ASHRAE's Advanced Energy Design Guide Series – Saving 30% the Easy Way

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Battelle

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

Partners in Advanced Guide Series

Development Principles (committee marching orders)

- Tightly controlled scope and purpose *(20,000 sq. ft., unitary systems)*
- Provide a way, *but not the only way* of achieving 30% energy savings relative to Standard 90.1-1999
- Use energy savings as the independent variable vs. cost effectiveness
- Use practical, off-the-shelf technology
- Produce a *useful* document in a *timely* manner
- Stay focused on the target market

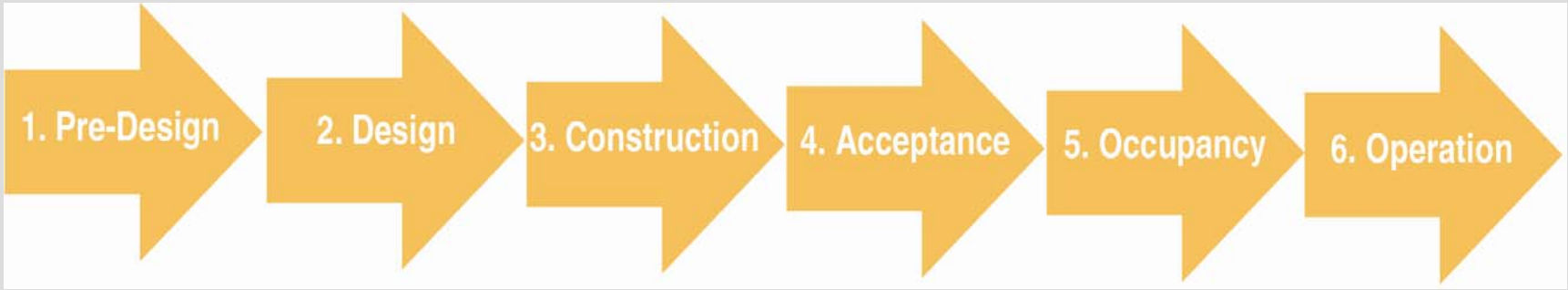
What's In the AEDG for Small Offices?

- Document Outline
- Climate Zones
- Format of Recommendation Tables
- Envelope Recommendations
- Lighting Recommendations
- HVAC Equipment and System Recommendations
- SWH Recommendations
- Example Building Designs
- How-To Guidance

AEDG Document Outline

- Section 1 – Introduction *(what we did, and why)*
- Section 2 - Integrated design process to achieve energy savings *(how to integrate energy into the design of the building)*
- Section 3 - Recommendations by climate zone including example building designs *(the meat)*
- Section 4 - How-to guidance for implementing recommendations *(helpful hints & cautions)*

