Agenda and Objectives

Trane Engineers Newsletter Live Series

Energy Saving Opportunities for LEED® and the Energy Policy Act

According to the U.S. Green Building Council (USGBC), buildings account for 36 percent of the energy used in the United States. On this ENL broadcast, we will discuss energy-saving strategies to implement for various HVAC system types, and quantify the impact of each toward achieving LEED points under the "Optimize Energy Performance" credit. In addition, we will discuss how these same strategies can help the building owner qualify for tax deductions through the Energy Policy Act.

By attending this event you will:

1. Learn energy-saving strategies to implement for various HVAC system types to help earn LEED points.
2. Understand the "big picture" of building energy use (impact of building envelope, lighting, plug loads, processes, etc.)
3. Learn how energy-saving strategies can help achieve LEED certification nd tax deductions through the Energy Policy Act
4. Learn the most common mistakes made during energy modeling and LEED energy analysis projects.

Agenda

1) Recent events
    - a) Rising energy costs
    - b) Change to LEED (mandatory two Optimize Energy Performance points)
    - c) Energy Policy Act
2) Energy-saving strategies to achieve two points (energy modeling results, review and explain ECMs)
    - a) Rooftop VAV systems
    - b) Self-contained VAV systems
    - c) Chilled-water VAV systems
    - d) Chilled-water fan-coil systems
    - e) Water-source heat pump systems
3) The "big picture" of building energy use
    - a) Examples
4) Top ten energy modeling mistakes
5) Summary

Presenters

Trane Engineers Newsletter Live Series

Energy-Saving Opportunities for LEED and the Energy Policy Act

(2008)

Matt Biesterveld | C.D.S manager | Trane

Matt is a marketing engineer at Trane with over nine years of experience with HVAC building load and energy analysis. As Manager for the Customer Direct Service (C.D.S.) group, he is responsible for overseeing development, support, and customer training for all C.D.S. HVAC applications.

During his time with C.D.S. he has served various roles as a project manager and later as Team Leader of Design applications. He is also a member of Trane's Advanced Engineering Support (AES) group which is responsible for building load and energy studies including LEED/90.1, EPACT, and performance contracting analyses. He received his B.S. in Mechanical Engineering from the University of Wisconsin – Platteville.

Neil Maldeis | ASC energy engineering manager | Trane

Neil has been with Trane for nine years and is currently responsible for the technical development, support and review of performance based contracting solutions including identifying, verifying, and approval of energy conservation measures on a national basis.

Neil has over 25 years of experience as a mechanical engineer in the building construction and energy conservation fields. He has been responsible for defining/developing the scope of energy conservation solutions, determining the engineering content of the solutions, incorporating customer requirements and analyzing the financial feasibility of the program measures.

He is a licensed professional engineer in the State of Minnesota and has been certified by the Association of Energy Engineers as Certified Energy Manager and Certified Green Building Engineer. He holds a Bachelors Degree in Mechanical Engineering from the University of Minnesota.

John Murphy | senior applications engineer | Trane

John has been with Trane since 1993. His primary responsibility as an applications engineer is to aid design engineers and Trane sales personnel in the proper design and application of HVAC systems. As a LEED Accredited Professional, he has helped our customers and local offices on a wide range of LEED projects. His main areas of expertise include dehumidification, air-to-air energy recovery, psychrometry, ventilation, and ASHRAE Standards 15, 62.1, and 90.1.

John is the author of numerous Trane application manuals and Engineers Newsletters, and is a frequent presenter on Trane's Engineers Newsletter Live series of satellite broadcasts. He also is a member of ASHRAE, has authored several articles for the ASHRAE Journal, and is a member of ASHRAE's "Moisture Management in Buildings" and "Mechanical Dehumidifiers" technical committees.

Energy-Saving Opportunities for LEED® and the Energy Policy Act

an
Engineers Newsletter Live
telecast

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Increasing Focus on Energy

- **Rising energy costs**
- **Increased environmental and social awareness**
- **Green building movement** (LEED®, ENERGY STAR, etc.)
- **Tax incentives**

Energy Policy Act of 2005

- **Tax deduction up to $1.80/ft^2 for commercial building owner (or leaseholder)**
  - Extended through 31 Dec 2008 by the Tax Relief & Health Care Act of 2006
- **U.S. Internal Revenue Service requires energy savings to be certified by computer modeling**
  - TRACE™ 700 has been approved

AIA continuing education
Learning Objectives

- Participants will learn the following about saving energy in buildings:
  - **HVAC system design and control strategies to help reduce building energy cost**
  - **How these strategies help achieve LEED® "Optimize Energy Performance" points**
  - **Help the building owner qualify for tax deductions through the Energy Policy Act**

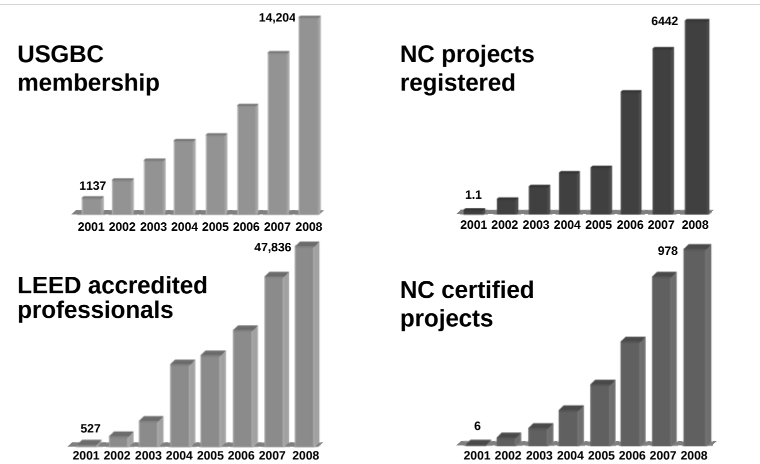
LEED "Optimize Energy Performance" Credit

engineers newsletter LIVE

Energy-saving opportunities for LEED® and the Energy Policy Act

Leadership in Energy and Environmental Design

Growing Interest in LEED



Source: U.S. Green Building Council, March 2008

LEED

Past ENL Broadcasts

- Feb 2004: HVAC and LEED
- Jan 2005: Refrigerant Selection – LEED Prerequisites and Credits
- May 2005: Energy Analysis – LEED Modeling
- Nov 2007: LEED Case Studies

What's New?

- As of 26 June 2007, all LEED projects are required to achieve at least two (2) points under Optimize Energy Performance

LEED-NC version 2.2

EA Credit 1

Reduction of overall building energy cost compared to a baseline building defined by ASHRAE 90.1-2004 (Appendix G)

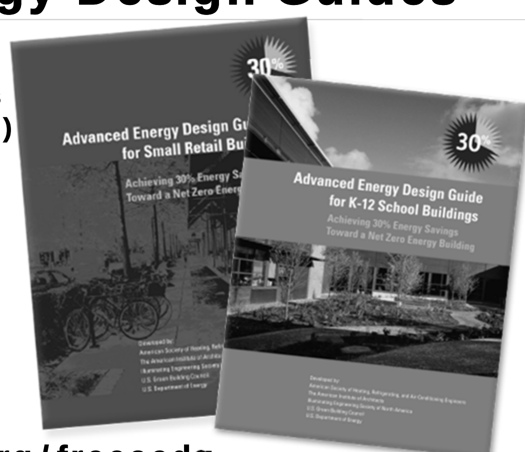
New building	Major renovation	LEED points
10.5 %	3.5 %	1
14	7	2
17.5	10.5	3
21	14	4
24.5	17.5	5
28	21	6
31.5	24.5	7
35	28	8
38.5	31.5	9
42	35	10

prescriptive path

Adv. Energy Design Guides

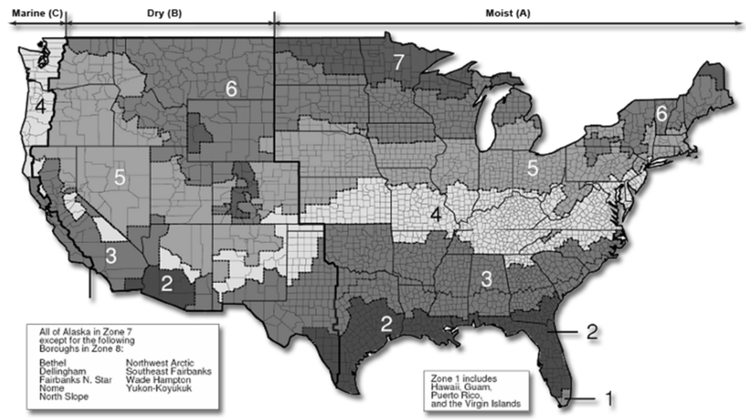
Climate-specific recommendations to achieve four (4) EA credit 1 points

