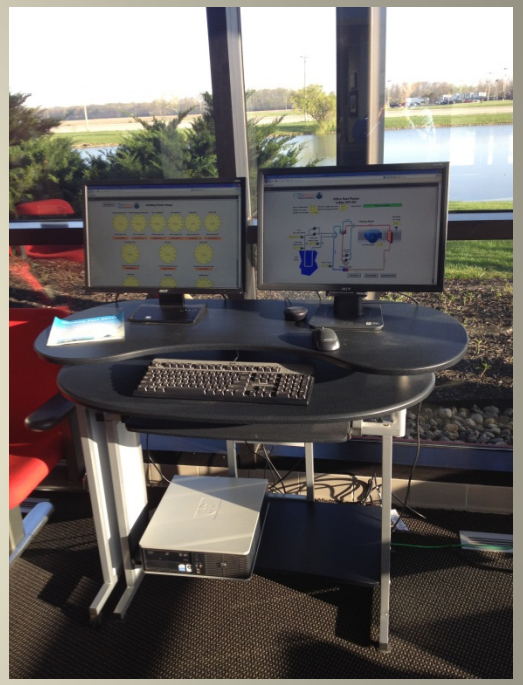
Welcome to WaterFurnace

Opportunity to Net Energy

WaterFurnace
Commercial Solutions

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 withminor 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

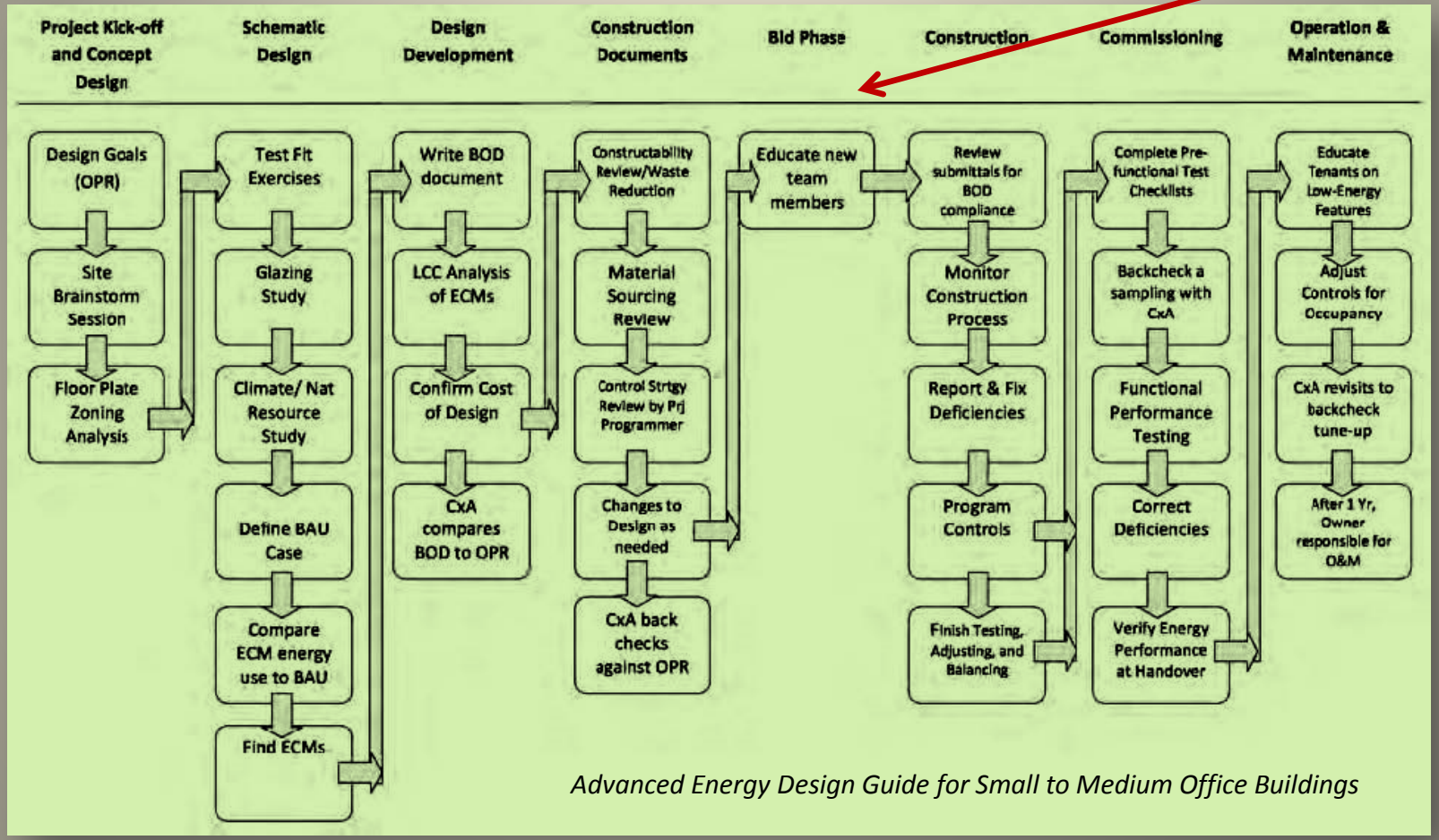
Achieving 50% Energy Savings Toward a Net Zero Energy Building

