Advanced Energy Design Guide K-12 School Buildings 50% Savings

Executive Summary Briefing

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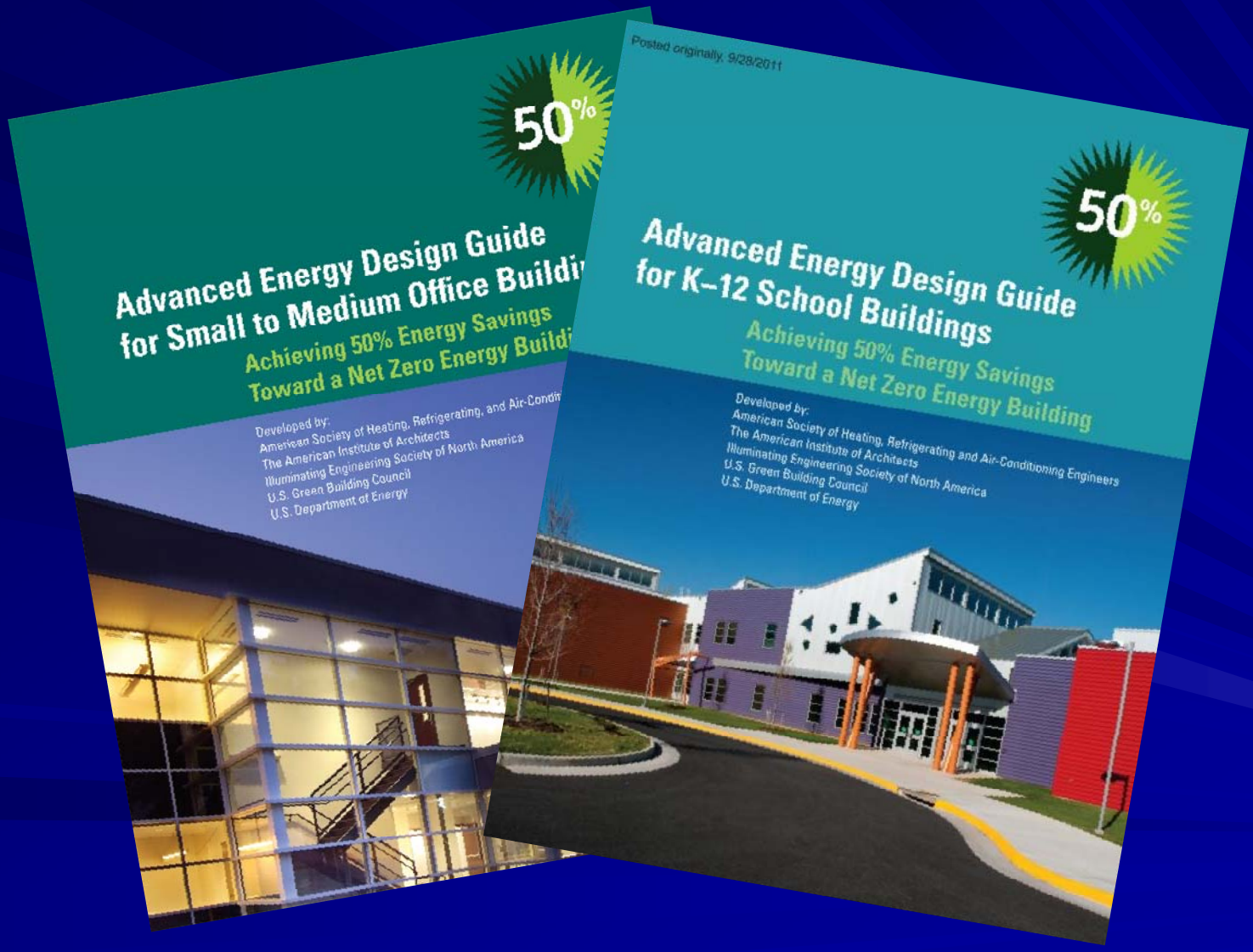
Acknowledgements

Support from DOE is greatly appreciated

AEDG K-12 School Buildings:
50% Savings
Shanti Pless, Chair

Six 30% Guides

Two 50% Guides



What are the AEDGs?

Goal

- ***A way, but not the only way*** to build energy efficient buildings that use significantly less energy than a minimum code compliant building
- At least 50% energy savings as compared to ANSI/ASHRAE/IESNA Standard 90.1-2004
- 50% progress toward a net zero energy building

Development

- Collaboration of 4 Partner Organizations
- Cooperation with & Funding from DOE
- Management via Steering Committee
- Volunteer effort (2250 - 5000 hours)
- Two Peer Reviews
- Educational Guidance – not a Standard

Development

- Target market is contractors, designers, and design/build firms – 50% guides assume higher level of modeling expertise
- Easy to use with prescriptive recommendation tables, “how-to” guidance and bonus savings – 50% Guides add “Performance” design strategies and/or energy targets
- 50% Guides have stronger emphasis on integration in design

Development

- 50% savings determined using whole building energy savings
- Energy is independent variable & cost-effectiveness is dependent variable
- TSDs include sections on cost effectiveness
- Guides recommend off-the-shelf technology – must be available from at least 2 manufacturers.

Focus

- Primarily New Construction
- Also applicable to:
  - Complete/Major Renovations
  - Building Additions
  - Remodeling/Modernization Projects
  - Systems Upgrades
- Covers Opaque Envelope, Fenestration, Daylighting, Lighting, HVAC, SWH, Plug, Kitchen Equipment, Q&A, M&V
- Includes Additional Bonus Savings

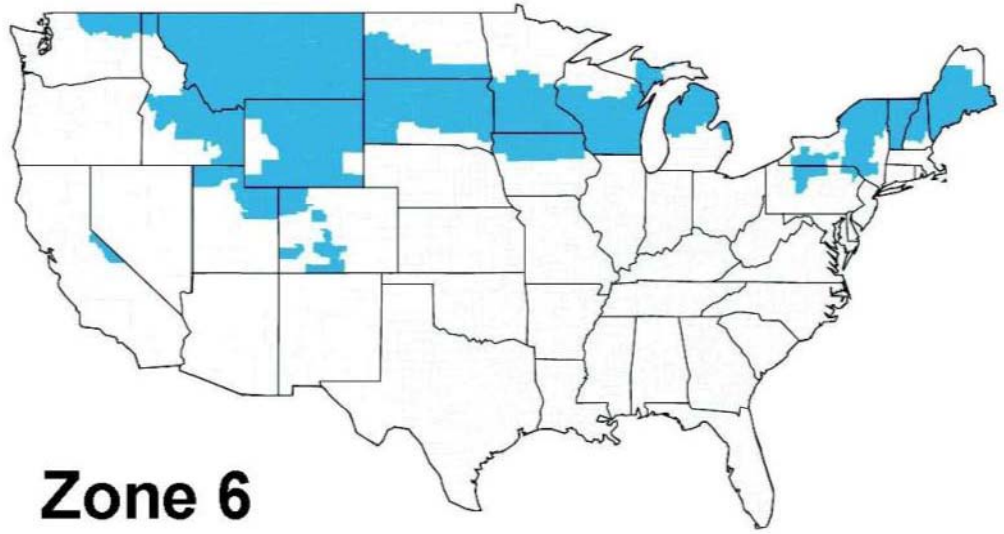
Format

- Foreword – Message to School Boards & Administrators
- Chapter 1 – Introduction
- Chapter 2 – Integrated Design Process & Best Practices
- Chapter 3 – Performance Targets & Whole Building Case Studies
- Chapter 4 – Prescriptive Recommendations by Climate Zone
- Chapter 5 - How-to Implement Recommendations with Technology Examples

