Texas Clean Energy Project: Coal Feedstock Poly-generation Plant with CCUS

Presentation To:

IOGCC

Vancouver, B.C. June 4, 2012

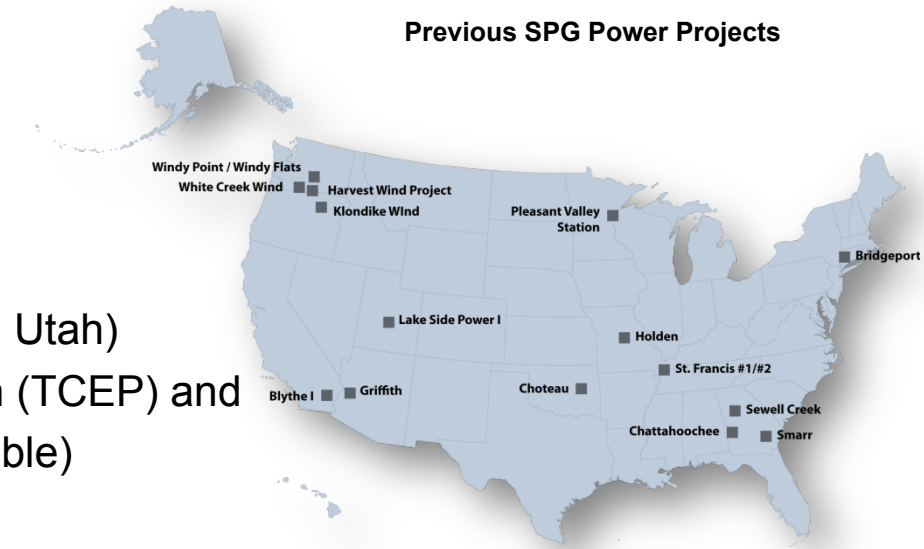
Introductions:
Summit Power Group, LLC

Founded twenty-one years ago by former U.S. Secretary of Energy Donald Paul Hodel & Chief Operating Officer of Department of Energy Earl Gjelde

Summit's Traditional Business is Power Project Development

- Developed over 7,000 MW of large, clean energy projects
- Over 1,000 MW in development or under construction

Previous SPG Power Projects



Summit's Principal Business Lines

- Wind power (including Fire Island in Alaska)
- Solar power (including NorthStar in California)
- Natural Gas Power Plants (including Lakeside in Utah)
- Carbon Capture including from Coal Gasification (TCEP) and from natural gas (multiple systems now available)

These remarks are my personal views and are not Summit Power's positions.

Main Points

- TCEP, the Texas Clean Energy Project—Integrated Gasification Combined Cycle w Carbon Capture, Utilization and Sequestration (IGCC/CCUS)
  - Capture 3mm tons a year of CO2, about 90%--mostly for oil production
  - The hydrogen product is burned for power and used for chemical feedstock
  - Technology isn't issue: gasification of coal and separation of CO2 is standard—developed in countries with little gas and lots of coal (China, South Africa, Germany)
  - Between 1/4th and 1/12th of CO2 emissions of comparable plants (depending on the compared technology)
  - We are ready to build as soon as we get financed, mostly thanks to DOE/NETL cash grant

- Fly in the ointment for others: For first-of-a-kind projects, "free market" doesn't support extra cost to integrate CCUS with making power or chemicals from coal

- Government incentives I would recommend as a project finance specialist:
  - Cash benefits are twice as good as tax benefits. But tax benefits are politically easier.
  - Incentives specifically contracted to individual projects are essential.
  - Incentives that last for 20 years are better than incentives that last for 10 years.

