Ilios
High Efficiency Water Heater

Heat Differently.™

Combined Heat and Power with Natural Gas Engine Driven Heat Pumps

Prepared for: Boston Green Tourism Meeting 1/14/16

Sheraton Commander Hotel

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HEWH-500-WS
"Water-Source"

Brought to you by: Tecogen — Advanced Modular CHP Systems

The leader in CHP for over 35 years!

What is CHP?

- Combined Heat and Power (CHP)
- Simultaneous production of shaft power and heat
- A prime mover (in many cases an internal combustion engine) turns a shaft to produce shaft work, and heat is recovered from the prime mover and purposefully reused.
- Electrical CHP ("cogeneration")
  - Shaft work turns a generator to create electricity, heat is recovered from prime mover
- Mechanical CHP
  - Shaft work turns a device such as a refrigeration compressor to drive a heat pump cycle, heat is recovered from prime mover

Mechanical CHP Applied

- HEWH-500-WS
  - Water-source natural gas engine-driven heat pump water heater.
  - 300-600 MBH Heat Output
  - Efficiencies 2.0-3.0+ (200-300%*)
  - Compact 3’ X 5’ X 6’ Box
    - Easy retrofit-fits through door ways, onto elevators, in tight mechanical rooms etc.
  - Applied as a dedicated heat recovery chiller (DHRC)- can provide simultaneous heating and cooling
    - Offsetting an existing boiler and peaking shaving an existing electric chiller

* 1.For comparison to a boiler only, efficiency > 100% is impossible…
2. This is a “source” COP, not a “site” COP, keep in mind when comparing to electric heat pumps…

HEWH-500-WS

Example of Ilios HEWH-500-WS producing hot and chilled water simultaneously.

Fuel In
(Natural Gas)

252,527 Btu/hr

Chilled Water

24 Tons
(287,638 Btu/hr)

Hot Water

476,289 Btu/hr*

Conditions:
Hot Water Out =120°F
Source Water = 47/54°F

$$\text{Coefficient of Performance (COP)} = \frac{\text{Total Energy Out}}{\text{Fuel In}} = \frac{287{,}638 + 476{,}289 \text{ Btu/hr}}{252{,}527 \text{ Btu/hr}} = 3.0$$

* Heating output so much higher than a comparable electric heat pump because of the waste heat recovered from the engine, i.e. combined heat and power.

Comparison to a Natural Gas Boiler

The average boiler installed in a hotel in downtown Boston will only convert 85%* of its input fuel into useful energy delivered, the rest goes up the stack…

Fuel In
(Natural Gas)

252,527 Btu/hr

Hot Water

214,647 Btu/hr

$$\text{Coefficient of Performance (COP)} = \frac{\text{Total Energy Out}}{\text{Fuel In}} = \frac{214{,}647 \text{ Btu/hr}}{252{,}527 \text{ Btu/hr}} = 0.85$$

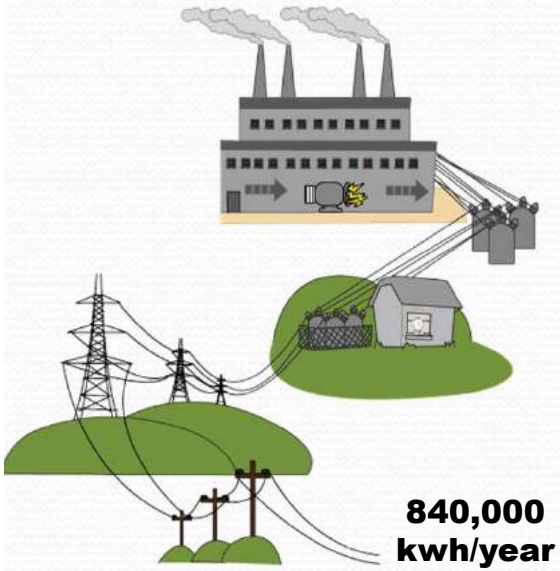
* 1. A new non-condensing boiler is likely to be 85% efficient, most older boilers will no longer be at 85%...
2. Converting steam to make hot water is generally even more inefficient…

