FUEL CELLS

Cost-Effective, Reliable, and Ready Now

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August 5, 2008

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Summary

- **Cost effective** – Now $3000/kW and *10-year* stack life
- **Reliable** – Fleet uptime is 97% *including* scheduled maintenance
- **Earth Friendly** – Lowers CO_2 and requires *Zero* water use

On-Line Emergency Power

Verizon
Garden City, New York

Assured Power

First National Bank of Omaha
Omaha, Nebraska

Renewable Fuel (ADG)

Wastewater treatment plants
New York, New York

Off-Grid Power

Central Park Police Station,
New York, New York

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Fuel Cell Markets

Transportation fuel cells

On-site power solutions

Space & defense fuel cells

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On-Site Power Options

PureCell® combined heat & power system
400 kW phosphoric acid fuel cell
Natural gas, anaerobic digester gas

Other combined cooling, heating & power systems

65kW microturbines & absorption chiller
natural gas

200kW microturbines & absorption chiller
natural gas

Reciprocating engines & absorption chiller
natural gas

PureCell® System Model 400

Features

- Grid-connected/ grid-independent operation
- Superior load following capability
- No make-up water
- No water discharge
- Stack Life 10 Years

At a Glance

PureCell® System
Model 400

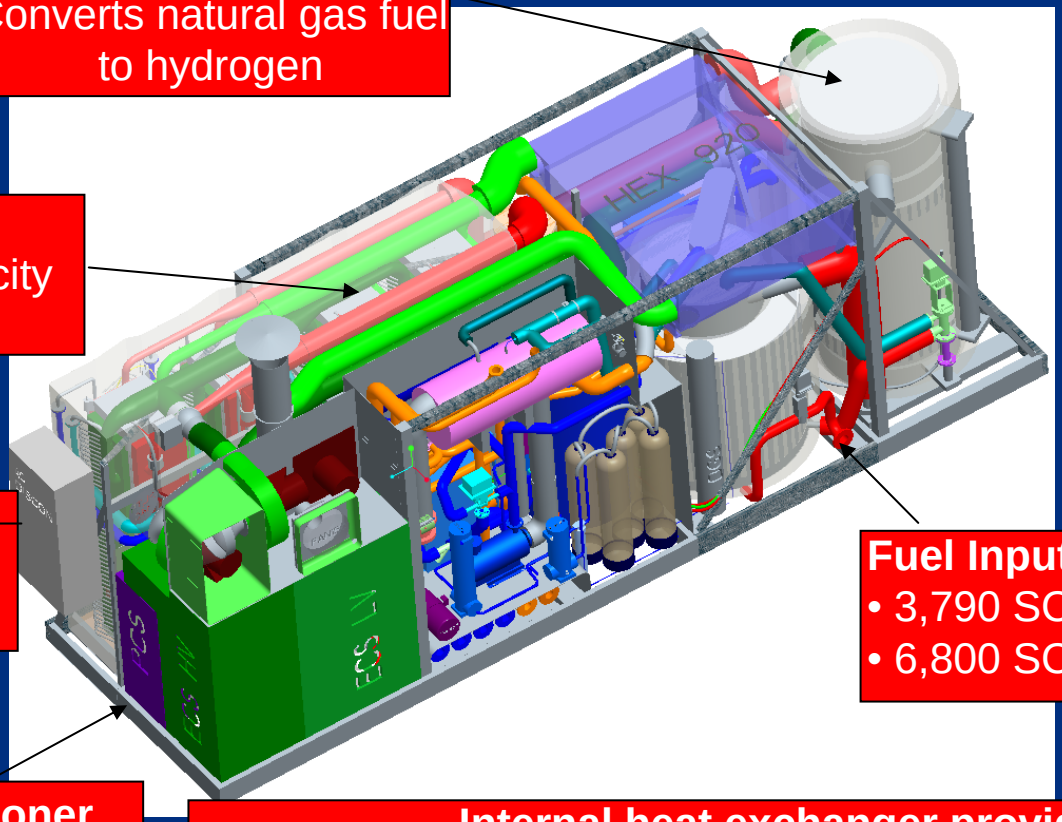
		Model 400
Electric Output		400 kW
Thermal Output		1.7 mmbtu
Electric Efficiency		40%
Fuel Cell Cost		$3,000/kW US*
O&M Cost		~2 cents per kWh US

