

## Technology for the Future of Geothermal Development



June 18, 2008



**UTC Power**

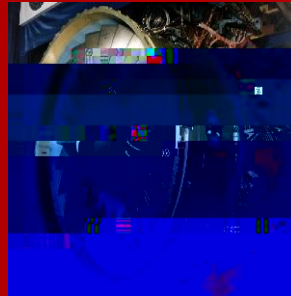
A United Technologies Company

# UTC Power – a UTC Corporation

*United Technologies: a \$54 billion company (2007)*



**UTC Power**  
Transportation Fuel Cells  
& On-Site Power Solutions



**Pratt & Whitney**  
Aircraft Engines,  
Gas Turbines &  
Space Propulsion



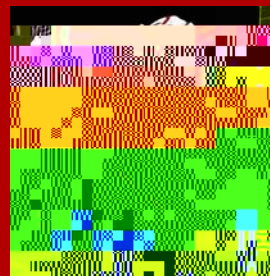
**Carrier**  
Heating, Cooling  
& Refrigeration



**Otis**  
Elevators, Escalators &  
People Moving  
Systems



**Sikorsky**  
Helicopters



**Hamilton Sundstrand**  
Aerospace & Industrial



**UTC Fire & Security**  
Security &  
Fire Protection



**UTC Research Center**  
Technology  
Advancement

# Benefits of Geothermal Power

- Energy independence – national priority
  - Improves our energy security and reduces dependence on foreign oil
- Environmentally friendly - provides clean and safe energy
  - Is renewable and sustainable
  - Zero emissions
- Generates continuous, reliable “baseload” power
- Cost competitive
- Conserves fossil fuels and contributes to diversity in energy sources
- Modular technology allows incremental development at remote sites
- Small powerplant footprint and little environmental impact
- Government mandates and incentives
  - Significant government mandates for green power
  - Attractive tax incentives

# Equivalent Emissions Reduction

## Avoid Emissions for a 1.0 MW system

	Annual Avoided CO <sub>2</sub> Emissions		Annual Avoided NO <sub>x</sub> Emissions	
	Tons	Equivalent acres of forest*	Tons	Equivalent number of cars**
<b>PureCycle® system (95% availability)</b>	<b>6,045</b>	<b>1,270</b>	<b>10.80</b>	<b>570</b>
Wind (25% availability)	1,585	335	2.86	150
Solar (14% availability)	885	185	1.60	85

\* Eed acre of forest assumed to absorb 1.3 tons Carbon/acre/year (Ref: International Panel on Climate Change)

\*\* Eed car assumed to generate 38 lbm/NO<sub>x</sub>/year (Ref: US EPA)