Recommendations Tables

Climate Zone 6 Recommendation Table for K-12 School Buildings

	Item	Component	Recommendation	How-To Tips	✓
	Roofs	Insulation entirely above deck	R-30.0 c.i.	EN2,17,19,21,22	
		Attic and other	R-49.0	EN3,17,19,20,21	
		Metal building	R-25.0 + R-11 L_s	EN4,17,19,21,22	
		Solar Reflectance Index (SRI)	Comply with Standard 90.1*		
	Walls	Mass (HC > 7 Btu/ft^2)	R-19.5 c.i.	EN5,17,19, 21	
		Steel framed	R13.0 + R-18.8 c.i.	EN6,17,19, 21	
		Wood framed and other	R-13.0 + R-12.5 c.i.	EN7,17,19, 21	
		Metal building	R-0.0 + R-19.0 c.i.	EN8,17,19, 21	
		Below grade walls	R-10.0 c.i.	EN9,17,19, 21,22	
		Mass	R-16.7 c.i.	EN10,17,19, 21	
	Floors	Steel framed	R-38.0	EN11,17,19, 21	
			R-38.0	EN11,17,19, 21	
			R-10 for 24 in.	EN12,14,17,19, 21, 22	
			R-20 for 48 in.	EN13,14,17,19, 21,22	
			U-0.50	EN15,17	
			U-0.50	EN16,17	
			Yes	EN17,18	
			Nonmetal framing = U-0.35 Metal framing = U-0.42	EN24	
			E or W orientation = 5% maximum N or S orientation = 7% maximum	EN24–25	
			E or W orientation = 0.42 N orientation = 0.62 S orientation = 0.75	EN24,32–33	
			S orientation only = PF-0.5	EN26,33	
			See Table 5-5 for appropriate VT value	DL1,5–6,23	
			S orientation = no glare during school hours	DL1,9,12,13,31	
			Daylight 100% of floor area for 2/3 of school hours	DL1–5,7–21, 24–30,32–41	
			Daylight perimeter floor area (15 ft) for 2/3 of school hours	DL1–5,8–12	
			Ceilings = 80% Wall surfaces = 70%	DL14	
			Whole building = 0.70 W/ft^2 Gyms, multipurpose rooms = 1.0 W/ft^2 Classrooms, art rooms, kitchens, libraries, media centers= 0.8 W/ft^2 Cafeterias, lobbies = 0.7 W/ft^2 Offices = 0.60 W/ft^2 Auditoriums, restrooms = 0.5 W/ft^2 Corridors, mechanical rooms = 0.4 W/ft^2	EL12–19	
Lighting/Lighting	Interior Lighting	Light source lamp efficacy (mean lumens per watt)	T8 & T5 > 2 ft = 92, T8 & T5 ≤ 2 ft = 85, All other > 50	EL4–6	
		T8 ballasts	Non-dimming = NEMA Premium Instant Start Dimming= NEMA Premium Program Start	EL4–6	



Case Studies

GREENSBURG K-12 SCHOOL

Greensburg K-12, a 120,000 ft^2, two-story facility located in Greensburg, KS, accommodates 375 students from pre-kindergarten through high school. The campus includes a library, a cafeteria, a kitchen, science labs, two gymnasiums, an art/music wing, courtyards, playgrounds, and a football stadium. After 95% of the town was destroyed by an EF5 tornado in May of 2007, the school was rebuilt as part of Greensburg's plan for a model "eco-community." Ground was broken on the facility in October of 2008, and the school's grand opening was held in August of 2010.

Designed to achieve the U.S. Green Building Council's LEED for Schools Platinum designation, Greensburg K-12 anticipates a 60% energy-use cost savings. Energy analysis modeling of this school versus an ASHRAE/IESNA Standard 90.1-compliant building of the same size and shape indicates a reduction of more than 50% before adding engines gained from the 50 kW

Examples of High Performance Buildings – Demonstrates Flexibility in Achieving Advanced Energy Savings

mer solar gains and allow winter passive solar tempering for more energy efficiency.

Lighting

The school was built facing east-west to make use of abundant daylight from north and south for both lighting and winter heating. Daylighting is used in all regularly occupied spaces:

- The classrooms and hallways are naturally lit to diminish the need for electric lighting and to improve student performance.
- Electronic timer light switches, indoor occupancy switches, and photoelectric switches are used to manage lighting levels and power usage.

Greensburg School Building Exterior

Source: Lynn Billman (courtesy of DOE/NREL)

- Skylights are used to reduce the use of electricity during daylight hours and to provide plenty of light to corridors and other common areas.

HVAC

Heating and cooling are supplied by a hybrid closed-loop GSHP system, combined with a fluid cooler, through almost one hundred 410 ft deep vertical wells. A sensor-controlled outdoor air system lets in outdoor air as needed. The heating and hot-water system are electric to best utilize both the on-site wind turbine as well as the abundant energy produced by the Greensburg wind farm. Carbon dioxide sensors control a dedicated outdoor air system with energy recovery ventilators to provide outdoor air ventilation as needed. All classrooms and most of the offices have operable windows in order to allow natural ventilation.

Other Sustainable Features

- Operable windows provide natural ventilation in classrooms, offices, and other spaces.
- An on-site wind generator provides 50 kW of power that supplements the 12.5 MW generated from the community wind farm.
- Rainwater is captured and stored, and bioswales are used to filter parking lot runoff. Waterless urinals and low-flow fixtures, faucets, and toilets minimize water usage.

(Right) Interior Hallway and (Left) Daylighted Classroom

Source: McClowGordon Construction (courtesy of DOE/NREL)

Pump for Closed Loop Hybrid Heat Pump System

Source: Greensburg GreenTown (courtesy of DOE/NREL)

Technology Examples

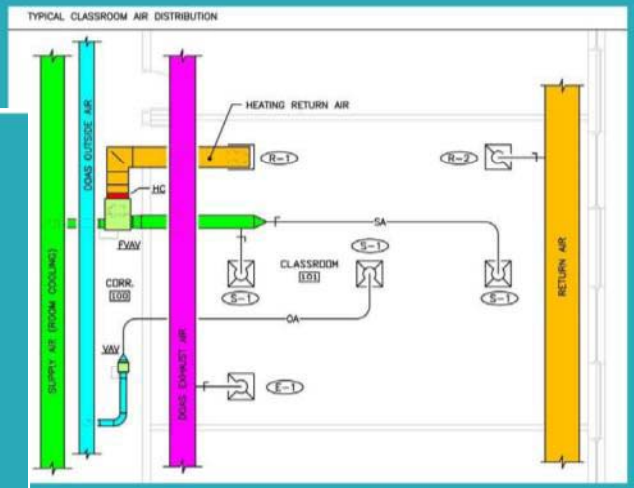
Examples of technologies recommended in the guide

Compatibility between Daylighting and Audiovisual Projection

Daylighted Classroom with Audio-Visual in Use

It is possible to allow full daylighting in the main seating area of the classroom while still retaining a darker light level at the projection screen and/or TV monitor locations. One approach is to design the space to intentionally darken the screen area without affecting the rest of the classroom. Locating television screens in a corner away from windows will minimize glare on the screen.

Variable-Air-Volume/Dedicated Outdoor Air System



Typical Classroom Air Distribution

hool, a 130,000 ft^2 facility completed in 2007, utilizes variable-air-volume (VAV) air-led with a dedicated outside air system (DOAS) similar to the system described in

had traditionally used standard, mixed-air VAV systems. The VAV/DOAS approach minate reheat energy and provide better control of outdoor air throughout the build-rovided with a parallel, fan-powered VAV terminal with a hot-water coil on the return nding unit (AHU) supplies air to the inlet air damper of each VAV box at a cold tem-ooling purposes. If room heating is required, the inlet damper closes, and the room t-water coil in the VAV box, which eliminates reheat of supply air. The DOAS unit parate shut-off VAV box for distribution of air directly to the room. It is supplied at es—colder in the summer months and neutral in the winter months. The DOAS var-m occupancy sensors and time of day schedules to vary the outdoor airflow deliv-ered to each room.