- Small offices
- Small retail
- K-12 schools

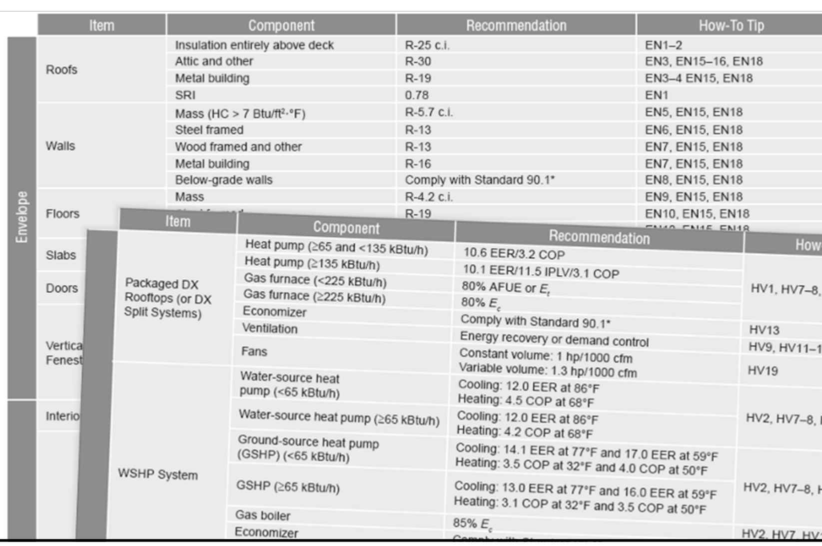


www.ashrae.org/freeaedg

Advanced Energy Design Guides
Climate Zone Map



Advanced Energy Design Guides
Recommendations Table



Item	Component	Recommendation	How-To Tip
Roofs	Insulation entirely above deck	R-25 c.i.	EN1–2
	Attic and other	R-30	EN3, EN15–16, EN18
	Metal building	R-19	EN3–4 EN15, EN18
	SRI	0.78	EN1
Walls	Mass (HC > 7 Btu/ft²·°F)	R-5.7 c.i.	EN5, EN15, EN18
	Steel framed	R-13	EN6, EN15, EN18
	Wood framed and other	R-13	EN7, EN15, EN18
	Metal building	R-16	EN7, EN15, EN18
	Below-grade walls	Comply with Standard 90.1*	EN8, EN15, EN18
Floors	Mass	R-4.2 c.i.	EN9, EN15, EN18
		R-19	EN10, EN15, EN18
Slabs			
Doors			
Vertica… Fenest…			
Interio…			

Item	Component	Recommendation	How-
Packaged DX Rooftops (or DX Split Systems)	Heat pump (≥65 and <135 kBtu/h)	10.6 EER/3.2 COP	HV1, HV7–8,
	Heat pump (≥135 kBtu/h)	10.1 EER/11.5 IPLV/3.1 COP	
	Gas furnace (<225 kBtu/h)	80% AFUE or E_t	
	Gas furnace (≥225 kBtu/h)	80% E_c	
	Economizer	Comply with Standard 90.1*	HV13
	Ventilation	Energy recovery or demand control	HV9, HV11–1
	Fans	Constant volume: 1 hp/1000 cfm Variable volume: 1.3 hp/1000 cfm	HV19
WSHP System	Water-source heat pump (<65 kBtu/h)	Cooling: 12.0 EER at 86°F Heating: 4.5 COP at 68°F	HV2, HV7–8, H
	Water-source heat pump (≥65 kBtu/h)	Cooling: 12.0 EER at 86°F Heating: 4.2 COP at 68°F	
	Ground-source heat pump (GSHP) (<65 kBtu/h)	Cooling: 14.1 EER at 77°F and 17.0 EER at 59°F Heating: 3.5 COP at 32°F and 4.0 COP at 50°F	HV2, HV7–8, H
	GSHP (≥65 kBtu/h)	Cooling: 13.0 EER at 77°F and 16.0 EER at 59°F Heating: 3.1 COP at 32°F and 3.5 COP at 50°F	
	Gas boiler	85% E_c	
	Economizer		HV2, HV7, HV1

Energy-Saving HVAC Strategies

engineers newsletter LIVE

Energy-saving opportunities for LEED® and the Energy Policy Act

LEED EAc1 "Golden Rule"

First, reduce the load.

- **Glazing:** Avoid glazing which faces east or west, shade exterior glazing, use insulating low-e glass, and make all glazing as small as possible (consistent with use of daylighting)
- **Daylighting / Lighting:** Design envelope and glazing so the sun provides interior lighting at perimeter, and design efficient supplemental interior lighting that modulates when not needed
- **Envelope:** Design and construct exterior enclosure to be as airtight as possible

More information: *ASHRAE Green Guide*
Advanced Energy Design Guide series
The ASHRAE Guide for Buildings in Hot and Humid Climates

Whole Building Simulation

- **Office building**
  - 270,000 ft^2
  - Four locations
- **Appendix G baseline**
  - Chilled-water VAV
  - Plug loads = 25% of total energy cost
  - Energy rates from EIA (www.eia.doe.gov)

Four Locations

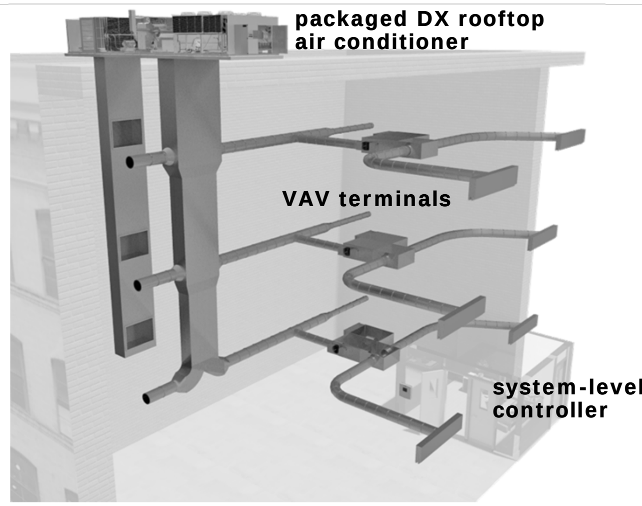
Scope of this Analysis

- HVAC-related energy-saving strategies <u>only</u>
- Commonly-used HVAC system types
- Achieve two (2) EAc1 points
- Energy-saving strategies for the envelope, lighting, and plug loads <u>should</u> be used
- Other system types could be used
- More points could be achieved

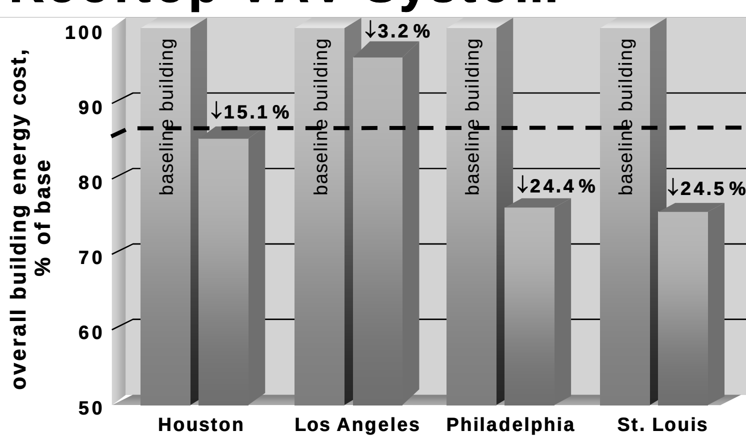
Energy-Saving Strategies

- Rooftop VAV systems
- Self-contained VAV systems
- Chilled-water fan-coil systems
- Water-source heat pump systems
- Chilled-water VAV systems

