

# ZEROS

## Zero-emission Energy Recycling Oxidation System



**ZEROS (Zero-emission Energy Recycling Oxidation System)** is an “oxy-fuel” technology developed in the late 1980s and 1990s to clean up oil-field waste without producing atmospheric emissions or water pollution. Using pure oxygen rather than air, ZEROS creates the high temperatures needed to completely oxidize hazardous organic wastes, producing oxygen, pure carbon dioxide, distilled water and ash.

ZEROS will soon be commercialized to produce electrical energy, liquid fuels, pure carbon dioxide and distilled water with a complete sequestration of carbon, carbon dioxide, nitrous oxides, sulfur, mercury, hydrocarbon particulates and other contaminants. A variety of organic materials can be used as feedstocks including coal, lignite, municipal waste, wood materials and agricultural biomass and manure.

By using pure oxygen as the oxidant, the system produces the high temperatures from fuels that would not normally be considered for traditional or Integrated Gasification Combined Cycle (IGCC) technologies. Since  $N_2$  from the air is not involved in the process, the system produces only pure carbon dioxide, water and ash.

### Primary Products

- **Electrical Energy**—Steam to drive turbines and generators
- **Liquid Fuels**—Synthetic gas that is reformed into liquid fuels
- **Pure Carbon Dioxide**—Pure carbon dioxide for injection into oil reservoirs to enhance production or other uses
- **Distilled Water**—Water used directly or blended with lower quality water for municipal and industrial use

### Carbon Dioxide Emissions

- **Zero carbon dioxide emissions** when powered with fossil fuels and when the resulting pure carbon dioxide is injected in deep geologic formations
- **Net negative carbon dioxide emissions** when powered with renewable biomass such as manure, wood waste and crop biomass and when carbon dioxide is injected in the geological formations



ZEROS UNIT

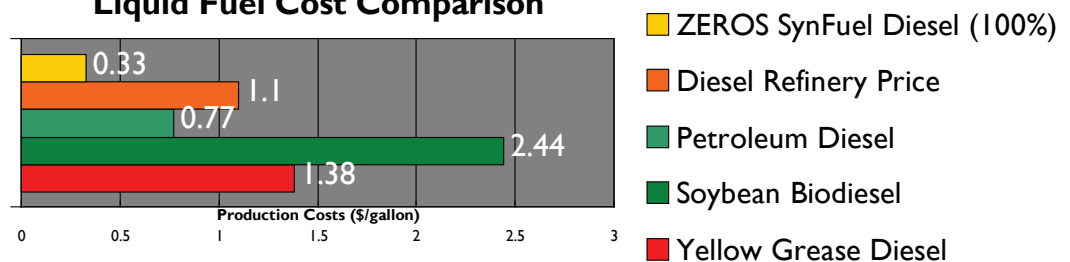


## The ZEROS Advantage

ZEROS combines several well-known technologies into a unique system with many advantages.

- **Multiple fuels** (coal, lignite, municipal solid waste, scrap tires, agricultural waste and biomass) can be used without significant pre-processing.
- **Fuels are oxidized** with pure oxygen from a co-located air separation unit.
- **Initial gasification**, partial oxidation of the fuels is accomplished in the primary reaction vessel, a rotary kiln. The partially oxidized fuel gas is then sent for complete oxidation for steam reforming.
- **The synthesis gas** that is produced in the rotary kiln moves to a secondary reaction vessel where it is completely oxidized with pure oxygen to  $\text{CO}_2$  and  $\text{H}_2\text{O}$ , which are captured as pure liquid (or solid)  $\text{CO}_2$  and distilled water.
- **Heat released by oxidation** of the syngas is used to boil water that drives a steam turbine and electrical generator.
- **A portion of the syngas can be steam reformed** by the well-known Fisher-Tropsch reaction to liquid fuels.
- **Commercial products include:**
  - Electricity
  - Pure liquid (or solid)  $\text{CO}_2$
  - Distilled water
  - Argon and nitrogen (from the air separation unit)
  - Liquid fuel (naptha, gasoline, kerosene, diesel, or home heating oil)

### Liquid Fuel Cost Comparison



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## IPCC Report Validates Oxy-Fuel Processes

The Intergovernmental Panel on Climate Change's (IPCC) "Special Report on Carbon Dioxide Capture and Storage" describes several advantages of oxy-fuel combustion. Oxy-fuel technology "uses oxygen instead of air for combustion, producing a flue gas that is mainly H<sub>2</sub>O and CO<sub>2</sub> and which is readily captured." The IPCC report states that "oxy-fuel combustion applied to furnaces, process heaters, boilers and power generation systems is feasible since no technical barriers for its implementation have been identified."

In addition, the report predicts that "future oxy-fuel capture systems based on coal firing...could potentially match the best efficiencies realizable today for pulverized coal-fired plants without CO<sub>2</sub> capture." It also predicts future "plant efficiencies for natural gas-fired oxy-fuel cycles with CO<sub>2</sub> capture above 50%." The IPCC report points out that it should be possible to retrofit oxy-fuel combustions systems "to existing equipment such as process heaters and boilers, in order to minimize development costs and achieve early market entry."

The IPCC report concludes that other key components of ZEROS technology are feasible and advantageous. For example:

- "The key separation step in most oxy-fuel capture systems (O<sub>2</sub> from air) is an existing technology."
- "Gasification ...is a chemical process aimed at making high-value products (chemicals, electricity, clean synthetic fuels) out of low-value solid feedstocks such as coal, oil refining residues, or biomass."
- "When using a low H:C ratio fuel such as coal it is possible to gasify the coal and to convert the syngas to liquid Fisher-Tropsch fuels and chemicals, which have a higher H:C ratio than coal."
- "The overall reduction in flow volumes, equipment scale and simplification of gas purification steps will then have the benefit of reducing both capital and operating costs of equipment deployed for combustion, heat transfer, and final gas purification in process and power plant applications."

## ZEROS Benefits for Communities

ZEROS promises multiple socioeconomic benefits for communities where it is installed. It can produce electrical energy, liquid fuels, carbon dioxide and water for local consumption without air pollution and zero or negative carbon dioxide emissions. Its fuels, including solid wastes and crop biomass, can be obtained locally, stimulating regional economies.

This process gives the power generation and utilities industries fuel diversity by using biomass, agricultural waste, scrap tires and coal waste to produce electricity with no adverse atmospheric emission and reducing the dependence on imported hydrocarbon fuels.