Energy Savings, Power Reliability, Environmental Stewardship

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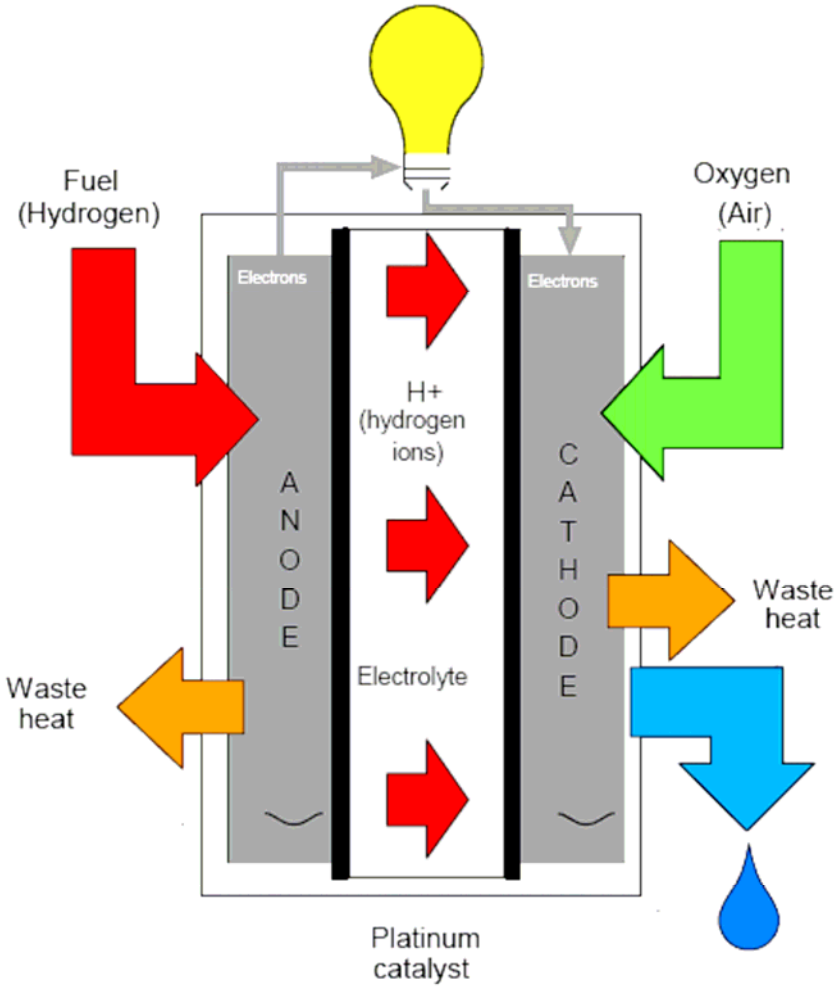
April 2007

FUEL CELL

Basic principle of operation



- Hydrogen flows into the fuel cell anode, where it is separated into protons (hydrogen ions) and electrons
- Protons pass through the electrolyte to the cathode
- Electrons flow through an external circuit in the form of electric current
- Oxygen flows into the fuel cell cathode, where it helps protons and electrons combine to produce pure water and heat

THE PURECELL™ SYSTEM

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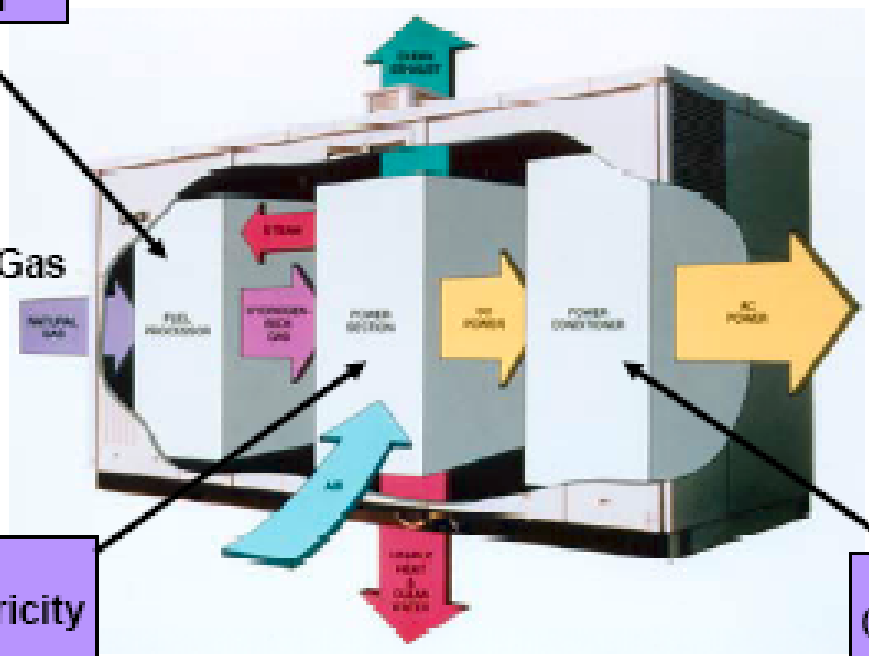
Three main components

