



# Advancing Clean Energy Technologies

## Oxy-Combustion Update

*“We are passionate about innovation and technology leadership”*

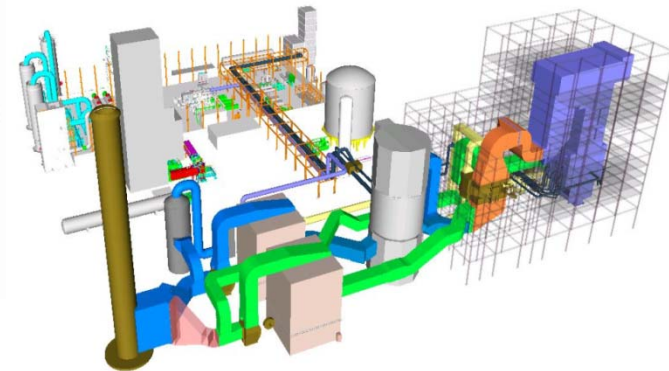
**Denny McDonald**  
*Technical Fellow, Oxy-combustion Lead  
Advanced Technology*

**Steve Moorman**  
*Manager -Business Development  
Advanced Technology*

**Solar  
Receivers**



**Post-Combustion  
Capture**



**Oxy-combustion**

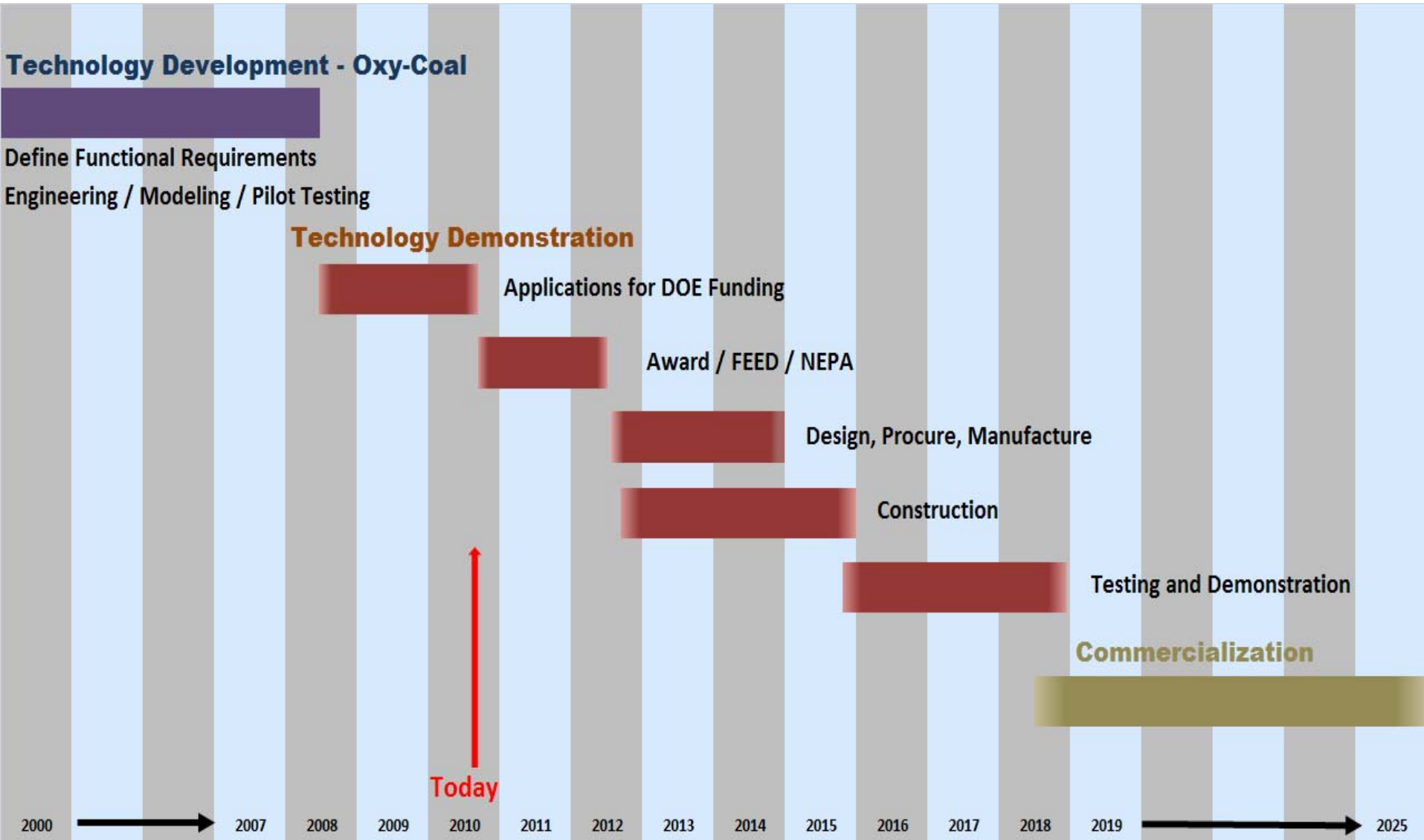
**Biomass  
Systems**



# ***Clean Energy Development activities***

- **B&W spin-off from McDermott – complete end of July 2010**
- **Large-scale integrated test of Oxy-PC – moving forward**
- **Oxy Reference Plant Study – in progress**
- **DOE Oxy Retrofit Study – complete 3<sup>rd</sup> qtr 2010**
- **B&W - Fluor joint development activities on Econamine PCC process for retrofit applications – ongoing**
- **Program development for testing of B&W advanced amine solvents at the NCCC – testing to begin 2<sup>nd</sup> Qtr 2011**
- **Concentrated Solar – DOE Molten Salt storage program – in progress**

# Path to Commercialization Oxy-Coal



***Relative to other power plant emissions CO2 capture is enormous.....***

**A 600 MW PC PRB coal plant generates**

- **< 1 ton/yr of Mercury**
- **8,000 tons/year of NOX**
- **30,000 tons/year of SO2**
- **150,000 tons/year of Ash**
- **4,500,000 tons/year of CO2**

***CO2 storage adds another order of difficulty***

***The cost of large-scale tests for CCS is huge and the technical and financial risks for participants are proportional***

**CCPI – Round3 CCS Demonstration Projects**

Host	Project	Plant Size MWs	DOE Cost Share \$Millions	Total Project Value \$Millions
Basin Electric	PCC	120	\$100	\$300
Hydrogen Energy	IGCC	400	\$308	\$2,300
American Elec Pwr	PCC	235	\$334	\$668
Summit Energy	IGCC	400	\$350	\$1,730
NRG	PCC	60	\$154	\$308
<b>Total</b>	<b>5</b>	<b>1215</b>	<b>\$1,246</b>	<b>\$5,306</b>

# Challenges to Success

## ***Funding***

- While Government money for Demos is available, dollar amounts are inadequate to fund a sufficient number of these very costly demonstration projects and the cost share required from the industry is major impediment to moving projects forward.

## ***Regulatory***

- The uncertainty of public policy regarding CO<sub>2</sub> that will provide owners the ability to cover their financial investment severely limits the development and deployment of CCS technologies.

