

# Welcome to WaterFurnace

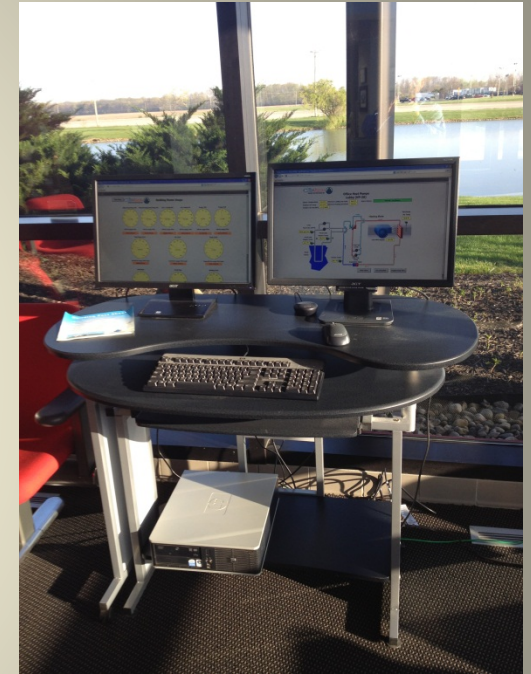
Opportunity to Net Energy



# Our building is GeoExchange even the plant and the labs



# Our Mechanical System!



Pumps & Headers  
just add water

# Fundamental Change!

If nothing changes – how can you get new results?

- Release Creativity
  - Application knowledge
  - Code
  - Contracts
- Team versus – “low bid!”
  - Do NOT Buy everyone’s mistakes
  - Are Projects too complex to maintain?
    - Artificial efficiency
    - Modeling accuracy
    - WSHP – simple and efficient by DESIGN even by DEFAULT

Posted originally, 4/28/11

Reposted with minor changes, 9/27/11

*Back in 2011 multiple design guides were produced  
They all encourage the Integrated Design Process  
And they all featured WSHP's as a possible solution*



# Advanced Energy Design Guide for Small to Medium Office Buildings

## Achieving 50% Energy Savings Toward a Net Zero Energy Building

Developed by:

American Society of Heating, Refrigerating, and Air-Conditioning Engineers

The American Institute of Architects

Illuminating Engineering Society of North America

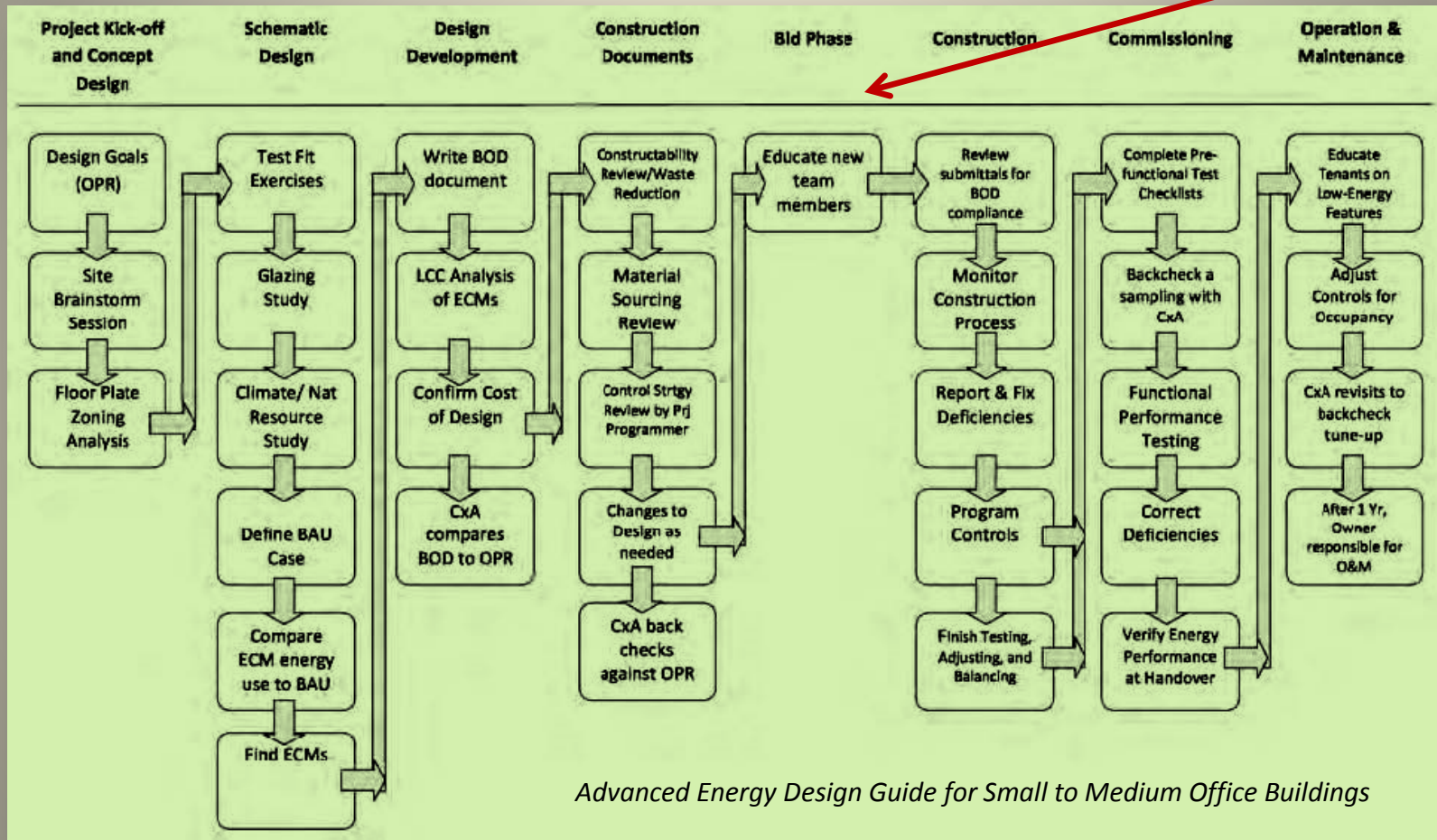
U.S. Green Building Council

U.S. Department of Energy



# Kickoff thru O&M the GREEN Team

Bid phase  
Too late for  
new team members



The integrated design process is the path to Net Zero

# Common sense evolution

- 1950's – water-cooled better than air-cooled
- 1960's – Closed loops in buildings
  - Installed cost
- 1970's – Energy transfer
- 1980's – exploded in offices and schools
- 1990's – EER and extended range expansion
- 2000's – Refrigerant, EER, and ECM

# System Selection

## **OPR** – Owner Project Requirements

- The owner wants to know options
  - Budget
  - Why use a system?
    - Installed cost
    - Operating cost
    - Space – interface cost
    - Reliability and risk
  - Function is required



– redundancy for example



# Energy Efficiency

## Lessons Learned ... By a utility

	<u>Projected kW Reduction</u>	<u>Actual kW Reduction</u>
Air Source Heat Pumps	0.33 kW/ton	0.165 kW/ton
Ground Source Heat Pumps (2.6 kW/4T home)	0.66 kW/ton	0.65 kW/ton

- *93% of rebates paid on “Replacement” & “New Construction”*
- *80% paid on Air Source & 20% paid on Ground Source Product*
- *60% return on rebate program*

*To accomplish our goals we must ...*

- *Focus on Ground Source & C&I and flip the historical ratio*
- *Be able to play in the replacement game*
- *Transitioning away from “Consumer Rebates”*

**Air Source returned  
Half of calculated  
Why?  
SEER vs. EER  
Water-cooled vs air-cooled  
Loop vs. Ambient**



# EER vs. SEER vs. IEER

S and I are already adjusted ratings

The background of the main title is a puzzle. The puzzle pieces are arranged to form a stylized illustration of a modern building with a glass facade and a grid of windows. The colors are primarily blue, grey, and white.

