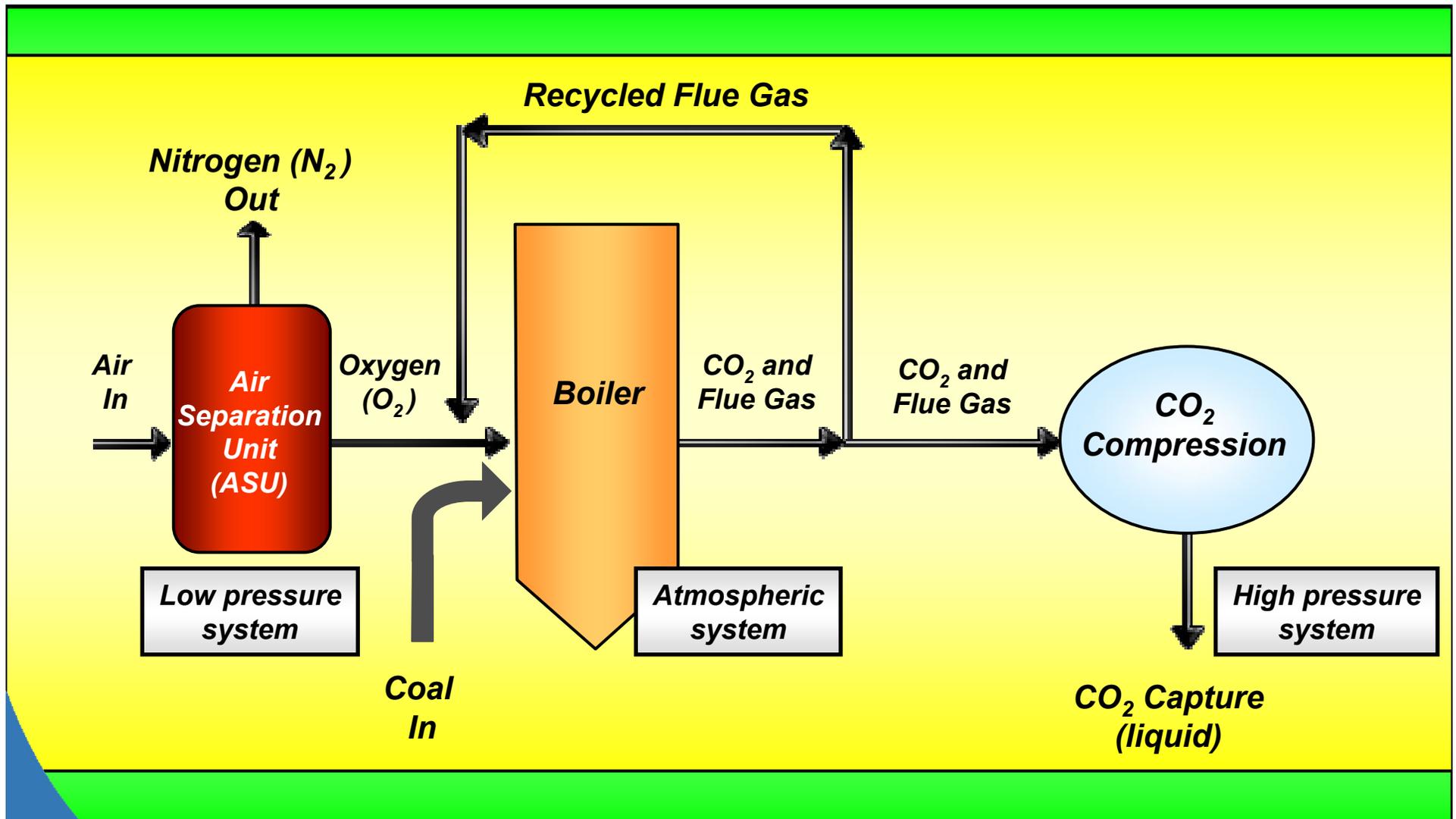


\* SCPC = Supercritical Pulverized Coal; Data obtained from various sources.



