Carson Hydrogen Power Project

California Energy Commission
May 29, 2007 Sacramento, CA
Workshop on Clean Coal Technology and
Carbon Capture and Storage

Project Drivers

- **Unique circumstances support application of Hydrogen power with CO_2 capture in Carson, California:**
  - 13,000 tons/day of petcoke produced in LA Basin
  - Sited in LA load pocket, natural gas is marginal fuel
  - Ample recycled water available
  - Low-GHG power sources needed to meet AB32, procurement cap
  - Potential for CO_2 enhanced oil recovery
  - Steam & hydrogen from gasification add value; alternate fuel is natural gas
  - Awarded $90 million tax credit under EPAct of 2005
- **Unique challenges too:**
  - BACT in LA Basin is natural gas CCGT emissions – first IGCC to achieve
  - Urban/industrial setting
  - Unclear legal/regulatory framework for CO_2 storage & long-term liability

What is petcoke?

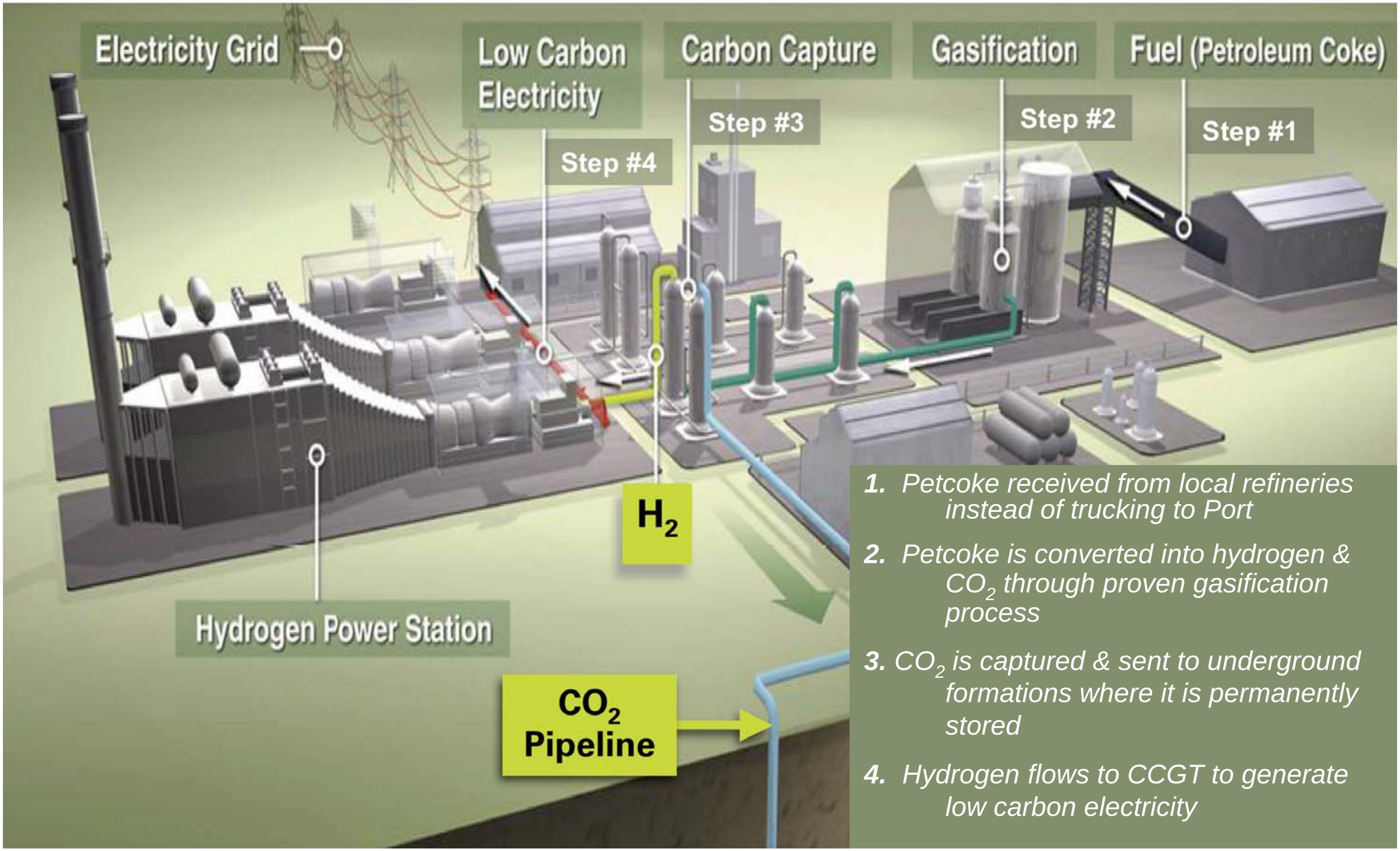
- **Petroleum coke is an unavoidable solid byproduct that remains after all useful liquids have been extracted from crude oil**
  - Still contains a significant amount of energy
- **Quite different from coal:**

