



*Clean Energy
Systems, Inc.
Power Without Pollution™*



Clean Energy Systems, Inc.

Up-Date On Oxy-Fuel Combustion

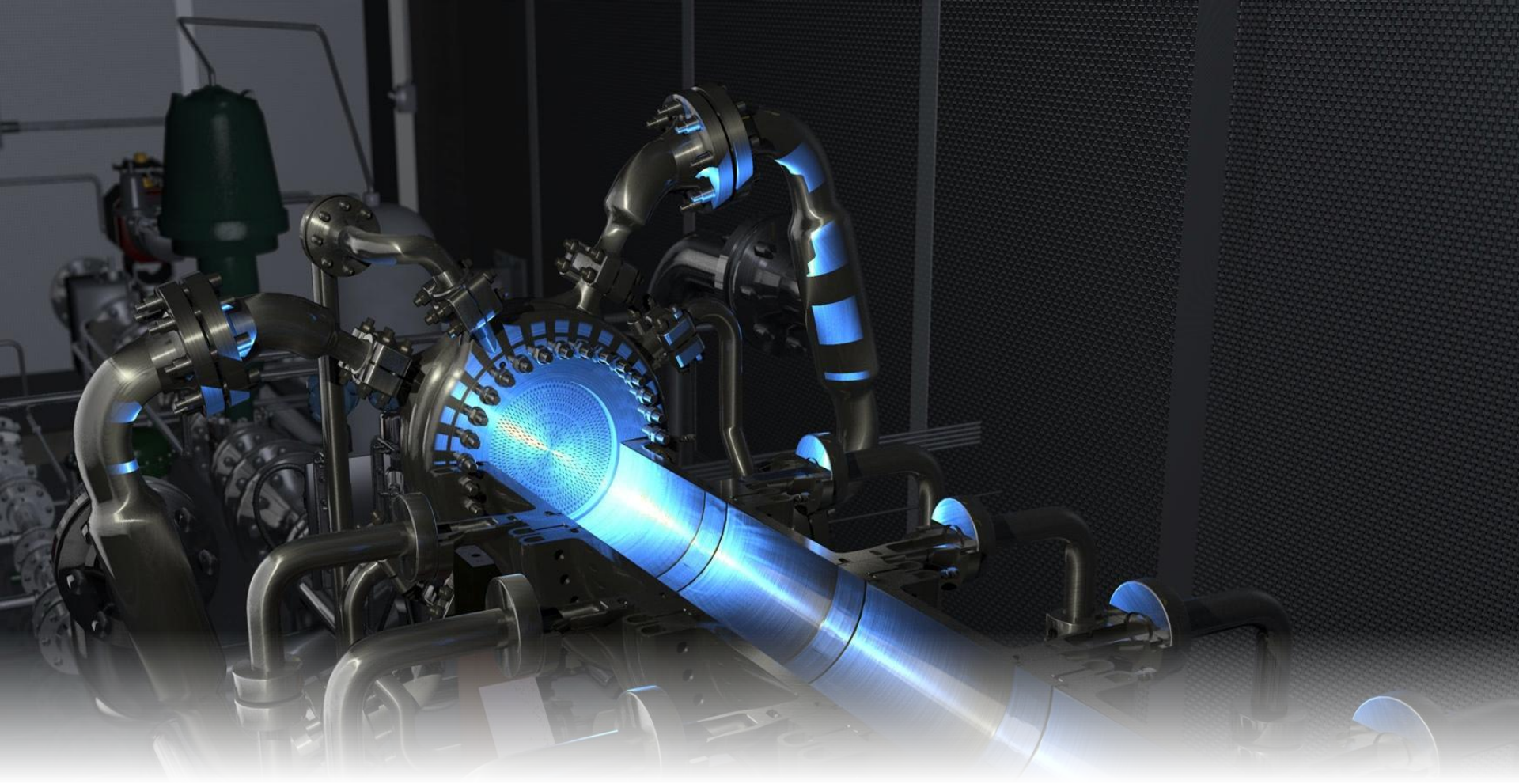
McIlvaine Hot Topic

January 2013

Clean Energy Systems, Inc.

Presentation Outline

- Company Background
- Technology Overview
- Markets and Product Development



Company Background

Company Background

History and Recent Developments

- Founded in Sacramento, California by former Aerojet (a GenCorp company) aerospace engineers; incorporated in 1996
- Specialize in oxy-fuel power generation
- CES technology portfolio
 - ⇒ 20 MWt 4" Oxy-Fuel Gas Generator
 - ⇒ 200 MWt 12" Oxy-Fuel Gas Generator
 - ⇒ 30 MWt Oxy-Fuel Reheaters
 - ⇒ 150 MWe Oxy-Fuel Turbine
 - ⇒ 30 – 45 MWe peaking oxy turbine
- 30 patents issued on zero-emissions oxy-combustion technology power cycles, 36 patents pending
- Owner of two power plants: Bakersfield and Santa Clarita, CA

Company Background

Equity and Strategic Partners

Equity Partners



Paxton Corporation is an energy-focused company based in Calgary, Alberta; aggregator of technologies including CES' oxy-fuel combustor for use in the extraction of hydrocarbons; significant equity position currently held by the largest shareholder of Paramount Resources Ltd.



A Sempra Energy utility

Southern California Gas Company (a subsidiary of Sempra Energy; \$16.0 B+ market capitalization) sells, distributes, and transports natural gas in the United States.



The AES Corporation (\$8.5 B+ market capitalization) is a global power company with generation and distribution businesses.

Strategic Partners



Maersk Oil (subsidiary of A.P. Møller – Maersk A/S. with a \$29 B+ market capitalization) is an international oil and gas company with operated production of about 625,000 barrels of oil (equivalent) per day. A licensee of CES technology.



Siemens Aktiengesellschaft (\$80 B+ market capitalization) is a diversified international electrical and engineering company that provides solutions to the energy and other sectors. A development partner with CES.



Paramount Resources Ltd. (\$2 B+ market capitalization) is an independent energy company that engages in the exploration, development, and production of natural gas, crude oil, and natural gas liquids in North America. A licensee of CES technology



US Department of Energy works together with the country's private sector to develop and foster new technologies to ensure America's long-term energy security.



LM Alternatives Inc. and its sister companies have been providing quality parts and related services to turbo machinery users in industrial, utility and aviation applications for more than four decades.