## How The Culture of Inefficiency Is Outfoxing LEED® , ASHRAE, And Efficiency Programs

**How many energy-efficient or certified buildings are not living up to the label? Very, very many, if this Ohio commissioning/auditing firm's experience is close to typical. They report on common weaknesses in efficiency strategies and on real-life patterns of upgrades gone wrong across an array of equipment types. While flaws in well-intentioned processes remain, a more careful investment of human energy can still yield the desired reduction in building energy.**

BY PETER KLEINHENZ, MS, P.E.; JOHN SERYAK, MS, P.E.; CHARLIE SCHREIER, MS, P.E.;  
FRANC SEVER, MS; AND GREGORY RAFFIO, MS, P.E.

# Benchmarking (LL84) - reporting

The screenshot shows the PlanNYC website interface. At the top, there is a navigation bar with links for Search, Email Updates, and Contact Us. Below this, there are links for Residents, Business, Visitors, Government, and Office of the Mayor. The main header features the PlanNYC logo and the text "Green Buildings & Energy Efficiency". A search bar is located on the right side of the header. Below the header, there is a navigation menu on the left with links for Home, About PlanNYC Green Buildings & Energy Efficiency, Greener, Greater Buildings Plan (with sub-links for LL84, LL85, LL87, LL88, and Outreach & Training), Greening the City's Codes & Regulations, Financing & Incentives, Greening Public Buildings, Other Initiatives, Other Green Building Resources, and Contact Information. The main content area features a large image of the New York City skyline with the Chrysler Building as the focal point. Below the image, the section is titled "Greener, Greater Buildings Plan". The text discusses the city's sustainability goals and the challenges of addressing existing buildings. It mentions that the city's square footage is highly concentrated in large buildings, which account for half of the city's square footage and 45 percent of its total greenhouse gas emissions. The text also describes the Greener, Greater Buildings Plan (GGBP) and its components, including the New York City Energy Efficiency Corporation (NYCEEC), the requirement for large buildings to benchmark their energy performance (LL84), the adoption of a local energy code (LL85), the requirement for energy audits and retro-commissioning (LL87), and the requirement for lighting upgrades (LL88).

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planNYC | Green Buildings & Energy Efficiency

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Home

About PlanNYC Green Buildings & Energy Efficiency

Greener, Greater Buildings Plan

- LL84: Benchmarking
- LL85: NYC Energy Conservation Code (NYCECC)
- LL87: Energy Audits & Retro-commissioning
- LL88: Lighting Upgrades & Sub-metering
- Outreach & Training

Greening the City's Codes & Regulations

Financing & Incentives

Greening Public Buildings

Other Initiatives

Other Green Building Resources

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Photo Credit: NYCECC

## Greener, Greater Buildings Plan

To reach its aggressive sustainability goals, New York City needs to do more than improve new construction and renovations. It has to proactively address its existing buildings, a problem that is difficult to tackle because New York City has almost a million of them. However, it turns out that the city's square footage is highly concentrated in less than two percent of its properties; two percent translates into 15,000 properties over 50,000 square feet, which account for half of New York City's square footage and 45 percent of New York City's total greenhouse gas (GHG) emissions. These larger buildings also tend to have more sophisticated management and more financial and technical resources than do smaller buildings.

Consequently, New York City enacted a comprehensive effort, called the Greener, Greater Buildings Plan (GGBP), which targets energy efficiency in these large existing buildings. The City's signature effort in energy efficiency is an internationally recognized, industry-transforming energy efficiency package that is leading the nation in energy efficiency policy. GGBP is designed to ensure that information about energy is provided to decision-makers and that the most cost-effective energy efficiency measures are pursued.

GGBP consists of four regulatory pieces supplemented with extensive jobs training and a financing entity called the [New York City Energy Efficiency Corporation \(NYCEEC\)](#). It includes a requirement that large buildings annually benchmark their energy performance ([LL84](#)); that a local energy code be adopted ([LL85](#)); that every 10 years these buildings conduct an energy audit and a retro-commissioning ([LL87](#)); and that by 2025, the lighting in the non-residential space be upgraded to meet code and large commercial tenants be provided with sub-meters ([LL88](#)).

## Quick Links

- » PlanNYC
- » [LL84: Benchmarking](#)
- » [Outreach & Training](#)
- » [Energy Aligned Clause](#)

Printer Friendly Version >

Coming to a city near you – report Energy and Water use

# A Stable Whole Building Performance Method For Standard 90.1

By Michael Rosenberg, Member ASHRAE, and Charles Eley, P.E., FAIA, Member ASHRAE

Wouldn't it be great if a single energy model could be used to demonstrate minimum code compliance, green code compliance, establish a LEED rating, and determine eligibility for federal tax and utility incentives? Even better, what if the basic rules for creating those models did not change every few years?

A recently proposed addendum to ANSI/ASHRAE/IES Standard 90.1-2010 aims to meet those goals. Addendum *bm* establishes the Performance Rating Method found in Appendix G of Standard 90.1 as a new method of compliance while maintaining its traditional use in gauging the efficiency of "beyond code" buildings. Furthermore, the addendum sets a common baseline building that would stay the same for 2013 and future versions of Standard 90.1, while only the improvement target will change with each new edition.

## Background

used for code compliance and the Performance Rating Method (PRM) used for LEED calculations and other beyond-code programs. The performance methods are similar in that the design or proposed building is compared to a baseline building that is in compliance with the prescriptive standards. The differences are in the details of how the baseline is defined and the scope of design elements that can be credited.

The ECB method is intended to be used for code compliance, and as result, the baseline building tracks the proposed design in many respects. For example, if

served by a water-source heat system, the comparison is to a building with wood-framed 20% window-to-wall ratio, all facing south, served by a water heat pump system, with all corridors just meeting prescriptive requirements. If the same building had made a 40% window-to-wall ratio, windows facing west, and an air-source heat pump system, the comparison is to a baseline building with maximum 40% window-to-wall ratio, all facing west, and an air source heat system, with all components just meeting prescriptive requirements.

## About the Authors

Michael Rosenberg is a senior research scientist at Pacific Northwest National Laboratory, Eugene, Ore. He is a member of the SSPC 90.1 Energy Cost Budget Subcommittee and the LEED Energy and Atmosphere Technical Advisory Group. Charles Eley, P.E., FAIA, is a consulting architect and mechanical engineer in San Francis-

## Compliance with 90.1

The two paths for compliance in ASHRAE Standard 90.1-2010 are the prescriptive- and performance-based paths.

The prescriptive path establishes criteria for energy-related characteristics of individual building components such as minimum R-values of insulation, maximum U-factors and solar heat gain coefficients of fenestration, maximum lighting power allowance, occupancy sensor requirements for lighting control, and economizer requirements for HVAC systems.

