

# *Microturbine Developments at Ingersoll Rand Energy Systems*

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# Microturbine Developments at Ingersoll Rand Energy Systems

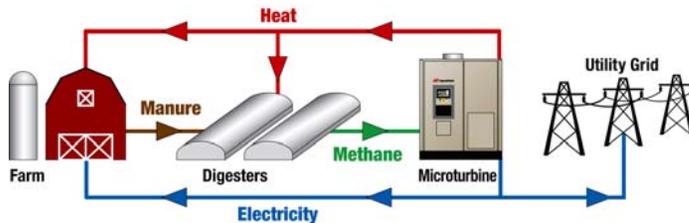
- Ingersoll-Rand Microturbine Technology
- Energy Services Company
- CARB 2007 Certification
- Dual Mode Capabilities
- Fuel Conditioning Skids
- Case Studies



MT70 & MT250

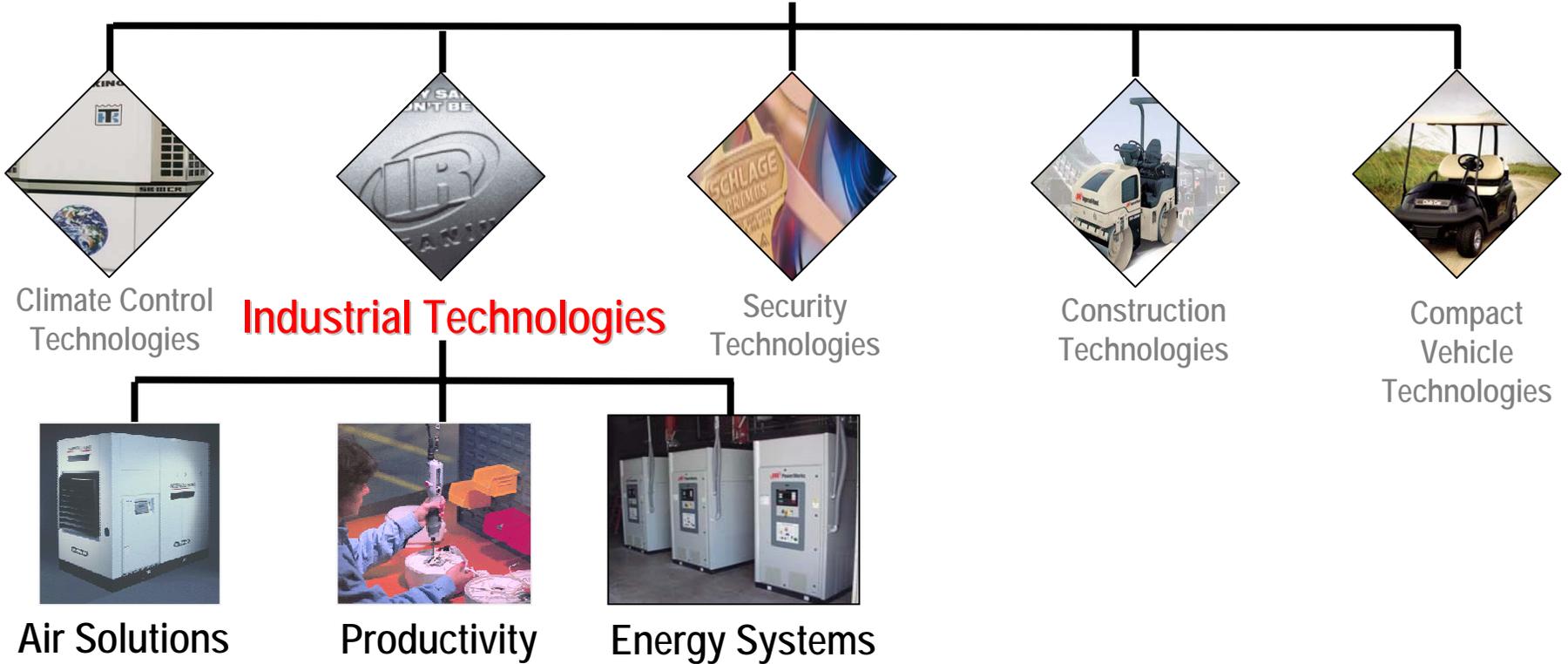


Fuel Conditioning



Clean DG

# Global Innovation and Solutions Provider



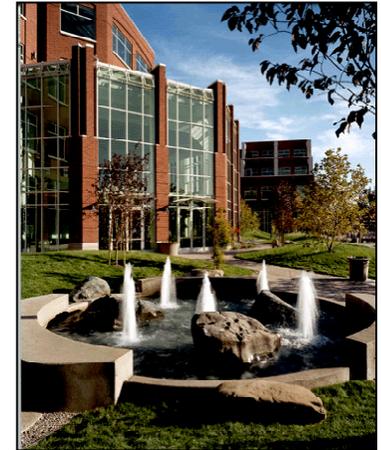
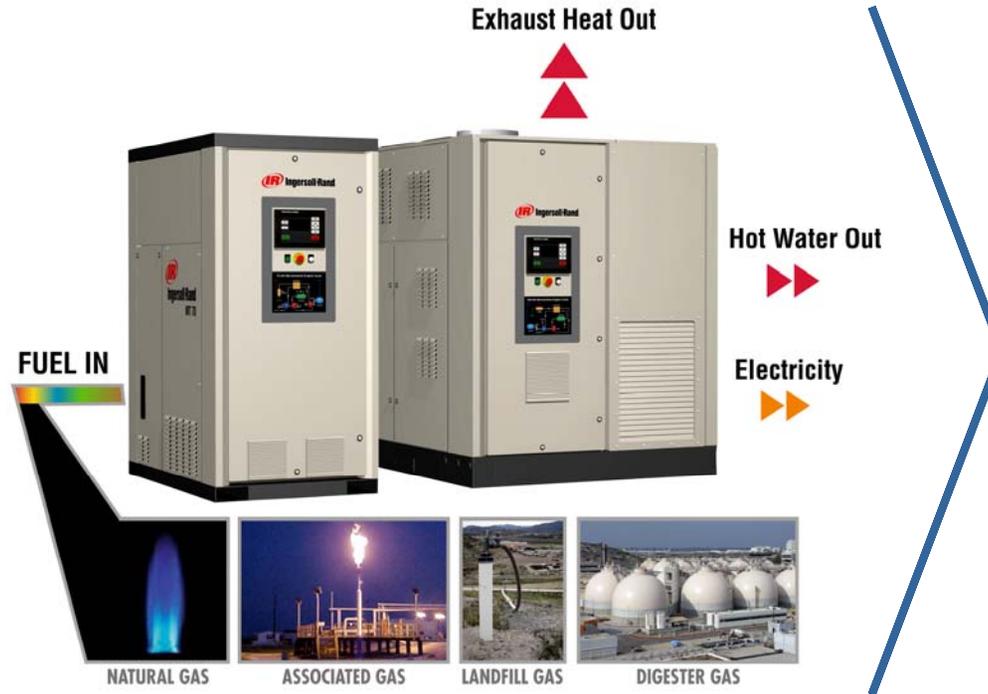
**\$10b Global Company (NYSE:IR) with a 100-year-old heritage of technological innovation**  
**40,000 employees and 80 manufacturing facilities worldwide**

