Energy & Store
Development Conference

E+SD 2015

Recommendations for 50% Energy Reduction in Grocery Stores

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AEDG Steering Committee Chair

Special Acknowledgement

- Michael Lane, Puget Sound Energy
- Daniel Nall, Syska Hennessy Group
- Caleb Nelson, CTA
- Paul Torcellini, NREL

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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
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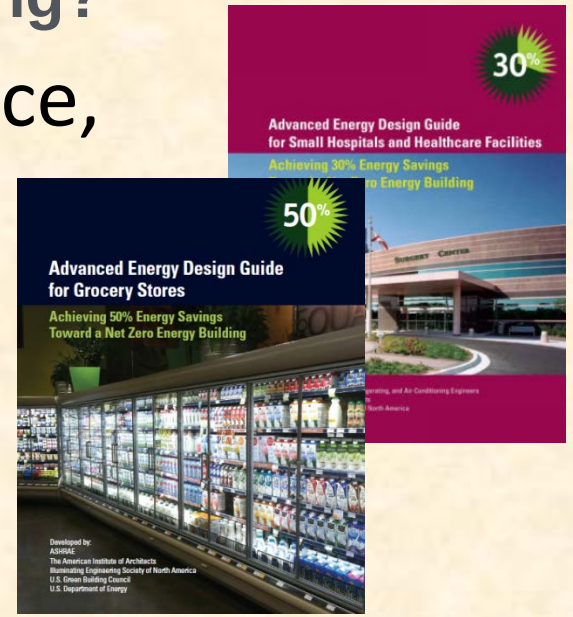
  - 30% energy savings
  - 50% energy savings



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

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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

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- The 30% AEDGs help promote building energy efficiency worldwide

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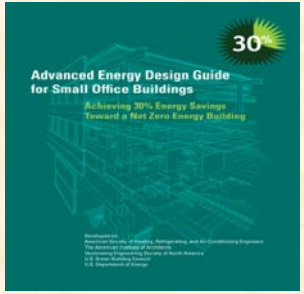
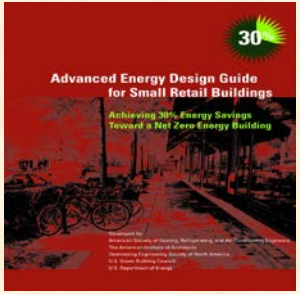


Small Office



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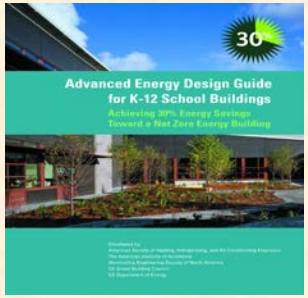

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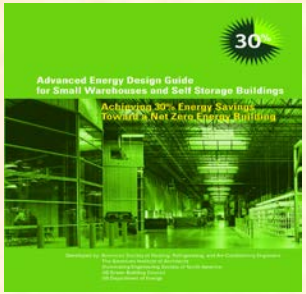

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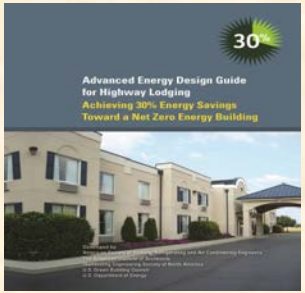
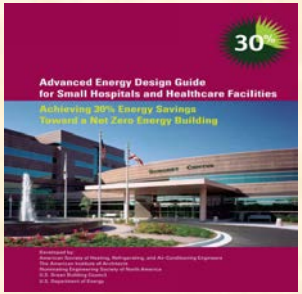


Highway Lodging



Small Hospital

Advanced Energy De

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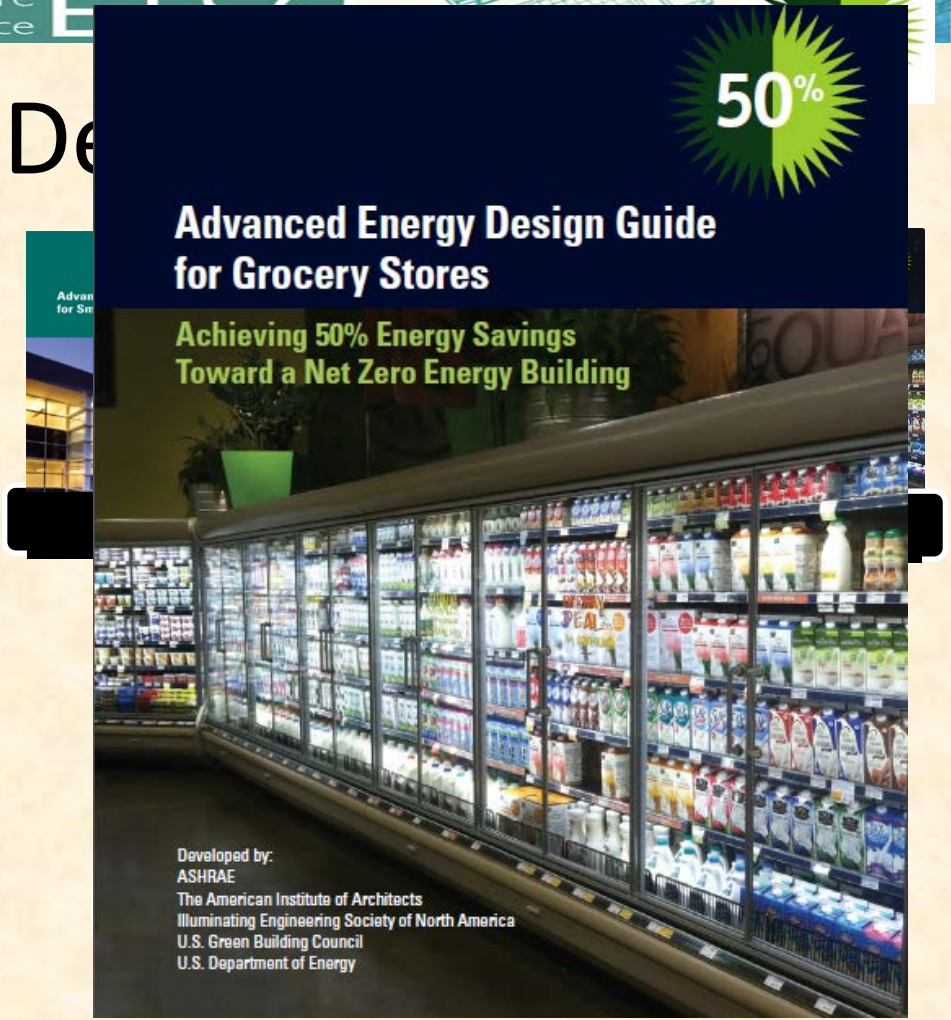

