FE0000663: The Hydrogen Energy California (HECA) Project- Commercial Demonstration of IGCC with 90% CO_2 Capture

N "Maha" Mahasenan
Principal Advisor- Policy & Strategy

NETL CO_2 Capture Technology Meeting
September 16, 2010
Pittsburgh, PA

HECA Project Overview

hydrogen energy

- IGCC with fully integrated CO_2 capture based on GE Quench Gasification and GE 7F Syngas turbine technologies
- Located in Kern County, California (west of Bakersfield), in close proximity to water, gas and transmission infrastructure
- Adjacent to Occidental Elk Hills Field and CO_2 injection point for EOR & sequestration
- Proximity to feedstock transloading (western bituminous coal and petcoke from CA refineries)
- Low population density

DOE CCPI-3 Award

- Selected in July 2009 based on January 2009 application under Clean Coal Power Initiative- Round 3
- Cooperative Agreement signed September 30, 2009
  - Overall Project Value $2.8 billion

    (includes costs during demonstration phase but excludes all revenues)
  - DOE Cost Share $308 million
- Milestone Dates:
  - Full Project Sanction 2012
  - Mechanical Completion 2015
  - Demonstration Phase/ Commercial Operation 2016

Project Participants

Hydrogen Energy California (HECA) Project developer and recipient of DOE CCPI-3 Award

Fluor Among world's largest publicly-held engineering and construction contractors, and leader in the design of gasification facilities

URS Permitting and NEPA contractor; Respected technical expertise and work relationships with CEC, EPA and local APCD's.

GE Energy Leading provider of IGCC technology, equipment and supporting services

Linde AGR technology provider, leader in gas processing technologies

Southern California Edison Nationally recognized, environmentally responsible electric utility

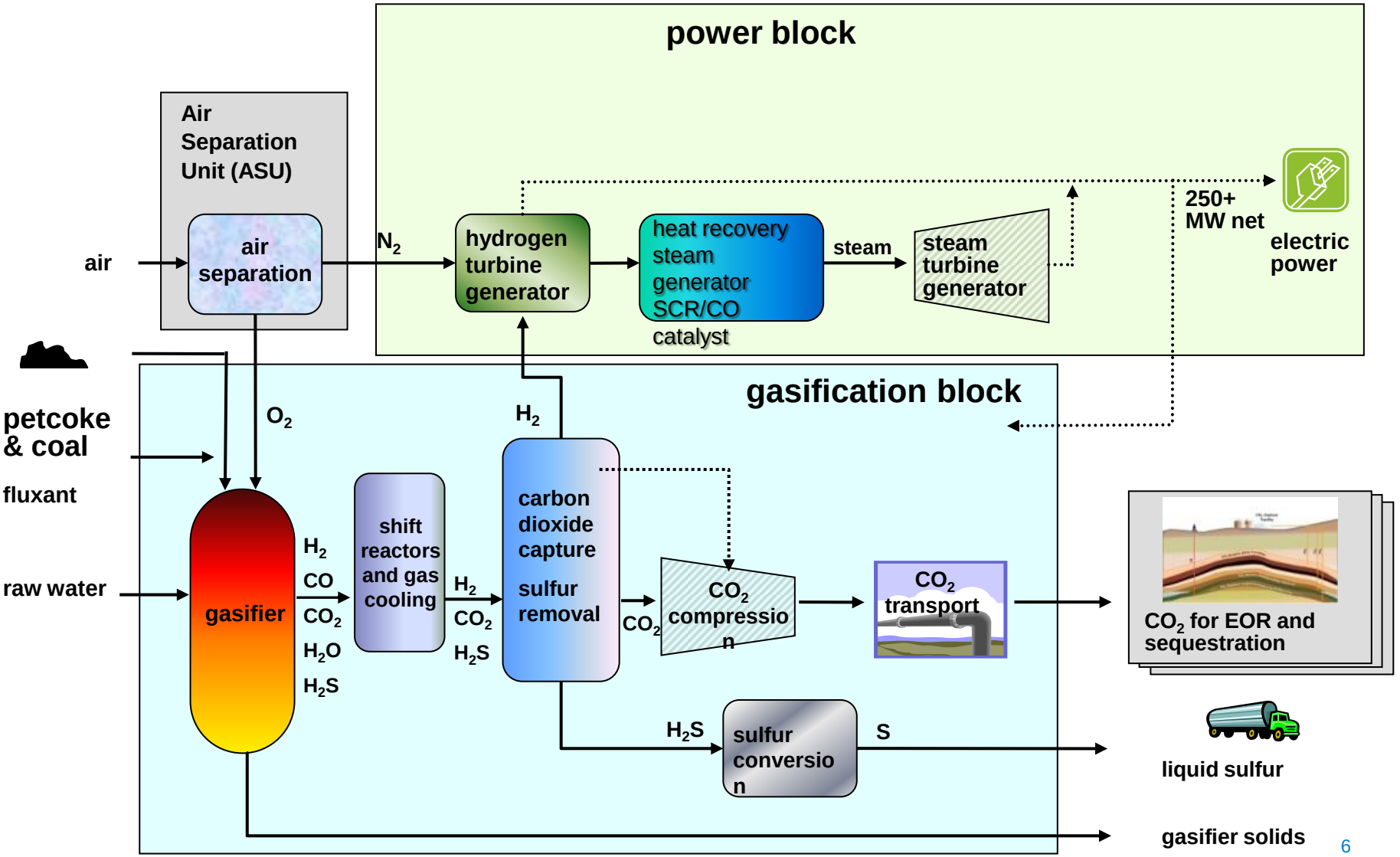
Occidental Petroleum (Oxy) World leader in oil and gas production, largest CO_2 EOR operator in the US.

