

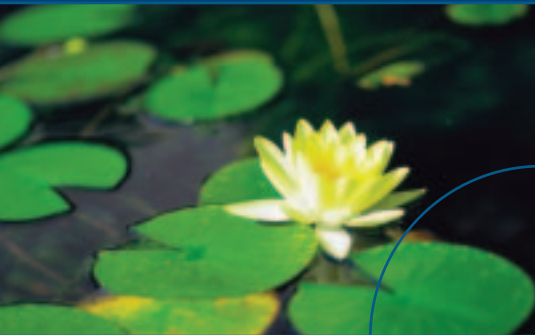
# PureCycle™ 200 Heat-to-Electricity Power System

Energy Savings



Power Reliability

Environmental Stewardship



INDUSTRIAL PROCESSES

RECIPROCATING ENGINES

GAS TURBINES

THERMAL OXIDIZERS

FLARES / INCINERATORS



**UTC Power**

A United Technologies Company

# Turn Waste Heat into Electricity - with Zero Emissions.

## The PureCycle™ 200 Power System

### The clean way to profit from waste heat.

Turn waste heat into electricity and cost savings with the PureCycle™ 200 power system, an innovative heat-to-electricity technology from UTC Power. The PureCycle™ 200 system delivers value to your operation by displacing purchased electricity to save cost, or selling power to the grid to generate revenue.

### Flexible, site-compatible design.

The PureCycle™ 200 power system is driven by a simple evaporation and condensation process to generate electricity from waste heat. Since no emissions are created, the PureCycle™ system is completely pollution-free, simplifying the siting process. Clean power coupled with increased profits are an attractive combination.

### Built and supported by energy experts.

While the PureCycle™ 200 power system is new, it draws upon decades of United Technologies Corporation innovation and experience.

At the system's core is technology from our sister company Carrier, the world leader in air-conditioning and refrigeration systems. Having this unique combination of resources makes UTC Power a highly reliable source for power generation – today, and for years to come.



PureCycle™ 200 Power Module

## PureCycle™ Systems Feature:

- ▼ **Waste-heat powered** – The PureCycle™ system's heat-to-electricity process runs entirely on recaptured waste heat – effectively free fuel.
- ▼ **Low life-cycle cost** – Since the PureCycle™ 200 power system uses waste heat as free fuel to generate electricity, operating and maintenance costs are as low as 1¢ per kilowatt hour. This translates into attractive paybacks.
- ▼ **Remote monitoring** – Enables our service organization to monitor system performance 24 x 7, and respond quickly if there's ever a need, maximizing uptime.
- ▼ **Fully automated and self-contained** – The system is hermetically sealed, eliminating air entrainment and corrosion. In addition, operation is fully automated – with no steam or water to monitor in the power cycle – allowing PureCycle™ systems to run 24 x 7 without supervision.
- ▼ **Environmentally friendly** – Heat is converted to electricity without producing any emissions. Non-flammable, non-ozone-depleting fluid is used inside the system to protect maintenance personnel and the environment.