How-to Tips

Climate Zones Specified

Tables of Information

Table 5-9 System Efficacy for Metal Halide Lam

Lamp	Magnetic Ballast	Electr Sc
35/39 W CMH	43	
50 W QMH	33	
70 W CMH	45	
100 W CMH	51	
150 W CMH	59	
175 W QMH	62	
400 W QMH	71	
400 W CMH	72	

Does not meet efficacy criteria

Meets 50 MLPW efficac and special lighting

EN28 ***Building Form and Window Orientation*** (Climate Zones: ❶ ❷ ❸ ❹)

In warm climates, north- and south-facing glass can be more easily shielded and can result in less solar heat gain and glare than do east- and west-facing glass. During site selection, preference should be given to sites that permit elongating the building in the east-west direction and that permit orienting more windows to the north and south. A good design strategy avoids areas of glass that do not contribute to the view from the building or to the daylighting of the space. If possible, configure the building to optimize north- and south-facing walls and glass by elongating the floor plan on an east-west axis. Since sun control devices are less effective on the east and west facades, the solar penetration through the east- and west-facing glazing should be minimized. This can be done by reducing the area of glazing or, if the glass is needed for view or egress, by reducing the SHGC. For buildings where a predominantly east-west exposure is unavoidable, more aggressive energy conservation measures will be required in other building components to achieve an overall 50% energy savings.

EN29 ***Glazing*** (Climate Zones: ❶ ❷ ❸ ❹)

For north- and south-facing windows, select windows with a low SHGC and an appropriate VT (see EN24). 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 can provide a balance between VT and solar heat gain. Window manufacturers market special "solar low-e" windows for warm climates. For buildings in warm climates that do not use a daylight design, north and south view windows should be limited to values no higher than

warm climates should be
fenestration assembly, in
ass values. For warm cli-
the window assembly U-
of-glass U-factor because

ASHRAE/IES Standard 90.1-2010 Occupancy Sensor Requirements

Occupancy sensors are required in Standard 90.1-2010 in the following spaces:

- Classrooms, conference rooms, meeting rooms, and training rooms, employee lunch and break rooms, storage and supply rooms between 50 ft^2 and 1000 ft^2, rooms used for document copying and printing, office spaces up to 250 ft^2, restrooms, and dressing/locker rooms

Standard 90.1-2010 requires that occupancy sensors shall either be manual ON or shall be controlled to automatically turn the lighting on to not more than 50% power, except in public corridors and stairwells, restrooms, primary building entrance areas and lobbies, and areas where manual ON operation would endanger the safety or security of the room or building occupant(s) where full automatic ON is allowed.

Highlighted Information

How-to Tips

Illustrations of Concepts

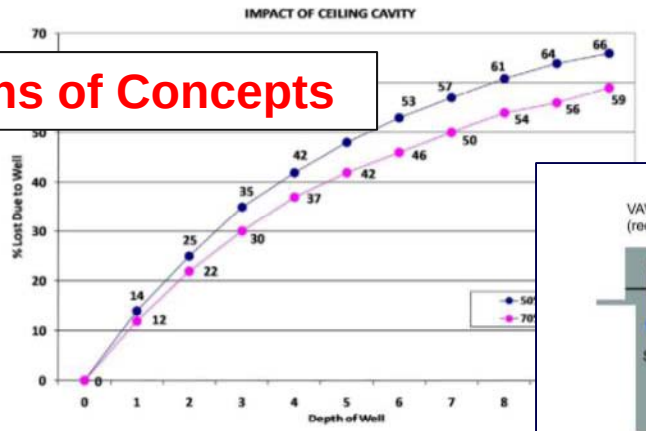


Figure 5-13 (DL37) Impact of Ceiling Cavity with 50% and 70% R

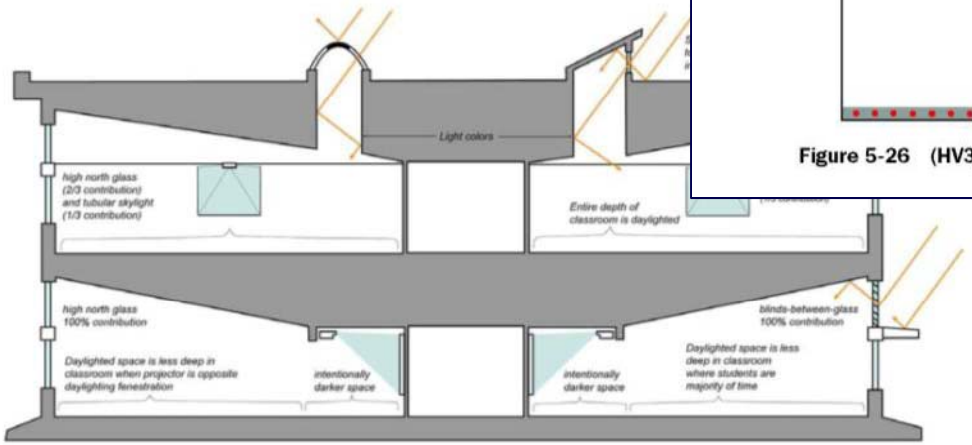


Figure 5-14 (DL 35) Sidelighting Enhanced with Toplighted Skylights or Roof Monitors

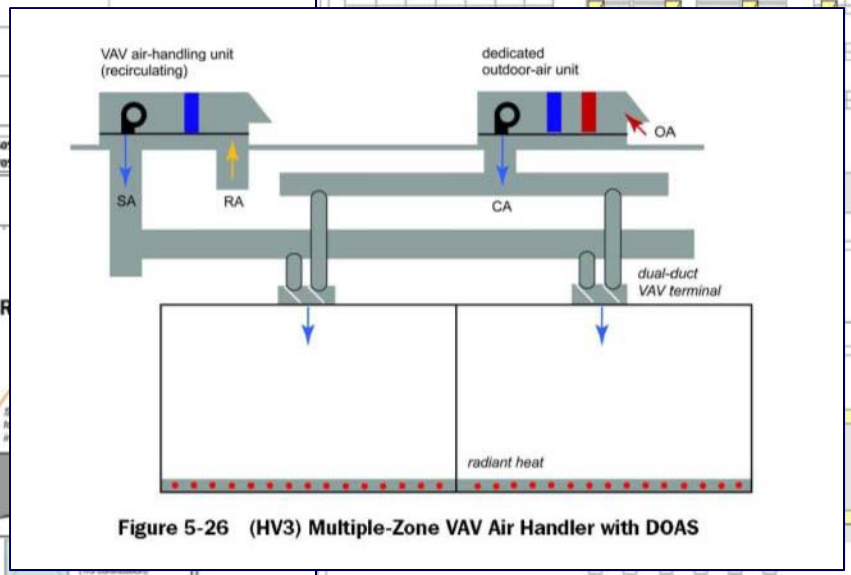


Figure 5-26 (HV3) Multiple-Zone VAV Air Handler with DOAS

(b)

AEDG for K-12 School Buildings: 50% Savings

Project Committee

- Shanti Pless (Chair)
- Merle McBride (Vice Chair)
- Mike Nicklas (AIA)
- John Murphy (ASHRAE)
- Craig Kohring & Chad McSpadden (IES)
- Ozgem Ornektekin & Bob Kobet (USGBC)
- Pete Jefferson & Mark Ryles (At-Large)
- Eric Bonnema and Matt Leach (NREL)

Scope

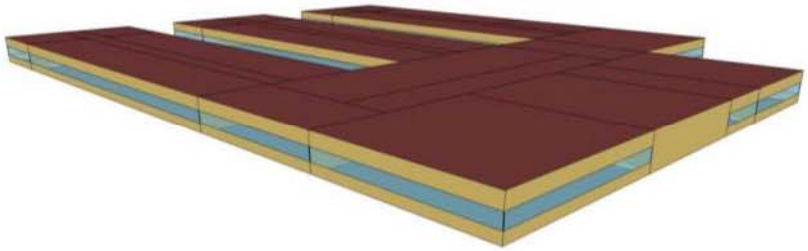
- All sizes of Elementary, Middle, High schools
- Space Types: Administrative, office, classroom, hallway, restroom, gymnasium,, assembly space, library, food prep, and dining.
- Excludes atypical spaces such as indoor swimming pools, wet labs, dirty dry labs, and spaces with extraordinary heat or pollution generation.