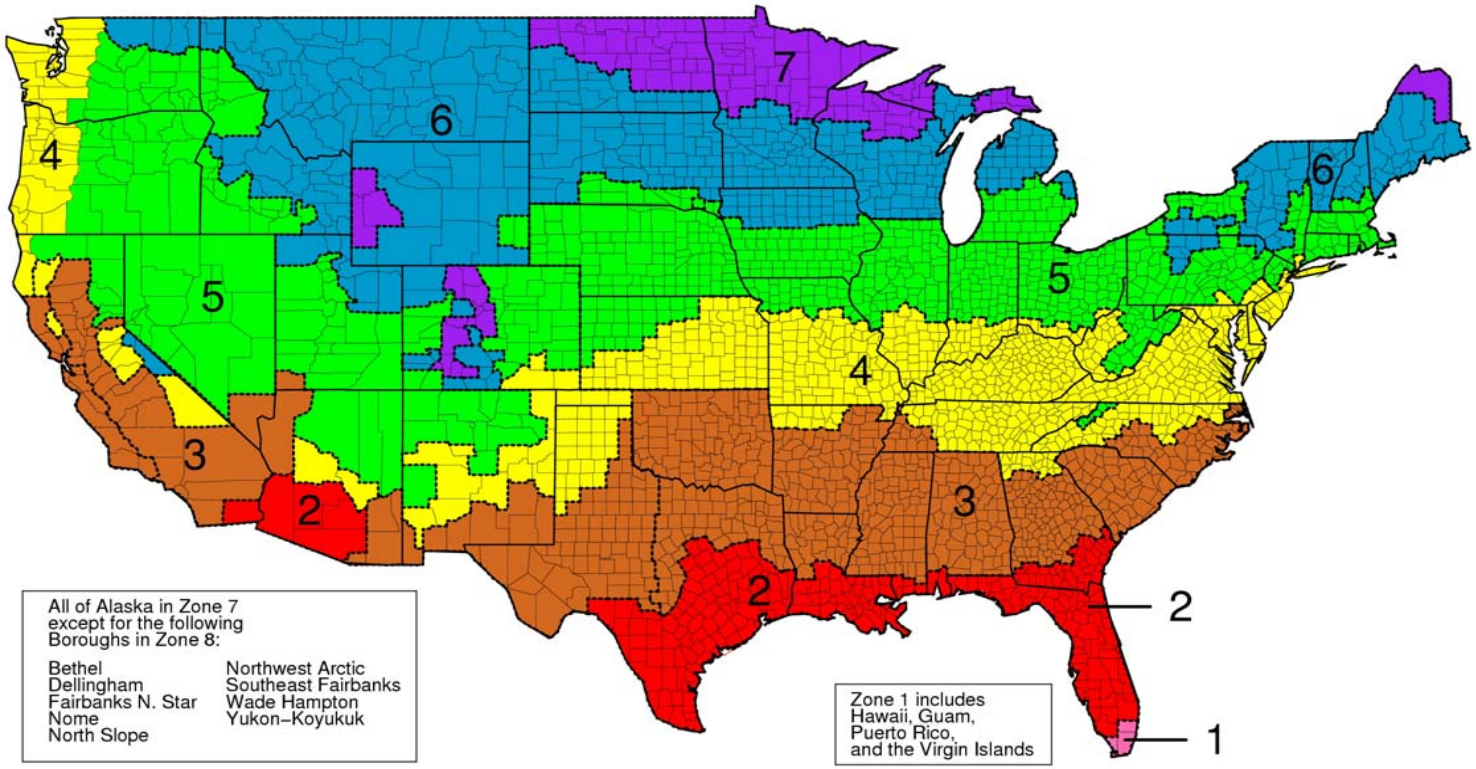
2-Integrated Design Process



- Recommendations are provided for each stage of design through occupancy to maximize energy savings
- Emphasis is placed on the integration of energy features early in the design rather than dealing with them as add-ons
- Design features with energy implications are clearly highlighted in the tables *(see * symbol in tables)*

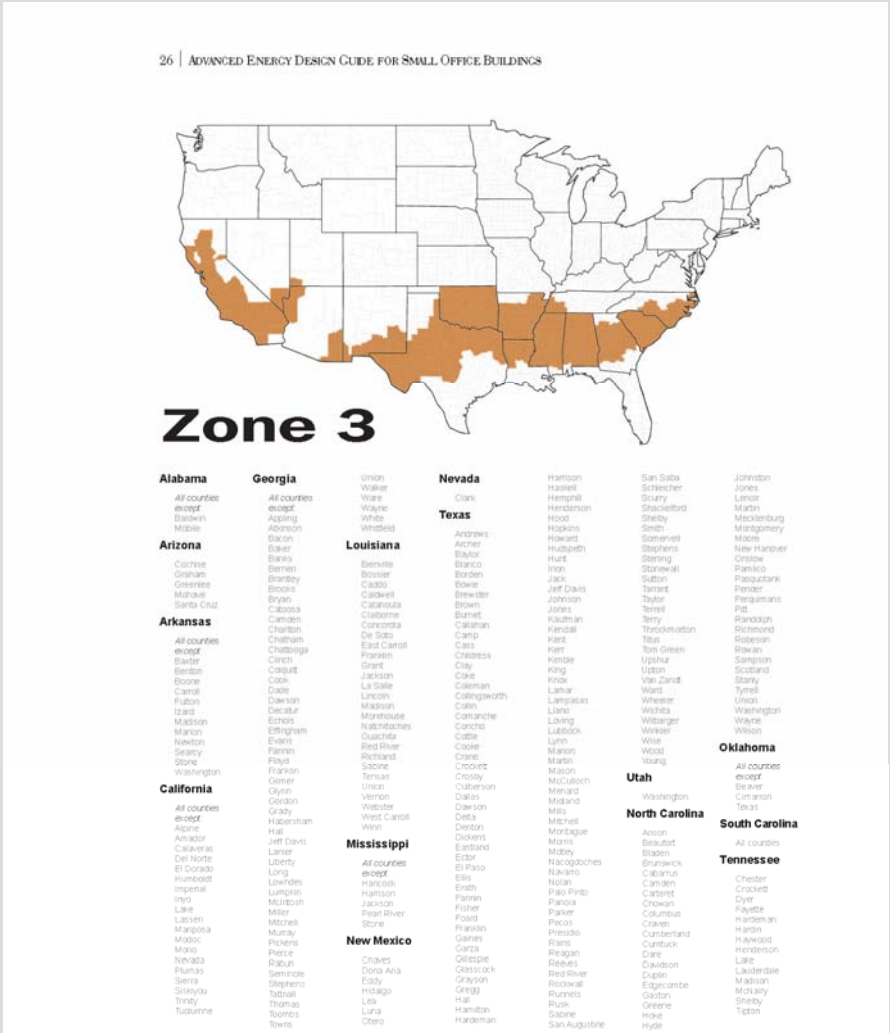
3-Recommendations by Climate

Use Climate Zone Map to Find Your Location



Note: Consistent climate zones used for ASHRAE Standards 90.1, 90.2 and IECC

Confirm Your Specific Climate Zone



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Zone 3

Alabama
All counties except
Baldwin
Mobile

Arizona
Cochise
Graham
Greenlee
Mohave
Santa Cruz

Arkansas
All counties except
Baxter
Benton
Boone
Carroll
Fulton
Izard
Madison
Marion
Newton
Searcy
Stone
Washington