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

WaterFurnace
Commercial Solutions Group

Kickoff thru O&M
the GREEN Team

Bid phase
Too late for
new team members



Advanced Energy Design Guide for Small to Medium Office Buildings

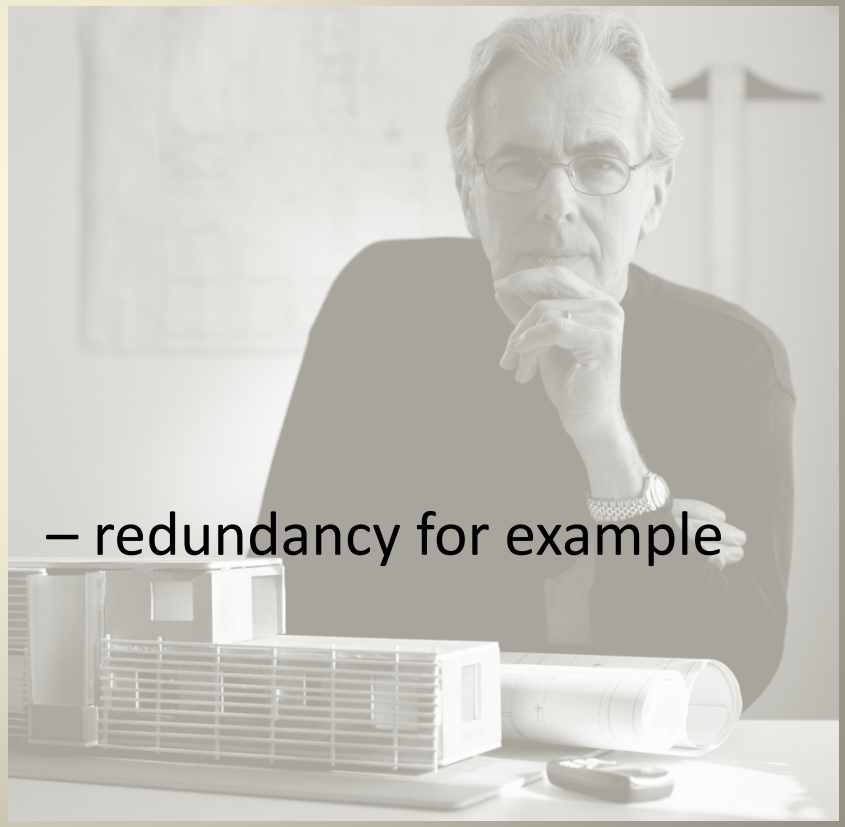
The integrated design process is the path to Net Zero

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



Energy Efficiency

Lessons Learned … By a utility

	Projected kW Reduction	Actual kW Reduction
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

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

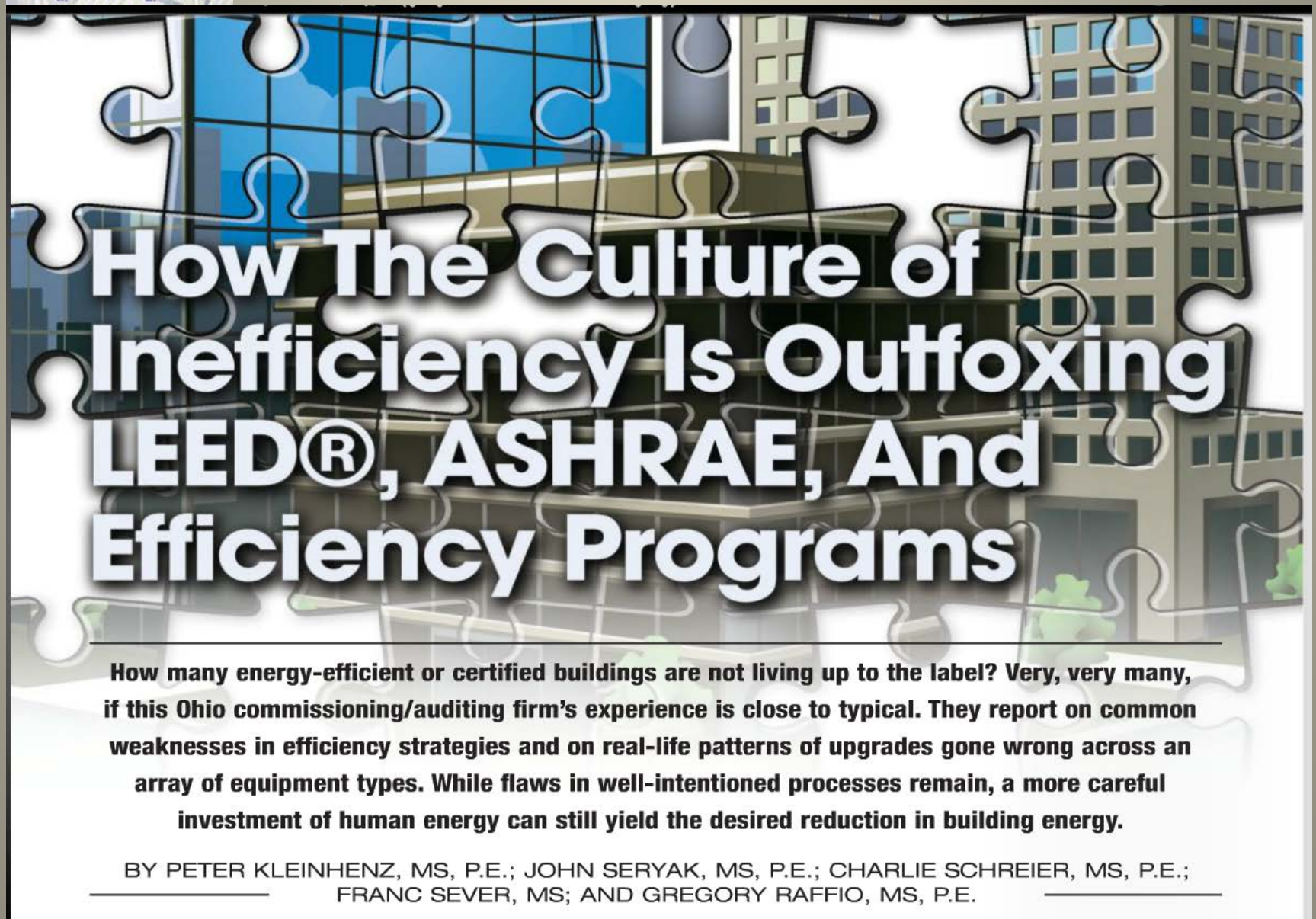
- *93% of rebates paid on "Replacement "& "New Construction"*
- *80% paid on Air Source & 20% paid on Ground Source Product*
- *60% return on rebate program*

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"*

EER vs. SEER vs. IEER

S and **I** are already adjusted ratings



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

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 he
system, the comparison is to a
building with wood-framed
20% window-to-wall ratio, all
facing south, served by a wat
heat pump system, with all cor
just meeting prescriptive requ
If the same building had ma
a 40% window-to-wall ratio,
dows facing west, and an air-so
pump system, the comparison
to a baseline building with mas
40% window-to-wall ratio, all
facing west, and an air source h
system, with all components just meeting prescriptive requirements.

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.

