Power County
Advanced Energy Center:
Project Summary and
CO2 Discussion
• Refined Energy Holdings (REH) formed in December 2006 to pursue development of gasification-based energy projects.
• REH is part of the Green Rock Energy, LLC portfolio of gasification companies.
• Sufficient equity secured to fully finance the Power County Advanced Energy Center
Power Co. Advanced Energy Center

• $2 Billion investment to be built over 2 phases
• Located near American Falls
• Produce
  – Nitrogen-Based Fertilizers (Phase I)
  – Transportation Fuels (Phase II)
  – Valuable By-Products (Phase I and II)
Site Suitability

- Zoned for heavy industry
- > 450 acres
- Union Pacific Railroad
- Nearby substations
- Interstate highway
- Interstate natural gas pipeline
- Water rights secured / grey water opportunities
Products: Phase I

• Phase 1 ~ $1 Billion
  – Ammonia – 500 tons/day
  – Urea – 1,800 tons/day (granulated)
  – UAN – 1,600 tons/day
  – Sulfuric Acid – up to 300 tons/day
  – CO2 – 90 MMSCFD
    • Urea Production
    • EOR Opportunities
**Process: Gasification**

- Gasification reacts coal with water and oxygen to create syngas at high temperature and pressure
  - Coal Slurry & Pure O2 enter top of vessel
  - Reactions:
    - $C + \frac{1}{2} O_2 \leftrightarrow CO$
    - $CO + \frac{1}{2} O_2 \leftrightarrow CO_2$
    - $H_2 + \frac{1}{2} O_2 \leftrightarrow H_2O$
    - $C + CO_2 \leftrightarrow 2CO$
    - $C + H_2O \leftrightarrow CO + H_2$
- Produces a syngas rich in H2 and CO
  - Carbon monoxide - 46%
  - Hydrogen - 34%
  - Carbon dioxide - 17%
**Process: Water-Gas Shift**

- Hydrogen is required for Ammonia production
  - \( \text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \)

- CO can be reacted with water over a catalyst in the WGS reaction to form H2
  - \( \text{CO} + \text{H}_2\text{O} \rightarrow \text{CO}_2 + \text{H}_2 \)

- WGS reaction is carried out in two stage reaction to achieve >96% conversion of CO

- Resulting syngas is H2 and CO2 rich:
  - Carbon monoxide - 1%
  - Hydrogen - 55%
  - Carbon dioxide - 41%
Process: Gas Cleanup

• UOP’s Selexol technology separates H2S and CO2 from syngas via an absorption/regeneration process
  • Physical solvent absorbs H2S and CO2 based on partial pressure difference
  • Higher selectivity to H2S allows for selective rejection of CO2
• Clean Syngas sent to ammonia production
• H2S – rich stream sent to WSA plant
• Produces two CO2 streams:
  • Urea Production
  • Vent/EOR
Process: Gas Cleanup

- Cleans syngas and creates acid gas stream and CO2 streams
  - Cleaned Syngas
    - Hydrogen - 95%
    - Nitrogen - 5%
  - Acid Gas
    - Hydrogen Sulfide - 31%
    - Carbon dioxide - 58%
    - Water - 10%
  - CO2 to Urea
    - Carbon dioxide - 99%
    - Water - 1%
  - CO2 to Vent/EOR
    - Carbon dioxide - 95+%  
    - Total Sulfur - <3 ppmv
Carbon Dioxide Production

• Phase I CO2 Production:
  – 70 MM scf/day
  – 1.5 MM TPY

• Phase II
  – 175 MM scf/day
  – 3.6 MM TPY
CO2 Strategy

• Corporate policy (REH and Green Rock) to develop projects with CO2 sequestration solution:
  – Environmental stewardship
  – Risk mitigation
• CO2 not currently regulated in Idaho, and PCAEC permit application based on CO2 venting
• Pursue parallel CO2 EOR opportunities with oil producers and pipeline companies
Mature oil fields in Wyoming are PCAEC’s best option for CO2 market. Pipeline from American Falls to Wyoming is required (~175-225 miles). SIE will partner with a pipeline company to build pipeline and market CO2 in Wyoming.
CO2 Strategy (cont.)

• PCAEC development separate from CO2 pipeline development due to different ownership structure and environmental considerations

• CO2 sequestration does not need to coincide with start-up:
  – PCAEC start-up scheduled for 2012
  – Earliest pipeline start-up likely 2013/14
PCAEC Schedule

• Schedule
  – 2008 – Air Permit from Idaho DEQ
  – Early 2009 – Groundbreaking
  – 2009-2011 – Phase 1 construction
  – 2011-2012 – Phase 1 startup
  – 2011-2014 – Phase 2 construction
  – 2014-2015 – Phase 2 startup
CO2 Pipeline Schedule

- Schedule
  - 2nd Quarter 2008 – Select Pipeline Partner
  - 3rd/4th Quarter 2008 – Negotiate Definitive Agreements
  - 2009 – Pipeline Route Alternatives
  - 2009/2010 – Negotiate ROWs, Initiate EIS
  - 2012/2013 – Complete EIS, Begin Construction
  - 2014/2015 – Pipeline Operation
Questions/Comments?
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