

Making Sense of innovations in **energy-reduction technologies.**

$$V_s = V_a \sqrt{P_a / P_s}^{k+1}$$

$$F_B = \frac{\pi}{4} (P_H - P_L) (d_2^2)$$



Meeting Future Refrigeration Energy Regulations With Today's Technology Alternatives

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Regulations Overview

Commercial Refrigeration Equipment



- Effective **March 27, 2017** on New Equipment
- Commercial Ref. Equipment Measured in **kWh/24-Hour Day**
 - Each Equipment Class Assigned Equation
 - Variable: Total Display Area (TDA) or Volume

Walk-In Coolers and Freezers



- Effective **June 5, 2017** on New Components
- Walk-In Coolers and Freezers Measured in Three Major Components: **AWEF, MEC, R-Value Panels**
- **AWEF Measured Using AHRI-1250 Testing Standard**
 - Each Equipment Class Assigned Equation
 - Variable: Q = System Capacity

Automatic Commercial Ice Makers



- Effective **January 1, 2018** on New Equipment
- Automatic Commercial Ice Makers Measured in **kWh/100 lbs Ice**
 - Each Equipment Class Assigned Equation
 - Variable: H = Harvest Rate in lbs per 24 Hours

Commercial Refrigeration Equipment (CRE)

Equipment Classes

U.S. DEPARTMENT OF
ENERGY | Energy Efficiency &
Renewable Energy

Low or Medium
Temperature

Vertical, Semi-
Vertical, Horizontal,
or Service Over
Counter

Self-Contained
or Remote
Condensing

With or Without
Solid/Transparent
Doors

Commercial
Refrigerator
and Freezer

Equipment Affected



commercial refrigeration equipment that is not currently covered by energy conservation standards

can be tested with DOE TP



cannot be tested with DOE TP



No Energy Conservation Standards and Test Procedures
Salad Bars, Prep Tables, Refrigerated Buffet Tables

HOWEVER...

**If There Is a Reach-In Under Them,
Waiver From DOE Must Be Requested**

Walk-In Coolers and Freezers (WICF)

Equipment Classes

Medium or Low Temp

Multiplex Condensing

▪ Dedicated

- Single walk-in feed
- A packaged dedicated system where the unit cooler and condensing unit are integrated into a single piece of equipment
- A split dedicated system with separate unit cooler and condensing unit sections

▪ Multiplex

- Unit coolers matched to multiplex condensing rack system

Recip. Hermetic, Semi-Hermetic Recip, or Scroll Compression

< 9K Btu/h or
> = 9K Btu/h

Indoor or Outdoor

Medium or Low Temp

Dedicated Condensing



Automatic Commercial Ice Makers (ACIM)

Equipment Classes

- Affecting **Batch** Ice Machines, Also Known as “Cubers”
- Affecting **Continuous** Ice Machines, Also Known as “Flakers” or “Nuggets”



Cuber Modular



Cubers Self-contained



Flakers



Nugget



Hotel Dispensers

Air or Water
Cooled

Self-Contained
or Remote
Condensing

Various Harvest
Rates

Frozen Carbonated Beverage Machines Not Affected

Regulations Overview

Operating Condition Summary

Commercial Refrigeration Equipment



- **Case Temp:** Med Temp = 38 °F
Low Temp = 0 °F
Ice Cream = -15 °F
- **Ambient:** 75 °F
- **Evap, Return Gas, Sub-Cooling, Defrosts Are Dependent on System Performance**
- **AHRI — 1200**

Walk-In Coolers and Freezers



- **Evap:** Cooler = 23 °F
Freezer = -22 °F
- **Ambient:** Indoor = 90 °F
Outdoor = 35 °F/59 °F/95 °F
- **Return Gas:** Cooler = 41 °F
Freezer = 5 °F
- **Sub-Cooling:** 5 °F
- **Defrost:** Frequency, Electric vs. Hot Gas, Non-Adaptive vs. Adaptive
- **AHRI — 1250**

Automatic Commercial Ice Makers



- **Ambient:** 90 °F
- **Water:** 70 °F
- **Evap, Return Gas, Sub-Cooling, Are Dependent on System Performance**
- **AHRI — 810**

