Energy & Store Development Conference

E+SD 2014

September 7-10, 2014
St. Louis Union Station Hotel
St. Louis, MO

FMI
THE VOICE OF FOOD RETAIL

Refrigeration System Comparison
Hy-Vee Case Study

Intro by:

Jon Scanlan

Hy-Vee

Presentation by:

Danny Halel

Hussmann Corporation

a partnership of…

HyVee®
EMPLOYEE OWNED

EMERSON™
Climate Technologies

HUSSMANN®

Outline

Intent & Data

Locations & Architectures

Store-level Metrics

Architecture Metrics

Conclusion & Closing

Preface

You can't compare apples-to-apples *unless* you *only* have apples…
But, you *can* compare commonalities between apples and oranges.
~TF

apples to apples

not apples to apples…
but, still fruit

Our intent… To generate metrics, derived from commonalities among refrigeration architectures, which may provide insight into how those architectures compare.

Definitions

- **Architecture:**
  Type of refrigeration system including its condenser (i.e. distributed, rack, secondary loop, DX, etc.)

- **Refrigeration [Energy]:**
  Sum of: Compressors + Condensers + Cases (lights, fans, anti-sweats, etc.) + Defrost

- **Compressor COP (Coefficient of Performance):**
  Required capacity [as kW] / comp input kW (ZF15K4E comp at -7F SST and 110F SCT has a capacity of 23,781 BTU/hr. and pulls 4.08 KW the COP = 23,781/(4.08*1000*3.41) = 1.71 (NOTE: The higher the COP, the better)

- **System COP:**
  Required capacity [as kW] / input kW (comp + cond + pumps + evap fans + load contributors‡)