Analytical Approach

- Two representative prototypes
- Recommendations for all 8 DOE CZ plus moist/dry for 16 total locations.
- Multiple HVAC Systems modeled: VAV/DOAS, FCU/DOAS, & GSHP/DOAS
- Energy Savings:
  - 51-65% relative to 90.1-2004
  - 47% relative to 90.1-2007
  - 28% relative to 90.1-2010
  - 55% relative to 90.1-1999

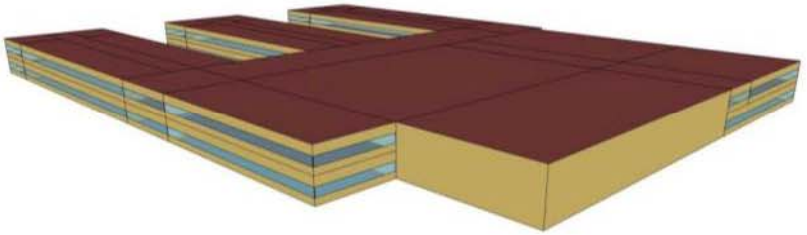
Baseline Prototype Characteristics

Primary School



Size	73,932 ft^2
Number of floors	1
Number of students	650
Window-to-wall ratio	35%
Wall construction	Mass
Roof construction	IEAD

Secondary School



Square footage	210,810 ft^2
Number of floors	2
Number of students	1200
Window-to-wall ratio	35%
Wall construction	Mass
Roof construction	IEAD

Baseline Prototype HVAC System Details

VAV Systems

- Heating plant
  - 80% efficient natural gas fired boiler
  - 60 ft w.c. 80% efficient pump
- Cooling plant
  - Primary school: None
  - Secondary school: 2.8 COP air-cooled chiller
  - 75 ft w.c. 80% efficient pump
- Air handler
  - Primary school: 25% efficient variable speed fan
  - Secondary school: 40% efficient variable speed fan
  - 80% efficient fan motor
  - 4.5 in w.c. system pressure drop
  - Hot water preheat coil
  - Primary school: 3.2 COP DX cooling coil
  - Secondary school: chilled water cooling coil
  - 55°F deck temperature
  - Differential enthalpy economizer (no economizer in climate zone 1A, 2A, 3A, 4A)
- Terminal units
  - Hot water reheat coils
  - 0.3 minimum flow fraction

PSZ Systems

Characteristic	Value
Heating type	Gas
Heating efficiency	80%
Cooling type	DX
DX COP	3.5
Fan type	CAV
Fan efficiency	30%
Fan pressure drop (in w.c.)	1.5
Economizer	Y*

*No economizer in 1A, 2A, 3A, 4A

Daylight Modeling Details

- Model Assumptions:
  - Target daylight illuminance: 50fc
  - Lighting Control: continuous dimming (10-100%), closed loop
  - Calculation grid:
    - 30" AFF
    - 2' on-center spacing
    - 2' wall offset
  - Daylight apertures only (no or opaque view windows)
  - Full direct solar control assumed
  - Daylight to floor area ratio based on model; within range for most climate zones
  - Material properties:
    - Ceilings: 90% Reflectance
    - Walls: 60% Reflectance
    - Floors: 35% Reflectance
    - Glazing: 80% Transmittance
- Nicklas models were used
  - South-facing Classroom
  - North-facing Classroom
  - Gymnasium w/ South-facing Roof Monitors
  - Cafeteria w/ South-facing Roof Monitors
  - Typical Office (South-facing)
- Single FFR, representative of most climate zones
- Annual simulations with Radiance (DAYSIM)
- Daylight illuminance averaged, blended with dimming setpoint (50fc) and occupancy schedule
- LPD schedule generated for each space for EnergyPlus

VAV/DOAS System Details

VAV/DOAS System

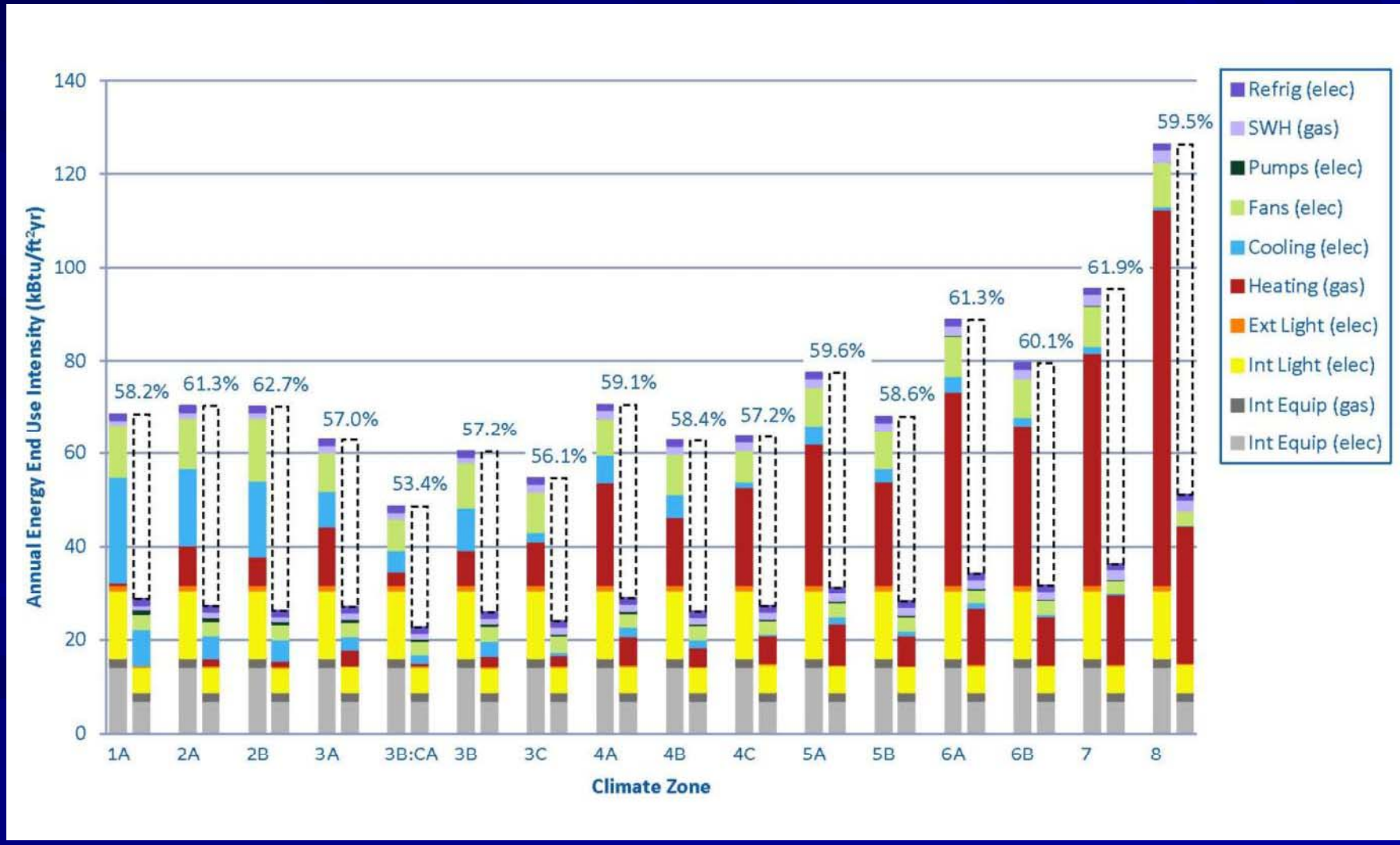
- Heating plant
  - 90% efficient natural gas fired boiler
  - 40 ft w.c. 90% efficient pump
- Cooling plant
  - 2.93 COP air-cooled chiller
  - 50 ft w.c. 90% efficient pump
- Cold deck
  - 69% efficient variable speed fan
  - 90% efficient fan motor
  - 4.5 in w.c. system pressure drop
  - Chilled water cooling coil
  - Neutral supply air temperature
- DOAS deck
  - 69% efficient fan
  - 90% efficient fan motor
  - 4.5 in w.c. system pressure drop
  - 75% sensible, 69% latent effectiveness ERV
  - Chilled water cooling coil
  - Hot water heating coil
  - Demand controlled ventilation
- Hot water baseboard heating