Rooftop VAV System



LEED-NC EAc1
Rooftop VAV System

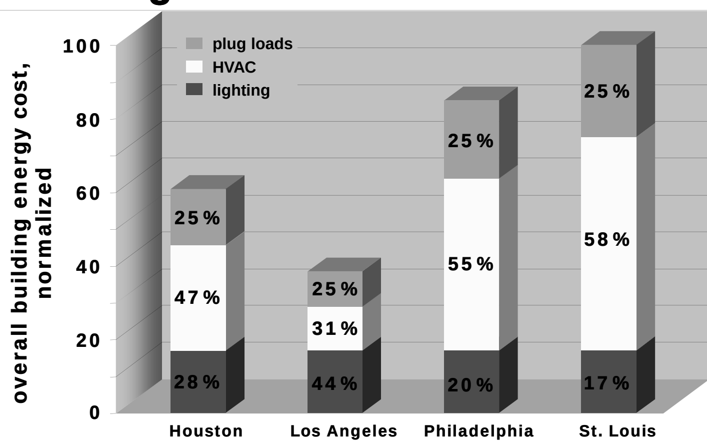


energy-saving strategies

Rooftop VAV System

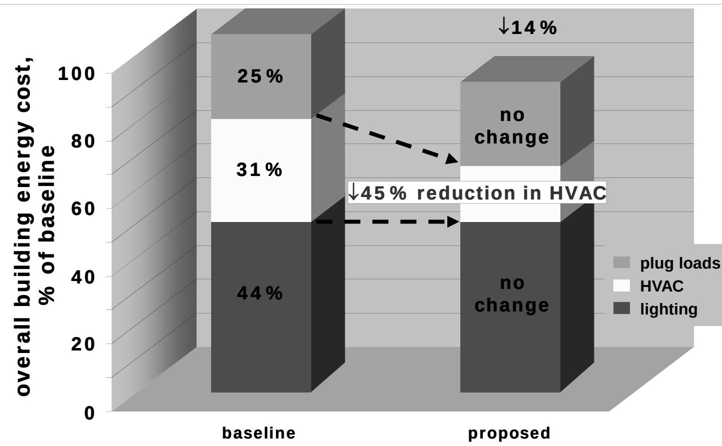
	Houston	Los Angeles	Philadelphia	St. Louis
High-efficiency rooftop unit (9.7 EER)	X	X	X	X
Ventilation optimization (demand-controlled ventilation at zone-level + ventilation reset at system level)	X	X	X	X
Improved supply-air-temperature reset	X	X	X	X
Parallel-fan-powered VAV (serving perimeter zones)	X	X	X	X
Cold-air distribution (52°F supply-air + 1°F increase on space cooling setpoint)	X	X		
Airside economizer	X	X	X	X

How Big is the HVAC Piece of Pie?



Trane, in proposing these system design and application concepts, assumes no responsibility for the performance or desirability of any resulting system design. Design of the HVAC system is the prerogative and responsibility of the engineering professional.

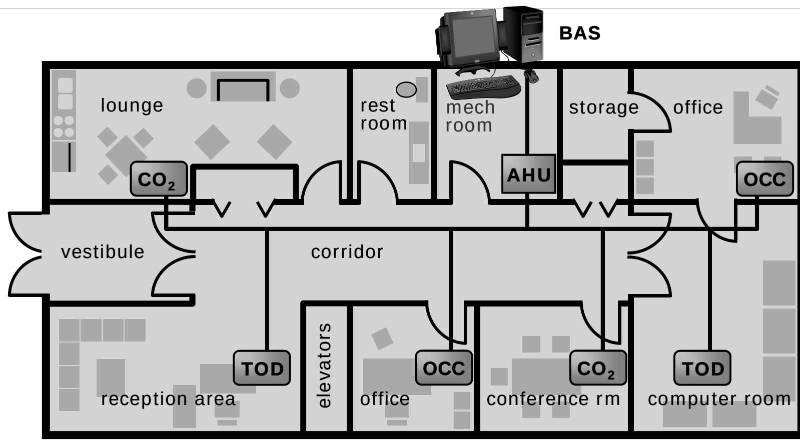
Los Angeles



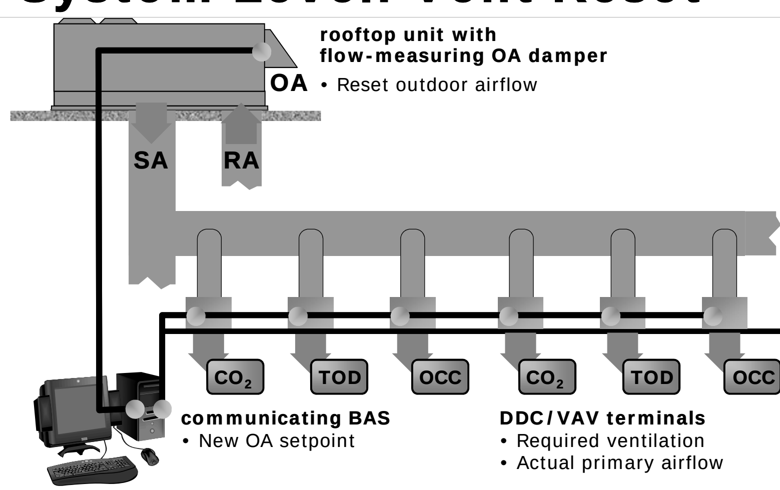
energy-saving strategies
Rooftop VAV System

	Houston	Los Angeles	Philadelphia	St. Louis
High-efficiency rooftop unit (9.7 EER)	X	X	X	X
Ventilation optimization (demand-controlled ventilation at zone-level + ventilation reset at system level)	X	X	X	X
Improved supply-air-temperature reset	X	X	X	X
Parallel-fan-powered VAV (serving perimeter zones)	X	X	X	X
Cold-air distribution (52°F supply-air + 1°F increase on space cooling setpoint)	X	X		
Airside economizer	X	X	X	X

ventilation optimization
Zone Level: DCV



ventilation optimization
System Level: Vent Reset

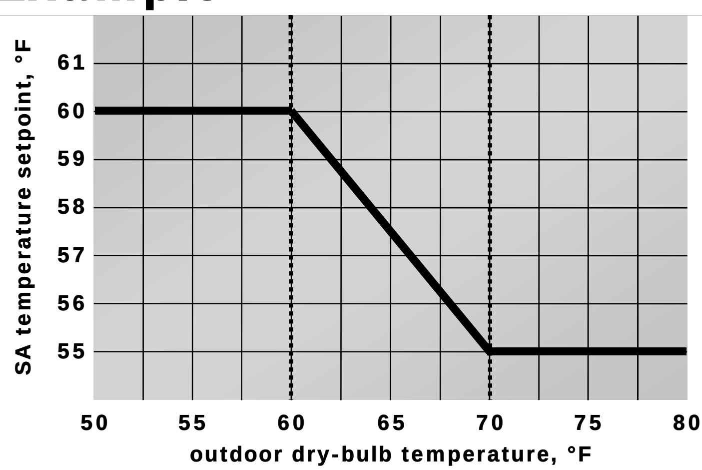


SA Temperature Reset

- **Benefits**
  - Decreases compressor energy
  - More hours of modulated economizing
  - Decreases reheat energy
- **Drawbacks**
  - Increases fan energy
  - Raises humidity level in the zones

SAT reset based on OA temperature

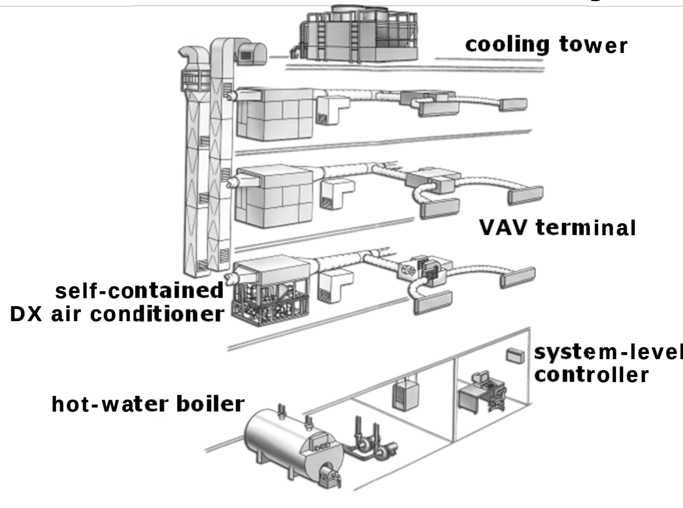
Example



Energy-Saving Strategies

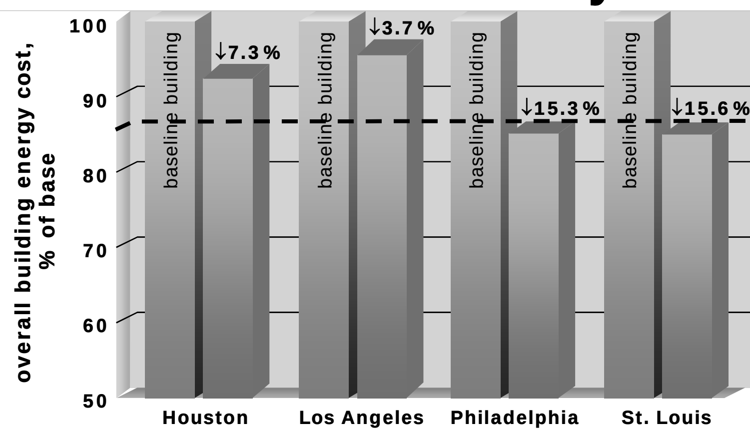
- Rooftop VAV systems
- Self-contained VAV systems
- Chilled-water fan-coil systems
- Water-source heat pump systems
- Chilled-water VAV systems