# Oxy-Coal Combustion Process:

$O_2$  Replaces Air •  $N_2$  Virtually Eliminated •  $CO_2$  is Concentrated



# Oxy-Coal Combustion

## First Generation Demonstration Plants



- **Reduce risk - mix oxygen with recycled flue gas to make “synthetic air”**
  - Applicable for lignite, PRB (sub-bit) and bituminous coals
  - Similar mass flows for heat transfer
  - Similar fuel drying and combustion
  - Similar boiler control system
  - Similar wet scrubber process for SO<sub>2</sub> control
  - Use commercially proven boiler equipment



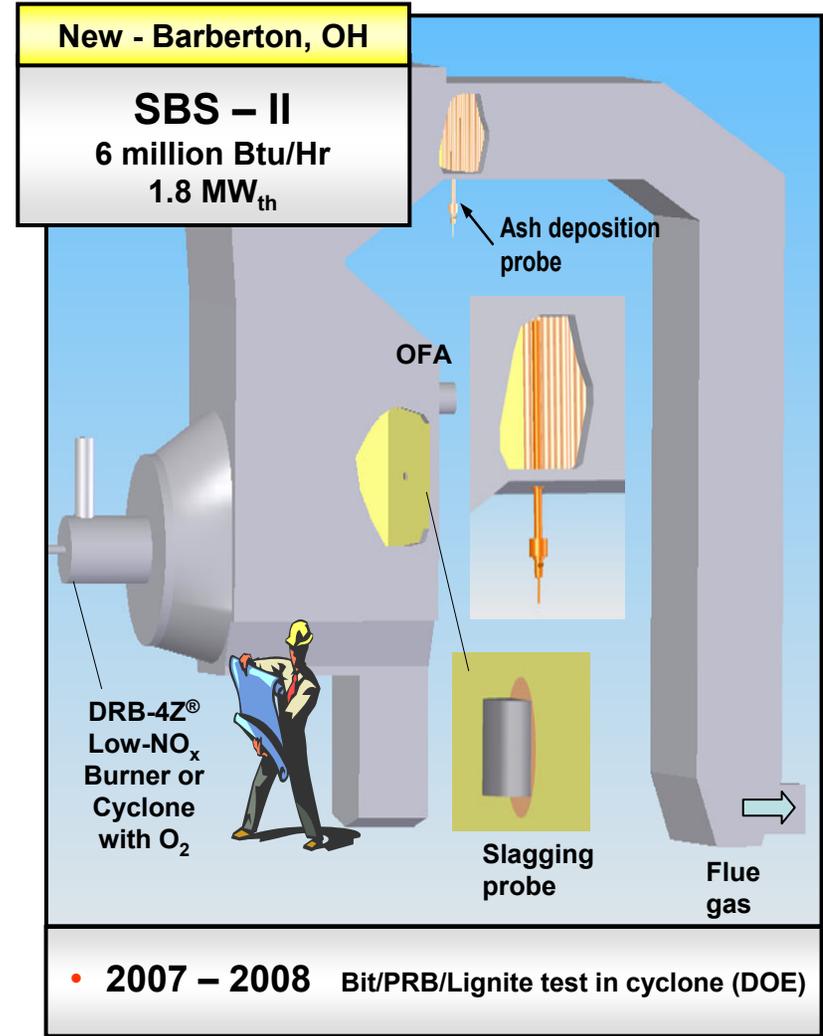
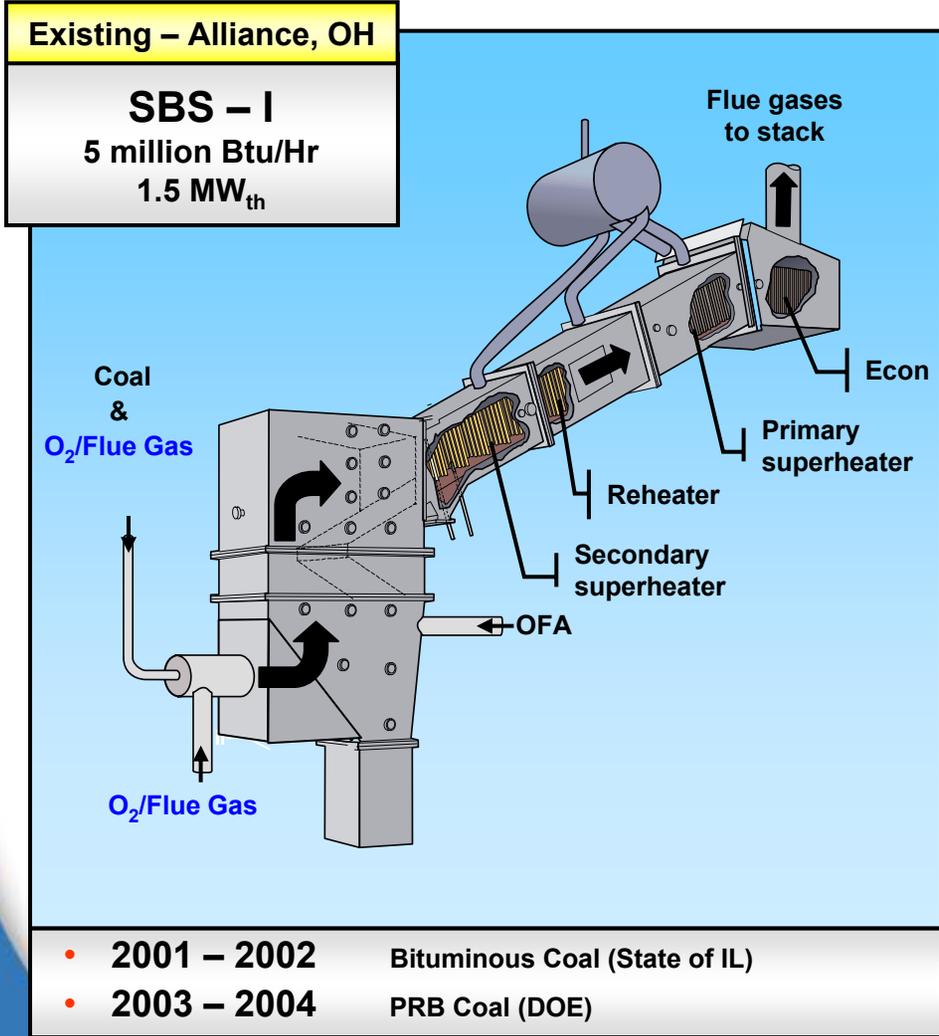
- **New challenges**
  - Mixing oxygen and recycle gas
  - Compression and purification unit (CPU) processes
  - ASU and CPU integration to boiler process
  - Minimize air leakage into process