Equipment Regulations Compliance

Commercial Refrigeration Equipment

- **New Commercial Refrigeration Equipment Post Date of Mfg. March 27, 2017**
- **Replacement Equipment Can Be Non-Compliant if Mfg. Before March 27, 2017**

Walk-In Coolers and Freezers

- **New & Service Components (Unit Coolers, Panels, Doors) Post Mfg. June 5, 2017**
- **Refrigeration Equipment Does Not Need to Be Replaced for Compliance When Serviced After June 5, 2017**
- **Replacement Equipment Can Be Non-Compliant if Mfg. Prior to June 5, 2017**

Automatic Commercial Ice Makers

- **New ACIM Equipment Post Date of Mfg. January 1, 2018**
- **Replacement Equipment Can Be Non-Compliant if Mfg. Before March 27, 2017**

DOE Impact to Channel



	Equipment Mfg.	Wholesaler	Contractors	Design Consultants, Mfg. Reps, Dealers	End Users
1. Equip. Cost Adder	X	X	X	X	X
2. Footprint Increase and Space Management	X	X	X	X	X
3. Equipment Architecture Change	X	X	X	X	X
4. System Architecture Change	X	X	X	X	X
5. Inventory and Existing Stock Sell Thru Provision Mgmt.	X	X			
6. Compliance Approval Mgmt.	X	X			
7. Service Training and Equipment Availability (New Eq. Cross-Reference)	X	X	X	X	X
8. Equipment Performance and Product Reposition and Consolidation	X	X		X	
9. Installation Changes and Retrofit Frequency		X	X		X
10. Equipment Operation and User Interface Differences	X	X	X	X	X
11. New Maintenance Training	X	X	X	X	X

Polling Question 1

How Well Aware Are You About the Upcoming DOE 2017 Regulations?

- A. Not Aware at All**
- B. Somewhat Aware**
- C. Completely Aware**

Overall System Improvement Options

✓ Webinar Topics

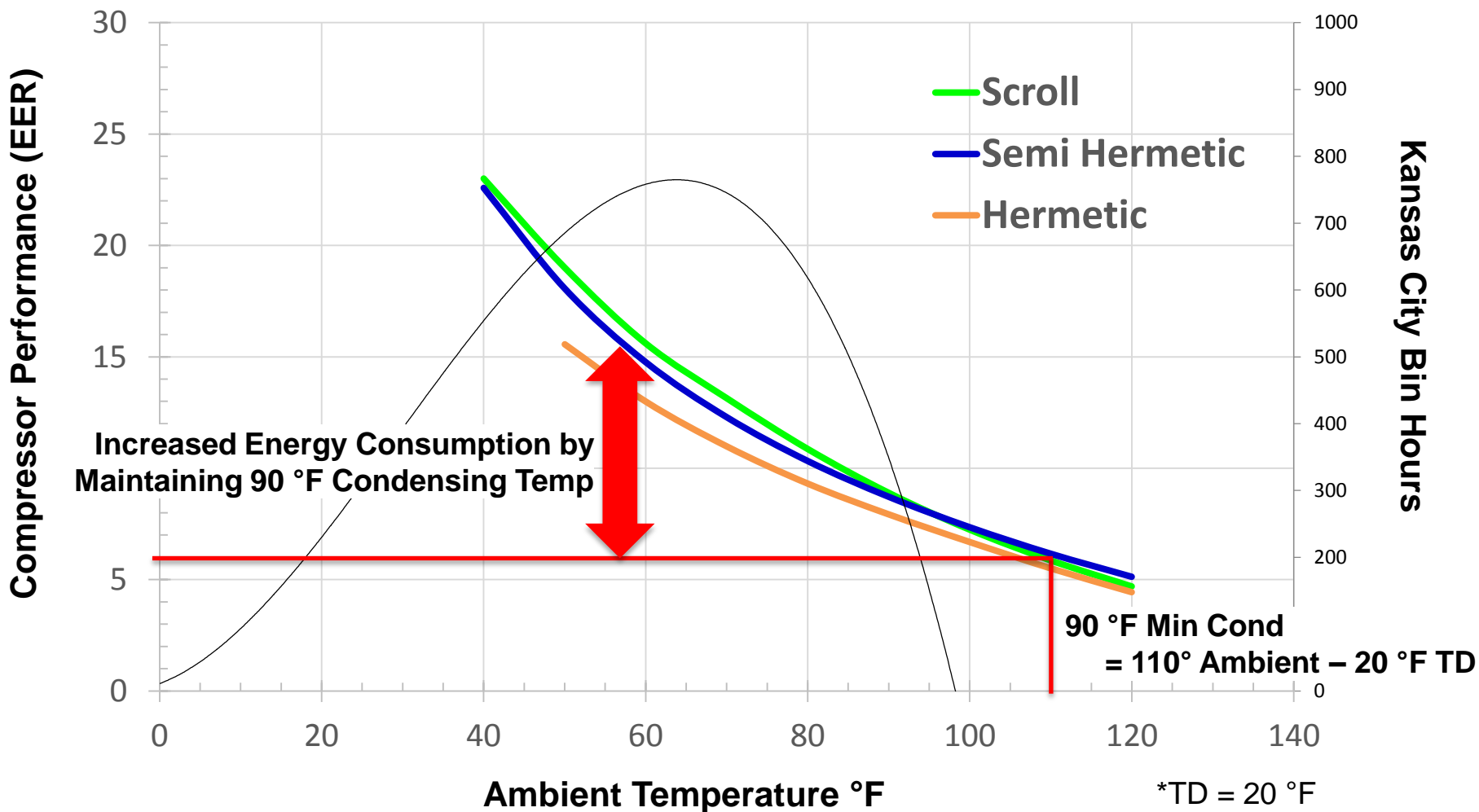
Compression Options	Commercial Refrigeration Equipment	Walk-In Coolers & Freezers	Automatic Commercial Ice Makers	System Options	Commercial Refrigeration Equipment	Walk-In Coolers & Freezers	Automatic Commercial Ice Makers
Highest Efficiency Compressor:				✓ Low Ambient Floating Head Pressures		●	
✓ Improved Compressor Motors (Addition of Run Cap)	●	●	●	✓ Improved Coil	●	●	●
✓ Compression Technology	●	●	●	✓ Improved Defrosts		●	
• Enhanced Vapor Injection		●		Alternative Refrigerants	●	●	●
• Variable Speed (BPM)	●	●	●	LED Lighting	●		
Fan Motors:				Improved Doors	●	●	
✓ EC Fan Motors	●	●	●	Improved Insulation	●	●	●
• Variable Speed Fan Motors	●	●	●	Improved Fan Blades	●	●	
Improved Auger Motor			●				