HECA Project Objectives

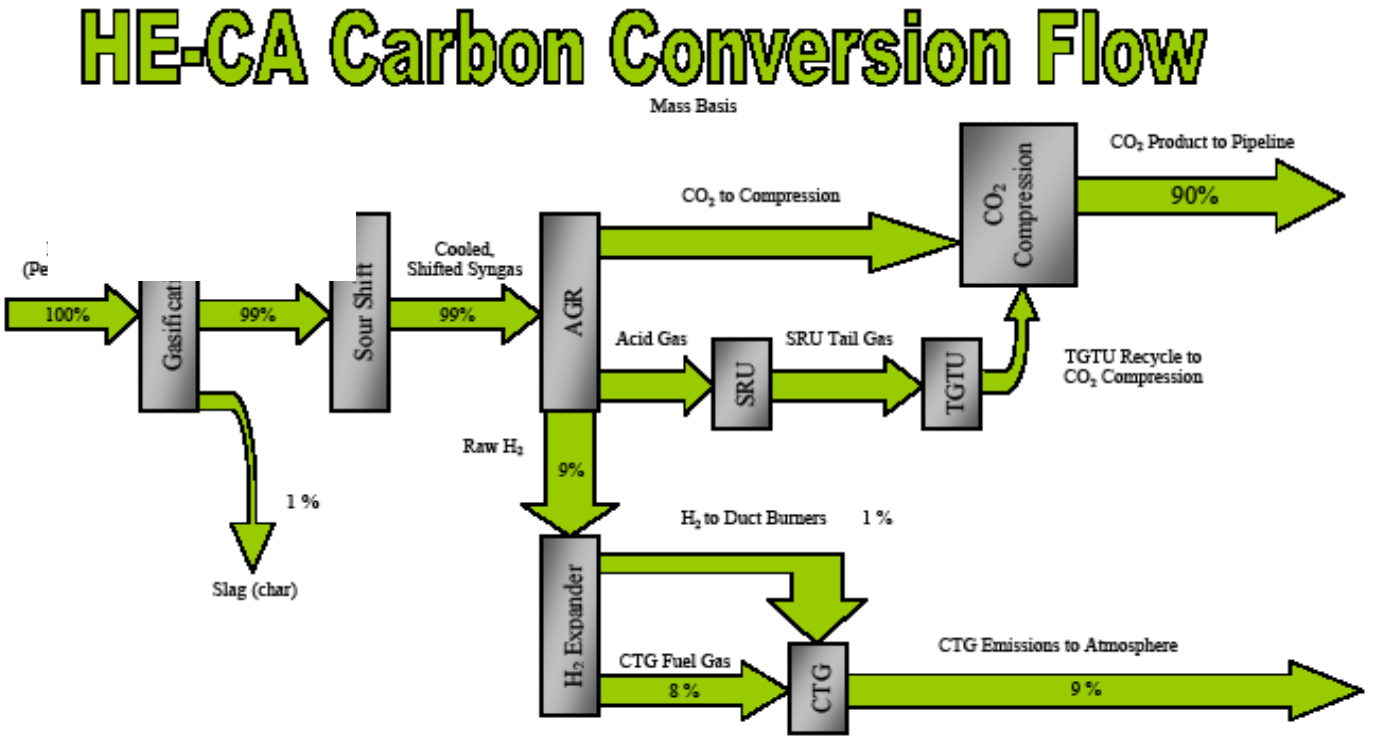
- Commercial demonstration of IGCC with 90% CO_2 Capture
- Use hydrogen-rich syngas to generate 250+ MW net of low carbon base-load power
- 90% CO_2 capture: ~2 million tons for enhanced oil recovery and sequestration in adjacent oil fields