50% Grocery AEDG Project Committee

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- **Bernie Bauer**, IES Represenative, Integrated Lighting Concepts
- **Aaron Daly**, Member-at-Large, Whole Foods Market
- **Don Fisher**, Member-at-Large, PG&E Food Service Technology Center
- **Michael Lane**, IES Representative, Puget Sound Energy
- **Ken Lowney**, AIA Representative, Lowney Architecture
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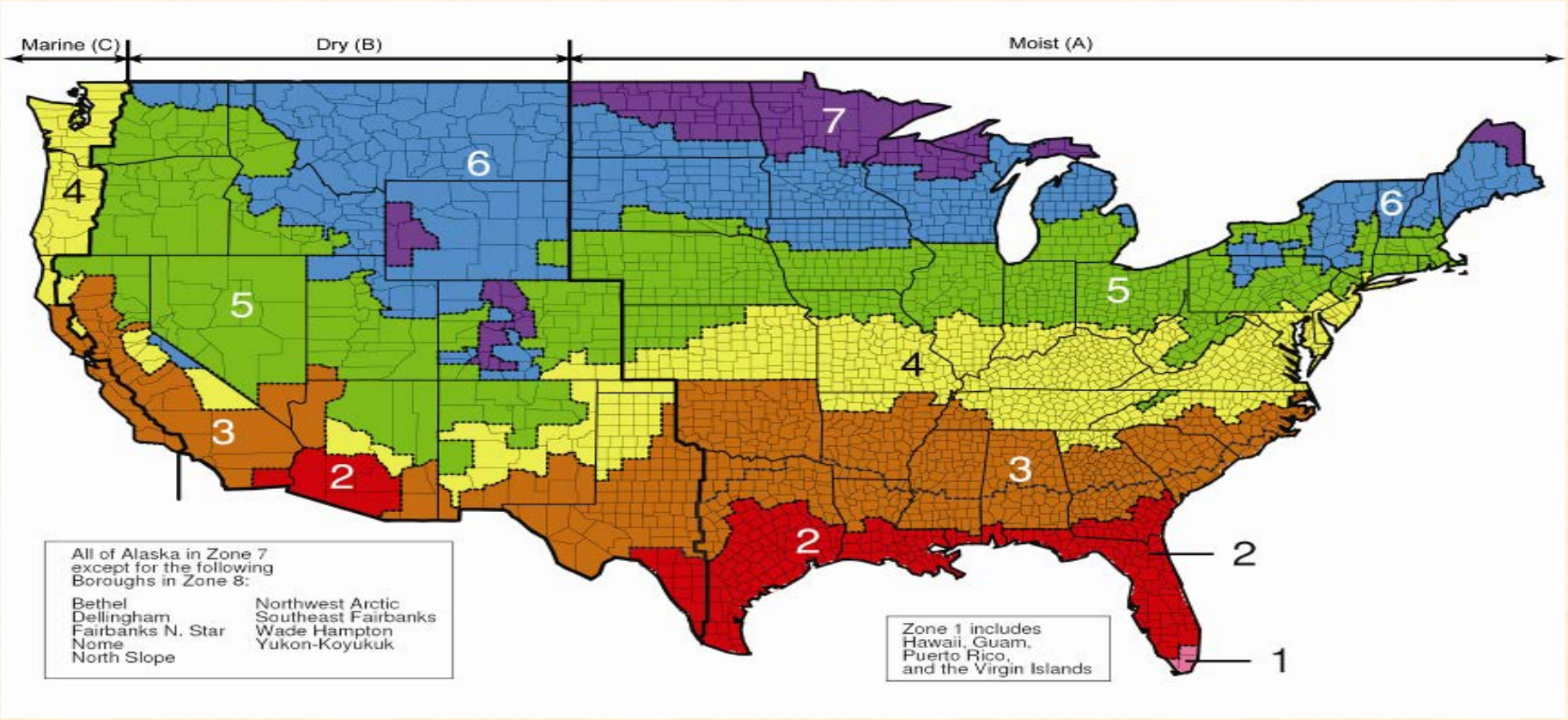
- **Jim McClendon**, ASHRAE Representative, Walmart Stores, Inc.
- **Daniel Nall**, AIA/USGBC Representative, Syska Hennessy Group
- **Caleb Nelson**, Member-at-Large Refrigeration, CTA
- **Doug Scott**, Member-at-Large Refrigeration, VaCom Technologies
- **Eric Bonnema**, Analysis Support, National Renewable Energy Laboratory
- **Lilas Pratt**, Staff Liaison, ASHRAE

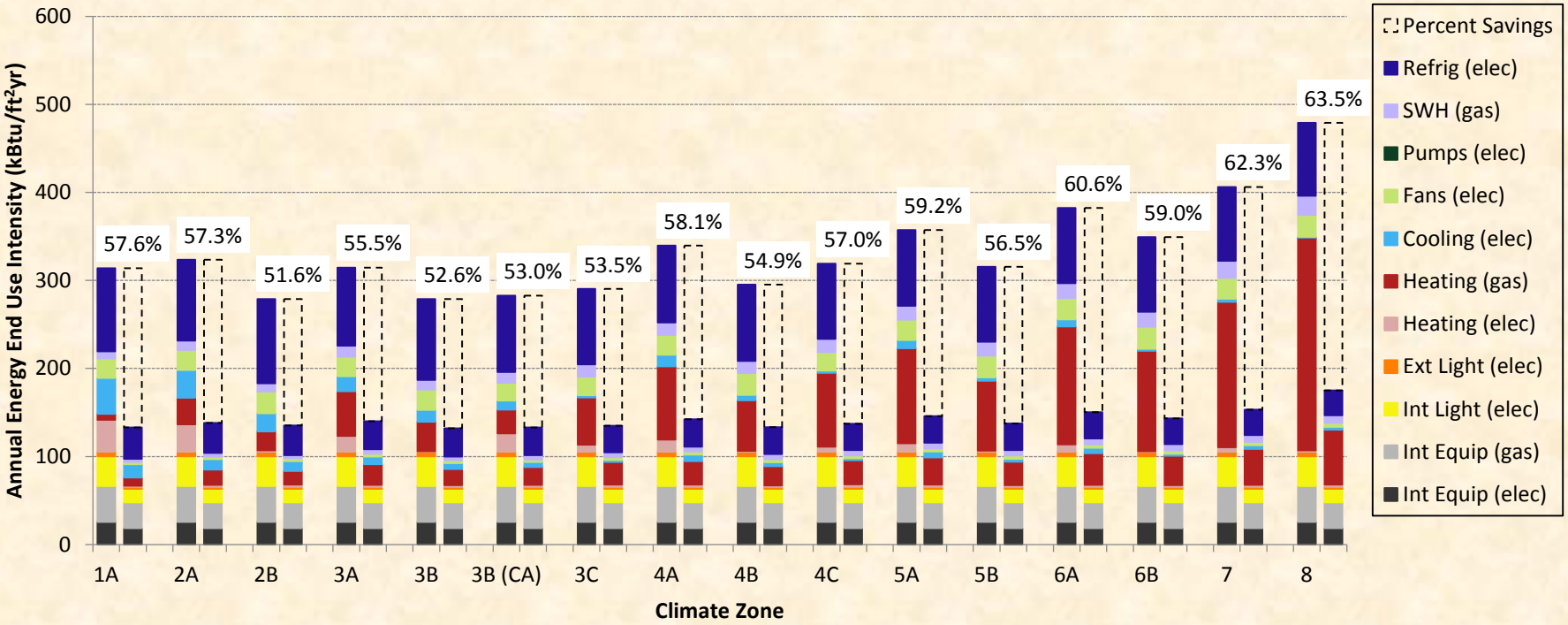
AEDG Table of Contents

- Chapter 1 – 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 – Design Concepts and Practices
  - Overview of the technical approaches to achieving 50% savings
  - Subsystem integration
- 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