PSZ Systems

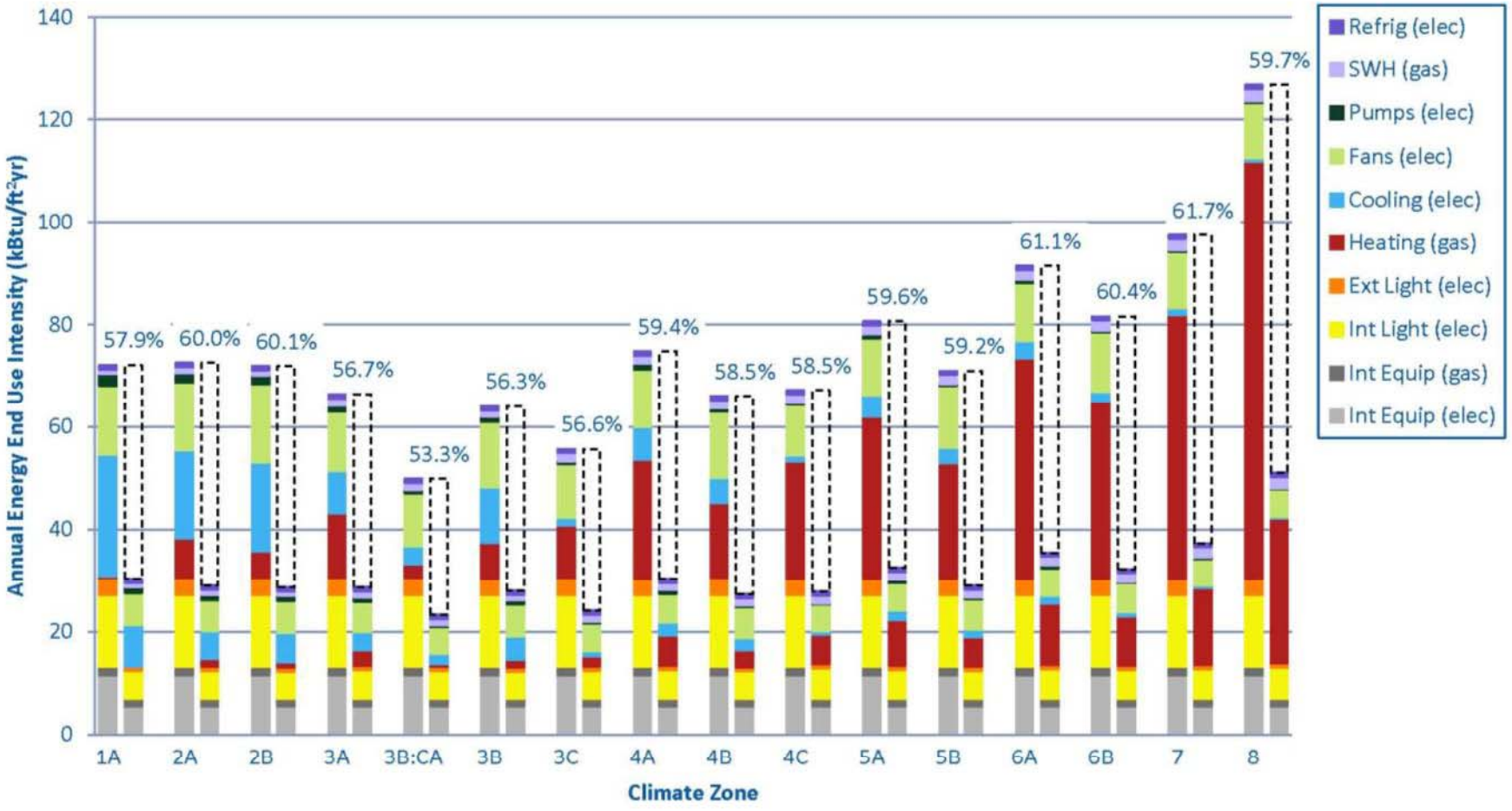
Characteristic	Value
Heating type	Gas
Heating efficiency	80%
Cooling type	DX
DX COP	4.0
Fan type	CAV
Fan efficiency	60%
Fan pressure drop (in w.c.)	1.0
Economizer	Y*
ERV sensible effectiveness	75%
ERV latent effectiveness	69%
ERV pressure drop (in w.c.)	0.5
DCV	Y

*No economizer in 1A, 2A, 3A, 4A

VAV/DOAS System Results
Primary School



VAV/DOAS System Results Secondary School



FCU/DOAS System Details

FCU/DOAS System

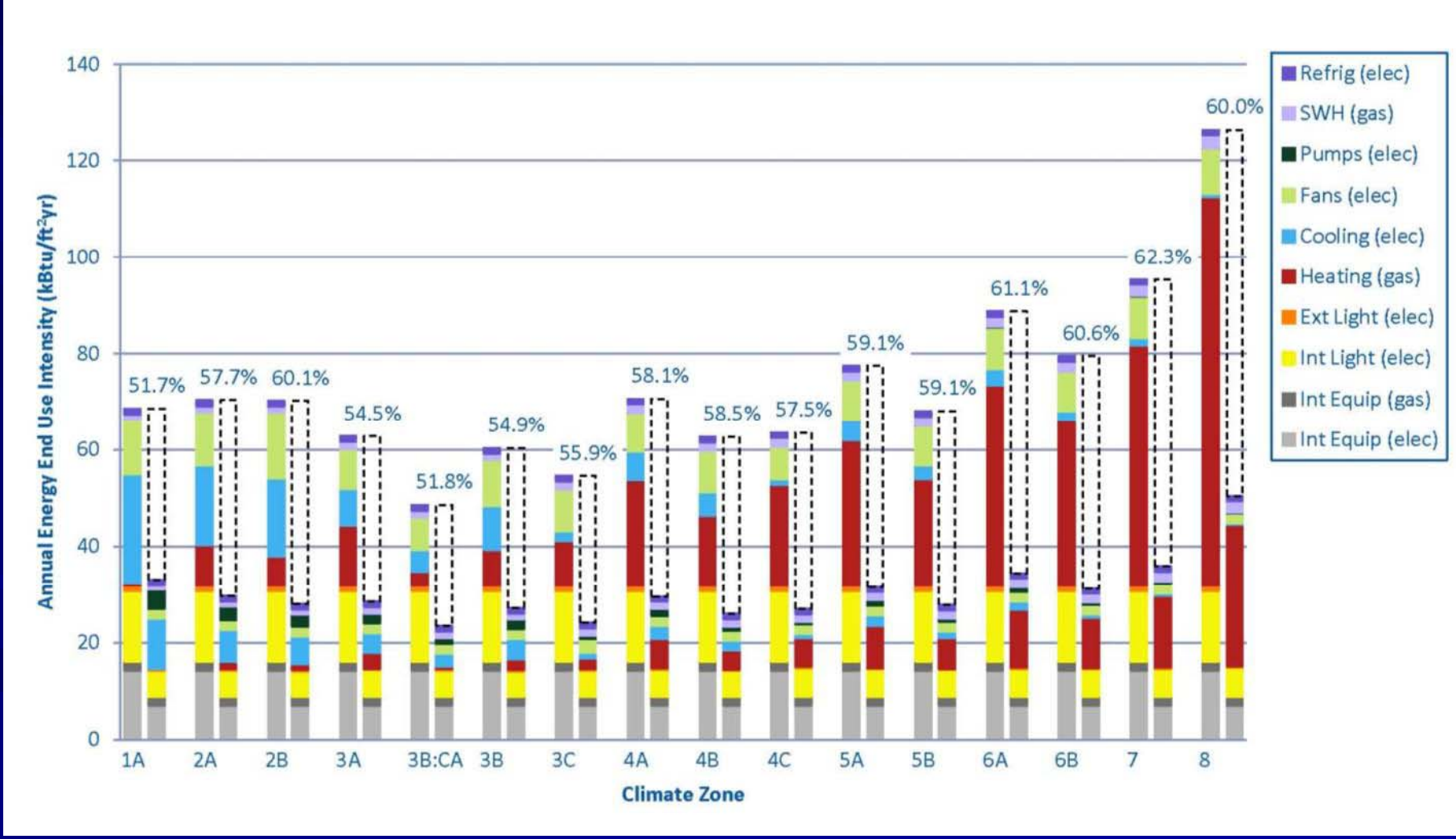
- Heating plant
  - 90% efficient natural gas fired boiler
  - 40 ft w.c. 90% efficient pump
- Cooling plant
  - 2.93 COP air-cooled chiller
  - 50 ft w.c. 90% efficient pump
- Four-pipe fan coils
  - 50% efficient cycling fan
  - 0.3 in w.c. pressure drop
  - Chilled water cooling coil
  - Hot water heating coil
- DOAS
  - 69% efficient fan
  - 90% efficient fan motor
  - 4.5 in w.c. system pressure drop
  - 75% sensible, 69% latent effectiveness ERV
  - Chilled water cooling coil
  - Hot water heating coil
  - Demand controlled ventilation