- Operate with feedstock flexibility by utilizing a range of feedstock from western bituminous coal to petroleum coke from CA refineries
- Preserve limited fresh water by utilizing 100% brackish water for plant needs, Zero Liquid Discharge (ZLD) technology and maximum internal water recycling

Plant Configuration



Achieving 90% Carbon Capture



- 90% carbon capture during normal steady state operation

Technology Overview

Two Project objectives guide technology selection:

- Demonstrate commercial scale IGCC with carbon capture operability at high capture rates and low emissions
- Prove associated economic viability; key aspect is ability to deliver a high reliability operating plant within a minimum period after initial startup

Strategic approach:

- Where available, select proven technology operating within industry at equivalent capacities and design criteria to reduce the overall risk profile

Achieving 90% CO_2 Capture: Shift Reaction

Shift reaction converts syngas into hydrogen-rich gas using sour shift catalyst:

$$CO + H_2O \leftrightarrow CO_2 + H_2$$

Raw syngas from GE quench gasifiers meets the shift reactor moisture content: *no steam injection is required during shift stage(s)*

2 stages needed to meet the Project's 90% carbon capture objective; one at high temperature, and one at moderate temperature.

Proven Technology: Sour shift Cobalt-Molybdenum catalysts have been proven in chemical plants at similar scale and operating conditions.

Acid Gas Recovery (AGR) Studies

hydrogen energy

Hydrogen rich fuel stream (to the gas turbine):

- less than 5 ppmv total sulfur (compatible with state-of-the-art SCR and anticipated air permit requirement)
- CO and CO_2 limited to maintain 90% minimum removal of carbon from the raw syngas. The CO content is controlled by the upstream shift reactors while the CO_2 content is controlled by the AGR system.

CO_2 stream (to the CO_2 compressor for EOR and storage):

- high purity CO_2 stream containing a max. of 1000 ppmv CO and a max. of 65 ppmv total S in order to support anticipated air permit requirements.
- The total CO_2 product includes a small proportion of CO_2 from the Sulfur Recovery Unit (SRU) Tail Gas Treating Unit (TGTU).