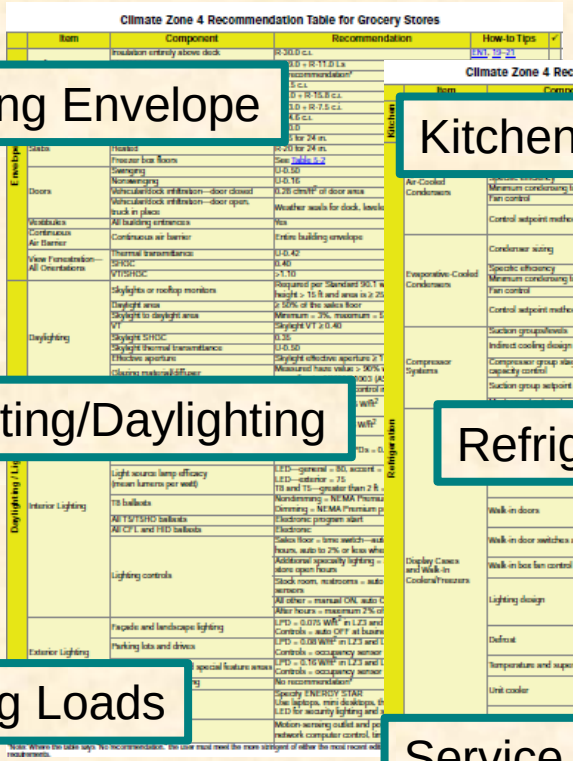
Climate Zones

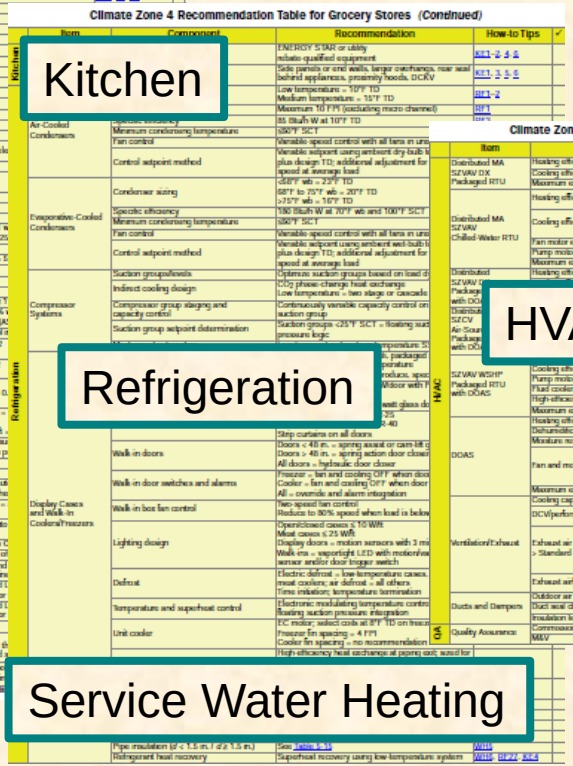


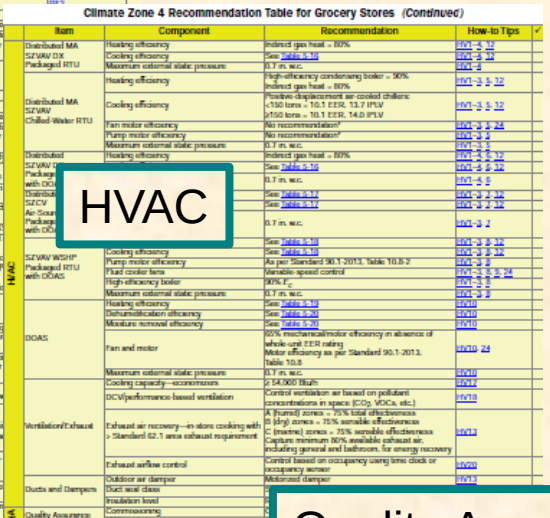
AEDG Savings by Climate Zone



Recommendation Tables


Climate Zone 4 Recommendation Table for Grocery Stores


Climate Zone 4 Recommendation Table for Grocery Stores (Continued)


Climate Zone 4 Recommendation Table for Grocery Stores (Continued)

Building Envelope

Kitchen

Lighting/Daylighting

HVAC

Refrigeration

Plug Loads

Service Water Heating

Quality Assurance

Consider this a menu of energy-saving options

Source: 50% AEDG Grocery Stores from ASHRAE

Recommendation Table Contents

	Item	Component	Recommendation	How-to Tips	✓

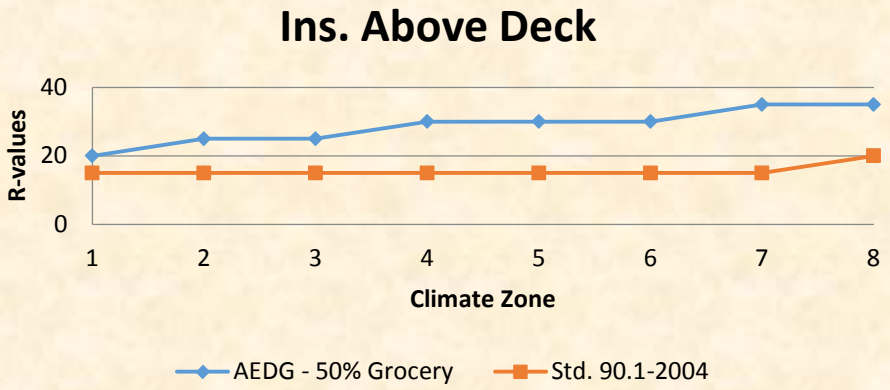
- How-to Tips contain
  - Specific recommendations
  - Guidance on good practice for implementation
  - Cautions to avoid known problems

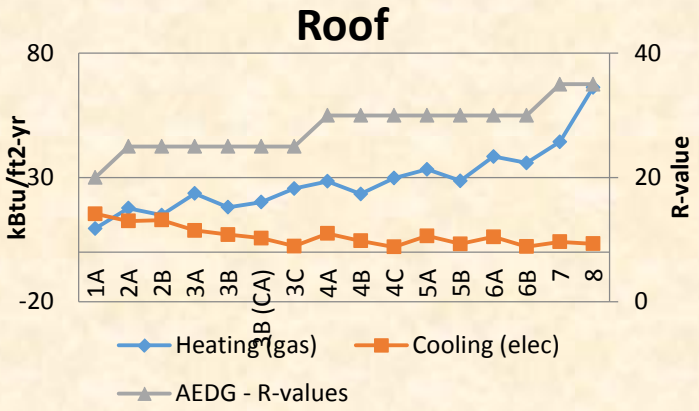
Source: 50% AEDG Grocery Stores from ASHRAE