OFT-900 Gas Accumulator Pad

Areva Solar Thermal Plant

60MW_e Generator

150MW_e Oxy-Fuel Turbine OFT-900

24MW_e Load Banks

Oxygen Accumulators

De-Min Tank

Oxygen Tank and Vaporizer

Gas Accumulators

Re-Heater Test Stand
Geo/Solar Thermal Booster Demo

12" Gas Generator 200MW_{th}

4" Gas Generator 20MW_{th}
(Inside Biomass Boiler Building)

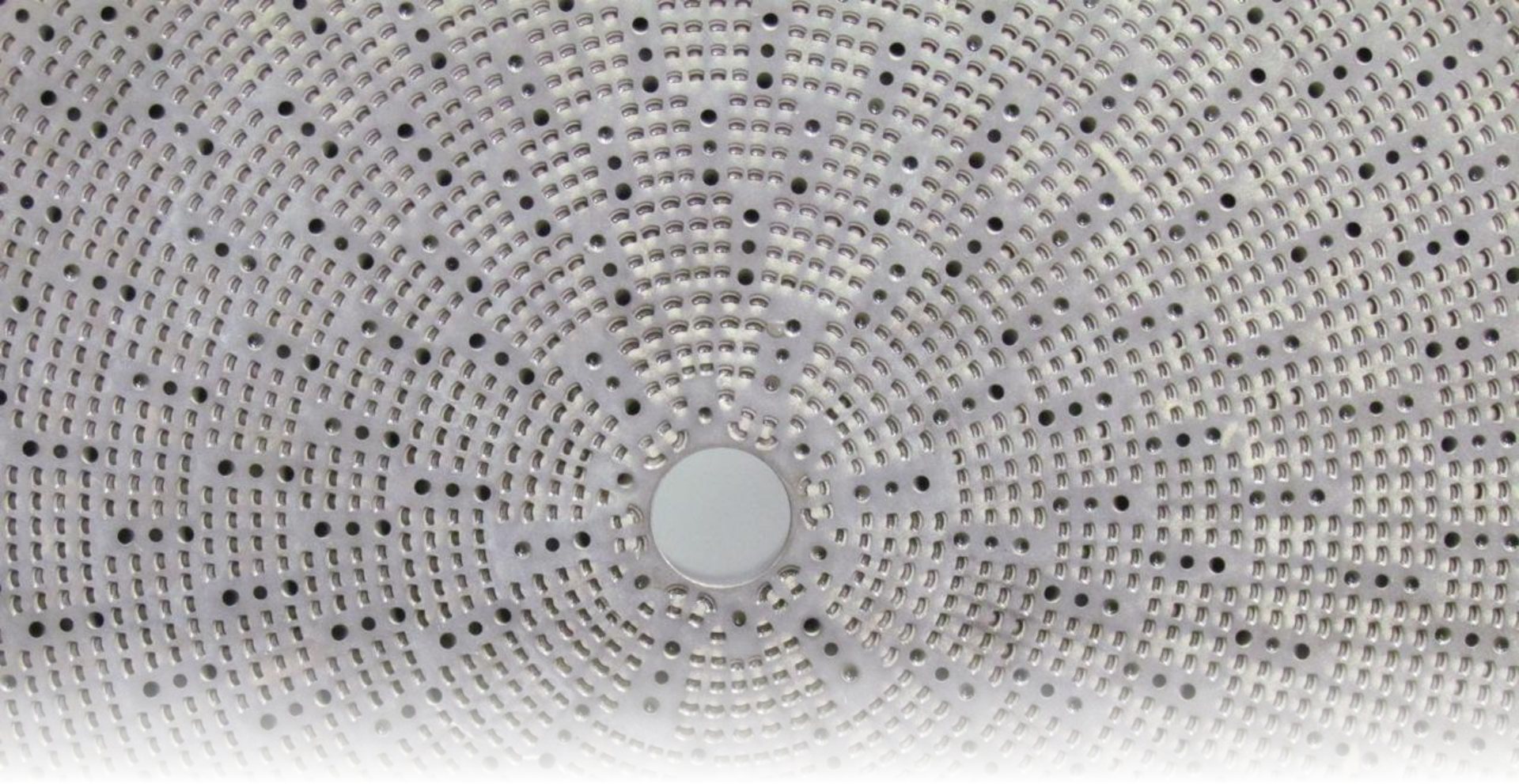
30MW_e Oxy-Fuel Turbine OFJ-79

G²S² SAGD Steam Separator

6MW_e Elliott Steam Turbine
(Inside Building)