Self-Contained VAV System



LEED-NC EAc1

Self-Contained VAV System

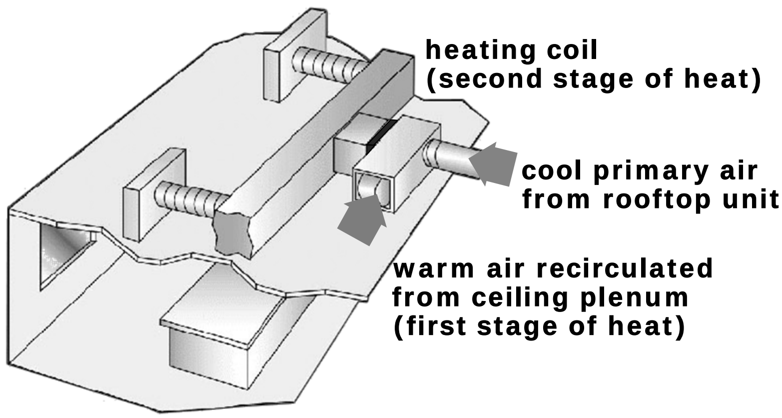


energy-saving strategies

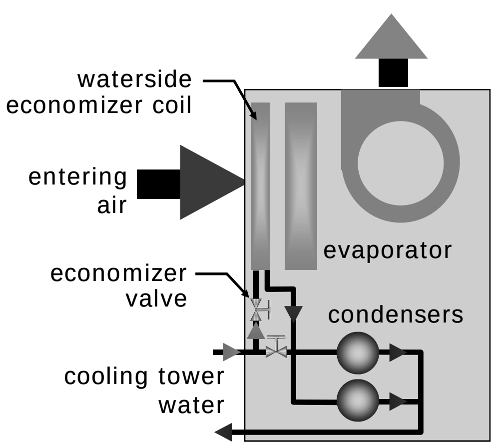
Self-Contained VAV System

	Houston	Los Angeles	Philadelphia	St. Louis
Ventilation optimization (demand-controlled ventilation at zone-level + ventilation reset at system level)	X	X	X	X
Improved supply-air-temperature reset	X	X	X	X
Lower condenser flow rate (12°F ΔT)	X	X	X	X
Parallel-fan-powered VAV (serving perimeter zones)	X	X	X	X
Cold-air distribution (50°F supply-air + 1°F increase in space cooling setpoint)	X	X		
Exhaust-air energy recovery (total-energy wheel)	X			
Waterside economizer	X	X	X	X
Optimized tower control		X		

parallel Fan-Powered VAV



self-contained VAV system Waterside Economizing



Energy-Saving Strategies

- Rooftop VAV systems
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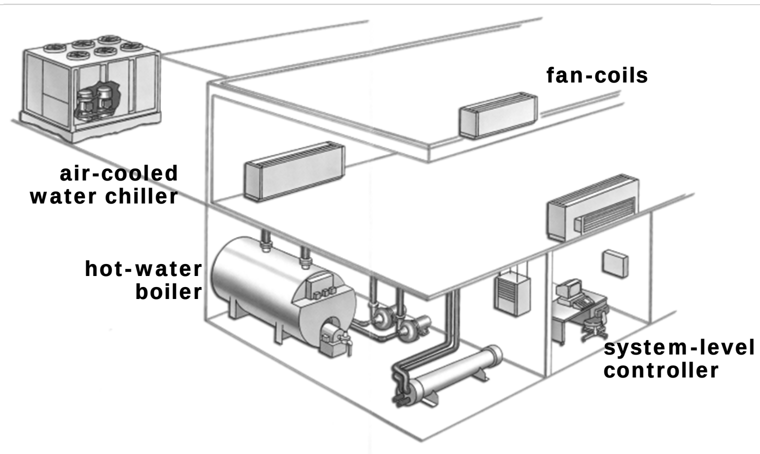
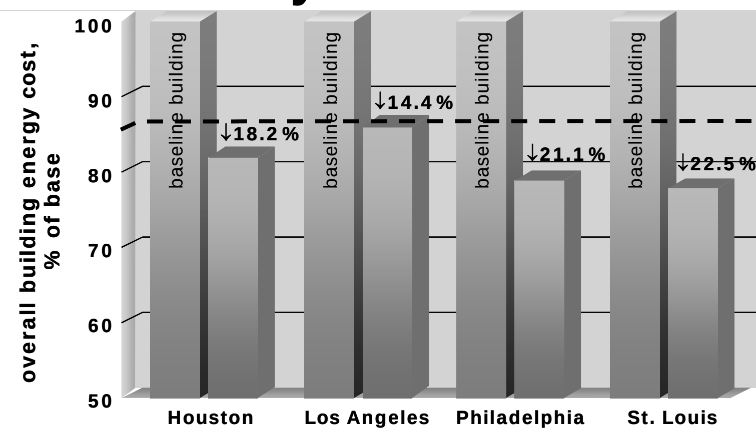
Chilled-Water Fan-Coil System



LEED-NC EAc1
Fan-Coil System

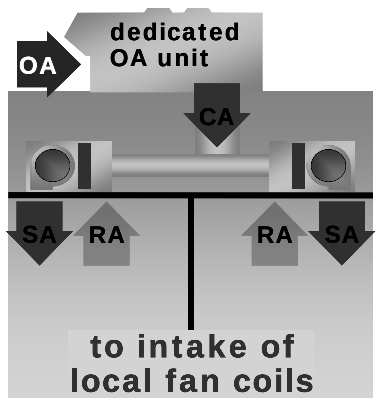


energy-saving strategies
Fan-Coil System

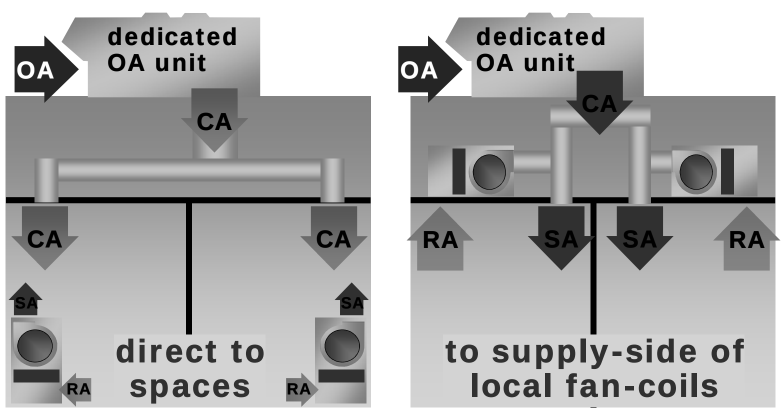
	Houston	Los Angeles	Philadelphia	St. Louis
Lower condenser flow rate (15°F ΔT)	X	X	X	X
Lower evaporator flow rate (14°F ΔT)	X	X	X	X
High-efficiency, water-cooled centrifugal chiller (0.59 kW/ton, or 0.48 kW/ton for Los Angeles)	X	X	X	X
Multiple-speed fans in fan coils	X	X	X	X
Deliver conditioned OA cold (rather than "neutral") directly to spaces	X	X	X	X
Demand-controlled ventilation		X		
Exhaust-air energy recovery (total-energy wheel in dedicated OA unit)	X		X	X
Waterside economizer (plate-and-frame heat exchanger)		X	X	X
Chiller-tower optimization control	X	X	X	X