Acid Gas stream (to the SRU for sulfur capture):

- minimum 45% H_2S content in order to achieve SRU combustion temperatures

AGR Study
product specifications

hydrogen energy

Treated Syngas (Hydrogen rich fuel)	
Total Sulfur (H_2S + COS)	5.0 ppmv (max)
CO_2	2.5 mol % (max)
CO_2 Pipeline Gas (Dry Basis)	
Carbon Dioxide	> 97 mol % (min)
Hydrocarbons (CH_4+)	1.0 mol % (max)
Nitrogen	< 2.0 mol % (max)
Total Sulfur (H_2S, & COS)	65 ppmv (max)
Carbon Monoxide	1000 ppmv (max)
Oxygen	10 ppmv (max)
Ammonia	1 ppmv (max)
Solvent (methanol)	200 ppmv (max)
Acid Gas	
Total Sulfur (H_2S + COS) Concentration	45 mol % (min)

Acid Gas Recovery Technology Evaluation

hydrogen energy

MDEA, Selexol™, Rectisol® considered

- MDEA couldn't achieve <5ppm total sulfur in H_2 rich syngas

Selexol™ vs Rectisol® lifecycle cost study undertaken

- consistent cost comparison methodology was applied by third party
- based on performance info and equipment sizing supplied by licensors
- Result: capital costs, operating costs and maintenance costs of the two options are similar and not considered determinative

Technical evaluation performed

- A Selexol™ plant based in Kansas achieves the required project specifications for total sulfur in the treated gas but at a smaller scale than the HECA Project
- Rectisol® has more commercial operating experience at the same scale as the HECA project at or below the required project specifications for total sulfur

Selexol™ vs. Rectisol®
General Observations

- CO_2 capture specification drives the cost
- Rectisol® uses Methanol and operates at low temperature to increase CO_2 loading and reduce solvent circulation rate. Low temperature steel alloys required.
- Selexol™ may require higher alloy steel due to the water soluble nature of the solvent and CO_2 creating slightly acidic conditions. Wet CO_2 requires drying.
- Selexol™ solvent (DMPEG – Dimethyl ethers of Polyethylene Glycol) is a proprietary solvent while methanol is a commodity product.
- Selexol™ solvent loss is low because of low vapor pressure, less flammable, less toxic.

Rectisol® selected: multiple operating units at similar scale to or below target H_2S level

Acid Gas Recovery
Rectisol® licensor evaluation

hydrogen energy

Further design studies undertaken with Rectisol® technology providers

- Same technical and lifecycle cost methodology used except with more detail
- Both licensors designs met the technical evaluation criteria (see below)
- Linde chosen on the basis of lower lifecycle cost in this application

AGR LICENSOR EVALUATION CRITERIA	
Commercially Proven Design	Impurities in Syngas addressed
Key References, experience	Methanol Solvent Makeup
Process Description, Process Flow Diagrams	Removal of Methanol from CO2 Product
Battery Limits H&MBs	Inherently Safe Design
Utilities, Effluents & Emissions	Design Complexity
Availability & Reliability Data	Plot & Elevation
Flexibility of CO2 recovery	Sized Equipment List
Metallurgical Issues	Specialty Equipment Cost
Product Specifications (Syngas, CO2, Acid gas)	O & M Costs
	Licensing Fees and PDP Cost
	PDP Timetable

HECA Project Progress

hydrogen energy

Engineering Progress

- Signed GE License Agreement, completed Process Design Package
- Selected AGR, SRU and Water Treatment vendors
- Open solicitations : ASU and MAC (Main Automation Contractor)

Application for Certification (AFC) with CEC

- May 2009: submitted “Application For Certification”
- Aug 2009: “data adequacy” achieved
- Sept 2009: Information hearing and HECA site visit completed
- Over 150 data requests addressed, 3 public workshops
- June 2010: Preliminary Determination of Compliance issued by San Joaquin Valley Air Pollution Control District
- August 2010: Preliminary Staff Assessment (Part 1) issued

NEPA Review

- Public scoping meeting held on April 14, 2010 in Bakersfield, CA
- CEC is Cooperating Agency for NEPA Process

hydrogen energy

www.hydrogenenergycalifornia.com