# Why Distributed Generation?



## Central power plant

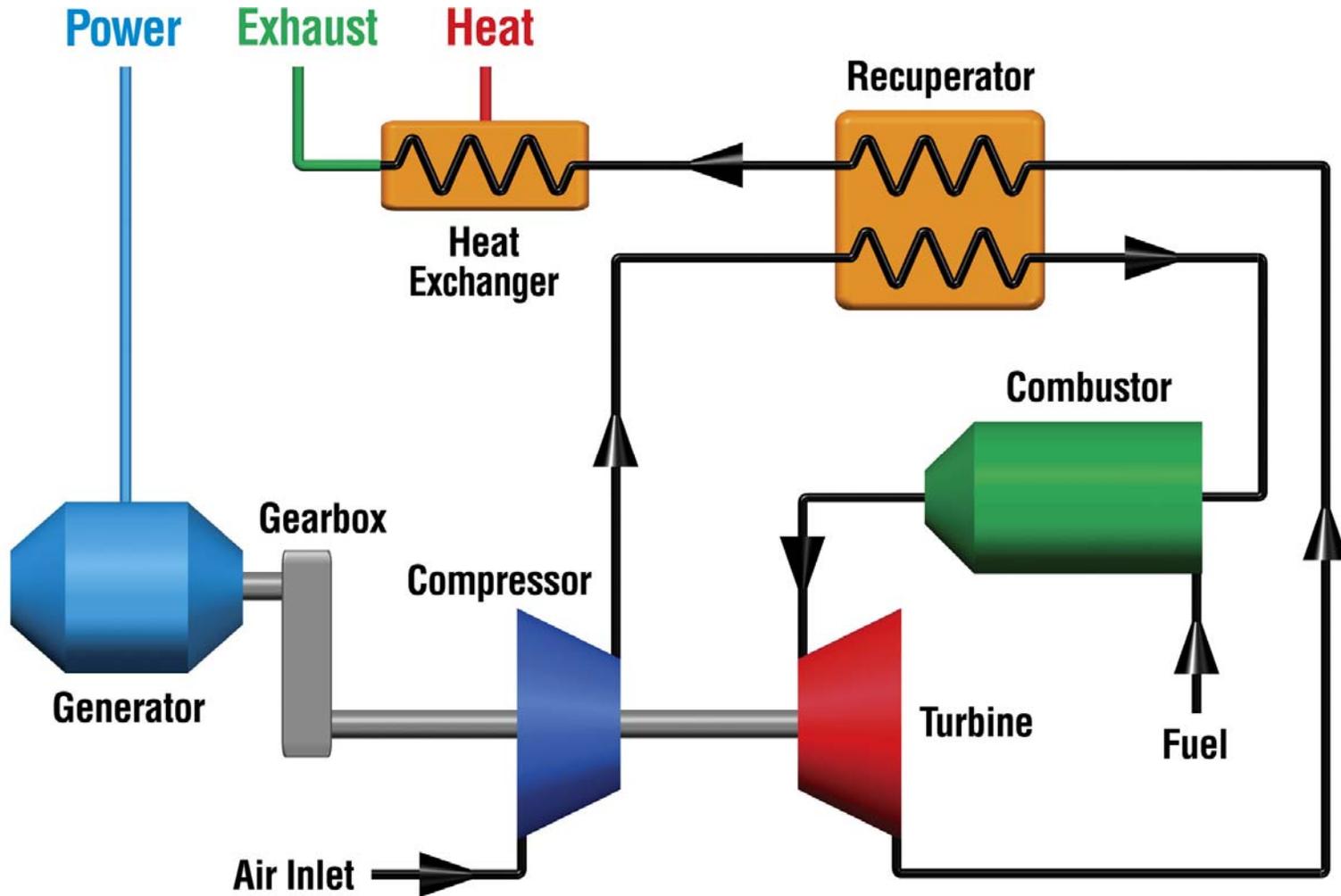
- Inefficient use of energy resources
- Limited opportunity for emission reduction
- Requires large T&D investment



