Reducing Energy Usage by 50%

Overview of the Advanced Energy Design Guides

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Mick Schwedler, PE, LEED® AP BD+C
Manager, Trane Applications Eng.
AEDG Steering Committee Chair
ASHRAE Director-at-Large

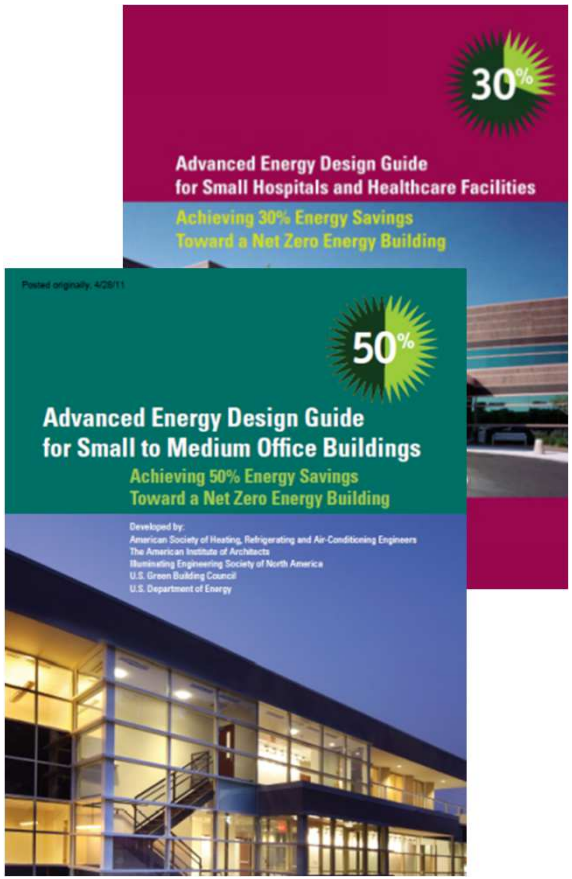
Acknowledgements

- Special thanks to….
  - Chris Wagner
  - David Terry

The AEDG Series

How do I achieve these energy savings targets (i.e., 30% or 50%) in my *real* building?

- Design and operation guidance — *not* a code or standard
- Two AEDG series:
  - 30% energy savings
  - 50% energy savings



AEDG Partnership

- Collaboration of professional organizations and DOE
- Specialized Project Committee for each guide
- Oversight is provided via AEDG Steering Committee
- Backed by DOE's national laboratory leadership, energy simulation, technical analysis and support
- Open peer review and commentary process

AEDG Document Content

AEDG presents:

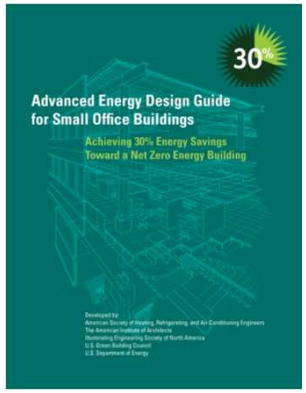
- "A Way Not The Only Way…" to achieve the desired savings.
- How to use energy modeling for design of buildings not amenable to tables.
- A prescriptive path by climate zone to achieve desired savings
- How-to tips and caveats for selected energy conservation measures

Advanced Energy Design Guides

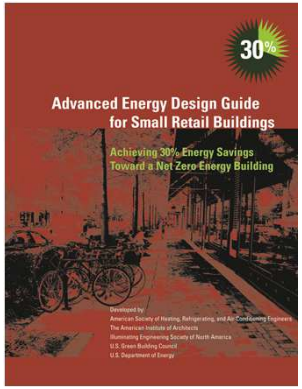
- Six 30% Guides published and available for free download
- Circulation of 30% Series Guides is 400,000+ copies
- 30% energy savings over 90.1-1999
- The 30% AEDGs help promote building energy efficiency worldwide

Free download at:

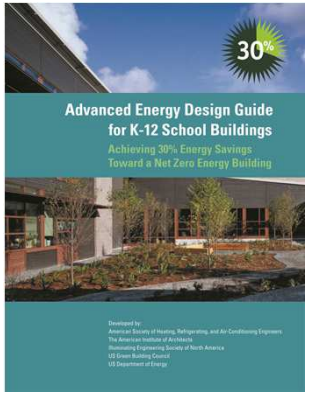
www.ashrae.org/freeaedg



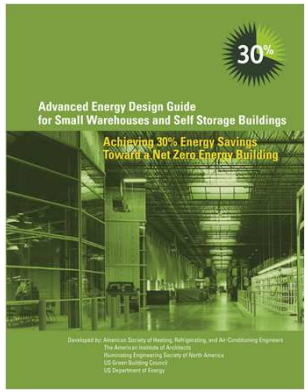
Small Office



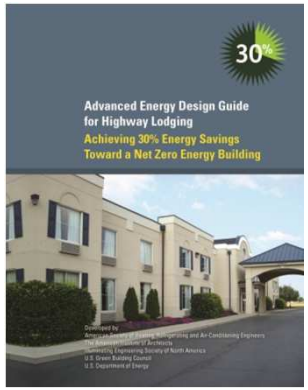
Small Retail



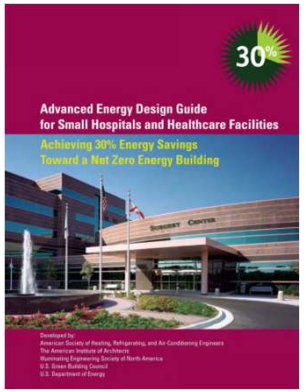
K-12 School



Warehouse



Highway Lodging



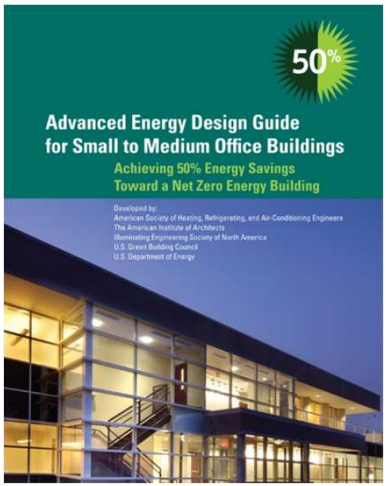
Small Hospital

Advanced Energy Design Guides

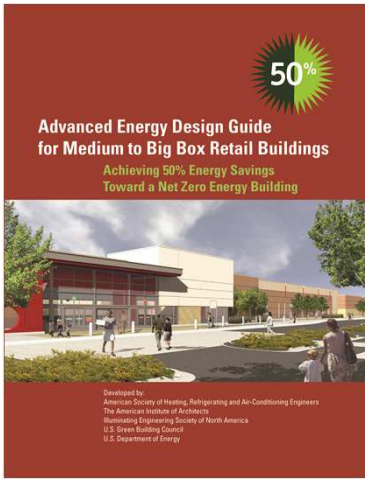
- Four 50% Guides published and available for free download
  - 50% Grocery Guide is in progress
- Circulation of 50% Series Guides is 100,000+ copies
- 50% energy savings over 90.1-2004
  - Think of the guides at 50% on the way to zero net energy

Free download at:

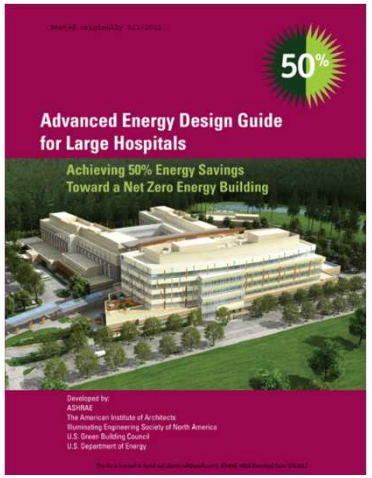
www.ashrae.org/freeaedg



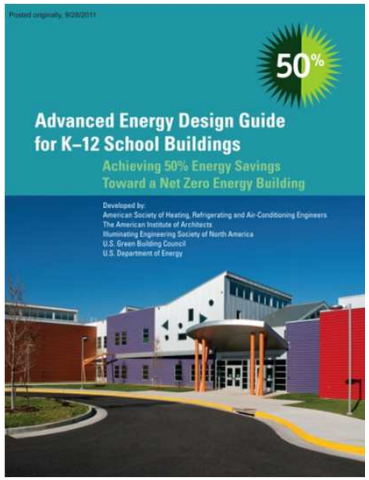
Office



Medium, Big Box Retail



Hospitals



K12 Schools

AEDG Table of Contents

Chapter – Introduction

- How to use this document

Chapter 2 – Integrated Design Process

- How the design process changes in order to achieve 50% energy savings

Chapter 3 – Integrated Design Strategies

- Overview of the technical approaches to achieving 50% savings

Chapter 4 – Design Strategies and Recommendations by Climate Zone

- Specific technical requirements to meet the 50% goal

Chapter 5 – How To Implement Recommendations

- Specific technical guidance for implementation of recommendations, including technical resources and warnings

Appendices

- Envelope Thermal Performance Factors
- International Climatic Zone Definitions
- Commissioning Information and Examples
- Early Phase Energy Balancing Calculations