* Not including government subsidies

PureCell® Model 400 Fuel Cell System

Fuel processor, cell stack, & power conditioner

Fuel Processor
Converts natural gas fuel to hydrogen



Fuel Cell Stack
Generates DC electricity from hydrogen

Electric Output:
- 400 kW, 480 V, 60 Hz
- 400 kW, 400 V, 50 Hz

Fuel Input
- 3,790 SCFH natural gas
- 6,800 SCFH 60% CH_4

Power Conditioner
Converts DC power to high quality AC power

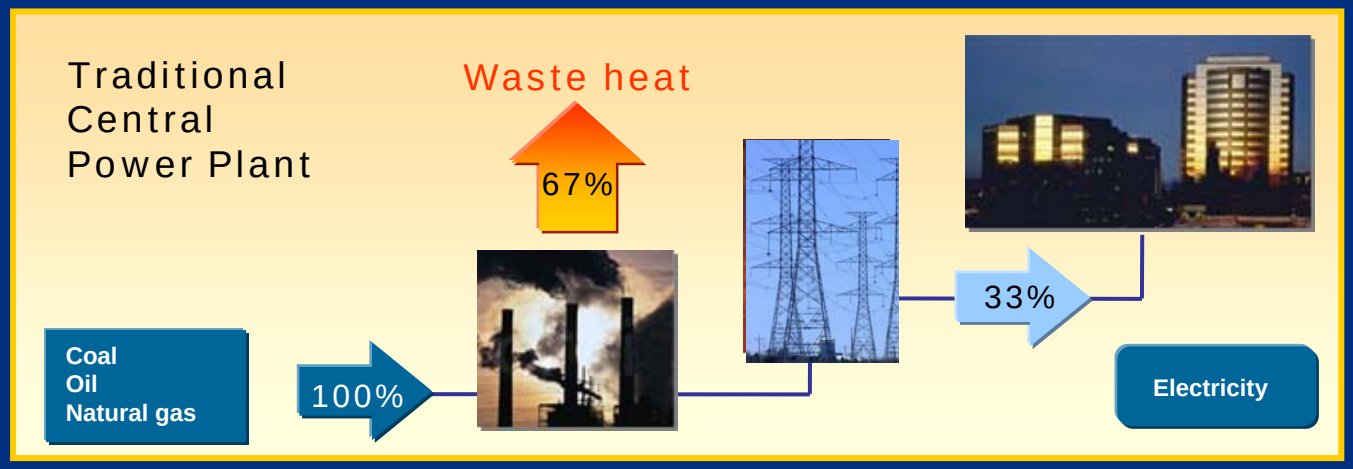
Internal heat exchanger provides:
- 1,700,000 BTU/hr @ 140°F

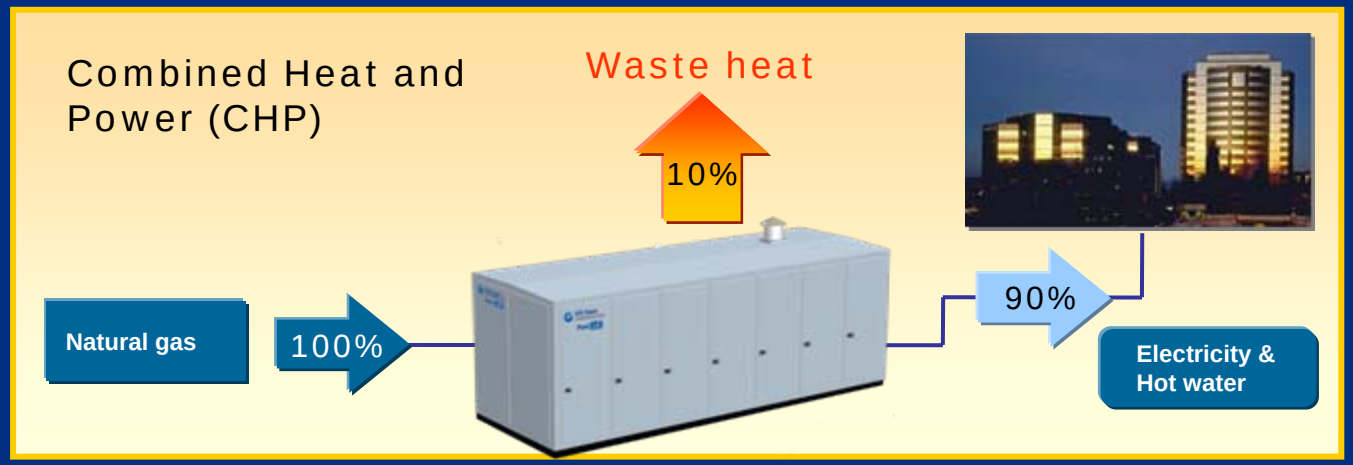
OR

- 800,000 BTU/hr @ up to 250°F & 900,000 BTU/hr @ 140°F

CHP Captures Waste Energy

Combined heat and power (CHP)





