

# Advanced Generation & Carbon Capture and Storage

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Advanced Generation & Carbon Capture and Storage

Palo Alto, California

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Board of Directors Meeting  
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via Webcast

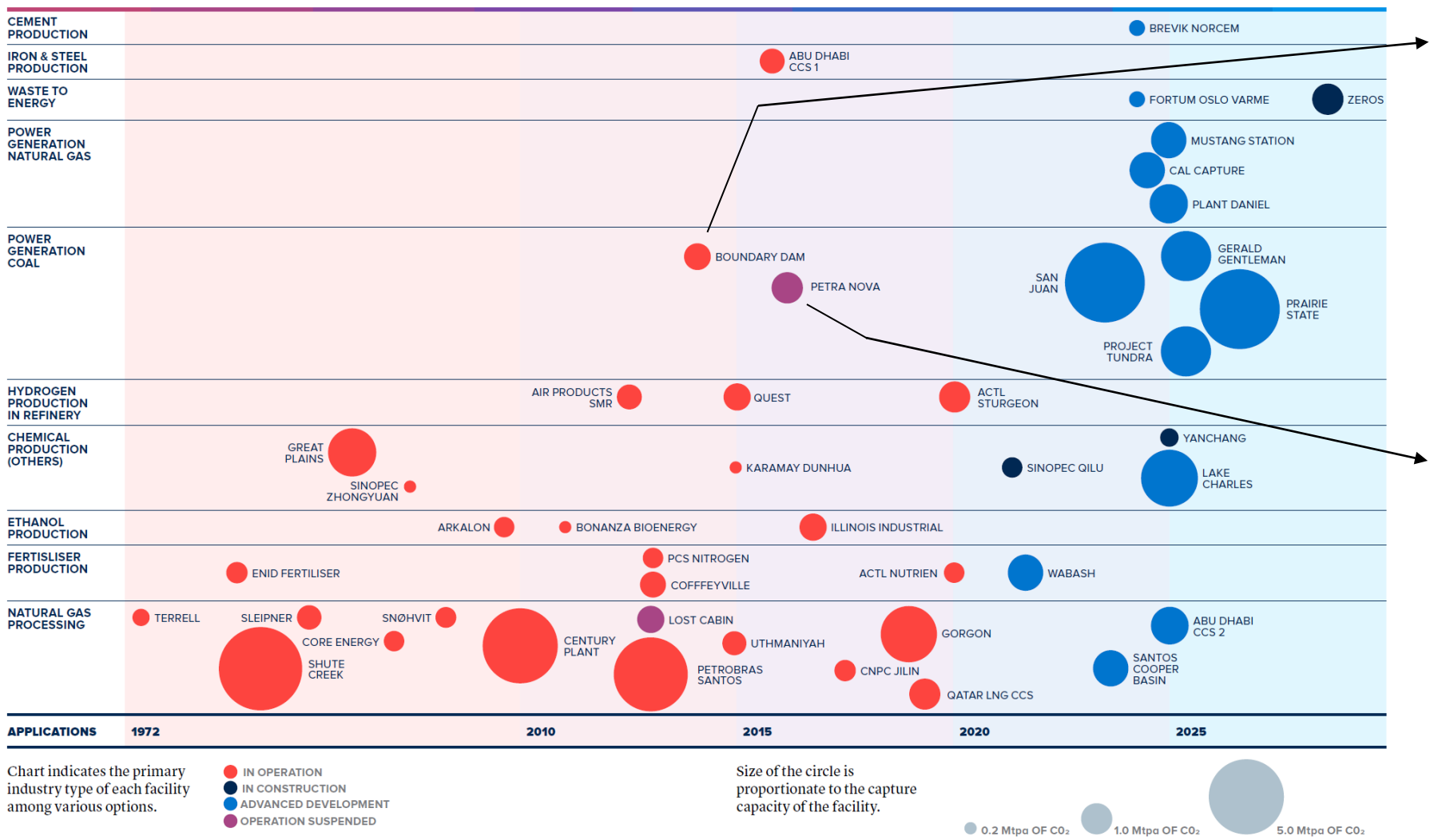


# About The Electric Power Research Institute

- Mission: Advancing **safe, reliable, affordable** and **environmentally responsible** electricity for society through global collaboration, thought leadership and science and technology innovation
- Established 1973 as independent, not-for-profit research center
- Major locations in Palo Alto, CA; Charlotte, NC; Knoxville, TN. ~1000 staff
- ~\$420 million/year revenue (25% international)
- 450+ participants in more than 30 countries
- EPRI members generate approximately 90% of the electricity in the United States