The alternative to prescriptive compliance in Standard 90.1-2010 is a performance-based approach known as the Energy Cost Budget (ECB) method. This method provides more flexibility by allowing a designer to "trade off" compliance by not meeting some prescriptive requirements if the impact on energy cost can be offset by exceeding other prescriptive requirements.

Using the ECB approach, a computer simulation of a proposed building design is compared to a reference building design (baseline) that is essentially a clone of the proposed design with each building component adjusted to "just meet" prescriptive requirements. A building is deemed in compliance when the annual energy cost of the proposed design is no greater than the annual energy cost of the reference building design. Instead of looking at components in isolation, this method allows recognition of the interactions of those components in demonstrating compliance.

Regardless of which approach (prescriptive or performance) a building chooses for compliance, there are a number of mandatory requirements that must be met and cannot be traded off. Examples of the mandatory requirements include building envelope air leakage, mechanical equipment efficiency, and thermostatic and lighting controls.

# Department of Energy is taking action to enhance collection and use of Data

[Home](#) » [Commercial Buildings](#) » Standard Energy Efficiency Data Platform

## STANDARD ENERGY EFFICIENCY DATA PLATFORM

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[Commercial Buildings](#)

[Advanced Energy Design Guides](#)

[Advanced Energy Retrofit Guides](#)

[Better Buildings Alliance](#)

[Better Buildings Challenge](#)

[Building Energy Data Exchange Specification](#)

[BuildingSync](#)

[Buildings Performance Database](#)

[Commercial Buildings Resource Database](#)

[Energy Asset Score](#)

[Energy Modeling Software](#)

[Penn State Consortium for Building Energy Innovation](#)

[Past Projects](#)

The Standard Energy Efficiency Data (SEED)<sup>™</sup> Platform is a software application that helps organizations easily manage data on the energy performance of large groups of buildings. Users can combine data from multiple sources, clean and validate it, and share the information with others. The software application provides an easy, flexible, and cost-effective method to improve the quality and availability of data to help demonstrate the economic and environmental benefits of energy efficiency, to implement programs, and to target investment activity.

The screenshot shows the SEED Platform website interface. At the top, there is a search bar and navigation tabs for 'Projects', 'Buildings', 'Data', and 'CONTACT'. The main content area features a 'Getting Started' banner with a city skyline background. Below the banner, there are three highlighted sections: 'Upload your data', 'Match your data', and 'Manage compliance'. The 'Upload your data' section includes a 'Download Sample Data' button. The 'Match your data' section describes how SEED helps with data matching. The 'Manage compliance' section mentions SEED's flexible labeling system. At the bottom, there is a 'U.S. DEPARTMENT OF ENERGY' logo and the text 'Energy Efficiency & Renewable Energy'.



U.S. DEPARTMENT OF ENERGY

### RESOURCES

[SEED Software Support](#)

[SEED Source Code](#)

[FAQs](#)

[What is Open Source?](#)

### GET UPDATES

Users and Software Developers can receive updates about SEED<sup>™</sup> by entering your email address.

User Email:

[SUBSCRIBE](#)

# Whole Building Approach

## Energy Profile:

Climate	Heat	Cool
People	Heat	Cool
Ventilation Air	Heat	Cool
Lights and equipment		Cool
Plug Loads		Cool
Water	Heat	
Unoccupied	Heat	Cool

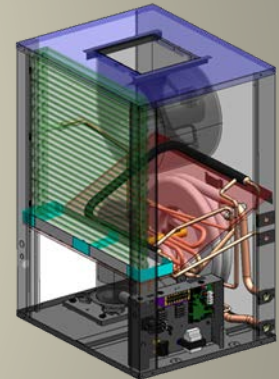
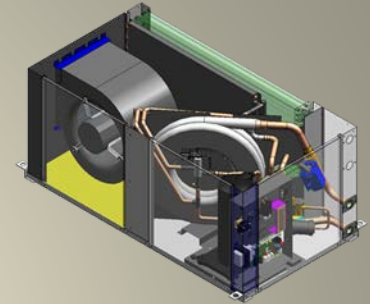
# Do you have both?

- Heating and Cooling
- WSHP system advantage – Nets loads
  - WSHP's are available from small units sized for a 200 sq. ft. room to 12000 sq. ft. core of the building
  - WSHP's reverse
    - Heat or cool independently
    - BUT – all tied together to cancel each other out
      - Heat and cool simultaneous
      - Heat and cool cyclically
        - » Cool during occupied then heat unoccupied
        - » Cool people then heat water
        - » ***Hot water is in PIPE, HVAC in pipe helps tie them together to net energy of the entire building***

# Commercial Products

## Horizontal and Vertical Products

- Versatec Base Series  
UBH and UBV Models 1/2 to 6 ton
- Versatec Ultra Series  
USH and USV Models 3/4 to 6 ton
- Envision2 Compact Series  
NBH and NBV Models  
Single and Dual Capacity 3/4 to 6 ton
- Versatec Condo Replacement  
UCV Models 1-1/2, 2, 2-1/2 and 3-1/2 ton
- Envision Series  
NLH/NXH and NLV/NXV Models 6 to 25 ton





# Commercial Products

## Console Products

- **Envision Console Series** 1/2 to 1-1/2 ton
  - NCS Models – Slope Top Cabinet
  - NCW Models – Flat Top Cabinet
  - NCC Models – Chassis Only
  
- **Envision Low Sill Console Series** 1/2 to 1-1/2 ton
  - LCS Models – Slope Top Cabinet
  - LCW Models – Flat Top Cabinet
  - LCC Models – Chassis Only

**22.5" H x 45.1" x 10.8"**

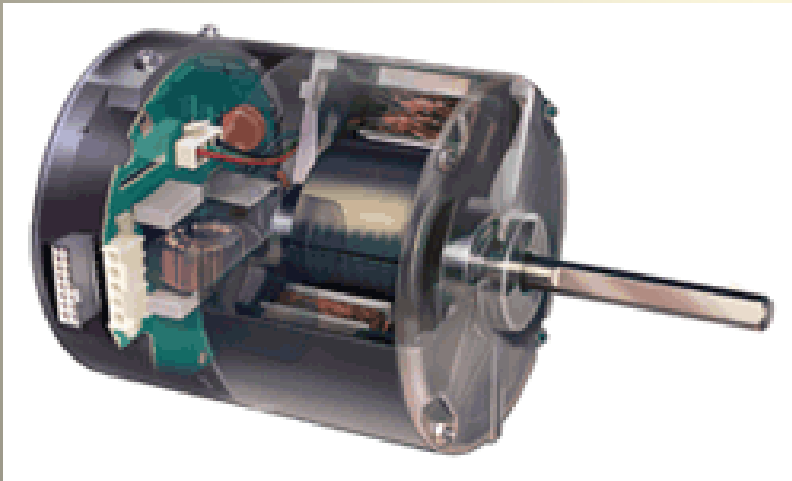


# Variable Technology Opportunities

## EC Motors

### ECM 2.3 - Electronically Commutated Motor

- More Efficient – Increases AHRI certified EER/COP
- Maintains constant CFM
- Quiet
- Soft Start at low speed – single compressor with multi-speed blower
- 5 to 12 CFM settings/unit – choice of CFM per ton



***Payback is less than 2 years!***

The ECM Blower turns the WSHP in to a variable speed air handler that can be remote from the space served and automatically respond to changes in duct design or installation

# Base Control Board or Communicating

ECM at choice from 5 or 12 speed motor



**Thermostat**



**Compressor**



**Base Control**



**Hand Held Tool**



# Water heating?

WSHP's that are available Water to Water

Different than a chiller or the same? Depends...