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-

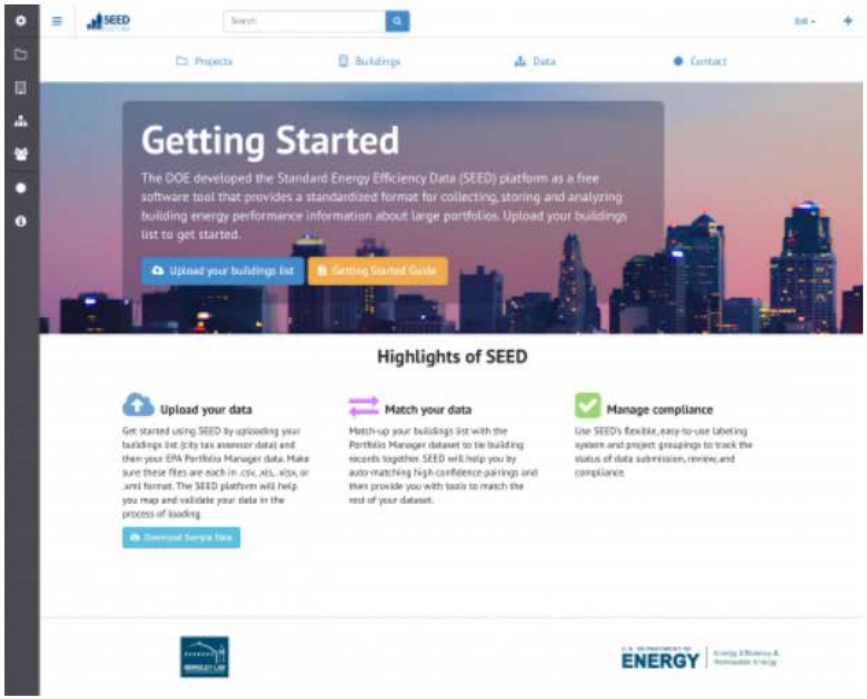
Department of Energy is taking action to enhance collection and use of Data

Home » Commercial Buildings » Standard Energy Efficiency Data Platform

STANDARD ENERGY EFFICIENCY DATA PLATFORM

- Buildings Home
- About
- Emerging Technologies
- Residential Buildings
- 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)™ 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.



SEED
STANDARD ENERGY EFFICIENCY DATA PLATFORM™
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™ by entering your email address.

User Email:

SUBSCRIBE

Whole Building Approach

Energy Profile:

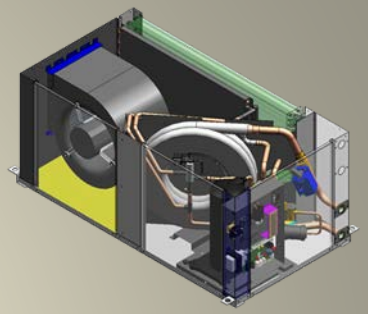
Climate	Heat	Cool
People	Heat	Cool
Ventilation Air	Heat	Cool
Lights and equipment		Cool
Plug Loads		Cool
Water	Heat	
Unoccupied	Heat	Cool

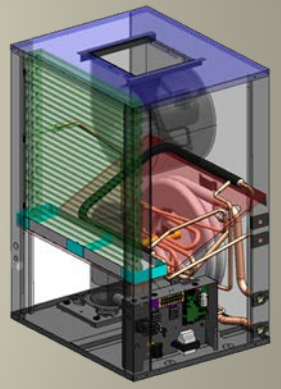
Do you have both?

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

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

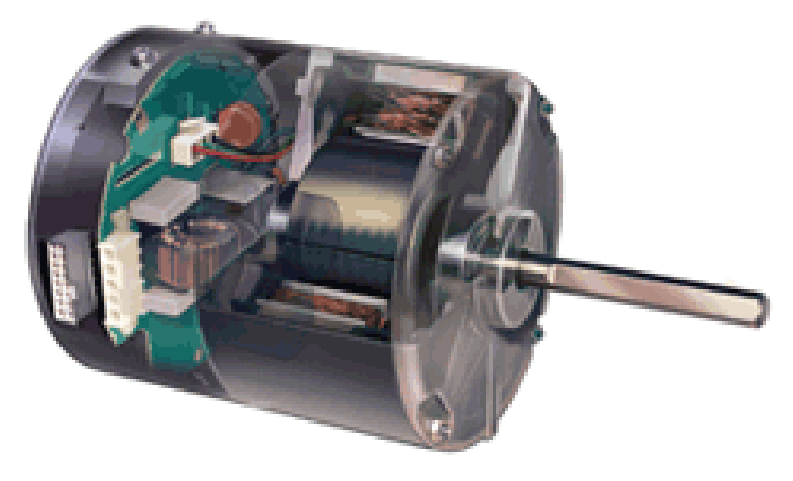
- **Envision Low Sill Console Series** 1/2 to 1-1/2 ton
  LCS Models – Slope Top Cabinet
  LCW Models – Flat Top Cabinet
  LCC Models – Chassis Only

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



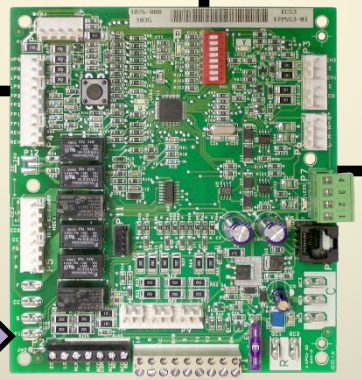
Payback is less than 2 years!

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

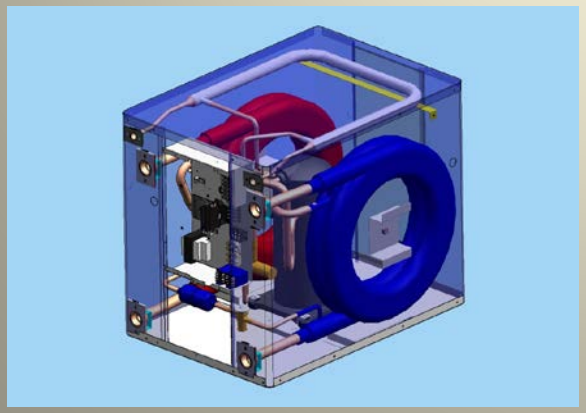
Water-to-Water units are chillers and they are