Chapter 5 – How-to Tips

Component	# tips	Notes
Envelope	29	
Daylighting	10	
Electric Lighting	35	
Plug Loads	9	
Kitchen Equipment	7	
Refrigeration	31	Includes 10 Display & Walk-in 5 Heat recovery
Water Heating	6	
HVAC	35	
Quality Assurance	17	
Bonus	12	Including renewable energy

Envelope – Roof Recommendations





Solar Reflective Index = 78

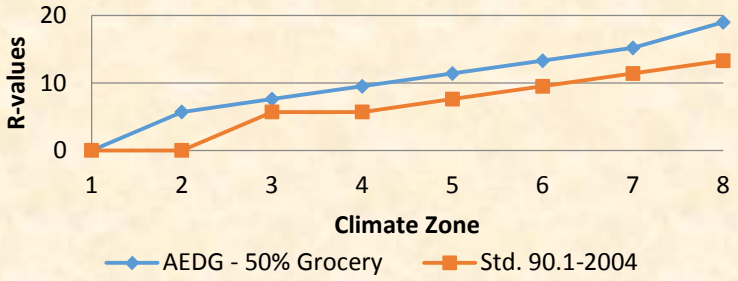
Table 5-1 Examples of Cool Roofs

Category	Product	Reflectance	Emissivity	SRI
Single ply	White polyvinyl chloride (PVC)	0.86	0.86	107
	White chlorinated polyethylene (CPE)	0.86	0.88	108
	White chlorosulfonated polyethylene (CPSE)	0.85	0.87	106
	White thermoplastic polyolefin (TSO)	0.77	0.87	95
Liquid applied	White elastomeric, polyurethane, acrylic coating	0.71	0.86	86
	White paint (on metal or concrete)	0.71	0.85	86
Metal panels	Factory-coated white finish	0.90	0.87	113

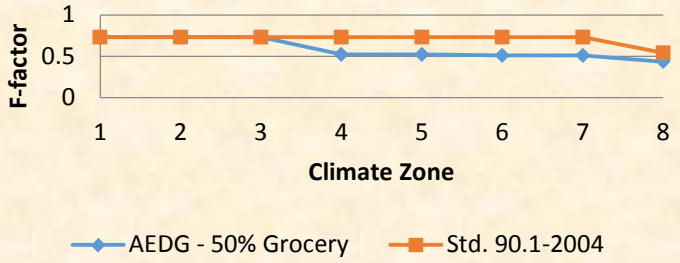
Source: 50% AEDG Grocery Stores from ASHRAE