Condenser water cooling is more efficient than air-cooled

WSHP loop is a net energy loop over a range for heat and cool

*The compressor circuit works against more favorable temperatures not outside air temperatures, but the designed and controlled loop temperature range.*

- » The equipment works like it is spring or fall all year
- » The loop is a range, easier to control versus a set point
- » From 40F to 100F even more the units will heat or cool
  - Easy, forgiving, and Net Energy
  - Green Technology Compatible
  - **System life over 20 years**

**Do not operate a boiler and a cooler at the same time for HVAC and water heating.**

**If you use hot water you need WSHP's**

# Radiant heating and cooling

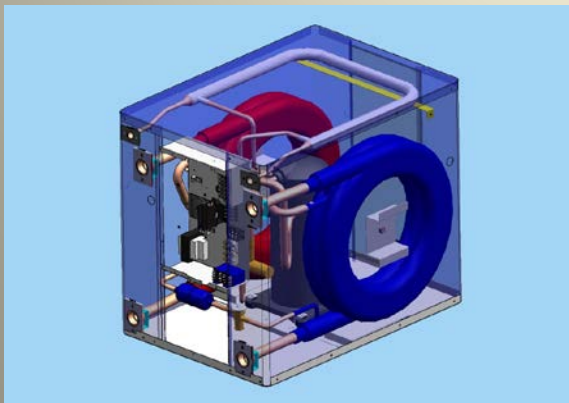
Water-to-Water units are chillers and they are

- NOT
  - They are not air-cooled
  - They do not depend on a fixed condenser water temperature
  - They do not have to deliver only chilled water
- Are – reversible
  - Variable temperature output
  - Hot Warm Cool Cold – **you choose, even simultaneous**
  - **Or two hot temperatures or two cold for coils and radiant**

# Commercial Products

## Water to Water Products

- Envision Reversible Chiller Series  
NXW Models 8 to 50 ton  
60 to 300 ton
- Envision Water to Water Series  
NDW Models 6 to 12 ton
- Envision Hydronic Series  
NSW Models 3/4 to 6 ton

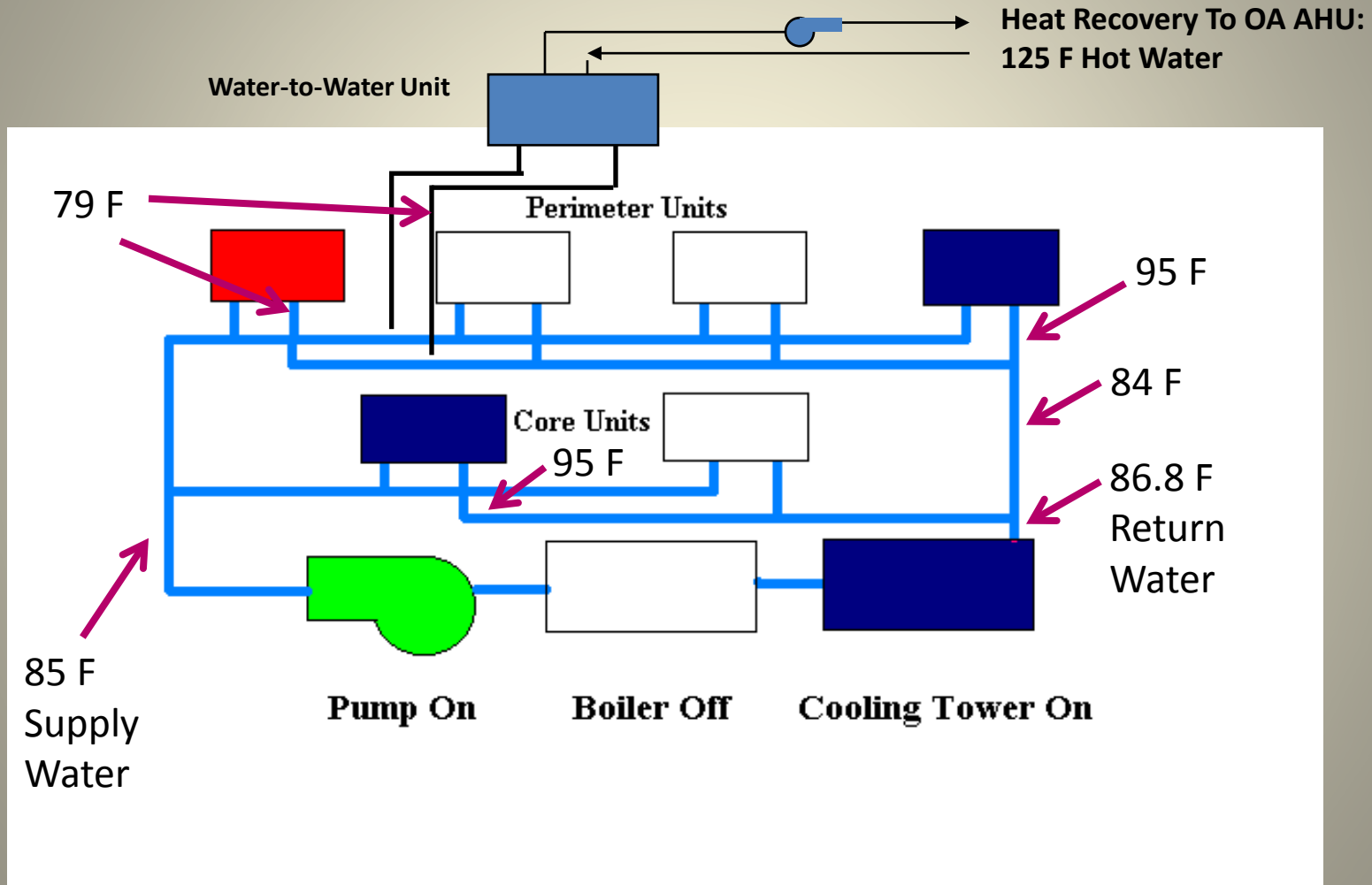


# Never pay for heating and cooling at the same time

- Options
  - Building needs heat – operate high efficiency boiler
  - Building has excess heat operate Fluid Cooler
  - Geothermal
    - Reject excess heat to ground
    - Extract heat from the ground
  - Hybrid
    - Combination of all of the above to meet the budget