# Large-Scale CCS



Courtesy Sask Power

Boundary Dam  
Saskatchewan, Canada



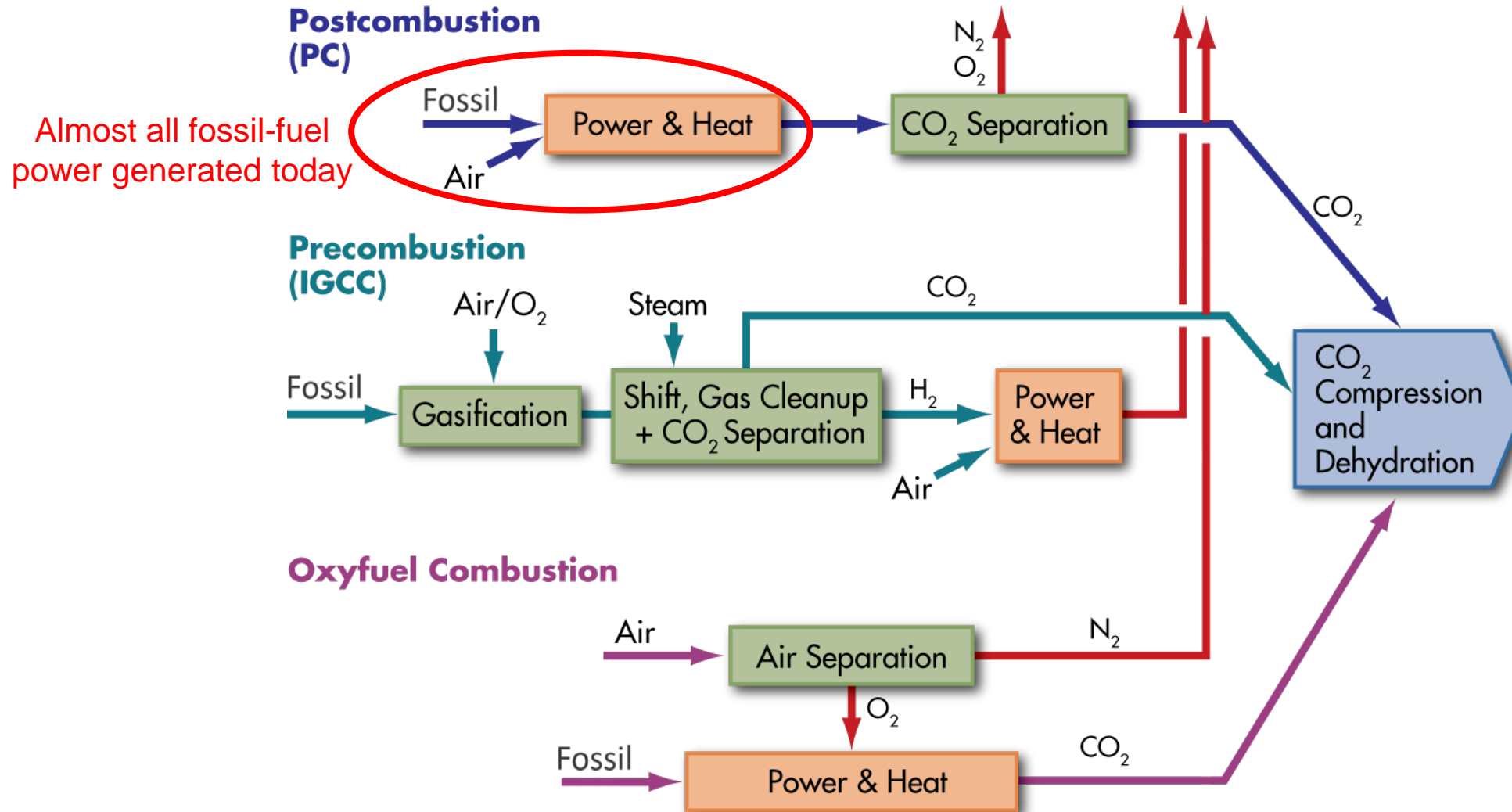
Courtesy NRG

Petra Nova  