- **Process opportunities with future generation plants**
  - Cyclone-fired combustion process potential
  - Recycle gas potential for added process control
  - Optimize the new system integrations

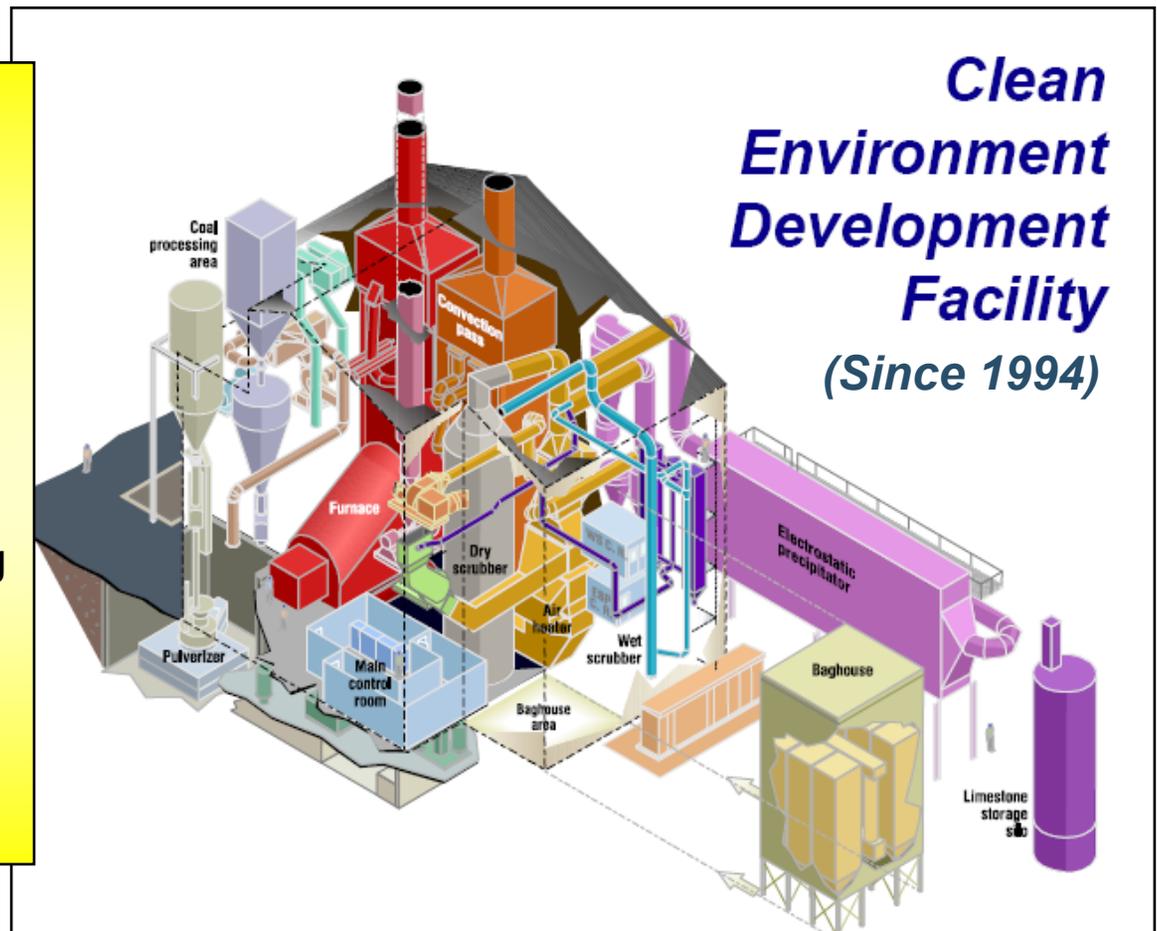


# “Just Do It” - Simulator Scale Oxy-Coal Combustion Tests with Air Liquide



## *“Just Do It” – Pilot Scale Oxy-Coal Tests – Summer of 2007*

- Oxy-coal combustion tests at B&W's 30 MW<sub>th</sub> CEDF
- Managed and funded by B&W, American Air Liquide, Inc. and Utility Advisory Group
- CEDF is being modified to use oxygen, direct coal-firing capability and other process parameters, including WFGD on oxy-coal
- Utility Advisory Group providing end user design feedback for commercial applications
- Test campaigns include Saskatchewan lignite, sub-bituminous (PRB) coal and eastern bituminous coal