Assumes full heat utilization

# PureCycle® Power System

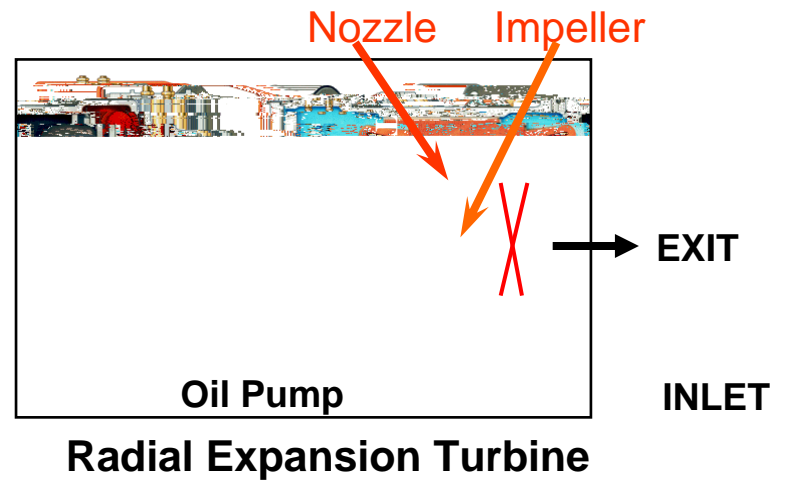
## Organic Rankine Cycle



*Geothermal Hot Water In – Power Out*

## Vapor Compression Cycle (VCC)

## Organic Rankine Cycle (ORC)



# Technology Demonstration

## Chena Hot Springs

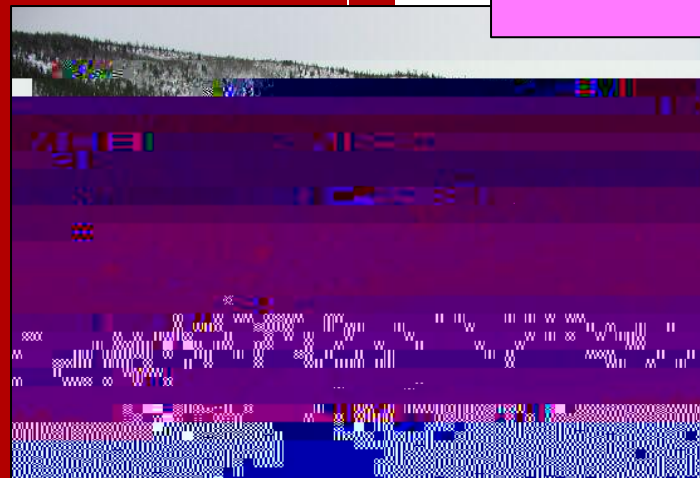
*1<sup>st</sup> unit commissioned July 2006*