CES Kimberlina Power Plant
October 2012



CES Technology Overview

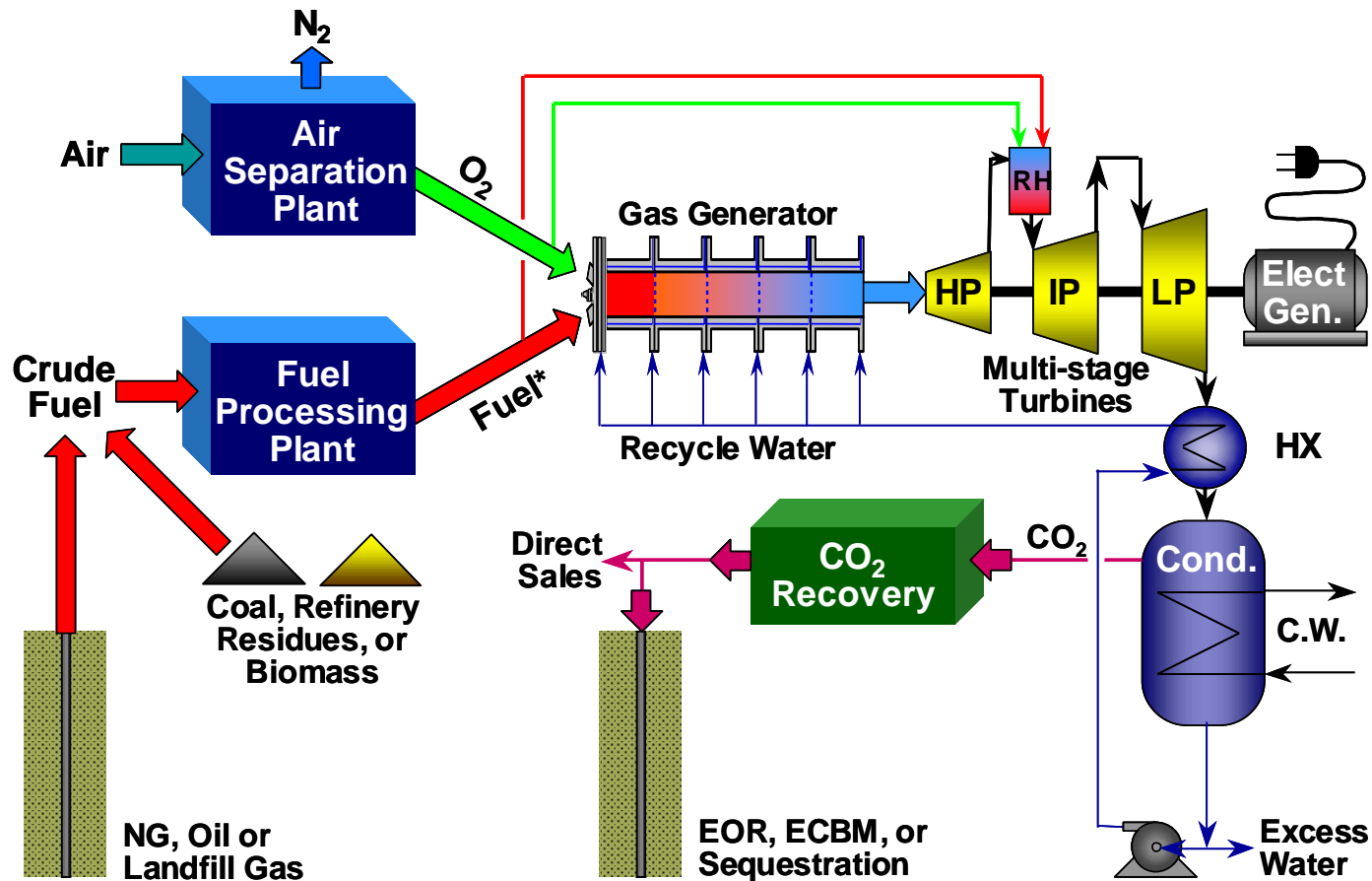
CES Technology Overview

The TriGen™ Oxy-Fuel Cycle

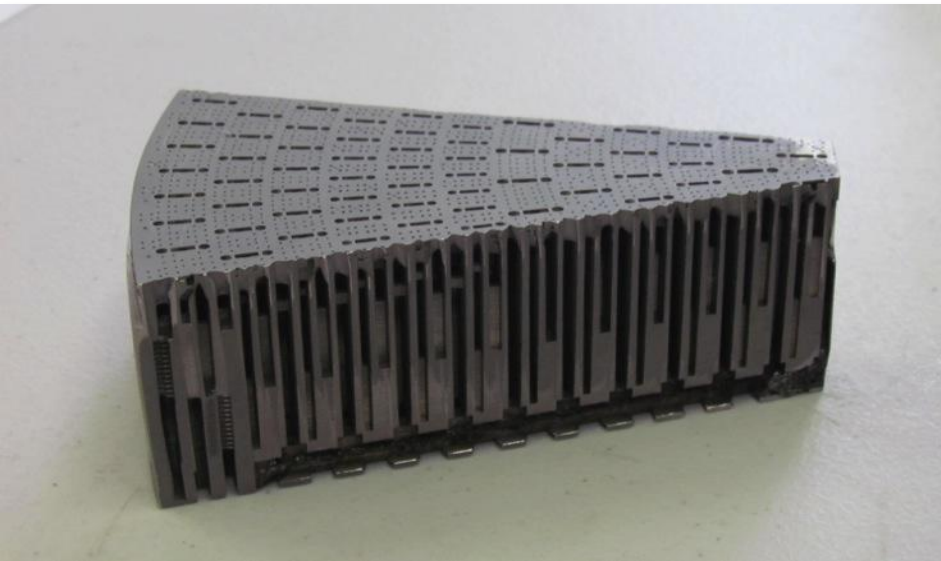
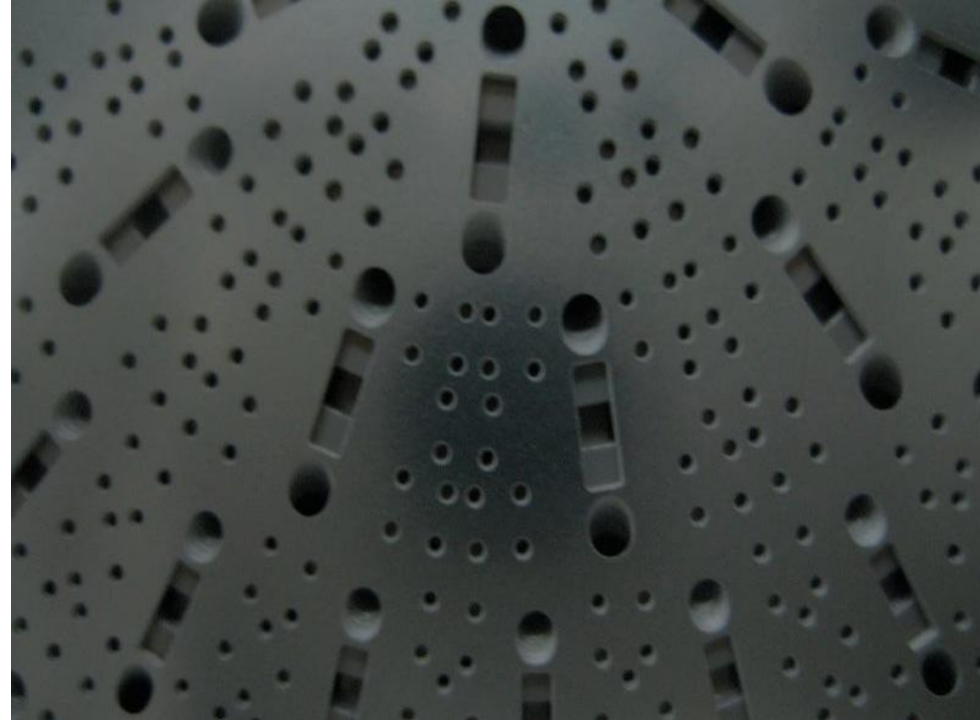
209 MW