Sample Application- 300-Room Hotel

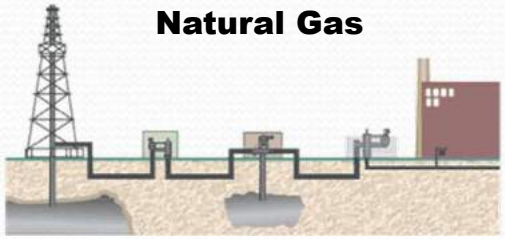
- Simultaneous heating and cooling
  - Get free chilled water (15-25 tons) while producing hot water at twice the efficiency of the existing boiler
- Chilled water value dependent on:
  - Existing electric chiller efficiency
  - Electric Rate
  - Demand Charges
  - Run Hours
- Hot water value dependent on:
  - Existing boiler plant efficiency
  - Cost of offset fuel (natural gas or steam)
  - Run Hours
- Any large building with a chilled water and boiler loop
- High end hotels are generally a great fit (4 star+)
- Anticipated run hours 4,000-5,000/year

Traditional Methods of Heating and Cooling (Before Ilios…)

Electricity



Natural Gas



$272,500

=

$168,000 **+** **$104,500** **=**

@ $0.20/kwh

@ $1.10/therm

840,000 kwh/year

95,000 therms/year

54°F CHWR

400 Ton Electric Chiller

η= 0.7kW/ton

44°F CHWS

120°F DHW Return

150 HP Boiler

η= 70%

140°F DHW Supply

Simultaneous Heating and Cooling with Ilios

~~= $156,800~~
~~= $168,000~~
@ $0.20/kwh

798,000
~~840,000~~
kwh/year

54°F CHWR

20 tons

$11,000 =
@ $1.10/therm

10,000
therms/year

~~= $76,215~~
~~$104,500 =~~
@ $1.10/therm

69,286
~~95,000~~
therms/year

~~400~~ Ton Electric
380 Chiller
η= 0.7kW/ton

44°F CHWS

$3000
Incremental
Maintenance

450 MBH

120°F DHW
Return

150 HP Boiler
η= 70%

140°F DHW
Supply

Ilios also saves 14 kW worth of Demand for at least 5 months!

NET SAVINGS = $28,645/year*

*Includes cooling tower water savings (evaporation), does not include savings from avoided sewer costs for dumping blow-down water or savings from reduced chemical treatment…

Savings Summary

Electric Savings= $168,000-$156,800= $11,200/year

Natural Gas Savings = $104,500-$76,215 = $28,285/year

Demand Savings= $28/kW* 5 months* 14 kW = $1960/year

Water Savings= $1,200/year (approx. 150,000 gallons)

Ilios Fuel Cost = $11,000/year

Ilios Incremental Maintenance Cost = $3,000/year

NET SAVINGS:

($11,200+$28,285+$1,960+$1,200)-($11,000+$3,000)

NET SAVINGS = $28,645

Return on Investment (ROI)

- Estimated Installed Cost ($125,000)
- Straight ROI based on $28,645 savings = 4.3 years *
- After Incentives
  - National Grid Therm Savings Custom Gas Incentive = $31,430 ($2.00/therm saved in first year)
  - 10% Federal Tax Credit (ITC) = $12,500
- ROI after incentives ≈ 2.8 years*

*1. Assumes 4,000 operating hours a year, sites with more run hours mean quicker ROI.
2. Assumes (1) unit installation, most properties could accept at least (2) units, same ROI, twice the savings.