*2<sup>nd</sup> unit December 2006*

*74°C hot water resource*

*4 – 7°C cooling water available*

*Drivers: Off-Grid, base load sustainable  
geothermal power*

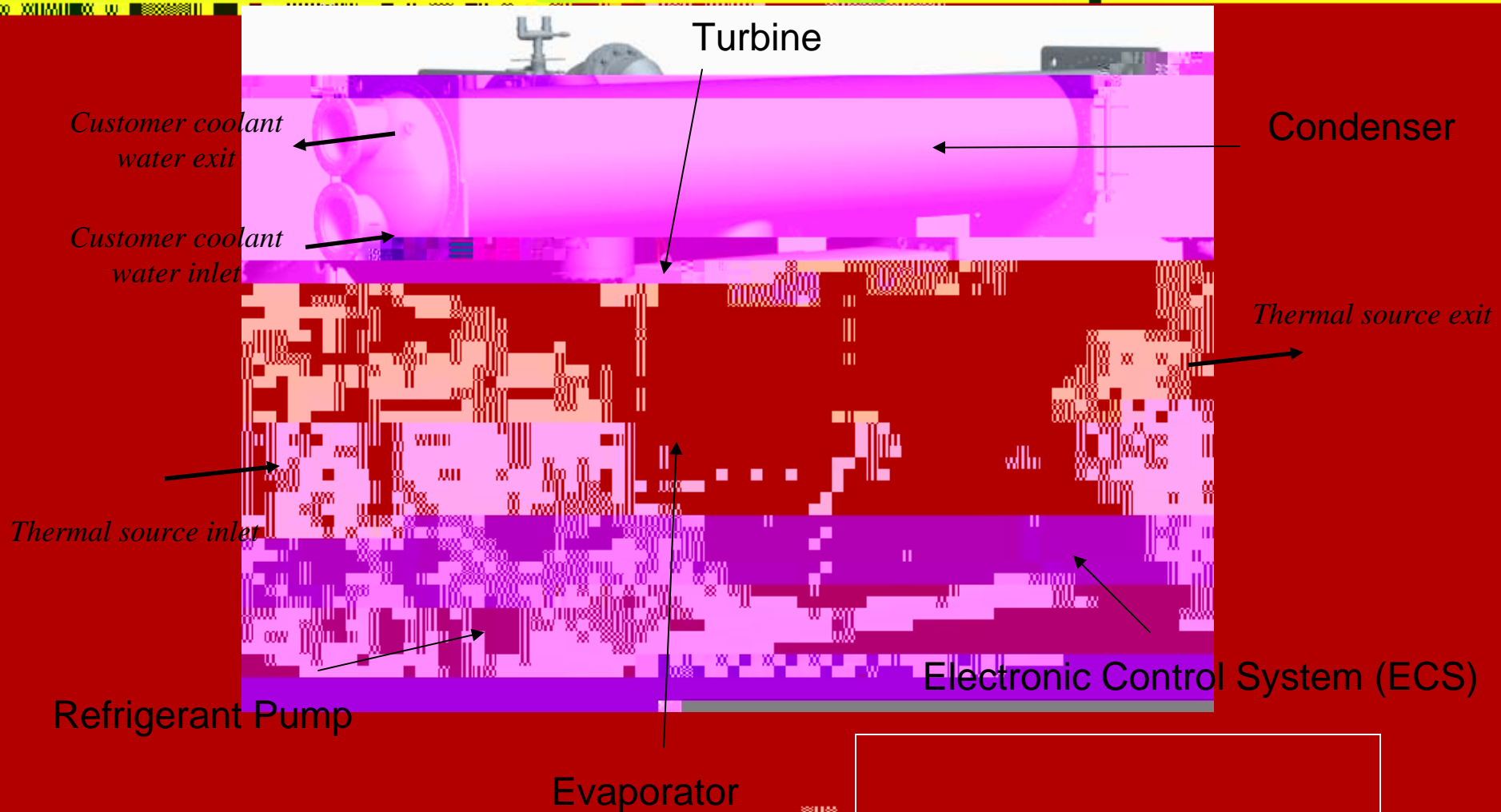


## ***UTC Passport process is foundation for product development activity***

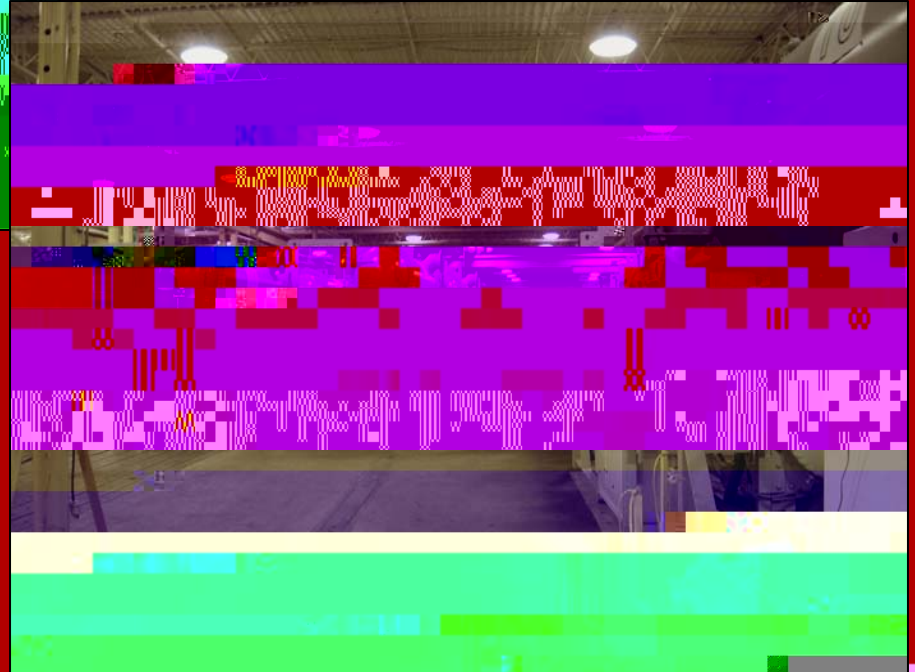
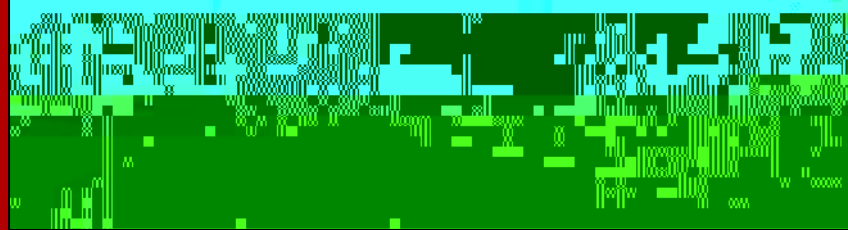
- Disciplined and structured process used across each UTC division
- Focus on risk management and gated control
- Standard work, process tools, lessons learned, and checklists
- Exit criteria: proven product that meets or exceeds