	PRB Coal	Petcoke
Moisture	**30%**	**4%**
Volatile matter	**31%**	**9%**
Fixed Carbon	**33%**	**86%**
Total Ash	**5%**	**<1%**
Sulfur	**<1%**	**4-6%**

- **Only IGCC allows the high level of sulfur removal needed to meet stringent local emission limits with petcoke**
  - Consequently, nearly all LA Basin petcoke is currently exported to Asia where it is combusted under less stringent emission controls


CoP
Valero
Praxair
Tesoro
Sub
Kinder
ConocoPhillips Refinery
CHPP
BP Carson Refinery
APCI
Sub

Conceptual Overview

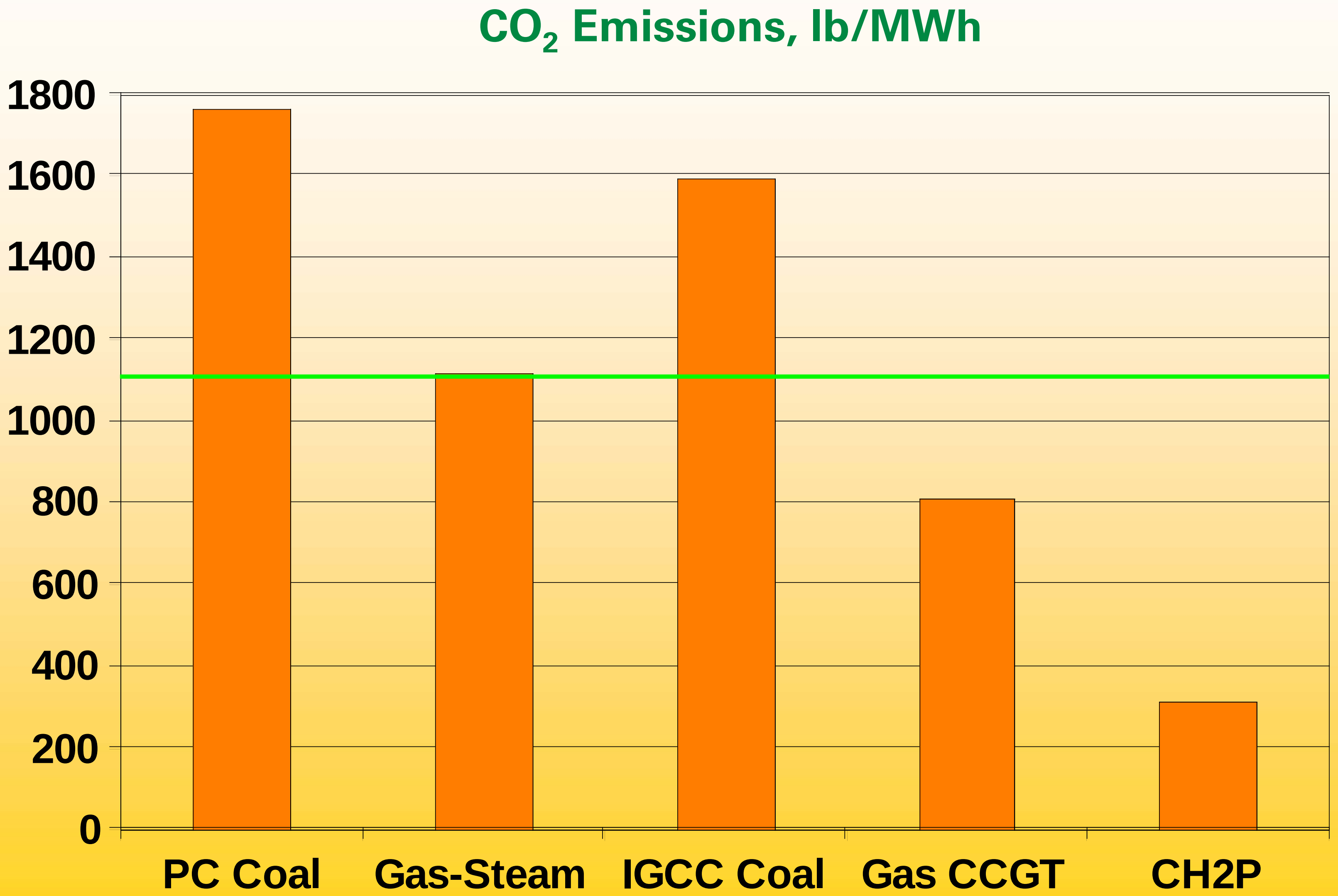


1. *Petcoke received from local refineries instead of trucking to Port*
2. *Petcoke is converted into hydrogen & CO_2 through proven gasification process*
3. *CO_2 is captured & sent to underground formations where it is permanently stored*
4. *Hydrogen flows to CCGT to generate low carbon electricity*

Environmental Design Considerations