Envelope Recommendations

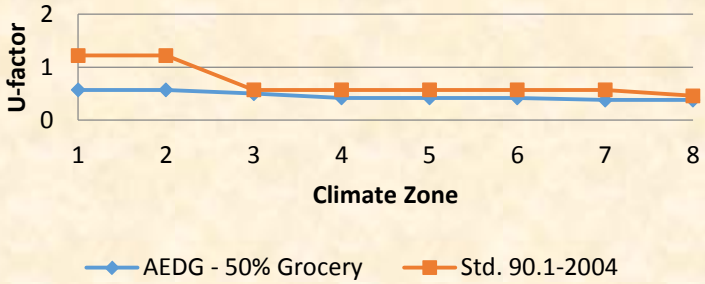
Mass Walls



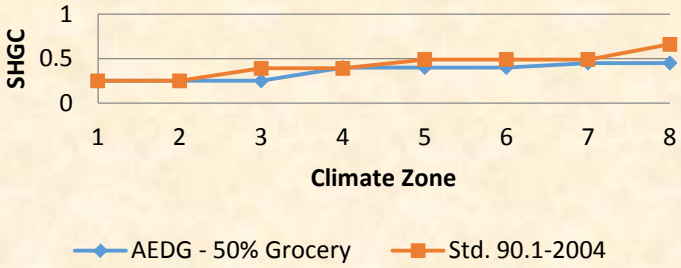
Slab Unheated



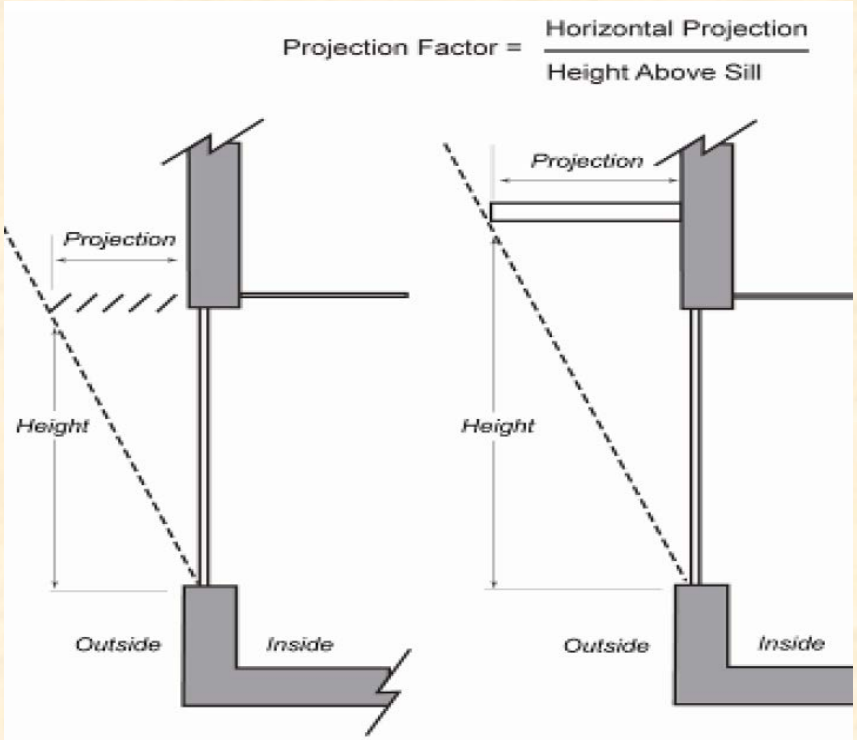
Fenestration



Fenestration



Windows with Overhangs

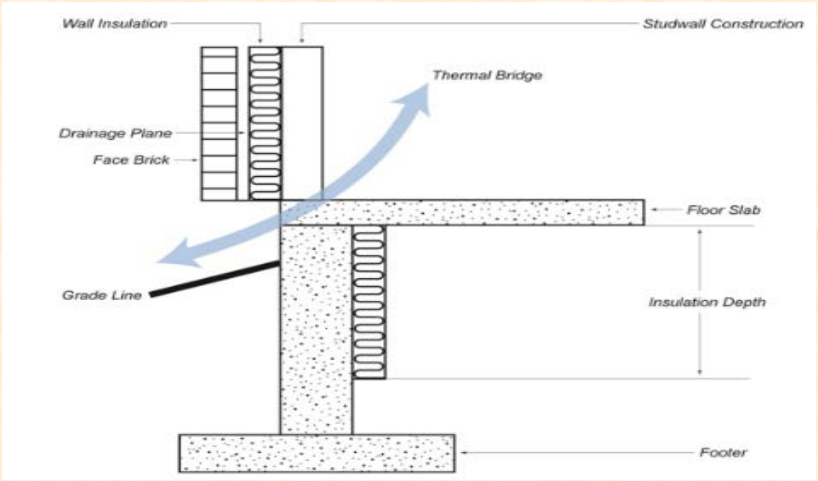


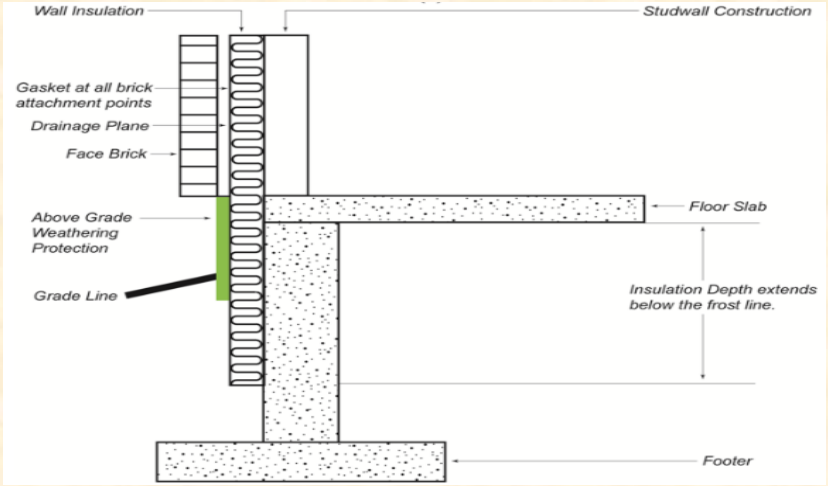
Good Design Strategies:

- Avoid glass that does not contribute to view or daylighting.
- Maximize north & south.
- Minimize east & west.
- Use overhangs to provide shading and reduce glare.

Source: 50% AEDG Grocery Stores from ASHRAE

Thermal Bridges – Slab Edges





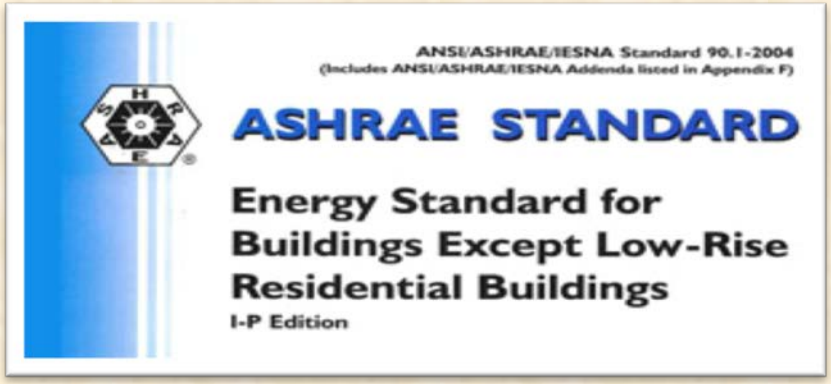
Problem

Solution

Source: 50% AEDG Grocery Stores from ASHRAE

Refrigeration

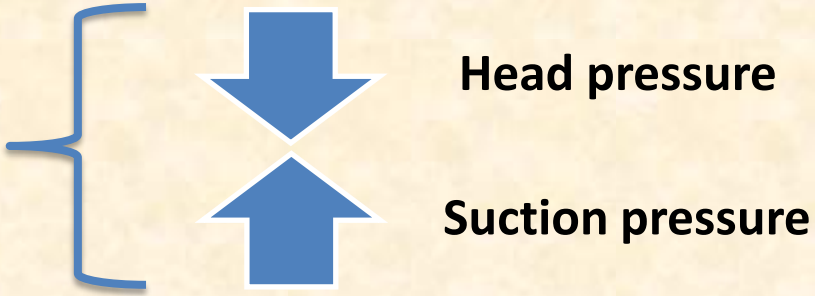
- New discipline for AEDG
- Baseline ASHRAE 90.1 – 2004



Refrigeration – Energy Reduction

- Specifying efficiency level is not enough
- Simplifying refrigeration system efficiency:
  - Reduce **LOAD**
  - Reduce **LIFT**

Compressor lift

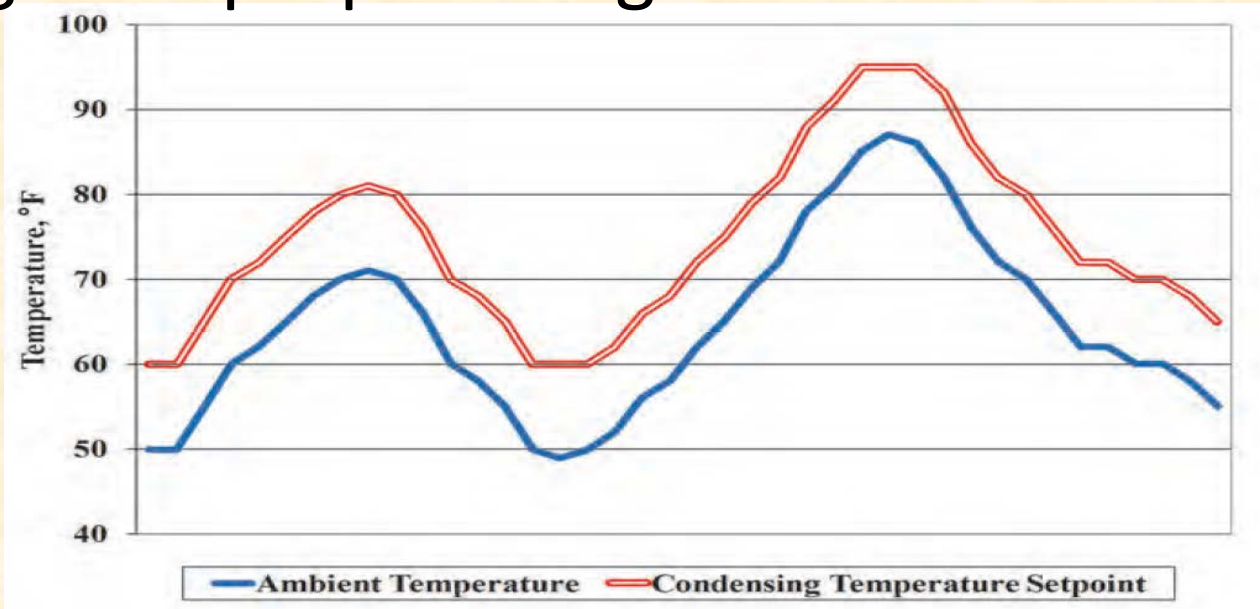


Refrigeration – Energy Reduction

- Reducing Load
  - Reduces compressor size
  - Reduces condenser size
- Examples
  - Insulation
  - Case LEDs
  - Doors on Cases

