



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

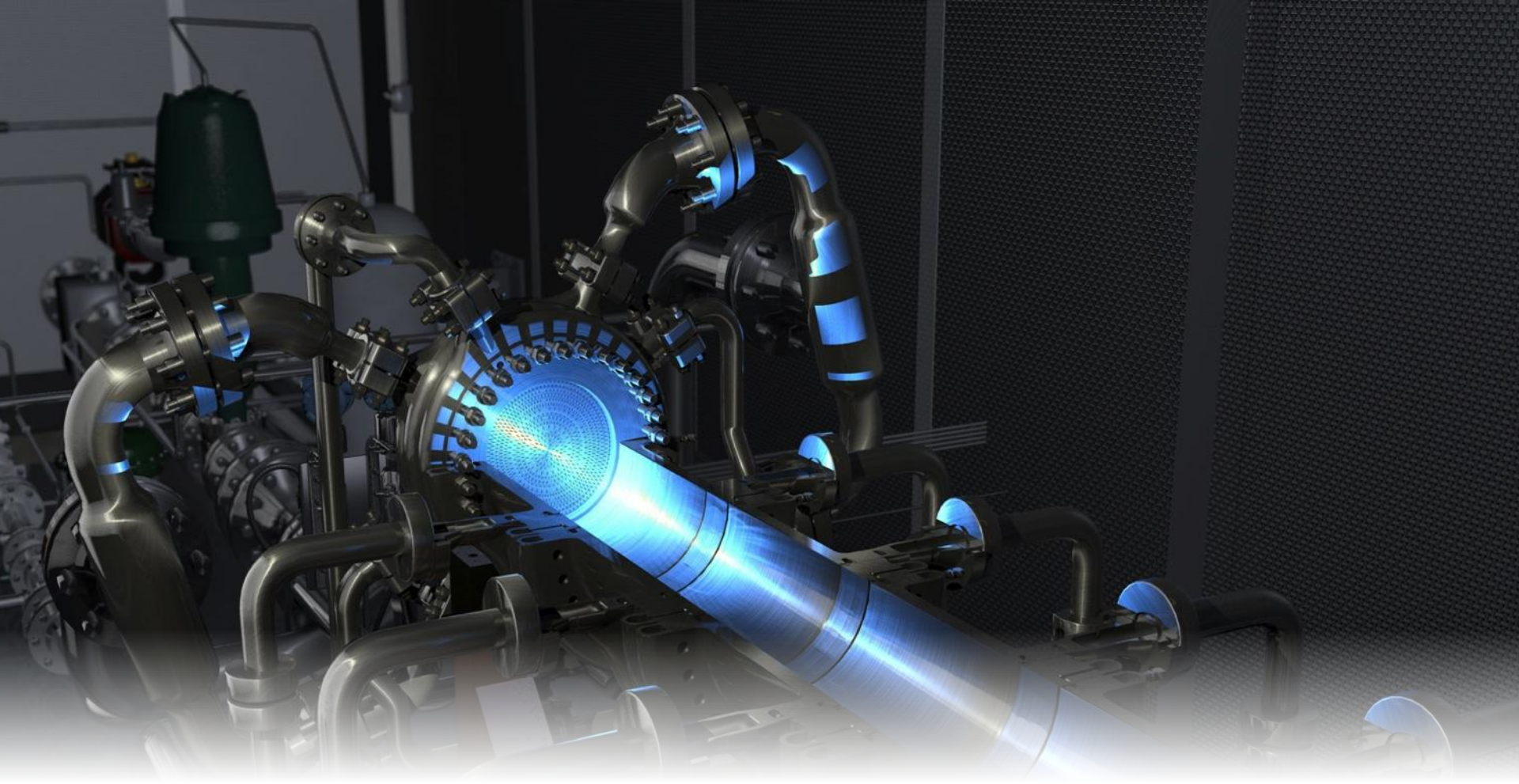
A composite image showing a space shuttle launch on the left, the shuttle Columbia in flight in the center, and a close-up of a turbine engine with a blue flame on the right.

Advanced Turbine Developments for Oxy-Combustion TriGen™ Plants

**2012 WESTCARB Business Meeting
October 16, 2012**

Agenda

- CES Overview
- CES Technology & Gas Generators
- First Commercial Oxy-Fueled Turbine (OFT-900)
- Manufacturing & Installation of OFT-900
- Next Steps



CES Overview

CES Overview

Company History and Recent Developments

- A technology company that uses proven rocketry principles to develop emission-free energy solutions for the energy industry:
 - ⇒ Principal deployment is the oxy-fuel combustor (“Gas Generator” or “GG”)
 - ⇒ Focus is the power and oil & gas sectors
- Diverse commercial applications:
 - ⇒ Zero-emission power plants (“ZEPP”)
 - ⇒ Enhanced oil recovery (EOR) and Potable Water for Commercial Markets
 - ⇒ Fast response ultra-clean peaking power plants
- Proprietary intellectual property and know-how: allows for creation of massive amounts of thermal energy, large volumes of high pressure steam, and CO₂
- Diverse commercial applications:
 - ⇒ 30 patents issued, 36 pending
 - ⇒ World’s largest oxy-fuel test facility: Bakersfield, CA
 - ⇒ Demonstration facility: Santa Clarita, CA

CES Overview

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.



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



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.



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.

CES Overview

Government Partners

United States



US Department of Energy: Two contracts awarded under competitive bidding: \$2.5 million in 2000 and \$4.8 million in 2005; increased by an additional \$30 million of ARRA funds in 2010. Total funding commitment: \$37.3 million



California Energy Commission: 3 separate contracts awarded; two for \$75,000 and one for \$4 million

International



UK Department of Energy and Climate Change (DECC): Co-funded a \$2 million study led by Jacobs Consultancy, with Siemens, MAN, Imperial College and others to study retrofitting existing coal-fired plants with the CES system



Norwegian Government: Provided funding through Gassnova to study offshore and industrial applications

Dutch Government: €18 million commitment for a steel mill demonstration project using CO₂ contaminated "fizzy gas"