- 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

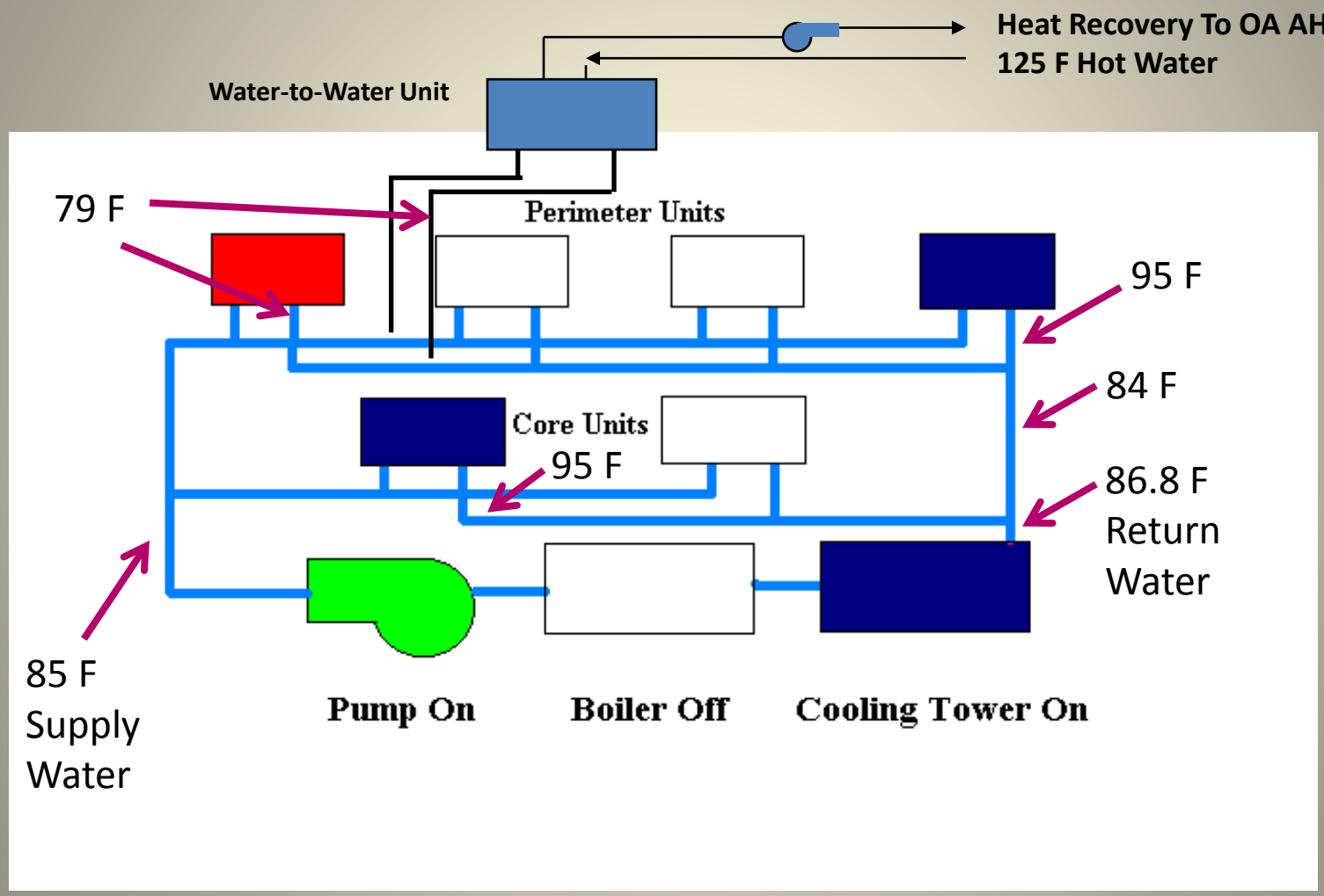
- Envision Reversible Chiller Series NXW Models — 8 to 50 ton, 60 to 300 ton
- Envision Water to Water Series NDW Models — 6 to 12 ton
- Envision Hydronic Series NSW Models — 3/4 to 6 ton



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

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

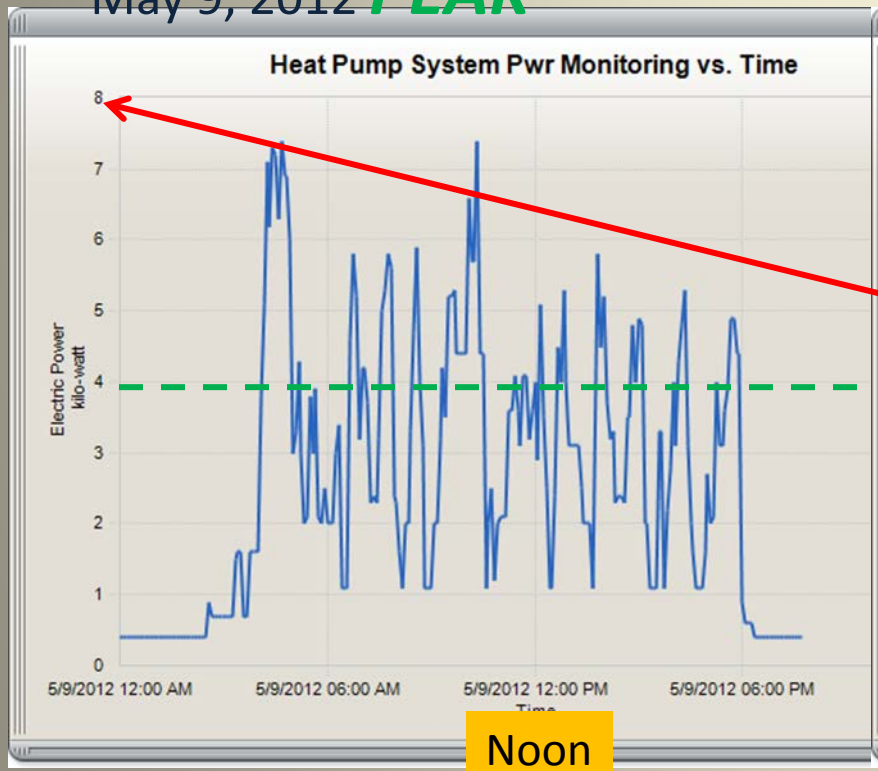
The results:
WLHP Enhanced Systems vs. VRF