Reducing Lift

- Hinges on proper design – and control

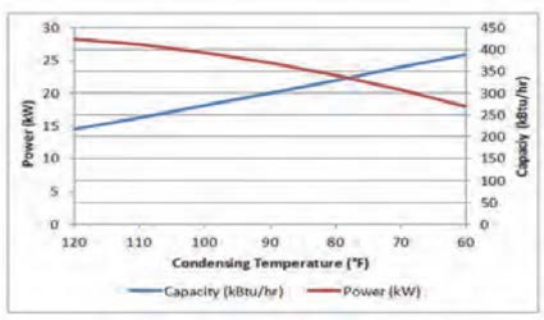


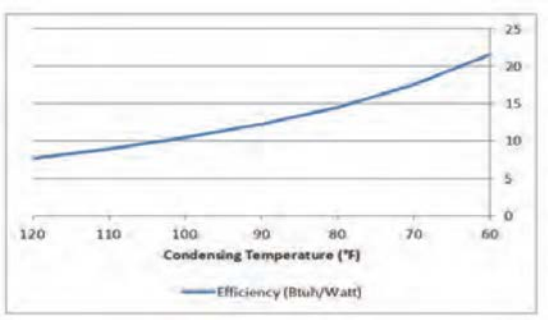
Source: 50% AEDG Grocery Stores from ASHRAE

Refrigeration – Energy Reduction

- Reducing Lift
  - Takes advantage of:
    - Reduced ambient temperatures
    - Part load operation
  - Affects system capacity and efficiency

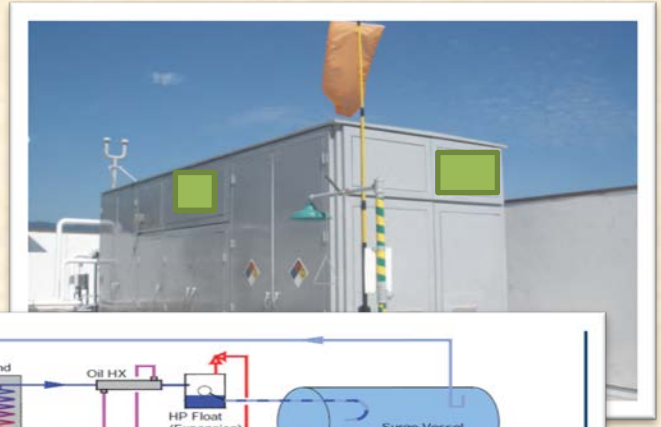
- Examples
  - Doors on Cases
  - Electronic Valves
  - Suction Grouping
  - Floating Controls

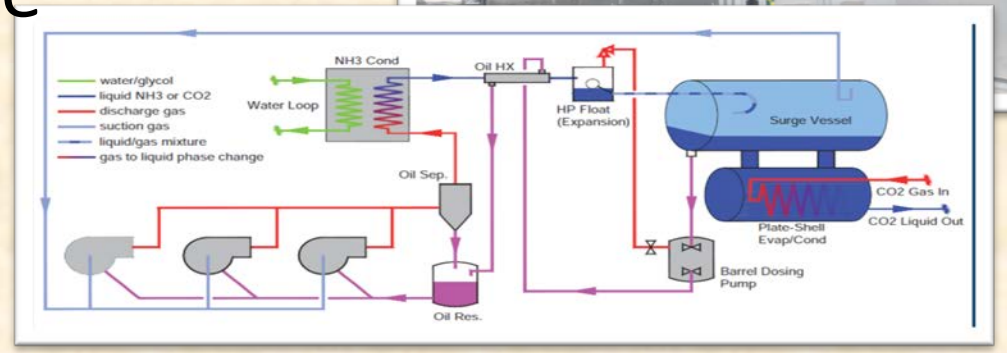




Refrigerant Impact

- Dealing with refrigerant GWP
  - Must consider energy impact
- System architecture
- Refrigerant glide





Source: 50% AEDG Grocery Stores from ASHRAE

Reducing Plug Loads

- Evaluate the plug loads
- Worksheets

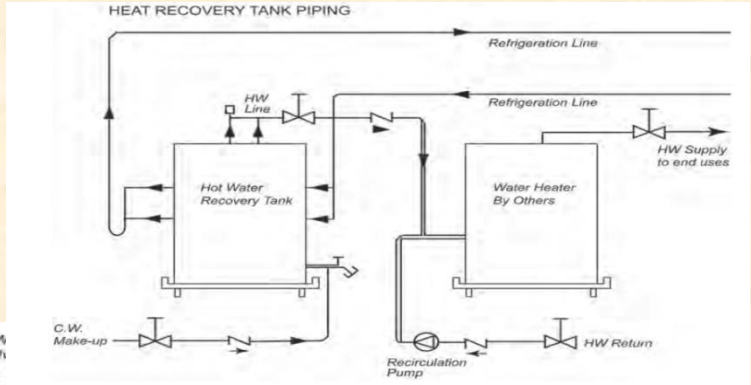
- Purchase Energy Star
- Auto-off Product Controls
  - Motion
  - Time-out
  - Load Sensing
  - Manual Switch

HVAC

- 5 system types modeled:
  1. Distributed MA SZVAV DX Packaged RTU
  2. Distributed MA SZVAV Chilled-Water RTU
  3. Distributed SZVAV DX Packaged RTU with DOAS
  4. Distributed SZVAV Air-source HP Packaged RTU with DOAS
  5. SZVAV WSHP Packaged RTU with DOAS
- Efficiency Specifications included in CH4 Tables
- Exhaust/Ventilation – Demand Control

Refrigeration and HVAC Interactions

- Thermal Comfort
  - Increased heating demand
  - Reduced cooling demand
  - Cold Aisle
- Heat Reclaim
  - Water
  - Air (heat and reheat)



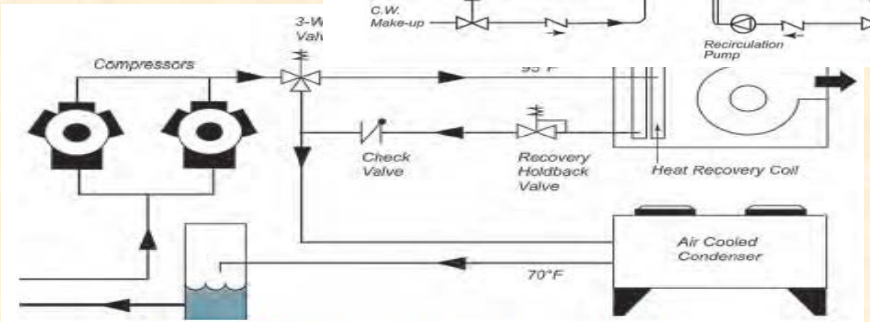


Figure 5-31 (RF29) Conventional Series-Connected Heat Recovery

Source: 50% AEDG Grocery Stores from ASHRAE

Refrigeration & HVAC Interactions

- Dehumidification
  - Required store condition: 75°F/55% R.H.
  - Refrigeration COP vs. A/C COP
  - Anti-sweat heater control

Source: 50% AEDG Grocery Stores from ASHRAE

HVAC Technology Examples

Table 5-21 Total System Effectiveness with Energy Recovery

Condition	Effectiveness, %		
	Sensible	Latent	Total
Heating at 100% airflow	78	70	75

Table 5-18 WSHP Efficiency Levels

Size Category	Cooling Efficiency*	Heating Efficiency*
<65,000 Btu/h selected at 3 and 5 tons	14.2 EER	5.0 COP
65,000–135,000 Btu/h selected at 10 tons	13.9 EER	4.4 COP
135,000–240,000 Btu/h selected at 15 tons	15.0 EER	5.0 COP
135,000–240,000 Btu/h selected at 15 tons	13.6 EER	4.8 COP
>240,000 Btu/h	Not recommended	

*EER = energy ef

Select cooling coils for a design chilled-water ΔT of at least 15^0F to reduce pump energy…

mendation tables in Chapter 4.