Savings Opportunities Vary with Climate

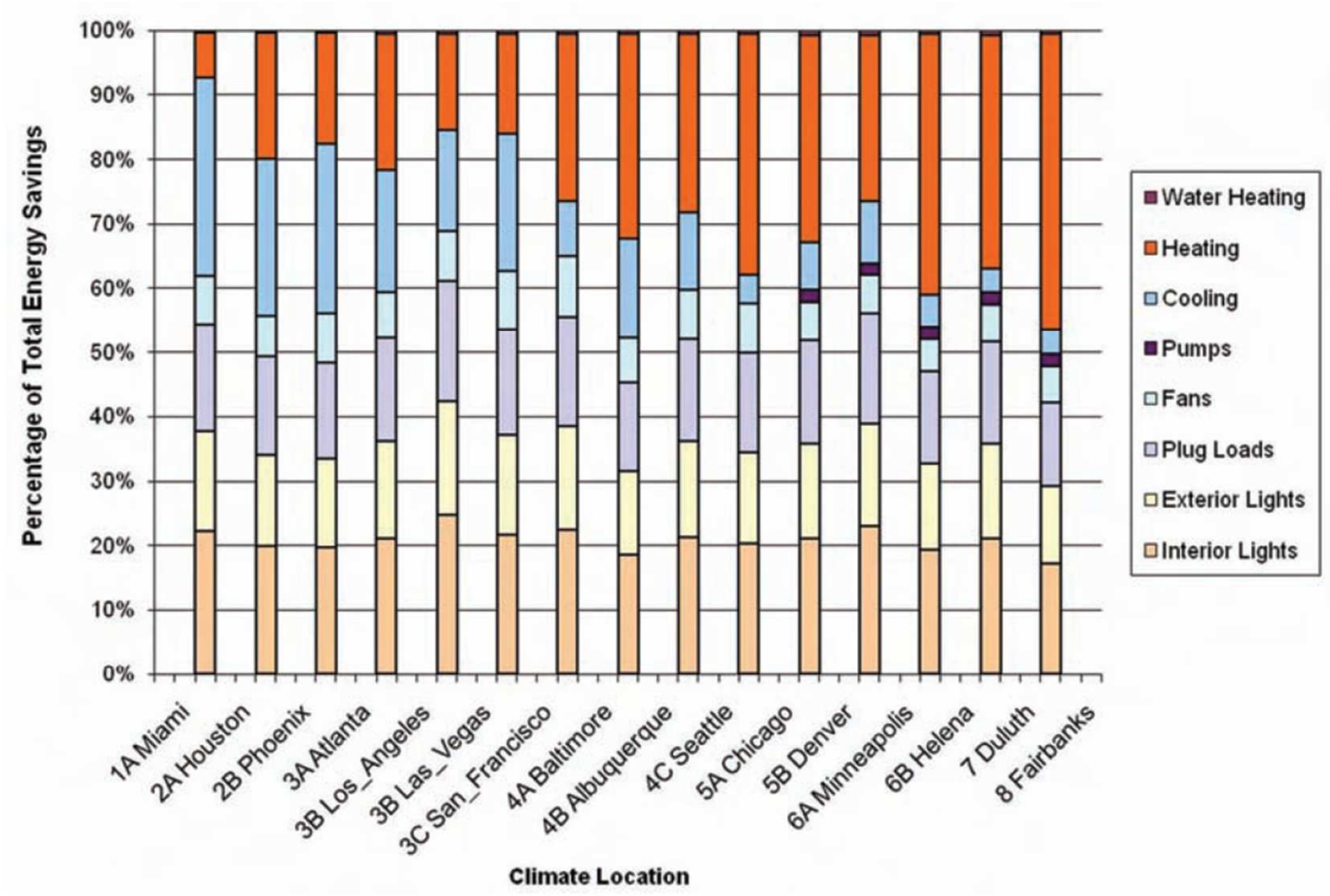
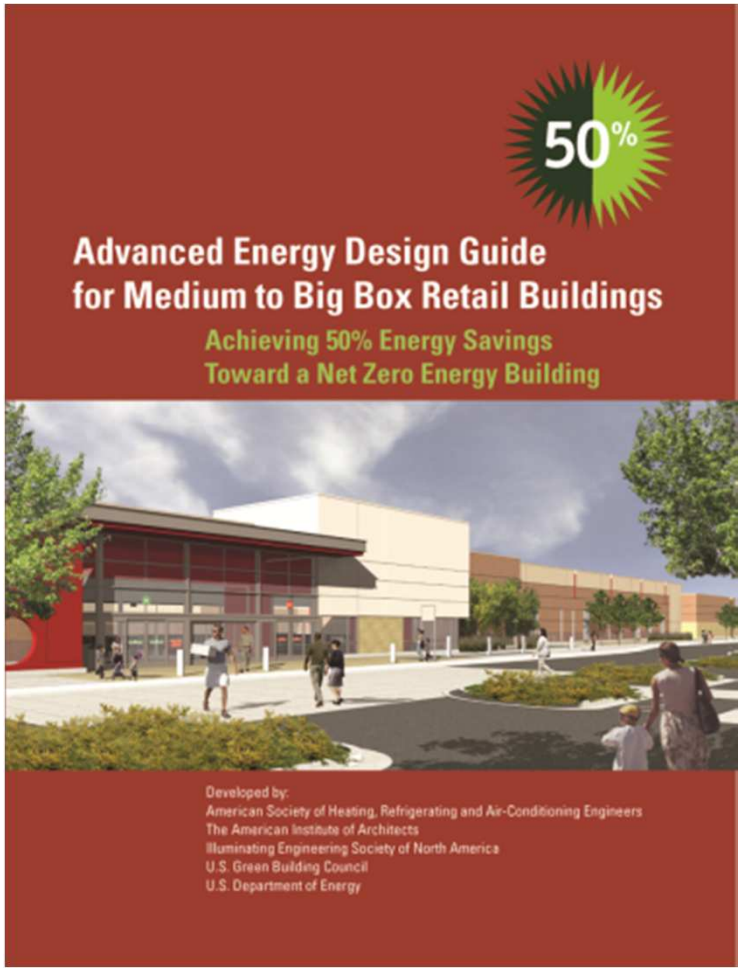


Figure 3-14 Percentage of Total Energy Savings arising from Each End-Use System
Source: Thornton et al. (2009)

Medium to Big Box Retail Buildings

- Applies primarily to retail buildings with 20,000 ft2 to 100,000 ft2 of floor area
- Many recommendations also apply to smaller and larger retail buildings
- Defines an MBR building as having the following common space types:
  - Sales areas
  - Administrative and office areas
  - Meeting and dining areas
  - Hallways and restrooms
  - Storage spaces and mechanical/electrical rooms
- Does not cover specialty items such as commercial refrigeration