Thompsons, Texas, USA

(Recently Announced Suspension  
due to low oil prices)

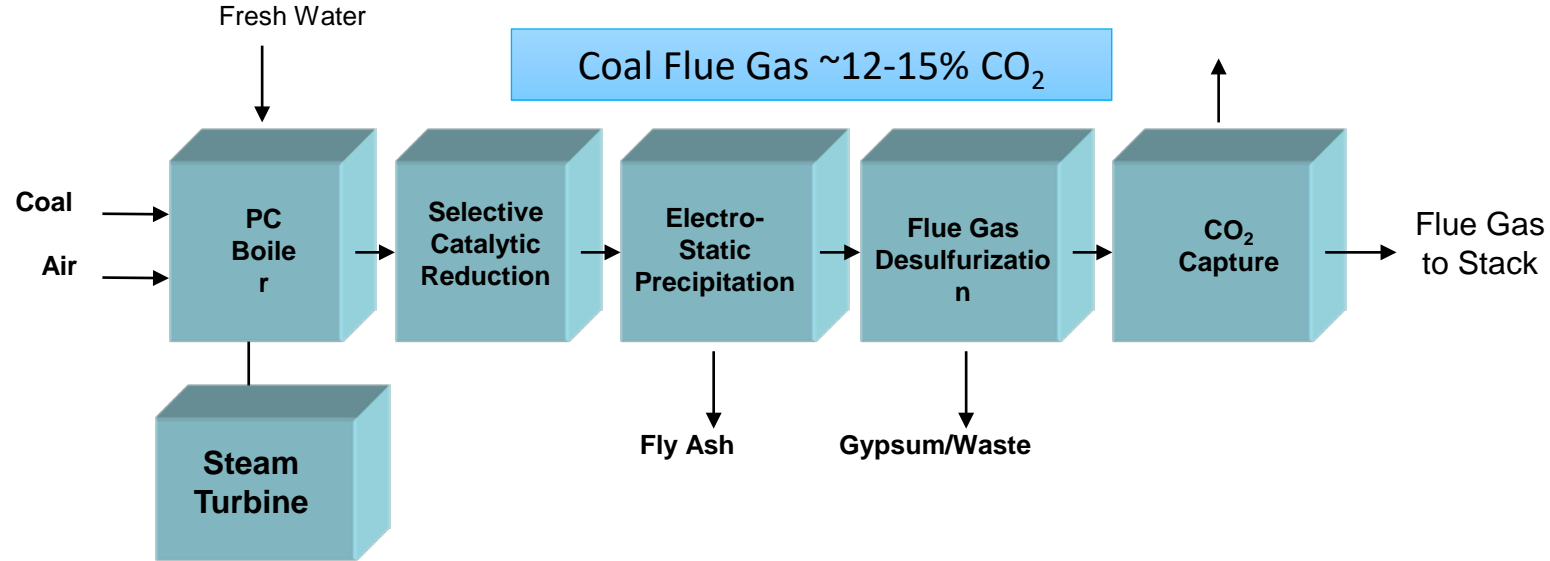
Figure from GCCSI, Global Status of CCS, 2020