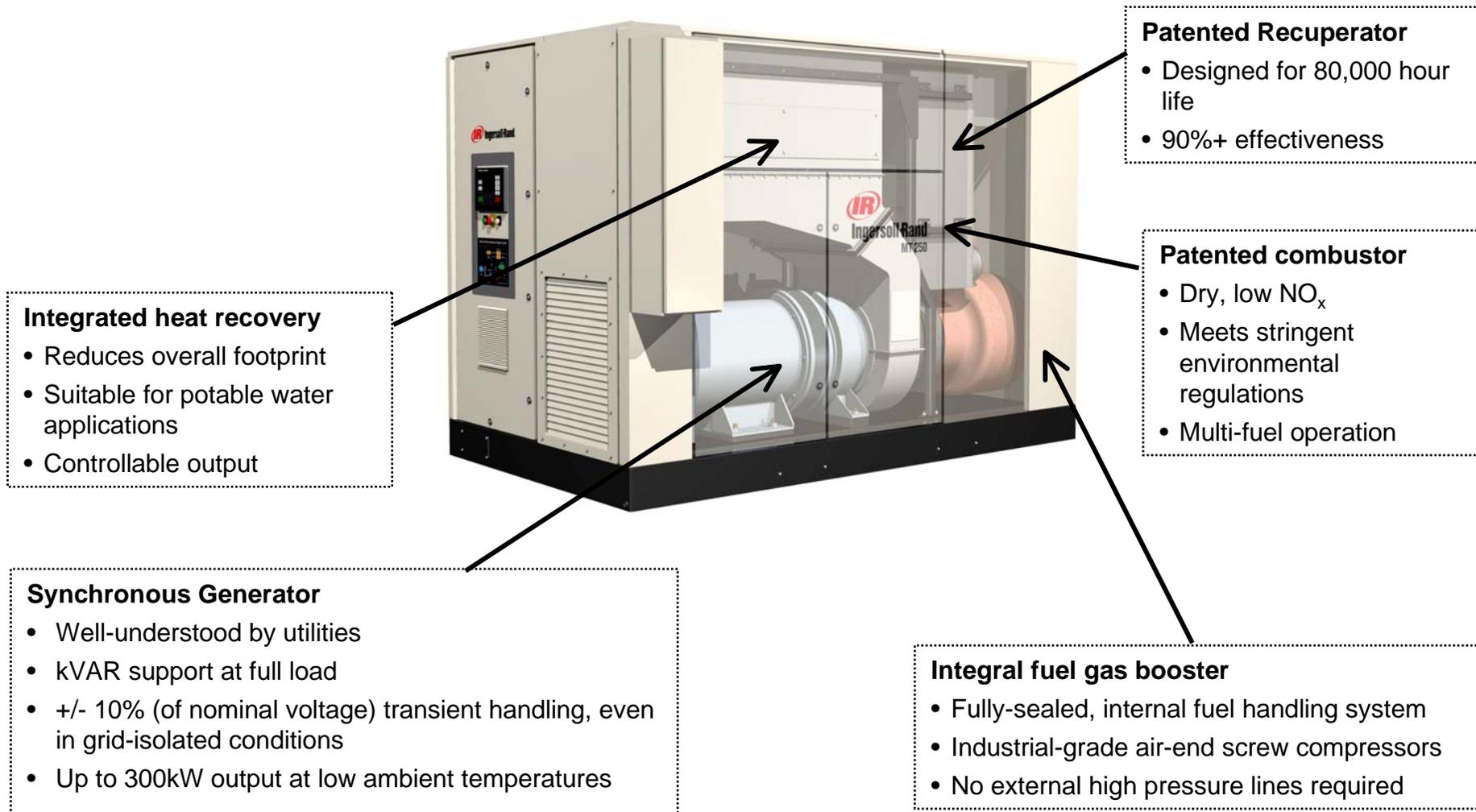
## Integrated Energy

- 50-80% system efficiency
- Reduce emissions
- Reduce need for T&D investment

# MT250 Microturbine – Engine Cycle



# MT250 Microturbine – Features and Benefits



# MT250 Microturbine – Energy Distribution

## Typical Energy Distribution at ISO Conditions



# Ingersoll Rand Energy Solutions



## EESCo Project

Wareham



**Prudential Financial**  
Growing and Protecting Your Wealth®



Emeryville, CA  
Commercial property

## Energy Service Company (ESCO)

(3) 250kW microturbines

### Customer Value Creation

- Receives discount off utility rate for electrical & thermal loads - guaranteed savings
- Lower energy cost volatility
- Provides an environmentally friendly solution
- Offsets infrastructure spending
- Establishes the framework for greater power reliability & an integrated backup solution