*ASHRAE 90.1-2004 requires 0.69 kW/ton (0.52 kW/ton for Los Angeles) for a centrifugal chiller operating at these differing water temperatures and flow rates

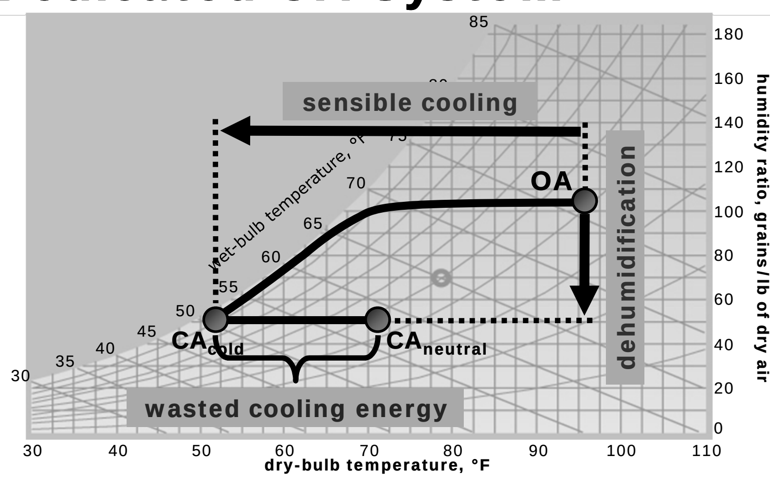
Dedicated OA System



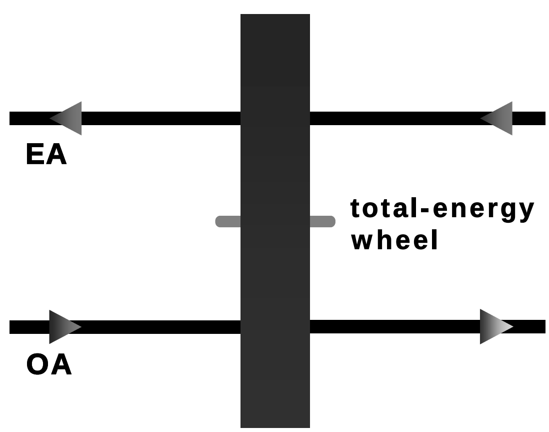
Dedicated OA System



Dedicated OA System



Exhaust-Air Energy Recovery



Energy-Saving Strategies

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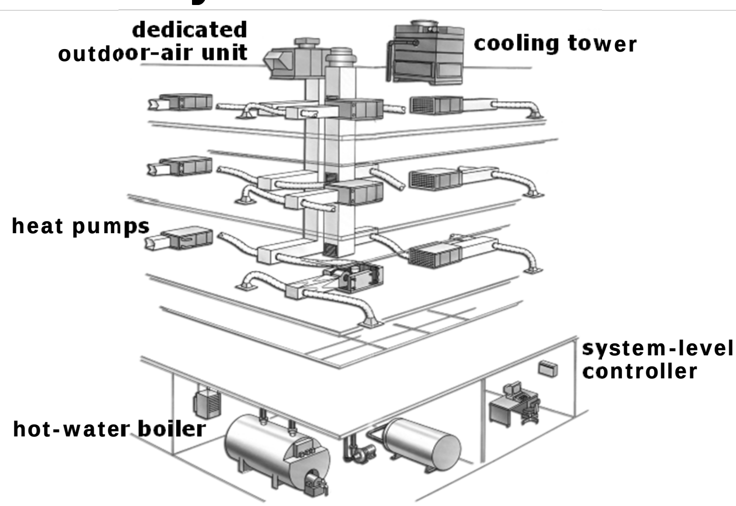
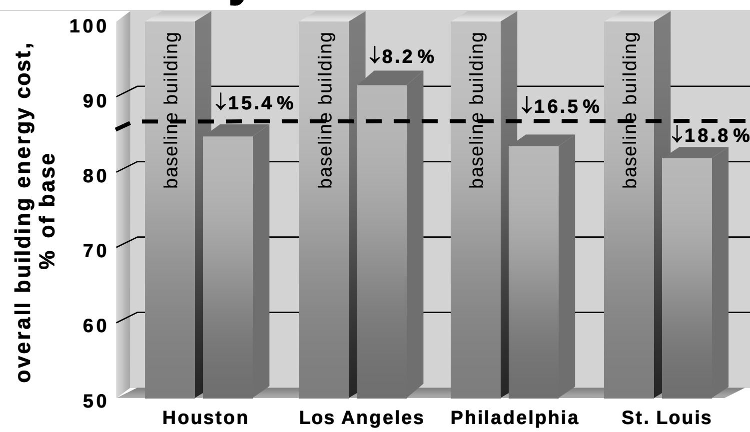
WSHP System



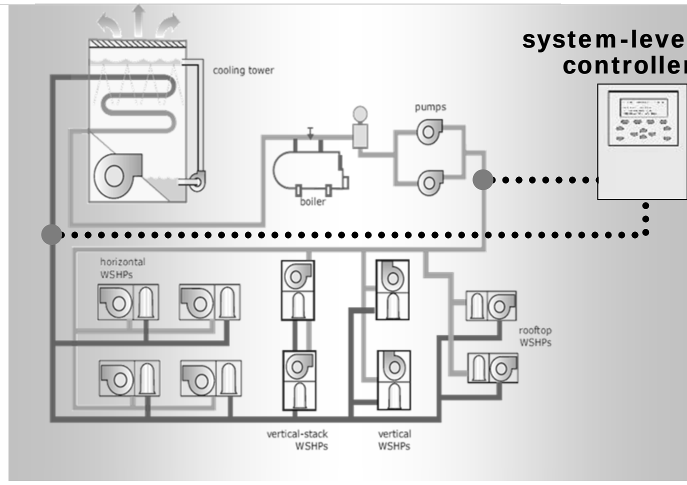
LEED-NC EAc1
WSHP System



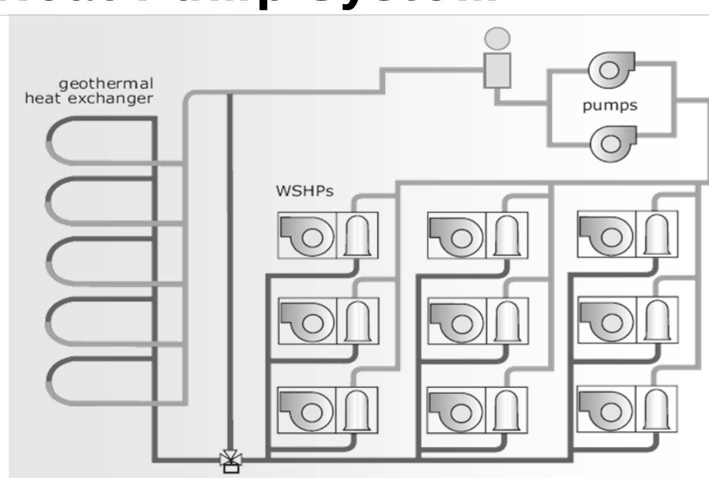
energy-saving strategies
WSHP System

	Houston	Los Angeles	Philadelphia	St. Louis
High-efficiency water-source heat pumps (15.7 EER)	x	x	x	x
Loop temperature optimization control sequence	x	x	x	x
Deliver conditioned OA cold (rather than "neutral") to spaces	x	x	x	x
Cycle WSHP fans with load		x		
Exhaust-air energy recovery (total-energy wheel in dedicated OA unit)	x		x	x
Demand-controlled ventilation		x		
Waterside economizer		x		