# Options for CO<sub>2</sub> Capture in Fossil Power Systems

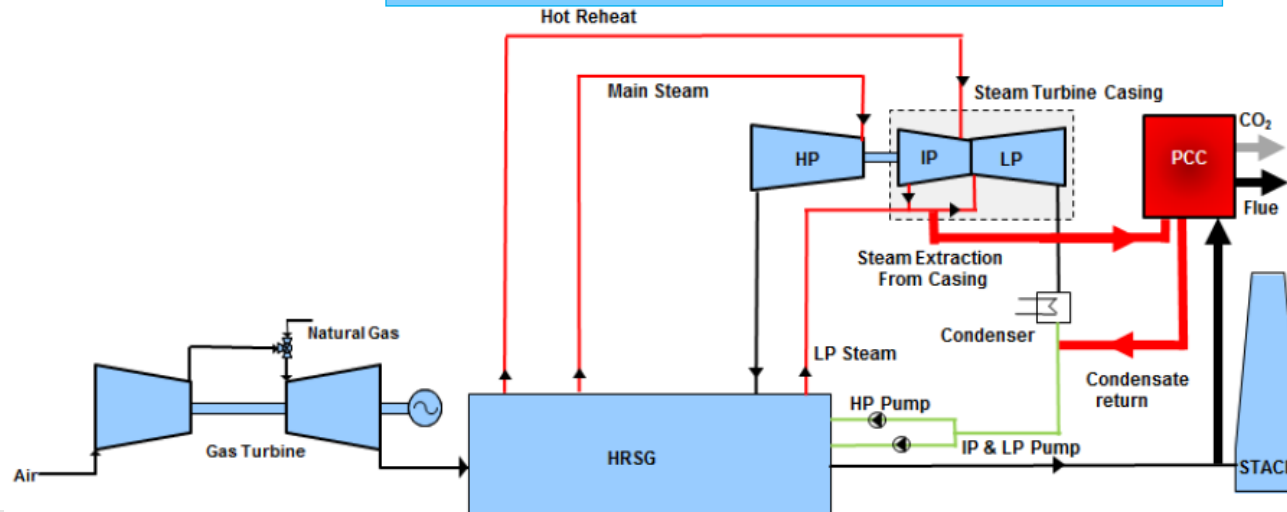




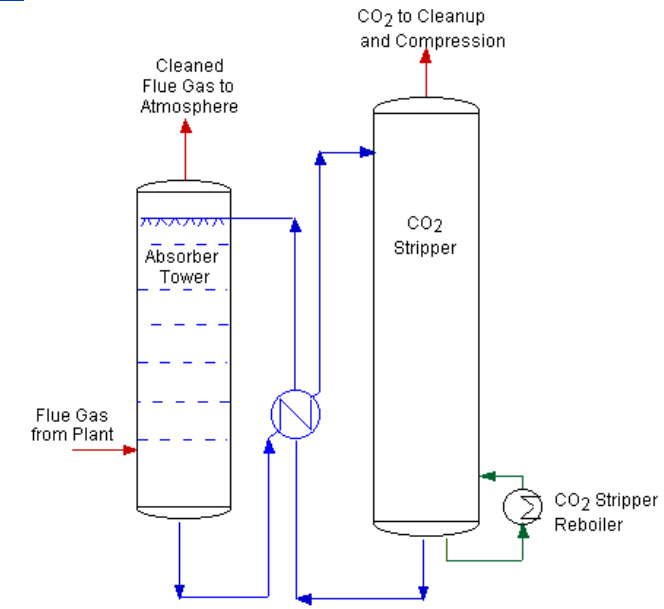
# Post-Combustion CO<sub>2</sub> Capture



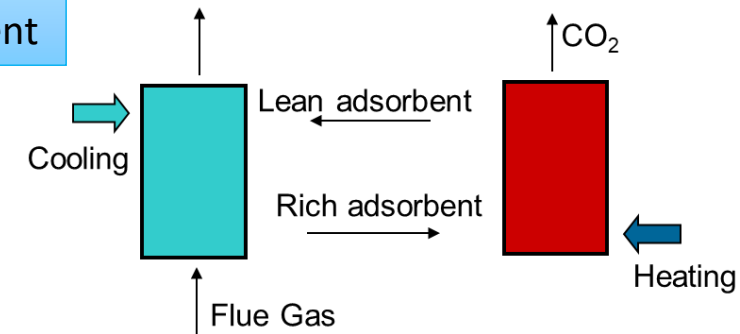
NGCC Flue Gas ~3-4% CO<sub>2</sub>  
(Higher concentrations with CO<sub>2</sub> recycle)