PSZ Systems

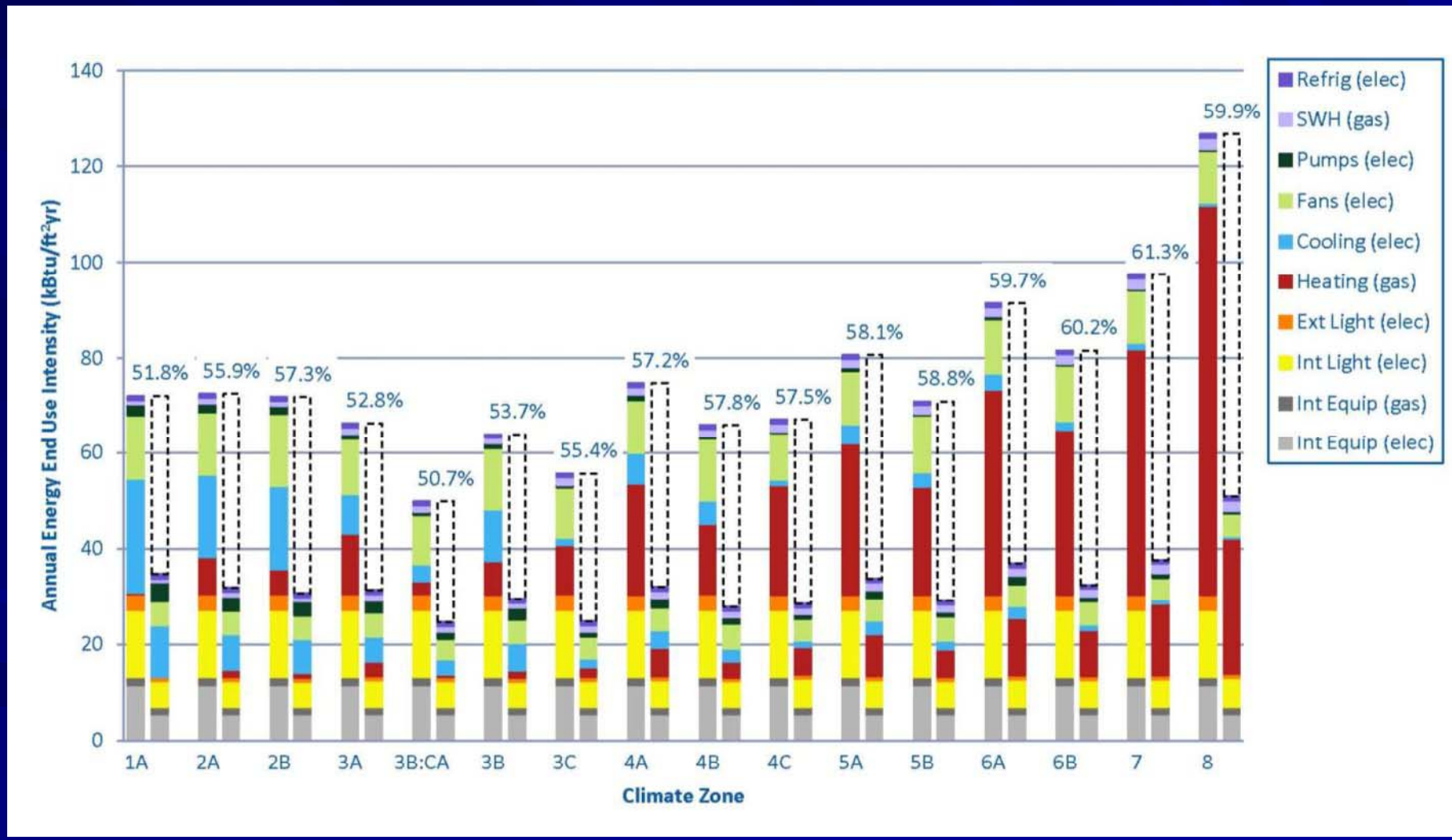
Characteristic	Value
Heating type	Gas
Heating efficiency	80%
Cooling type	DX
DX COP	4.0
Fan type	CAV
Fan efficiency	60%
Fan pressure drop (in w.c.)	1.0
Economizer	Y*
ERV sensible effectiveness	75%
ERV latent effectiveness	69%
ERV pressure drop (in w.c.)	0.5
DCV	Y

*No economizer in 1A, 2A, 3A, 4A

FCU/DOAS System Results
Primary School



FCU/DOAS System Results Secondary School



GSHP/DOAS System Details

GSHP/DOAS System

- Heating plant
  - 90% efficient natural gas fired boiler
  - 40 ft w.c. 90% efficient pump
- Cooling plant
  - 2.93 COP air-cooled chiller
  - 50 ft w.c. 90% efficient pump
- Ground-source heat pumps
  - 50% efficient cycling fan
  - 0.3 in w.c. pressure drop
  - 6.45 cooling COP
  - 4.0 heating COP
  - Electric supplemental heat
- DOAS
  - 69% efficient fan
  - 90% efficient fan motor
  - 4.5 in w.c. system pressure drop
  - 75% sensible, 69% latent effectiveness ERV
  - Chilled water cooling coil
  - Hot water heating coil
  - Demand controlled ventilation