ASHRAE Headquarters in Atlanta

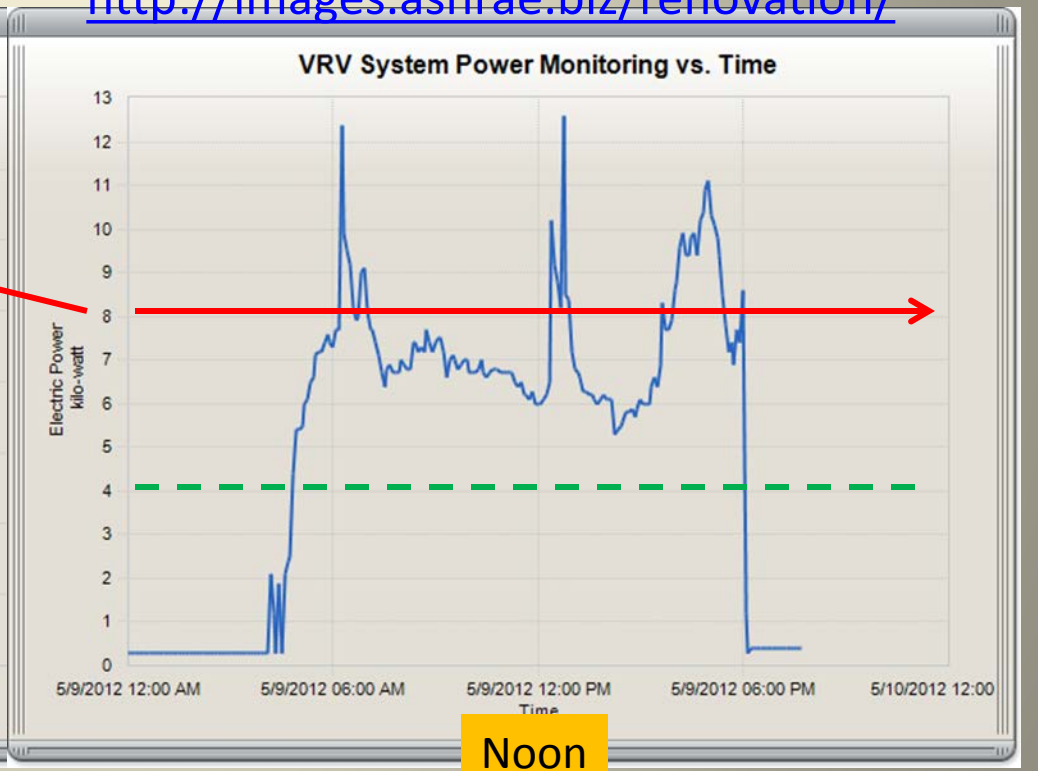
Live Data Available online

May 9, 2012 ***PEAK***

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



Noon



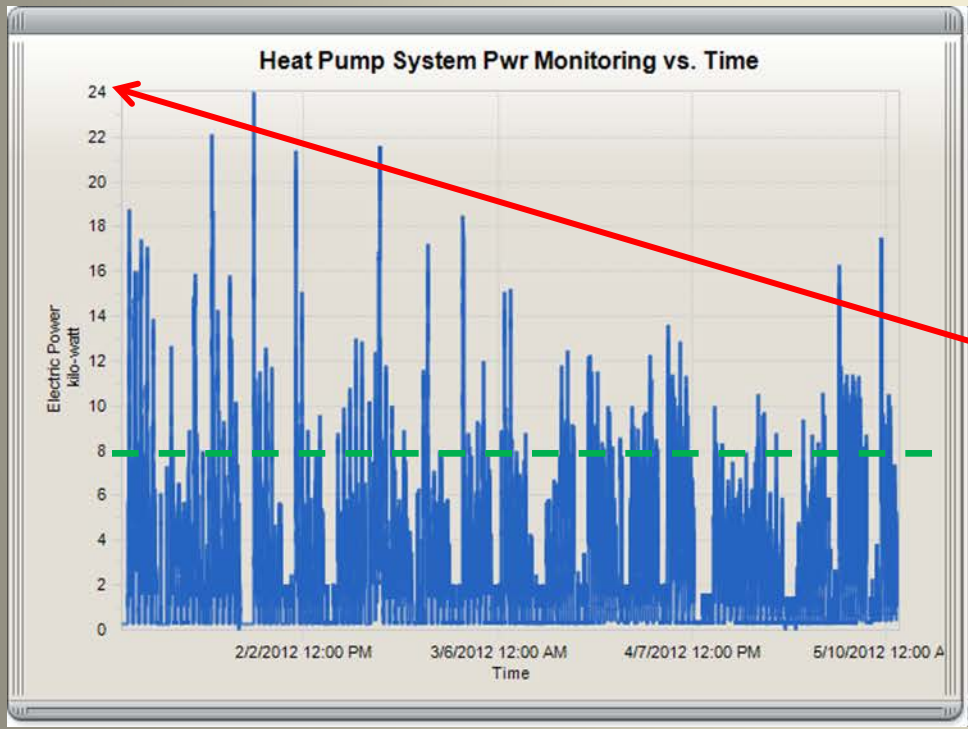
Noon

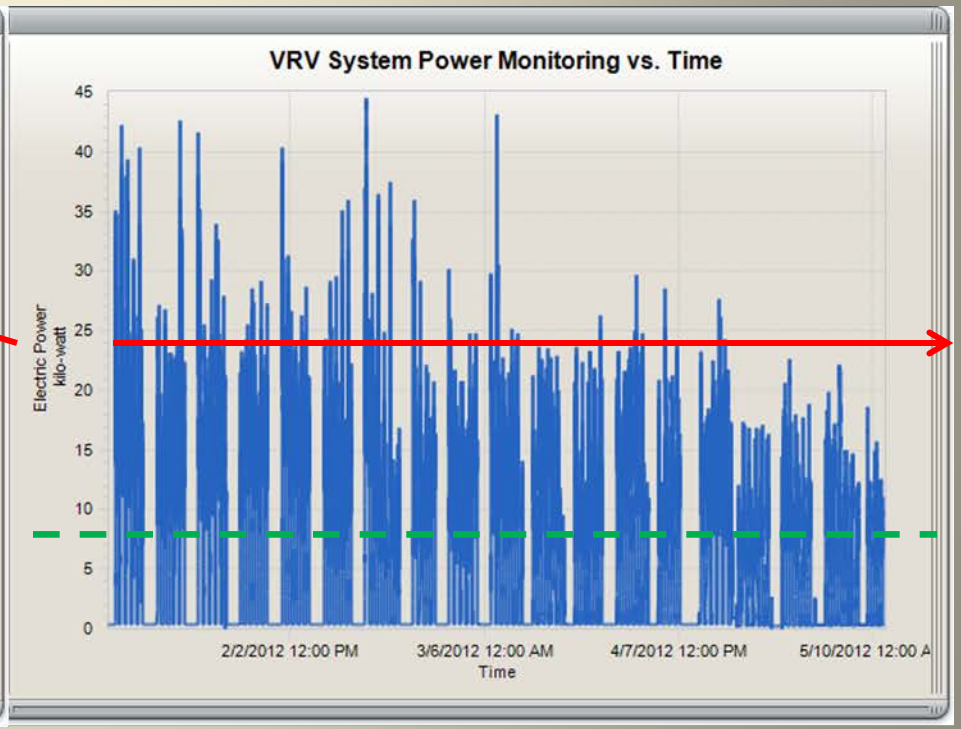
GLHP System Dramatically reduces Daily Peak Load