PureCycle™ 200 Condenser

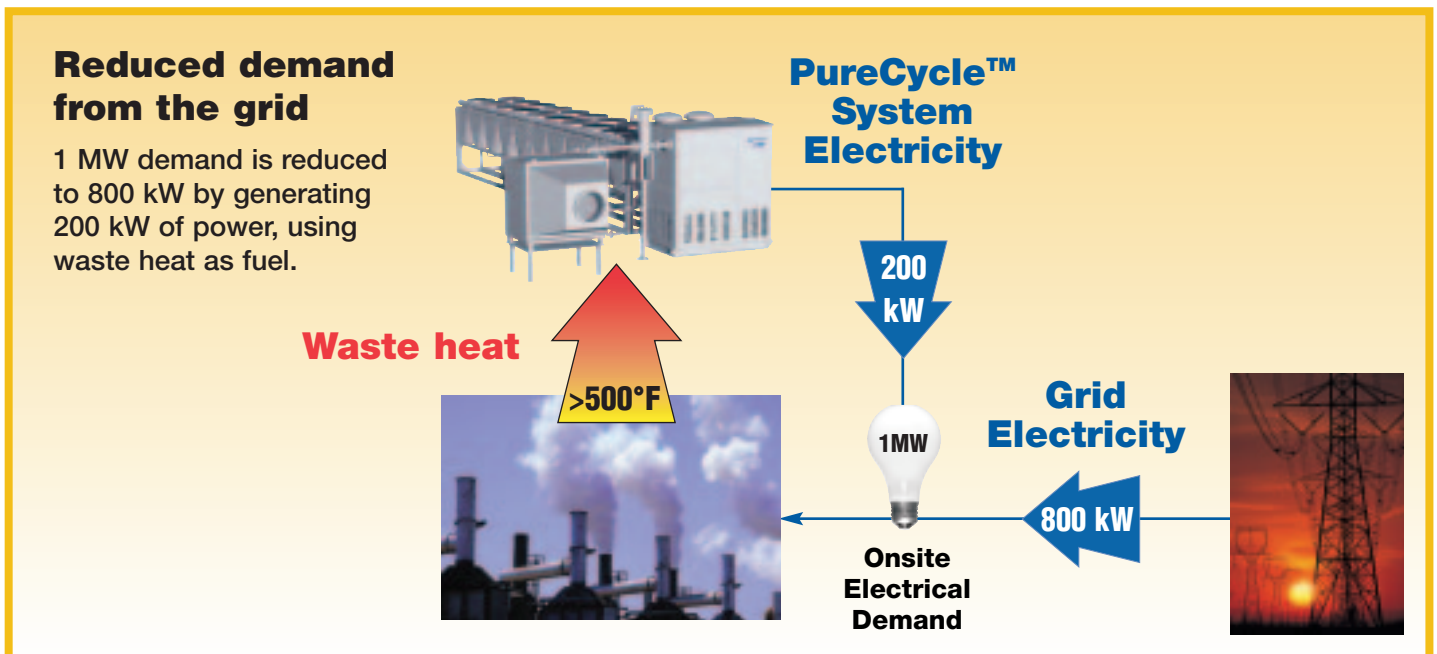
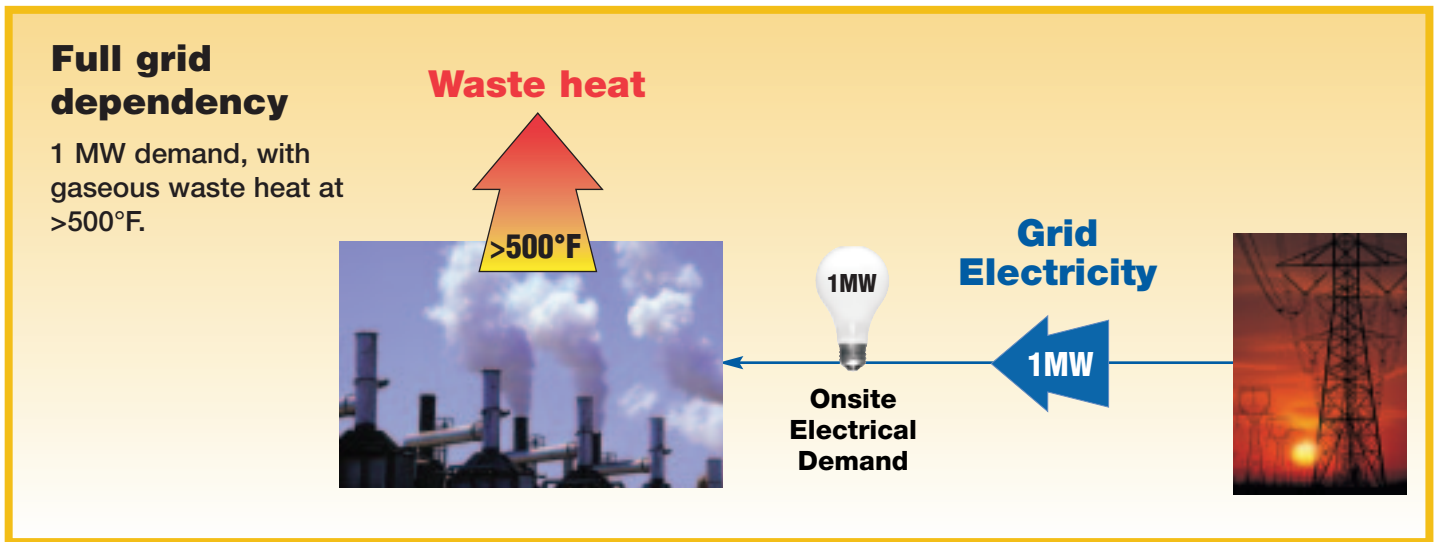