- **Air Quality**
  - Eliminates truck & ship transport of petcoke to/thru Port of Long Beach
  - More expensive Rectisol AGR to achieve ultra-low H_2S in fuel gas
    - Required to meet natural gas BACT
    - Minimizes PM10 production in SCR
  - Syngas filtration to capture particulates in fuel
  - Sulfur recovery unit tailgas recycle to eliminate emission
  - All non-emergency process vents have emission control equipment
- **Waste Streams**
  - Recycled water used for all plant requirements
  - ZLD for process wastewater stream
  - Fluxant selected to allow slag use for metals recovery
- **CO_2 Sales or Storage**
  - CO_2 capture equal to ~90% of carbon in fuel
  - Stored in depleted oil/gas field or saline aquifer; potential enhanced oil recovery

Low GHG Emissions a Necessity in CA



Regional CO_2 Storage Capacity

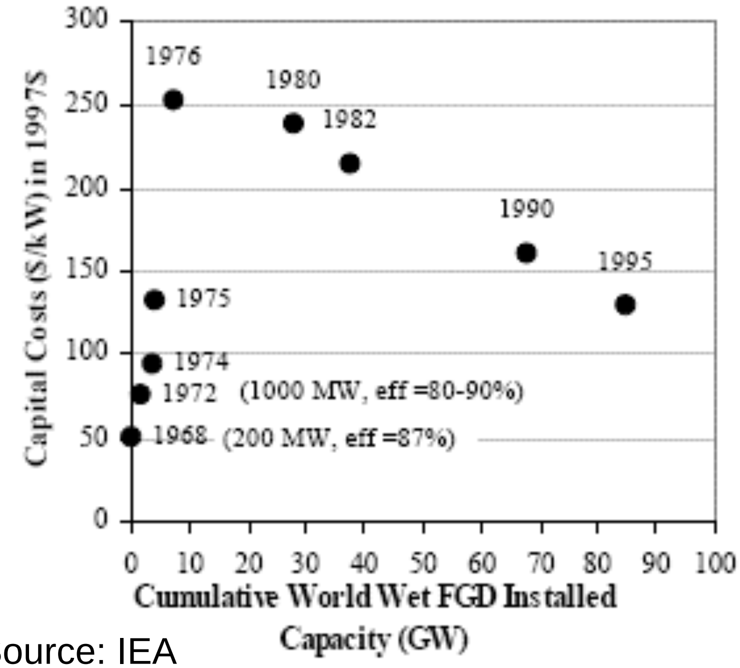
According to 2005 DOE Report:

- **>1 billion tonnes of CO_2 storage capacity in local California oilfields**
- **57 billion barrels of stranded oil resource; 5-10% technically recoverable via CO_2 EOR**
- **CH2P's technical studies underway to determine local formations most suitable for storage & EOR**
- **Our studies include:**
  - Recovery potential
  - Reservoir characterization for safe long-term sequestration
  - Feasibility of pipeline routes
  - Effective monitoring techniques

Reported Construction Costs

- **Duke Cliffside – 2 x 800 MW PC**
  - $3 billion (90-100% increase since 2002)
- **Xcel Big Stone II - 630 MW supercritical PC**
  - $1.6 billion
- **Duke Edwardsport – 630 MW coal IGCC**
  - $2 billion
- **Excelsior Mesaba – 600 MW coal IGCC**
  - $2.3 billion
- **FutureGen – 275 MW coal IGCC w/CCS**
  - $1.5 billion (technology development platform)
- **Carson Hydrogen Power – 450 MW petcoke IGCC w/CCS** & polygen
  - ~$2 billion (early commercial demonstration)
  - Includes sales tax, offsite linears, owner’s costs; each of the above on different basis – can’t compare

Technology Learning Curve for FGD



Source: IEA

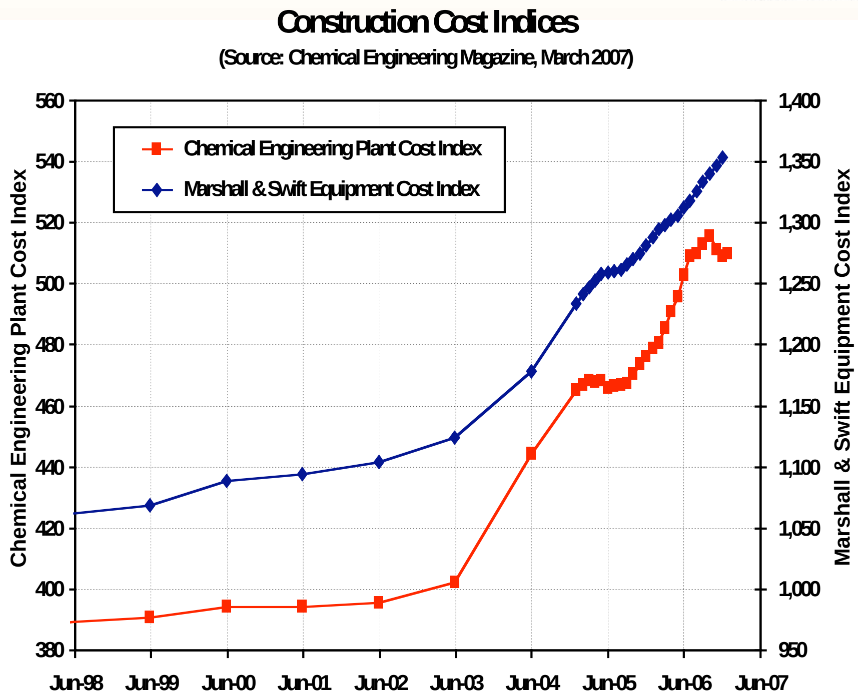
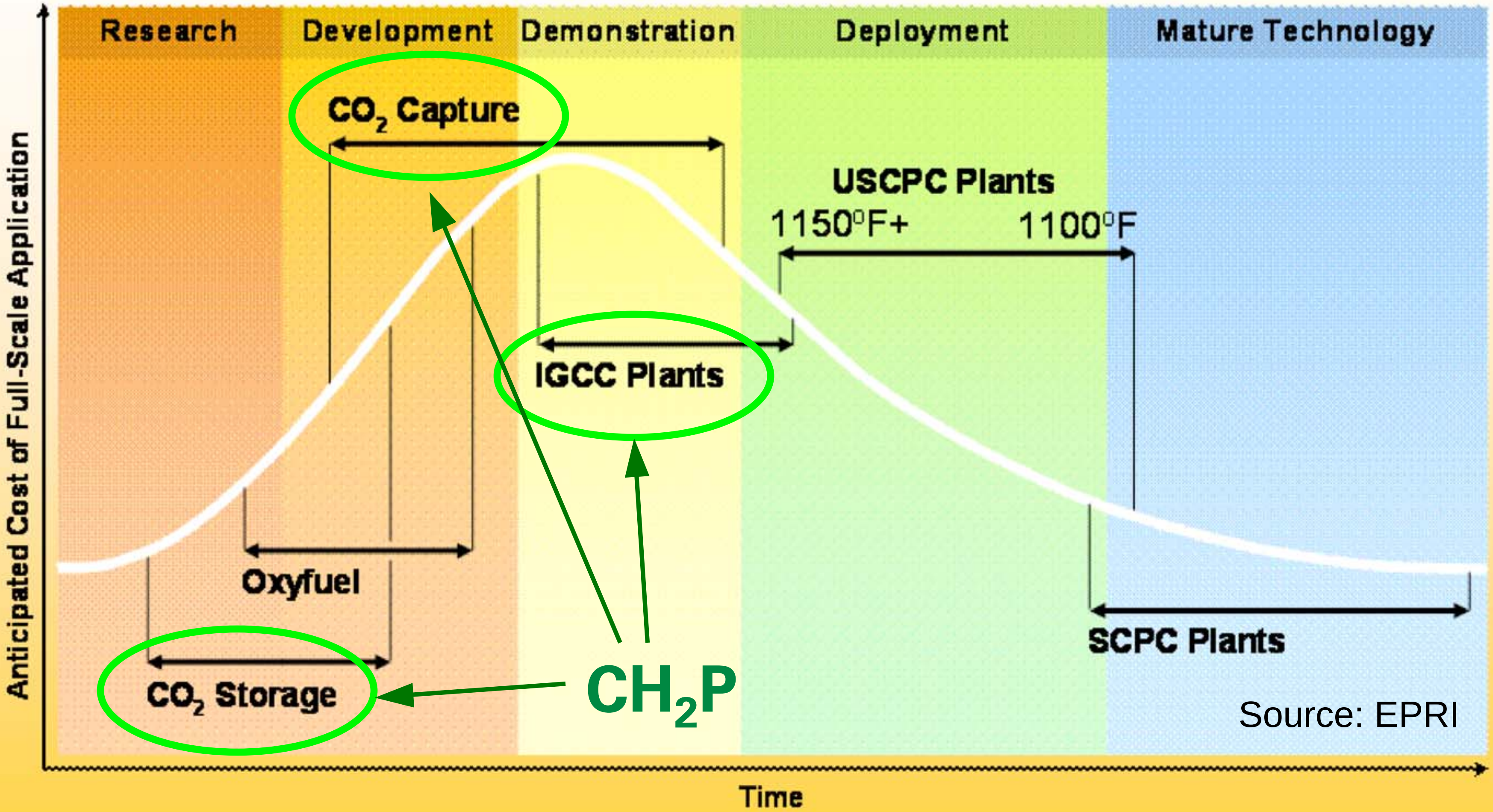


Figure 3. Capital and O&M cost trends of wet limestone FGD systems at a standard new coal-fired power plant,[5] including studies conducted during the period of early commercial application.

- **Theoretical optimism ➔ costly first-movers ➔ technology advancement & cost reduction**
- **Complicated by global construction & commodity escalation**

EPRI Technology Cost Learning Curve



- **Initial commercial demonstrations will require public policy support to advance learning curve**

Sponsors and Participants

- **BP** – Global leader in decarbonized fuels projects, including gasification projects and CO_2 sequestration
  - *CO_2 EOR experience*
  - *$C0_2$ Capture Project, In Salah and others*
- **Edison International/Edison Mission Energy** - Pioneer in IGCC:
  - *120 MW Cool Water IGCC in CA, 1st commercial scale IGCC*
  - *528 MW ISAB IGCC in Italy, 1st large scale deployment of IGCC*
- **GE Energy** – Leading provider of IGCC technology/equipment/services
  - *>2500 MW operating IGCCs worldwide*
- **Fluor** – One of the world's largest EPC contractors
  - *Leader in the design of clean coal, carbon capture, power generation*
- **West Basin Water District** – Nationally recognized water recycler
  - *CHPP will reuse treated wastewater provided by West Basin*

Simplified Process Flow Diagram