California
All counties except
Alpine
Amador
Calaveras
Del Norte
El Dorado
Humboldt
Imperial
Inyo
Lake
Lassen
Mariposa
Modoc
Mono
Nevada
Plumas
Sierra
Siskiyou
Trinity
Tuolumne

Georgia
All counties except
Appling
Atkinson
Bacon
Baker
Banks
Berrien
Brantley
Brooks
Bryan
Catoosa
Camden
Charlton
Chatham
Chattooga
Clinch
Coquitt
Cook
Dade
Dawson
Decatur
Echols
Effingham
Evans
Fannin
Floyd
Franklin
Gilmer
Glynn
Gordon
Grady
Habersham
Hall
Jeff Davis
Lanier
Liberty
Long
Lowndes
Lumpkin
McIntosh
Miller
Mitchell
Murray
Pickens
Pierce
Rabun
Seminole
Stephens
Tattnall
Thomas
Towns
Union
Walker
Ware
Wayne
White
Whitfield

Louisiana
Bienville
Bossier
Caddo
Caldwell
Catahoula
Claiborne
Concordia
De Soto
East Carroll
Franklin
Grant
Jackson
La Salle
Lincoln
Madison
Morehouse
Natchitoches
Ouachita
Red River
Richland
Sabine
Tensas
Union
Vernon
Webster
West Carroll
Winn

Mississippi
All counties except
Hancock
Harrison
Jackson
Pearl River
Stone

New Mexico
Chaves
Dona Ana
Eddy
Hidalgo
Lea
Luna
Otero

Nevada
Clark

Texas
Andrews
Archer
Baylor
Branco
Borden
Bowie
Brewster
Brown
Burnet
Callahan
Camp
Cass
Childress
Clay
Coke
Coleman
Collingsworth
Collin
Comanche
Concho
Cottle
Cooke
Crane
Crockett
Crosby
Culberson
Dallas
Dawson
Delta
Denton
Dickens
Eastland
Ector
El Paso
Ellis
Erath
Fannin
Fisher
Foard
Franklin
Gaines
Garza
Gillespie
Glasscock
Grayson
Gregg
Hall
Hamilton
Hardeman
Harrison
Haskell
Hemphill
Henderson
Hood
Hopkins
Howard
Hudspeth
Hunt
Irion
Jack
Jeff Davis
Johnson
Jones
Kaufman
Kendall
Kent
Kerr
Kimble
King
Knox
Lamar
Lampasas
Llano
Loving
Lubbock
Lynn
Marion
Martin
Mason
McCulloch
Menard
Midland
Mills
Mitchell
Montague
Morris
Motley
Nacogdoches
Navarro
Nolan
Palo Pinto
Panola
Parker
Pecos
Presidio
Rains
Reagan
Reeves
Red River
Rockwall
Runnels
Rusk
Sabine
San Augustine
San Saba
Schleicher
Scurry
Shackelford
Shelby
Smith
Somervell
Stephens
Sterling
Stonewall
Sutton
Tarrant
Taylor
Terrell
Terry
Throckmorton
Titus
Tom Green
Upshur
Upton
Van Zandt
Ward
Wheeler
Wichita
Wilbarger
Winkler
Wise
Wood
Young

Utah
Washington

North Carolina
Anson
Beaufort
Bladen
Brunswick
Cabarrus
Camden
Carteret
Chowan
Columbus
Craven
Cumberland
Currituck
Dare
Davidson
Duplin
Edgecombe
Gaston
Greene
Hoke
Hyde
Johnston
Jones
Lenoir
Martin
Mecklenburg
Montgomery
Moore
New Hanover
Onslow
Pamlico
Pasquotank
Pender
Perquimans
Pitt
Randolph
Richmond
Robeson
Rowan
Sampson
Scotland
Stanly
Tyrrell
Union
Washington
Wayne
Wilson

Oklahoma
All counties except
Beaver
Cimarron
Texas

South Carolina
All counties

Tennessee
Chester
Crockett
Dyer
Fayette
Hardeman
Hardin
Haywood
Henderson
Lake
Lauderdale
Madison
McNairy
Shelby
Tipton

- Climate zone highlighted on U.S. map in consistent color
- States covered by the climate zone are listed below the map
- Specific counties within the climate zone are listed for reference (no counties are split)