Big Box Retail with Variable Air Volume

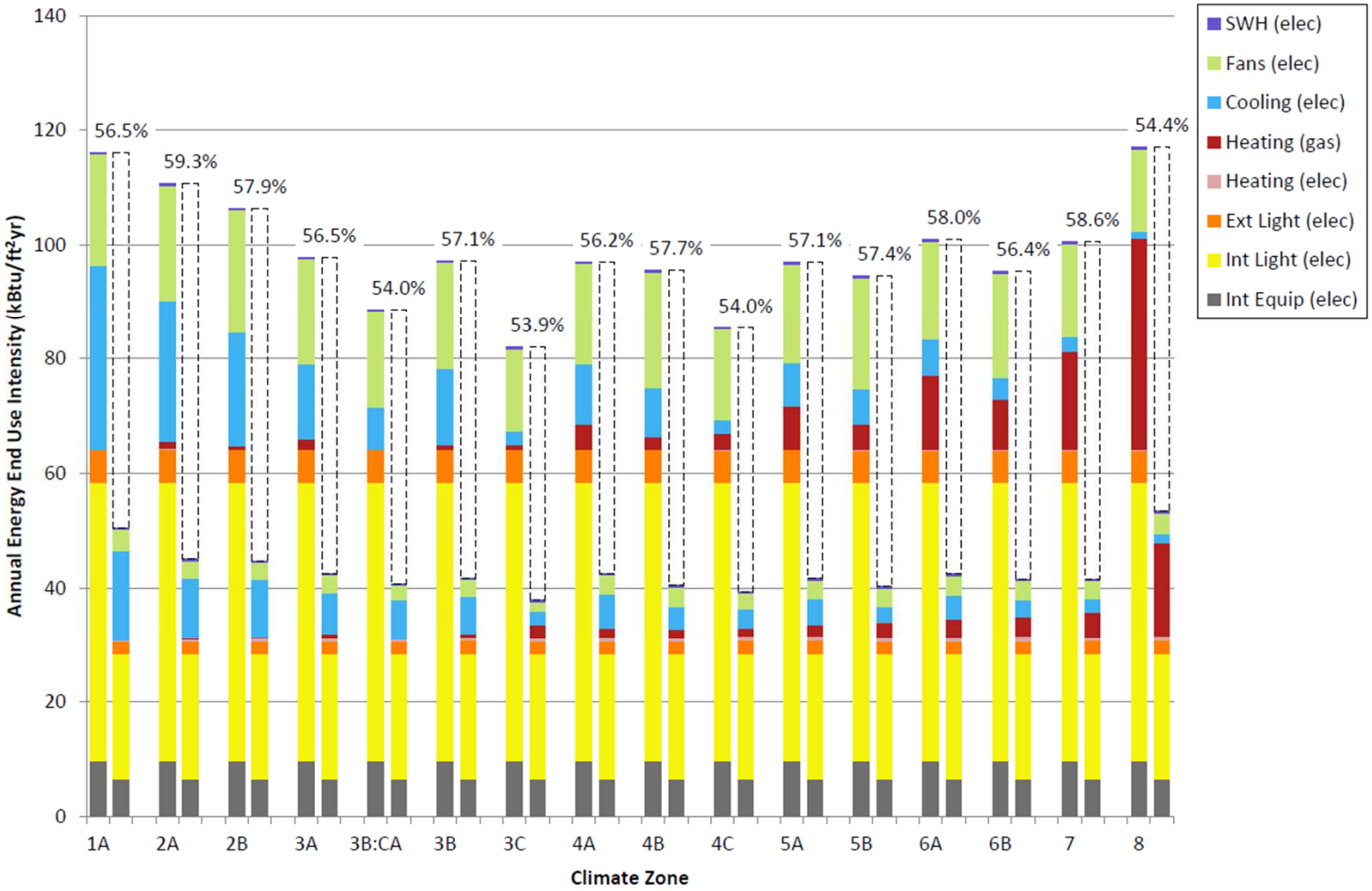
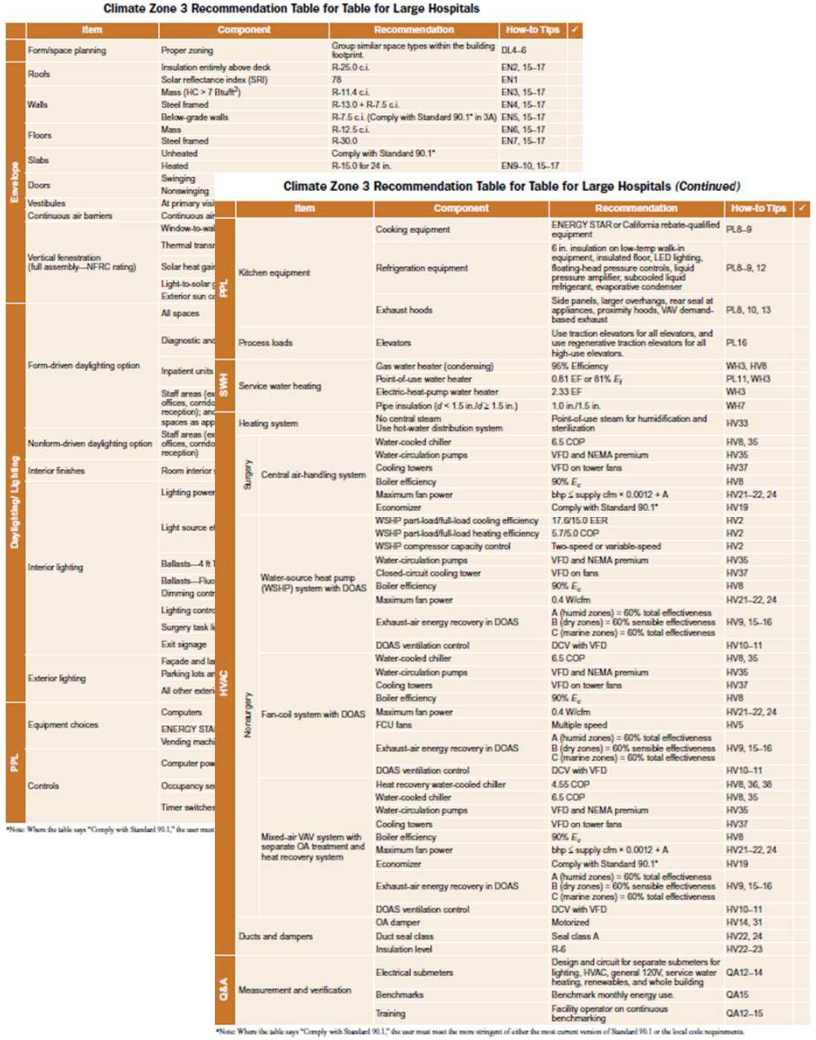


Figure 5–3 Big box VAV simulation results

Baseline and Energy Efficient Building EUI Comparison

Recommendations by Climate Zone
Each CZ table fits on two pages

- **Building envelope**
  - insulation, fenestration, leakage
- **Lighting**
  - interior, exterior, daylighting
- **HVAC**
  - design, equipment, controls
- **Plug/process loads**
  - equipment, controls, kitchens
- **Service water heating**
  - equipment, insulation
- **Measurement & verification**