Loop Temperature Optimization



Ground-Source Heat Pump System



Energy-Saving Strategies

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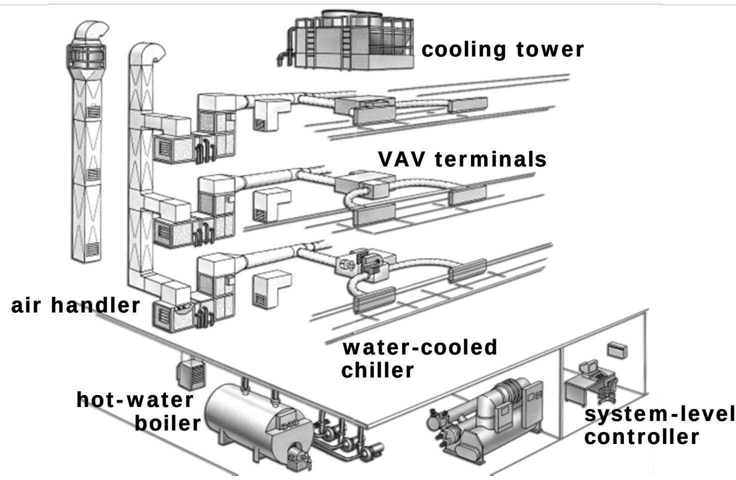
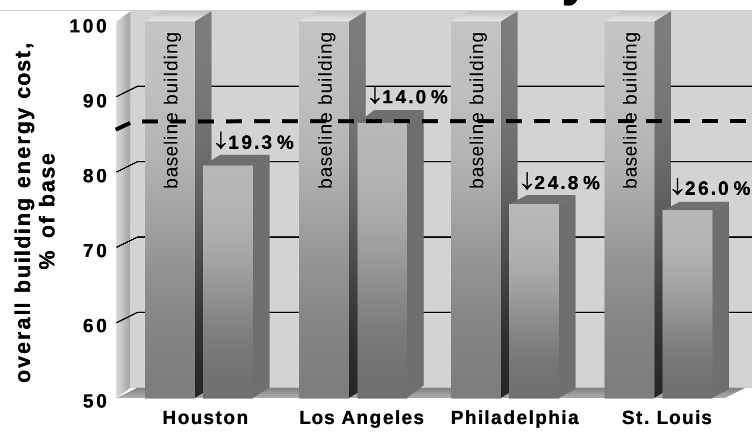
Chilled-Water VAV System



LEED-NC EAc1

Chilled-Water VAV System



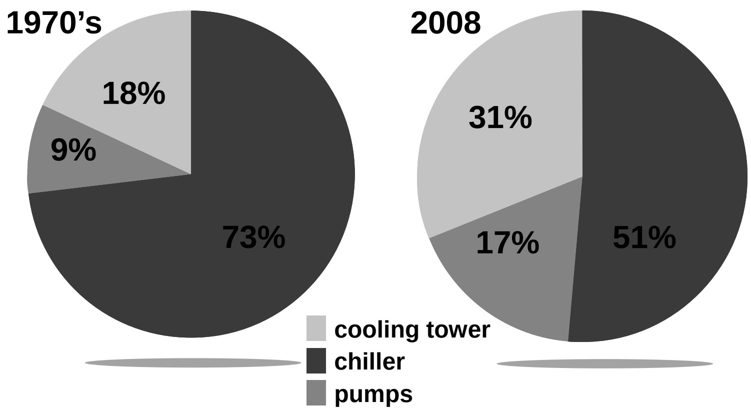
energy-saving strategies

Chilled-Water VAV System

	Houston	Los Angeles	Philadelphia	St. Louis
Lower condenser flow rate (15°F ΔT)	X	X	X	X
Lower evaporator flow rate (14°F ΔT)	X	X	X	X
High-efficiency, water-cooled centrifugal chiller (0.59 kW/ton, or 0.48 kW/ton for Los Angeles)	X	X	X	X
Ventilation optimization (DCV at zone-level + ventilation reset at system level)	X	X	X	X
Improved supply-air-temperature reset	X	X	X	X
Parallel fan-powered VAV (serving perimeter zones)		X	X	X
Cold-air distribution (48°F supply-air + 1°F increase in space cooling setpoint)		X	X	X
High-efficiency, airfoil supply fan	X	X	X	X
Airside economizer		X		
Chiller-tower optimization	X	X	X	X

*ASHRAE 90.1-2004 requires 0.69 kW/ton (0.52 kW/ton for Los Angeles) for a centrifugal chiller operating at these differing water temperatures and flow rates

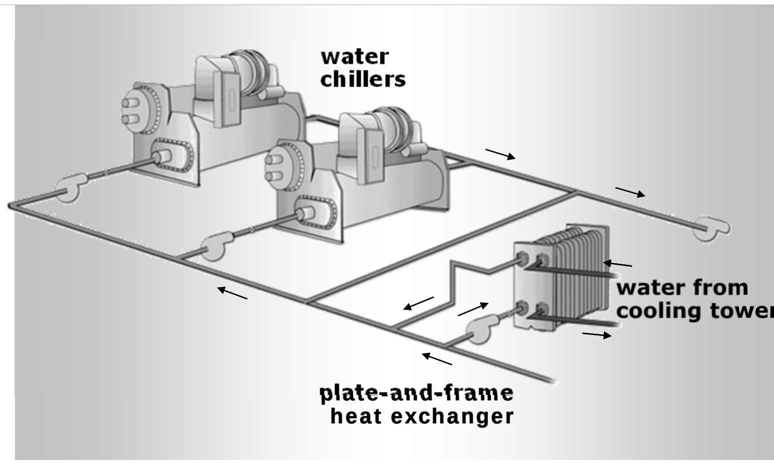
annual energy use of the
Chilled-Water Plant



Lower Flow Rates

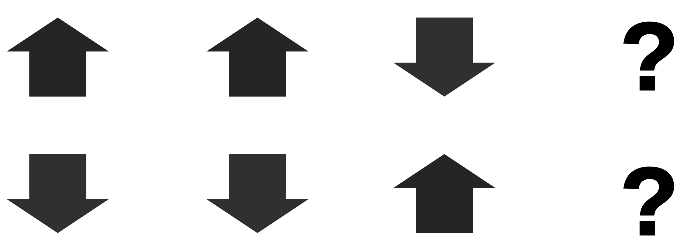
	chilled / condenser flow rates (gpm/ton)	
	2.4 / 3.0	1.5 / 2.0
chiller	256 kW	292 kW
chilled-water pump	32	8
condenser-water pump	25	9
cooling tower fans	24	16
total kW	**337**	**325**

Waterside Economizer



Chiller-Tower Optimization

condenser water temperature	chiller kW	+	tower kW	=	combined kW



"Cold" Supply Air

- **Benefits**
  - Reduces supply airflow (smaller air handlers, ductwork, VAV terminals, and supply fan)
  - Reduces supply fan energy
- **Drawbacks**
  - Increases reheat energy
  - Fewer hours when economizer provides all necessary cooling (compressors shut off)

energy-saving HVAC strategies

Summary

- **Results from this analysis cannot be submitted for your specific project**
  - USGBC requires the actual building to be modeled to estimate savings
- **Goal: To provide guidance as to what strategies should be investigated for the HVAC system you may be leaning toward using on a given project**

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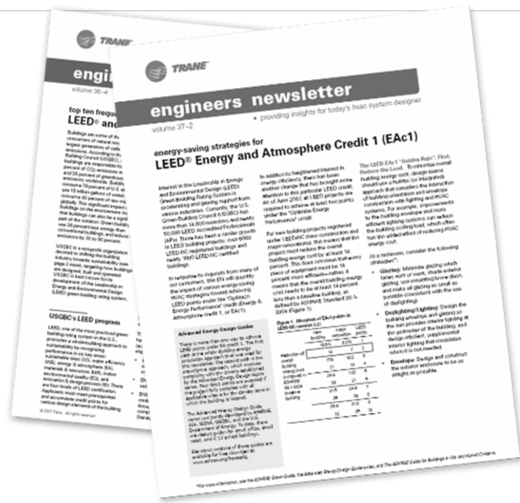
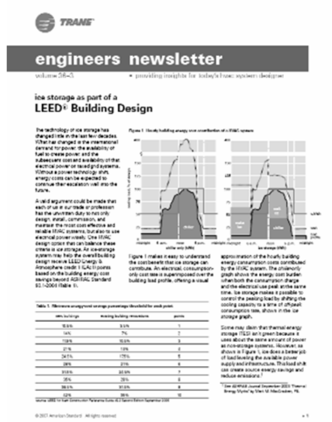


energy-saving HVAC strategies

Summary (continued)

- **Don't discard a system just because it didn't achieve 14% energy cost savings in this particular example**
  - Actual savings depends on layout and usage of the specific building, climate, and baseline system requirements
  - Our example: large building, baseline HVAC system was chilled-water VAV
  - For smaller buildings, baseline HVAC system will be different

EN on Ice Storage and LEED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ice storage as part of a LEED® Building Design