Fuel Processor
Converts natural gas fuel to hydrogen

Fuel Input
- 2,050 SCFH Natural Gas



Electric Output:
- 200 kW, 480 V, 60 Hz

Fuel Cell Stack
Generates DC electricity from hydrogen

Power Conditioner
Converts DC power to high quality AC power

Internal heat exchanger provides:
- 885,000 BTU/hr @ 140F

OR

- 435,000 BTU/hr @ 250F & 450,000 BTU/hr @ 140F

COGENERATION ADVANTAGES

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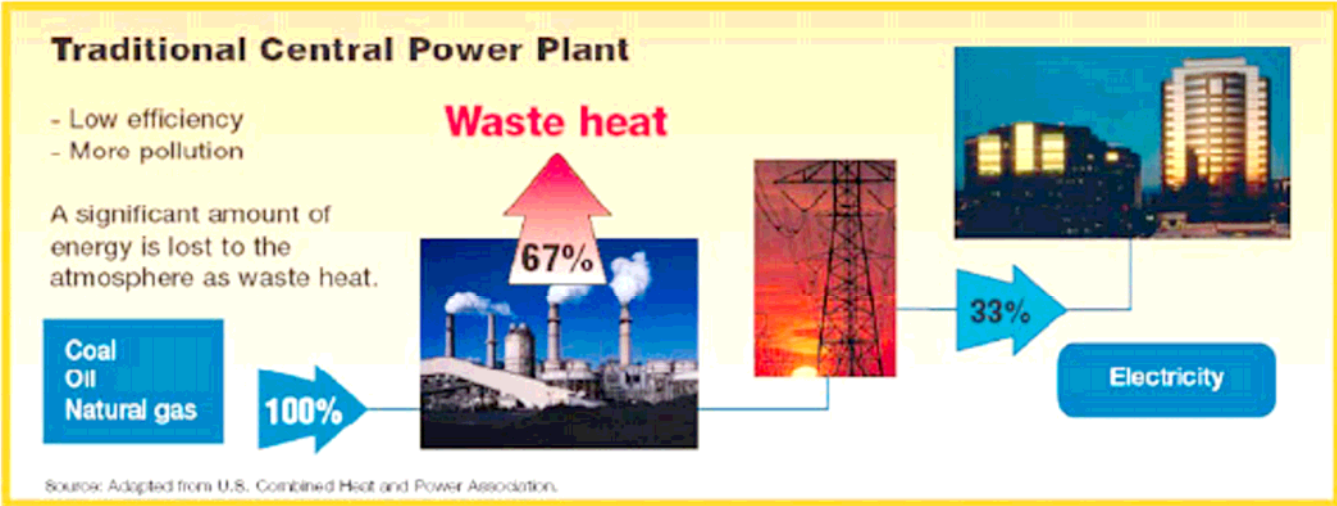
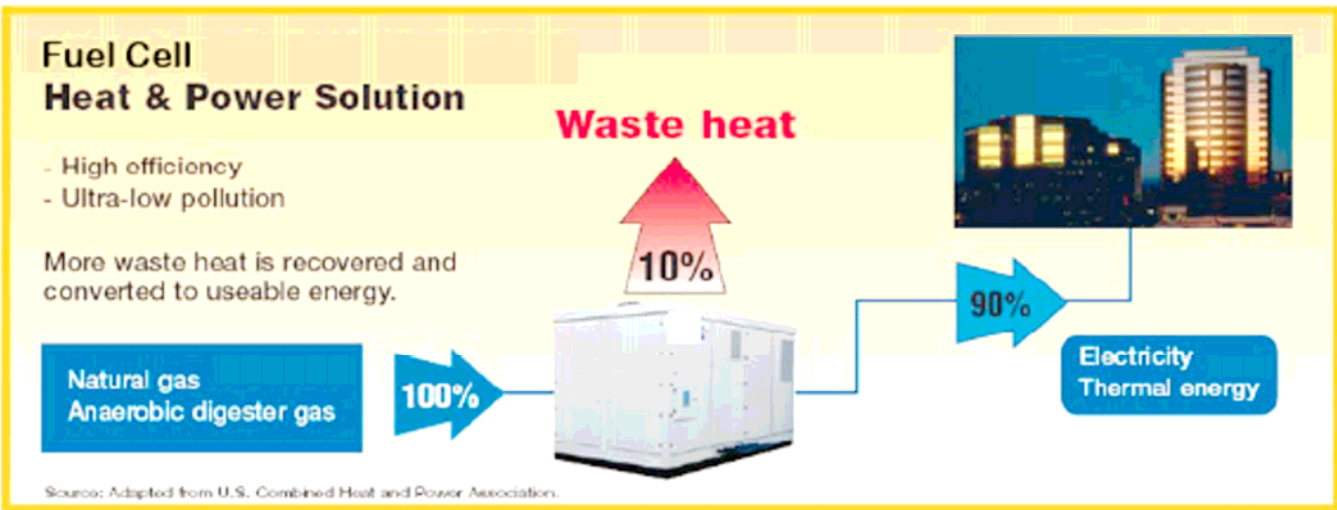
Higher efficiency & ultra-low pollution