Fuel Cell

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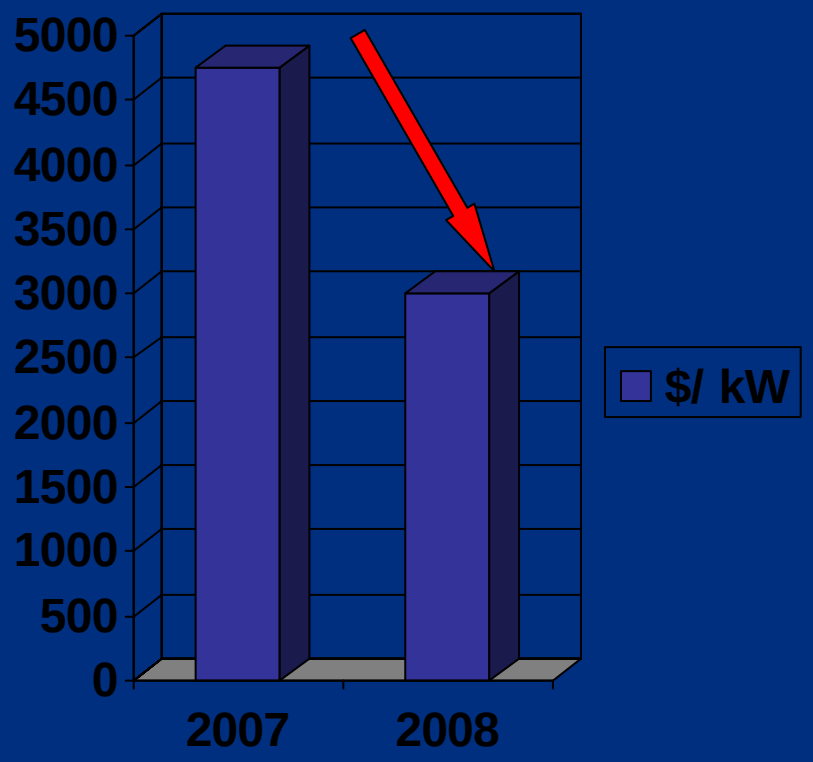
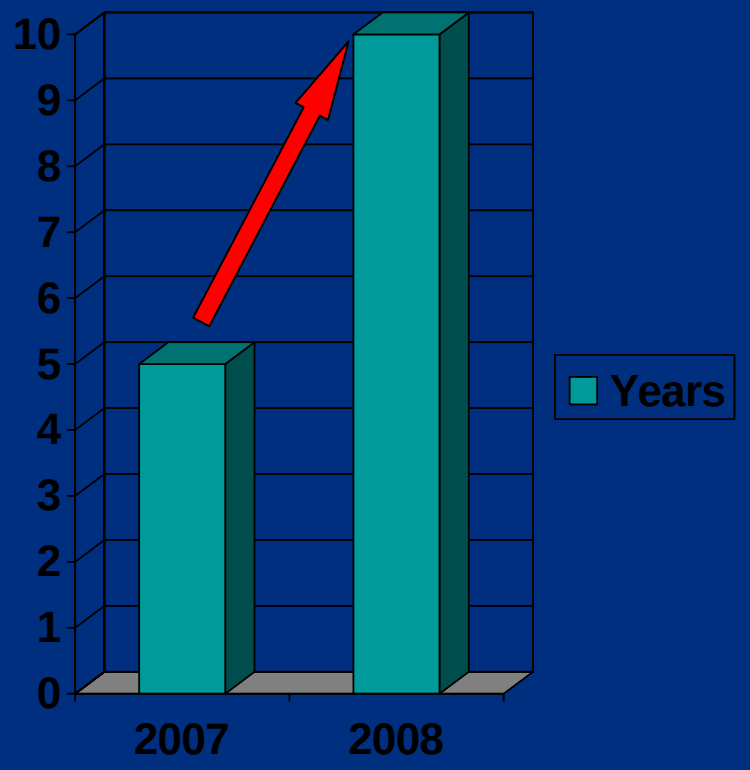
Cost Effective