State of California  
AIR RESOURCES BOARD  
Executive Order DG-009  
Distributed Generation Certification of  
Ingersoll-Rand Energy Systems  
250SM Microturbine

WHEREAS, the Air Resources Board (ARB) was given the authority under California Health and Safety Code section 41514.9 to establish a statewide Distributed Generation (DG) Certification Program to certify electrical generation technologies that are exempt from the permit requirements of air pollution control or air quality management districts;

WHEREAS, this DG Certification does not constitute an air pollution permit or eliminate the responsibility of the end user to comply with all federal, state, and local laws, rules and regulations;

WHEREAS, on May 31, 2005, Ingersoll-Rand Energy Systems applied for a DG Certification of its 250 kW, 250SM Microturbine, including its Generator Braking Resistor power-management component (model number GBR-250), and whose application was deemed complete on June 30, 2005;

WHEREAS, the 250SM Microturbine is manufactured and sold integrated with combined heat and power technology;

WHEREAS, Ingersoll-Rand Energy Systems has demonstrated that its 250SM Microturbine, complies with the minimum efficiency requirement in section 94203 (b)(1)(B);

WHEREAS, section 94203 (b)(1) allows for a credit at the rate of one megawatt-hour for each 3.4 million British Thermal Units of heat recovered to be used when calculating emission standards;

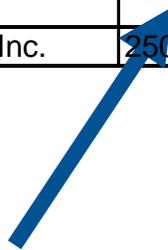
WHEREAS, Ingersoll-Rand Energy Systems has demonstrated, according to test methods specified in title 17, California Code of Regulations (CCR), section 94207 and the credit allowed in section 94203 (b)(1), that its natural-gas-fueled 250SM Microturbine has complied with the following emission standards:

1. Emissions of oxides of nitrogen no greater than 0.07 pound per megawatt-hour;
2. Emissions of carbon monoxide no greater than 0.1 pound per megawatt-hour;
3. Emissions of volatile organic compounds no greater than 0.02 pound per megawatt-hour; and

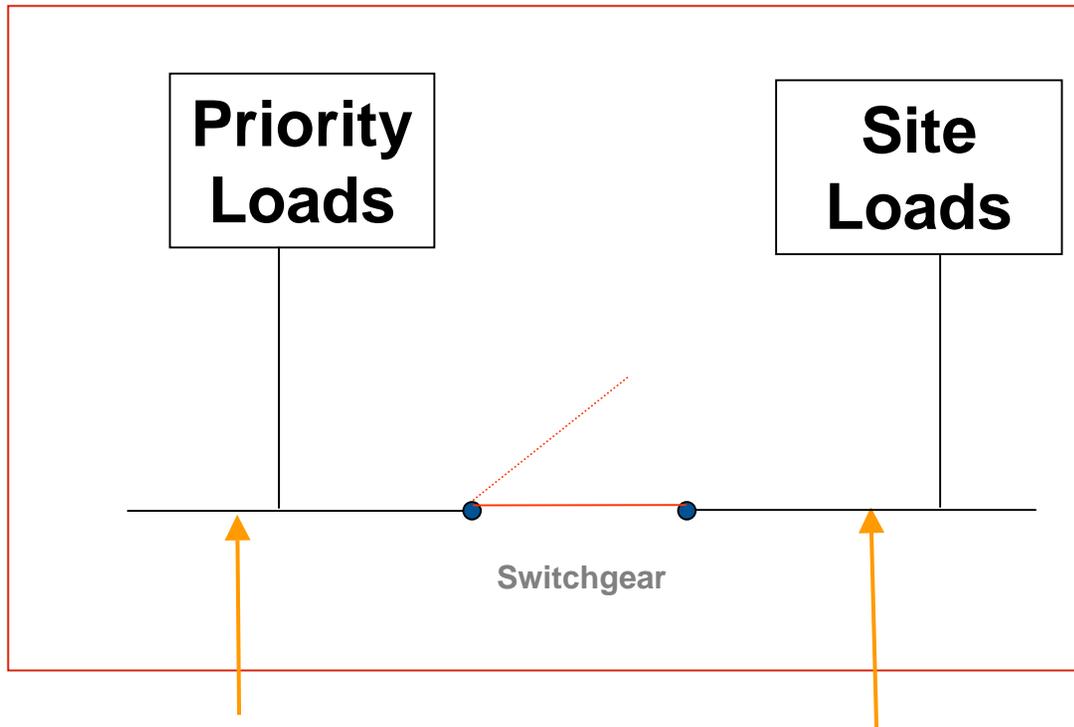
- 250SM (natural gas) model: **1<sup>st</sup> and only microturbine certified to CARB 2007 limits**
- Meets CA SGIP NOx requirement 0.14 lb/MWh
- Meets East Texas and New Jersey air permitting
- Emissions @100% load
  - NOx <0.07 lb/MWh
  - CO <0.10 lb/MWh
  - VOC <0.02 lb/MWh
- Toxics analysis using AP-42 database may be required depending on specific air district rules and site location