CO₂: 2,300 TPD

Water: 508,000 GPD

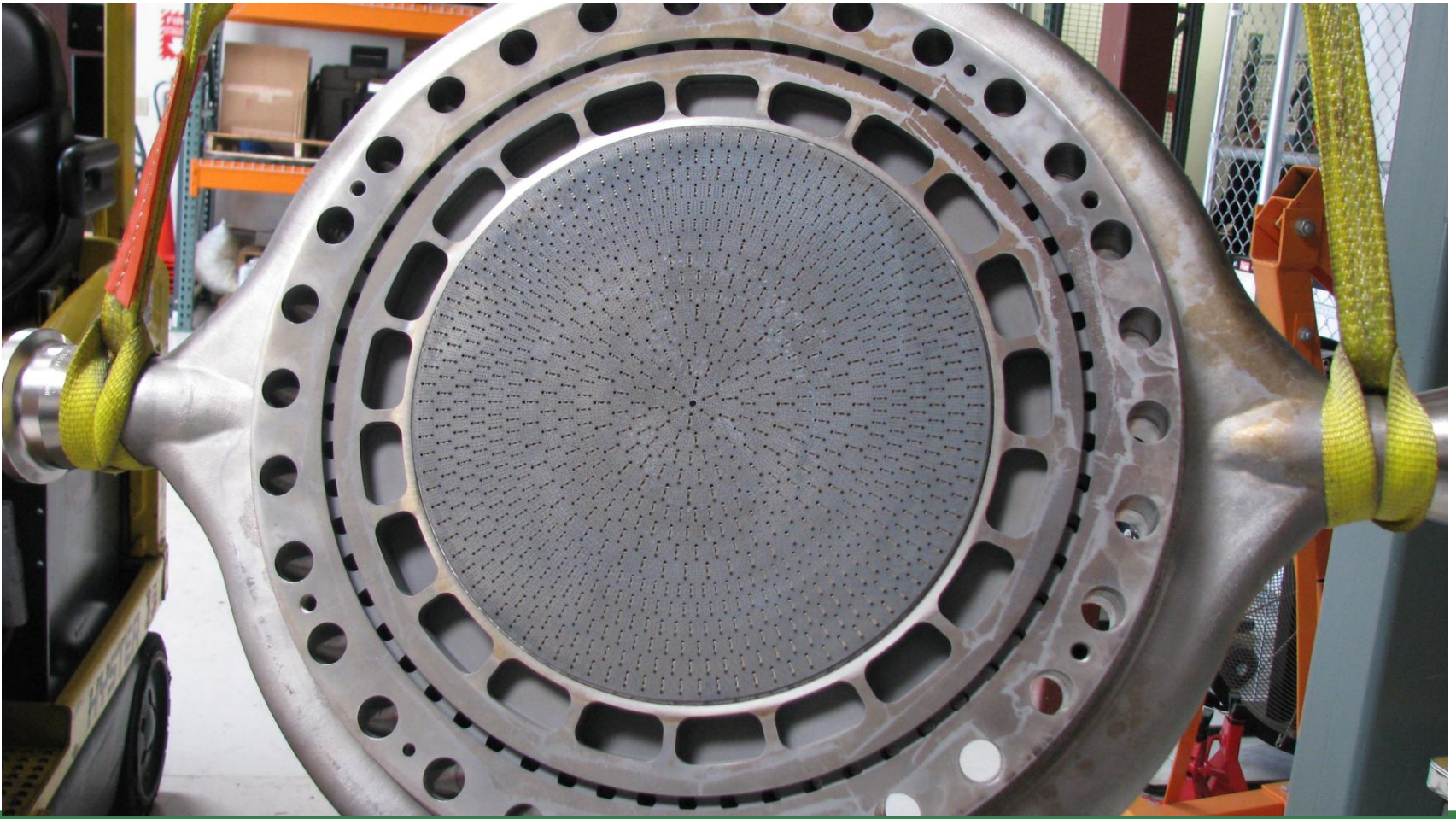


- **CES Combustor Technology:**
 - ⇒ Hundreds of individual platelets are photo-etched to form 3-D channels
 - ⇒ Precisely stacked platelets are pressure bonded into a monolithic structures
 - ⇒ Intricate pathways channel fuel, oxygen, and water into hundreds of combustors
 - ⇒ Intimate, stoichiometric mixing for complete combustion