First Cost ***DOWN 37%***



PureCell® Model 200

Stack Life ***UP 100%***



PureCell® Model 400

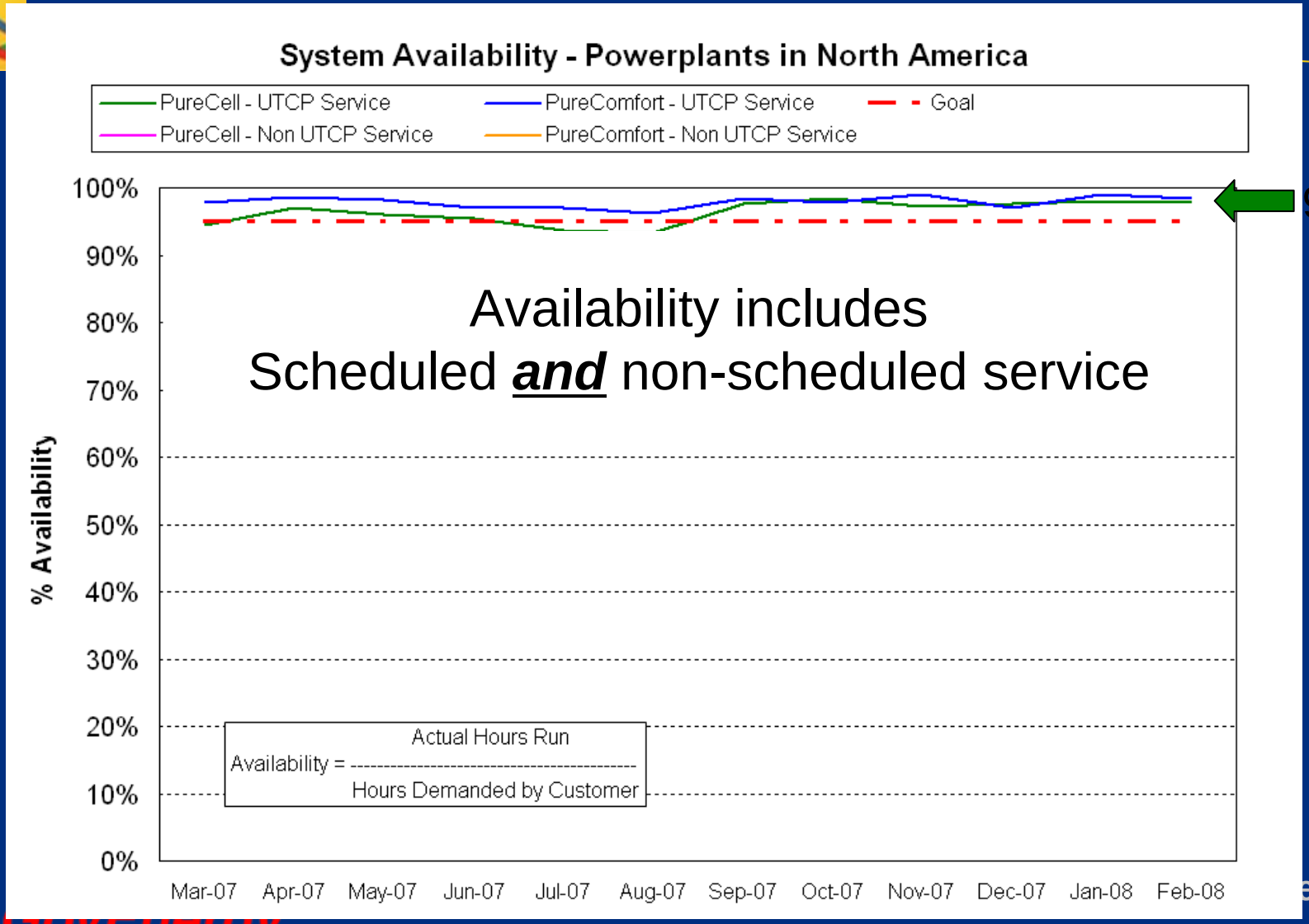
Is Your Existing Source of Power Reliable?

"Fixed installations are 99% dependent on the **commercial power grid** and other critical national infrastructure, which is **fragile and vulnerable and poses serious risks to critical missions**."

Source: Report of the Defense Science Board Task Force on DoD Energy, "More Fight – Less Fuel," February 2008. Office of the Under Secretary of Defense for Acquisition, Technology and Logistics