# WSHP Basics – System Schematic

## Move BTU – HVAC, Hot Water, DOAS – Hybrid?



**GOAL: "THE" or Multiple - Net Energy Solutions**



# One Compressor

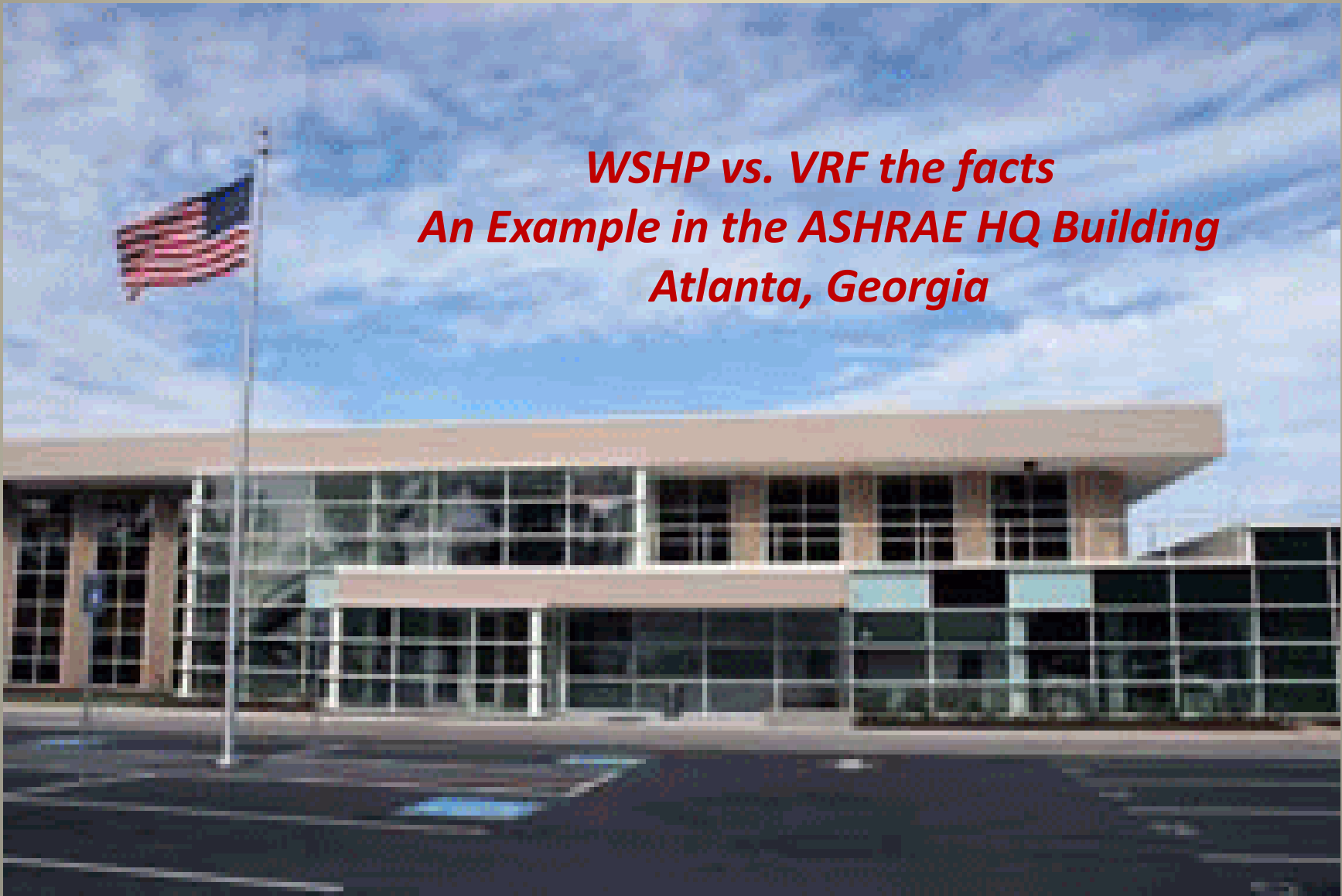
- Large Variable speed or staged Water to Water
  - Hot water to cold water - direct
  - Not one compressor to heat then one to cool
- Start at 60 tons and up
- Need a source of heat or to reject excess
  - Simultaneous, take heat from one loop add to cool loop. When one is satisfied the other goes to part load capacity.
  - It is your energy – use it wisely

# WSHP installed Advantages

- Less pipe – 2-pipe system even 1-pipe option
- Multiple sizes and function
- Multiple Certified Manufacturers
- Demand Control – **Energy Monitored or Billed**
  - Comfort
  - Compressor horsepower
  - Blower horsepower
  - Pump horsepower



## ASHRAE HEADQUARTERS RENEWAL



*WSHP vs. VRF the facts*  
*An Example in the ASHRAE HQ Building*  
*Atlanta, Georgia*

# Three Simple Slides

- The WSHP data Y axis fits BELOW VRF data
- The Peaks
  - VRF is air cooled so peaks in afternoon
  - WSHP do not
- Energy Consumption
  - WSHP efficiency is so high that non-geo WSHP's would be more efficient than VRF
- Three simple slides follow – available online