AEDG Recommendation Table

Climate Zone 3 Recommendation Table

	Item	Component	Recommendation	How-To's in Chapter 4
Envelope	Roof	Insulation entirely above deck	R-20 c.i.	EN1-2, 17, 20-21
		Metal building	R-13 + R-13	EN1, 3, 17, 20-21
		Attic and other	R-38	EN4, 17-18, 20-21
		Single rafter	R-38	EN5, 17, 20-21
		Surface reflectance/emittance	0.65 initial/0.86	EN1
	Walls	Mass (HC > 7 Btu/ft²)	R-9.5 c.i.	EN6, 17, 20-21
		Metal building	R-13	EN7, 17, 20-21
		Steel framed	R-13 + R-3.8 c.i.	EN8, 17, 20-21
		Wood Framed and other	R-13	EN9, 17, 20-21
		Below-grade walls	No recommendation	EN10, 17, 20-21
	Floors	Mass	R-8.3 c.i.	EN11, 17, 20-21
		Steel framed	R-19	EN12, 17, 20-21
		Wood framed and other	R-30	EN12, 17, 20-21
	Slabs	Unheated	No recommendation	EN17, 19-21
		Heated	No recommendation	EN17, 19-21
	Doors	Swinging	U-0.70	EN15, 20-21
		Non-swinging	U-1.45	EN16, 20-21
	Vertical Glazing	Window to wall ratio (WWR)	20% to 40% maximum	EN23, 36-37
		Thermal transmittance	U-0.45	EN25
		Solar heat gain coefficient (SHGC)	N, S, E, W - 0.31 N only - 0.46	EN27-28
		Window orientation	$(A_N * SHGC_N + A_S * SHGC_S) > (A_E * SHGC_E + A_W * SHGC_W)$	A_x–Window area for orientation x EN26-32
		Exterior sun control (S, E, W only)	Projection factor 0.5	EN24, 28, 30, 36, 40, 42 DL5-6
	Skylights	Maximum percent of roof area	3%	DL5-7, DL8, DL13
		Thermal transmittance	U-0.69	DL7, DL8, DL13
		Solar heat gain coefficient (SHGC)	0.19	DL8, DL13
Lighting	Interior Lighting	Lighting power density (LPD)	0.9 W/ft²	EL1-2, 4, 8, 10-16
		Light source (linear fluorescent)	90 mean lumens/watt	EL4, 9, 17
		Ballast	Electronic ballast	EL4
		Dimming controls for daylight harvesting for WWR 25% or higher	Dim fixtures within 12 ft of N/S window wall or within 8 ft of skylight edge	DL1, 9-11, EL6-7
		Occupancy controls	Auto-off all unoccupied rooms	DL2, EL5, 6
		Interior room surface reflectances	80%+ on ceilings, 70%+ on walls and vertical partitions	DL3-4, EL3
HVAC	HVAC	Air conditioner (0-65 KBtuh)	13.0 SEER	HV1- 2, 4, 6, 12, 16-17, 20
		Air conditioner (>65-135 KBtuh)	11.0 EER/11.4 IPLV	HV1- 2, 4, 6, 12, 16-17, 20
		Air conditioner (>135-240 KBtuh)	10.8 EER/11.2 IPLV	HV1- 2, 4, 6, 12, 16-17, 20
		Air conditioner (>240 KBtuh)	10.0 EER/10.4 IPLV	HV1- 2, 4, 6, 12, 16-17, 20
		Gas furnace (0-225 KBtuh - SP)	80% AFUE or E_t	HV1- 2, 6, 16, 20
		Gas furnace (0-225 KBtuh - Split)	80% AFUE or E_t	HV1- 2, 6, 16, 20
		Gas furnace (>225 KBtuh)	80% E_c	HV1- 2, 6, 16, 20
		Heat pump (0-65 KBtuh)	13.0 SEER/7.7 HSPF	HV1- 2, 4, 6, 12, 16-17, 20
		Heat pump (>65-135 KBtuh)	10.6 EER/11.0 IPLV/3.2 COP	HV1- 2, 4, 6, 12, 16-17, 20
		Heat pump (>135 KBtuh)	10.1 EER/11.0 IPLV/3.1 COP	HV1- 2, 4, 6, 12, 16-17, 20
	Economizer	Air conditioners & heat pumps- SP	Cooling capacity > 54 KBtuh	HV23
	Ventilation	Outdoor air damper	Motorized control	HV7-8
		Demand control	CO_2 sensors	HV7, 22
	Ducts	Friction rate	0.08 in. w.c./100 feet	HV9, 18
		Sealing	Seal class B	HV11
		Location	Interior only	HV9
		Insulation level	R-6	HV10
SWH	Service Water Heating	Gas storage	90% E_t	WH1-4
		Gas instantaneous	0.81 EF or 81% E_t	WH1-4
		Electric storage 12 kW	EF > 0.99 – 0.0012xVolume	WH1-4
		Pipe insulation (d<1½ in./ d≥1½ in.)	1 in./ 1½ in.	WH6

Note: If the table contains "No recommendation" for a component, the user must meet the more stringent of either Standard 90.1 or the local code requirements in order to reach the 30% savings target.