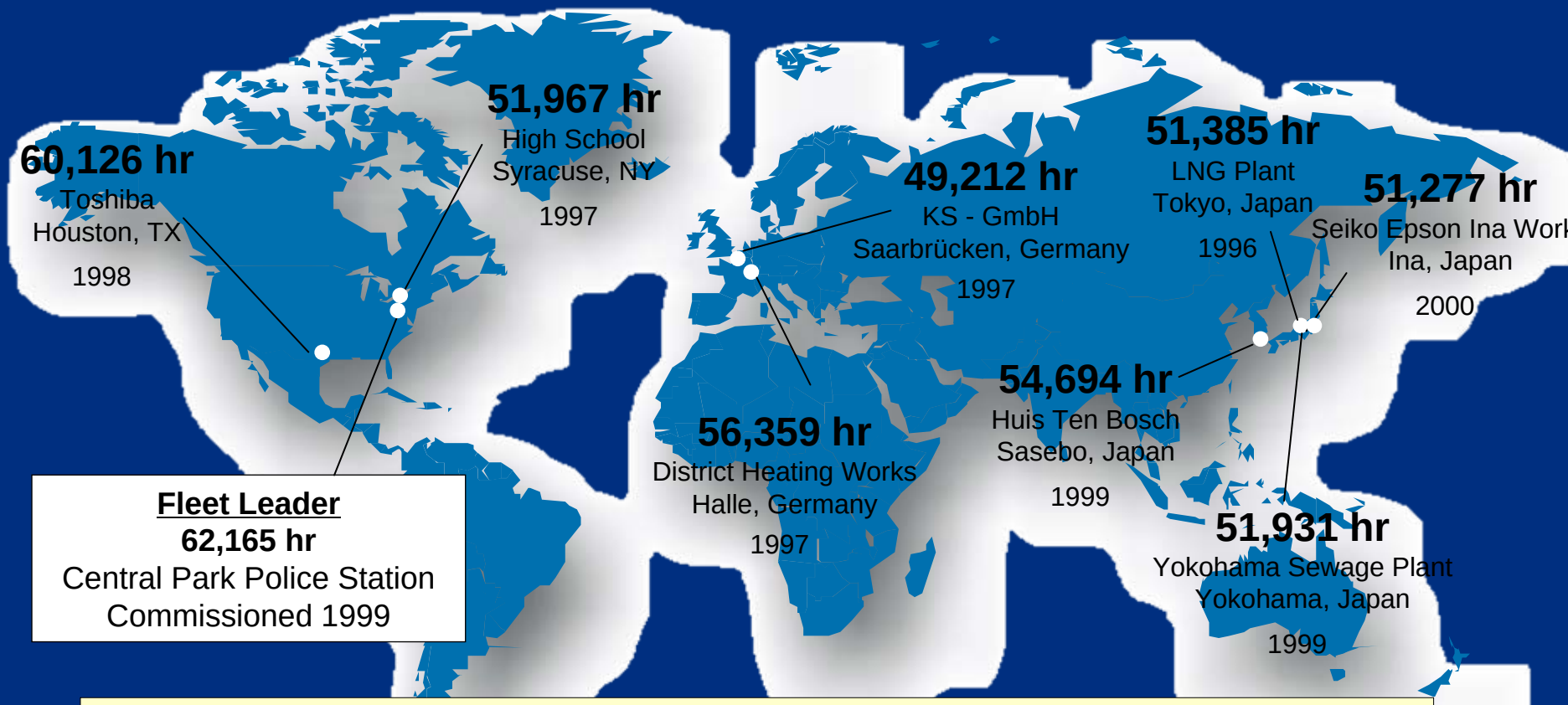
Phosphoric Acid Fuel Cells are Reliable

Service Expertise is Required to Attain 98% Uptime



Phosphoric Acid Fuel Cells Life

PureCell® Model 200 proven durability



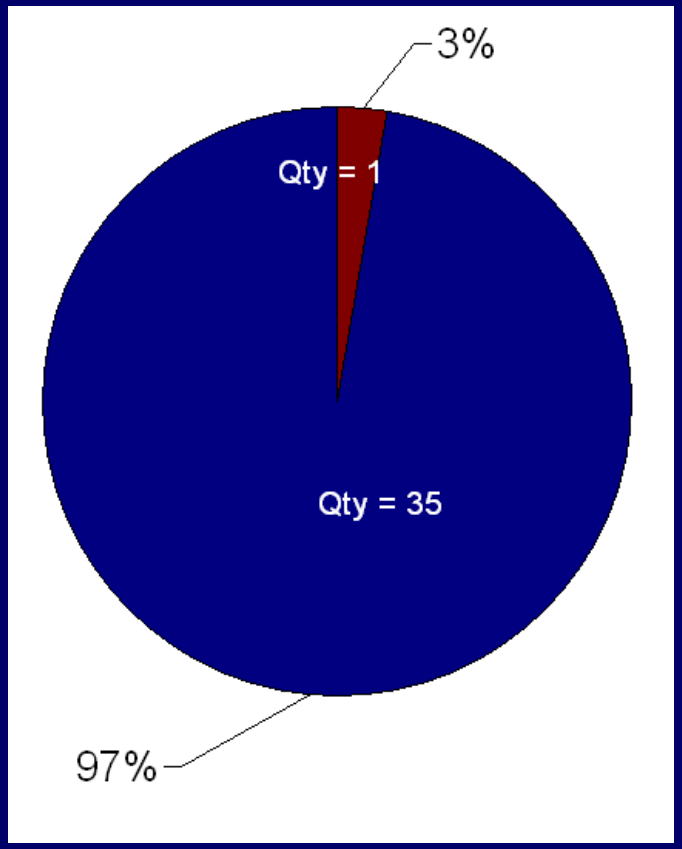
Fleet Leader
62,165 hr
Central Park Police Station
Commissioned 1999