Energy & Carbon Savings

Electric Savings= 42,000 kwh/year

= 32 tons of CO_2 or 6 passenger cars removed

Natural Gas Savings = 15,715 therms/year

= 92 tons of CO_2 or 17.5 passenger cars removed

Total Greenhouse Gas Reduction

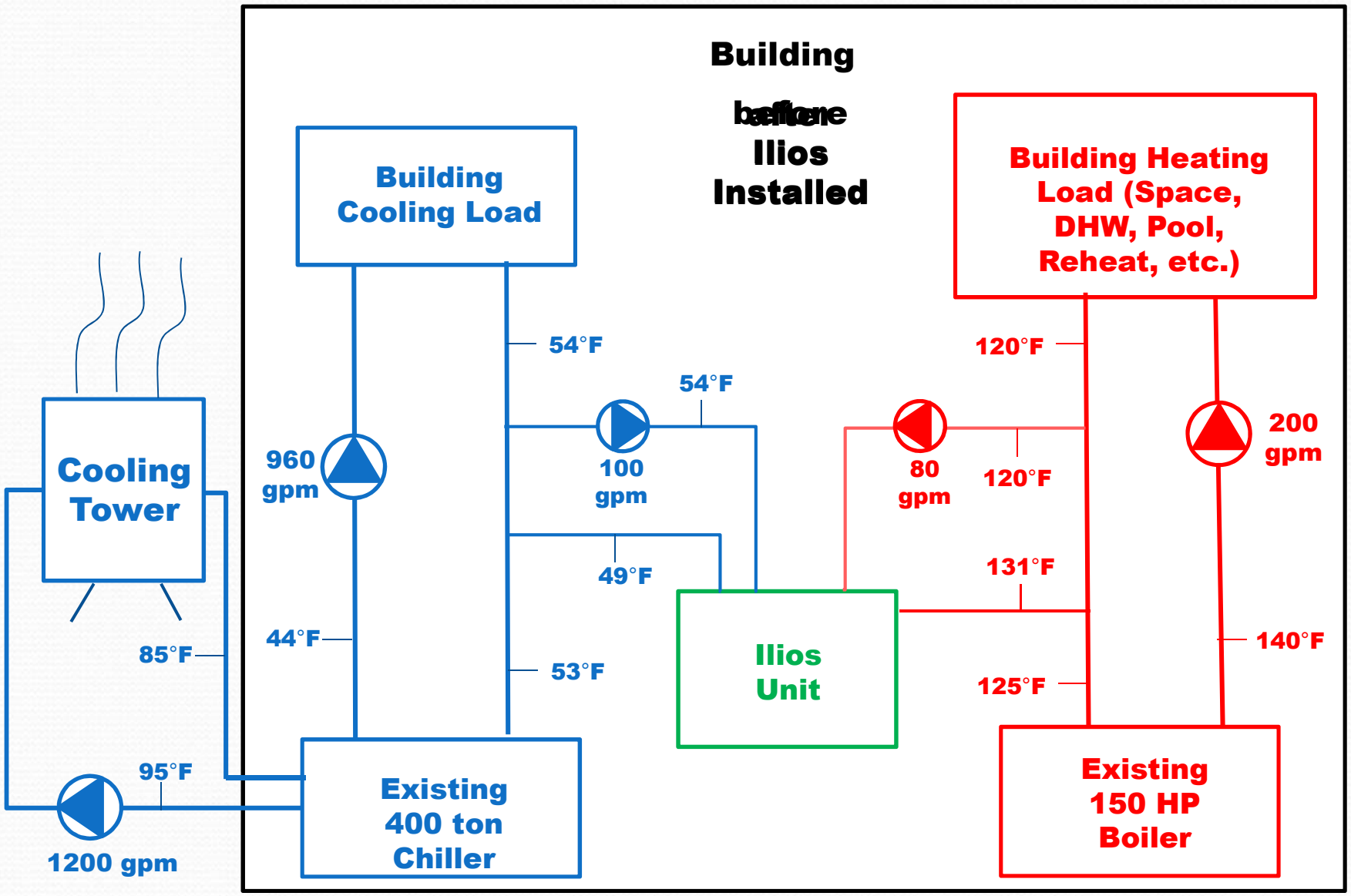
= 124* tons of CO_2 every year!

*1. Assumes 4,000 operating hours a year, sites with more run hours result in more carbon savings
2. Assumes (1) unit installation, most properties could accept at least (2) units, same ROI, twice the carbon savings

How do I know if my building is a good fit?

- Must have centralized hot water system
- Must have a chiller (hydronic cooling)
- Natural gas supply to building
- It can even work if you have steam…
  - The Ilios unit can be deployed in buildings fed off of district steam in downtown Boston. The Ilios unit can provide DHW and Chilled Water and offset very expensive steam. Unit would run off cooking gas supply line.
  - Steam is often 2-3X more expensive than natural gas on a per BTU basis, the savings generated by offsetting steam are <u>huge</u>.