CES Overview

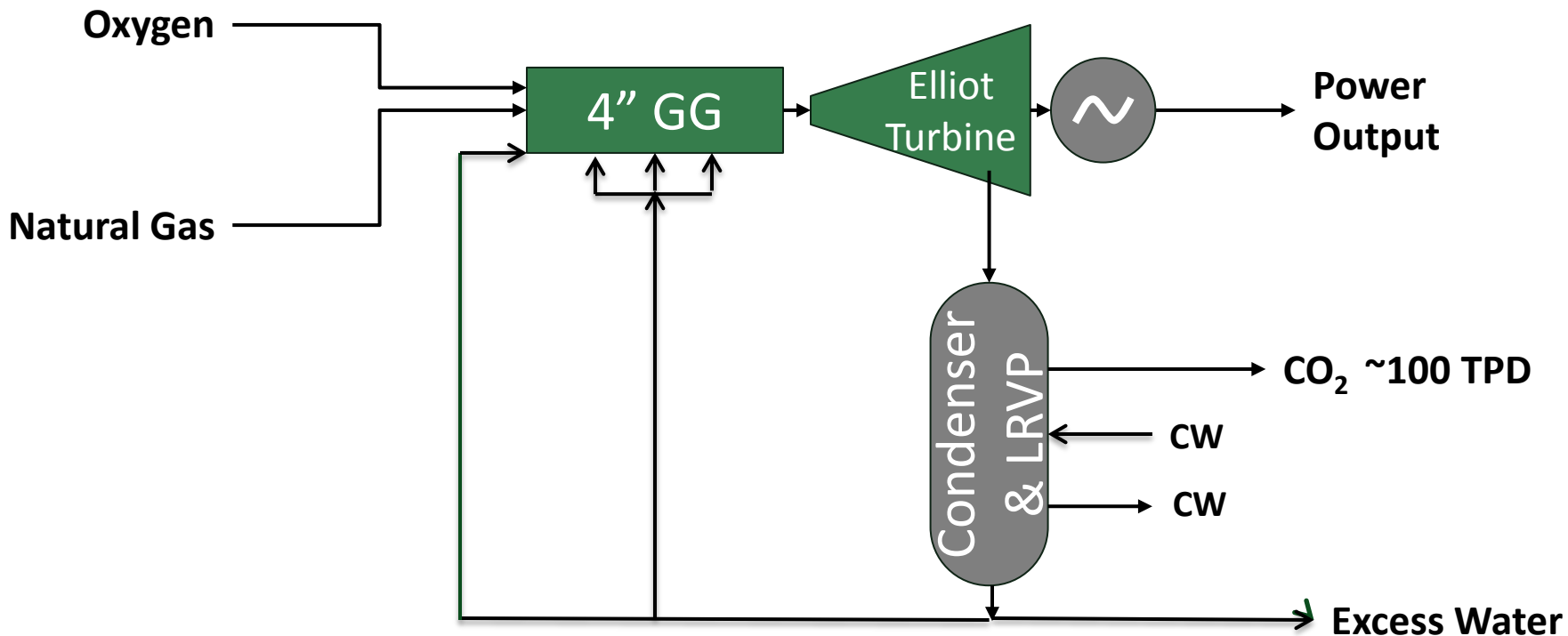
CES Facilities

- **Kimberlina Power Plant**
 - ⇒ World's largest oxy-fuel combustion facility
 - ⇒ 6 MW carbon capture, oxy-fuel power plant
 - ⇒ Primarily for R&D and sub-commercial operations
- **Placerita Power Plant, Santa Clarita, CA**
 - ⇒ Formerly a 120 MWe CHP plant
 - ⇒ Robust infrastructure ideal platform to deploy a wide variety of commercial products

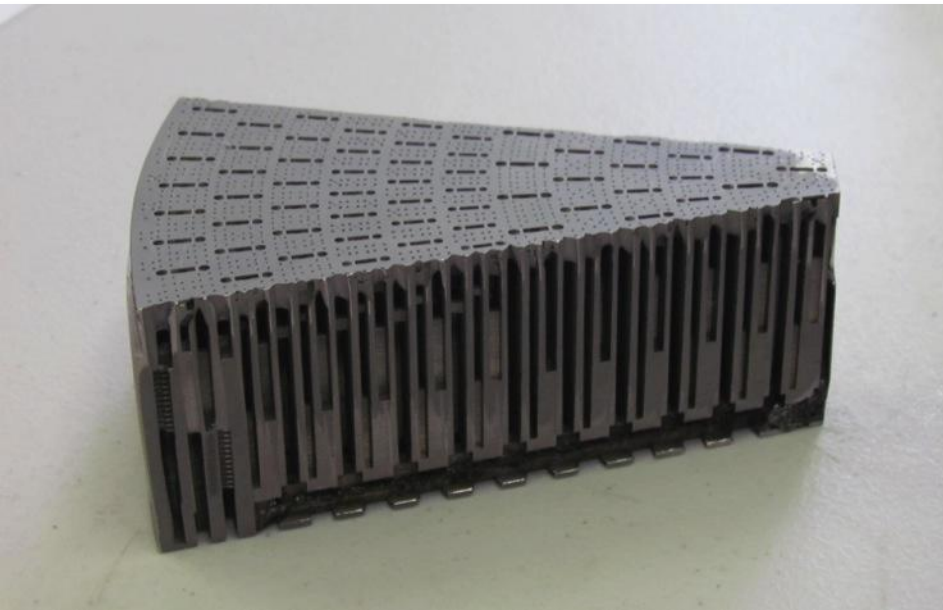
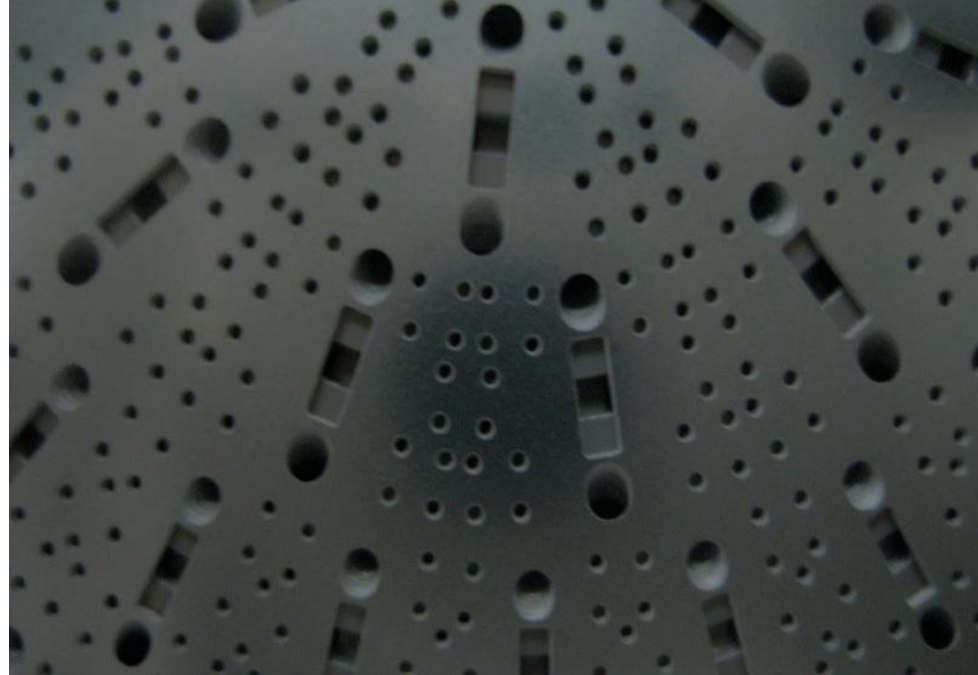


CES Overview

Kimberlina: World's First Oxy-Fuel 100% Carbon Capture Power Plant



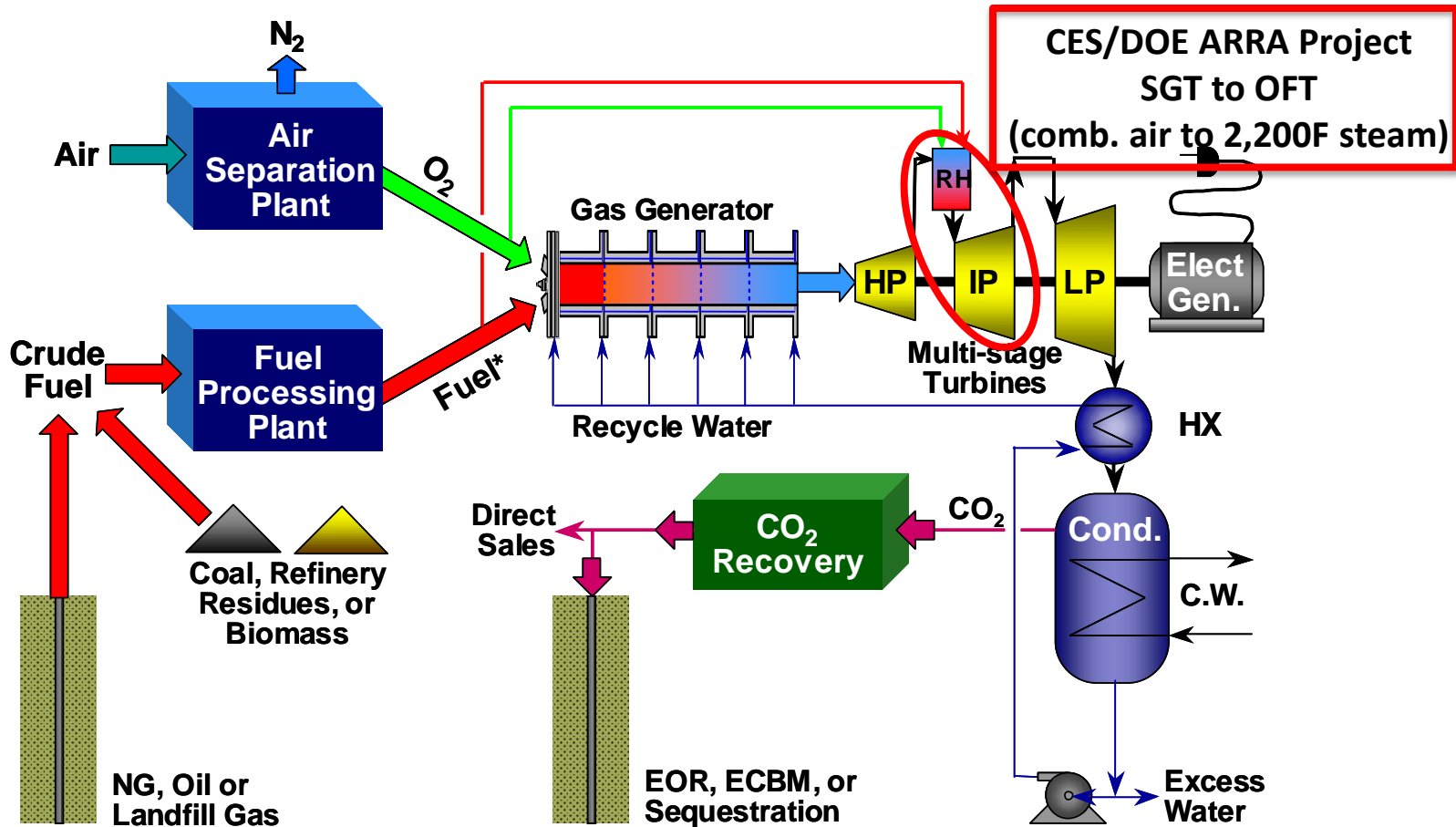
- **CES Technology: Platelet-Based Fuel Injectors**
 - ⇒ Hundreds of individual platelets are photo-etched to form 3-D channels
 - ⇒ Precisely stacked the platelets get pressure bonded into monolithic structures
 - ⇒ Intricate pathways channel bulk fuel, oxygen, and water into hundreds of combustors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