## ***The Public***

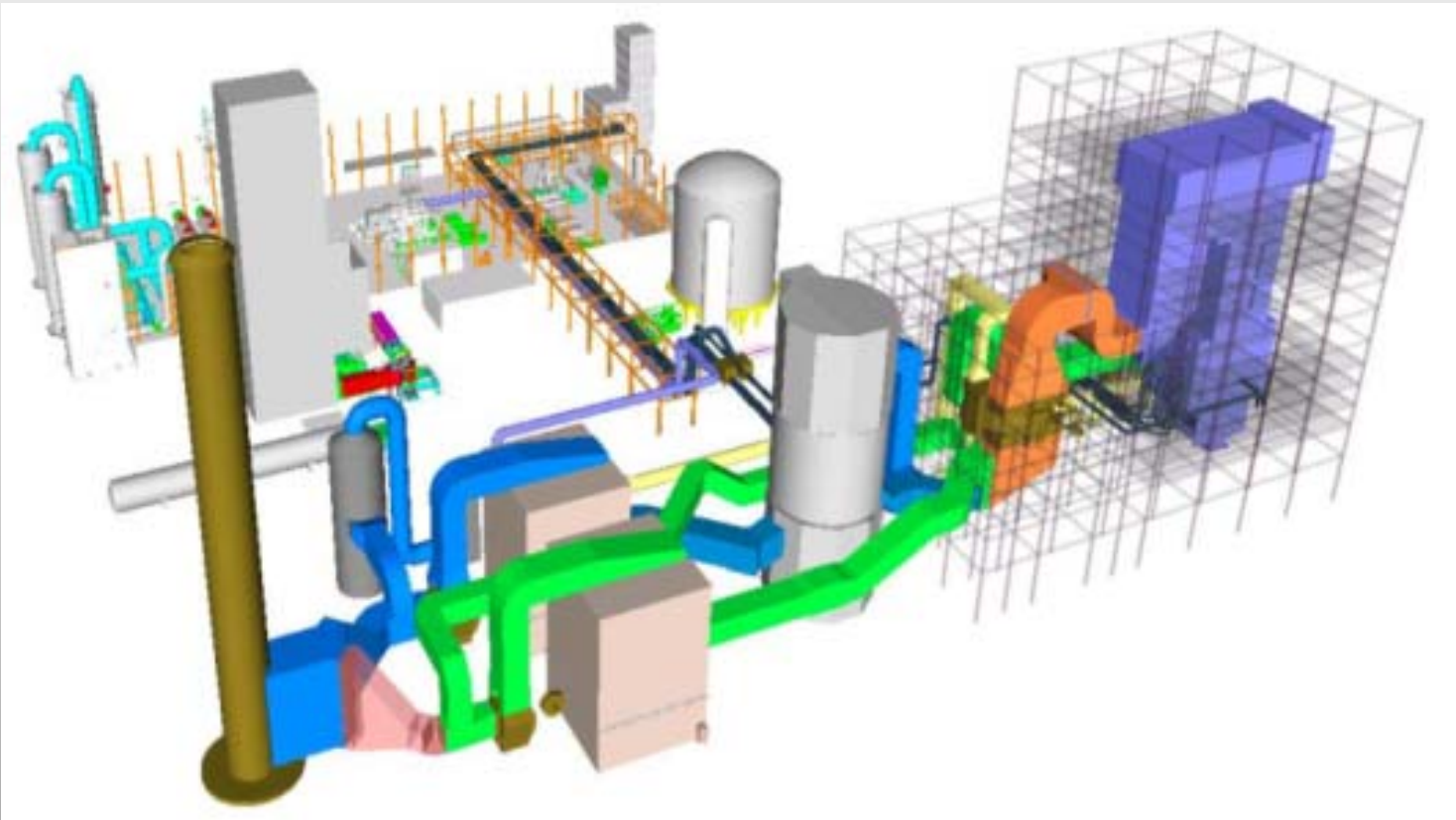
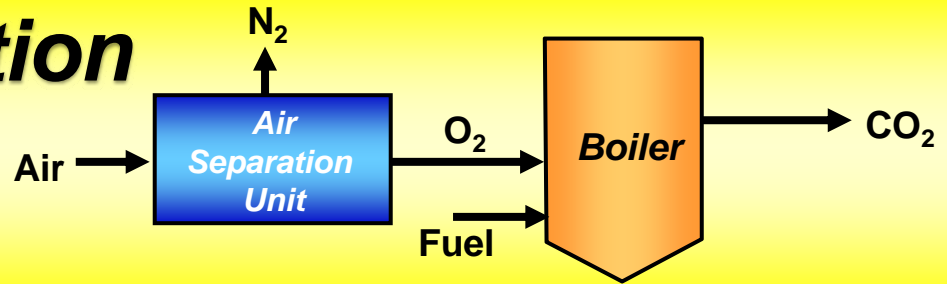
- Acceptance of transport and storage systems for large volumes of CO<sub>2</sub> has not been established.
- Risks and liabilities for land owners regarding storage are uncertain

## ***Scale of Effort***

- Do policy makers and the public really understand the scale (and cost) of the effort that will be required to have a meaningful impact on CO<sub>2</sub> levels in the atmosphere?