In today's centralized power generation, a plant typically releases 67% of energy from fuel as waste heat, and the remaining 33% as electricity.



POLLUTION ADVANTAGES

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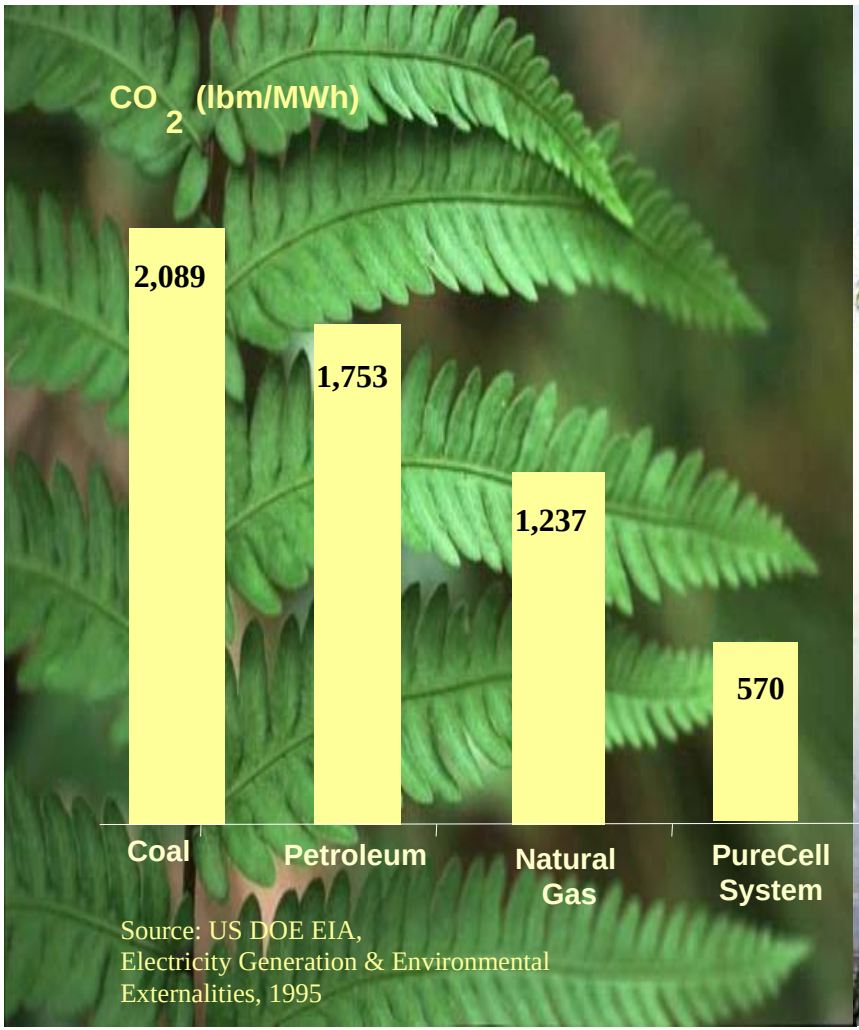
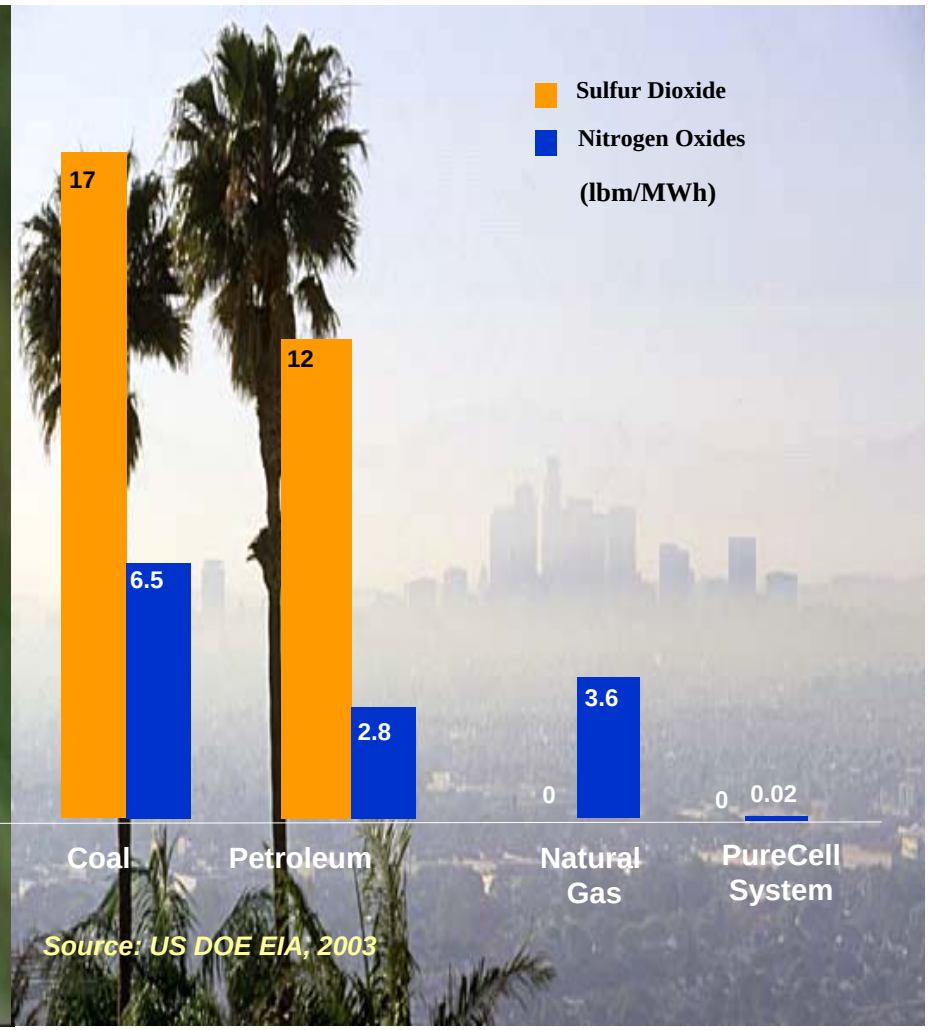
Comparison with the US central power plants





