Climate Neutral Combustion Technology
Carbon Sequestration Forum VIII
November 14, 2007
Discussion Topics

1. CES Power Plant Process and Technology
2. Current Fabrication
3. Economics
4. Current Projects
Vision

Technology to make “Power without Pollution”™

We use aerospace technology to change the way power is produced and eliminate all atmospheric emissions including carbon dioxide. Our gas generation technology uses hydrogen, all hydrocarbon fuels and many renewable fuels.
Investors and Partners

• AES Corporation
  – An investor since 2003, one of the largest global power companies, with 44,000 MW from 121 plants in 26 countries.

• Southern California Gas Co.
  – An investor since 2006, an energy services company, with $12 billion in revenues. Largest gas distributor in the US.

• Paxton/Quadrise
  – Investors since 2007, two affiliated companies developing projects using “MSAR” made from emulsified heavy oils. Paxton is controlled by Paramount Resources, a publicity traded Canadian oil and gas exploration company.

• Siemens Power Generation
  – A partner through two US Department of Energy contracts to develop advanced turbines and combustion systems. DOE portion valued at $19 million.

• DOE and CEC PIER Grant Program
What We Do

- We have proprietary oxy-combustion zero emissions concepts. Our patents are on the plant process, not just the component. We license IP.

- We make the critical component in the plant – the gas generator and control system.

- We subcontract manufacturing. But we control or do: marketing, business development, engineering, project management, quality control, final assembly, testing, and installation. We profit from hardware sales.

- We are prepared to take ownership in the first generation plants if either mandated or economically attractive. But this will directly impact our financing plan (ex: “CA-ZEPP 1”)
Unique Factors

- Zero Emission
- The market’s “Other 85%”
- Base Load
- Scalability
- Speed to Market
- Patent Protected
- Proven Technology
Clean Energy Systems

Zero-Emission Power Plants

- Raw Materials: Air, Oxygen, Nitrogen, Fossil Fuels (Coal, Gas, Oil, Biomass)
- Clean Fuel Preparation: Air Separation Plant, Fuel Processing Plant
- Steam Generation: Water, Injector mixes O₂, fuel, & H₂O in precise ratios, Combustion Chamber
- Electrical Power: Steam Turbines, Turbines drive electrical generator

By-products: Carbon dioxide for EOR, ECBM, etc.
Kimberlina Power Plant

• 1700 hours of operation with 325+ starts
• Operated on natural gas, simulated syngas, and liquid fuels with sulfur
• Partners include US DOE, California Energy Commission, Air Liquide, Siemens, Air Products, and others
Kimberlina Power Plant

• Pollution control equipment: before and after the changeover to oxy-fuel combustion
• 95-98% sequestration ready CO₂
Gas Generator Components

DIUENT NO. 1
DIUENT NO. 2
DIUENT NO. 3
DIUENT NO. 4
CHAMBER NO. 3
CHAMBER NO. 4
CHAMBER NO. 5
COMBUSTION CHAMBER NO. 1
COMBUSTION CHAMBER NO. 2

OX MANIFOLD
INJECTOR
RESONATOR

94.43
GG – OXY Manifold as Machined
Injector Body Machined
Resonator Rings
Chamber Housing
Assembled Diluent Injector
Assembled Gas Generator
ENCLOSURE FABRICATION SHOP
Technology Migration Path

- **Proof of concept 5 MW Kimberlina demonstration**
- **2004**
- **50% η; $900/kW; 400 MW; Siemens; DOE; $60-40/MWh**
- **2009**
- **40-45% η; $1500/kW; 100 MW; LM 2500/SGT 900; $80-55/MWh**
- **2012**
- **25-30% η; $2500/kW; 50 MW; J79, indirect cycle, or STG; $120-60/MWh**
- **2015**
- **??% efficiency**
Project Pipeline
In Development: CA ZEPP Kimberlina

- First US Zero Emission Power Plant (ZEPP)
- 50 MW using natural gas, MSAR™, petcoke and/or renewable fuels
- Possible upgrade of plant with a higher-temperature turbine
- Final phase of negotiations for 20 year PPA
- Facility will supply 1 million tons CO₂ to West Coast Regional Carbon Sequestration Project (WestCarb)
- Contract awards for preliminary detailed engineering and permitting preparation to be awarded in October 2007
In Development: CA ZEPP 2

- Significant commitment from major CA oil producer
- Preliminary discussions with area utility
- 50 MW ZEPP plant producing 300,000 tons/yr of CO$_2$ for EOR
- Investigating feasibility of MSAR$^\text{TM}$ and petcoke to increase CO$_2$ and lower resulting electric costs
- Zero emissions: CO$_2$, PM$_{10}$, NOx, etc.
- Project participants ready to go forward, 2010/11 start-up
- CO$_2$ and area electric requirements justify 7-10X project phase up
Ongoing Europe ZEPP Projects

SEQ-1 (www.seqnederland.nl)

- 40 MW SEQ-1 Project in the Netherlands. EGR use of CO₂
- First revenues ($1,000,000) received, and full commitment expected in 2007. N₂ sold to gas transportation company.
- Eneco (Dutch utility), Wintershall (BASF), Siemens, and Visser Smit committed to project.

ZENG (www.zeng.no)

- 70 MW Project in Stavanger
- ZENG AS formed: Lyse Energi, CO₂ Global, Procom Ventures, NEBB Engineering. Additional funding from Shell, Statoil, and Norwegian government ~ $1 million in funding
- CES to supply gas generator; decision to proceed expected in summer 2008
SEQ-1 Conceptual View