PSZ Systems

Characteristic	Value
Heating type	Gas
Heating efficiency	80%
Cooling type	DX
DX COP	4.0
Fan type	CAV
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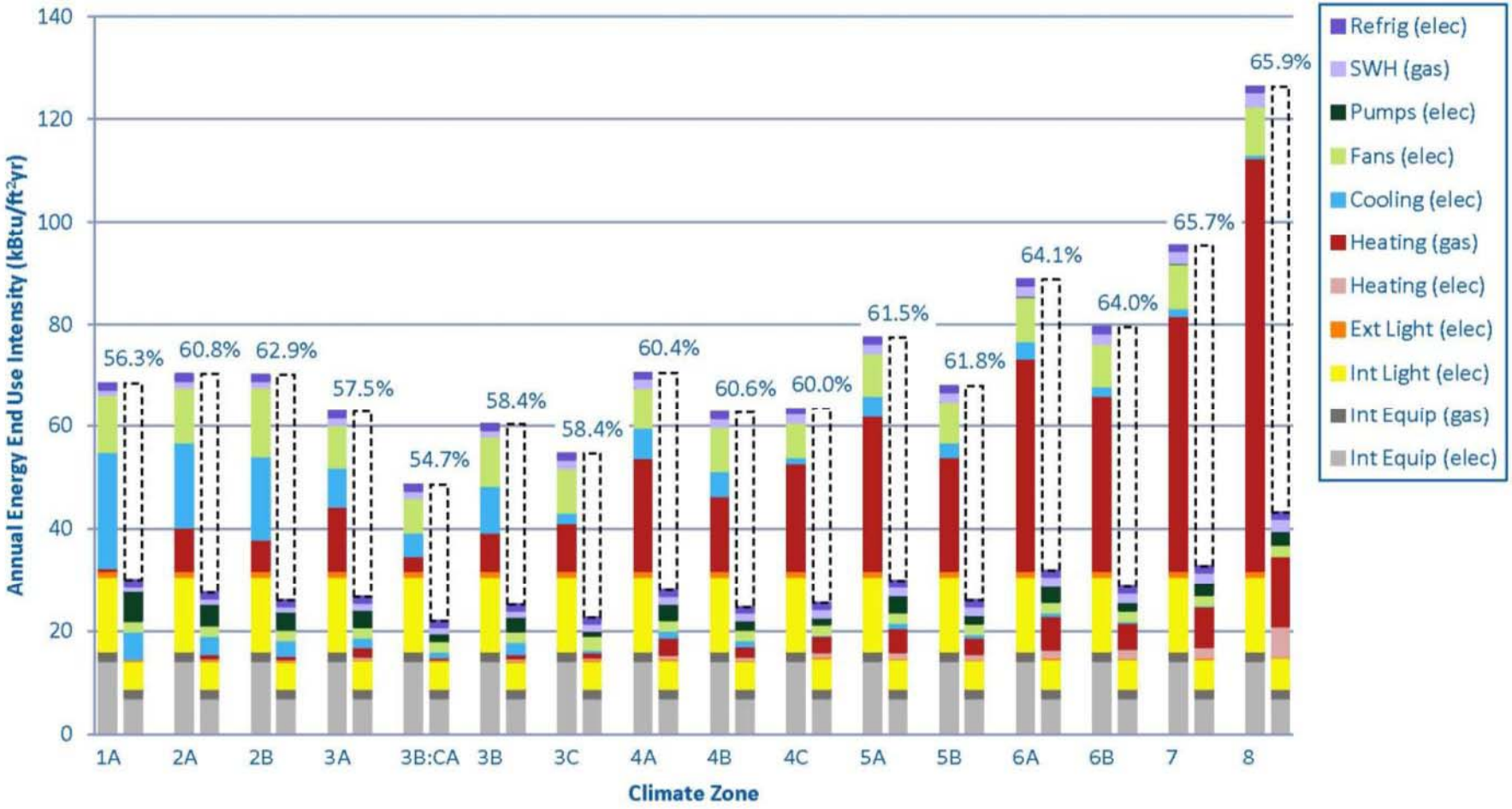
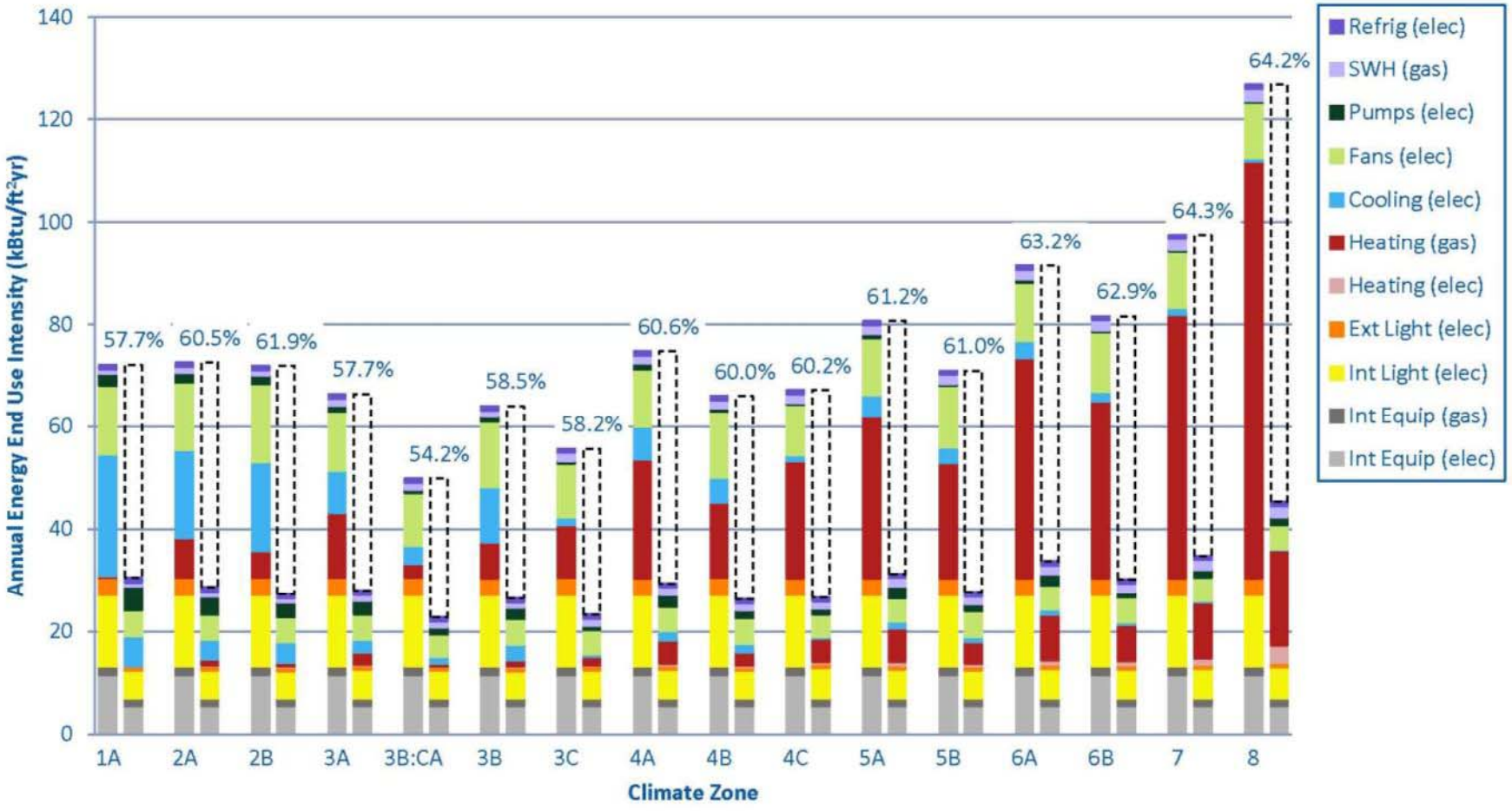
Fan pressure drop (in w.c.)	1.0
Economizer	Y*
ERV sensible effectiveness	75%
ERV latent effectiveness	69%
ERV pressure drop (in w.c.)	0.5
DCV	Y

*No economizer in 1A, 2A, 3A, 4A

GSHP/DOAS System Results
Primary School



GSHP/DOAS System Results Secondary School



Prescriptive Recommendations:

- Envelope – Insulation, Vestibules
- Fenestration – FFR, SHGC, VT, Sun Control
- Daylighting – % of Floor Area
- Interior Lighting – LPD, Ballasts, Controls
- Exterior Lighting – Facades, Parking lots
- Plug Loads – Equipment, Controls, Kitchen
- SWH/ HVAC Systems
  - VAV-DOAS, FCU-DOAS, GSHP-DOAS
- Quality Assurance – Cx, M&V, Benchmarking

Prescriptive Recommendations:

	Item	Component	Recommendation
Envelope	Roofs	Insulation entirely above deck	R-30.0 c.i.
		Attic and other	R-49.0
		Metal building	R-25.0 + R-11 L_s
		Solar Reflectance Index (SRI)	Comply with Standard 90.1*
	Walls	Mass (HC > 7 Btu/ft^2)	R-19.5 c.i.
		Steel framed	R13.0 + R-18.8 c.i.
		Wood framed and other	R-13.0 + R-12.5 c.i.
		Metal building	R-0.0 + R-19.0 c.i.
		Below grade walls	R-10.0 c.i.
	Floors	Mass	R-16.7 c.i.
		Steel framed	R-38.0
		Wood framed and other	R-38.0
	Slabs	Unheated	R-10 for 24 in.
		Heated	R-20 for 48 in.
	Doors	Swinging	U-0.50
		Nonswinging	U-0.50
	Vestibules	At building entrance	Yes
	View Fenestration	Thermal transmittance	Nonmetal framing = U-0.35 Metal framing = U-0.42
		Fenestration-to-floor-area ratio (FFR)	E or W orientation = 5% maximum N or S orientation = 7% maximum
		Solar heat gain coefficient (SHGC)	E or W orientation = 0.42 N orientation = 0.62 S orientation = 0.75
		Exterior sun control	S orientation only = PF-0.5