Energy Policy Act of 2005

- **Tax deduction up to $1.80/ft^2 for commercial building owner (or leaseholder)**
  - Extended through 31 Dec 2008 by the Tax Relief & Health Care Act of 2006
  - Must achieve 50% energy and cost savings
- **U.S. Internal Revenue Service requires energy savings to be proven through building simulation or compliance type qualified software**
  - TRACE 700 has been approved

Energy Policy Act of 2005

- **Tax deduction up to $0.60/ft^2 for partially qualifying commercial property**
  - Must achieve 16.67% energy and cost savings
    - Envelope
    - Lighting
    - HVAC and Service Water Heating
- **Interim Lighting Rule**
  - Must achieve 25% lower LPD (50% for warehouses)
  - Sliding scale percentage of deduction between 25 and 40%

The "Big Picture" of Building Energy Use

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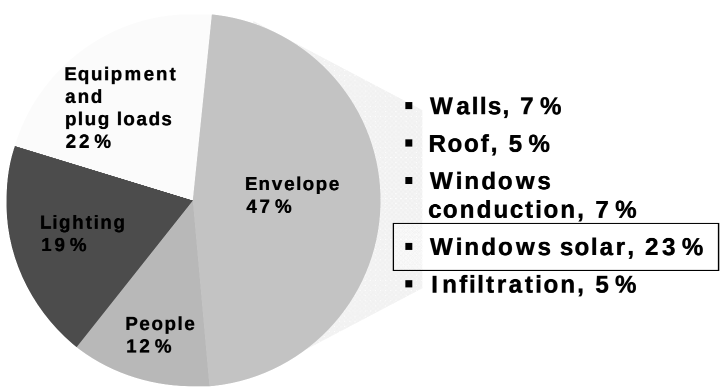
Energy-saving opportunities for LEED® and the Energy Policy Act

Understand Design Elements That Impact Energy Use

- **Building Envelope**
  - Roof/Insulation
  - Shading
  - Windows
  - Orientation/Site
  - Natural Lighting

- **LEED Points Available**
  - Sustainable Site
  - Indoor Environmental Quality
  - Energy and Atmosphere

Typical 10,000 Ft² Office Building – Southwest U.S.



Look At Options for Windows

- Window U-factors, tinting or films, shading provided by the building

Typical window performance values

Glazing type	U-value of glazing	Shading coefficient	Solar heat gain coefficient	Visible light transmittance
Single-pane, clear	0.88	1	0.86	90%
Double-pane, clear	0.48	0.87	0.75	81%
Double-pane, clear, low-e	0.32	0.7	0.6	73%
Double-pane, tinted (bronze)	0.48	0.59	0.5	48%
Double-pane, tinted (green), low-e	0.32	0.48	0.42	61%
Double-pane, reflective	0.48	0.26	0.22	18%

Windows Can Have a Significant Impact

Typical 10,000 ft^2 office building in Southwestern U.S.

Window type	Percent savings
Single-pane, clear	0%
Double-pane, clear	5%
Double-pane, clear, with shade screen (SC=0.35)	20%
Double-pane, tint (SC=0.50), low-e	11%
Double-pane, reflective (SC=0.20)	26%

Impact of Insulation and Roof Color

Typical 10,000 ft² office building in Southwestern U.S.

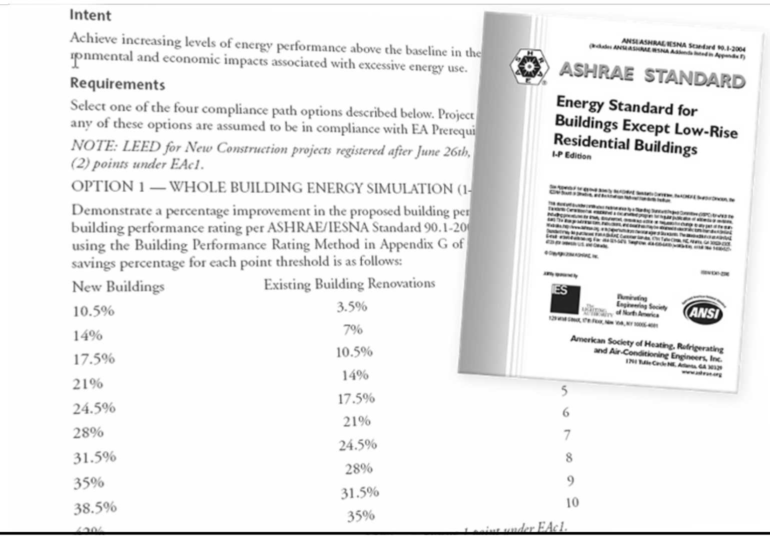
Insulation level	Roof color	Cost ft²
No insulation R=0	dark	$2.26
	light	$ 2.17
R-19	dark	$ 1.80
	light	$ 1.69
R-30	dark	$ 1.23
	light	$ 1.11

Other Factors To Consider to Reduce Energy Consumption

- Building Orientation
- Daylighting
- Landscaping


BETHEL MIDDLE SCHOOL

ASHRAE Standard 90.1 and LEED®-NC Version 2.2 Energy & Atmosphere Credit 1



Intent

Achieve increasing levels of energy performance above the baseline in the ...onmental and economic impacts associated with excessive energy use.

Requirements

Select one of the four compliance path options described below. Project ... any of these options are assumed to be in compliance with EA Prerequi...

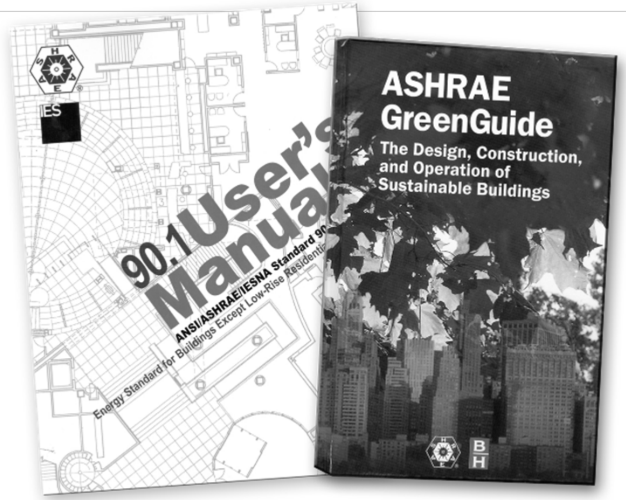
NOTE: LEED for New Construction projects registered after June 26th, ... (2) points under EAc1.

OPTION 1 — WHOLE BUILDING ENERGY SIMULATION (1-...

Demonstrate a percentage improvement in the proposed building per... building performance rating per ASHRAE/IESNA Standard 90.1-20... using the Building Performance Rating Method in Appendix G of ... savings percentage for each point threshold is as follows:

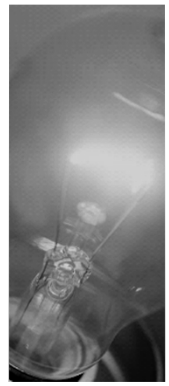
New Buildings	Existing Building Renovations	
10.5%	3.5%	
14%	7%	
17.5%	10.5%	
21%	14%	
24.5%	17.5%	5
28%	21%	6
31.5%	24.5%	7
35%	28%	8
38.5%	31.5%	9
	35%	10

ASHRAE 90.1 User's Manual



Consider Use Factors That Impact Building Energy Use

- **Internal Loads**
  - Equipment loads
  - Lighting systems
- **Operating Schedules**
  - HVAC schedules
  - Thermostat settings and set back
- **Occupancy Schedules**
  - People loads



Typical Office Equipment Cost to Operate

Equipment	Typical power requirement (watts)	Annual energy cost-off at night	Annual energy cost – on 24 hrs/day
Computer	55	$9	$39
Monitor (15”)	75	$12	$54
Laser Printer	60	$14	$44
Fax machine	35	$9	$27
Copier (small)	115	$30	$83
Copier (large)	310	$80	$224

Don’t Be a Statistic

- Many firms make a good living implementing energy-saving strategies
- Opportunities to save energy can exist in all buildings (regardless of type or age)
- Good news: greater focus today on green and sustainable design