- **Energy vs Power:**
  Energy = consumption in kWh
  Power = demand in kW

‡ contributors = case lights, defrost & anti-sweats

Outline

Intent & Data

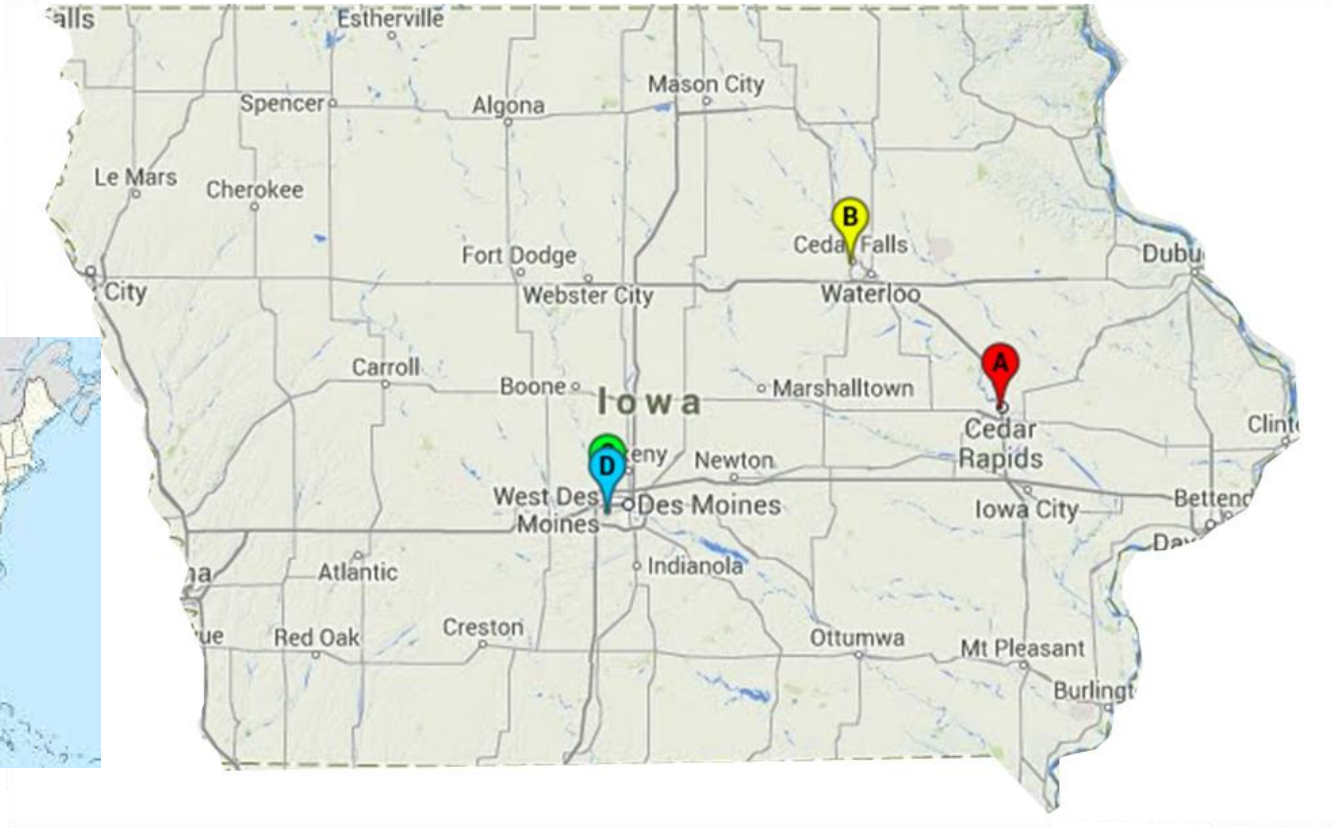
Locations & Architectures

Store-level Metrics

Architecture Metrics

Conclusion & Closing

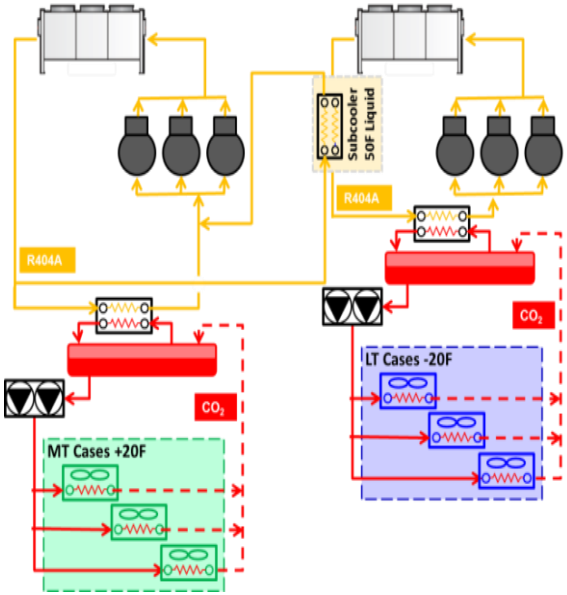
Locations Chosen



A. Open-drive DX Racks / Evap. Cooled	Cedar Rapids, IA
B. Multiple DX Racks/Distributed (1)	Cedar Falls, IA
C. MT & LT Secondary CO_2 Racks	Urbandale, IA
D. Distributed DX	West Des Moines, IA