The Physical Volume of CO_2 Created by Pulverized Coal ("PC") Plants is Staggering—Hence IGCC/CCUS

100 Watt Light Bulb

Running for 1 year

876,000 Wh

(i.e. about 1 MWh)

950 pounds coal (bituminous coal like PRB)

1 ton CO_2 — would fill most of Washington Monument

Reminder: What is Gasification?
Turn Coal to Gases; Clean and Separate, Then Burn

Water + Coal + Oxygen	gasify →	Hydrogen Gas (H_2) + Carbon monoxide (CO)
Steam (H_2O) + H2 + CO	shift →	H_2 (lots) + CO (little)+ CO_2 (lots)
H_2 (lots) + CO CO_2 (lots)	use →	High-H_2, low-C fuel Oil recovery, urea, etc.

TCEP Conceptual Schematic

Wyoming Coal via Railroad

Coal 1.8mm tpy

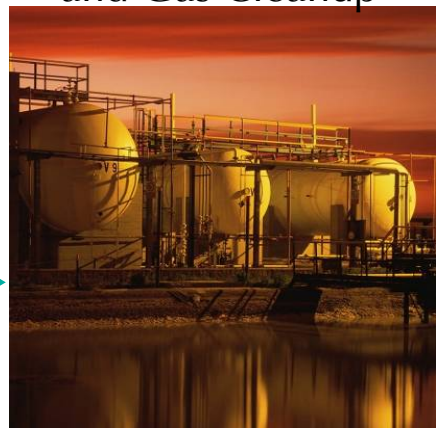
Brackish Water Purified via Reverse Osmosis

Water

Air Separation Unit

Pure Oxygen

Coal Gasification and Gas Cleanup



2/3 of Syngas

1/3 of Syngas

1/6 of CO_2

5/6 of CO_2

Hydrogen Burning Power Plant

195 MW low carbon power delivered to City of San Antonio (20% of revenues)*

Ammonia / Urea Complex

710,000 tons/yr delivered to Fertilizer Company (54% of revenues)*

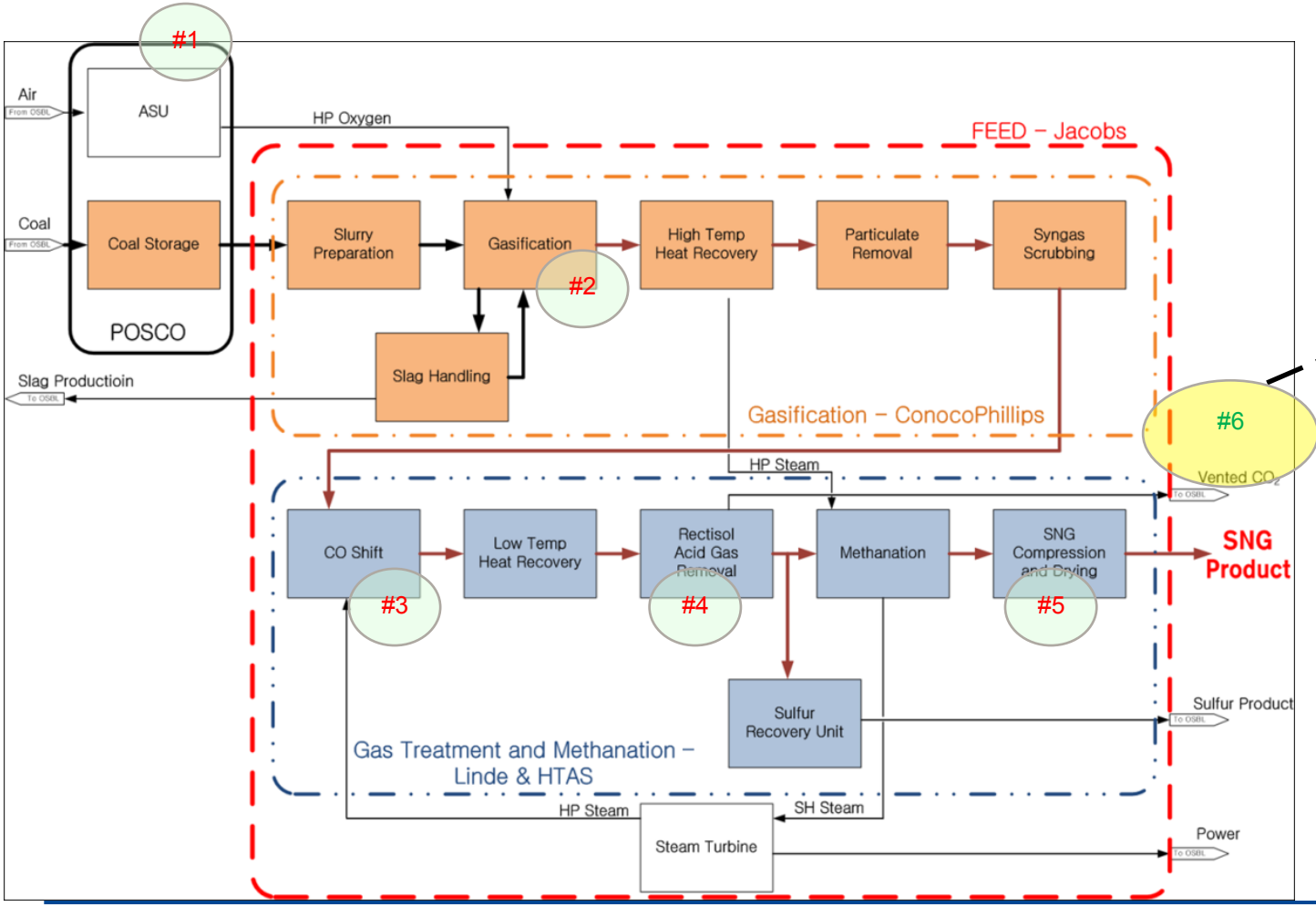
CO_2 Delivered to Oil Fields via Pipeline