UTC Power would like to recognize our collaboration with DOE DE (Office of Distributed Energy within the Office of Energy Efficiency and Renewable Energy) in developing the technology that enables commercialization of the PureCycle™ product.

## PureCycle™ 200 power system – a unique heat-to-electricity system.

Most industrial facilities rely on the utility grid as their primary source of electrical power. Others have discovered the benefits of on-site power generation to provide a portion of their electrical power needs. The PureCycle™ 200 system is an alternative way to self-generate electricity, with two key advantages: it produces electricity from free fuel – supplied in the form of waste heat – and produces zero emissions.

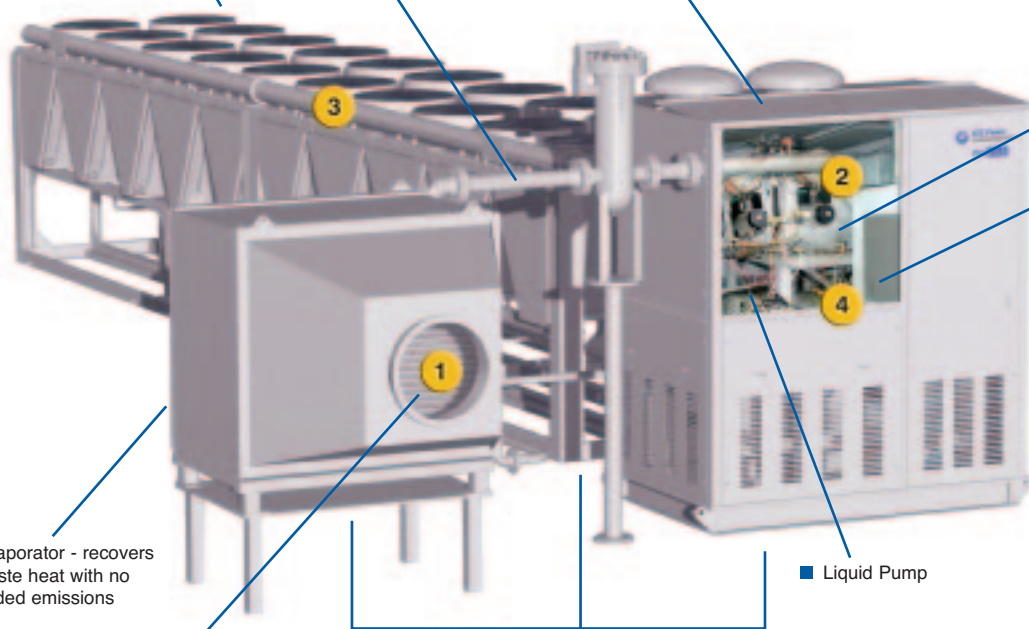
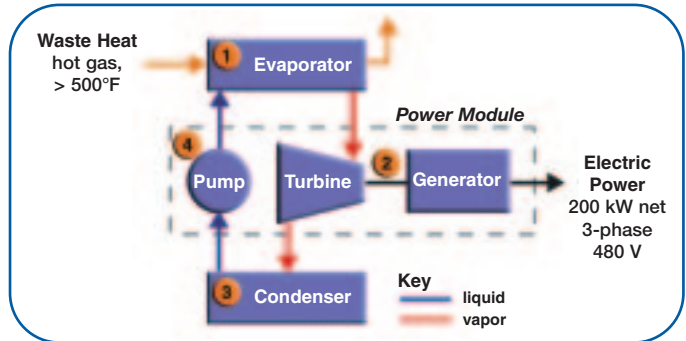
As long as sufficient heat is present, the PureCycle™ system can keep running – 24 hours a day, 365 days a year. Every kilowatt of electricity from the PureCycle™ system is one less kilowatt of electricity purchased from the grid, providing continuous cost savings to your business. While a PureCycle™ system may not entirely replace the need for grid-supplied power, it can substantially reduce onsite electrical demand.