CES Overview

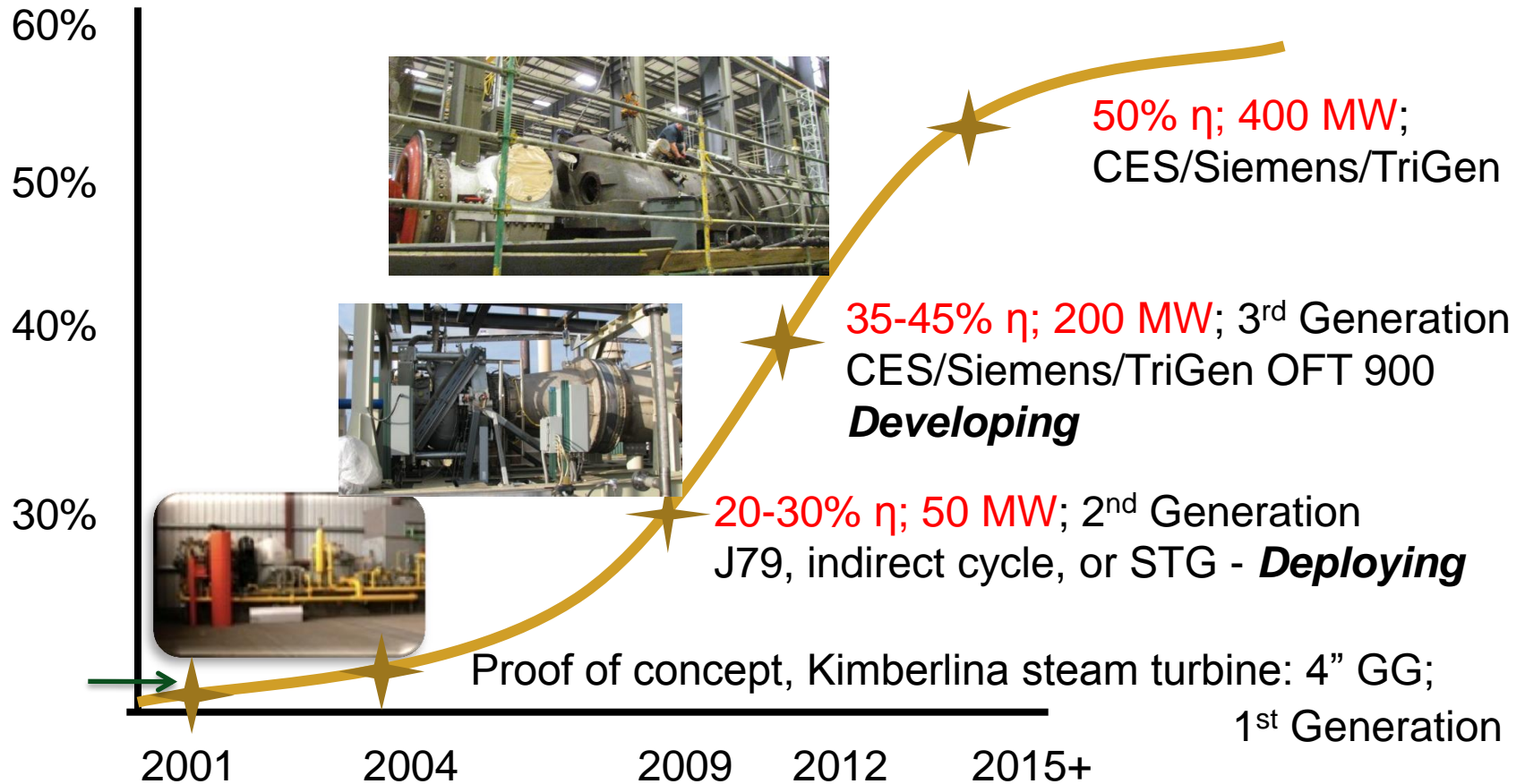
The TriGen™ Oxy-Fuel Cycle

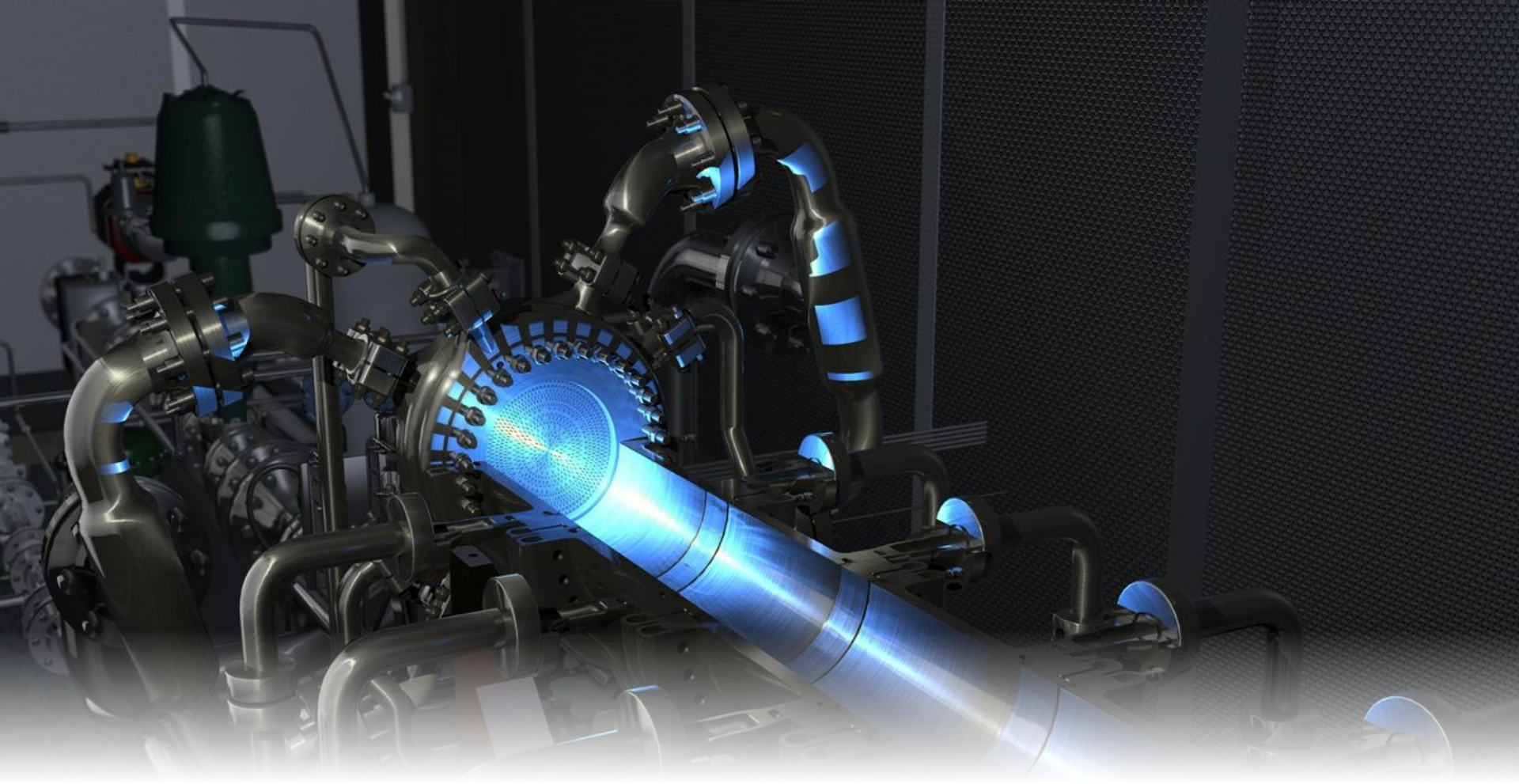
209 MW
CO₂: 2,300 TPD
Water: 508,000 GPD