# California ARB Certifications List

Company Name	Technology	Standards Certified To	Executive Order	Expiration Date
United Technologies Corporation Fuel Cells	200 kW, Phosphoric Acid Fuel Cell	<b>2007</b>	<u>DG-001</u>	29-Jan-07
Capstone Turbine Corporation	60 kW, C60 MicroTurbine	2003	<u>DG-002</u>	31-Dec-06
FuelCell Energy, Inc.	250 kW, DFC300A Fuel Cell	<b>2007</b>	<u>DG-003</u>	7-May-07
Ingersoll-Rand Energy Systems	70 kW, 70LM Microturbine, version C	2003	<u>DG-004-A</u>	31-Dec-06
Ingersoll-Rand Energy Systems	70 kW, 70 LM Microturbine, version WD	2003 with Combined Heat and Power	<u>DG-005</u>	31-Dec-06
Plug Power Inc.	5 kW, GenSys™ 5C Fuel Cell	<b>2007</b>	<u>DG-006</u>	16-Jul-08
FuelCell Energy, Inc.	1 MW, DFC1500 Fuel Cell	<b>2007</b>	<u>DG-007</u>	13-Sep-08
Turbec AB	100 kW, T100 Microturbine CHP System	2003	<u>DG-008</u>	31-Dec-06
<b>Ingersoll-Rand Energy Systems</b>	<b>250 kW, 250SM Microturbine</b>	<b>2007</b>	<u>DG-009</u>	<b>21-Oct-09</b>
FuelCell Energy, Inc.	250 kW, DFC300MA Fuel Cell	<b>2007</b>	<u>DG-010</u>	16-Dec-09

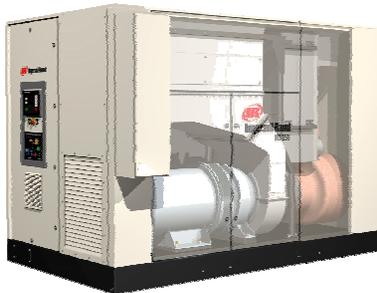


# Dual Mode Capabilities



- Operate Grid parallel
- Add switchgear, segregate priority loads
- Separate from grid, create intentional island
- No downtime, no loss of power
- Controlled transition back to grid

MT250  
Microturbine



Grid Power



# Ingersoll Rand Fuel Conditioning

## *Water knockout system*

- ✓ High efficiency filtration for total system protection
- ✓ Shut-offs to protect down-stream components
- ✓ Easy isolation of fuel skid from gas line