The results:
WLHP Enhanced Systems vs. VRF

ASHRAE Headquarters in Atlanta Live Data Available online http://images.ashrae.biz/renovation/

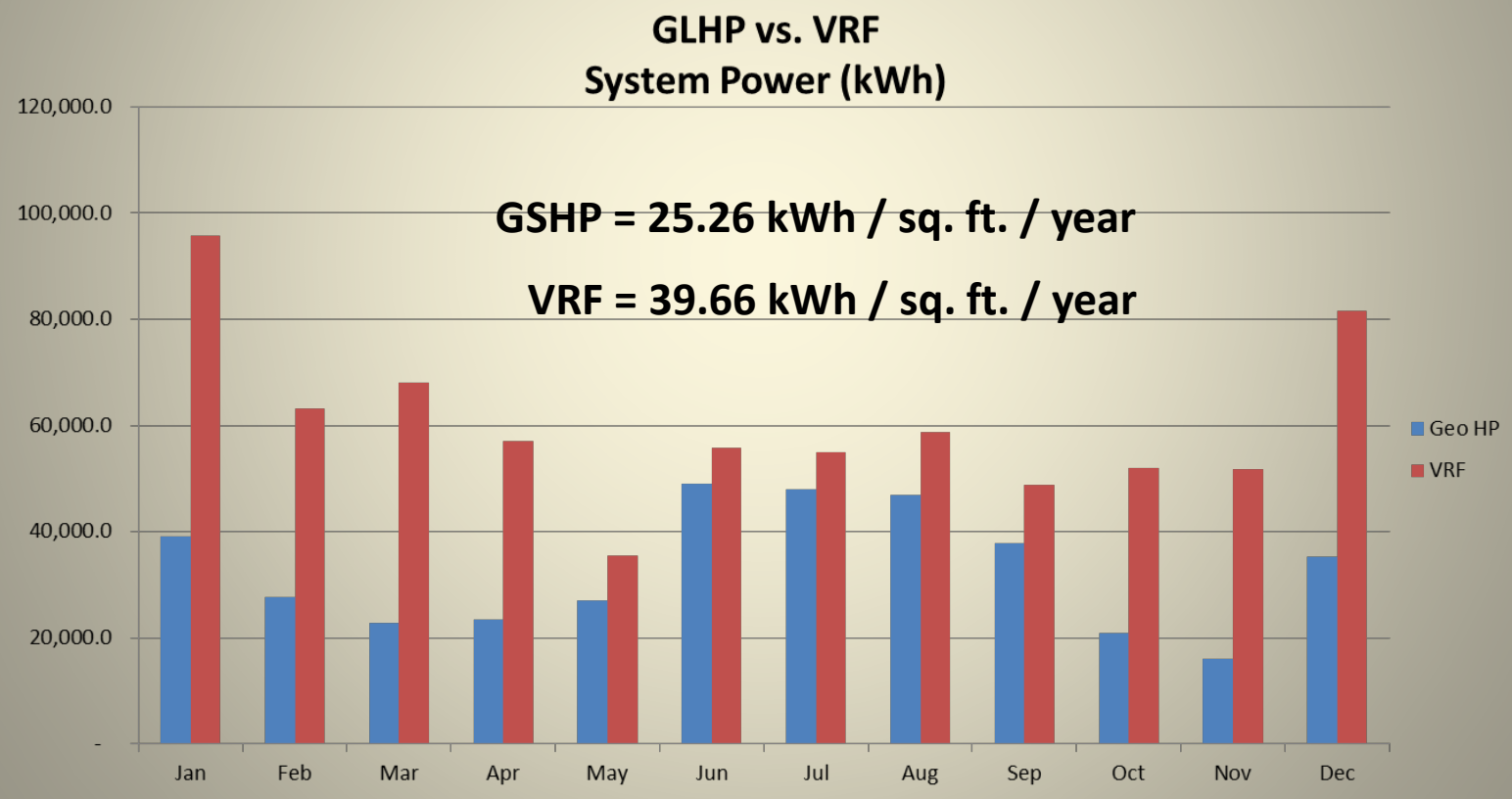
January 1, 2012 to May 9, 2012 ***Energy Use***