CES Overview

Technology Development Plan





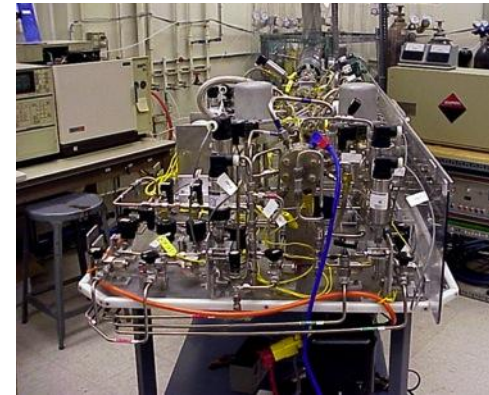
CES Gas Generators

CES Gas Generators

CES Gas Generators Evolution

- Bench-Scale (110kWt):
 - ⇒ 0.5" internal diameter
 - ⇒ Funded in part by the California Energy Commission
 - ⇒ Demonstrated proof-of-principle

- Pilot-Scale (20MWt):
 - ⇒ 4" internal diameter
 - ⇒ Replaces Kimberlina's boiler and drives 6 MW turbine
 - ⇒ Provides 100% carbon capture
 - ⇒ ~1600 starts
 - ⇒ ~2300 total run hours



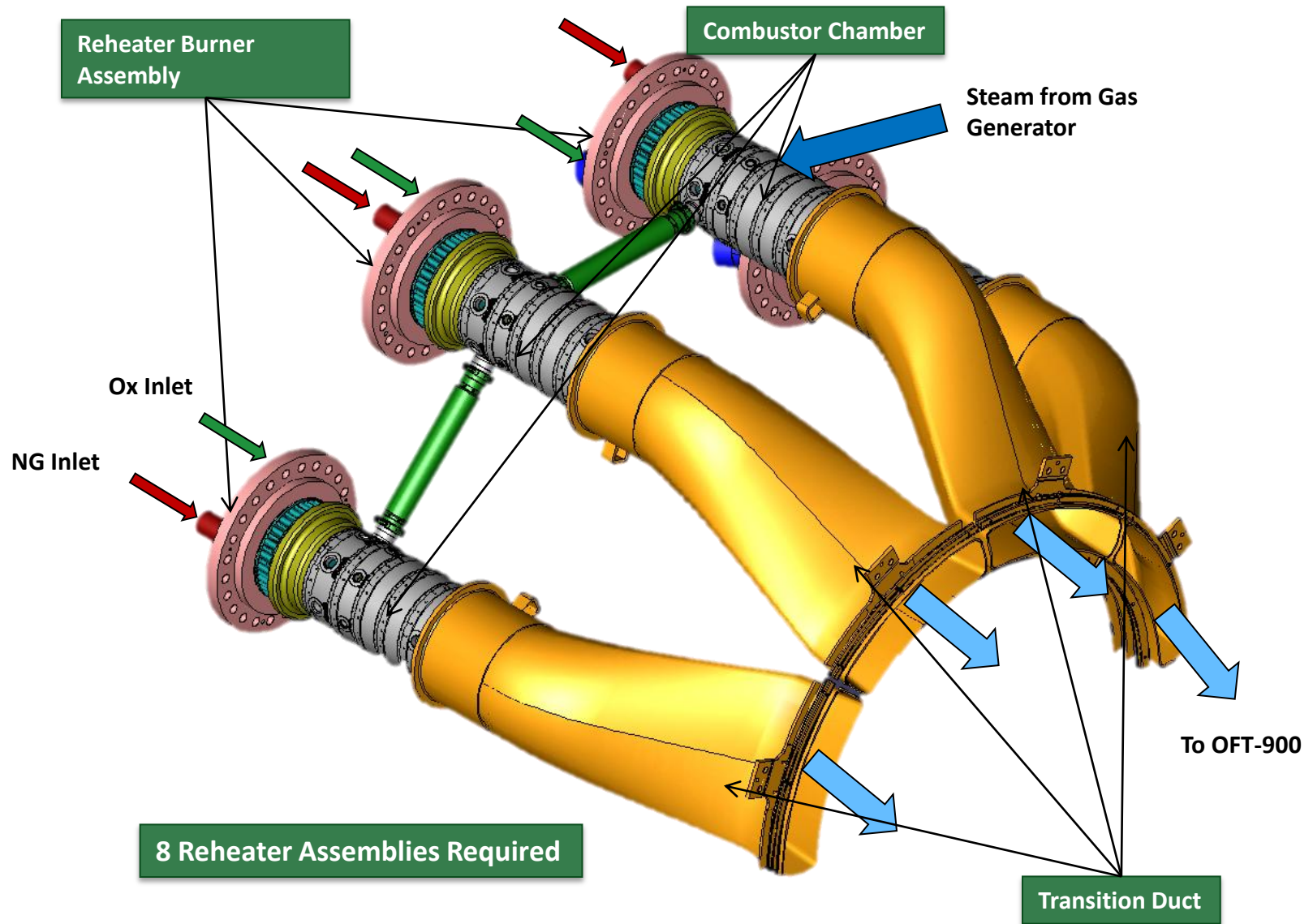
CES Gas Generators

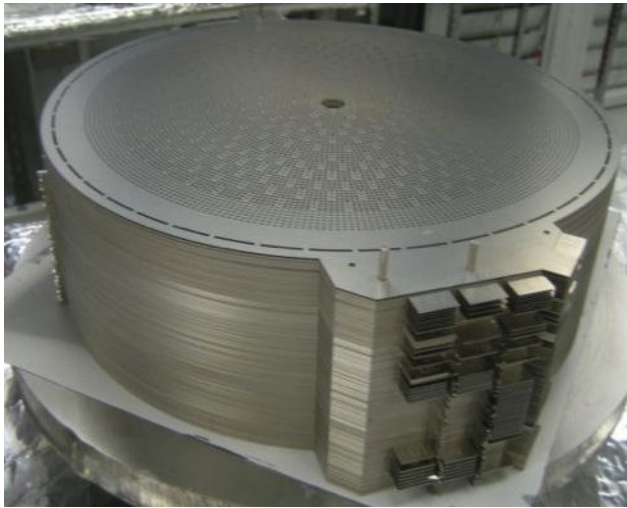
CES 12" Gas Generator For Powering Oxygen Fuel Turbines (OFTs)