POLLUTION ADVANTAGES

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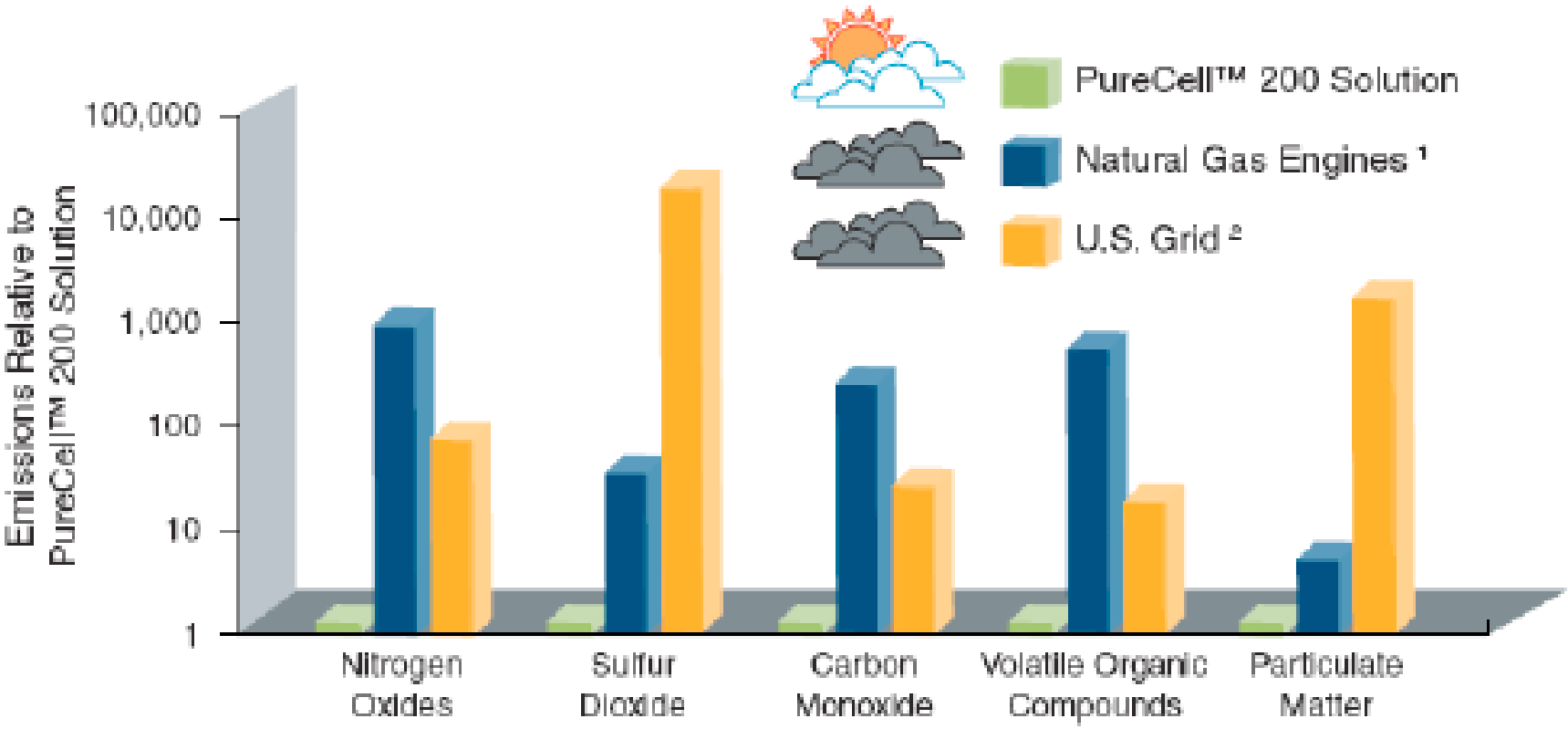
Comparison with the US Grid and Natural Gas Engines