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%

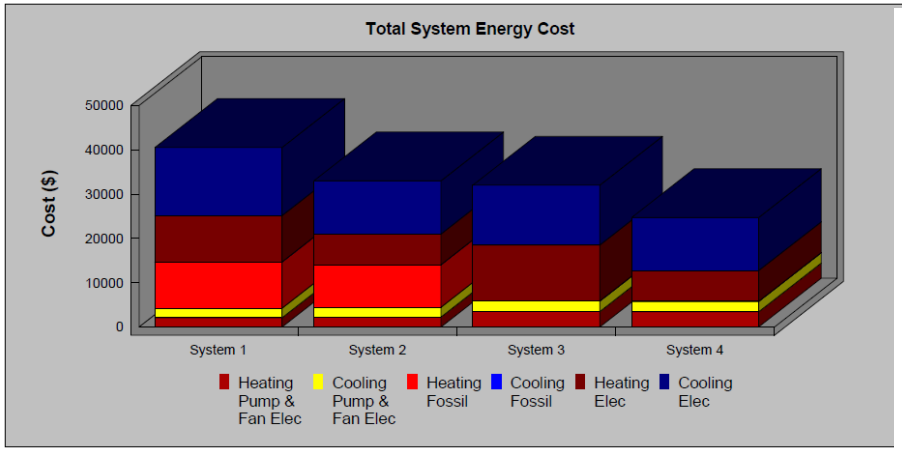
Net Energy Solutions

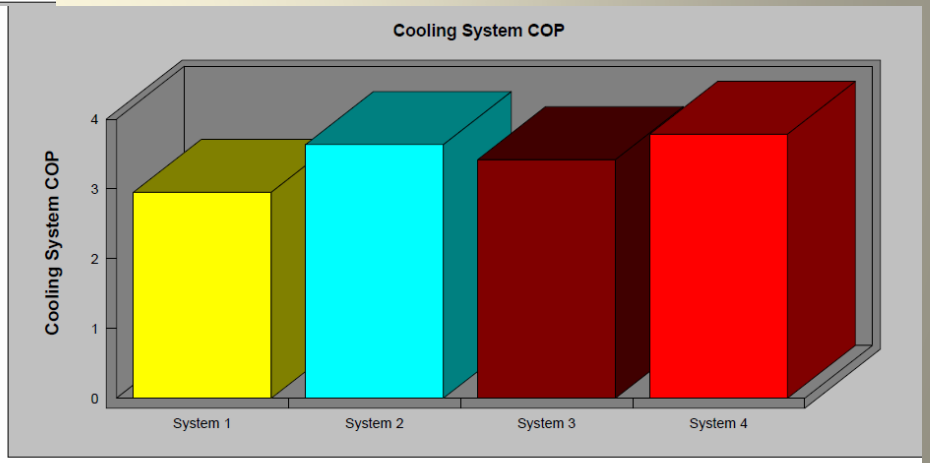
This means non-geothermal would be more energy efficient than VRF and a lot lower installed cost!

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

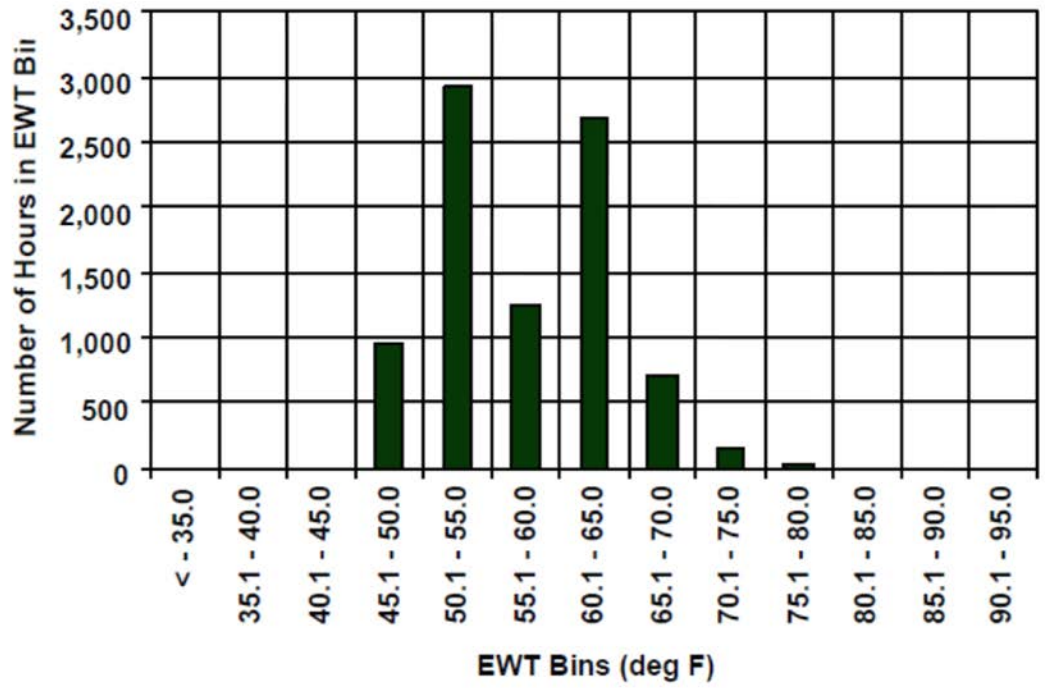


Fig. 2.5. Distribution of 1996 heat pump entering water temperatures (EWTs) as recorded by the Maxey EMS. Total hours operation were 8760.

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

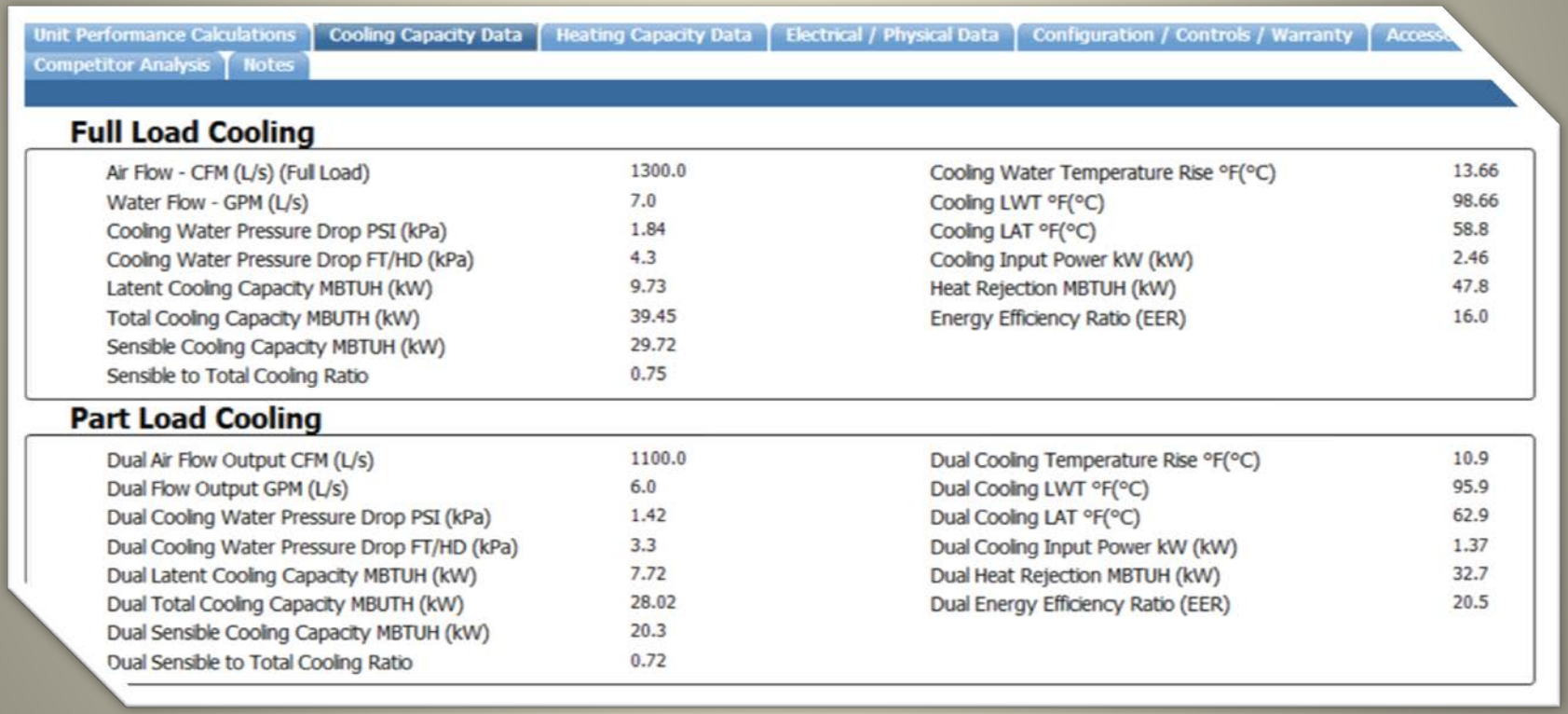
- Hybrids or GeoExchange as a supplement
- Mange first cost to operating cost
  - Cooling tower or dry cooler augment loop - economizer
  - Boiler to eliminate antifreeze – DHW boiler already?
- Controls
  - Onboard basic and communicating
  - Loop control panels
  - Standalone programmable, learning, 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 | Acces...
Competitor Analysis | Notes