# *“Just Do It” – Commercial Demonstration Scale Opportunity*



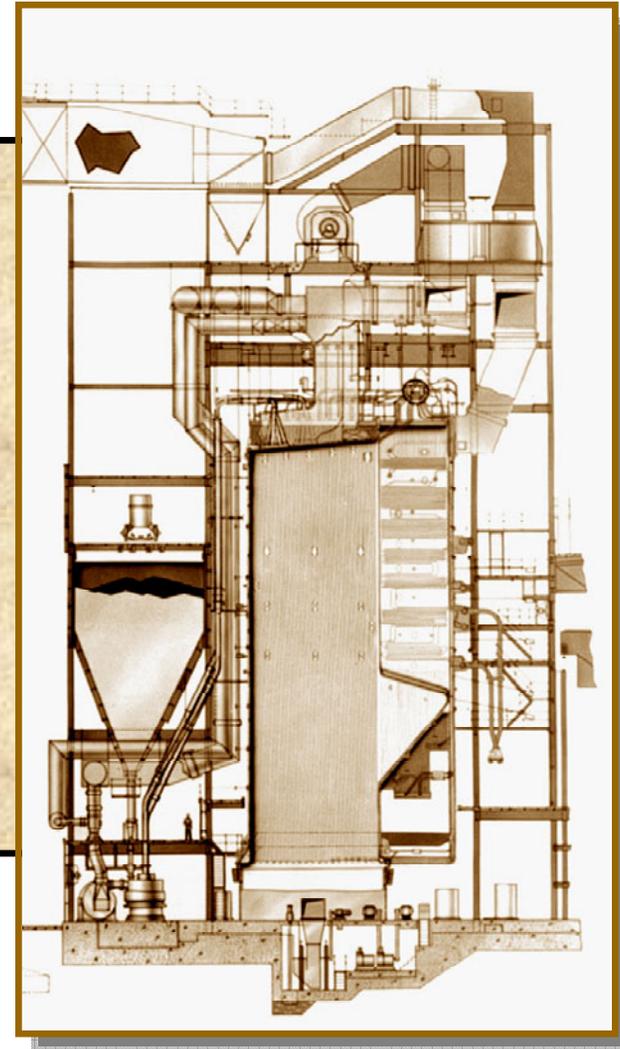
## **SaskPower Clean Coal Project Shand Station • Estevan, SK**

- **SaskPower has announced plans to build a 300MW, lignite fired clean coal plant anticipated to be in service by 2012**
- **Oxy-coal technology was selected over solvent based technology (B&W and Air Liquide process)**
- **Plant will capture, purify and compress carbon dioxide to be utilized for enhanced oil recovery with 90% capture and storage**
- **Upon approval, this will be the first commercial-scale utility “near zero emission plant” (NZEP) in North America**



# ***Commercial Scale Oxy-Coal Retrofit Feasibility Study with American Electric Power (AEP)***

- **Convert a small, older coal-fired unit to Oxy-coal combustion**
- **150 MW to 250 MW drum boiler retrofit preferred**
- **M.O.U. signed and negotiations in progress regarding scope, price and schedule of feasibility study**
- **Feasibility study targeted to complete 2Q 2008**
- **Plant retrofit timeframe ~ 2010 - 2012**



# First Things First!

1. Accelerate the effort to develop diversified CCS solutions
2. Solicited, government-sponsored competition for up to 5 demos (1Mmt CO<sub>2</sub>/year)
3. Develop promising demonstration-ready CO<sub>2</sub> capture technologies
4. Develop CO<sub>2</sub> storage knowledge and CONFIRM capability
5. Disseminate results to advance the art and provide “learning by doing” feedback

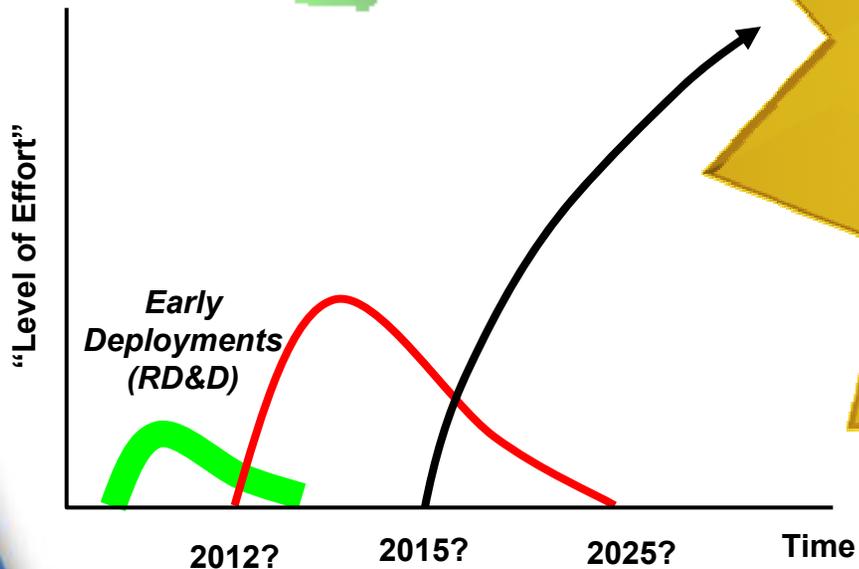


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