Process Flow Diagram



Utility Incentives

- The Ilios natural gas engine driven heat pump falls under existing custom incentive programs
- Utilities will pay $1.00-$2.50/therm saved in the first year. This could be anywhere from $15,000-$50,000 depending on the installation
- Most hotels will have National Grid supplied natural gas in downtown Boston (outside of Boston proper could have Eversource natural gas)
- Your local natural gas utility contact can assist with incentive

Federal Incentives

- The Ilios natural gas engine driven heat pump qualifies for the 10% Investment Tax Credit as it is considered mechanical CHP. This is available until December 21, 2016*.
- Per section 48(a)(3)(A)(v) of the IRC the CHP Tax Credit is defined as:

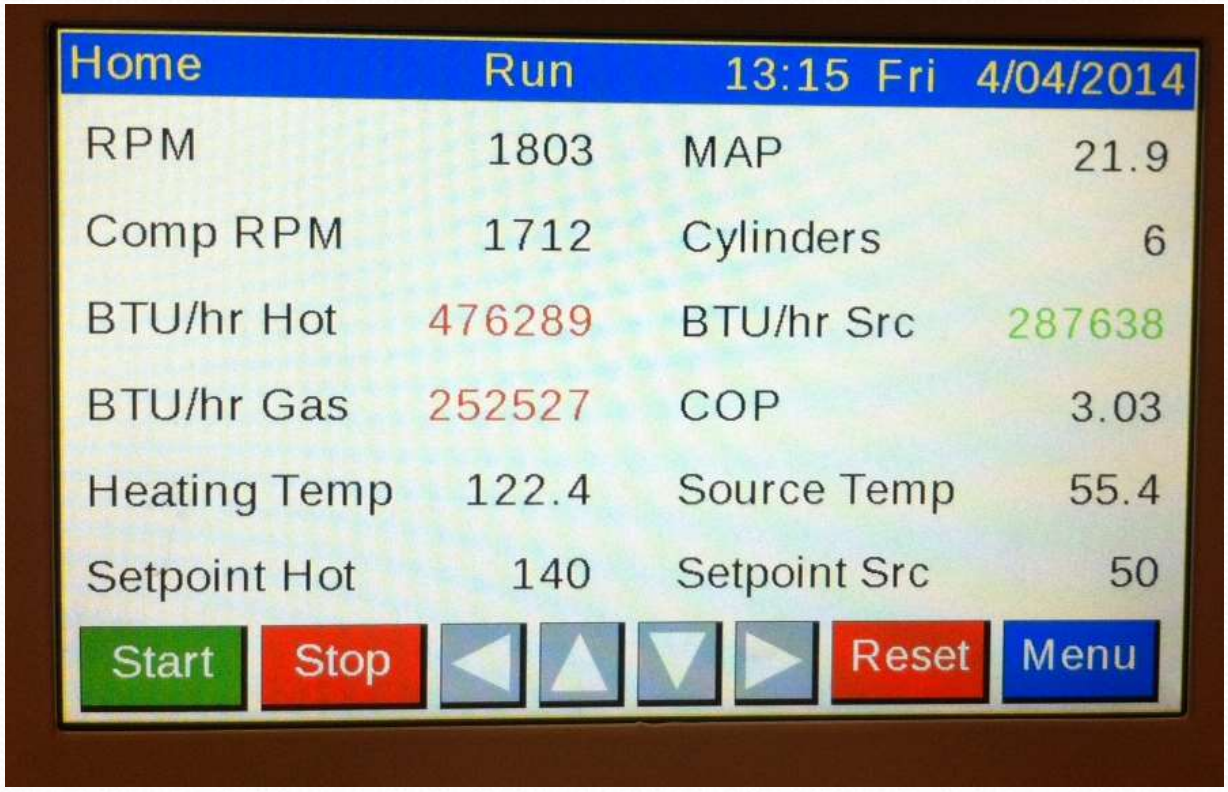
  "A property compromising of a system which uses the same energy source for simultaneous or sequential generation of electrical power, mechanical shaft power, or both, in combination with the generation of steam or other forms of useful thermal energy (including heating and cooling applications"

*Project must be installed by December 21, 2016.