- Energy-saving recommendations for each climate zone contained on single page
- Tables color-coded to maps
- Prescriptive recommendations help to achieve energy savings without costly calculations or analysis
- Recommendations address building envelope, lighting, HVAC equipment, HVAC systems and service water heating
- Recommendations must be used with underlying code or standard (see footnote)
- Note references to "how-to" section

AEDG Recommendations for Envelope

- Enhanced insulation levels for many assemblies
- Window-to-wall ratio (WWR) limited to 40%
- Recommendations on window orientation (*minimize window area on E-W*)
- Exterior sun control recommendations (*use of overhangs*)
- Maximum skylight area of 3%

AEDG Recommendations for Lighting and Electrical

- Lighting power density of 0.9 W/ft2
- Source efficiency of 90 mean lumens/watt
- Electronic ballasts
- Daylight controls for WWR >25% within 12 feet of N-S window wall, 8 feet of skylight edge
- Occupancy sensors
- Minimum surface reflectance recommendations

AEDG Recommendations for HVAC Equipment and Systems

- Higher efficiency unitary equipment – varies with climate zone
- Motorized outside air damper control
- Economizers needed down to 4.5 tons
- Demand controlled ventilation
- Lower duct friction rate *(design them better)*
- No exterior ductwork *(reduce possible leakage)*

Example Designs for Each Climate Zone

- Features real examples of advanced building energy designs
- Demonstrates flexibility offered in achieving advanced energy savings levels
- Selected from award winning designs by architects
- Text describes energy features employed

4-How to Implement Recommendations

- Section begins with recommendations for quality assurance through commissioning
- Sample commissioning scope statement provided for the owner/builder
- “How tos” organized by building system as follows:
  - Good design practices
  - Cautions
  - References
- Each “how to” numerically referenced in recommendation tables

Example "How-to" Guidance

EN27 ***Glazing* (Climate Zones: ❶ ❷ ❸ ❹ ❺ ❻)**

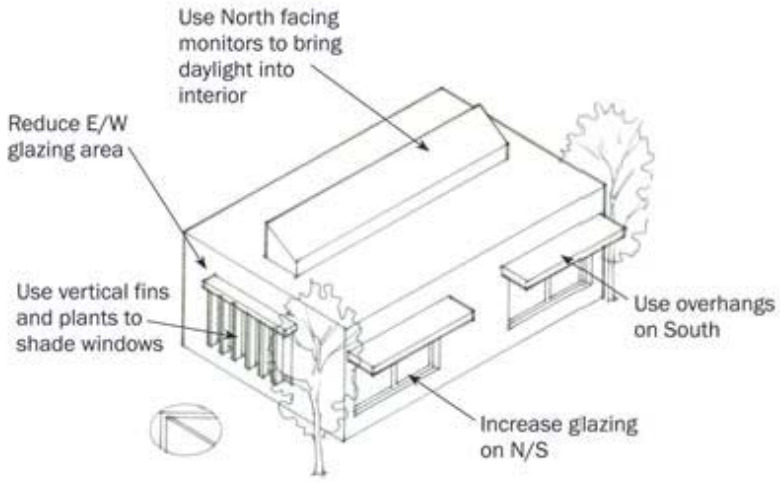


Figure 4-19. (EN27) Exterior sun control.

For north- and south- facing windows, select windows with a low solar heat gain coefficient and an appropriate visible light transmission (VLT). See EN32. Certain window coatings, called selective low-e, transmit the visible portions of the solar spectrum selectively, rejecting the nonvisible infrared sections. These glass and coating selections provide superior view and daylighting, while minimizing solar heat gain. Window manufacturers market special "solar low-e" windows for warm climates. For buildings in warm climates that do not utilize daylight-responsive lighting controls, north and south window glazing should be selected with a solar heat gain coeffi-

How Did We Get There?

- Organizational Partnership *(mentioned previously)*
- Committee Meeting Schedule
- Peer Reviews
- Development Challenges/Issues
- The Results

Committee Meeting Schedule 1st Guide

- Chairman given a year to complete project
- 12 Meetings/conference calls
- First organizational meeting October 1, 2003
- Last conference call to approve document in May, 2004
- Do the math, 8 months!