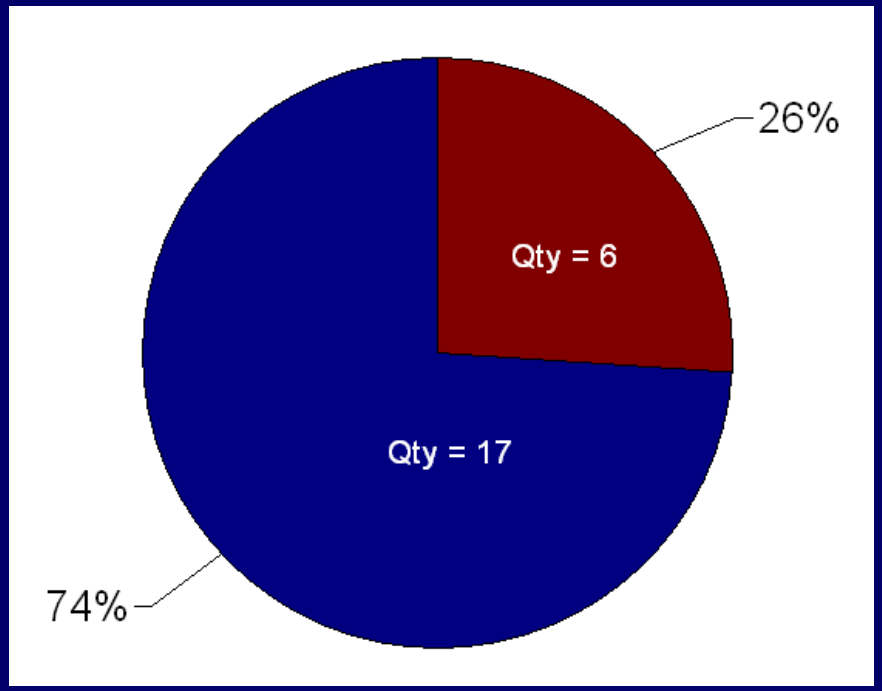
Current PureCell® Model 200 stack exceeds 40,000 hr (5 yrs)
Next-generation stack will meet 80,000 hr (10 yrs)

*As of 17 October 2006

Phosphoric Acid Fuel Cells are Durable

97% Hit at least 37,000 hour threshold





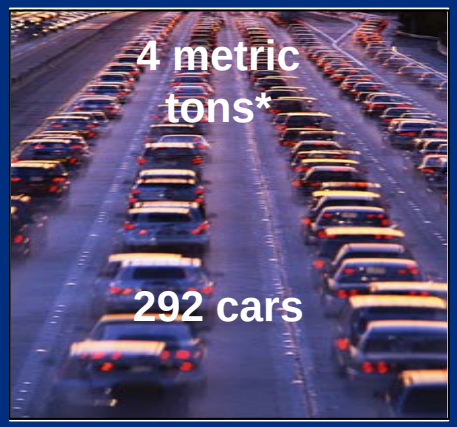
Recent History of 40,000-Hour Stacks

Stack Running Stack Failed < 37,000 Hrs

Phosphoric Acid Fuel Cells are Responsible

Annual reductions with PureCell® 400 fuel cell system*

CO_2	NO_x	H_2O
347 metric tons*	4 metric tons*	1.6 million gallons**
69 acres forest	292 cars	2.4 Olympic Pools



* Based on combined e-grid averages of CA, CT, MA, NY, NJ

** Based on national average of utility water use

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Government Experience

Ft. Huachuca, AZ

Low Grade Heat:

- *Domestic hot water*

High Grade Heat:

- *Boiler water pre-heat*

Fort Huachuca, AZ

19,240 hours of operation

Government Experience

Los Alimitos, CA

<u>Low Grade Heat</u>:

- *Heat pool water*

10,548 hours of operation

Critical Loads – Call Center

Garden City, NY

Power

+

Absorption Chilling

+

Heating

EPA Energy Star® Combined Heat & Power Award

2008

First National Bank of Omaha – Data Center

- Commissioned 1999
- High quality power
- Off-grid capable
- 99.999995 availability

Schools/ Emergency Shelters

East Hartford H.S., CT

East Rochester H.S., NY

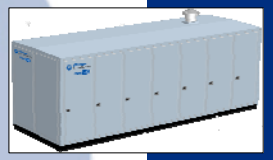
Middletown H.S., CT

24/7 Remote Monitoring

Comprehensive service and maintenance

24 x 7 remote monitoring

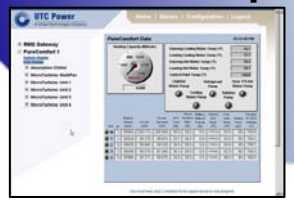
Reduced equipment down time/ reduced maintenance costs