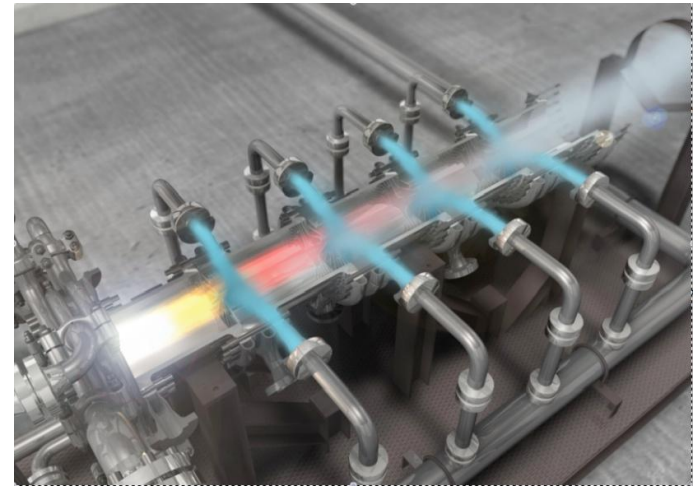
CES Technology Overview

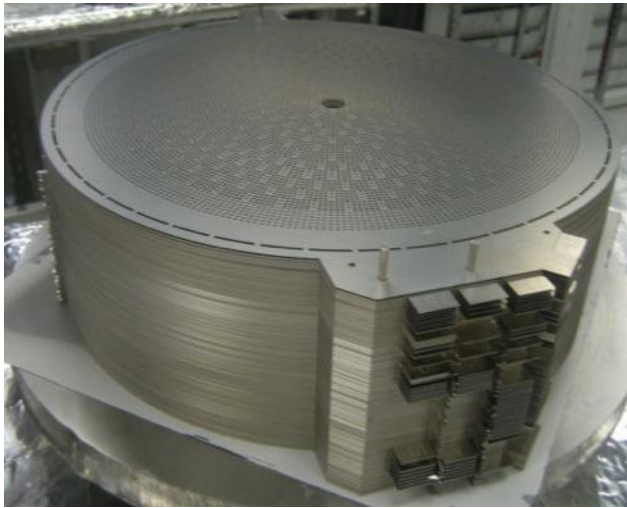
12" Gas Generator Combustor Face



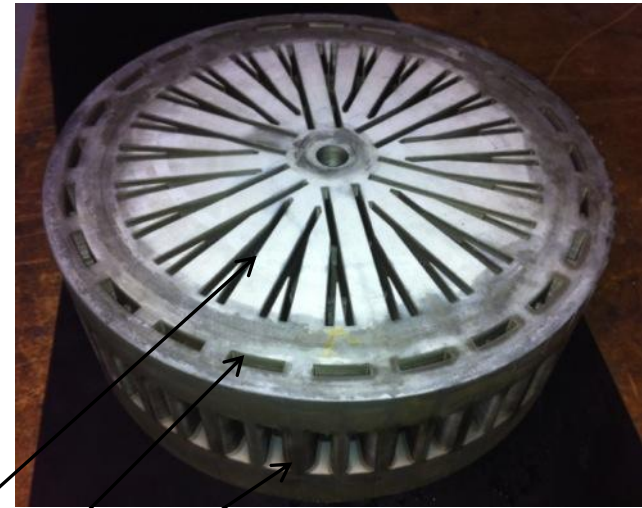
CES Technology Overview

12" Gas Generator

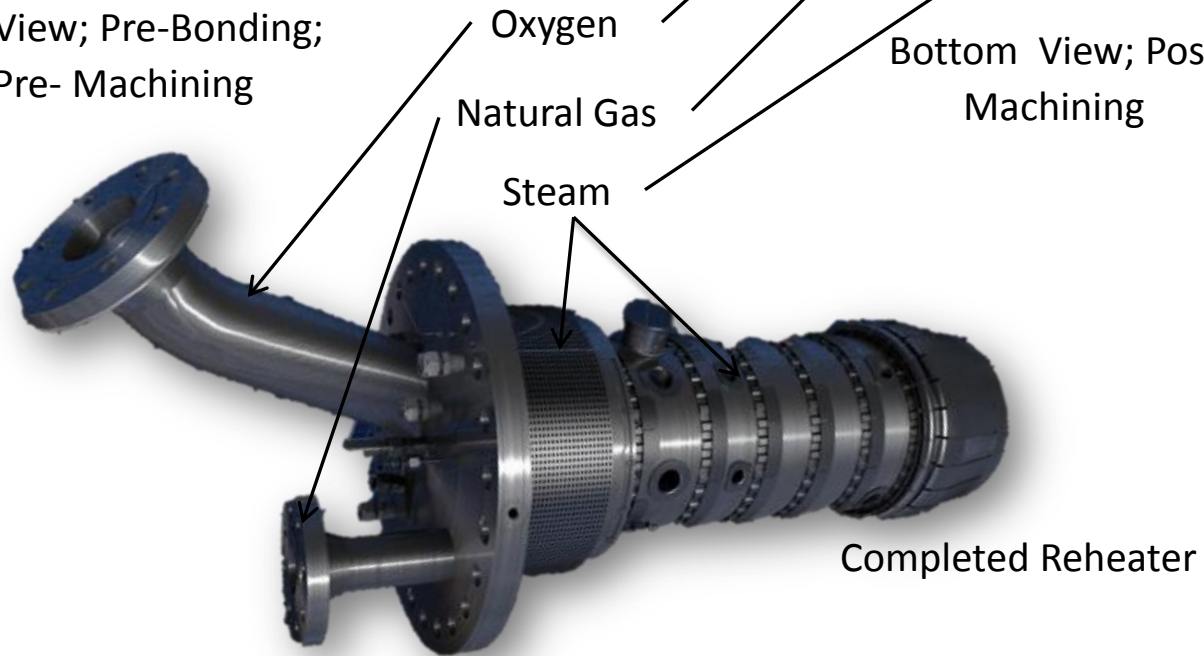




Top View; Pre-Bonding;
Pre- Machining



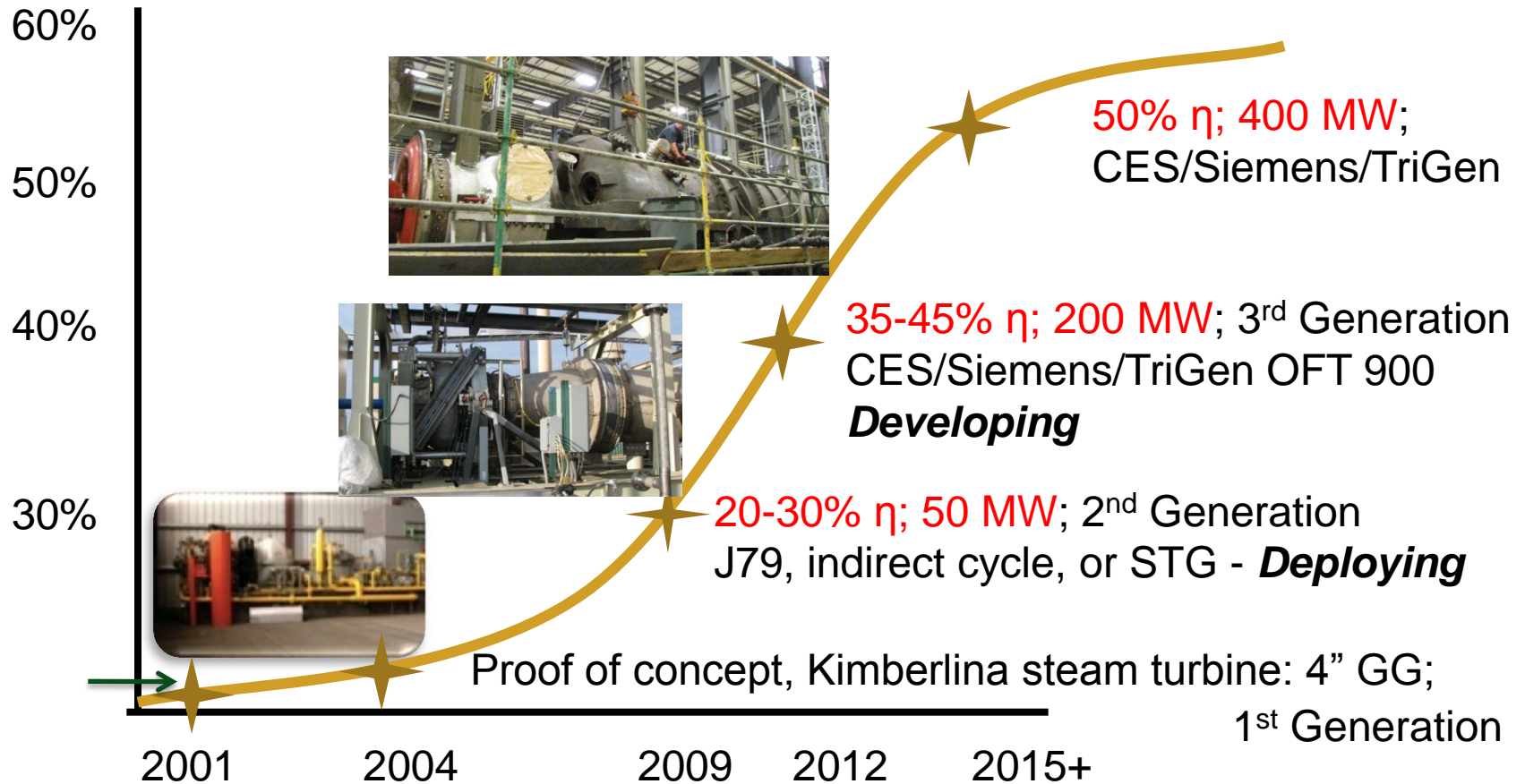
Bottom View; Post
Machining

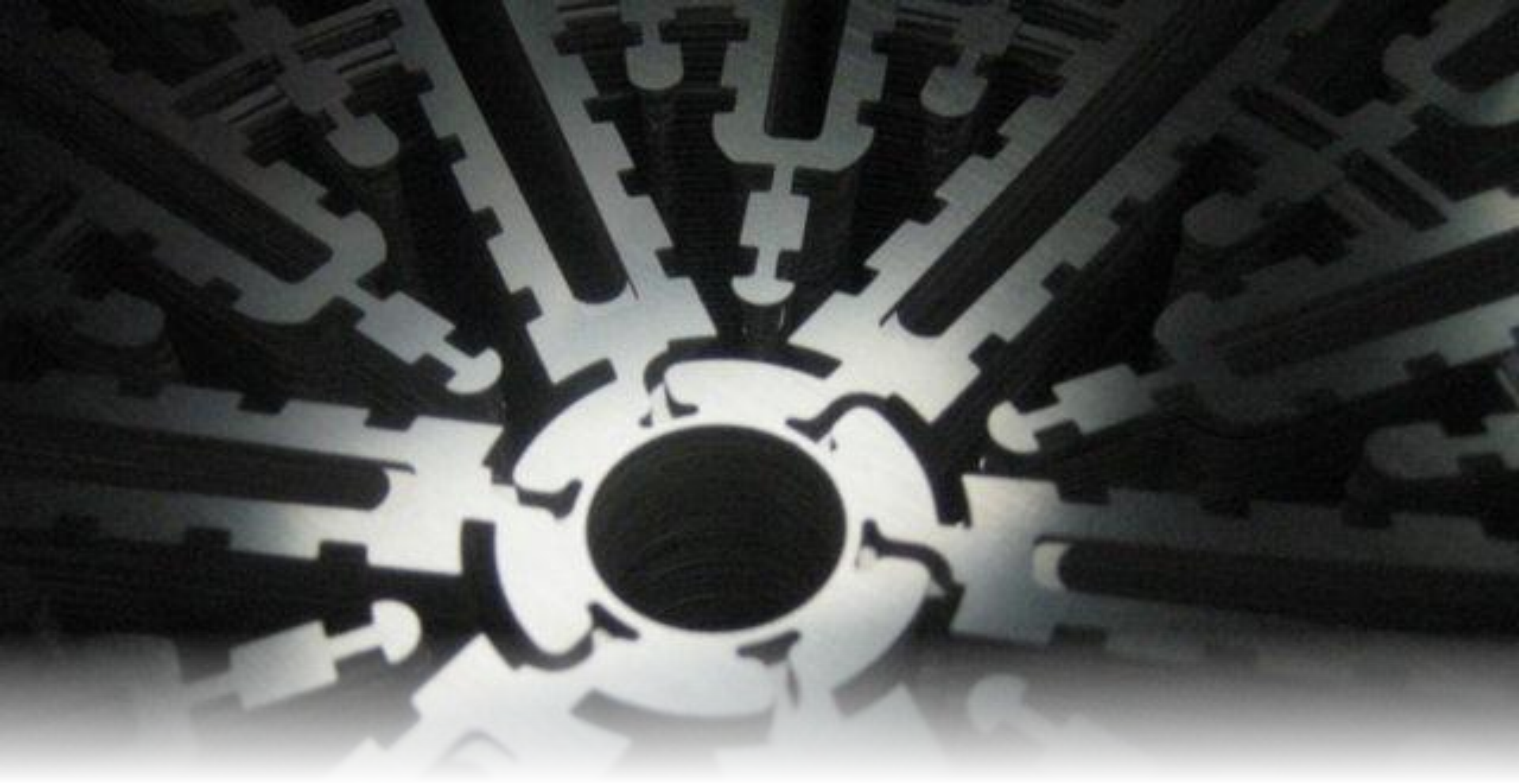


Completed Reheater

CES Technology Overview

Technology Development Plan







Markets and Product Development

Markets and Product Development

Ongoing Market Applications

- Zero Emission Power Plants 
 - Power or CO2 as the Primary Product
 - Monetizing Opportunistic Fuels 
 - Low BTU Gas, Syngas, Bitumen, Biofuels, etc.
 - Maersk Trigeneration: Power, CO2 for EOR and Water 
 - See: <http://www.maerskoiltrigen.com/>
 - SAGD and Heavy Oil Recovery 
 - Peaking Power Plant 
 - Zero Emission Load Balancing
 - Energy Storage To Optimize Renewable Energy 
- Ongoing project development