## *Rotary screw gas compressor*

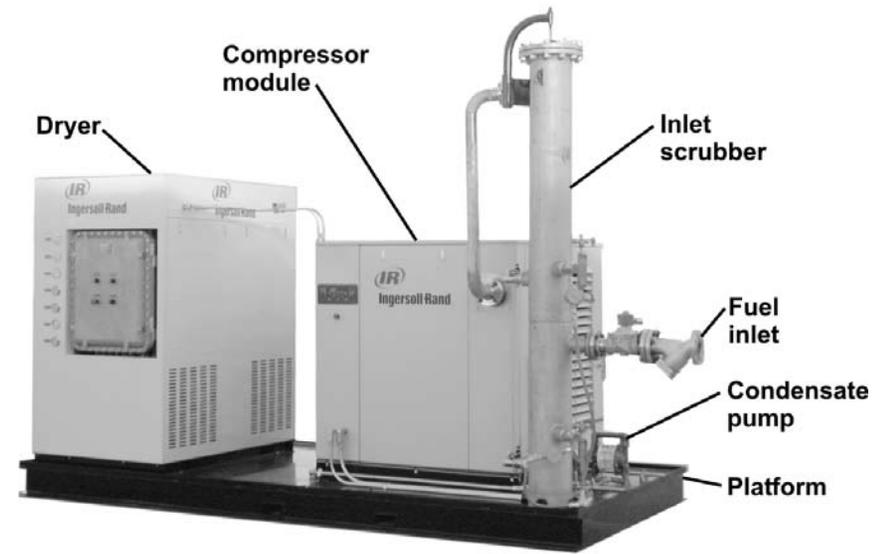
- ✓ IR designed air-end for outstanding dependability and reliability
- ✓ Isolation mounted for low vibration levels
- ✓ Proven controls

## *Siloxane removal*

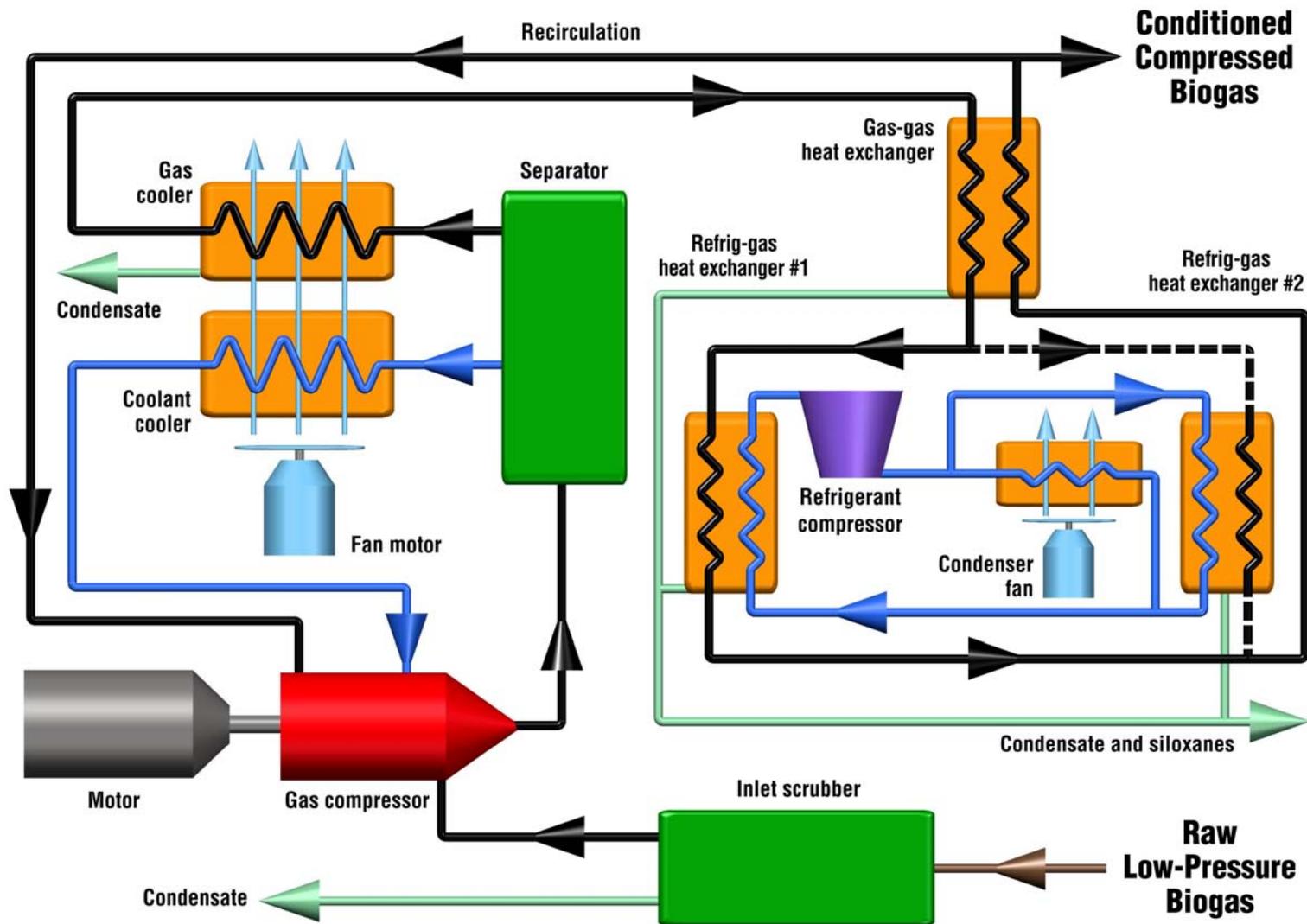
- ✓ Patented deep-chilling technology
- ✓ Automatic defrost cycle for continuous operation
- ✓ Allen Bradley microprocessor
- ✓ Eliminated need for hazardous and non-hazardous desiccant disposal