Commissioning:
Leads to Success

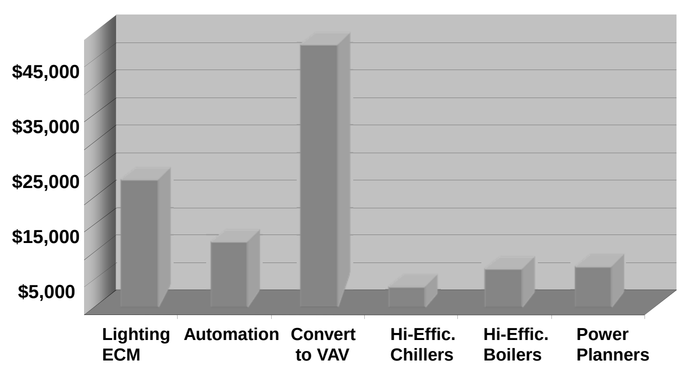
- Ensures meeting design intent
- Minimizes operational problems
- Acceptance is growing
- LEED prerequisite

Use Modeling to Help Make Design Decisions

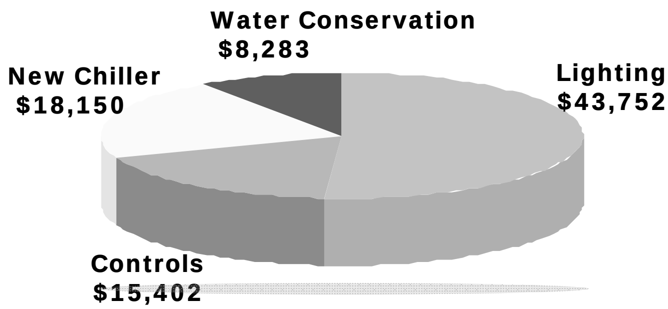
- **Alternatives are easy to set up**
- **Do "What ifs" to see energy impact**
- **Simple changes or improvements can have a huge impact**
- **Modeling automatically takes a whole building approach**

Whole Building Project Approach Results

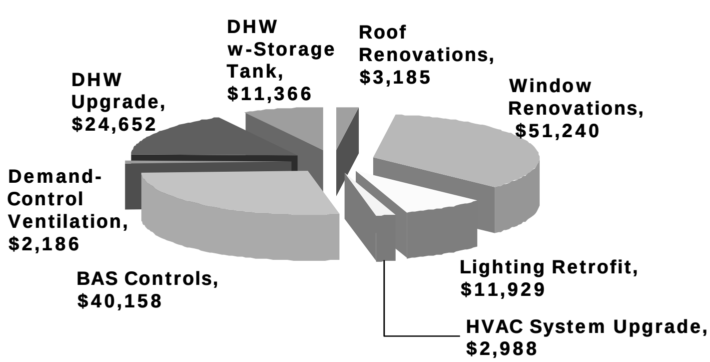
- **Typical College Campus**



Typical Hospital Complex



Typical K-12 Buildings



Common Building Energy Modeling Mistakes

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Energy-saving opportunities for LEED® and the Energy Policy Act

Performance Rating Method

Common Mistakes

- **Building envelope**
  - Maximum glass percentage assumed to be same as used in ECB method
  - Glass not evenly distributed in horizontal bands across all orientations

Performance Rating Method

Distribution of Windows

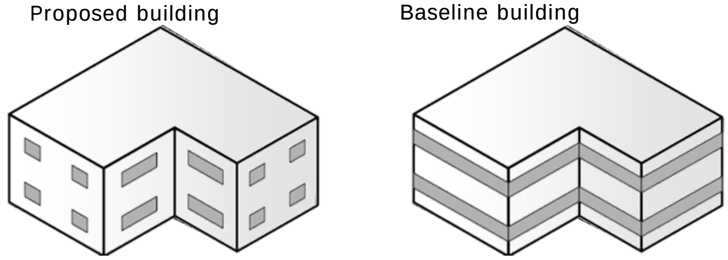

Figure G-D – Horizontal bands

Performance Rating Method

Common Mistakes

- **Building envelope**
  - Maximum glass percentage assumed to be same as used in ECB method
  - Glass not evenly distributed in horizontal bands across all orientations
  - Lightweight roof, wall, and floor assemblies not used
  - Reflectivity of roof surface not set to 0.3

Performance Rating Method

Common Mistakes

- **HVAC system**
  - Incorrect baseline system selection

Performance Rating Method

Baseline HVAC Systems

Table G-A—Baseline Building HVAC System Types and Descriptions

This table combines Table G3.1.1A and Table G3.1.1B from Standard 90.1-2004 *for ease of use and clarity. The building types and sizes are shown as columns. System types and specifications are shown in rows. These are grouped first by proposed buildings that use fossil fuels and then by proposed buildings that use electricity.*

			Nonresidential		
Heating Source		Residential More than 3 stories	Less than 3 floors or less than 75,000 ft²	4 or 5 floors or less than 75,000 ft² or 5 floors or less and 75,000–150,000 ft²	More than 5 floors or more than 150,000 ft²
Fossil Fuel, Fossil/Electric Hybrid & Purchased Heat	Number/Code	1—PTAC	3—PSZ-AC	5—PVAV w/Reheat	7—VAV w/Reheat
	System Type	Packaged terminal air conditioner	Packaged rooftop air conditioner	Packaged rooftop variable air volume with reheat	Variable air volume with reheat
	Fan Control	Constant Volume	Constant Volume	VAV	VAV
	Cooling Type	Direct Expansion	Direct Expansion	Direct Expansion	Chilled Water
	Heating Type	Hot Water Fossil Fuel Boiler	Fossil Fuel Furnace	Hot Water Fossil Fuel Boiler	Hot Water Fossil Fuel Boiler
Electric and Other	Number/Code	2—PTHP	4—PSZ-HP	6—PVAV w/ PFP Boxes	8—VAV w/ PFP Boxes
	System Type	Packaged terminal heat pump	Packaged rooftop heat pump	Packaged rooftop variable air volume with reheat	Variable air volume with reheat
	Fan Control	Constant Volume	Constant Volume	VAV	VAV
	Cooling Type	Direct Expansion	Direct Expansion	Direct Expansion	Chilled Water
	Heating Type	Electric Heat Pump	Electric Heat Pump	Electric Resistance	Electric Resistance

Performance Rating Method

Common Mistakes

- **HVAC system**
  - Incorrect baseline system selection
  - Packaged unit supply fan, condenser fan, compressor energy not properly separated
  - IPLV requirement ignored
  - Use of default equipment that significantly exceeds (or does not meet) required part load performance

Performance Rating Method

Common Mistakes

- **HVAC system (continued)**
  - Fan power improperly calculated
  - Fan cycling not modeled
  - Pump power limitations ignored (or not applying limitation to the sum of all pumps)
  - Unmet load hours exceeds 300 hrs (or proposed model exceeds baseline by more than 50 unmet hrs)

Performance Rating Method

Common Mistakes

- **HVAC system (continued)**
  - Optimum start ignored for systems greater than 10,000 cfm
  - Design flow rates not using a 20°F ΔT for baseline building systems
  - 8760 hour simulation not used

Energy Modeling

Common Mistakes

- **General**
  - Using default or invalid assumptions on schedules
  - Using default equipment despite significant changes in design conditions
  - Over simplifying thermal zoning
  - Improperly entering ventilation

Energy Modeling

Common Mistakes

- **General (continued)**
  - Overly constraining the model to meet expectations
  - Extending modeling capabilities beyond the intent
  - Using design assumptions during typical building simulation

Answers to Your Questions

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Energy-saving opportunities for LEED® and the Energy Policy Act

This concludes the American Institute of Architects Continuing Education System Program

energy-saving opportunities

Summary

- **Impact of energy-saving strategies depend on climate, building usage, and utility costs**
- **Building analysis tools (like TRACE™) can convert energy savings to operating cost dollars to:**
  - Save clients money
  - Achieve LEED points under EA credit 1
  - Qualify for tax deductions (Energy Policy Act)

energy-saving opportunities

Summary

- **First, reduce the load. Then, make the HVAC systems more efficient.**
  - Lots of energy can be saved through non-HVAC strategies
- **Any of these HVAC systems can be used on a LEED project**
  - In some cases, envelope or lighting improvements may be needed too

references for this broadcast

Where to Learn More

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www.trane.com/bookstore

Insightful topics on HVAC system design:

- Chilled-water plants
- Air distribution
- Refrigerant-to-air systems
- Control strategies
- Industry standards and LEED®
- Energy and the environment
- Acoustics
- Ventilation
- Dehumidification

mark your calendar

2008 ENL Broadcasts

- **September 10**
  Small chilled-water systems
- **November 12**
  ASHRAE Standards 90.1 and 62.1 and VAV Systems