- **Gas Generator (200MWt):**

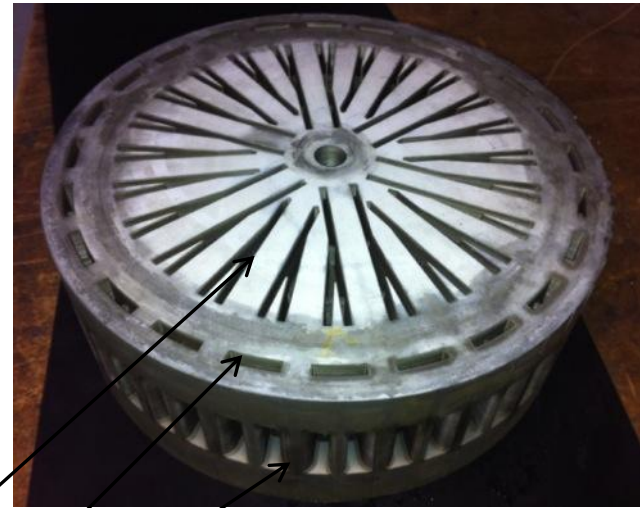
- ⇒ 12" internal diameter
- ⇒ ~500 starts
- ⇒ ~36 total run hours
- ⇒ Ranges: 20–800psig &
- ⇒ 400–1250°F (exhaust)



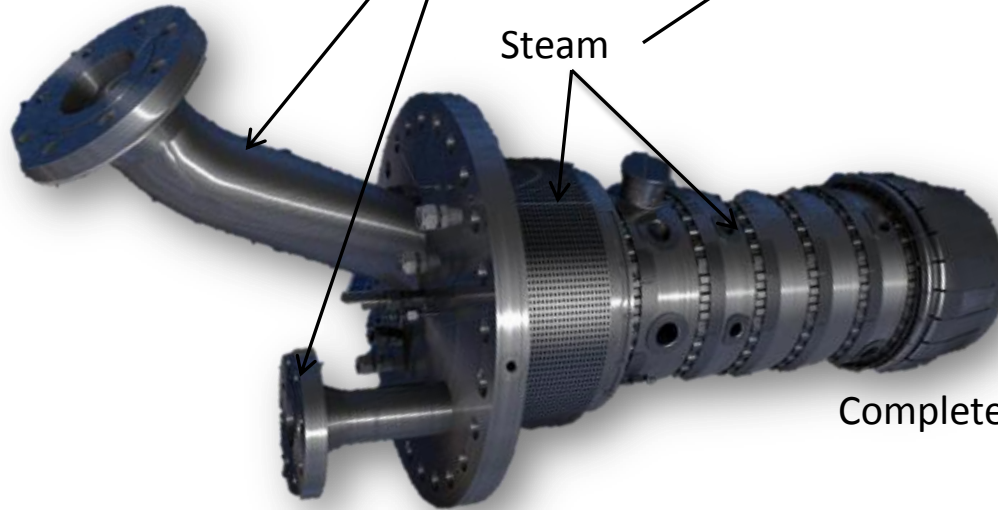




Top View; Pre-Bonding;
Pre- Machining



Bottom View; Post
Machining



Completed Reheater

Oxygen

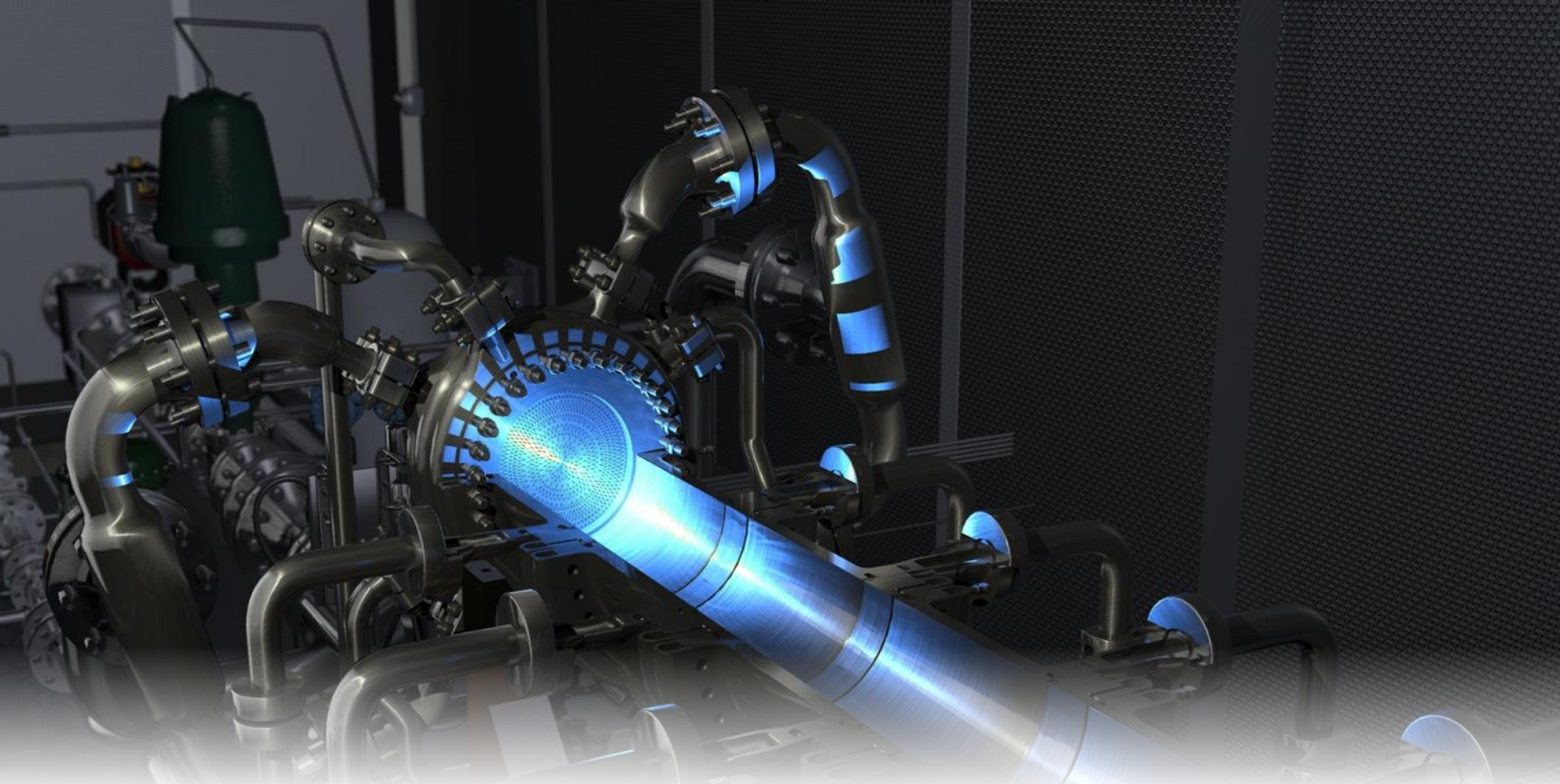
Natural Gas

Steam

CES Gas Generators

OFT-900 Re-Heater Test Stand





CES Commercial Oxy-Fueled Turbine (OFT-900)

CES – First Commercial Oxy-Fueled Turbine

US DOE Cooperative Agreement

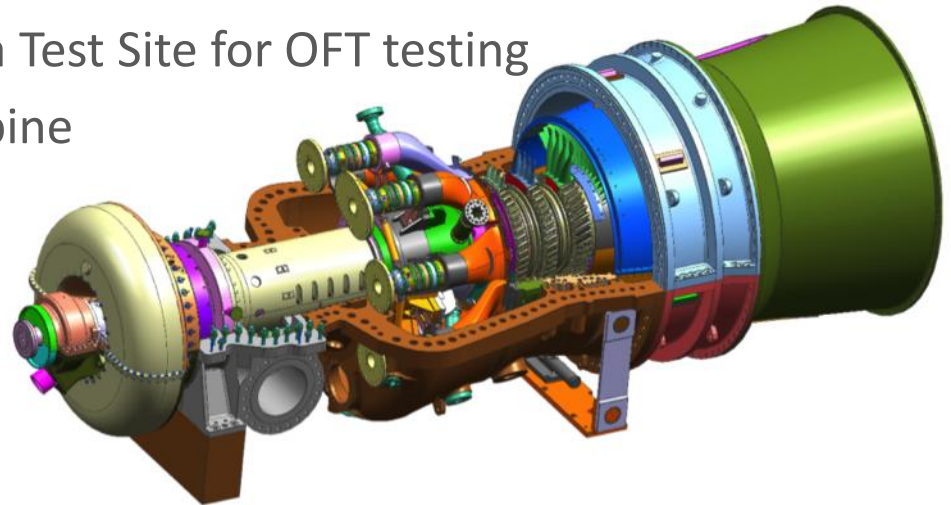
- Objective: Design, manufacture & test a commercial-scale oxy-fuel turbine (OFT) for use in industrial O-F plants that:
 - ⇒ Capture and sequester 99% of produced CO₂
 - ⇒ Operate at competitive cycle efficiencies
- Budget & Schedule:
 - ⇒ 48 months; FY2011 thru FY2014
 - ⇒ \$30M DOE (ARRA) funds & \$13M match funding
- Major Strategic Partners:
 - ⇒ Siemens Energy: Oil & Gas Division; TurboCare
 - ⇒ Florida Turbine Technologies, Inc.
- Results
 - ⇒ CES will complete all objectives by first quarter 2013; one-year ahead of schedule and on budget