FUEL CELL OPERATION

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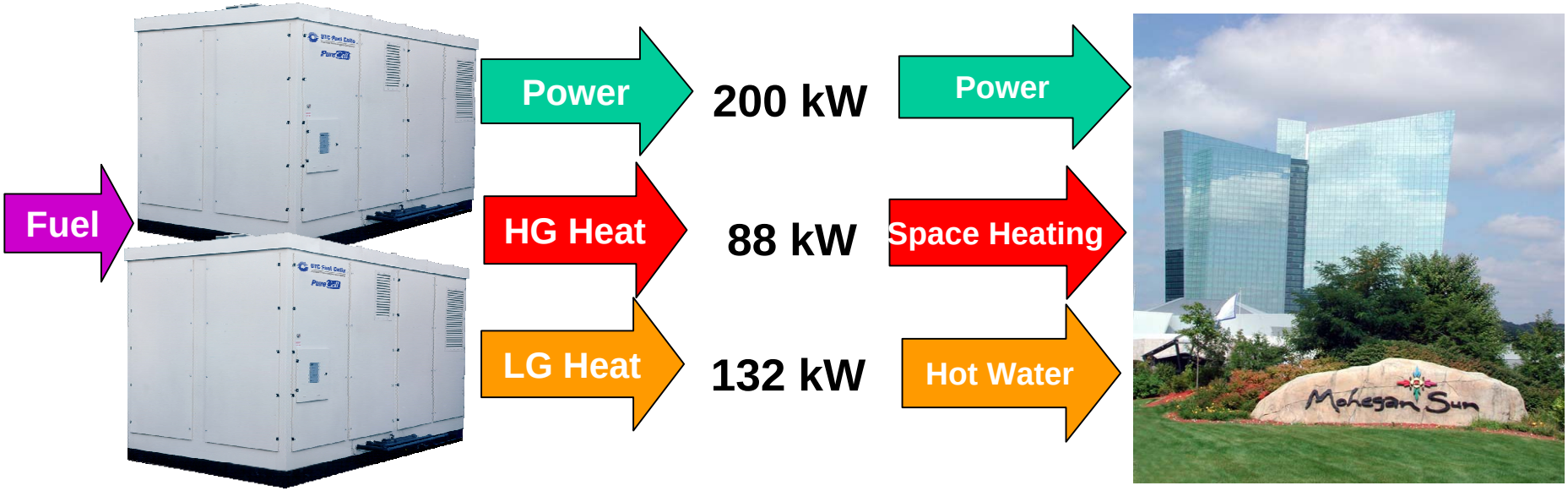
Efficient use of power and heat from the fuel cells