Polling Question 2

What Is Your Organization Doing to Meet the Upcoming DOE 2017 Regulations?

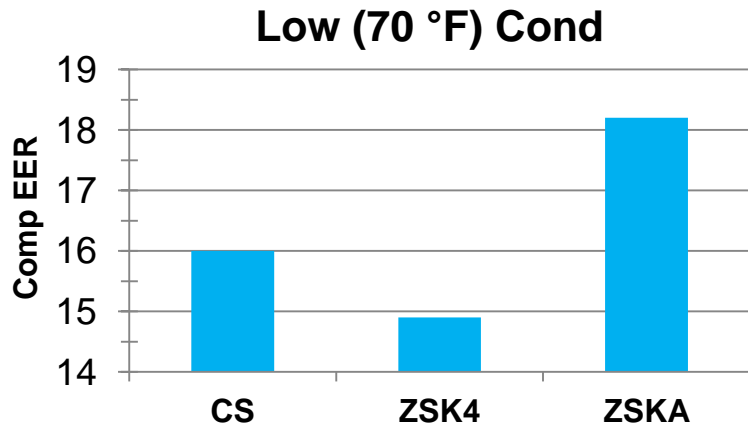
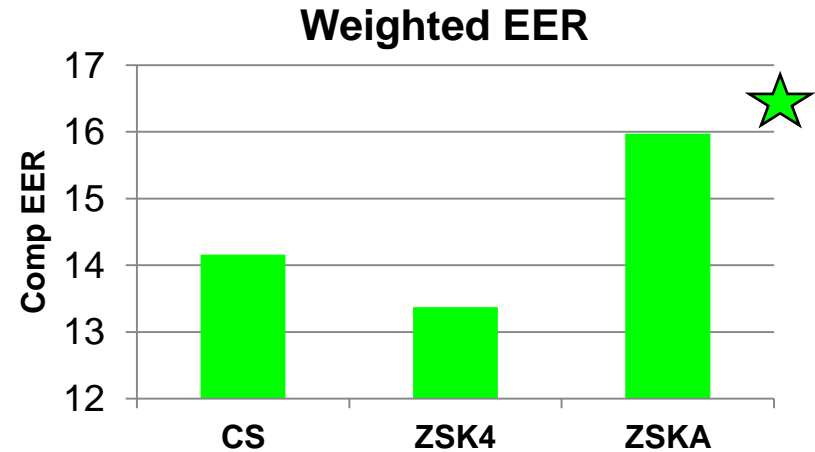
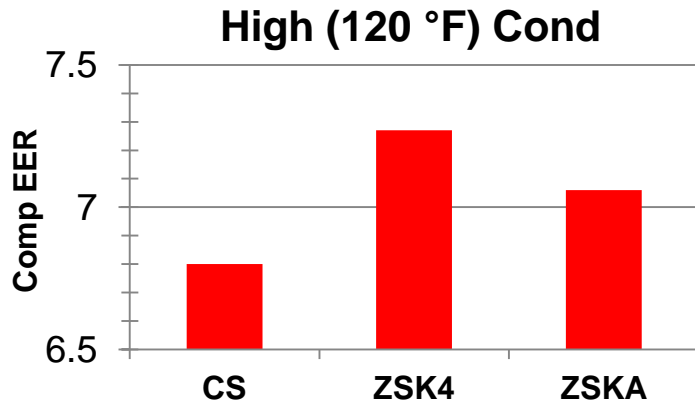
- A. No Actions Today and No Plans**
- B. No Actions Today, but Currently Working on Plans**
- C. Currently Taking Some Actions**
- D. Fully Invested With Resources to Address**