Modifications/adjustment (locally or via internet)

Generate standard reports/ alarm history reports

Allow for key system metrics to be captured



ECONOMIC VALUE

Massachusetts Example

UTC Power Solution:	PureCell Model 400	
Quantity:		1
Electrical Capacity (Net):		400 kW
High Grade Heat Capacity:		785 MBH
Low Grade Heat Capacity:		1,314 MBH
Cooling Capacity:		46 RT
Fuel Rate (HHV):		3.79 MMBTU/hr

Project Proforma		
Total Installed Cost	$4,103 /kW	$1,641,382
MA LORI + Keyspan	$1,250 /kW	($500,000)
Federal Investment Tax Credit	$1,000 /kW	($342,415)
Net Installed Cost	**$1,997 /kW**	**$798,968**

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ECONOMIC VALUE

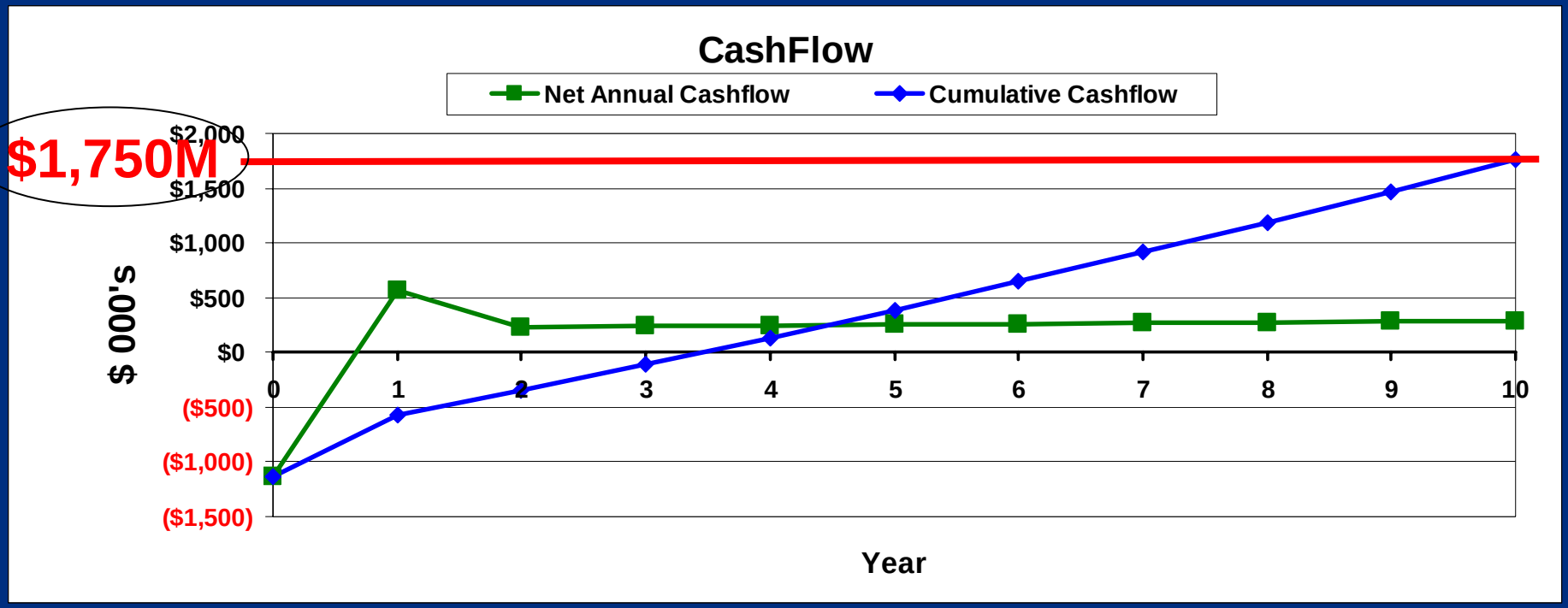
Massachusetts Example

Year 1 Annual Savings		
Avoided Electric Demand:	400 kW	$0
Avoided Electric Energy:	3,468,960 kWh	$475,248
Avoided Heating Fuel:	4,693 MMBTU	$51,621
Avoided Cooling:	174,583 kWh	$23,918
Renewable Energy Credits:	2.5 ¢/kWhr	$86,724
CHP Gas:	32,855 MMBTU	($336,761)
Service Contract:	2.2 ¢/kWhr	($76,500)

Payback (years)	**3.4**
IRR	**25.1%**
NPV	**$707,536**
ROI	**88.56%**
Year 1 Cost of Electric Generation	**8.4 ¢/kWhr**