Efficiency up to 90%

"The especially high rate of return achieved using the fuel cell waste heat recovery to preheat boiler feed water and domestic hot water make the Mohegan fuel cell installation a success story"

OPERATION AT MOHEGAN SUN

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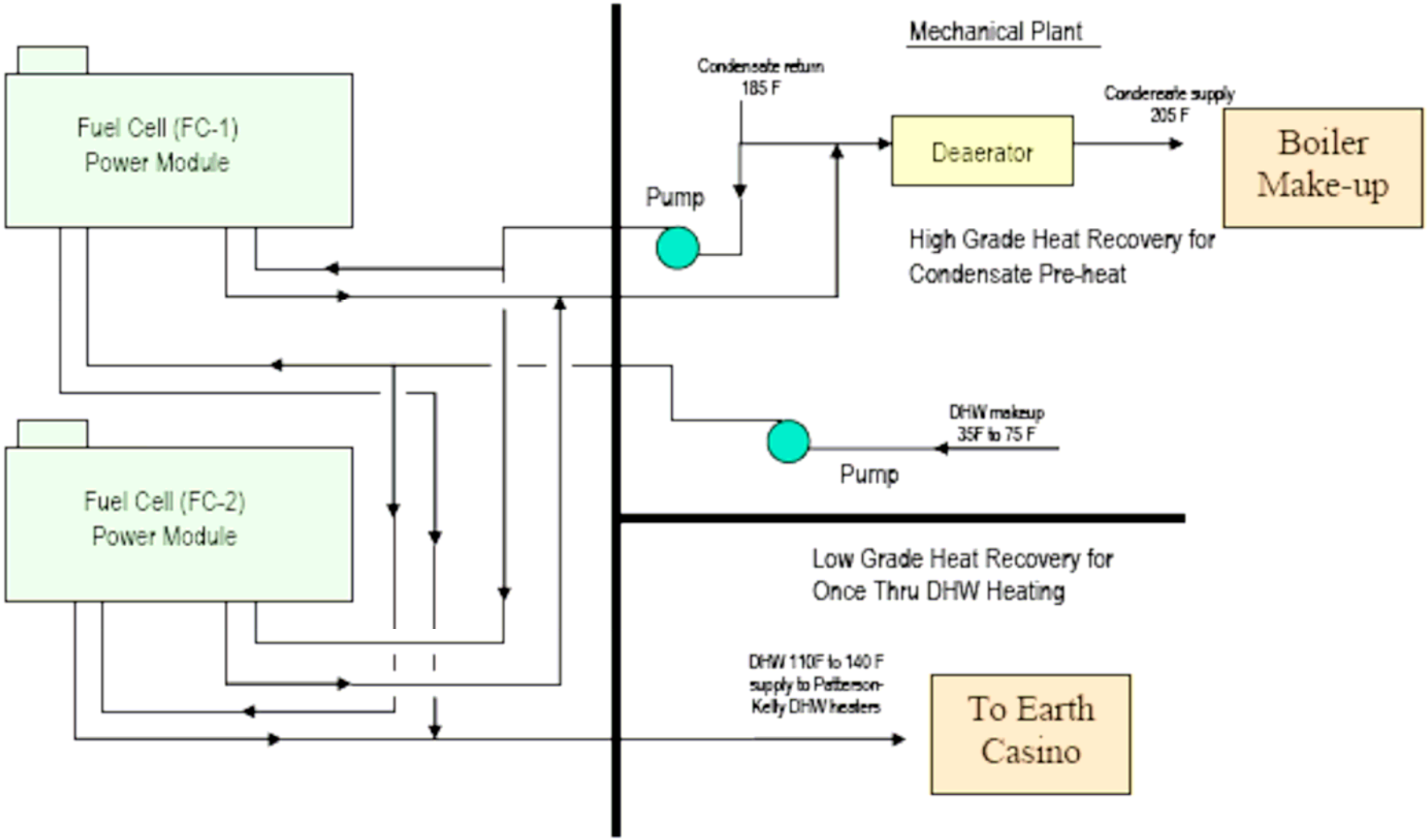
Full utilization of power and heat generated