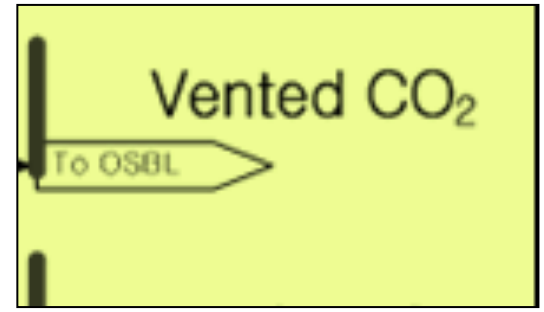
2.5mm tons per year delivered to Oil Companies (19% of revenues)*

** Remaining 7% of revenue from other byproduct sales*

Q: Isn't this New Process Risky? **A**: No. Used Worldwide, Except. . .

SKorean SNG plant has identical front-end of plant, but vents its pure CO_2.





Yellow box says "Vented CO2"—to OSBL. OSBL means "Outside Battery Limits," i.e., into atmosphere.

Currently Operating Installation of Five SFG-500 Gasifiers at Shenhua Plant, Ningxia, China

A Few Recent Asian Coal Gasification Plants

Total Capacity Last Decade is ~20x TCEP

Plant Name	Year	Country	Technology Name	Feed Class	Product	Syngas Output
Inner Mongolia Chemical Plant	2011	China	Shell Gasification Process	Coal	Methanol	3373
Ningxia Coal to Polypropylene Project (NCPP)	2010	China	Siemens SFG Gasification Process	Coal	Polypropelene	1912
Perdaman	2013	Australia	Shell Gasification Process	Coal	Chemicals	1283
Tianjin Chemical Plant	2010	China	Shell Gasification Process	Coal	Ammonia	1124
Jincheng Project	2012	China	Siemens SFG Gasification Process	Coal	Ammonia	874
Coal to UREA Project	2013	Australia	Siemens SFG Gasification Process	Coal	Ammonia	765
Guizhou Chemical Plant	2010	China	Shell Gasification Process	Coal	Ammonia	562
Hebi	2012	China	Shell Gasification Process	Coal	Chemicals	546
Datong	2013	China	Shell Gasification Process	Coal	Chemicals	546
Sinopec, Anqing	2006	China	Shell Gasification Process	Coal	Ammonia	509
Dong Ting Ammonia Plant	2006	China	Shell Gasification Process	Coal	Ammonia	466.2
Hubei Ammonia Plant	2006	China	Shell Gasification Process	Coal	Ammonia	466.2
Yuntianhua Chemicals, Anning	2007	China	Shell Gasification Process	Coal	Ammonia	465
Yunzhanhua Chemicals, Huashan	2007	China	Shell Gasification Process	Coal	Ammonia	465
Puyang Plant	2008	China	Shell Gasification Process	Coal	Methanol	463