C

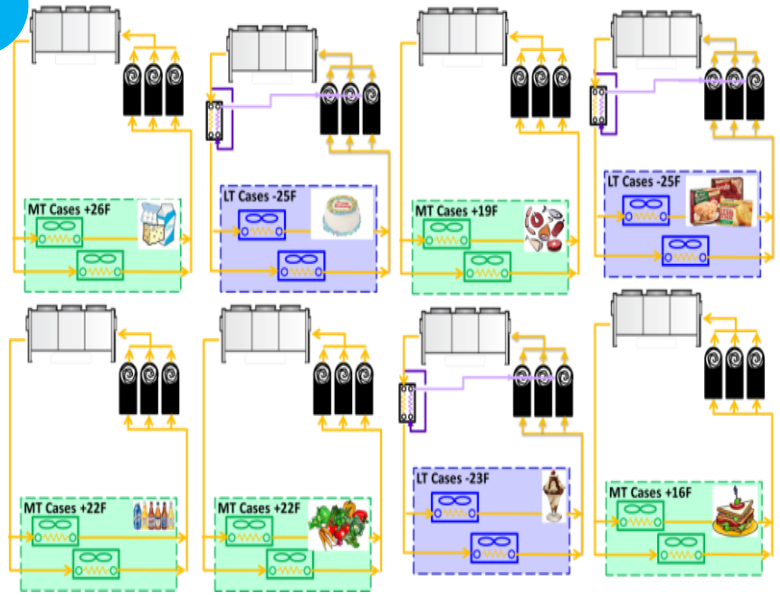
Urbandale @ 95k sq-ft



Centralized Liquid CO_2 Recirc. Rack

D

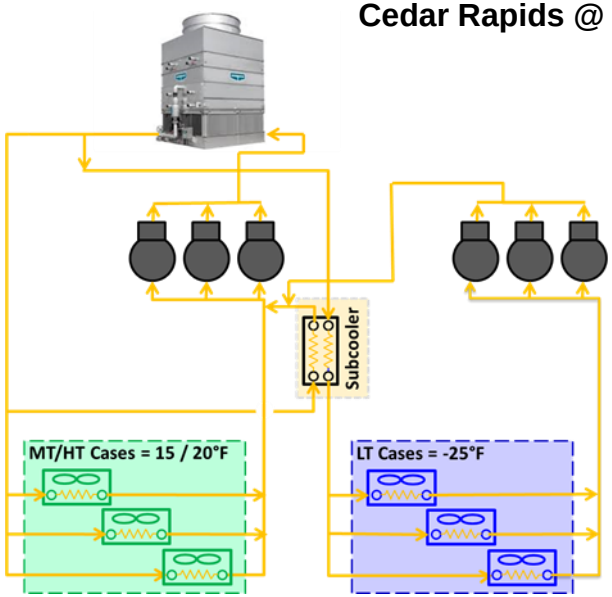
W. Des Moines @ 83k sq-ft



Distributed DX Racks

A

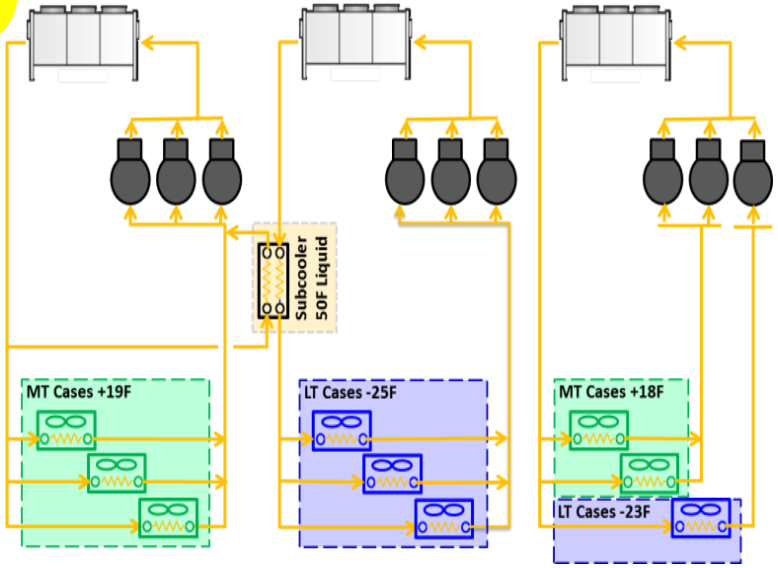
Cedar Rapids @ 67k sq-ft



Centralized DX Rack / Evaporative Cooled

B

Cedar Falls @ 81k sq-ft



Centralized DX Rack

Architectures

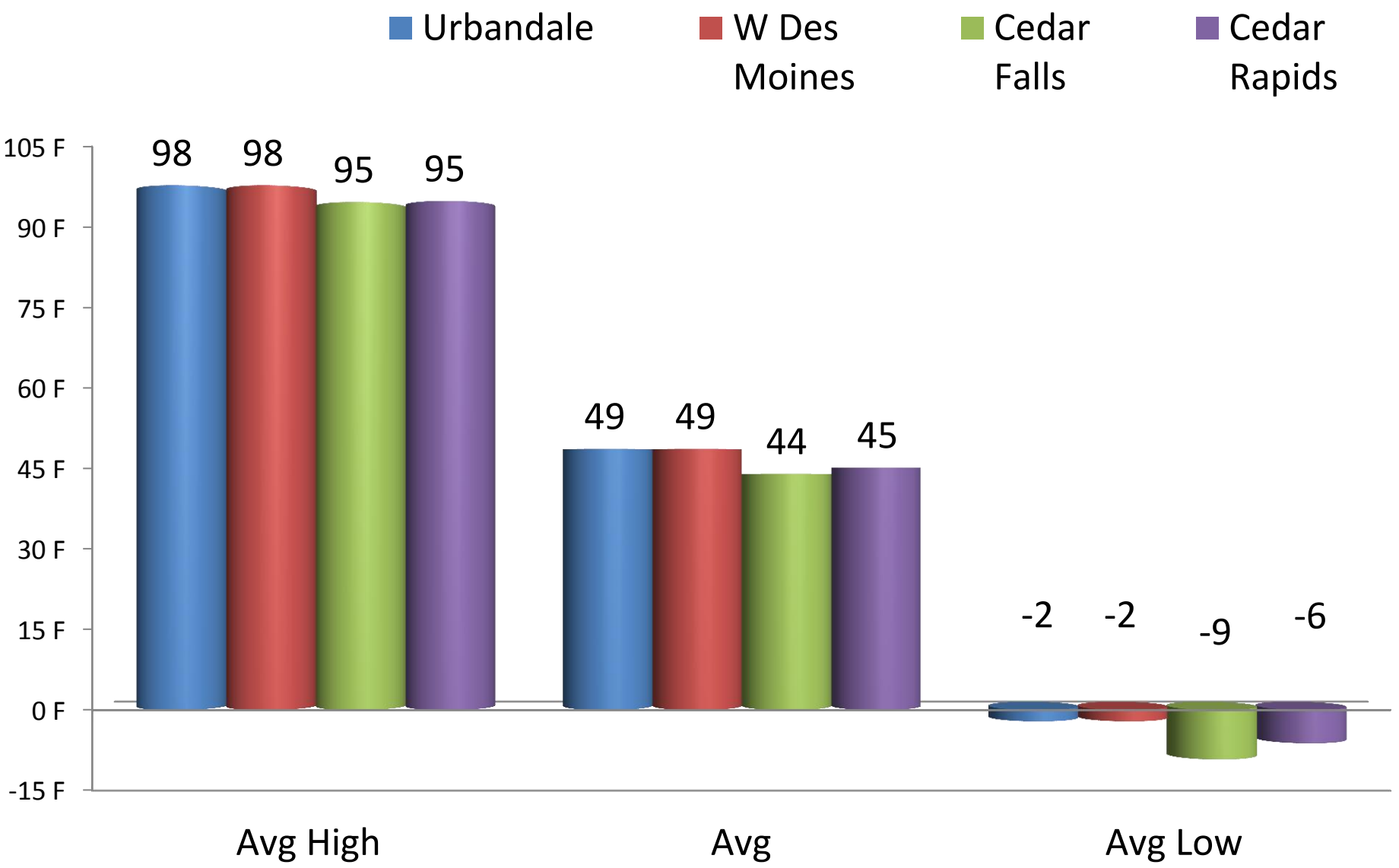
Location	LT	MT	Cond	LEDs	Doors
Urbandale	R-404A & CO_2 LR	R-404A & CO_2 LR	Air	LT & MT Dairy	LT & MT Dairy
W. Des Moines	R-404A DX Distributed	R-404A DX Distributed	Air	NO	LT
Cedar Falls	R-404A DX Rack	R-404A DX Rack & Distributed (for wine/spirits)	Air	NO	LT
Cedar Rapids	R-404A DX Open Drive	R-404A DX Open [Direct] Drive	Evap	NO	LT

Note: Urbandale MT Dairy has 256 ft. of Open Throat cases applied with doors reducing the load from 1,260 BTU/ft. to 252 BTU/ft. (an 80% reduction)

Summary Case Data - LT

Location	App.	Fans (Watts)/Type	Lights (Watts)/Type	Total (Watts)	Total by store (Watts)
Urbandale	LT	4,815 HE	4,144 LED	**8,959**	**38,402**
	MT	12,127 HE	17,316 LED/Fl	**29,443**	
W. Des Moines	LT	13,321 Std.	12,412 Fl	**25,733**	**73,195**
	MT	21,252 HE	26,210 Fl	**47,462**	
Cedar Falls	LT	13,995 Std.	14,520 Fl	**28,515**	**76,254**
	MT	20,164 HE	27,575 Fl	**47,739**	
Cedar Rapids	LT	6,927 HE	11,528 Fl	**18,455**	**66,372**
	MT	22,771 HE	25,146 Fl	**47,917**	