# Oxy-Coal Combustion





# ***B&W-AL Oxy-Coal Combustion R&D Summary***

- **1.5 MWth small pilot testing with DOE 2001-2004**
- **ASU efficiency optimization program ongoing since 2007**
- **30 MWth large pilot test completed 2008**
- **Computer modeling and simulation validated**
- **Greenfield and retrofit studies**
- **PC Oxy-combustion Power Plant study DOE/NETL 2007-1291**
- **Bottom-up Integration Study with ASU & CPU in 2008**
- **1.8 MWth Oxy-cyclone testing in 2009**
- **CPU pilots at Lacq, Callide and BWRC (2008-2011)**



***30 MWth  
Test Facility***



***CEDF Oxygen  
Supply System***

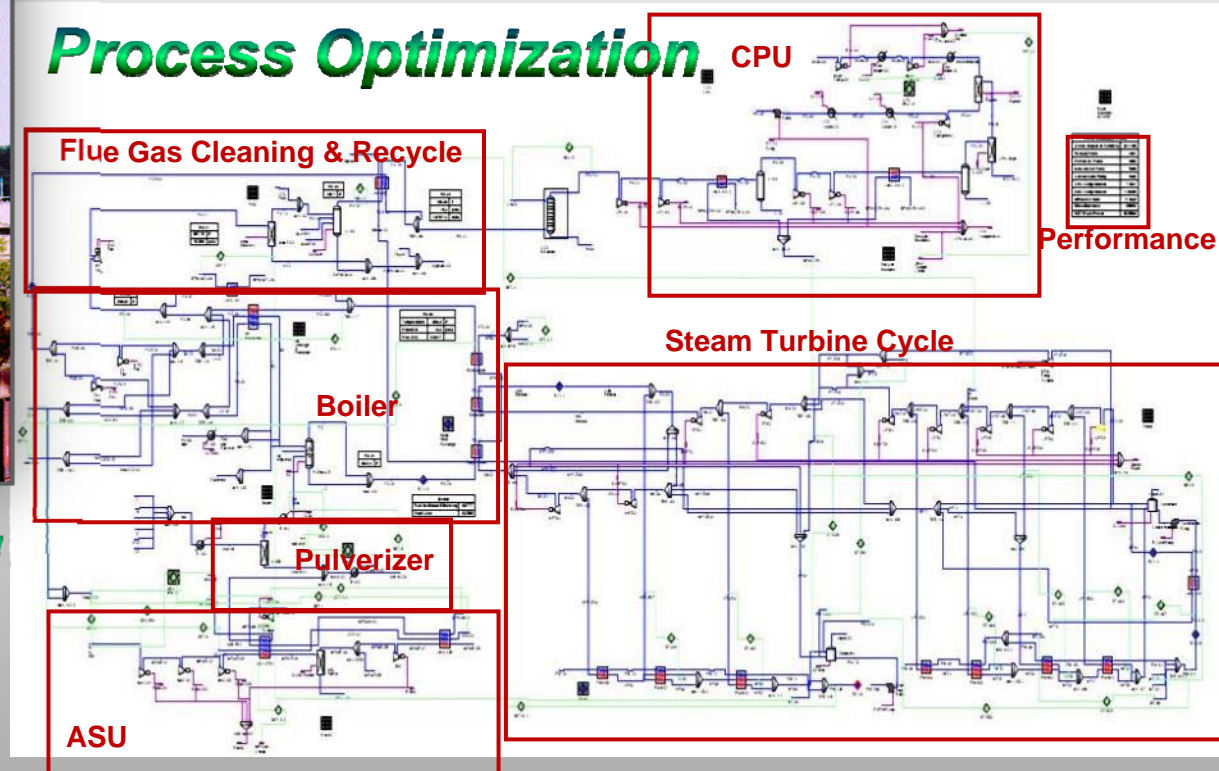


***Oxy-combustion  
Flame***

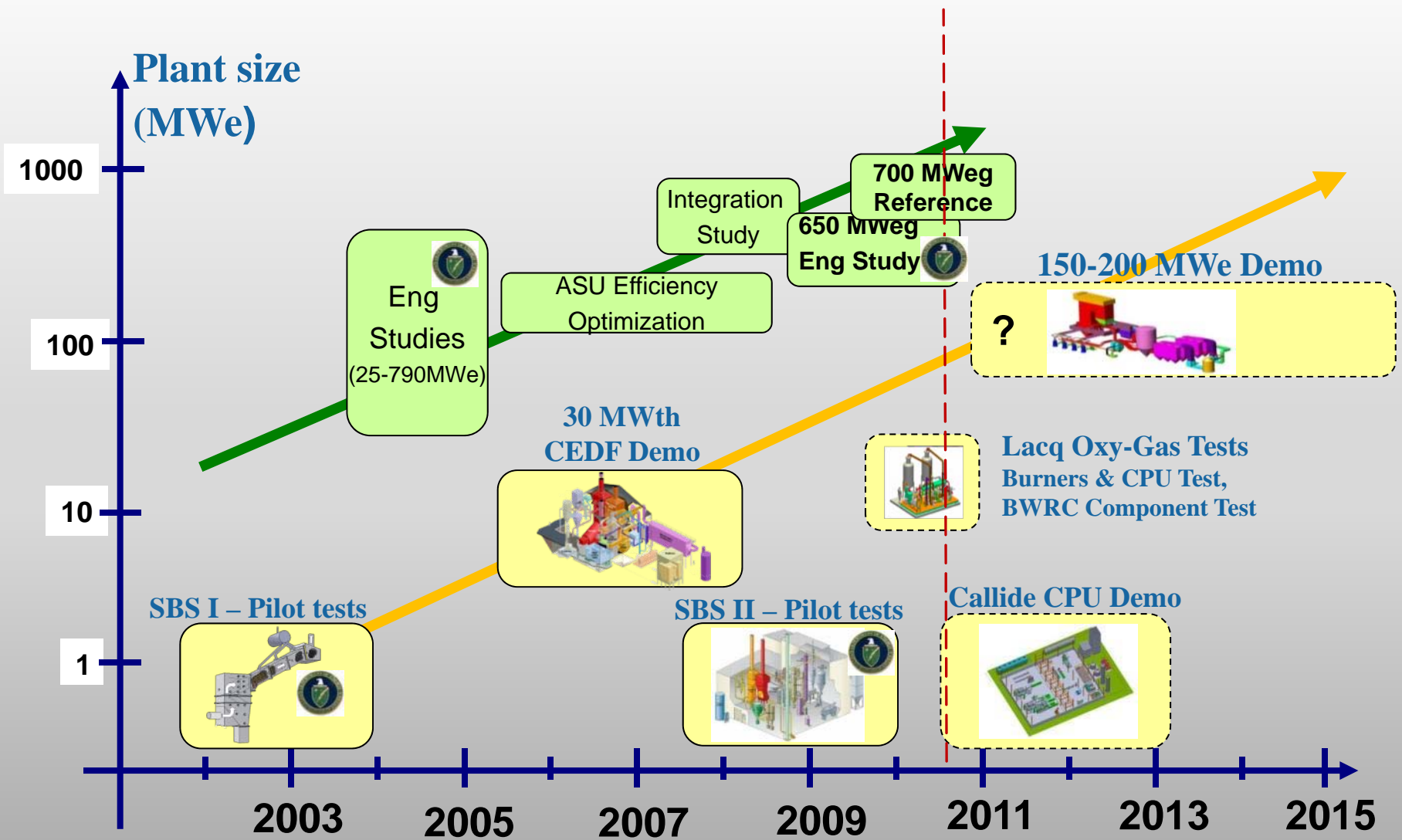
# B&W-AL Oxy-Coal Combustion R&D Summary