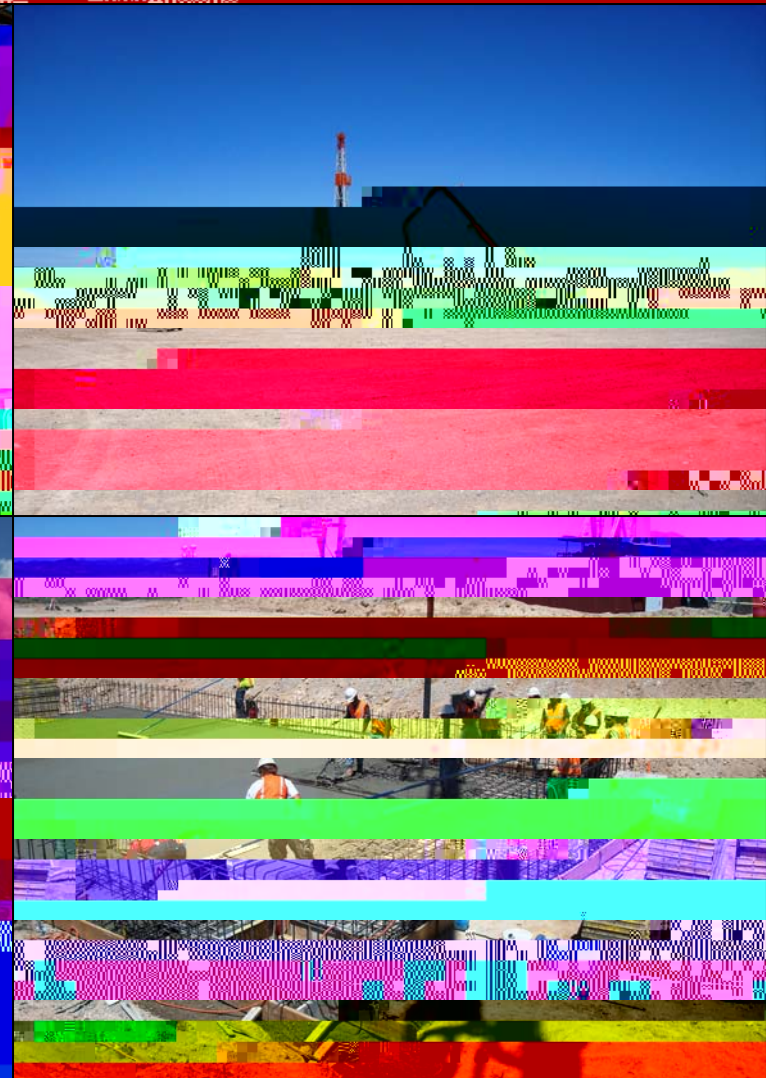
# Top Level Assembly



# Production Units



# Raser Update





www.3ds.com

www.3ds.com

www.3ds.com

**Off-the-shelf production; rapid deployment**

**Low to moderate temps**

**Low cost modular skid**

**Full remote control**

- No equipment operators required**

**Full service contracts**

# PureCycle® Next Steps

**Production ramp up for Model 280 system**  
**Larger unit product development**  
**Advanced low temperature development**  
**Oil & Gas, industrial applications**  
**International markets**



**Thank you**

Ed Fichtel  
*Product Manager*  
*PureCycle® Power System*