CES – First Commercial Oxy-Fueled Turbine

Overview of CES/DOE Project

- Main Tasks:

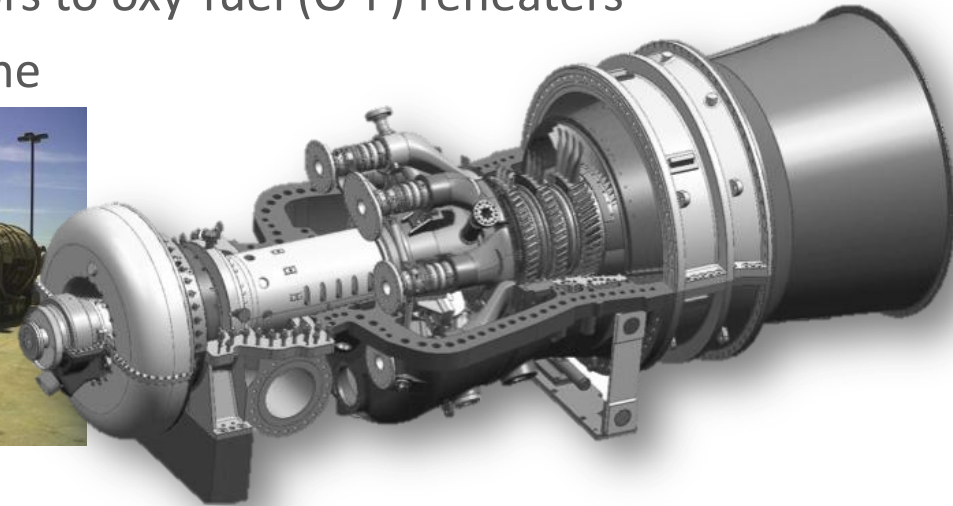
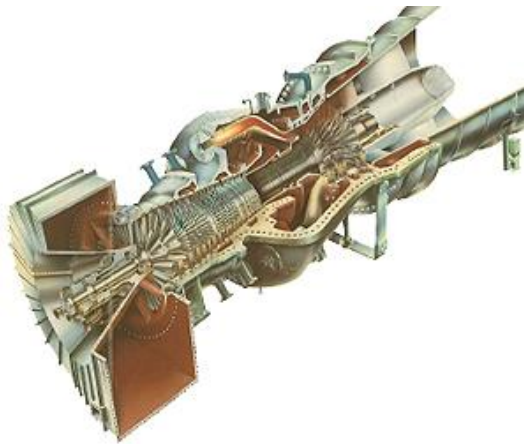
- ⇒ Prepare 12” GG for powering OFT-900
- ⇒ Finalize oxy-fuel turbine design
- ⇒ Evaluate & purchase base SGT
- ⇒ Design & manufacture OFT from base SGT
- ⇒ Upgrade existing Kimberlina Test Site for OFT testing
- ⇒ Install and test oxy-fuel turbine



CES – First Commercial Oxy-Fueled Turbine

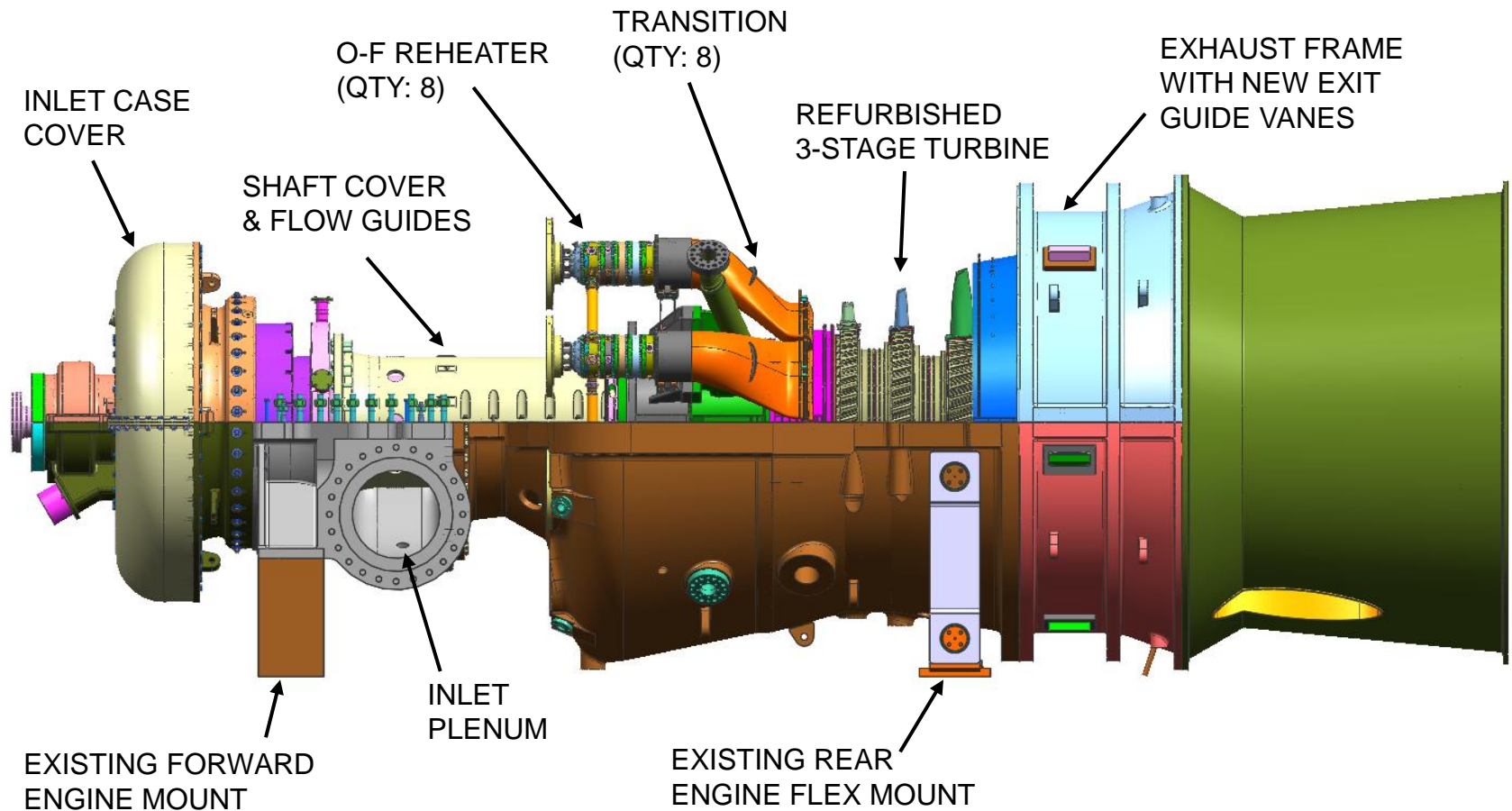
Major Changes to Convert an existing SGT-900 to an CES OFT-900