Peer Reviews

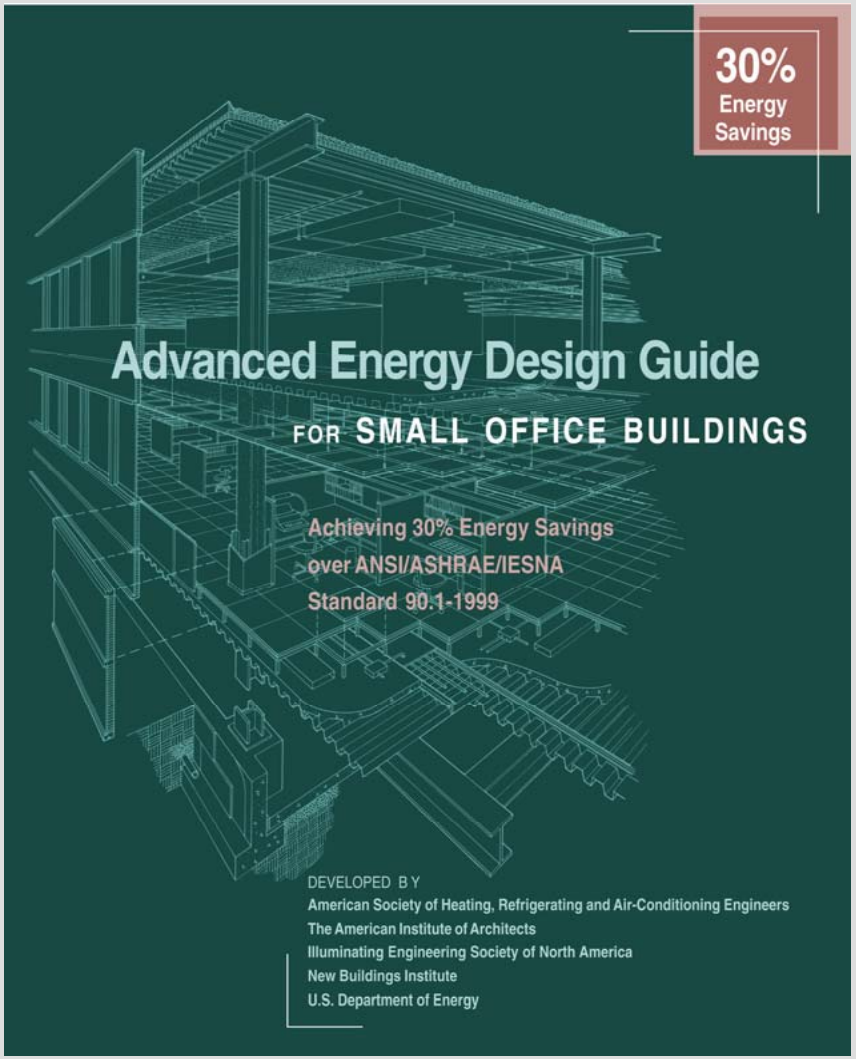
- Peer reviews provided primarily by committees or individuals from participating organizations
- Around 100 reviewers actively participated
- Concept review stage *(50% complete)*
- Technical refinement review stage *(80% complete)*
- Final review stage *(100% complete)*
- Focus group made up of target market folks also influenced final document

Development Challenges/Issues

- Keeping everyone focused through 11 meetings during the year
- Plug loads – in or out?
- Keeping criteria on single page
- Keeping document within page limit
- Keeping this “simple”
- Possible problems reaching 30% savings consistently in all locations
- Trying to work with very different styles
- Keeping all constituencies informed

The Results: Did We Do It? You Bet!

- Next up in the 30% series is K-12 schools and Warehouses
- Working on plans for 50% and 70% series guides
- AEDG Small Office qualifies for 4 energy credit points in LEED-NC Version 2.2
- Small Office guide received Alliance to Save Energy's Energy Star award and SBIC Best Practices award



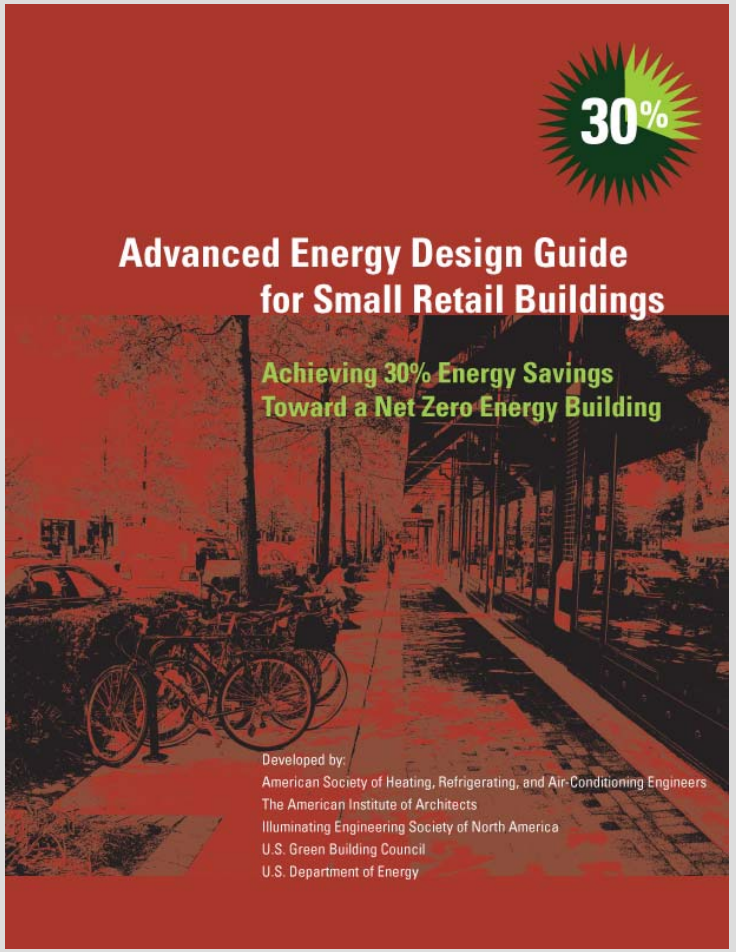
Here's What Others Have Said….