# Generate Electricity from a Large Number of Industrial Heat Sources.

## PureCycle™ 200 Power System product specifications.

- Condenser - simple, robust design derived from Carrier product line
- Power Module - protected by weatherproof enclosure
- Safe Working Fluid - non-flammable, non-ozone depleting



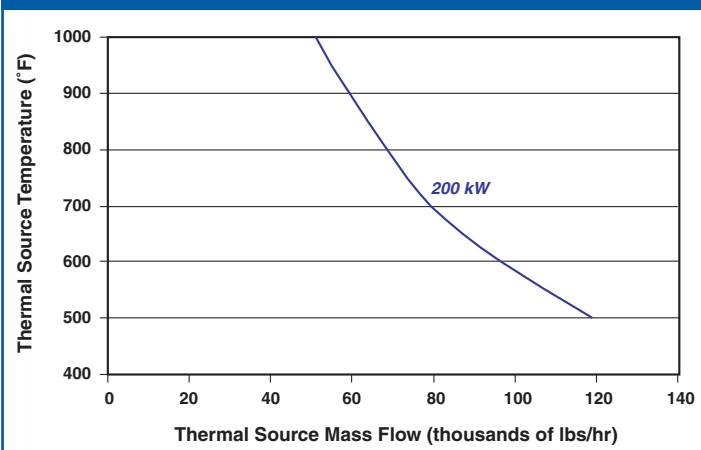
- Evaporator - recovers waste heat with no added emissions
- Interface to waste heat source
- Unattended Operation - fully automated and self-contained system
- Turbine - adapted from existing, field-proven Carrier compressor
- Generator
- Liquid Pump

- 1 Waste heat enters the evaporator and vaporizes a pressurized working fluid.
- 2 In the power module, the hot vapor is expanded through a turbine to drive a generator producing electric power.
- 3 The condenser cools the expanded vapor, returning it to liquid form.
- 4 The cooled liquid re-enters the power module, where the pump re-pressurizes it and returns it to the evaporator

### Product Benefits

- Energy cost savings
- Reliability
- Low maintenance
- Environmentally friendly - zero emissions
- Remote monitoring
- Weather resistant

### Thermal Source Temperature vs. Mass Flow



### PureCycle™ System Product Data

Net Power, kW @ 59°F (ISO)	200 kW
Voltage	480 V, 3-phase
Form of Waste Heat	Gaseous
Required Input Heat Temperature	500°F - 1000°F
Required Flow Rate	See chart to left

### PureCycle™ System Product Data

Component	System Dimensions			Weights
	length	width	height	
Power module	9'10"	5'7"	10'2"	13,000 lbs
Condenser	39'4"	7'5"	7'8"	11,650 lbs
Evaporator	11'3"	6'8"	6'6"	7,000 lbs



## Applications.

PureCycle™ systems can generate electricity from a large number of heat sources with gaseous waste heat above 500°F.

Industrial processes, reciprocating engines, gas turbines, thermal oxidizers, incinerators, and flares – wherever there's continuous heat that can be recaptured, there's potential to generate power.

The two photographs shown below illustrate standard PureCycle™ system installations. For the flare installation, rather than simply throwing away flare heat, useful electricity is produced for on-site usage or sale, under a power purchase agreement. For the reciprocating engine installation, the electrical power output and efficiency are increased by the addition of a PureCycle™ system.

