Fuel Cell Waste Heat Utilization
at the University of Bridgeport

IDEA Conference
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Linfeng Zhang, Department of Electrical Engineering
Junling(Joyce) Hu and Nouman Kan, Department of Mechanical Engineering
David P. Cote, P.E., Executive Director – Facilities Planning and Operations

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University of Bridgeport:

- The University of Bridgeport, an independent and non-sectarian institution, offers career-oriented undergraduate and graduate degrees.

- Comprised of 5,500 students with 1,250 on-campus residents.

- 52 buildings including Academic, Administrative, Dormitory and Apartments equaling approximately 1.5M square feet.

- Over 53 acres crossing several city streets

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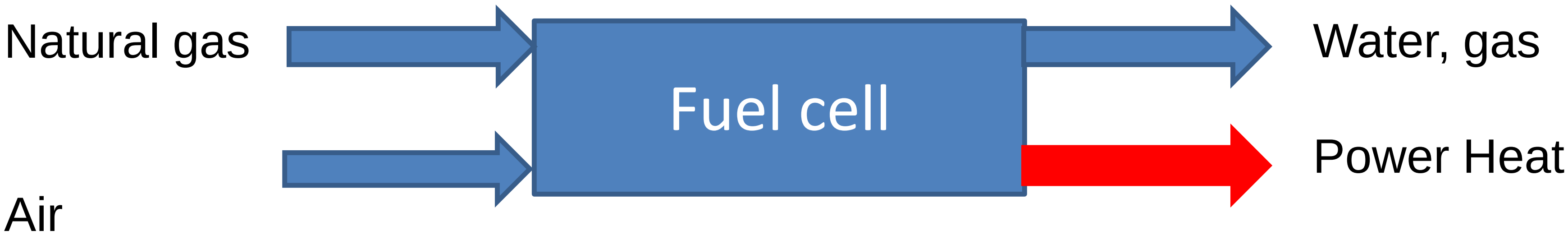
Why Fuel Cells at UB?



- Efficiency: 47% for electrical power, higher for CHP
- Energy security and reliability for a microgrid (point of common coupling)
- Low emission as a clean energy source
- Quiet generator

❖ Another entity owns and operates the fuel cell
❖ We purchases the electric power while the heat is available for free.

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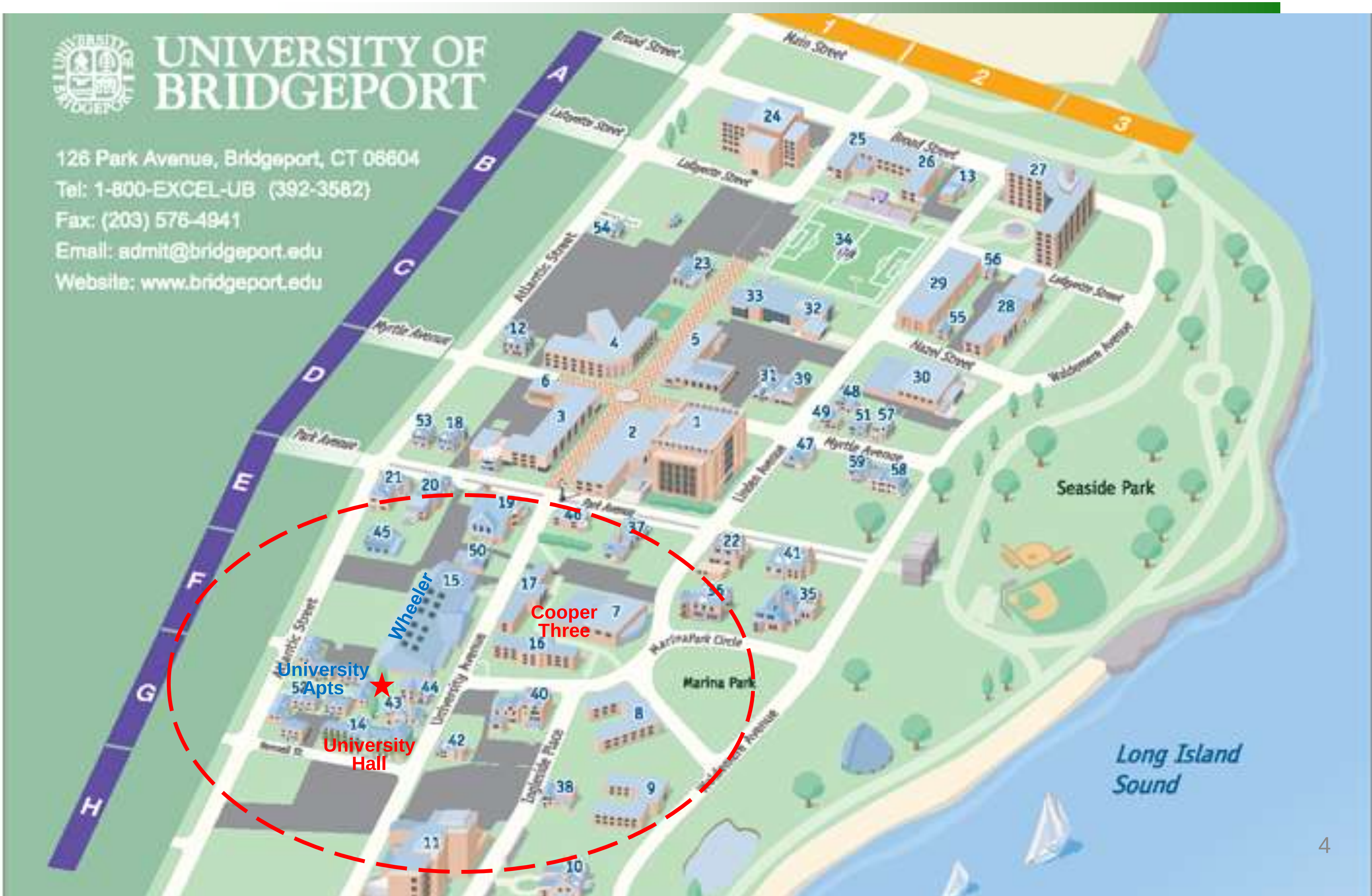

