Using Coal Mine Methane as a Clean Power Source for Mining Operations

Ener-Core manufactures power generation products which enable coal mine operations to cleanly generate power from gases that previously were wasted or had no economically viable use. Ener-Core's systems leverage an anticipated worldwide trend towards decreasing methane emissions and increasing coal mine gas utilization. Ener-Core Powerstations utilize a greater range of gas including low-quality gas for:

- Avoiding flaring and venting
- Transforming a source of unwanted emissions and pollution into onsite power
- Powering production processes by converting difficult to destroy methane gas into low emissions electricity

Ener-Core's Solution to Convert Air Pollution into Clean Power

Ener-Core's Gradual Oxidation technology can effectively convert impure and low energy density gases into a form which can be processed by gas turbines to produce electricity and heat.

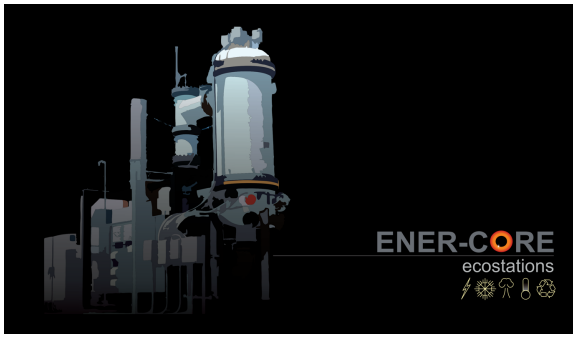
We believe that our customers can greatly reduce the cost of compliance with air quality and emission regulations by avoiding the chemicals, catalysts, and complex permitting required by competing systems. Our products are specifically engineered for fuel flexibility and modularity, so that low-quality fuel gases can be used as an energy resource instead of being a waste and emissions source from venting and flaring.

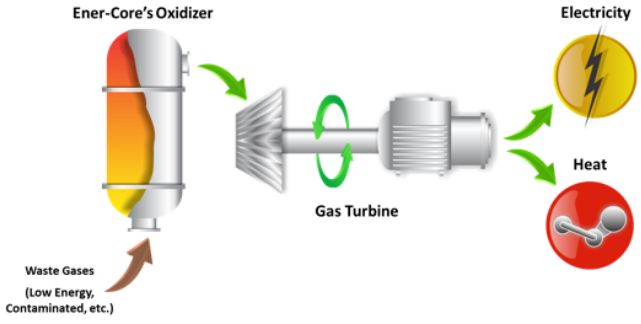
Technology

Gradual Oxidation works by replacing a combustion reaction with a chemically similar, but slower chemical oxidation reaction which occurs at lower temperatures than combustion. Our technology extends a historical trend in engine technology seeking to improve emissions and expand the fuel operating range. Our systems are designed to allow for the extraction of energy from previously unusable fuels, reduce harmful pollutants, and create useful energy products such as heat and electricity. We have completed a number of development and deployment milestones in the last five years. In 2012, our technology successfully underwent testing and verification completed by an independent third party as part of U.S. Department of Defense ("DoD") demonstration program.

Coal Mine Methane Utilization Benefits of an Ener-Core Powerstation

- Unprecedented capability to use weaker fuels like vented gas from coal mine operations
- No need for water, chemicals or catalysts
- Tolerant of changes to gas composition while operating
- Achieve low emissions (Less than 1ppm NOx is achievable)
- Capability of generating from a wide range of coal operations including coal bed methane (CBM), abandoned mine methane (AMM) and ventilation air at 1.5% methane (VAM)
    - FP250: up to 10,500 metric tons of CO_2e avoided annually from a 250 kW system
    - KG2-3GO: up to 68,000 metric tons of CO_2e avoided annually from a 1850 kW system





TURN POLLUTION INTO A RESOURCE THAT PAYS FOR ITSELF

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Is your operation ideal for an Ener-Core Powerstation? *It may be if it has several of the following…*

- ☑ **Low Quality Gas**:
  - **Low Energy Density Gas (Low Calorific Value)**
    - Gas from abandoned/closed mines may be too low in energy density (below 300 Btu/scf) to use in reciprocating engines or gas turbines. Disposing of this gas without interruption to operations may be difficult, especially if venting and/or flaring are restricted.
  - **Ventilation Air Methane (VAM)**
    - Underground mine vent air has large amounts of methane gas, but is too low in methane content (below 2% methane) to be flared without supplement fossil fuel or to be converted to power with traditional reciprocating engines or gas turbines.
  - **Methane Drainage Systems**
    - Some mines have degasification or methane drainage systems. The bleeder or bore hole for these drainage systems may have gas which is low in energy density, ranging from about 3% methane to 25% methane. This low energy density limits the choices to venting or flaring with added fossil fuel.
- ☑ **Emissions Concerns or Emissions in Non-attainment.** The site may need to reduce existing air pollution, such as high oxides of nitrogen (which leads to ozone and then smog) and carbon monoxide emission levels, to avoid fines, operations restrictions or shutdown within a non-attainment region.
- ☑ **Coal Mine Gas Collection with Continuous Supply of Gas.** Flares are currently in place, and gas is being flared or vented continuously.
- ☑ **Demand for Onsite Power or Supply Concerns from Utility Grid.** If there are onsite energy needs or are concerns about supply from the grid, then retail electricity prices can be offset with low value gas