Climate Zone 3 Recommendation Table for Table for Large Hospitals

	Item	Component	Recommendation	How-to Tips	✓
Envelope	Form/space planning	Proper zoning	Group similar space types within the building footprint.	DL4–6	
	Roofs	Insulation entirely above deck	R-25.0 c.i.	EN2, 15–17	
		Solar reflectance index (SRI)	78	EN1	
	Walls	Mass (HC > 7 Btu/ft²)	R-11.4 c.i.	EN3, 15–17	
		Steel framed	R-13.0 + R-7.5 c.i.	EN4, 15–17	
		Below-grade walls	R-7.5 c.i. (Comply with Standard 90.1* in 3A)	EN5, 15–17	
	Floors	Mass	R-12.5 c.i.	EN6, 15–17	
		Steel framed	R-30.0	EN7, 15–17	
	Slabs	Unheated	Comply with Standard 90.1*		
		Heated	R-15.0 for 24 in.	EN9–10, 15–17	
	Doors	Swinging			
		Nonswinging			
	Vestibules	At primary visi			
	Continuous air barriers	Continuous air			
	Vertical fenestration (full assembly—NFRC rating)	Window-to-wal			
		Thermal transr			
		Solar heat gai			
		Light-to-solar g			
		Exterior sun c			
Daylighting/ Lighting	Form-driven daylighting option	All spaces			
		Diagnostic and			
		Inpatient units			
		Staff areas (ex offices, corrido reception); and spaces as app			
	Nonform-driven daylighting option	Staff areas (ex offices, corrido reception)			
	Interior finishes	Room interior			
	Interior lighting	Lighting power			
		Light source e			
		Ballasts—4 ft t			
		Ballasts—Fluo			
		Dimming contr			
		Lighting contro			
		Surgery task li			
		Exit signage			
	Exterior lighting	Façade and la			
		Parking lots ar			
		All other exteri			
PPL	Equipment choices	Computers			
		ENERGY STA			
		Vending machi			
	Controls	Computer pow			
		Occupancy se			
		Timer switches			

*Note: Where the table says "Comply with Standard 90.1," the user must

Climate Zone 3 Recommendation Table for Table for Large Hospitals *(Continued)*

	Item		Component	Recommendation	How-to Tips	✓
PPL	Kitchen equipment		Cooking equipment	ENERGY STAR or California rebate-qualified equipment	PL8–9	
			Refrigeration equipment	6 in. insulation on low-temp walk-in equipment, insulated floor, LED lighting, floating-head pressure controls, liquid pressure amplifier, subcooled liquid refrigerant, evaporative condenser	PL8–9, 12	
			Exhaust hoods	Side panels, larger overhangs, rear seal at appliances, proximity hoods, VAV demand-based exhaust	PL8, 10, 13	
	Process loads		Elevators	Use traction elevators for all elevators, and use regenerative traction elevators for all high-use elevators.	PL16	
SWH	Service water heating		Gas water heater (condensing)	96% Efficiency	WH3, HV8	
			Point-of-use water heater	0.81 EF or 81% E_f	PL11, WH3	
			Electric-heat-pump water heater	2.33 EF	WH3	
			Pipe insulation (d < 1.5 in./d ≥ 1.5 in.)	1.0 in./1.5 in.	WH7	
HVAC	Heating system		No central steam Use hot-water distribution system	Point-of-use steam for humidification and sterilization	HV33	
	Surgery	Central air-handling system	Water-cooled chiller	6.5 COP	HV8, 35	
			Water-circulation pumps	VFD and NEMA premium	HV35	
			Cooling towers	VFD on tower fans	HV37	
			Boiler efficiency	90% E_t	HV8	
			Maximum fan power	bhp ≤ supply cfm × 0.0012 + A	HV21–22, 24	
			Economizer	Comply with Standard 90.1*	HV19	
		Water-source heat pump (WSHP) system with DOAS	WSHP part-load/full-load cooling efficiency	17.6/15.0 EER	HV2	
			WSHP part-load/full-load heating efficiency	5.7/5.0 COP	HV2	
			WSHP compressor capacity control	Two-speed or variable-speed	HV2	
			Water-circulation pumps	VFD and NEMA premium	HV35	
			Closed-circuit cooling tower	VFD on fans	HV37	
			Boiler efficiency	90% E_t	HV8	
			Maximum fan power	0.4 W/cfm	HV21–22, 24	
			Exhaust-air energy recovery in DOAS	A (humid zones) = 60% total effectiveness B (dry zones) = 60% sensible effectiveness C (marine zones) = 60% total effectiveness	HV9, 15–16	
			DOAS ventilation control	DCV with VFD	HV10–11	
	Nonsurgery	Fan-coil system with DOAS	Water-cooled chiller	6.5 COP	HV8, 35	
			Water-circulation pumps	VFD and NEMA premium	HV35	
			Cooling towers	VFD on tower fans	HV37	
			Boiler efficiency	90% E_t	HV8	
			Maximum fan power	0.4 W/cfm	HV21–22, 24	
			FCU fans	Multiple speed	HV5	
			Exhaust-air energy recovery in DOAS	A (humid zones) = 60% total effectiveness B (dry zones) = 60% sensible effectiveness C (marine zones) = 60% total effectiveness	HV9, 15–16	
			DOAS ventilation control	DCV with VFD	HV10–11	
		Mixed-air VAV system with separate OA treatment and heat recovery system	Heat recovery water-cooled chiller	4.55 COP	HV8, 36, 38	
			Water-cooled chiller	6.5 COP	HV8, 35	
			Water-circulation pumps	VFD and NEMA premium	HV35	
			Cooling towers	VFD on tower fans	HV37	
			Boiler efficiency	90% E_t	HV8	
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			DOAS ventilation control	DCV with VFD	HV10–11	
	Ducts and dampers		OA damper	Motorized	HV14, 31	
			Duct seal class	Seal class A	HV22, 24	
			Insulation level	R-6	HV22–23	
QAA	Measurement and verification		Electrical submeters	Design and circuit for separate submeters for lighting, HVAC, general 120V, service water heating, renewables, and whole building	QA12–14	
			Benchmarks	Benchmark monthly energy use.	QA15	
			Training	Facility operator on continuous benchmarking	QA12–15	