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FC Overview

- 1.4 MW combined heat & power fuel cell power plant
- Space requirement ~ 40 ft x 60 ft
- Electric production ~ 11 million kWh per year
- Utilities needed: natural gas or bio gas fuel, potable water, sewer
- Supplies 80% of campus power needs
- Waste heat converted to hot water and supplied to three locations on campus
- Connecticut Microgrid Program Award

Benefits

- Cost savings during normal operations
- In a grid outage, power to critical facilities – shelter ~2700 persons, security, dining
- Emissions reductions: 7,000 tons CO_2, 64 tons SOx, 28 tons NOx
- Renewable Energy Research Lab – “practice what we teach”

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SureSource 1500 1.4 Mega Watts Fuel Cell Power Plant

PERFORMANCE

Gross Power Output

Power @ Plant Rating	1,400 kW
Standard Output AC voltage	480 V
Standard Frequency	60 Hz
Optional Output AC Voltages	By Request
Optional Output Frequency	50 Hz

Efficiency

LHV	47 +/- 2 %

Available Heat

Exhaust Temperature	700 +/- 50 ºF
Exhaust Flow	18,300 lb/h
Allowable Backpressure	5 iwc

Heat Energy Available for Recovery

(to 250 ºF)	2,216,000 Btu/h
(to 120 ºF)	3,730,000 Btu/h

Fuel Consumption

Natural gas (at 930 Btu/ft3)	181 scfm
Heat rate, LHV	7,260 Btu/kWh

Water Consumption

Average	4.5 gpm
Peak during WTS backflush	15 gpm

Water Discharge

Average	2.25 gpm
Peak during WTS backflush	15 gpm

Pollutant Emissions

NOx	0.01 lb/MWh
SOx	0.0001 lb/MWh
PM10	0.00002 lb/MWh

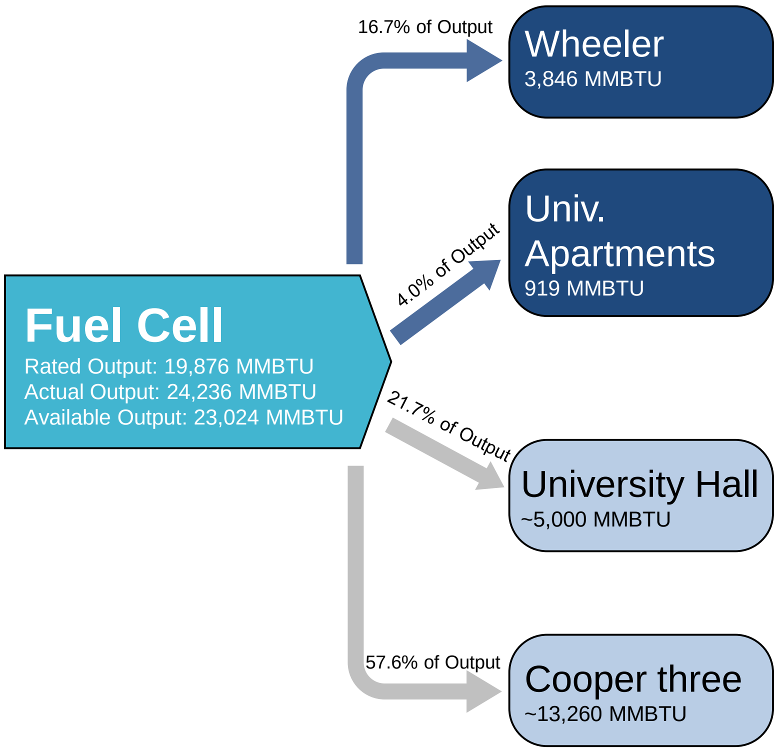
Greenhouse Gas Emissions

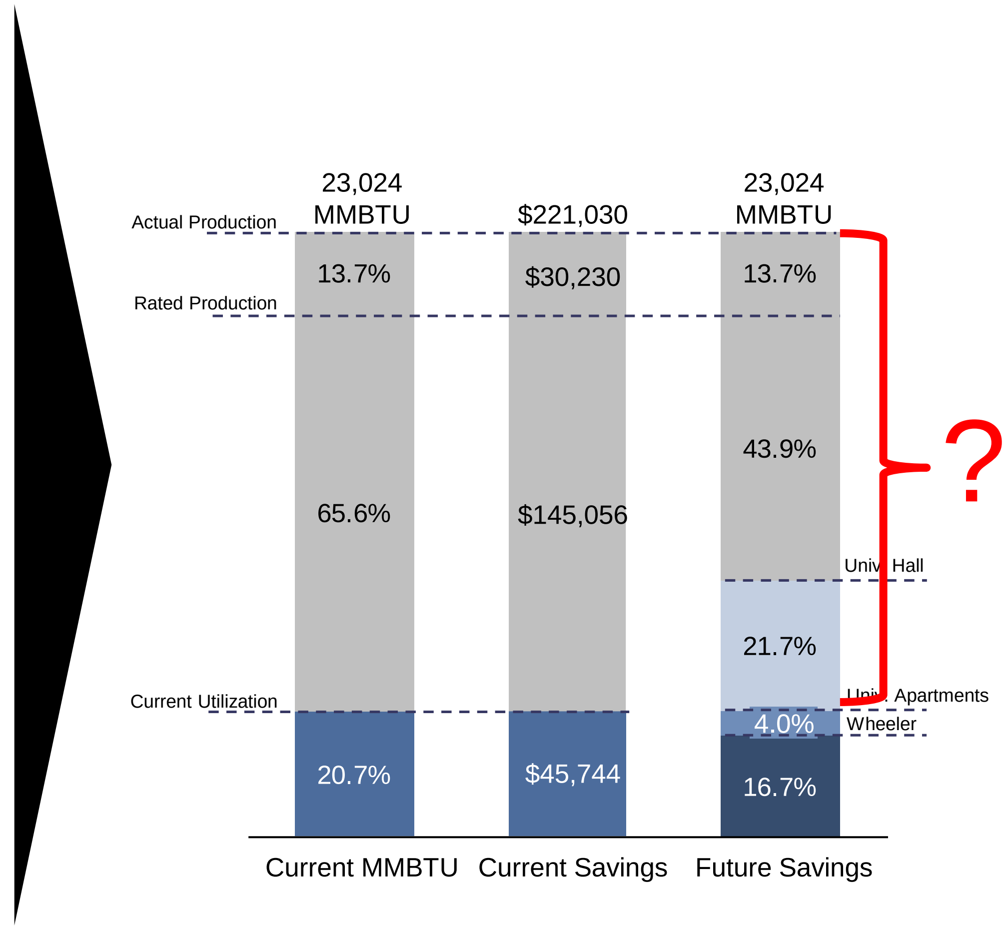
CO2	980 lb/MWh
CO2 (with waste heat recovery)	520-680 lb/MWh