# The results:

## WLHP Enhanced Systems vs. VRF

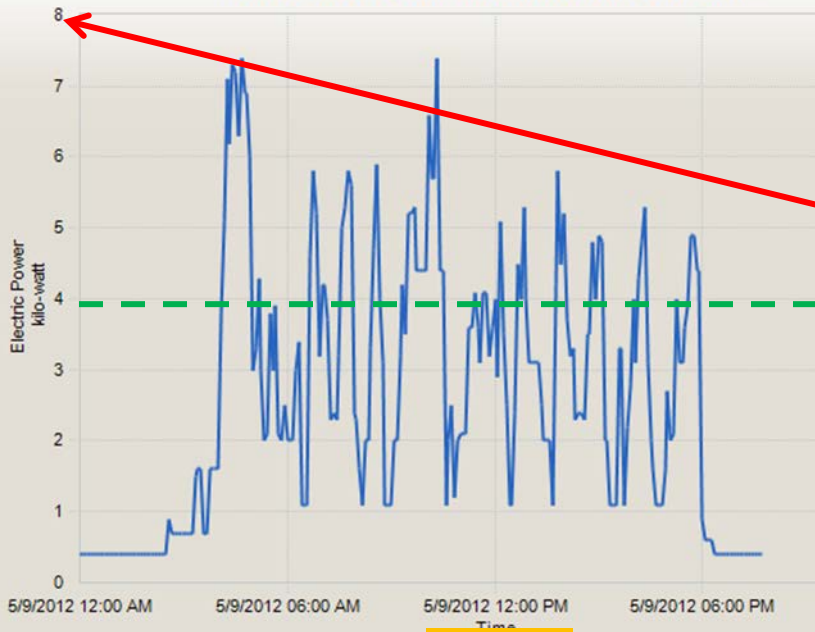
### ASHRAE Headquarters in Atlanta

Live Data Available online

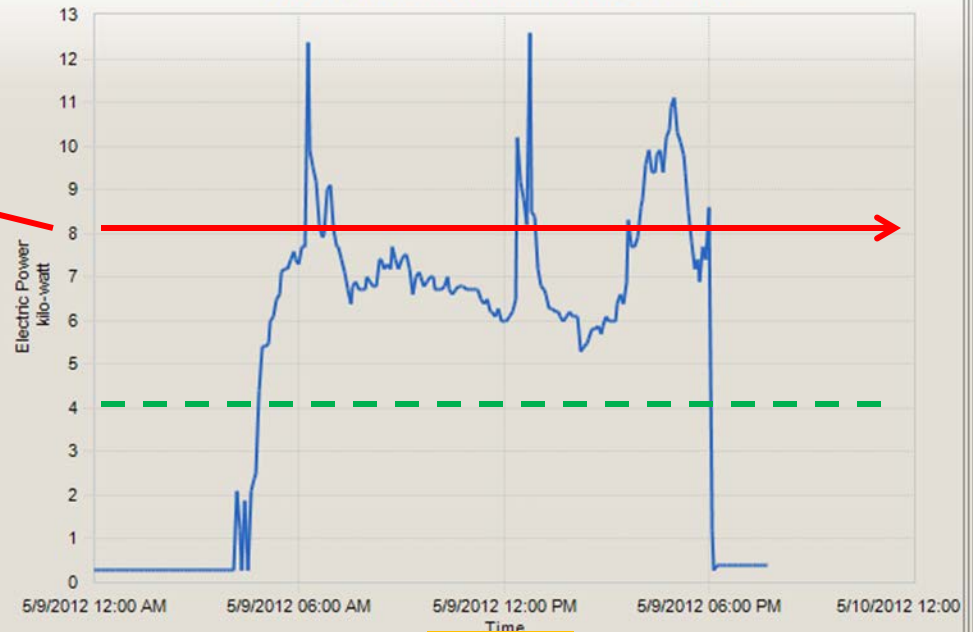
May 9, 2012 **PEAK**

<http://images.ashrae.biz/renovation/>

Heat Pump System Pwr Monitoring vs. Time



VRV System Power Monitoring vs. Time



**GLHP System Dramatically reduces Daily Peak Load**

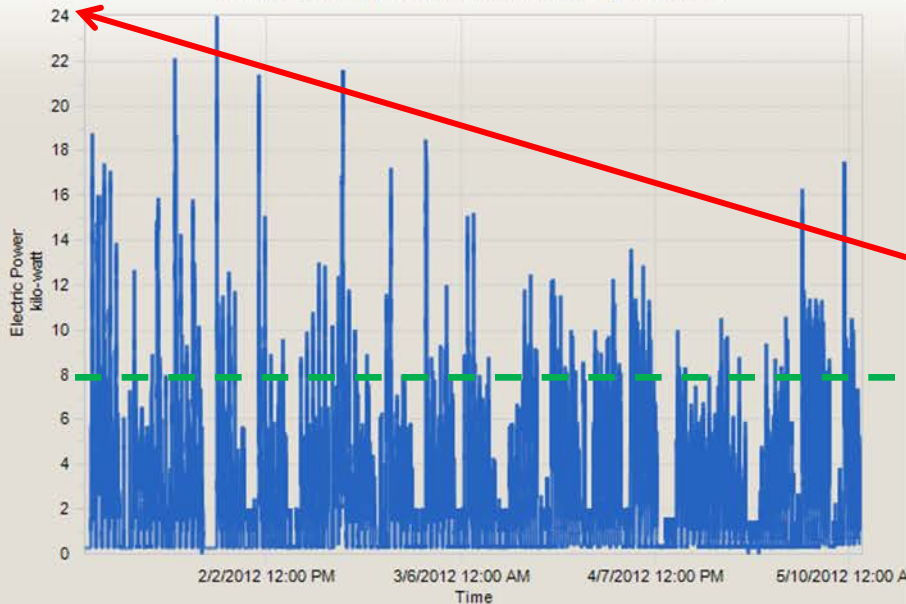
# The results: WLHP Enhanced Systems vs. VRF

ASHRAE Headquarters in Atlanta

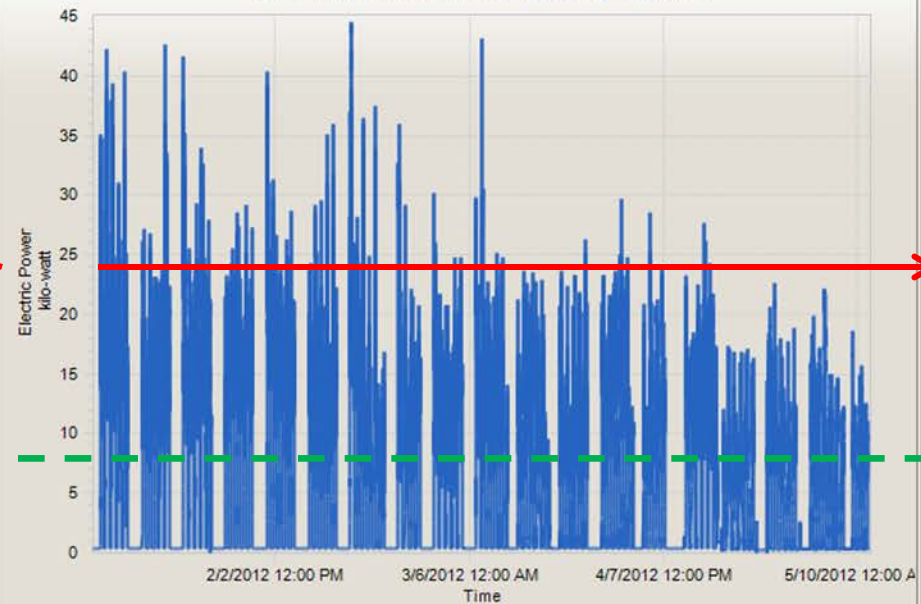
Live Data Available online <http://images.ashrae.biz/renovation/>