## Applicable Heat Sources

INDUSTRIAL PROCESSES

RECIPROCATING ENGINES

GAS TURBINES

THERMAL OXIDIZERS

FLARES / INCINERATORS

FURNACES

KILNS

PROCESS HEATERS



*Landfill Flare Exhaust*



*Reciprocating Engine Exhaust*



## Waste heat - Why throw it away when you can profit from it?

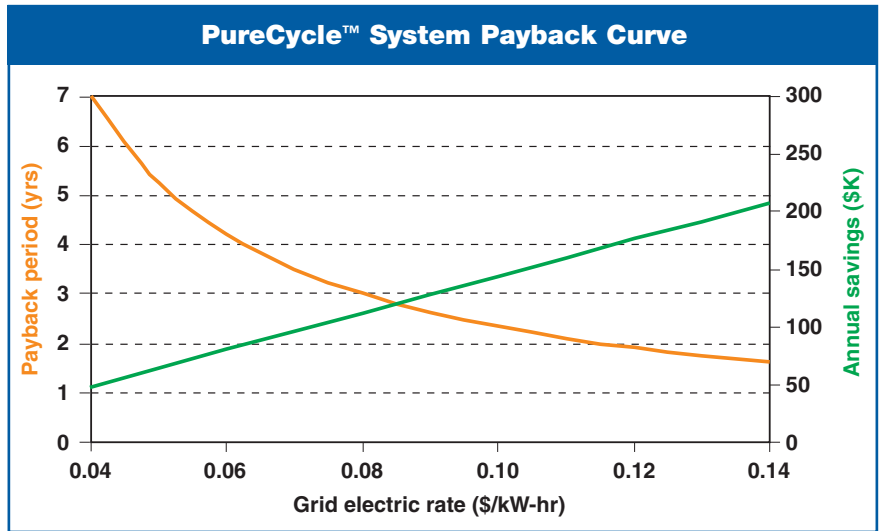
The beauty of the PureCycle™ system is that it is driven by heat you would otherwise not use. Chances are, you have at least one suitable waste heat source in your facility right now. So why release that heat it into the environment? Turn it into a profitable asset, year round, with a PureCycle™ system.

# A Proven, Efficient, Clean Method of Producing Power.

## Significant financial and environmental benefits.

Several factors determine how quickly a PureCycle™ system will pay for itself, and how much will be saved thereafter in energy costs. There are regional factors – local cost of electricity, for example – as well as application variables. In many cases, savings can be substantial.

As shown in the graph, a less than 3-year payback is achieved if the electricity value is over 8 cents/kWh. If your PureCycle™ system operates in certain regions of California, you could enjoy payback in as little as 2 years and subsequent annual savings of over \$150,000.



Each installed PureCycle™ 200 power system produces

**100% less CO<sub>2</sub>** per megawatt-hour than the average fossil-fueled utility power plant.

Source: DOE, EPA

The PureCycle™ 200 power system employs a closed cycle, called an organic Rankine cycle, to generate electricity from waste heat. Since no combustion occurs, the PureCycle™ 200 power system is completely pollution-free.

The PureCycle™ 200 system's zero-emissions characteristic puts it on par with renewable energy sources, such as wind and solar, but with much higher availability.

Each installed PureCycle™ 200 power system also produces about 8,200 lbs/year less NO<sub>x</sub> than typical fossil-fueled grid power, the equivalent of taking more than 200 average passenger cars off the road.



Source: EPA & Statistical Abstracts of the United States

## UTC Power. Experience you can count on.

UTC Power is a company wholly dedicated to providing cost effective, reliable on-site power systems. By leveraging the resources and expertise of Carrier, the world leader in air conditioning and refrigeration, and UTC Fuel Cells, UTC Power has become a fully integrated, single-source on-site power supplier with tremendous experience:

- Over 73 MW installed
- Over 8 million hours of combined fleet operation (microturbines and fuel cells)
- Turnkey systems
- Interconnection experience
- Installations in 85 cities and 19 countries

### Turbine:

- No liquid lubricants or coolants
- Low maintenance



UTC Power's innovative PureCycle™ 200 power system uses existing, field-proven Carrier technology and parts, and applies them in a unique way to generate electric power. Whether you have reciprocating engines, gas turbines, thermal oxidizers or other waste heat generating equipment or processes, UTC's experience with the critical components will give you confidence in the reliability of the PureCycle™ 200 power system.

## Waste Heat.

You can throw it away or you can use it to generate continuous energy **savings.**

**The PureCycle™ 200 Power System**

United Technologies (UTC)  
is a \$31 billion corporation  
providing high-technology products  
to the aerospace and building systems  
industries throughout the world.

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