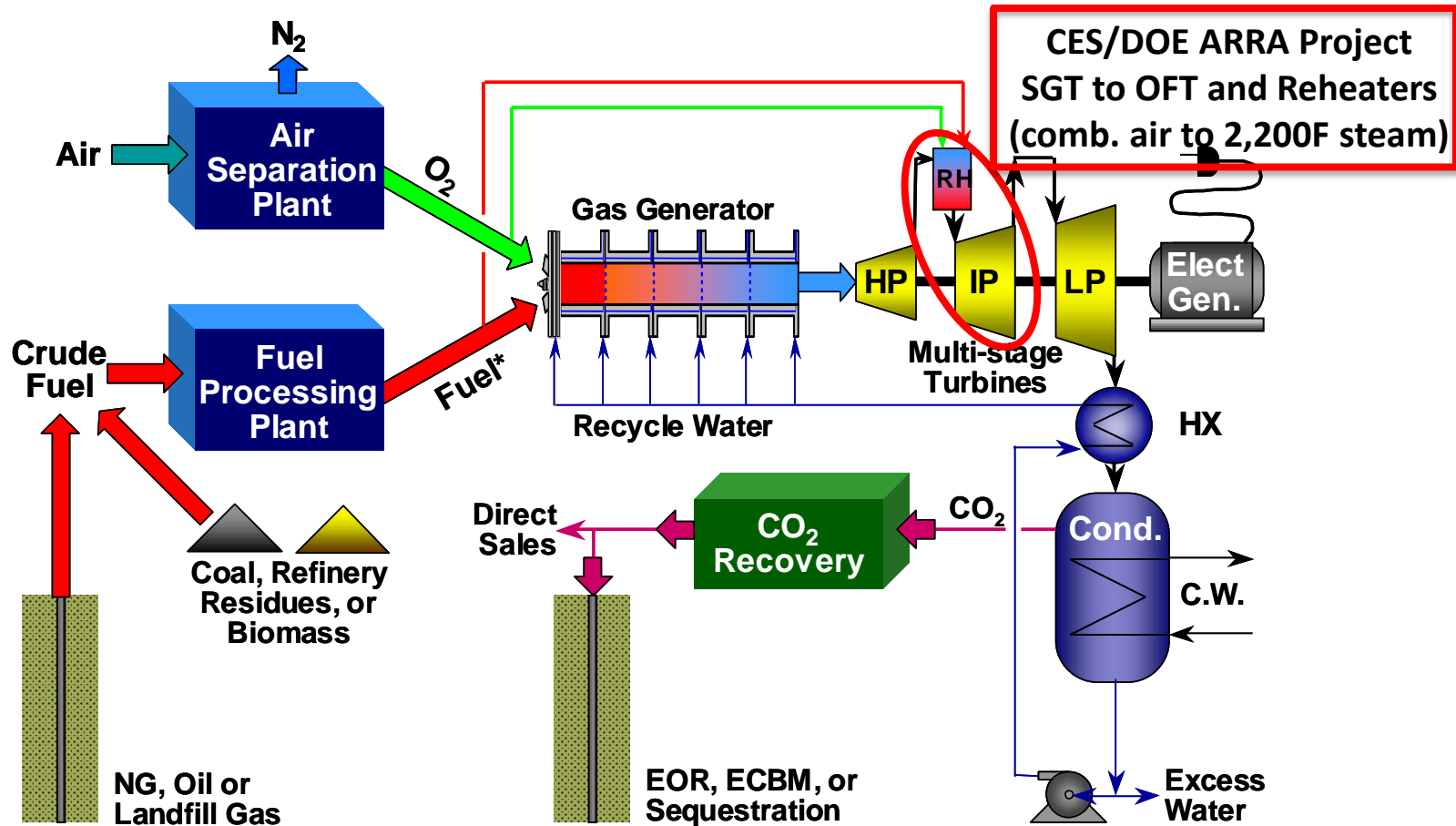
Markets and Product Development

209 MW

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Water: 508,000 GPD

The TriGen™ Oxy-Fuel Cycle



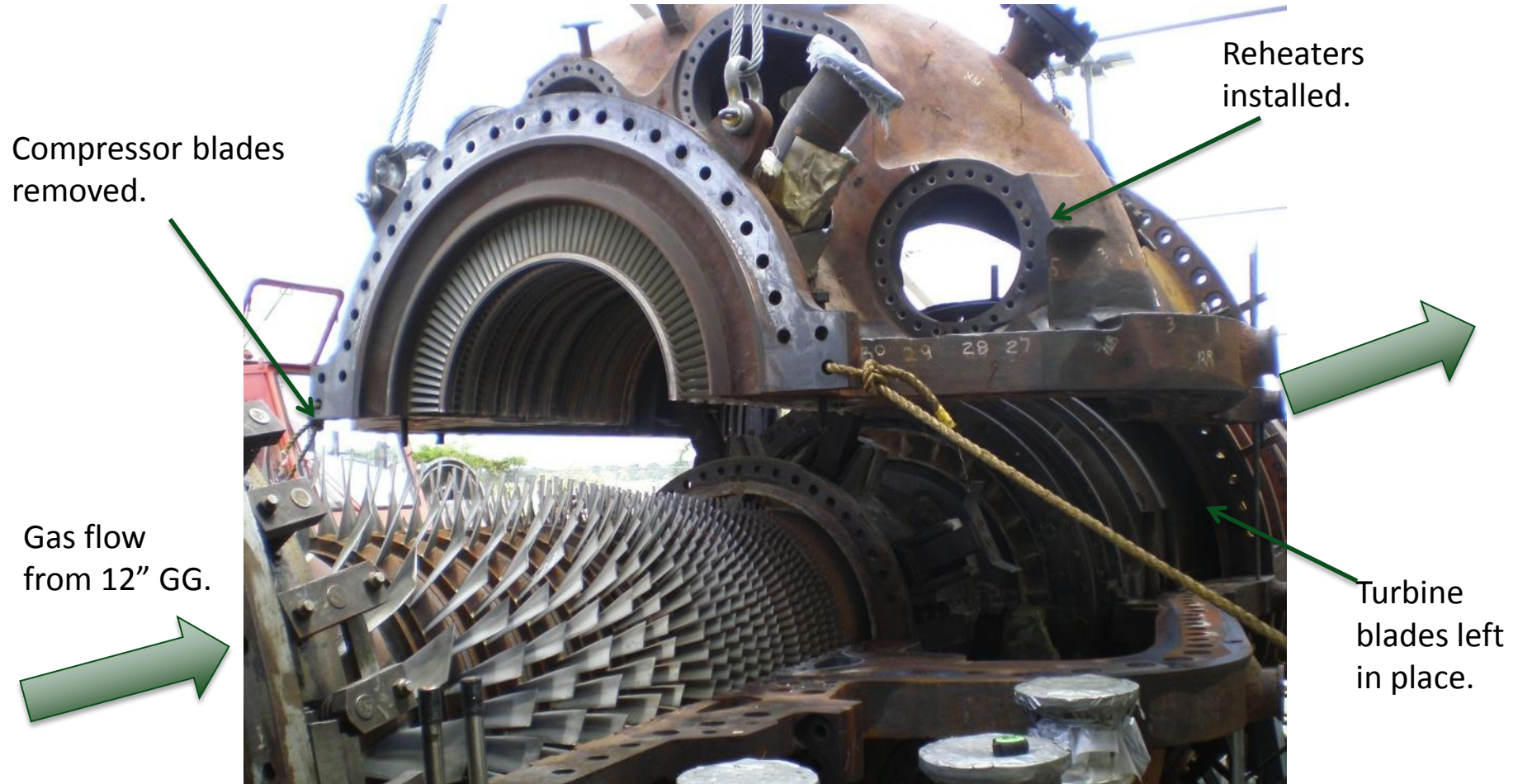
Markets and Product Development

Turbine Removal from Abitibi Bowater Facility: March 2011



Markets and Product Development

SGT-900 Disassembly and Inspection: June 2011



Markets and Product Development

Turbine Shaft With Power Turbine Blades Re-Installed: May 2012



Markets and Product Development

Completed OFT-900