By Any Measure TCEP will Save a Lot of CO_2 Emissions

TCEP CO_2 Emissions vs. (i) Gas-based Power and Urea Plants Making Same Output or (ii) Conventional Coal Power Plant Using Same Inputs	
Case Examined	Annual standard tons of CO_2 emitted
TCEP annual CO_2 emissions (no coal is burned; it is turned into clean gases and almost all the CO_2 is captured)	300,000 tons
Power and Fertilizer, same product quantities as TCEP, made with natural gas	1,200,000 tons—4x TCEP
Conventional coal plant, using (burning) same amount of coal feedstock as TCEP	3,600,000 tons—12x TCEP

Anthropogenic CO_2 is Critical to Grow Oil Production

- Texas's Permian Basin is 40-year old CO_2 market for Enhanced Oil Recovery
- 3,000 miles of CO_2 pipelines (Cortez pipeline in red/top left = 500 miles)
- TCEP within 100 miles or less of 72% of all existing EOR-using fields
- We are ~7% of 37mm TPY new CO_2 market
- CO_2 demand 3x supply --all sources of supply (geologic and man-made)
- No "fracking" involved

CCUS is Good for Earth, Good for Oil, But What if the First-of-A-Kind Plants Cost an Extra Billion Dollars?

- TCEP makes two commercial outputs: baseload power and fertilizer.
  - Baseload power without carbon capture is typically accomplished with a Combined Cycle Natural Gas Plant (combustion turbine coupled with steam turbine). Very efficient but until now, all the carbon in CH_4 molecule ends up in emitted CO_2
  - Typical urea plant uses a Steam Methane Reformer process to get hydrogen needed for ammonia and then urea. The methane burned for heat in reformer is the principal source of carbon-dioxide from this process.
  - NOTE: CO2 capture from natural gas is now possible, but requires a different example
- Prices and estimates of capital costs of non-capture CCGTs and methane feedstock urea plants vary, but for discussion purposes, <u>assume you could save $1bn of capital</u> if you made zero effort to capture the CO_2.
- The question is, can you get a high enough revenue stream from selling CO_2 to pay for the extra capital for first-of-a-kind plants? If not, what form of government program would be sufficient to cover the gap?

Deriving Needed incentive—Methodology Example

Warning—These are Really Rough Numbers—the Methodology is Illustrative!

- Assume extra $1bn upfront capital cost. 20 years, level payment, 12% after tax weighted average cost of capital = ~$130mm/yr
- Annual extra costs of running carbon capture-oriented plant = ~ $90mm (portion of internal power plus ~1/2 of O&M)

  ~($220mm/year) Extra Costs of CO_2 Capture

- CO_2 revenues 2.5mm tpy x $35/ton @100/bbl WTI* = $85mm
- Other ancillary revenues as consequence of gasification = ~$35mm

  +$120mm/yr Extra Revenues w/o Support

- Gap = $100mm on 2.5mm tpy CO_2 →$40/ton Support Needed
  - [Could tweak various numbers and get different answers]

*Roughly, price per ton CO2 is 35% of the going price of a barrel of WTI. At $100 WTI, $35 CO_2.

Facts of Life for Developing CCUS Projects

- **Projects are "project financed" not "balance sheet financed":**
  - Project financing means lenders and equity solely rely on the revenue stream of the project to pay off its mortgage. No deep pocket, no rich uncle.
  - Balance sheet finance, as when Exxon does a new plant, means that all of Exxon's thousands of other cash-producing successful projects can help to bail out a new flop project.