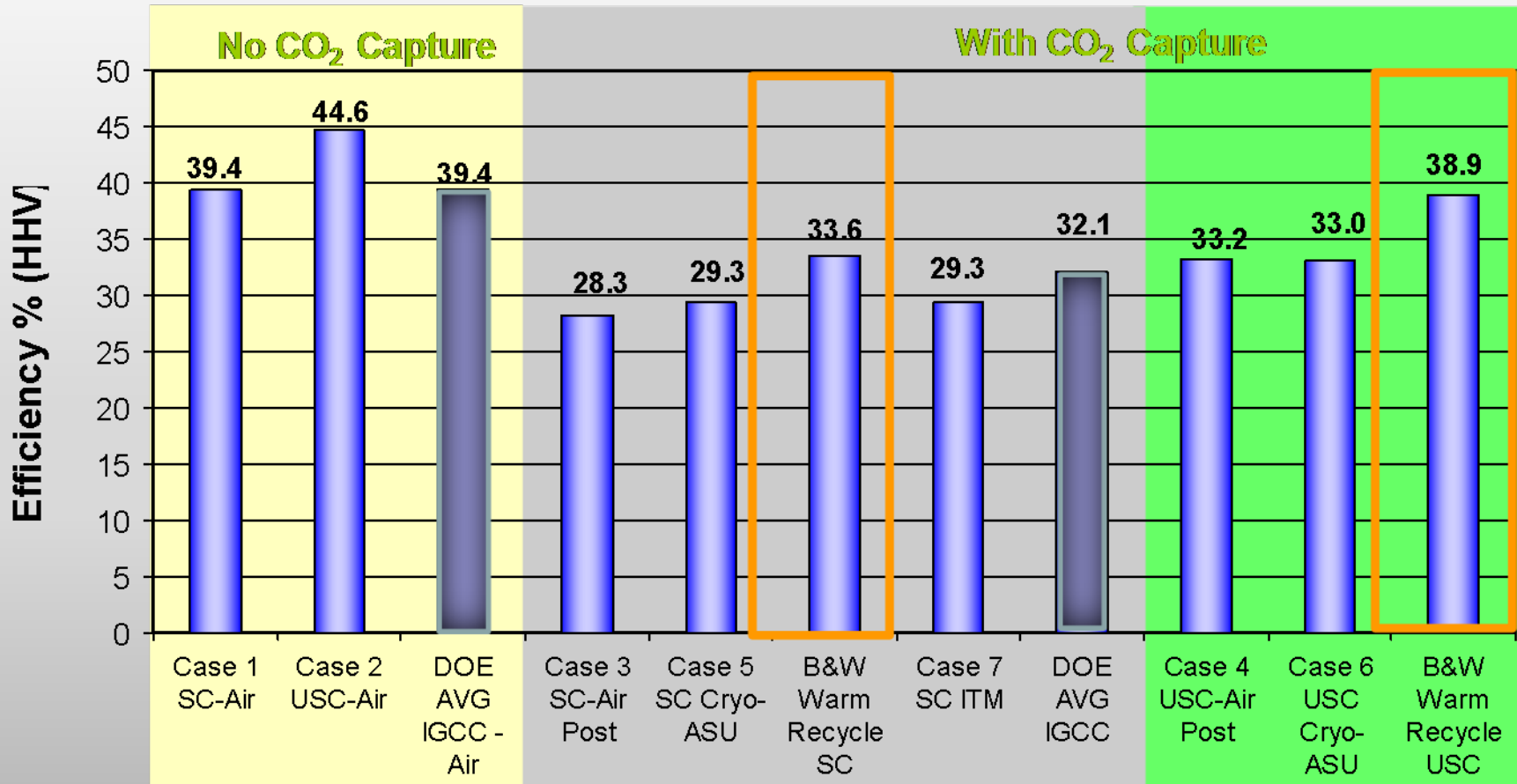
30 MWth Pilot Testing



# B&W-AL Oxy-Coal Combustion R&D Summary

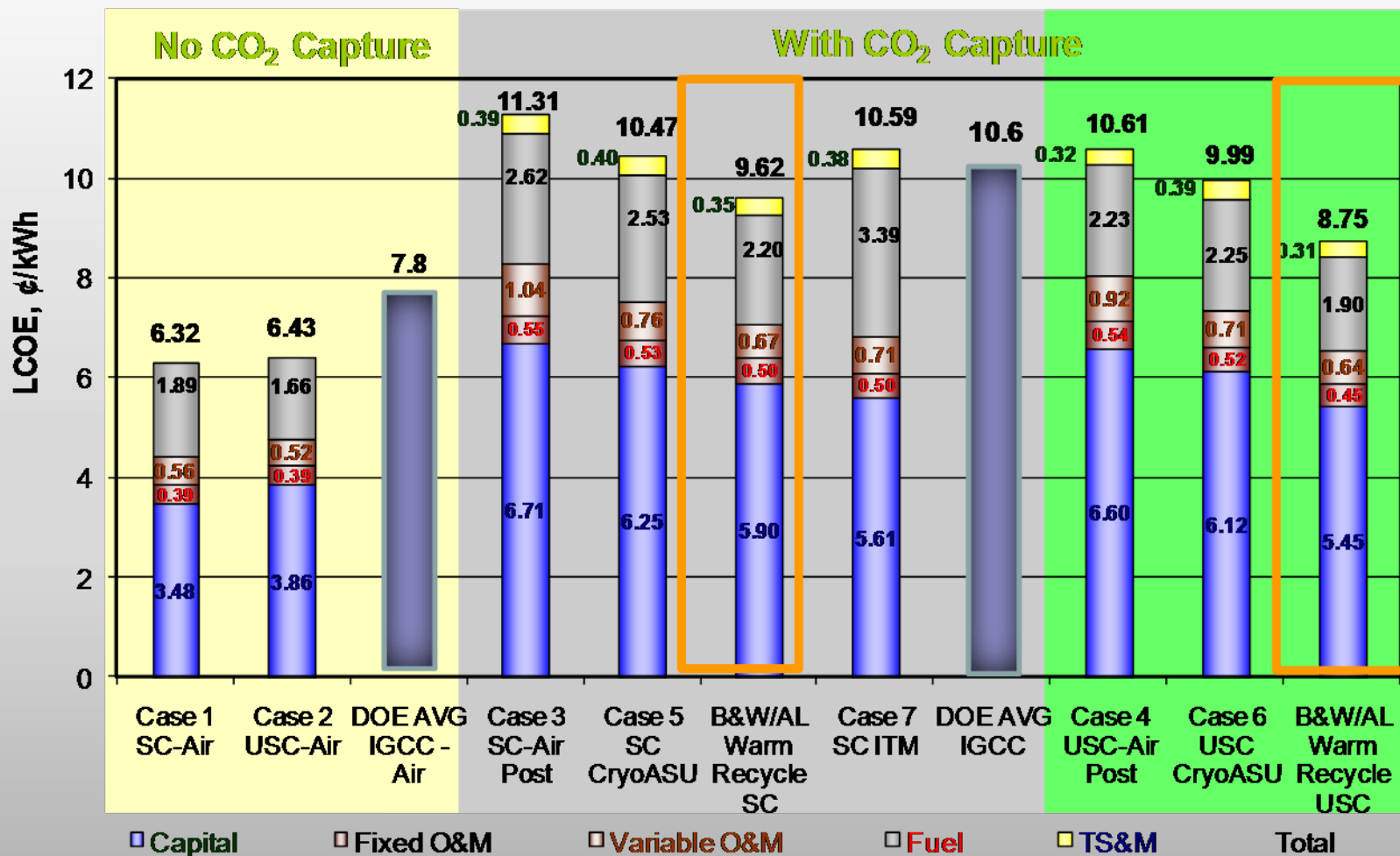


# Oxy-Coal Net Plant Efficiency



References: DOE/NETL 2007 - 1291 "Pulverized Coal Oxy-combustion Power Plants" Rev. 2, DOE/NTL 2007-1281 "Cost and Baseline for Fossil Energy Plants" Rev.1 , and B&W/AL Integration Study

# Oxy-Coal Net Plant Efficiency



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# Oxy-Coal Air Emissions

	Air-Fired Plant	IGCC Plant (2) w/CCS	Oxy-Fuel Plant w/CCS	Air-Fired Plant	Oxy-Fuel Plant w/CCS
<b>Fuel Type</b>	Bituminous	Bituminous	Bituminous	Sub-bit	Sub-bit
<b>Steam Conditions (PSI/F/F)</b>	3600/1100/1100		3600/1100/1100	3600/1100/1100	3600/1100/1100
<b>Plant Performance</b>					
Gross MW	598	745	733	604	733
Net MW	550	556	550	550	550
Net Plant Heat Rate (Btu/kWh)	8662	10505	10143	9250	10831
Capacity Factor (%)	85%	80%	85%	85%	85%
<b>Conventional Emissions (Expected)</b>					
NOx (lb/MBtu)	0.06	0.0470	Note 1	0.06	Note 1
SOx (lb/MBtu)	0.04	0.010	Note 1	0.08	Note 1
Particulate (lb/MBtu)	0.015	0.007	Note 1	0.012	Note 1
Hg (lb/TBtu) (3)	0.784	0.571	Note 1	0.820	Note 1
<b>CO2 Emissions (Expected)</b>					
CO2 Removal Efficiency (%)	0	90.0%	92.5%	0	92.5%
CO2 Produced (Million Metric Tons/Year)	3.26	3.64	3.82	3.68	4.31
CO2 Captured (Million Metric Tons/Year)	0	3.28	3.53	0	3.99
CO2 Emitted (Million Metric Tons/Year)	3.26	0.36	0.29	3.68	0.32