Low Ambients Enable System Efficiency Improvement Opportunities



Compressor Designs Evolved

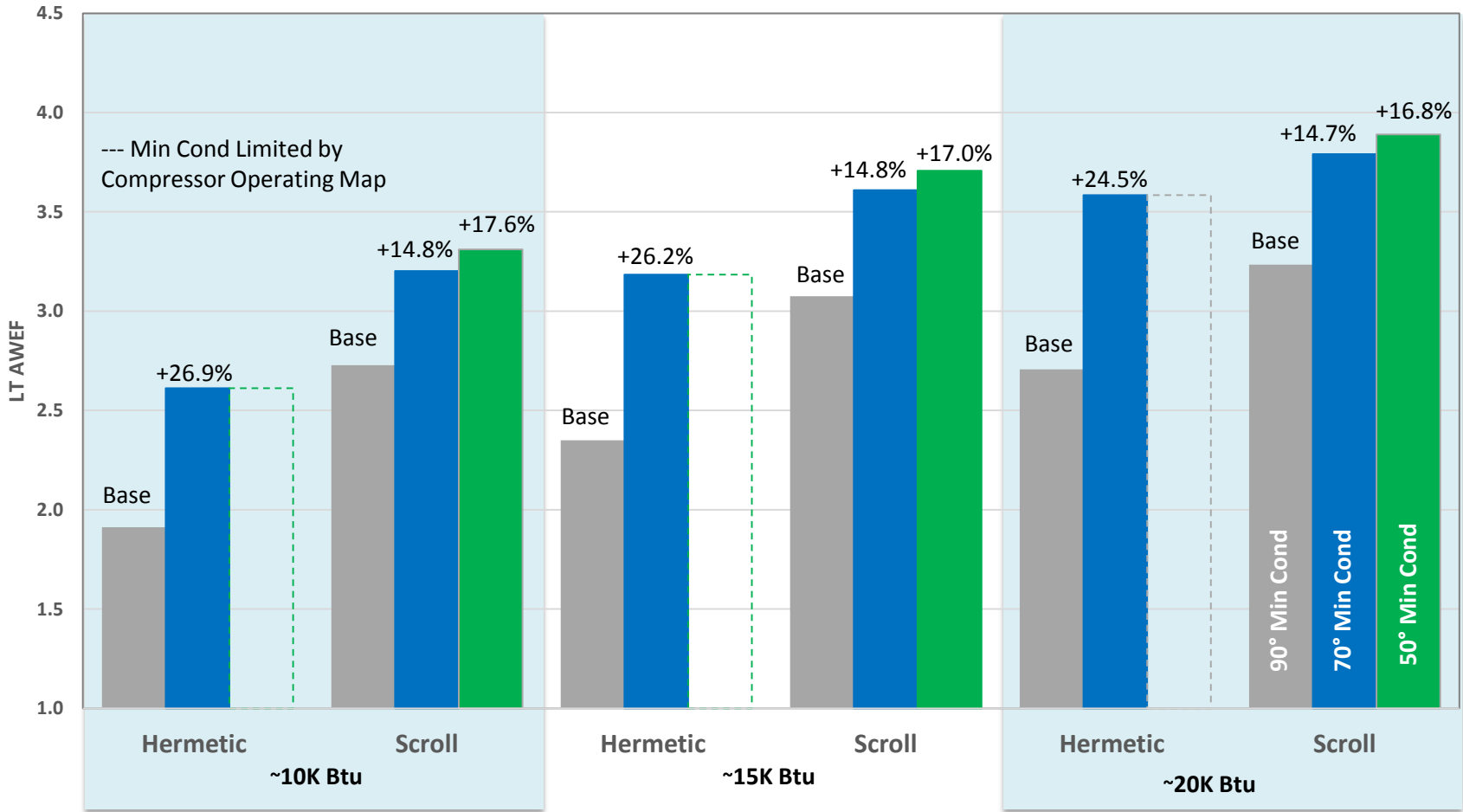
ARI Condition → Maximizing Efficiency Throughout Entire Year