FUEL CELL OPERATION

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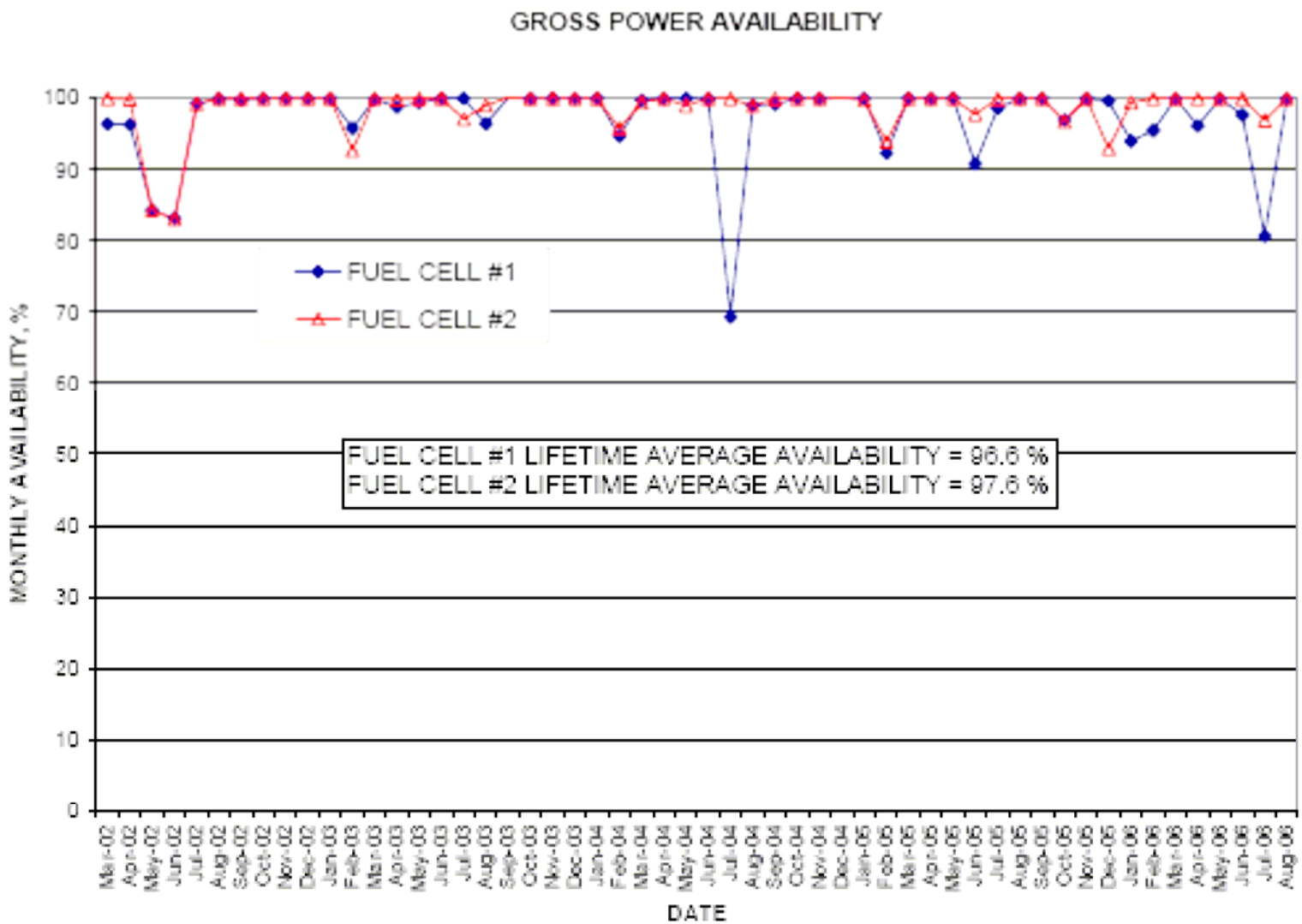
Power plant availability