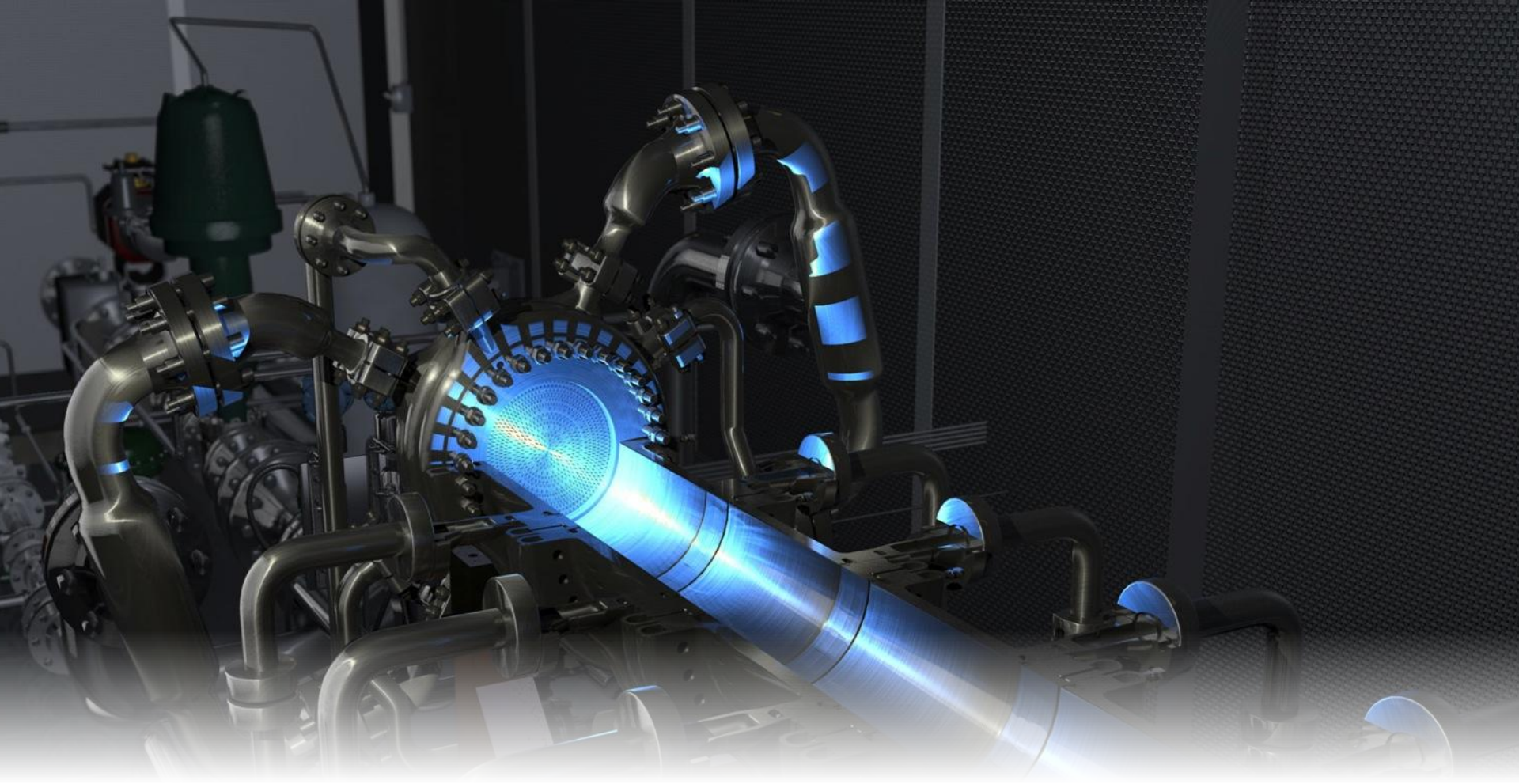
- Converting a 50MWe W251 turbine to a 150MWe oxy-turbine:
 - ⇒ Replace air intake with inlet steam flow system
 - ⇒ Replace compressor with new thrust balance system
 - ⇒ Convert air-breathing combustors to oxy-fuel (O-F) reheaters
 - ⇒ Add guide vanes at exit of turbine



CES – Commercial Oxy-Fueled Turbine

Final OFT-900 Design





OFT-900 Manufacturing and Installation

Manufacturing and Installation of the OFT-900

Turbine Removal from Abitibi Bowater Facility: March 2011



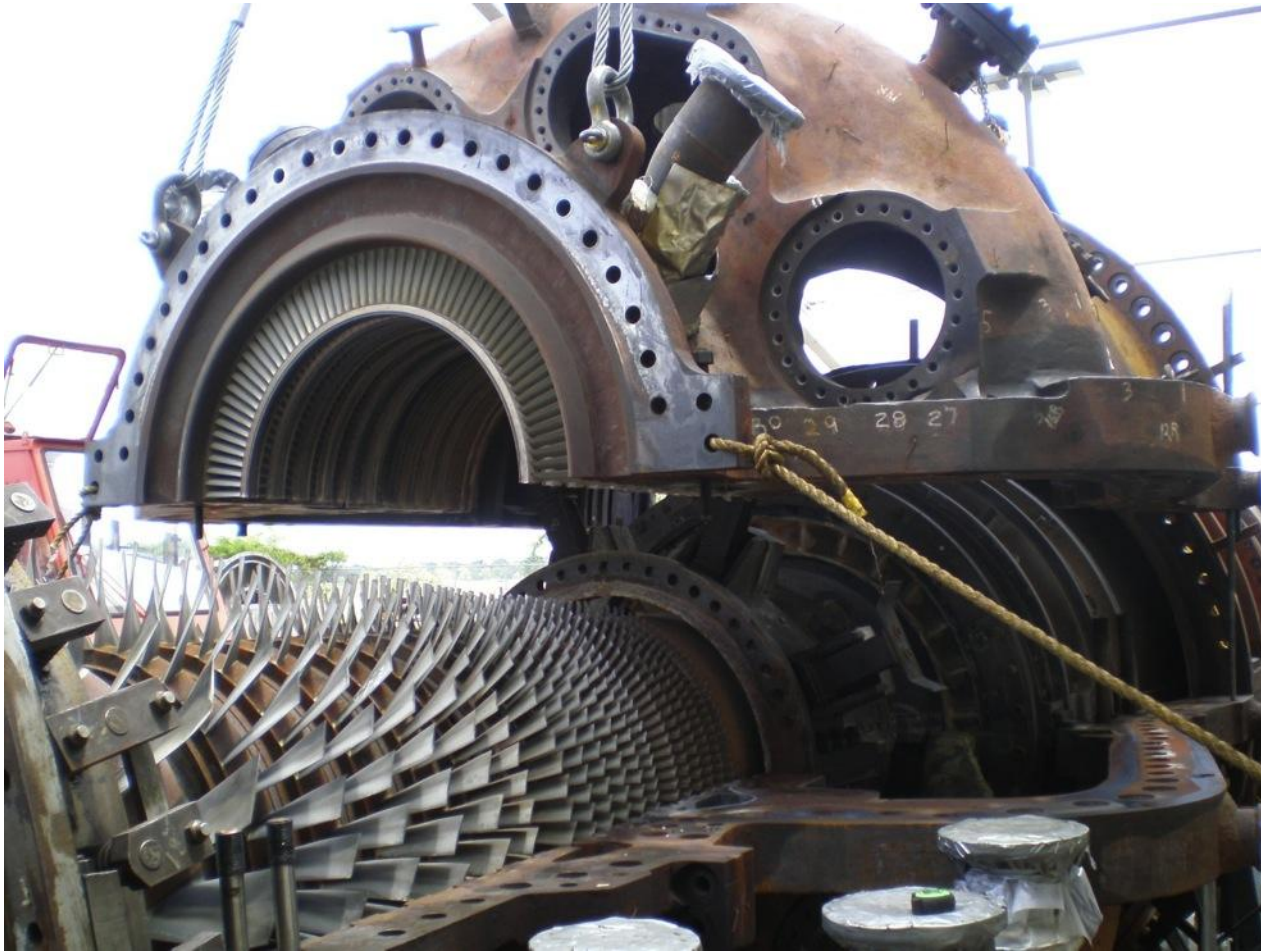
Manufacturing and Installation of the OFT-900

Arrival at TurboCare Facility: April 2011



Manufacturing and Installation of the OFT-900

SGT-900 Disassembly and Inspection: June 2011



Manufacturing and Installation of the OFT-900

Rotor Removal and Inspection: July 2011



Manufacturing and Installation of the OFT-900

Rotor Work Including Removal of Air Compressor: January 2012



Air compressor blades and disks have been removed.