Next Generation of Compressor Optimally Designed for Systems Taking Advantage of Low Condensing

* Medium Temp: Evap = 20 °F RG = ?? SC = ??
Weight EER: 20% @ ARI 80% @ 70 °F Cond

Systems With Low Minimum Ambient Capability Generate Better AWEF Scores

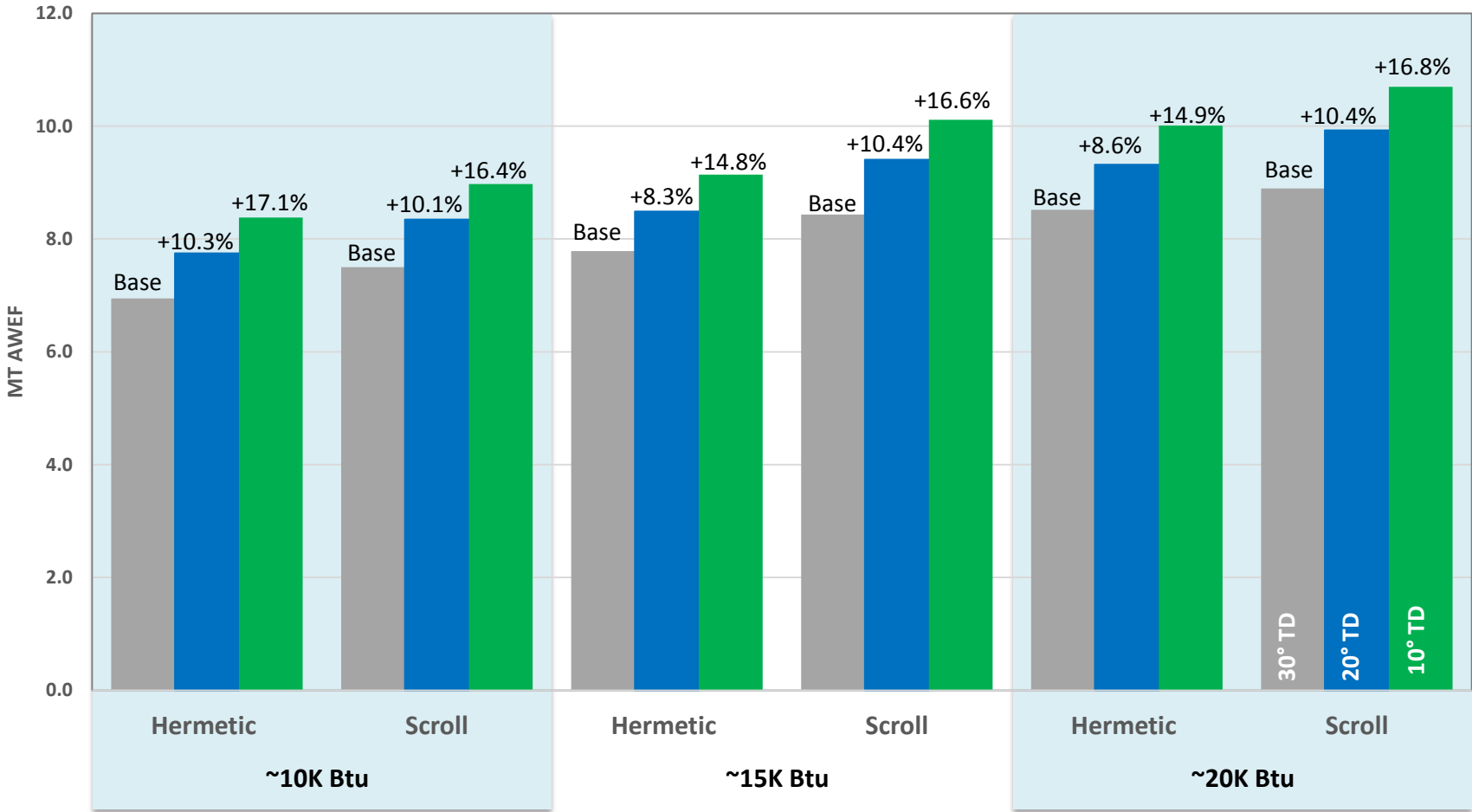


*Outdoor: -22 °F Evap. 5 °F RG 5°SC Electric Defrost

Coil Performance Improvement Options

- **Evaporating and Condensing Coils Are Uniquely Designed per Application and System Design**
- **Coil Performance Is Measured in Temperature Differential (TD)**
 - Evap TD = Refrigerated Air Temp. - Evap SST
 - Cond TD = Cond SCT - Ambient Temp.
- **Temperature Differential Can Be Improved by**
 - Increase Surface Area of Heat Exchanger
 - Overall Size
 - Fin Density and/or Fin Size
 - Improve Air Flow
 - Fan Blade Speed / Design
 - Coil Design: Counter-Flow, MicroChannel

Improved Coil Performance Significantly Impacts System Ability to Meet Regulations