ECONOMIC VALUE

Massachusetts Example



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PureCell® Model 5 Power System

- **Seamless Backup Power: 5kW Regulated/Programmable 48VDC Output**
- **Compact 19” Rack Mount (<13U high)**
- **Push Button Start – Automatic Standby-Power mode with on site or remote monitoring and control via Ethernet connectivity.**
- **Low Maintenance – Annual air and water filter replacement, re-fueling as needed**
- **Full rated power without de-rate (40C, 1800m)**

Grid Independent Back-Up Power Solution

- **Grid Independent Solution**

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UTC POWER FUEL CELLS

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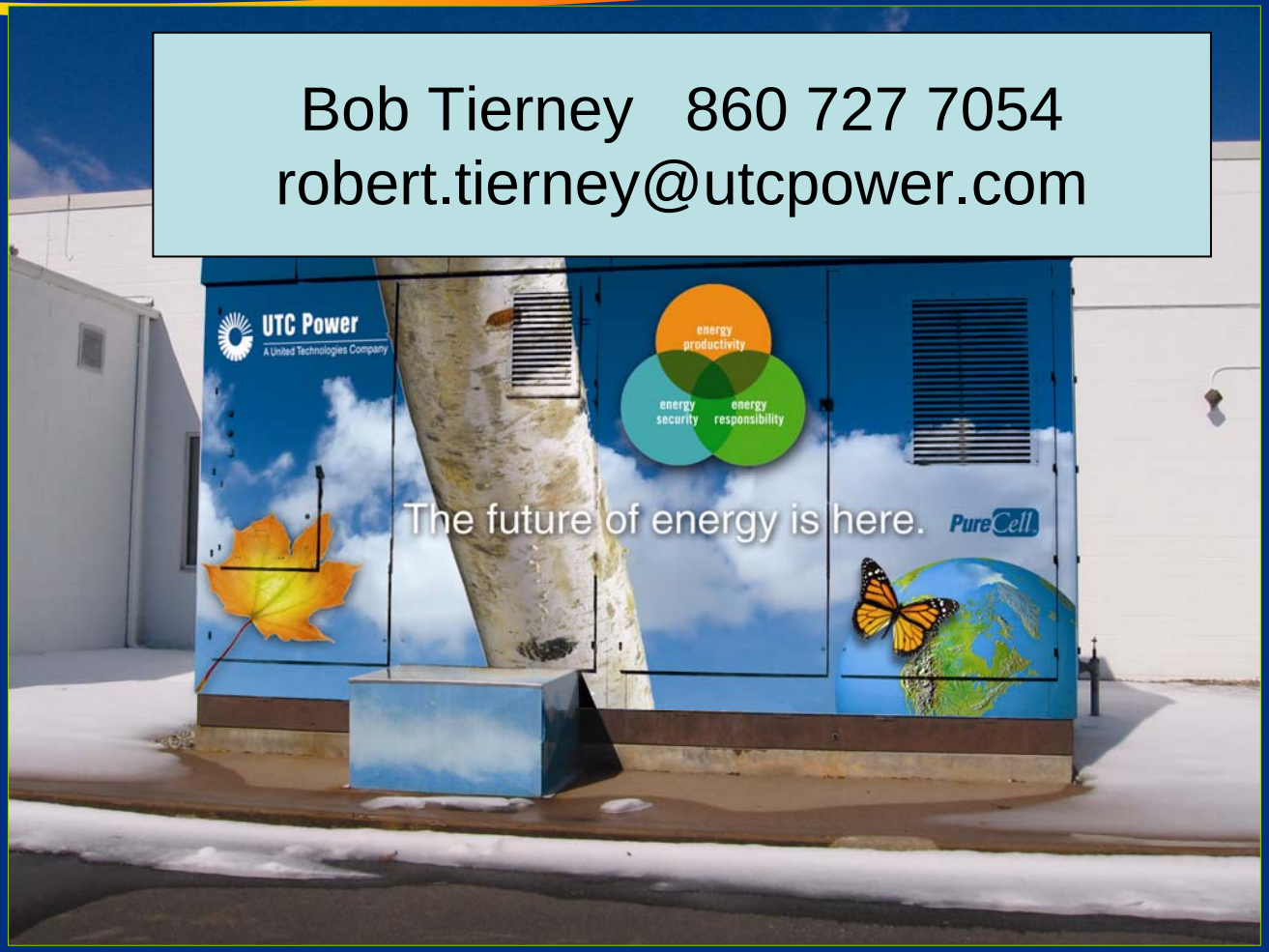

Would you like to know more about this session?

- Robert Tierney
- UTC Power
- South Windsor, CT
- robert.tierney@utcpower.com
- Don’t forget to fill out and drop off your session evaluations.