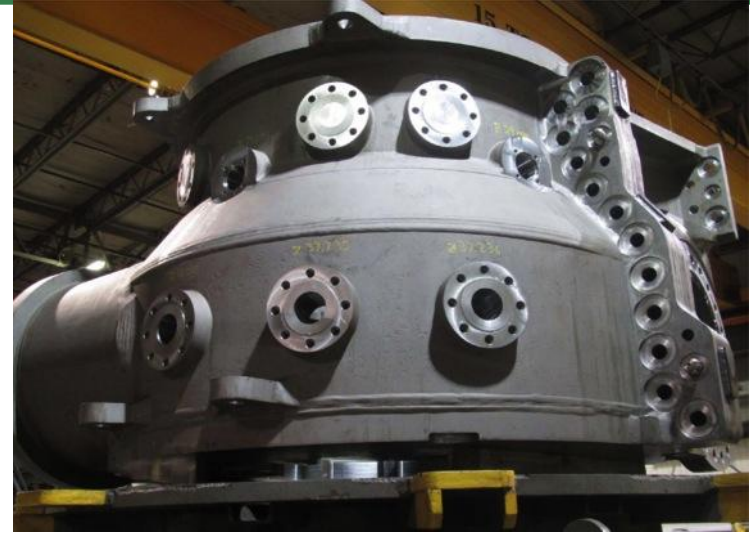
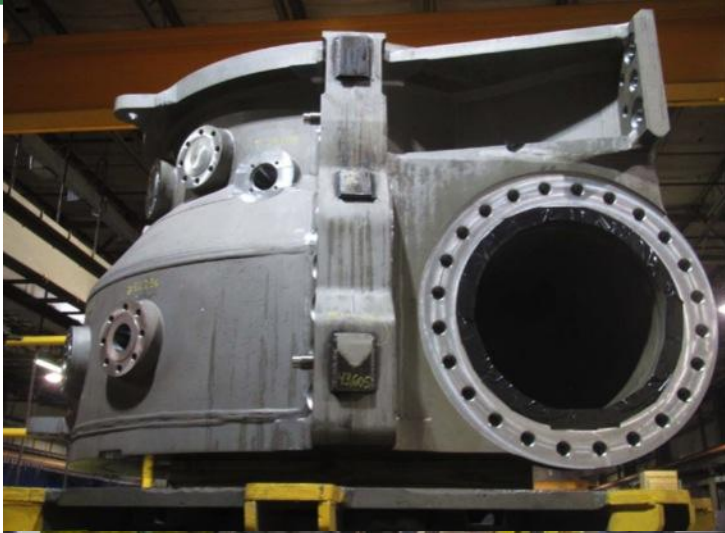
Manufacturing and Installation of the OFT-900

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



Manufacturing and Installation of the OFT-900

Manufacturing of OFT-900 Components: March 2012



Inlet Plenum



Inlet Housing Cover

Manufacturing and Installation of the OFT-900

Construction of OFT-900 Foundation at Kimberlina: May 2012



Manufacturing and Installation of the OFT-900

Re-Assembly of the SGT-900 as OFT-900: June 2012



Manufacturing and Installation of the OFT-900

Completion and Shipping of the OFT-900: July 2012



Manufacturing and Installation of the OFT-900

Arrival of the OFT-900 in Bakersfield: August 2012



Manufacturing and Installation of the OFT-900

Placing the OFT-900 on Foundation: September 2012



Manufacturing and Installation of the OFT-900

Installed OFT-900: September 2012



Manufacturing and Installation of the OFT-900

Installing the Generator: September 2012



Manufacturing and Installation of the OFT-900

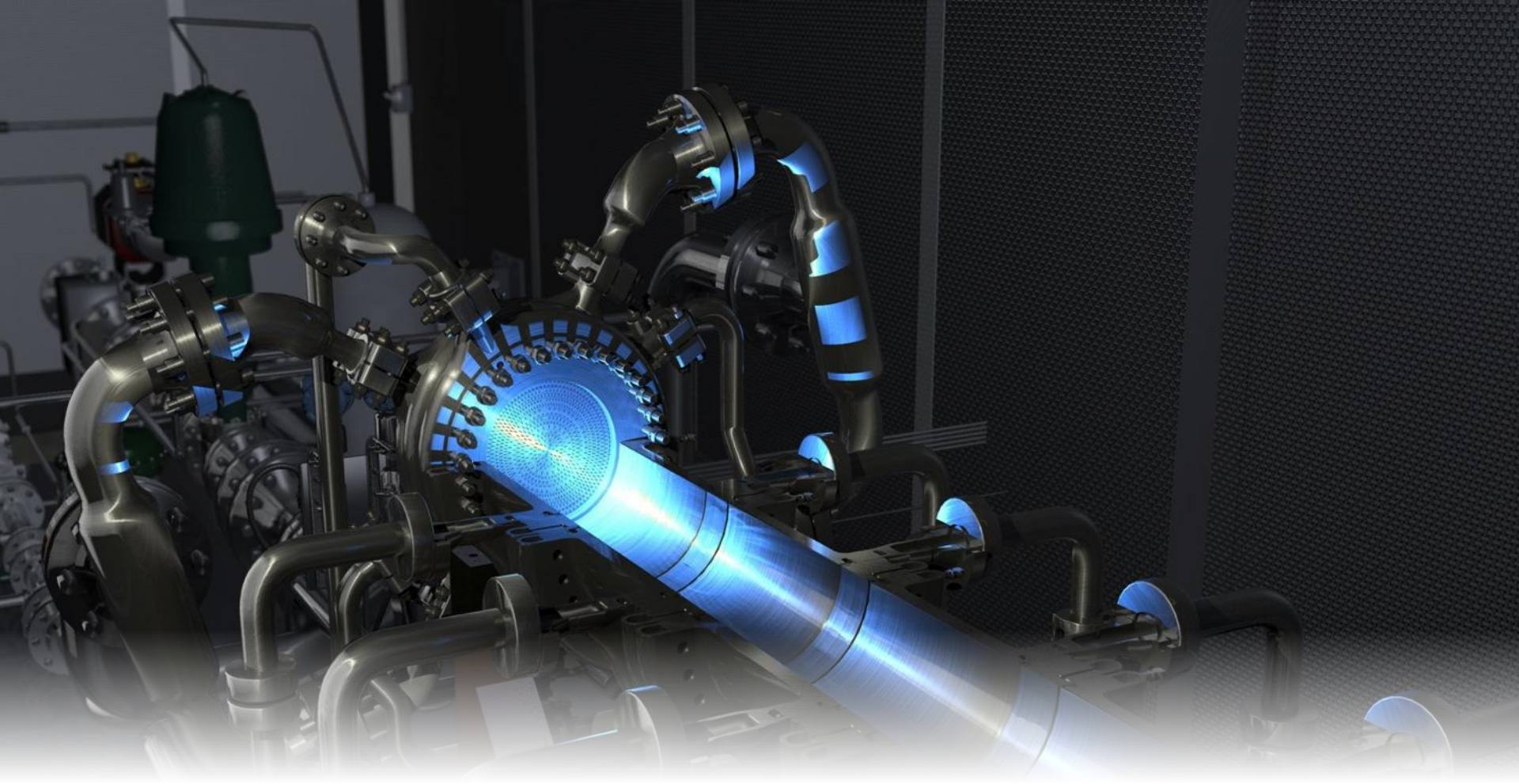
Installation of Temporary Stack: September 2012



Manufacturing and Installation of the OFT-900

Completed Installation of OFT-900 and Generator: September 2012





CES' Next Steps

Next Steps

1. Complete DOE contract during 1st qtr. 2013: on schedule and on budget.
2. Conduct post DOE system testing to further demonstrate commercial readiness of the OFT-900 system.
3. Place KPP-45 into long-term operations.
 1. CO2 supply contract(s) to EOR operations
 2. PPA and/or wholesale electric supply contract(s)
 3. Potable water supply agreement
4. Develop alternative project plans/locations if KPP-45 contracts and funding are better achieved elsewhere.
5. Continue ongoing discussions with strategic partners for US and global TriGen (i.e. zero-emission power, CO2 , potable water) projects