"But, the part that seems to defy the laws of nature is that a thirteen-member committee, all with 'day jobs' and representing not just ASHRAE but the DOE and three other professional organizations, came together to produce a well-designed, 96-page guide in only eight months. That is a true combination of performance and efficiency."

Robert Beverly, Engineered Systems Editor, February 2005

Just Out- AEDG for Retail!

- On sale in bookstore right now
- Similar in structure to the Office guide-
- More focus on lighting strategies
- USGBC working on credit points in LEED-NC for AEDG Small Retail



Why Should You Care About This?

Concerns over energy and sustainability will increasingly drive future building decisions.

As an HVAC&R professional you will need the tools to remain competitive and help your clients make informed, cost effective decisions.

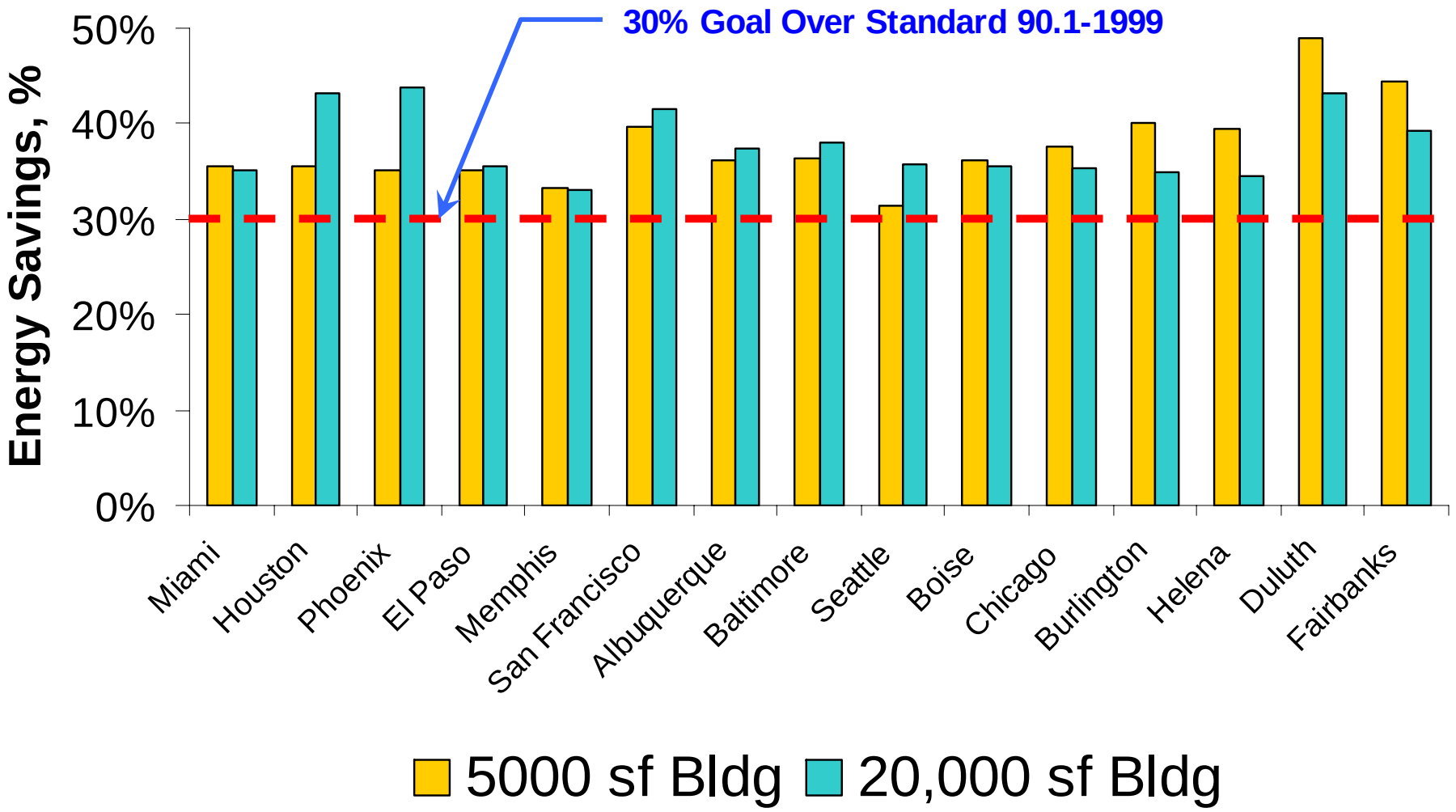
<u>This Guide will be one of those tools</u>.