*Outdoor: 23 °F Evap. 41 °F RG 5°SC

Fan Motor Types

Shaded Pole



~25% – 35% Efficient

- Single Set of Coils
- Relatively Inexpensive, Low Powered, Low Starting Torque and Efficiency

Permanent Split Capacitor (PSC)



~40% – 50% Efficient

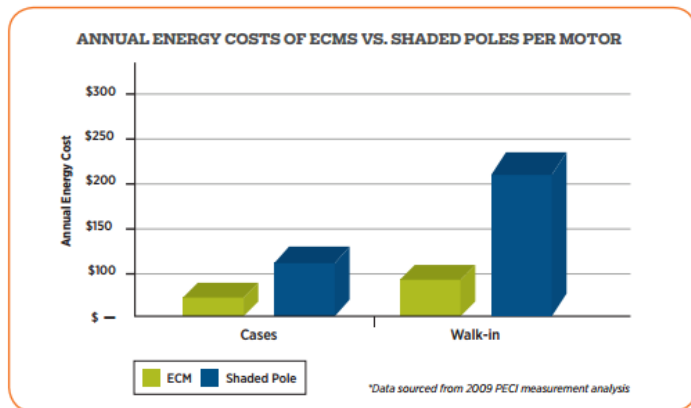
- On and Off Operation
- Electrical Output Not Controllable → No Speed Variance
- Energy Consumption Is Constant, Regardless if Load and Efficiency Are Lost

Electronically Commutated Motors (ECM)



~65% – 75% Efficient

- DC Design Allows for Variable Speeds
 - 50% Fan Speed at 12.5% Power
 - Reduces Fan Motor Energy Consumption
- Gradual Speed Increases to Match Loads
 - More Stable Head Pressure
 - More Stable Liquid Temperature
- Maintains Product Integrity
- Reduced Operating Costs
- Improves Compressor and Fan Motor Durability



Energy savings are estimates only. They are based on an average \$0.13/kWh energy cost in PG&E territory.