January 1, 2012 to May 9, 2012 *Energy Use*

Heat Pump System Pwr Monitoring vs. Time

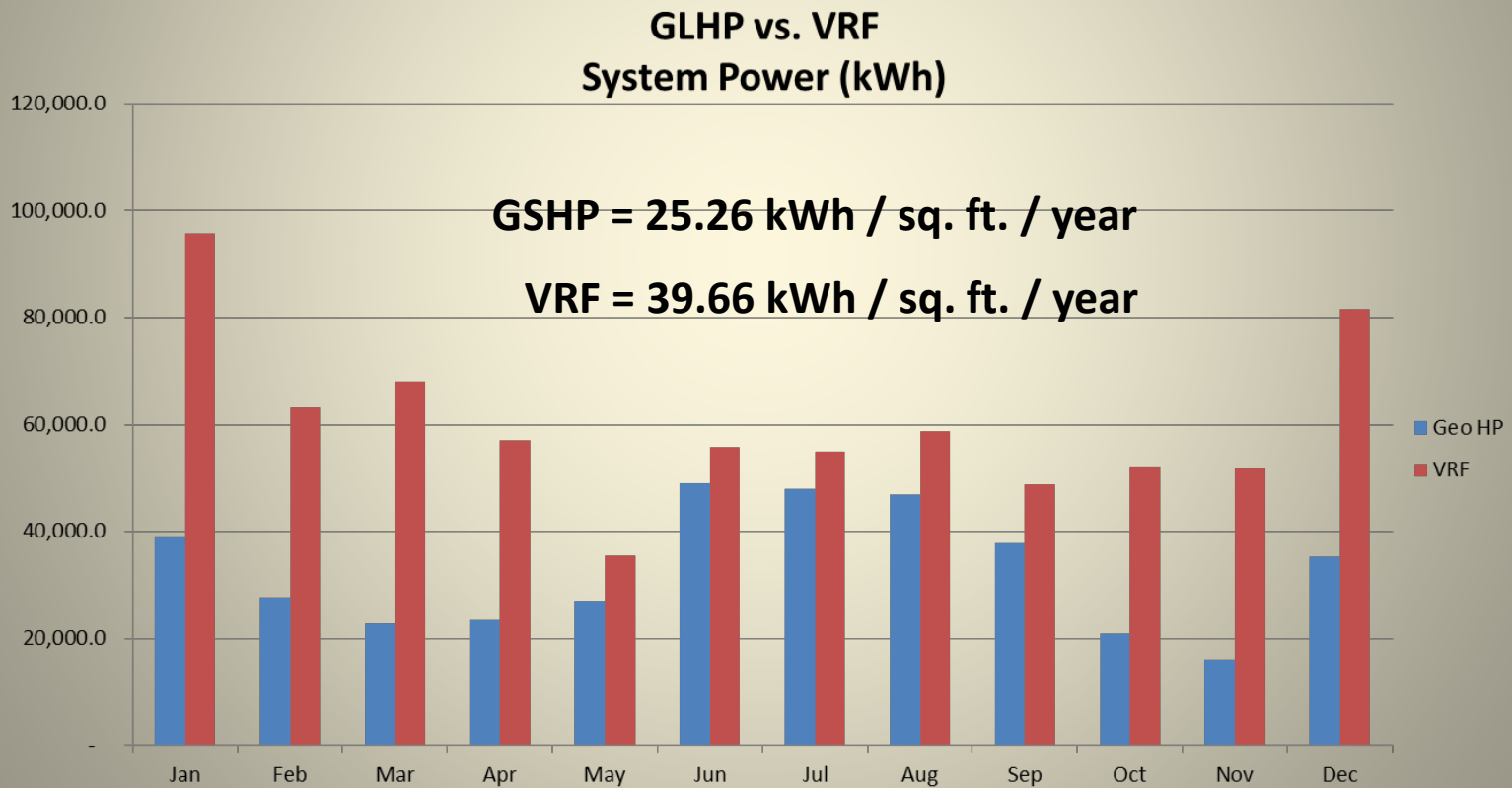


VRV System Power Monitoring vs. Time



# The results: WLHP Enhanced Systems vs. VRF

## ASHRAE Headquarters in Atlanta 2010 HVAC Energy



# The Numbers in ATLANTA

39.66 kWh – 25.26 kWh = 14.40/sq. ft./year

WSHP saves 36.3% or VRF costs 57% premium

$$14.40/25.26 = 57\%$$

*Net Energy Solutions*

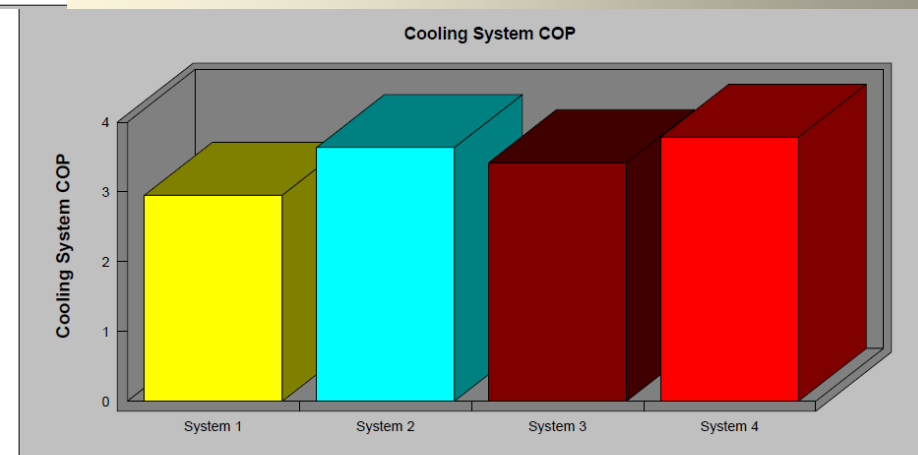
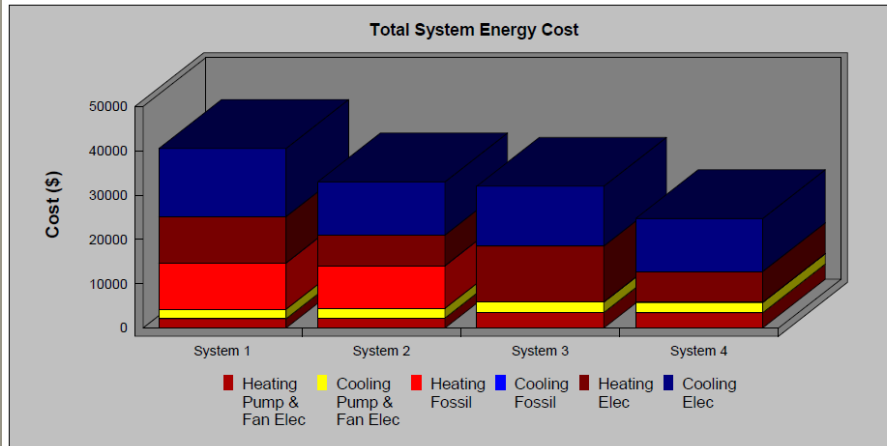
***This means non-geothermal  
would be more energy efficient than VRF  
and  
a lot lower installed cost!***



# WSHP Enhanced

## System Comparison Taco Energy Analysis Apr 20, 2012

	System 1	System 2	System 3	System 4	
Heating Pump & Fan HP:	2.49	2.49	2.49	2.49	HP
Cooling Pump & Fan HP:	12.57	12.86	14.93	14.82	HP
Cooling System COP:	2.95	3.64	3.42	3.79	
Electrical Consumption:	166700	130397	186924	142798	KWHr
Electrical Consumption Cost:	16670	13040	18692	14280	\$
Electrical Demand Cost:	13425	10385	13308	10426	\$
Total Electrical Cost:	30095	23424	32000	24706	\$
Fossil Fuel Consumption:	6969	6386	0	0	
Fossil Fuel Cost:	10453	9579	0	0	\$
Total Cost:	40547	33003	32000	24706	\$
Savings for System 4:	15841	8297	7294		



- System 1: Heat Pump Water Source - 2 Pipe
- System 2: Heat Pump Water Source - 2 Pipe boiler and EER
- System 3: Heat Pump Water Source - 2 Pipe GEO low eff - default
- System 4: Heat Pump Water Source - 2 Pipe Geo higher eff