FUEL CELL OPERATION

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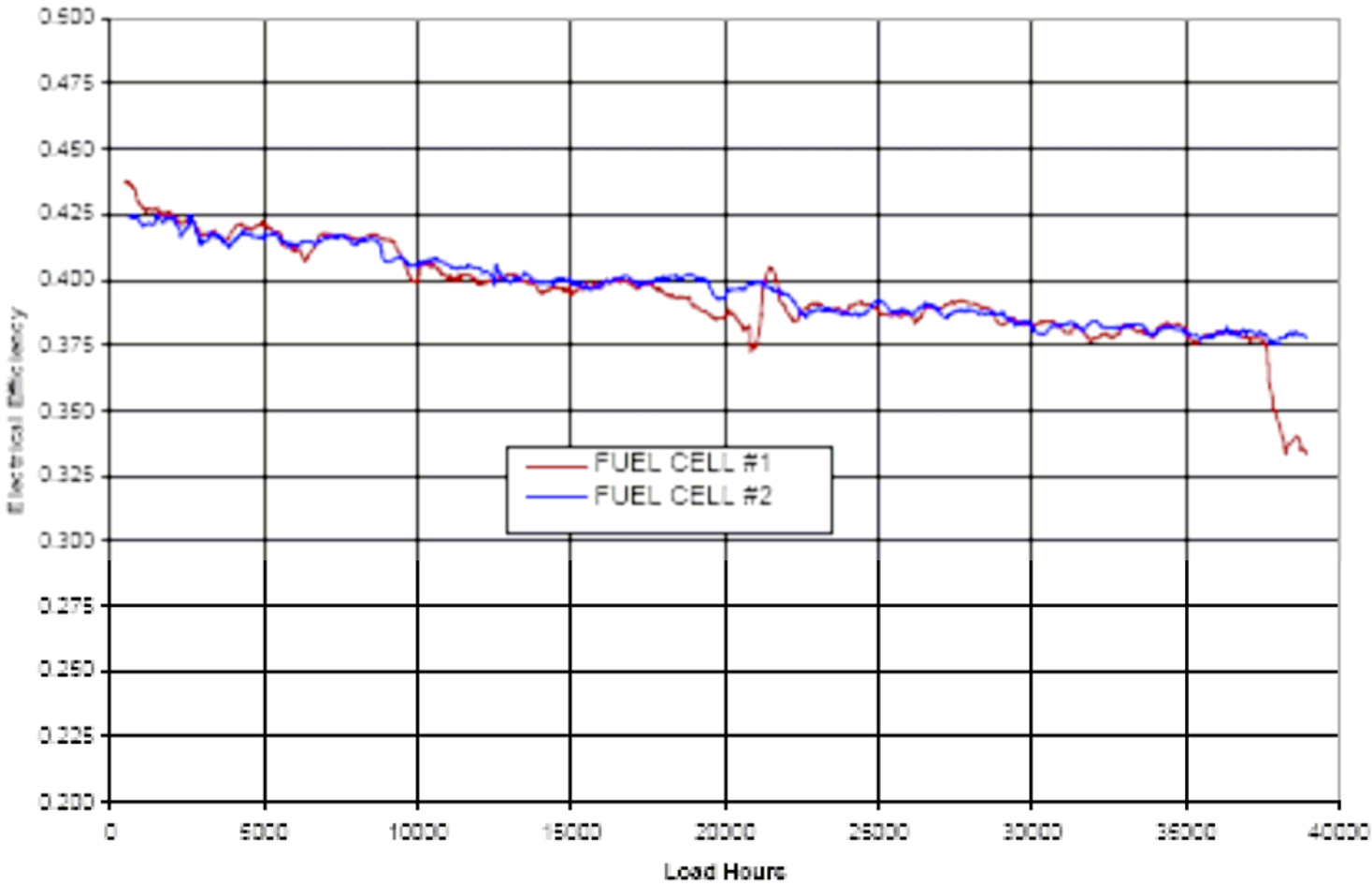
Electrical Efficiency – variation with time



FUEL CELL SUMMARY

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Performance, Cost, and Savings+

Total MWhrs Produced	**16,677 MWhrs**
Heat Produced	**83,217 MMBtu**
Availability	**97-98%**
Electrical Efficiency	**43 – 34 %**
Overall Efficiency	**~ 85-90 %**

Electric Savings*	**$1,313,024**
Thermal Savings*	**$1,081,413**
Cost (equipment, installation, and maintenance)	**$2,848,360**
Cost of fuel*	**$1,736,765**
Operational savings**	**$243,672**
Revenue from REC's	**$276,810**

* At Tribal Utility rates.** Operational savings is (Electric savings + Thermal savings) – (cost of fuel & maintenance)
+ March 2002 – Feb 2007

POTENTIAL SAVINGS

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Commercial rates

Electric Savings*	**$2,501,535**
Thermal Savings*	**$1,144,236**
Cost (equipment, installation, and maintenance)	**$2,848,360**
Cost of fuel*	**$1,400,452**
Operational savings**	**$2,245,319**

* At December 2006 commercial rates
** Operational savings is (Electric savings + Thermal savings) – (cost of fuel & maintenance)

CONCLUSIONS

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Fuel cells are a sure bet at Mohegan Sun!!

- Ultra low emissions, safe, quiet, efficient, reliable, ascetics, and ease of installation
- Significant cost savings were achieved in electrical power and heat recovery
- Mohegan Sun (at utility discount rates) saved **$1,313,024** in electrical power and **$1,081,413** in heat recovery or an **additional 82 %** saving by using fuel cell waste heat recovery to preheat boiler feed water and domestic hot water
- A typical commercial customer paying Dec. 2006 commercial electric and gas rates would have saved more than **$3,600,000**.
- Mohegan Sun is considering using fuel cells for future applications.