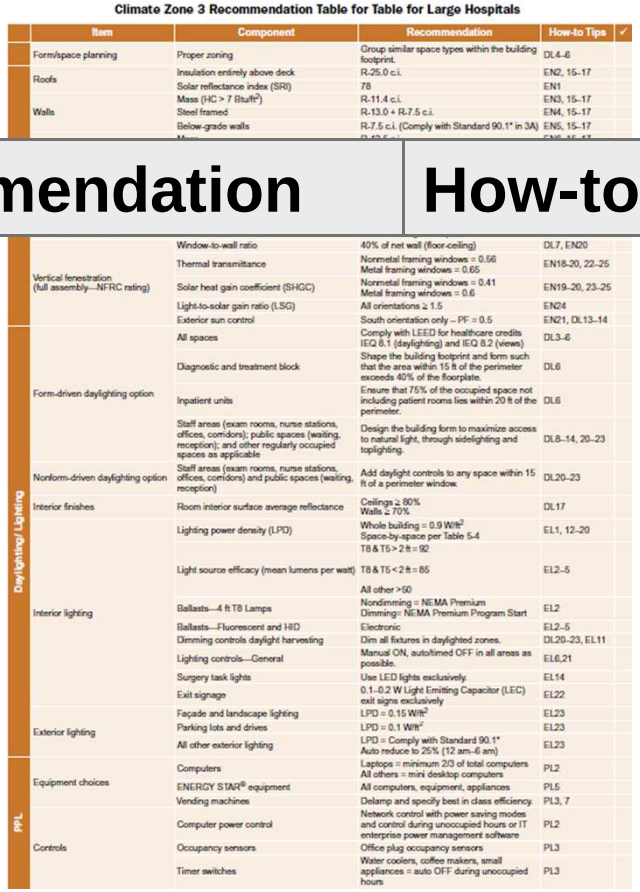
*Note: Where the table says "Comply with Standard 90.1," the user must meet the more stringent of either the most current version of Standard 90.1 or the local code requirements.

Source: 50% AEDG for Large Hospitals from ASHRAE

Recommendation Table Contents

Item	Component	Recommendation	How-to Tips

- How-to Tips contain
  - Specific recommendations
  - Guidance on good practice for implementation
  - Cautions to avoid known problems



Climate Zone 3 Recommendation Table for Table for Large Hospitals

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		Solar reflectance index (SRI)	78	EN1	
		Mass (HC > 7 Btu/ft²)	R-11.4 c.i.	EN3, 15–17	
	Walls	Steel framed	R-13.0 + R-7.5 c.i.	EN4, 15–17	
		Below-grade walls	R-7.5 c.i. (Comply with Standard 90.1* in 3A)	EN5, 15–17	
		Window-to-wall ratio	40% of net wall (floor-ceiling)	DL7, EN20	
	Vertical fenestration (full assembly—NFRC rating)	Thermal transmittance	Nonmetal framing windows = 0.56 Metal framing windows = 0.65	EN18–20, 22–25	
		Solar heat gain coefficient (SHGC)	Nonmetal framing windows = 0.41 Metal framing windows = 0.6	EN19–20, 23–25	
		Light-to-solar gain ratio (LSG)	All orientations ≥ 1.5	EN24	
		Exterior sun control	South orientation only – PF = 0.5	EN21, DL13–14	
Daylighting/Lighting	Form-driven daylighting option	All spaces	Comply with LEED for healthcare credits IEQ 8.1 (daylighting) and IEQ 8.2 (views)	DL3–6	
		Diagnostic and treatment block	Shape the building footprint and form such that the area within 15 ft of the perimeter exceeds 40% of the floorplate.	DL6	
		Inpatient units	Ensure that 75% of the occupied space not including patient rooms lies within 20 ft of the perimeter.	DL6	
		Staff areas (exam rooms, nurse stations, offices, corridors); public spaces (waiting, reception); and other regularly occupied spaces as applicable	Design the building form to maximize access to natural light, through sidelighting and toplighting.	DL8–14, 20–23	
	Nonform-driven daylighting option	Staff areas (exam rooms, nurse stations, offices, corridors) and public spaces (waiting, reception)	Add daylight controls to any space within 15 ft of a perimeter window.	DL20–23	
	Interior finishes	Room interior surface average reflectance	Ceilings ≥ 80% Walls ≥ 70%	DL17	
	Interior lighting	Lighting power density (LPD)	Whole building = 0.9 W/ft² Space-by-space per Table 5-4	EL1, 12–20	
		Light source efficacy (mean lumens per watt)	T8 & T5 > 2 ft = 92 T8 & T5 < 2 ft = 85 All other >50	EL2–5	
		Ballasts—4 ft T8 Lamps	Nondimming = NEMA Premium Dimming= NEMA Premium Program Start	EL2	
		Ballasts—Fluorescent and HID	Electronic	EL2–5	
		Dimming controls daylight harvesting	Dim all fixtures in daylighted zones.	DL20–23, EL11	
		Lighting controls—General	Manual ON, auto/timed OFF in all areas as possible.	EL6,21	
		Surgery task lights	Use LED lights exclusively.	EL14	
		Exit signage	0.1–0.2 W Light Emitting Capacitor (LEC) exit signs exclusively	EL22	
	Exterior lighting	Façade and landscape lighting	LPD = 0.15 W/ft²	EL23	
		Parking lots and drives	LPD = 0.1 W/ft²	EL23	
		All other exterior lighting	LPD = Comply with Standard 90.1* Auto reduce to 25% (12 am–6 am)	EL23	
PPL	Equipment choices	Computers	Laptops = minimum 2/3 of total computers All others = mini desktop computers	PL2	
		ENERGY STAR® equipment	All computers, equipment, appliances	PL5	
		Vending machines	Delamp and specify best in class efficiency.	PL3, 7	
		Computer power control	Network control with power saving modes and control during unoccupied hours or IT enterprise power management software	PL2	
	Controls	Occupancy sensors	Office plug occupancy sensors	PL3	
		Timer switches	Water coolers, coffee makers, small appliances = auto OFF during unoccupied hours	PL3	