- **Projects don't make money (for tax purposes):**
  - With giant depreciation expense and interest expense (both tax deductible) the project itself may owe no federal tax for 15 years
  - So a tax incentive doesn't create any value for the project unless it is **easily, cleanly transferrable** to others who are tax payers.

Implications for Government Incentives*

Project-financed → Incentives need to be rock solid predictable → Current sequestration tax credit--limited amounts, first-come first serve, no contract, doesn't cut it.

Projects Don't Pay Tax → Need smooth, clean, uncomplicated mechanism to transfer tax benefits → Current clunky rules "sell" tax benefits at cents on the $ to rich financial players

*This is not a criticism of CCPI Federal cost-sharing award system, which is not a tax incentive and has been invaluable to TCEP! Rather this slide refers to features of Section 45Q program as discussed in NEORI presentation.

What Would Be an Improvement on Current Status?

Financially Ideal: $	**Political Reality: Tax Incentives** **(i.e., Items Below are an Improvement over Status Quo for Section 45Q sequestration credits)**
Cash—can service bond payments, hence is source of project capital	Tax benefit — harder to use, but at least no appropriations or FEIS required
Able to be pledged and liened by debt parties	Should be able to go to operator, tax owner, oil producer (by contract). Or anybody else.
Project specific contract	Project specific allocation of credit
20 years (if cash)—access to long-term bonds	10 years—OK if tax because of high discount rates applicable in tax deal
Structure like a fixed-for-floating swap. Incentive moves inverse to WTI.	If tax, needs to be fixed price so tax attributes can be split off for fixed dollar proceeds.

State of Texas Made a Huge Difference to TCEP

Item
Sales tax exemptions on most of plant & for oilfield facilities to use CO_2 from plant for EOR
Property tax exemption for pollution control equipment
Long-term exemption from franchise tax
Royalty benefit for oil fields for using our CO_2
Expertise of state's Bureau of Economic Geology and settled law on CO_2

Fun CO2 Facts

ICBE> CarbonDatabase> CO2 Volume Calculation

Volume calculation of one ton CO2
One ton = 1000kg
One cubic meter = 1000liters
One mole CO2 = 44.0g (CO2 = 12.0g + 32.0g = 44.0g)
One ton contains 22730 moles of CO2 (1,000,000g / 44.0g/mole)
One mole is 24.47L (Boyle's law at 25°C and 1 atmosphere pressure)
Volume of one ton CO2 = 22730moles × 24.47L/mole = 556200L = 556.2m³
One ton of CO2 occupies 556.2m³ of volume.

Height of CO2 on US land surface
US 1997 CO2 production = 5,456,000,000ton
US volume of CO2 production = 5,456,000,000ton × 556.2m³/ton = 3,035,000,000,000m³
US land surface area 9,158,960km²
Height of CO2 on US land surface = CO2 volume / surface area = 3,035,000,000,000m³ / 9,158,960km²= 33.14cm (about 1.1 feet high)
Every year the United States emits a 33.14cm high blanket of carbon dioxide over its land area.

Volume CO2 from one gallon of conventional gasoline
Gasoline density = 2791grams/gallon
Percent carbon by mass = 85.5%
Mass of CO2 from 1 gal of gas = 2.791kg/gal × 85.5% × (44.0g CO2 / 12.0g C) = 8.750kg
Volume of CO2 from one gallon of gas = 8.750kg × 556.2m³/ton = 4.867m³
The combustion of each gallon of conventional gasoline produces 4.867m³ or 171.88ft³ of CO2.

CO2 and the Washington Monument
Volume of the Washington Monument = 22026ft³ = 623.7m³
Gallons of gasoline needed to fill the Washington Monument with CO2 = 623.7m³ / (4.867m³/gallon) = 128 gallons
The New Beetle can run about 4000 miles on 128 gallons.
A New Beetle, driving 12,000 miles, will create enough CO2 emissions to fill up the Washington Monument three times

CO2 emission data from USEPA and land area data from CIA