Sound Level

Standard	72 dB(A) at 10 feet

A Study of Fuel Cell Waste Heat Utilization





1BTU=252Calories

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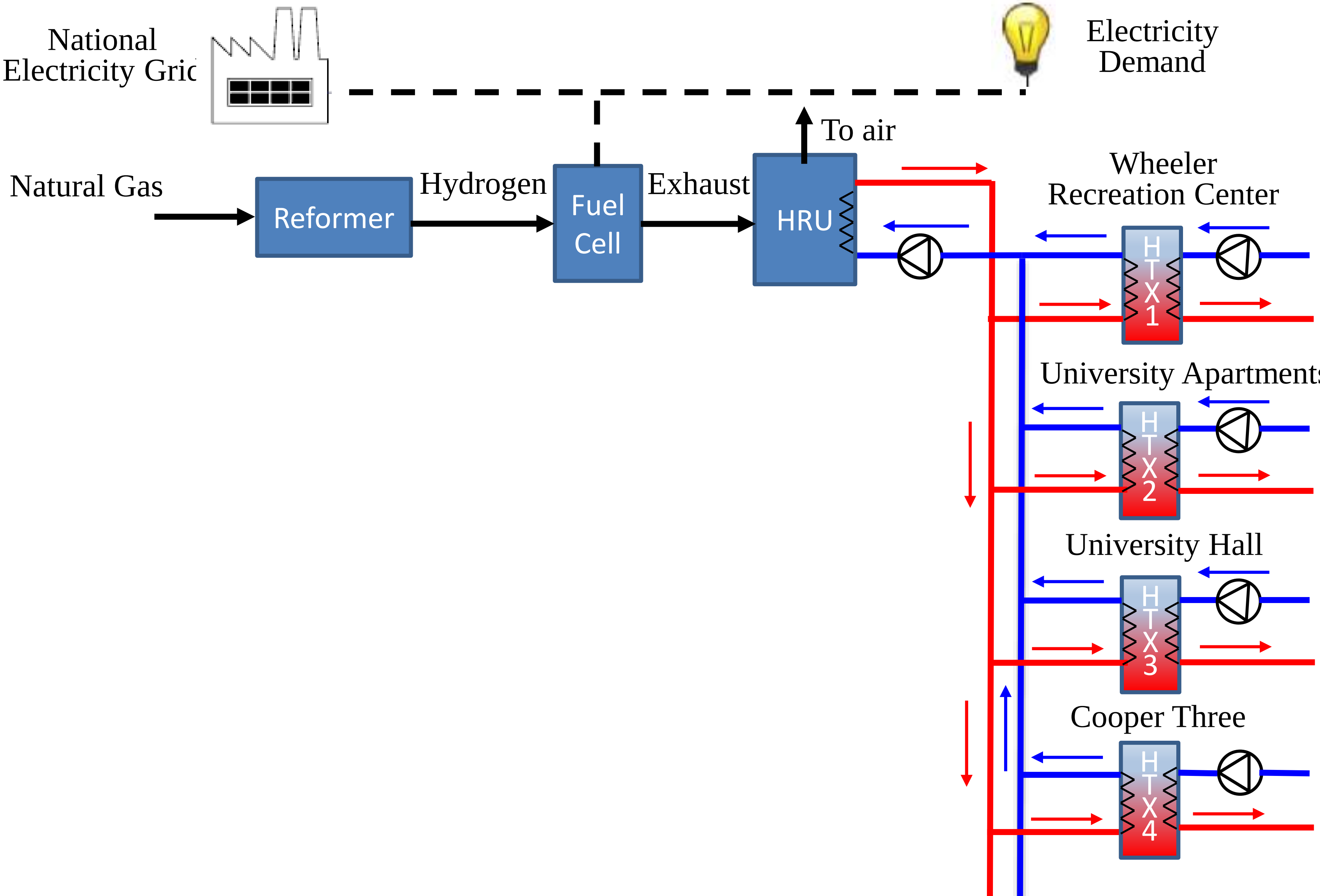

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Fuel Cell Heat for Current and Potential Connections :

- The heat demand of University Apartments and Wheeler Recreation Center is less than half of the total Fuel Cell recovered heat
  - 24% in the summer season
  - 54% in the winter season

- Switching on University Hall
  - Connection has been built
  - Expansion tank size is questionable
- Connecting Cooper Three buildings
  - The total heat demand exceeds the total heat recovered from Fuel Cell in winter

The goal: identify costs and benefits of expanding hot water network to provide heat from fuel cell to additional buildings

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Life cycle cost

#	Components	Life span (years)	Initial cost ($)	Present worth ($)
1	Heat Exchanger	25	5,000	5,000
600 ft	4” Pex piping	25	16,587	16,587
1	Pump	10	2,500	2,500
1	Pump (10 year)			2487.5
1	Pump (20 year)			2,475
57	Installation	N/A	159,000	159,000
N/A	Miscellaneous	N/A	5,000	5,000
7	Annual Maintenance		300	7,451
Life cycle cost				200,500

Inflation rate is set as 2.3%, Interest rate is set as 2.35%

The cumulative present worth **factor**

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Saving in 25 years

Heat (MMBTU)	Annual saving (k$)	25 years (k$)
6630	79	1,965

$12 for 1MBTU

2.5 yr payback

Social cost

Heat (MMBTU)	Natural gas (ton HHV)	CO_2 (ton)	Annual Social cost (k$)	25 years (k$)
6630	126	347	13.9	345.2