Compressor and Fan Induction Motors

Compressor & Fan Motor Types

Single-Phase Induction Motor Type	Peak Efficiency Range	Relative Cost
Shaded Pole	20–40%	\$
Resistance Start Induction Run (RSIR)	50–60%	\$\$
Capacitor Start Induction Run (CSIR)	50–60%	\$\$
Permanent Split Capacitor (PSC)	50–70%	\$\$
Capacitor Split Capacitor Run (CSCR)	50–70%	\$\$\$

Motor Improvement Selection

Equip.	Comp.	Cond. Fan	Evap. Fan	Auger	Pump
CRE	Improved to CSCR or 3-Ph	Improved to ECM	Improved to ECM	Brushless DC	
WICF					
ACIM					

Resulting Efficiency

Equip.	Comp.	Cond. Fan	Evap. Fan	Auger	Pump
CRE	85% → 90%	20% → 70%			
WICF		29% → 70%			
ACIM	45% → 55%	25% → 83%		70% → 83%	25% → 83%

Defrost Schemes

Electric Time-Based Defrosts

- Mechanical Timer Based
- Redundant and/or Wasted Defrost Cycles
- Less Efficient

Smart Electric Demand Defrosts

- Defrost as Needed
- Extra Sensors Needed to Monitor TD Drop Across Coil
- Controller and Algorithms Required

Hot Gas

- Recirculation of Hot Gas Discharged From Compressor to Warm Evaporator During a Defrost
- Controls Required
- Extra Piping Required

- **Coolers do not need to account for defrost in AWEF calculation**
- **Defrost energy and heat load apply only to freezers**
- **Demand-defrost controls yield 2.5 defrosts per day on average**
- **Nominal values are used for AWEF calculation**
- **Hot gas defrost typically results in higher/better AWEF than electric defrost**
 - Lower energy / lower heat load contribution

Putting It All Together...

Example Efficiency Improvement Analysis for CRE

Condensing Unit to System Contribution Assumptions

Example Customer System Energy Draws

Condensing Unit Improvements

Source: Adapted from ADL 1996

Typical Reach In Freezer/Refrigerator System					
	Condensing Unit	Anti-Sweat Heater	Electric Defrost	Evaporator Fans	Lighting
Energy Consumption	77.5%	9.5%	8%	4.5%	0.5%
Duty Cycle <small>Varies Depending Upon Size of System</small>	65%	100%	6%	100%	3%

	Transparent Door Reach-In Refrigerator
Current kWh/day	9.42
DOE 2017 kWh/day	6.46
Delta	31%

	Compressor Motor	Fan Motor	Coil	Cond. Unit EER
Current	CSIR	PSC	"X"	3.80
New	CSCR	ECM	+10% Fin Size	5.00
Resulting Efficiency Gain	+5–10%	+5%	+10–15%	+25–30%

Polling Question 3

What Design Option Is Your Organization Most Likely Going to Be Redesigning to or Supporting an Equipment Manufacturer to Design to?

- A. Low Condensing for WICF**
- B. Evaporator and Condenser Coil Improvements**
- C. Compression Technology Upgrades**
- D. System Component Upgrades**
- E. Other Technology Upgrades**

Wrapping up...

✓ Webinar Topics

Compression Options	Commercial Refrigeration Equipment	Walk-In Coolers & Freezers	Automatic Commercial Ice Makers	System Options	Commercial Refrigeration Equipment	Walk-In Coolers & Freezers	Automatic Commercial Ice Makers
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• Enhanced Vapor Injection		●		Alternative Refrigerants	●	●	●
• Variable Speed (BPM)	●	●	●	LED Lighting	●		
Fan Motors:				Improved Doors	●	●	
✓ EC Fan Motors	●	●	●	Improved Insulation	●	●	●
• Variable Speed Fan Motors	●	●	●	Improved Fan Blades	●	●	
Improved Auger Motor			●				

For More Information...

- **Past Webinars**

- [EmersonClimate.com/MakingSense](https://emersonclimate.com/making-sense)
- WICF AWEF Understanding
- Low Condensing
- EPA Regulations on Delisting Refrigerants

- **Future Webinars**

- Vapor Injected Scroll Technology 101 and Need for DOE 2017

- **E360: Emerson-Hosted Industry Stewardship Forum**

- [EmersonClimate.com/E360](https://emersonclimate.com/e360)
- Presentations on Variety of Refrigeration Topics Related to Foodservice and Food Retail

Thank You!

Questions?

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