Markets and Product Development

OFT-900 Re-Heater Test Stand



Markets and Product Development

OFT J79 Peaking Power Turbine, 42 MW

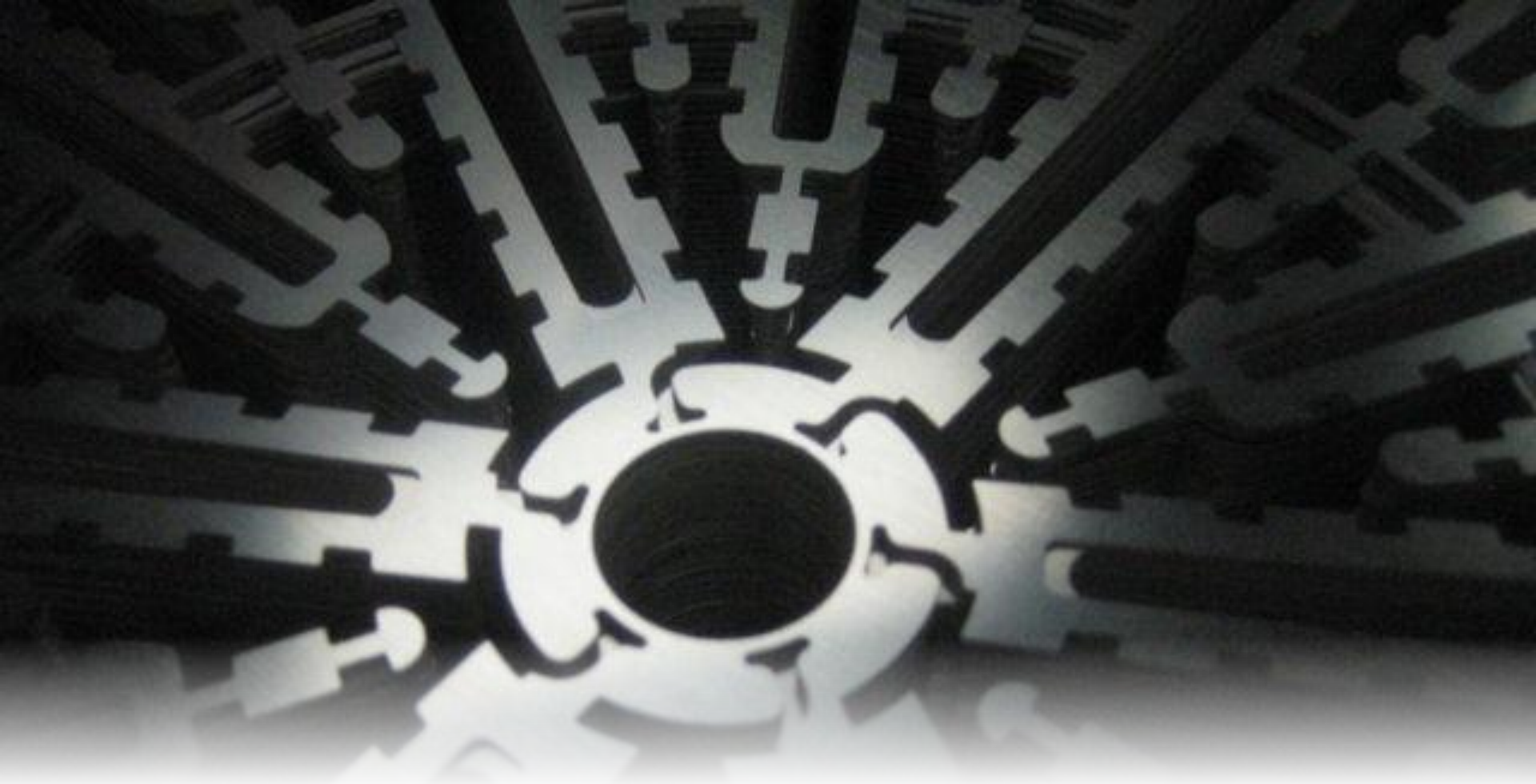
Applicable Markets

- Peaking power facilities (<10% CF)
- Enhanced gas and oil recovery
- Off-spec gas utilization
(approximately one-third of future gas production)

Product Advantages

- Low capital cost
- Small footprint and modular
- Effectively zero NOx and PM
- Fast power ramp up to full load <2 min.
- 4.4 hours @ max power
with 50,000 gallon O₂ storage





The End