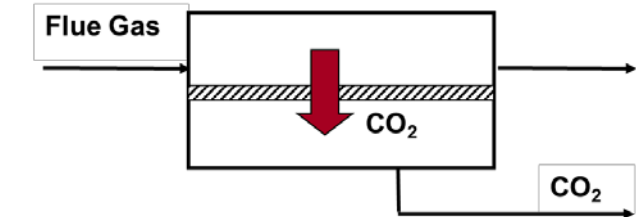
Solvent



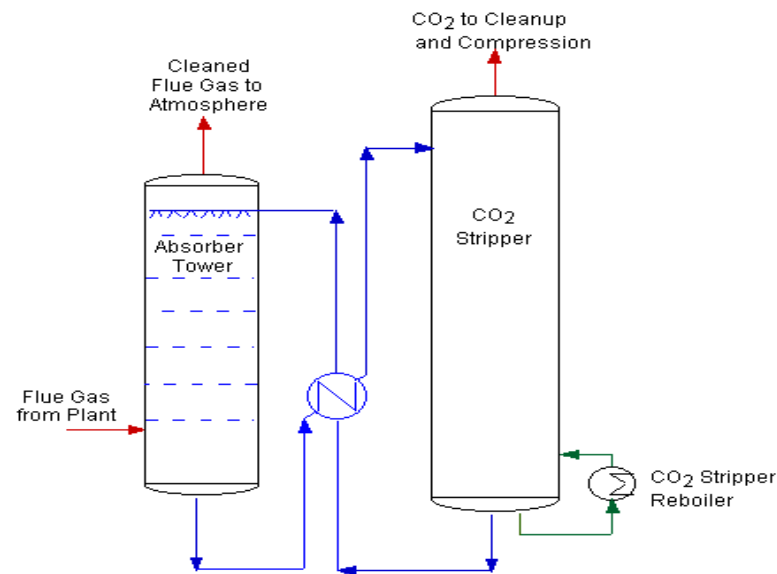
Adsorbent



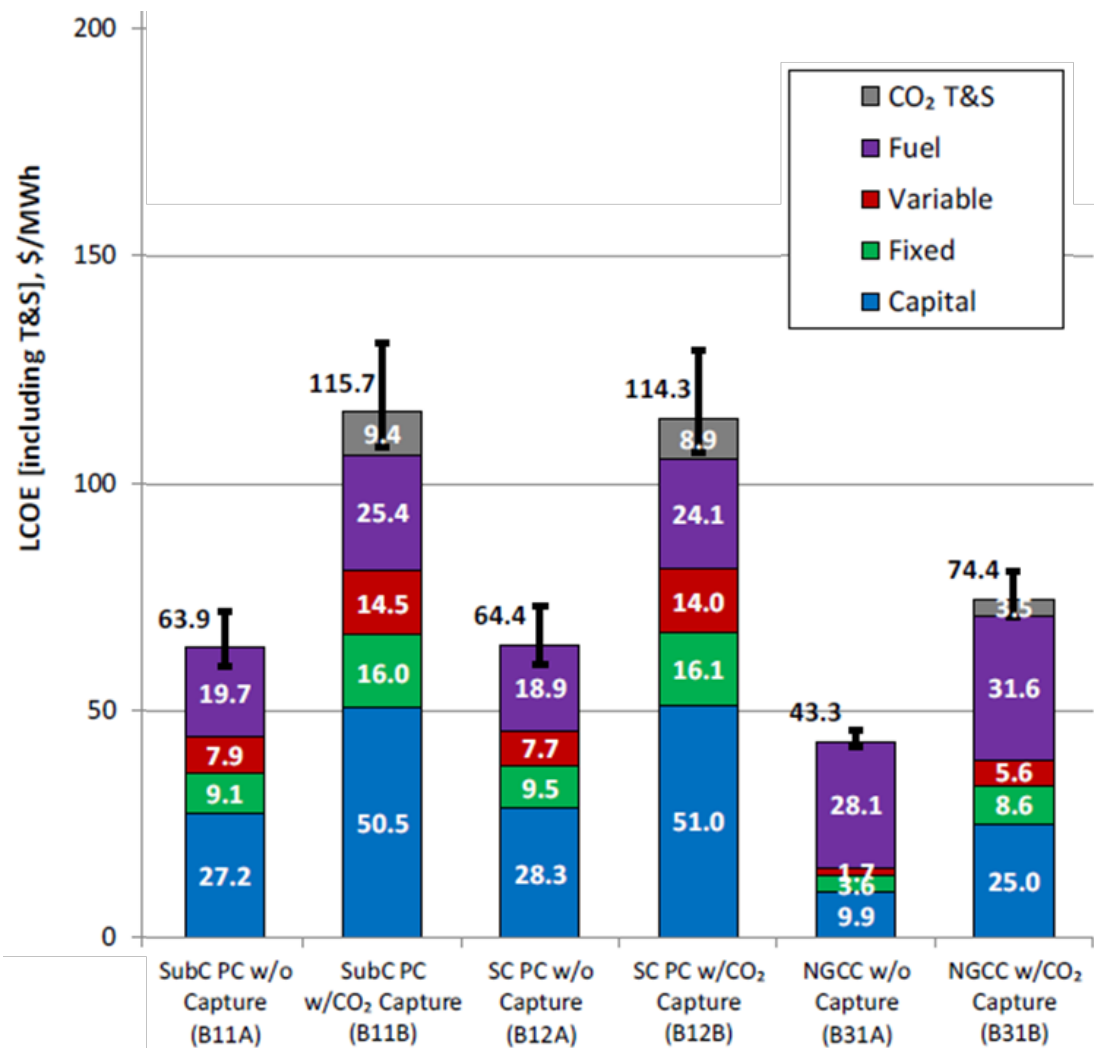
Membrane



# Post-Combustion CCS



	Supercritical Coal Plant	Natural Gas Combined Cycle
CO <sub>2</sub> Concentration	12-15%	3-4%
t CO <sub>2</sub> /MWh (w/o CCS)	~ 0.86	~ 0.38
Efficiency Reduction with CCS, %	~22%	~11%
Breakeven CO <sub>2</sub> Sales Price, \$/t CO <sub>2</sub>	~\$46	~\$80
LCOE increase	~77%	~72%



Source: NETL-PUB-226383 September 24, 2019

EPRI's R&D objective is to reduce cost of CCS and mitigate risk

# Allam-Fetvedt Cycle Overview

- CO<sub>2</sub> as working fluid improves efficiency
- Heat provided by in-situ oxy-combustion
- CO<sub>2</sub> removed at pipeline pressure
- Oxy-gas combustor is novel, operating at pressures 10 times greater than a natural gas combustion turbine
- Reduced turbine size / cost and potentially improved flexibility
- CO<sub>2</sub> and other byproducts (Ar, H<sub>2</sub>O, and N<sub>2</sub>) generate revenue
- Projected efficiency with CCS for NG: up to 59% LHV\*
- Projected low capital costs: \$900–1200/kW\*



*50 MWth Pilot, Courtesy NET Power*

*\* Values provided by NET Power*

**NET Power is the developer of the natural gas version**

A blue-tinted photograph of four people standing in a row. From left to right: a woman with curly hair and glasses wearing a lab coat; a man with glasses wearing a lab coat and safety glasses; a woman wearing a lab coat, a hard hat, and safety glasses; and a man with a beard and glasses wearing a button-down shirt. The lab coats and hard hat have the 'EPRI' logo on them. The text 'Together...Shaping the Future of Electricity' is overlaid in white in the center.

# Together...Shaping the Future of Electricity