Full Load Cooling

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		

Part Load Cooling

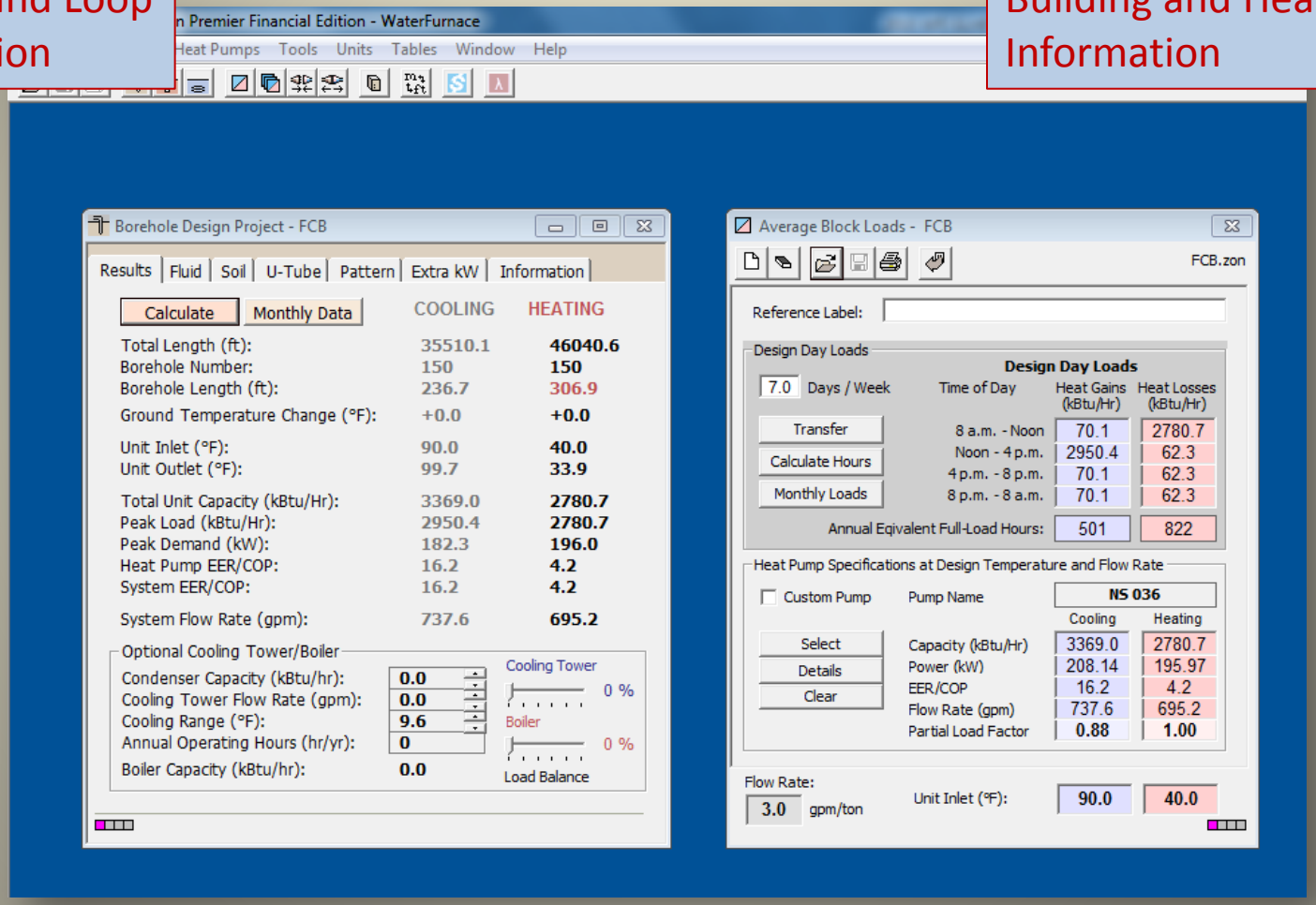
Dual Air Flow Output CFM (L/s)	1100.0	Dual Cooling Temperature Rise °F(°C)	10.9
Dual Flow Output GPM (L/s)	6.0	Dual Cooling LWT °F(°C)	95.9
Dual Cooling Water Pressure Drop PSI (kPa)	1.42	Dual Cooling LAT °F(°C)	62.9
Dual Cooling Water Pressure Drop FT/HD (kPa)	3.3	Dual Cooling Input Power kW (kW)	1.37
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



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

WaterFurnace®

Commercial Solutions Group

Thank you