Source: 50% AEDG Grocery Stores from ASHRAE

Kitchen Equipment

Climate Zone 4 Recommendation Table for Grocery Stores *(Continued)*

	Item	Component	Recommendation	How-to Tips	✓
Kitchen	Kitchen Equipment	Cooking equipment	ENERGY STAR or utility rebate-qualified equipment	KE1–2, 4, 6	
		Exhaust hoods	Side panels or end walls, larger overhangs, rear seal behind appliances, proximity hoods, DCKV	KE1, 3, 5, 6	

- New technology for AEDGs
  - DCKV (Demand Controlled Kitchen Ventilation)

Source: 50% AEDG Grocery Stores from ASHRAE

Lighting Design

Source: 50% AEDG Grocery Stores from ASHRAE

Lighting Goals

- Support
  - Attracting customers
  - Facilitating merchandise evaluation
  - Enabling completion of the sale
- Lower LPDs can be achieved by
  - high-efficacy light sources
  - lighting controls
  - good design practice

Lighting Levels

- Ambient lighting; **15 to 50 fc** depending on the store type and merchandising strategies
- Perimeter lighting; Illuminance ratios of no more than **2:1 of ambient light levels**
  - T8, T5 or LED lighting can achieve these efficiently
- Task lighting; **1.5 to 2** times that of ambient lighting
- Accent lighting; typically **ratios of 5:1**
  - Point source directional luminaries such as LED

EL21 Accent Lighting

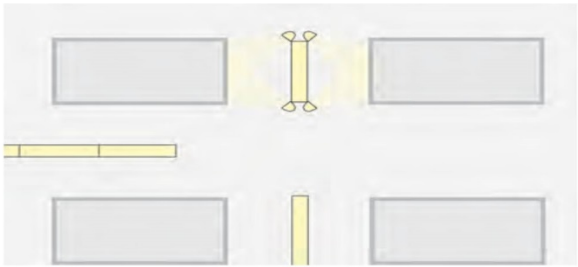


Figure 5-19 (EL23) Accent Lighting in Merchandise Sales Area

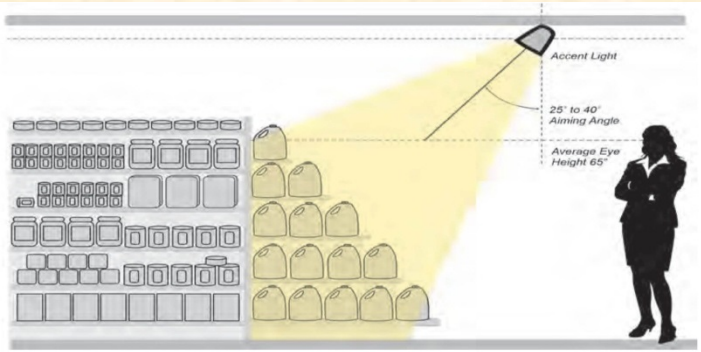


Figure 5-15 (EL4 and EL5) Accent Lighting Aimed at 40 Degrees

- Use LED task and accent lighting to highlight key merchandise locations or vignettes to "feature display" light levels (three to ten times the general merchandise lighting level in the area of the display). The use of accent lighting to highlight all merchandise does not create the proper contrast ratios and should be avoided.

- Controls
- Accent lighting = Auto ON only during store open hours

Source: 50% AEDG Grocery Stores from ASHRAE

Daylighting

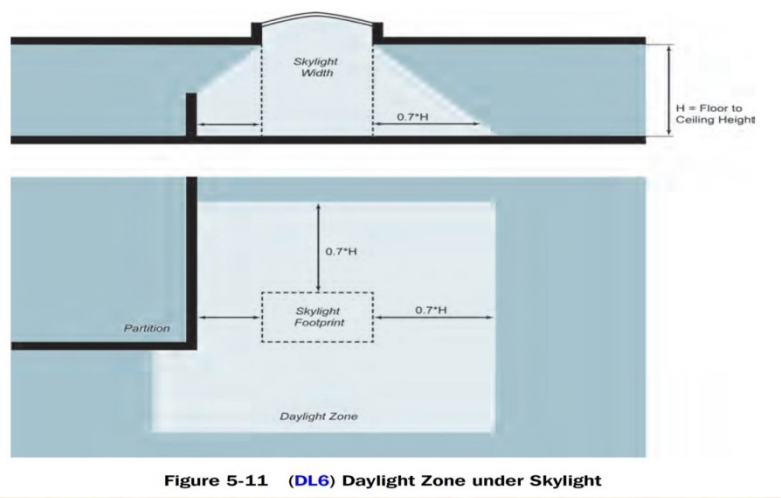


Figure 5-11 (DL6) Daylight Zone under Skylight

- Toplighting required by 90.1
  - Climate zones 1-5
  - Spaces > 2500 ft2
  - Directly under a roof
  - Ceiling height > 15 ft
- Install skylights that daylight at least 50% of the sales floor area

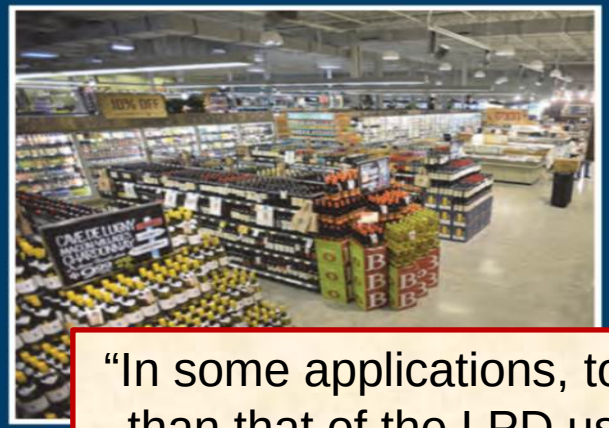
Controls

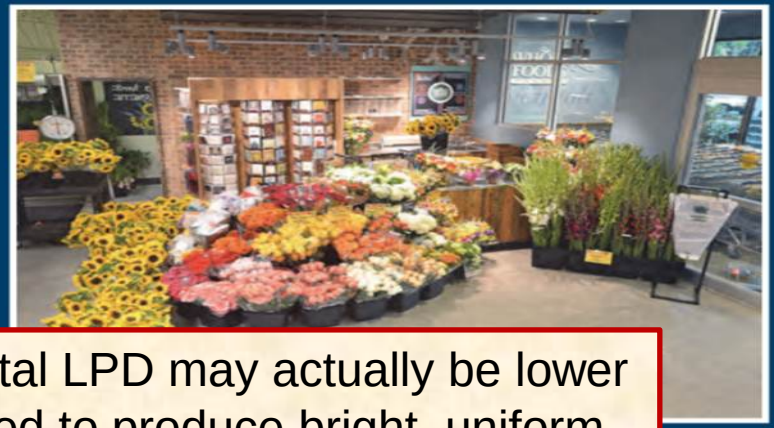
- General lighting auto controlled in response to daylight

Source: 50% AEDG Grocery Stores from ASHRAE

Layering of light

Using high-efficacy luminaires coupled with a layered lighting strategy produces dynamic lighting with accents and feature display illumination while meeting or exceeding code compliance and energy targets. In some applications, total LPD may actually be lower than that of the LPD used to produce bright, uniform lighting.