Products

FP250

250 kW Product: The Ener-Core Powerstation FP250 combines Gradual Oxidization with a 250 kW gas turbine, developed by Ingersoll-Rand plc. and FlexEnergy, Inc. Ener-Core's Gradual Oxidizer replaces the turbine's standard combustor, resulting in a generation system with a wide fuel operating range and ultra-low emissions.

KG2-3G w/GO

2 MW Product: Our next generation product, the Ener-Core Powerstation KG2-3G w/GO, combines our Gradual Oxidizer technology with a two megawatt gas turbine, developed by Dresser-Rand Group Inc. Ener-Core is accepting orders for this unit now.

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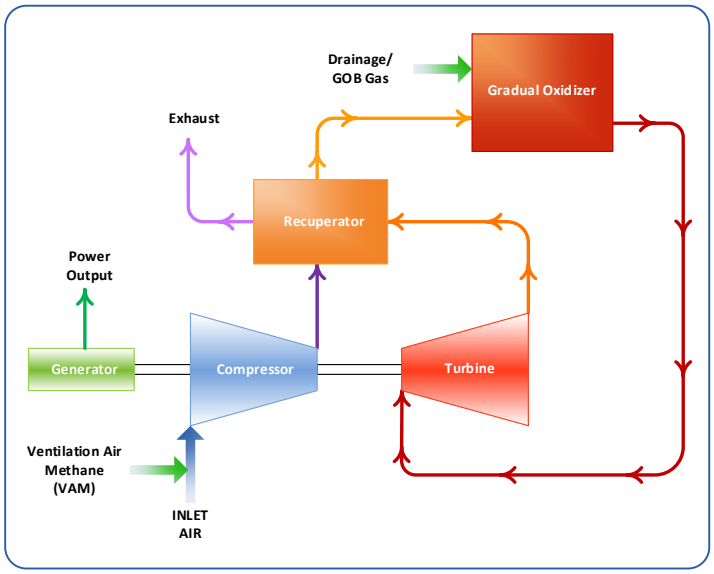
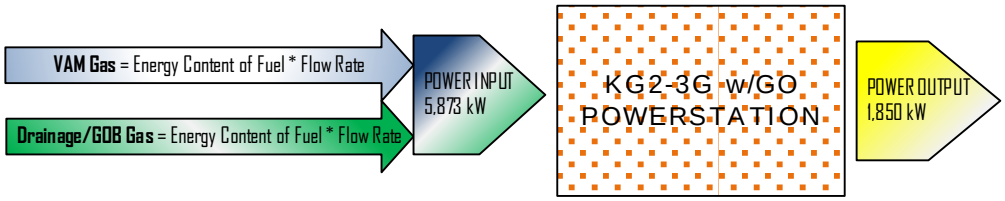
Technical Specification

In coal mine applications, Ener-Core's Powerstation will operate on a combination of ventilation air methane (VAM) and drainage or GOB gas. The VAM will be aspirated at the compressor inlet as the inlet air while the GOB gas will be delivered at pressure directly into the Gradual Oxidizer. The process flow for this "dual" configuration is shown in the figure on the left. A dual-feed approach is utilized because the VAM alone doesn't contain enough energy to operate the Powerstation. During operation the Powerstation will control the amount of GOB gas injected in the oxidizer to regulate the energy input. As the VAM concentration fluctuations, the GOB gas flow rate will be increased or decreased to maintain the gas energy conditions in the Gradual Oxidizer.



Powerstation Energy Balance:

The KG2-3G w/GO requires 5,873 kW of power input while the FP250 requires 1042 kW of power. The energy input of the machine is a function of the flow rate and energy content of the two fuels. Should the methane concentrations for the VAM increase less GOB flow will be required and vice-versa.



Typical Fuel Input Requirements:

The following table indicates the flow requirements for 0.8% ventilation air methane and 70% methane drainage/ GOB gas.

	FP250		KG2-3G w/GO	
	VAM Fuel Requirements			
% Methane	0.8%			
Flow Rate	3615 scfm	6130 NM^3/hr	15923 scfm	27001 NM3/hr
Pressure	5 psig	35 kPa	5 psig	35 kPa
	Drainage/GOB Gas Fuel Requirements			
% Methane	70.0%			
Flow Rate	44 scfm	75 NM^3/hr	299 scfm	507 NM^3/hr
Pressure	75 psig	517 kPa	140 psig	965 kPa
Power Output	250 kW		1850 kW	

Please contact Ener-Core (info@ener-core.com) for an analysis tailored to your site or project needs. (www.ener-core.com)