Note – all of these systems are WSHP compared to each other

# Hybrid GLHP Systems

Cooling Load is out of balance with the Heating Load

Lincoln Public Schools

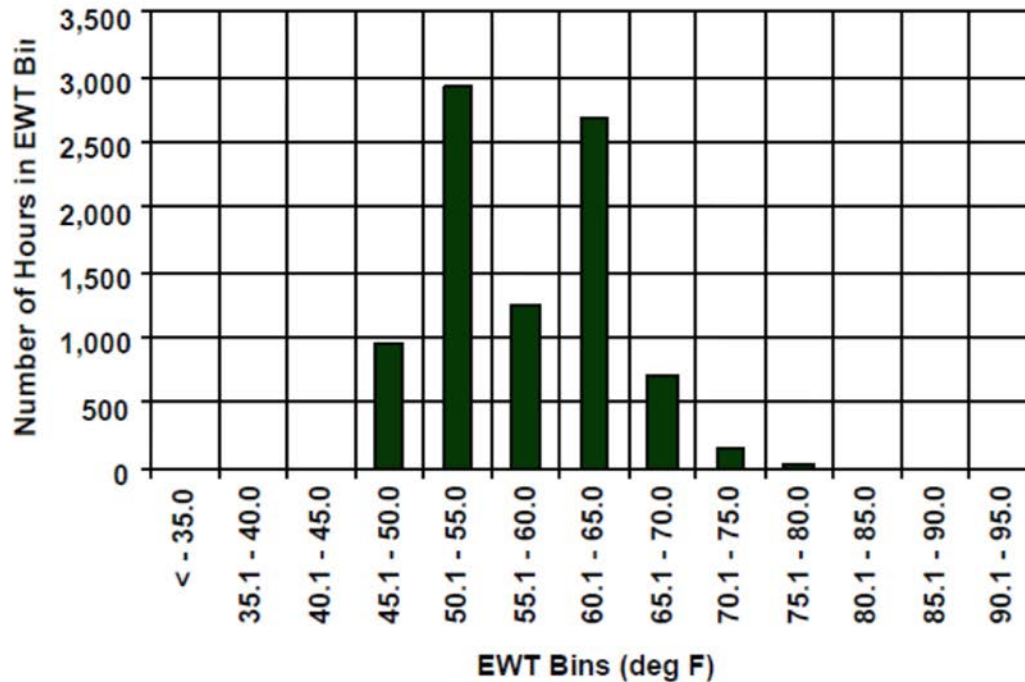


Fig. 2.5. Distribution of 1996 heat pump entering water temperatures (EWTs) as recorded by the Maxey EMS. Total hours of operation were 8760.

GeoExchange demonstrates exceptional response to Part load Conditions with even higher efficiency

OAK RIDGE  
NATIONAL LABORATORY

MANAGED BY UT-BATTELLE  
FOR THE DEPARTMENT OF ENERGY

# Even More Enhancements

- Hybrids or GeoExchange as a supplement
- Manage first cost to operating cost
  - Cooling tower or dry cooler augment loop - economizer
  - Boiler to eliminate antifreeze – DHW boiler already?
- Controls
  - Onboard basic and communicating
  - Loop control panels
  - Standalone programmable, learning, and zoning
  - BMS – BacNet, Lon – virtual? Web?
  - Self-commissioning
  - Monitoring – even if only the Bill...
- Piping options including LoadMatch GeoExchange
- Heat exchangers, pumping, mass tanks
- Unit mounted accessories from valves to fusing
- The challenge is to identify heat sources and loads and add it to what makes sense within the BUDGET!



**Recommended: The development of a simplified user-friendly tenant education guide**

# A mature Industry provides Help

Multiple Configurations and Models – Horizontal, Vertical, Console, W2W

## AHRI certified performance

Unit Performance Calculations			
Cooling Capacity Data		Heating Capacity Data	
Electrical / Physical Data		Configuration / Controls / Warranty	
Accessories		Competitor Analysis	
Notes			
<b>Full Load Cooling</b>			
Air Flow - CFM (L/s) (Full Load)	1300.0	Cooling Water Temperature Rise °F(°C)	13.66
Water Flow - GPM (L/s)	7.0	Cooling LWT °F(°C)	98.66
Cooling Water Pressure Drop PSI (kPa)	1.84	Cooling LAT °F(°C)	58.8
Cooling Water Pressure Drop FT/HD (kPa)	4.3	Cooling Input Power kW (kW)	2.46
Latent Cooling Capacity MBTUH (kW)	9.73	Heat Rejection MBTUH (kW)	47.8
Total Cooling Capacity MBUTH (kW)	39.45	Energy Efficiency Ratio (EER)	16.0
Sensible Cooling Capacity MBTUH (kW)	29.72		
Sensible to Total Cooling Ratio	0.75		
<b>Part Load Cooling</b>			
Dual Air Flow Output CFM (L/s)	1100.0	Dual Cooling Temperature Rise °F(°C)	10.9
Dual Flow Output GPM (L/s)	6.0	Dual Cooling LWT °F(°C)	95.9
Dual Cooling Water Pressure Drop PSI (kPa)	1.42	Dual Cooling LAT °F(°C)	62.9
Dual Cooling Water Pressure Drop FT/HD (kPa)	3.3	Dual Cooling Input Power kW (kW)	1.37
Dual Latent Cooling Capacity MBTUH (kW)	7.72	Dual Heat Rejection MBTUH (kW)	32.7
Dual Total Cooling Capacity MBUTH (kW)	28.02	Dual Energy Efficiency Ratio (EER)	20.5
Dual Sensible Cooling Capacity MBTUH (kW)	20.3		
Dual Sensible to Total Cooling Ratio	0.72		

Geo as far back as the 50's, growth in the 70's, closed loop in the 80's

# Software – where do you get data

Ground and Loop Information

Building and Heat Pump Information

The screenshot displays two windows from the WaterFurnace software. The left window, titled 'Borehole Design Project - FCB', shows design parameters for cooling and heating. The right window, titled 'Average Block Loads - FCB', shows design day loads and heat pump specifications.

	COOLING	HEATING
Total Length (ft):	35510.1	46040.6
Borehole Number:	150	150
Borehole Length (ft):	236.7	306.9
Ground Temperature Change (°F):	+0.0	+0.0
Unit Inlet (°F):	90.0	40.0
Unit Outlet (°F):	99.7	33.9
Total Unit Capacity (kBtu/Hr):	3369.0	2780.7
Peak Load (kBtu/Hr):	2950.4	2780.7
Peak Demand (kW):	182.3	196.0
Heat Pump EER/COP:	16.2	4.2
System EER/COP:	16.2	4.2
System Flow Rate (gpm):	737.6	695.2

Time of Day	Heat Gains (kBtu/Hr)	Heat Losses (kBtu/Hr)
8 a.m. - Noon	70.1	2780.7
Noon - 4 p.m.	2950.4	62.3
4 p.m. - 8 p.m.	70.1	62.3
8 p.m. - 8 a.m.	70.1	62.3
<b>Annual Equivalent Full-Load Hours:</b>	<b>501</b>	<b>822</b>

	NS 036	
	Cooling	Heating
Capacity (kBtu/Hr)	3369.0	2780.7
Power (kW)	208.14	195.97
EER/COP	16.2	4.2
Flow Rate (gpm)	737.6	695.2
Partial Load Factor	0.88	1.00

# Investment Financial Analysis

*Advanced Energy Design Guide for Small to Medium Office Buildings + Retail, Schools or Hotels*

- **Life-Cycle Cost Analysis (LCCA)** is a calculation method that adds first cost to 20–25 years of annual energy and maintenance costs, inclusive of equipment replacement costs and an estimate on inflation. The option that has the lowest life-cycle cost is usually chosen if the budget allows.
- **Simple Payback Period** is a calculation method that divides first cost by the annual energy savings to determine how long it will take to break even on the investment.
- **Return on Investment (ROI)** is a calculation that takes the ratio of the energy savings over a predefined number of years minus the first costs divided by the first costs.

**Capitalization Rate – How much will my building Earn?**

**Utility bills are what is referred to as “relevant operating cost”**

**For the “life of” or at the “sale of” the building**

**that cost will effect Net Profit \$ and building value**

# Tools to balance the budget



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*Thank you*