## *Energy saving design*

- ✓ Demand-based fuel supply strategy for multiple microturbine installation and compensation in variances in fuel energy content
- ✓ Recirculation system to minimize parasitic losses



# Ingersoll Rand Fuel Conditioning



# Case Study: Wastewater Treatment

## Municipal Wastewater Treatment Plant Southern California

### Problem:

Wasting renewable resource



➤ Electricity: 11 ¢/kWh est.

### Value drivers:

- **Technology leadership**
- Health and safety
- Energy cost volatility
- Power reliability
- Power security
- **Environmental compliance**
- **Emissions reductions/credits**
- Water conservation
- Infrastructure spending offset
- Productivity
- **Energy savings**

### Application drivers:

- Thermal balance
- **Spark spread**
- **Operating hours**
- **Fuel value**
- Installation and site requirements

### Solution:

(1) Ingersoll-Rand MT250 microturbine with fuel treatment system



- Reduction of greenhouse gas emissions
- Efficient electricity and thermal energy from waste gases
- Renewable electricity for Antelope Valley Green Energy Program
- Offset of costly utility power
- California Public Utilities Commission's Self-Generation Incentive Program
- Electricity: **4.3 ¢/kWh**

**\$225,000 Annual Electrical Savings**

# Case Study: Landfill Gas

## ACME Project Power Plant, Bulldog Gas and Power Martinez, California

### Problem:

Wasting renewable resource



- Electricity: 11 ¢/kWh est.

### Value drivers:

- Technology leadership
- Health and safety
- **Energy cost volatility**
- Power reliability
- Power security
- **Environmental compliance**
- **Emissions reductions/credits**
- Water conservation
- Infrastructure spending offset
- Productivity
- **Energy savings**

### Application drivers:

- Thermal balance
- Spark spread
- Operating hours
- **Fuel value**
- Installation and site requirements

### Solution:

(4) Ingersoll-Rand MT70 microturbines



- Reduction of greenhouse gas emissions
- Offset of costly utility power

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**\$127,000 Annual Electrical Savings**

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# Summary

- Multiple Microturbine Technology Options available ... solutions.
- Energy Services Company Working
- MT250 has CARB 2007 Certification
- Dual Mode Capabilities
- Fuel Conditioning Skids

**Thank you**



**IR**

***Ingersoll Rand***

*Industrial Technologies*