Source: 50% AEDG for Large Hospitals from ASHRAE

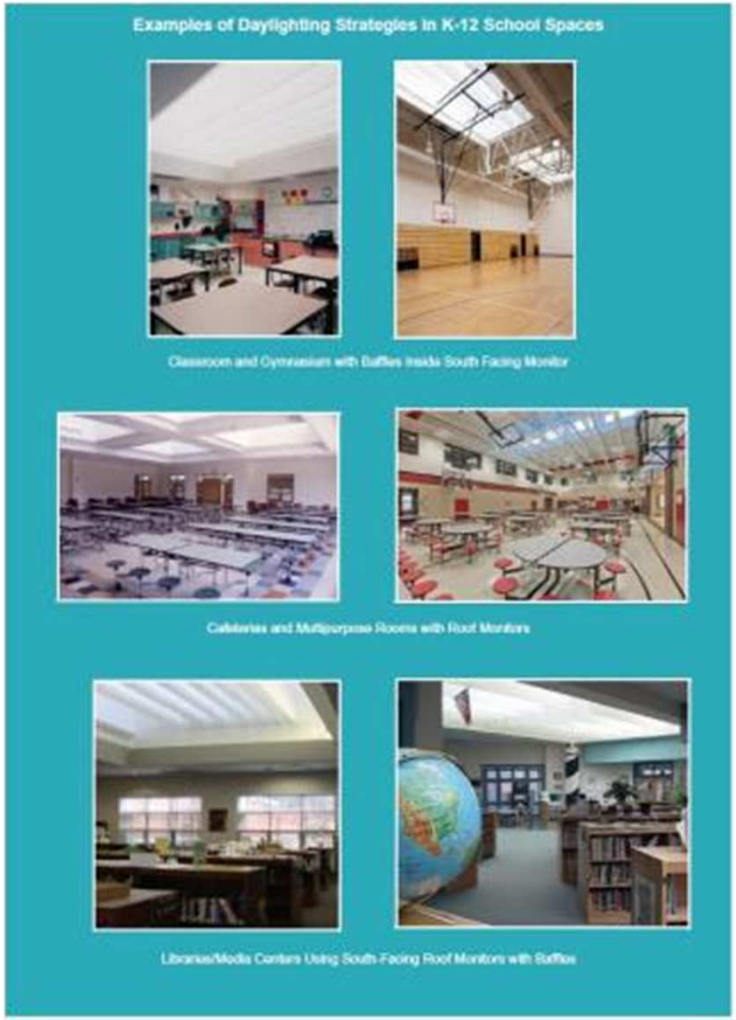
Guide Contents—Case Studies

Great River Medical Center

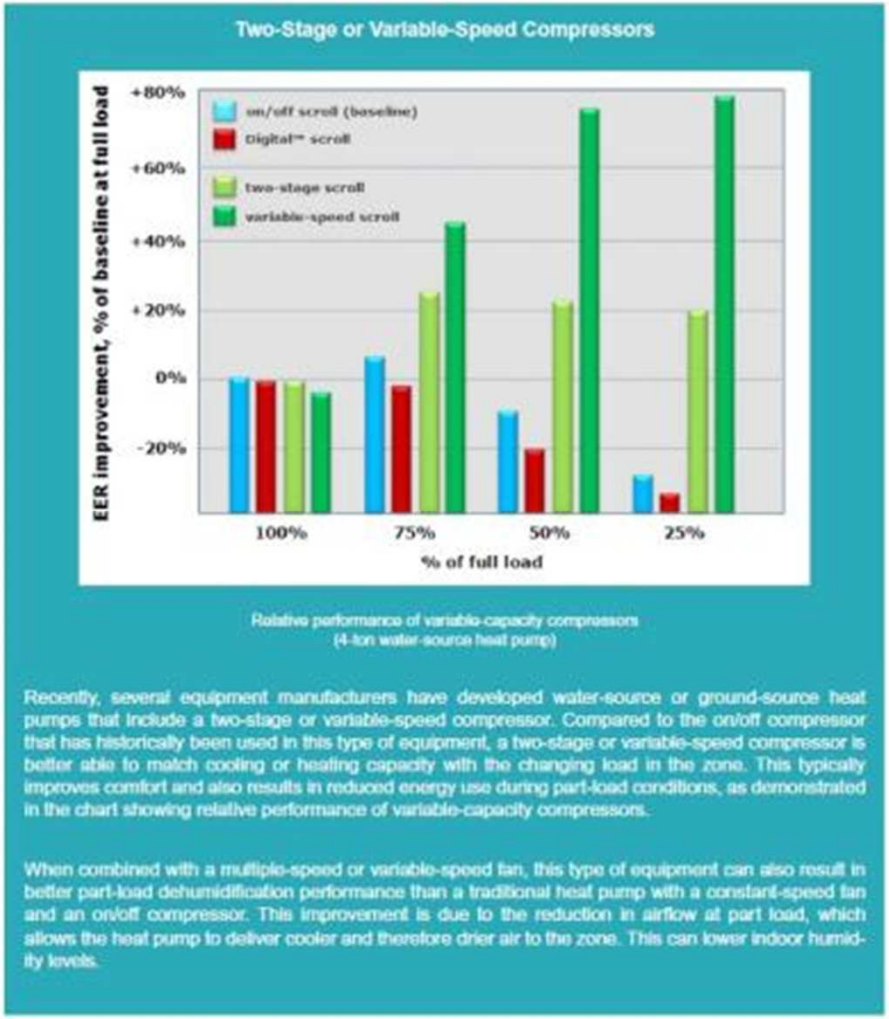
- West Burlington, Iowa
- 700,000 ft^2
- 190 inpatient beds, 8 operating rooms
- Two 99,000-ft^2 medical office buildings
- Heated and cooled with one of the largest lake-coupled geothermal systems in the United States
  - 1800 tons of cooling
  - 85-mile long piping system
  - 800 heat pumps
- 96 kBtu/ft^2·yr whole-building energy use intensity
  - Average hospital is at about 240 kBtu/ft^2·yr
- \$0.94/ft^2·yr in utility costs
  - Average hospital is at about \$2.39/ft^2·yr