What about the service??

- Annual preventive maintenance-just like a boiler
  - Up to 8,000 hour oil change intervals!
- Tecogen Full Factory Service available
  - Local service center right in Waltham, MA (factory office)
- All economic analysis presented includes service fee
- Everything is covered “bumper-to-bumper”
  - Essentially an unlimited parts & labor warranty
- The first Tecogen cogeneration module has been running for over 31 years at Harvard University-serviced by Tecogen!

HEWH-500-WS



Screen shot of unit running at full load producing 122°F hot water using a 55°F chilled water return as the source temperature. As you can see the unit is putting out 476,289 Btu/hr of heat with a gas input of only 252,527 Btu/hr. This provides a COP = (476,289+287,638)/252,527 = 3.0

This is 4X the efficiency of a typical gas boiler!!

Why would I want this?*

- You have interest in traditional cogeneration but have electrical interconnection restrictions
  - "On the network" (spot network)
- You feel the capital cost of traditional cogeneration is too high or return too long
- You have aging and inefficient mechanical equipment, and want to add some "efficient redundancy"
- Have attacked all the low hanging fruit, lighting, etc. and looking for the next big energy saver
- Want to take advantage of utility incentives and federal tax credits

* In addition to cutting your water heating bills in half, saving electricity in your existing chiller, and reducing your carbon foot print substantially…

How do I start saving?

- Free site evaluation from factory application/sales engineer and/or local rep (Green Technology Associates)
- Free economic analysis
- Preliminary proposal, outlines project costs, savings, estimated range of ROI
- Tecogen provides Full Turn-Key proposal, or "Turn-Key Lite™"
  - Tecogen Full Turn-Key- we project manage entire project from design through commissioning
  - Turn-Key Lite™ involves factory assistance for pre-installation design, packaged integration skids but you use your own mechanical contractor

Case Study

Solace on Peachtree-Atlanta, GA

- (2) Ilios HEWH-500-WS
- Installed in multi-family residential apartment building
- Serving DHW and space heating, year round cooling.
- With 2-pipe system, they had no way of supplying winter cooling to retail space and common areas in shoulder season before Ilios
- Annual savings after service costs $45,000

  ROI ≈ 4 years*

*Energy prices in Boston are much higher, and larger incentives are available, so ROI will be faster in Boston.

Case Study

The Hotchkiss School-Lakeville, CT

- (1) Ilios HEWH-500-WS
- Installed in athletic center, machine is serving DHW & Pool heating as well as cooling (chilled water)
- Like many hotels, school is heating water while cooling the space simultaneously
- Annual savings after service costs $25,000

  ROI ≈ 4 years*

*Energy prices in Boston are much higher, and larger incentives are available, so ROI will be faster in Boston.

Case Study

Landstown High School-Virginia Beach, VA

- (1) Ilios HEWH-500-WS
- Traditional "school" application, machine is serving reheat, space heat, and cooling loads
- Schools are good candidates because they have summer cooling loads as well as winter cooling loads (on the interior)
- They also have a hot water demand all year long space heating in the winter, and reheat in the summer for humidity control
- Annual savings after service costs $25,000

ROI ≈ 5 years*

*Energy prices in Boston are much higher, and larger incentives are available, so ROI will be faster in Boston.

Case Study

Scripps Research Institute, Jupiter, FL

- (7) Ilios HEWH-500-WS
- Lab application, machines are serving reheat and cooling loads, also some industrial hot water
- Serving 24/7 "mission critical" need for simultaneous heating and cooling in lab/pharma applications
- Annual savings after service costs $200,000

  ROI ≈ 3 years*

*Energy prices in Boston are much higher, and larger incentives are available, so ROI will be faster in Boston.

Examples of Factory Pre-Packaged Pump & Heat Exchanger "Integration" Skids*

* These allow for a quick and easy installation, skids are fully assembled with factory quality control (pressure testing, etc.). Also the integration skids can be serviced by Tecogen as well as the units themselves.

Questions?

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Tecogen
Advanced Modular CHP Systems

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#HeatDifferently

#CHPMadeEasy

#EfficientRedundancy

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