"In some applications, total LPD may actually be lower than that of the LPD used to produce bright, uniform lighting."

Source: 50% AEDG Grocery Stores from ASHRAE

Lighting Conclusions

- Layer the lighting
  - General lighting at 15 to 50 fc
  - Perimeter lighting 2:1 of ambient light levels
  - Accent lighting 2:1 to 5:1 of ambient light levels
- LED lighting is a viable option for all lighting

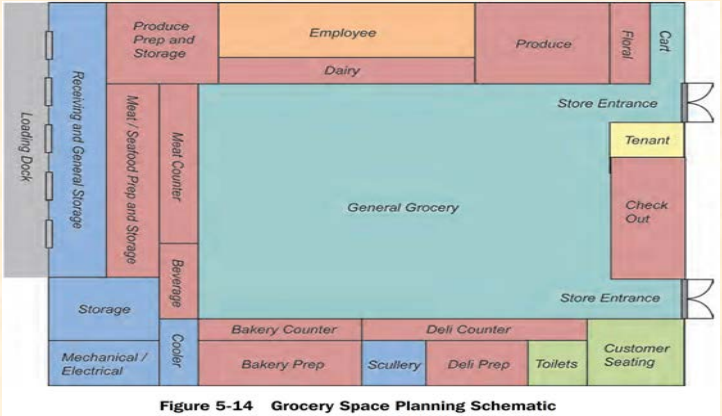


Figure 5-14 Grocery Space Planning Schematic

Source: 50% AEDG Grocery Stores from ASHRAE

Quality Assurance How-To Tips

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

Bonus Savings and Renewables How-To Tips

Not required, available for additional savings

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

Source: 50% AEDG Grocery Stores from ASHRAE

Case Study

Refrigeration

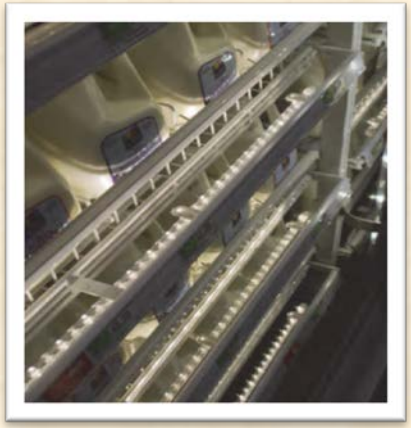
- Case doors
- A.S. control
- LED
- EC motors

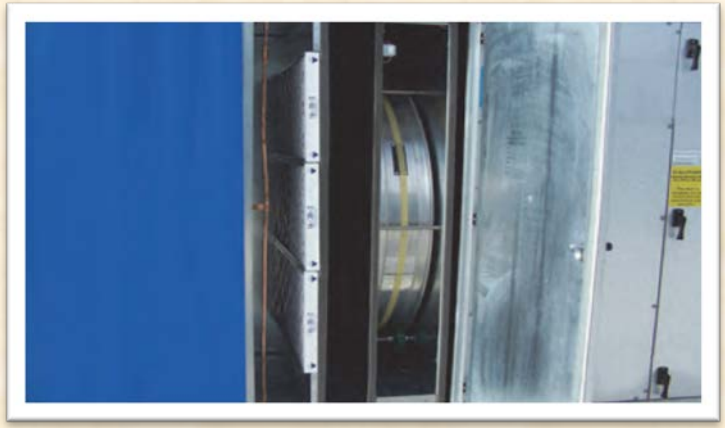
HVAC

- Desiccant wheel
- Heat Reclaim
- Reduced airflow / Fan savings

Kitchen

- Hood side panels
- DCKV responds to heat/smoke



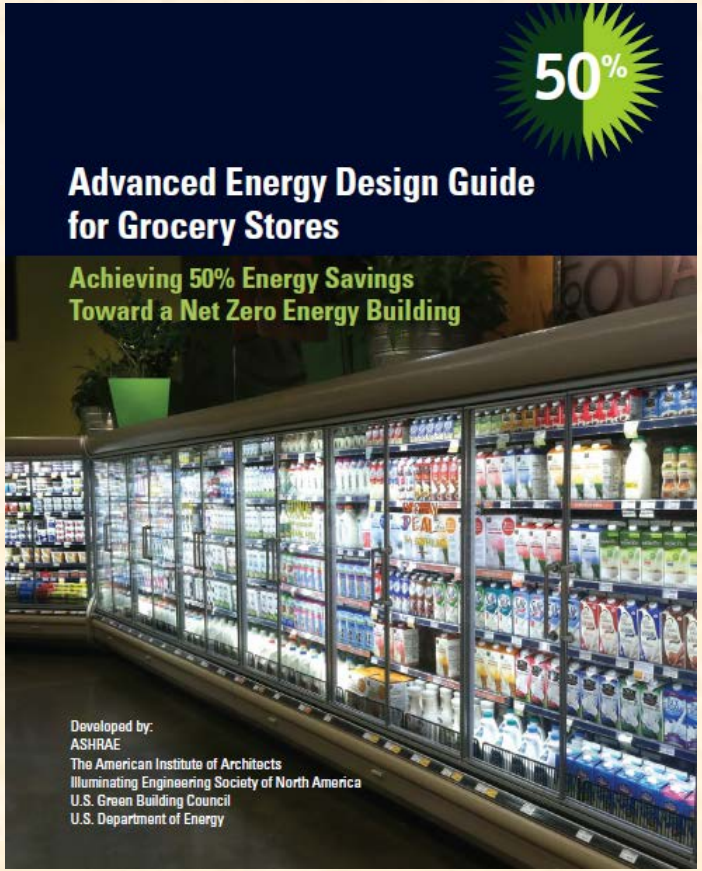


Source: 50% AEDG Grocery Stores from ASHRAE

50% AEDG for Grocery Stores

- Developed by AIA, ASHRAE, IES and USGBC; and supported by the U.S. DOE
- Grocery store owners and engineers on the committee
- Uses “off the shelf” technologies
- Recommendations fit on three pages
  - Practitioners consider this a menu of vetted options
- Significant “How-to” expertise shared
- May download for free; www.ashrae.org/freeaedg

Questions



www.ashrae.org/freeaedg

Source: 50% AEDG Grocery Stores from ASHRAE