Guide Contents—Technology Case Studies

- Daylighting Examples



- Variable-Speed Compressors



7. Quality Assurance How-To Tips

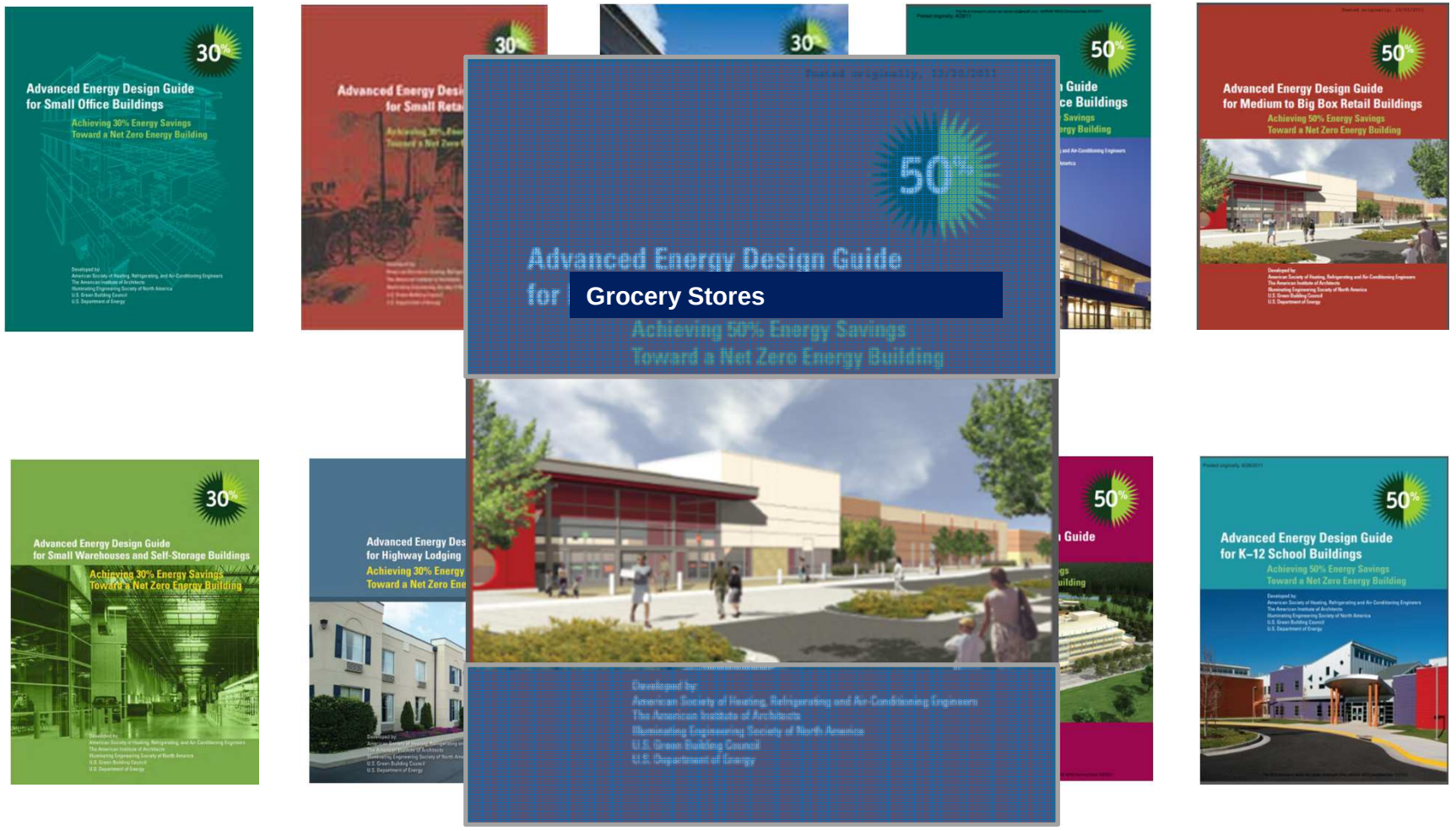
- Good Design Practice
- Commissioning
- Measurement and Verification
- Operations and Maintenance

8. Bonus Savings and Renewables How-To Tips

The below strategies are not required to achieve the performance goals of the AEDG's, but offer the opportunity for additional savings:

- Natural Ventilation
- Thermal Storage
- Cogeneration
- Evaporative Cooling
- Solar Thermal
- Photovoltaics
- Wind Energy

The ASHRAE Advanced Energy Design Guides



Advanced Energy Design Guides

- Developed by AIA, ASHRAE, IES and USGBC; and supported by the U.S. DOE
- Recommendations fit on two pages
  - Practitioners consider this a menu of vetted options
- Significant “How-to” expertise shared
- May download for free

Questions?

www.ashrae.org/freeaedg