How You Might Use These Guides

- Consulting Engineer
  - Demonstrate knowledge of efficient building design
  - Show the client “what it will take” without additional work
- Facility Manager
  - Demonstrate knowledge of efficient building design
  - Make effective arguments for energy efficiency to management
- Product Sales
  - Showcase your products that help meet recommendations from the guide

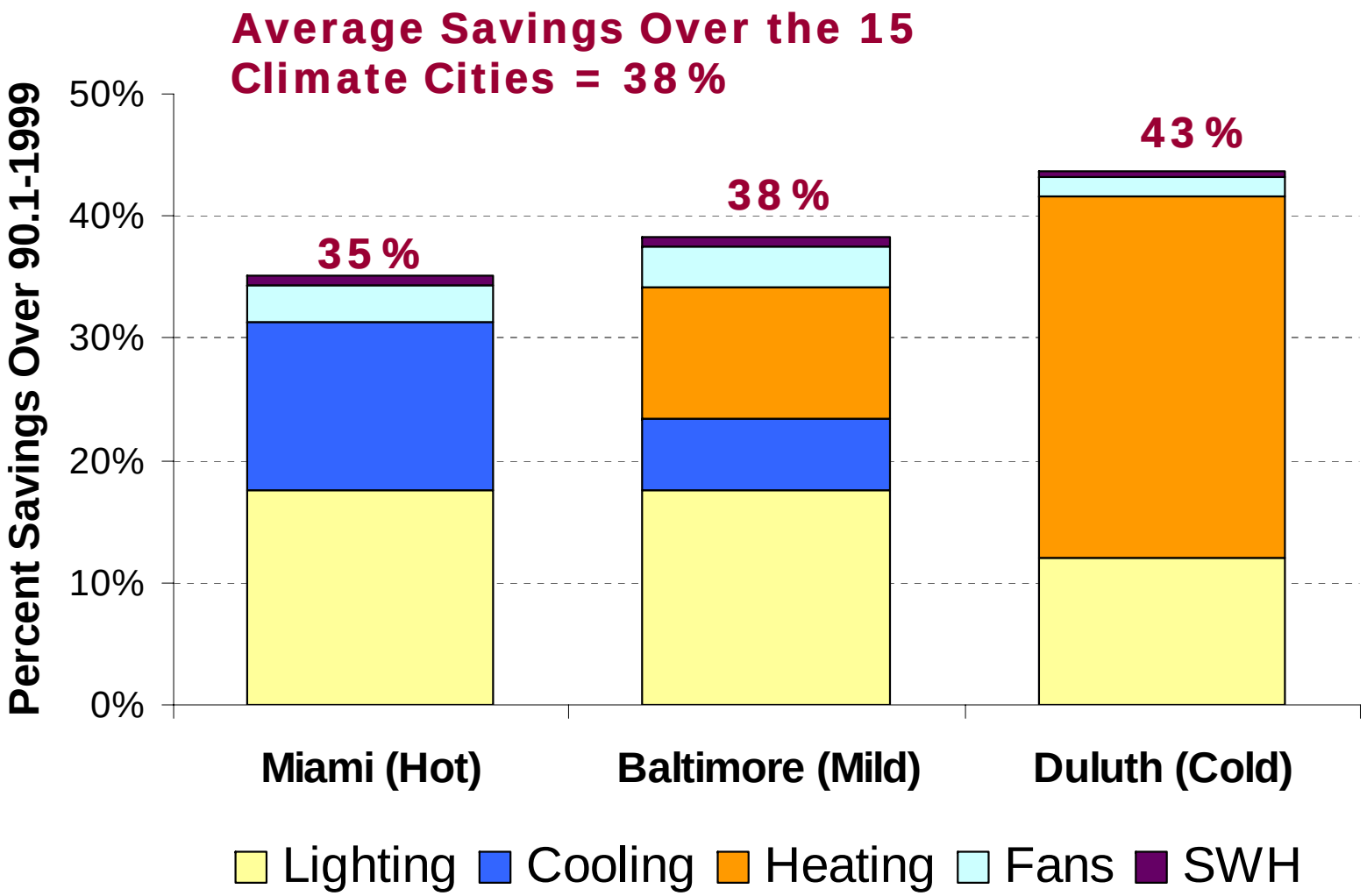
Energy Saving Impacts of AEDG

Energy Savings of Large and Small Offices



Comparison of Energy Savings

20,000 sf Office Building



Now, Surely You Must Have a Question or Two…..

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