1) Oxy emissions are below practical measurement limits

2) IGCC from GE IGCC system w/CO2 Capture per DOE/NETL-2007/1281 Report, Case 2

3) Air-fired emissions based on 90% removal expected

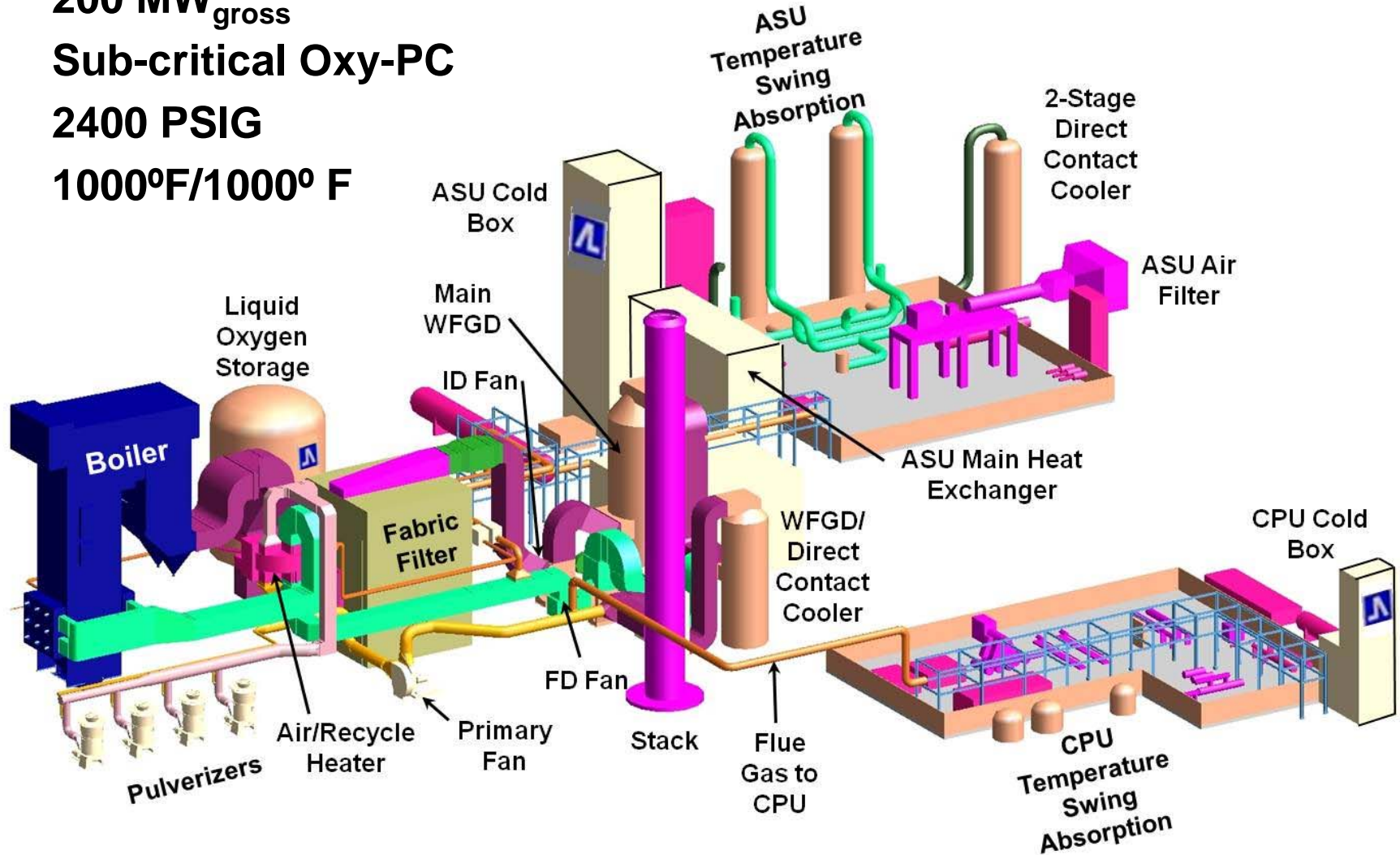
# Oxy-Coal Demonstration

200 MW<sub>gross</sub>

Sub-critical Oxy-PC

2400 PSIG

1000°F/1000° F



*Thank You!*