Daylighting/Lighting	Daylight Fenestration	Visible transmittance (VT)	See Table 5-5 for appropriate VT value
		Interior/exterior sun control (S orientation only)	S orientation = no glare during school hours
	Daylighting	Classroom, resource rooms, cafeteria, gym, and multipurpose rooms	Daylight 100% of floor area for 2/3 of school hours
		Administration areas	Daylight perimeter floor area (15 ft) for 2/3 of school hours
	Interior Finishes	Interior surface average reflectance for daylighted rooms	Ceilings = 80% Wall surfaces = 70%
	Interior Lighting	Lighting power density (LPD)	Whole building = 0.70 W/ft^2 Gyms, multipurpose rooms = 1.0 W/ft^2 Classrooms, art rooms, kitchens, libraries, media centers= 0.8 W/ft^2 Cafeterias, lobbies = 0.7 W/ft^2 Offices = 0.60 W/ft^2 Auditoriums, restrooms = 0.5 W/ft^2 Corridors, mechanical rooms = 0.4 W/ft^2
		Light source lamp efficacy (mean lumens per watt)	T8 & T5 > 2 ft = 92, T8 & T5 ≤ 2 ft = 85, All other > 50
		T8 ballasts	Non-dimming = NEMA Premium Instant Start Dimming= NEMA Premium Program Start
		T5/T5HO ballasts	Electronic program start
		CFL and HID ballasts	Electronic
		Dimming controls daylight harvesting	Dim all fixtures in daylight zones
		Lighting controls	Manual ON, auto/timed OFF in all areas as possible
	Exterior Lighting	Façade and landscape lighting	LPD = 0.075 W/ft^2 in LZ-3 & LZ-4 LPD = 0.05 W/ft^2 in LZ-2 Controls = auto OFF between 12am and 6am
		Parking lots and drives	LPD = 0.1 W/ft^2 in LZ-3 & LZ-4 LPD = 0.06 W/ft^2 in LZ-2 Controls = auto reduce to 25% (12am to 6am)
		Walkways, plaza, and special feature areas	LPD = 0.16 W/ft^2 LZ-3 & LZ-4 LPD = 0.14 W/ft^2 in LZ-2 Controls = auto reduce to 25% (12am to 6am)
		All other exterior lighting	LPD = Comply with Standard 90.1* Controls = auto reduce to 25% (12am to 6am)

SWH	Service Water Heating	Gas water heater (condensing)	95% efficiency
		Electric storage EF (≤12 kW, ≥20 gal)	EF > 0.99 – 0.0012 × Volume
		Point-of-use heater selection	0.81 EF or 81% E_t
		Electric heat-pump water heater efficiency	COP 3.0 (interior heat source)
		Solar hot-water heating	30% solar hot-water fraction when LCC effective
		Pipe insulation (d < 1.5 in./d ≥ 1.5 in.)	1/1.5 in.
HVAC	Ground Source Heat-Pump (GSHP) System with DOAS	GSHP cooling efficiency	17.1 EER
		GSHP heating efficiency	3.6 COP
		GSHP compressor capacity control	Two stage or variable speed
		Water-circulation pumps	VFD and NEMA Premium Efficiency
		Cooling tower/fluid cooler	VFD on fans
		Boiler efficiency	90% E_c
		Maximum fan power	0.4 W/cfm
		Exhaust air energy recovery in DOAS	A (humid) zones = 60% enthalpy reduction B (dry) zones = 60% dry-bulb temperature reduction
		DOAS ventilation control	DCV with VFD
	Fan-Coil System with DOAS	Water-cooled chiller efficiency	Comply with Standard 90.1*
		Water circulation pumps	VFD and NEMA Premium Efficiency
		Boiler efficiency	90% E_c
		Maximum fan power	0.4 W/cfm
		FCU fans	Multiple speed
		Economizer	Comply with Standard 90.1*
		Exhaust air energy recovery in DOAS	A (humid) zones = 60% enthalpy reduction B (dry) zones = 60% dry-bulb temperature reduction
		DOAS ventilation control	DCV with VFD
	VAV Air-Handling System with DOAS	Air-cooled chiller efficiency	10 EER; 12.75 IPLV
		Water-cooled chiller efficiency	Comply with Standard 90.1*
		Water circulation pumps	VFD and NEMA Premium Efficiency
		Boiler efficiency	90% E_c
		Maximum fan power	0.8 W/cfm
		Economizer	Comply with Standard 90.1*
		Exhaust air energy recovery in DOAS	A (humid) zones = 60% enthalpy reduction B (dry) zones = 60% dry-bulb temperature reduction
		DOAS ventilation control	DCV with VFD
	Ducts and Dampers	Outdoor air damper	Motorized damper
		Duct seal class	Seal Class A
		Insulation level	R-6

	Item	Component	Recommendation
Kitchen	Kitchen Equipment	Cooking equipment	ENERGY STAR or California rebate-qualified equipment
		Walk-in 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
		Exhaust hoods	Side panels, larger overhangs, rear seal at appliances, proximity hoods, VAV demand-based exhaust
Plug Loads	Equipment Choices	Laptop computers	Minimum 2/3 of total computers
		ENERGY STAR equipment	All computers, equipment, and appliances
		Vending machines	De-lamp and specify best in class efficiency
	Controls/ Programs	Computer power control	Network control with power saving modes and control off during unoccupied hours
		Power outlet control	Controllable power outlets with auto OFF during unoccupied hours for classrooms, office, library/ media spaces All plug-in equipment not requiring continuous operation to use controllable outlets
		Policies	Implement at least one: • District/school policy on allowed equipment • School energy teams
M&V	M&V/ Benchmarking	Electrical submeters	Disaggregate submeters for lighting, HVAC, general 120V, renewables, and whole building
		Benchmarking	Begin submetering early to address issues during warranty period Benchmark monthly energy use Provide training on benchmarking

Additional Bonus Savings

- Additional HVAC Systems
  - Natural Ventilation, Evaporative Cooling, IAQP
  - Thermal Storage, Thermal Mass,
  - Thermal Displacement Ventilation
- Renewable Energy
  - Photovoltaic, Wind Turbine,
  - Transpired Solar Collector,
  - Power Purchase Agreements

Distribution

- Downloads of 50% K12 available 9/30
- Pre-sales of 50% K12 print copies offered at discount starting 10/5
- Print copies available 10/31
- As of Dec 9, 2011
  - 30% Downloads = 323,910 copies
  - 50% SMO Downloads = 26,650
  - 50% K12 Downloads = 5,999
  - Total = 378,754 distribution (incl. print copies)

Marketing

- Notice on ASHRAE Home Page on 10/13
- News Release on 10/13
  - Trade Media
  - ASHRAE Members & Interested Parties
  - Society & Other Newsletters
- Email to Past Downloaders on 10/26
  - Sent to 22,445
  - Opened by 5125
  - Forwarded by 1039
  - Download link clicked by 468

Availability

- EEG-Existing Buildings: Technical Implementation – Available now
- 50% AEDG for Mid-Big Box Retail Buildings – December 30, 2011
- 50% AEDG for Large Hospitals – April 30, 2011

What's Next ?

- Additional 50% Guides
  - Quick Service Restaurants, Grocery ? Highway Lodging, Warehouses ?
- Next Steps
  - Net Zero Energy Guides ?
  - Documents, Web Tools ?

Questions & Answers and Discussion

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