Weather (NOAA)



Outline

Intent & Data

Locations & Architectures

Store-level Metrics

Architecture Metrics

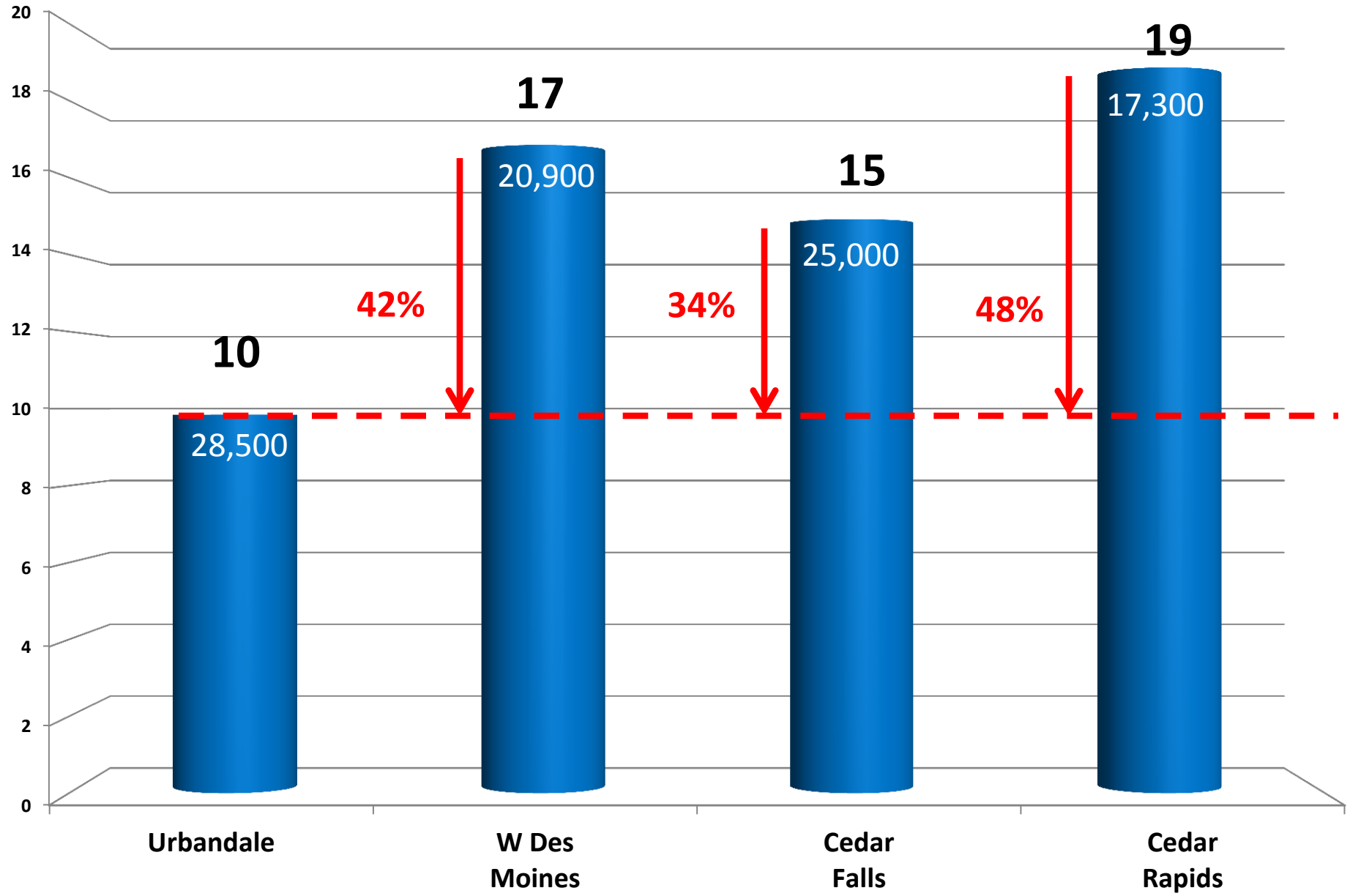
Conclusion & Closing

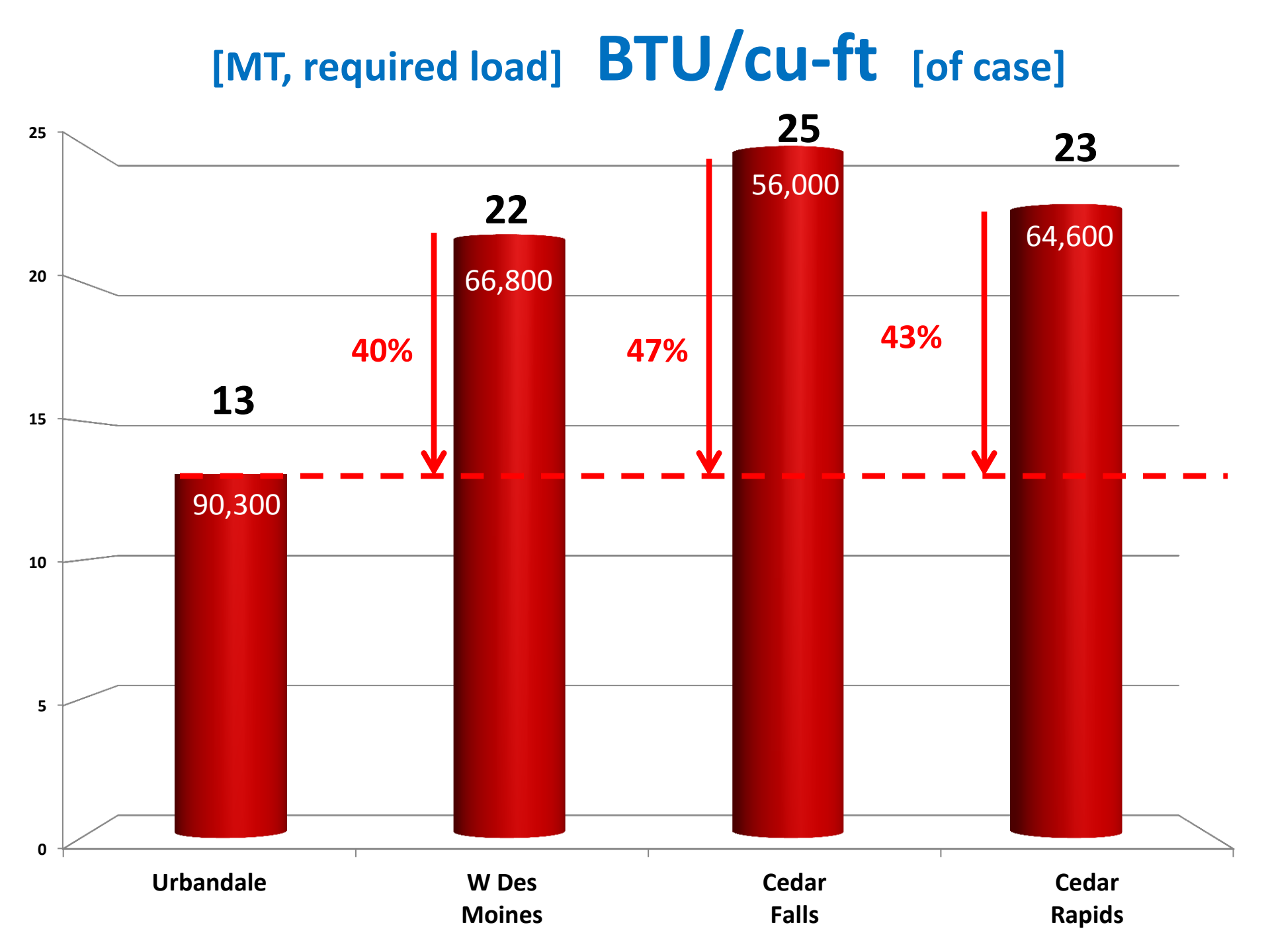
Store Characteristics

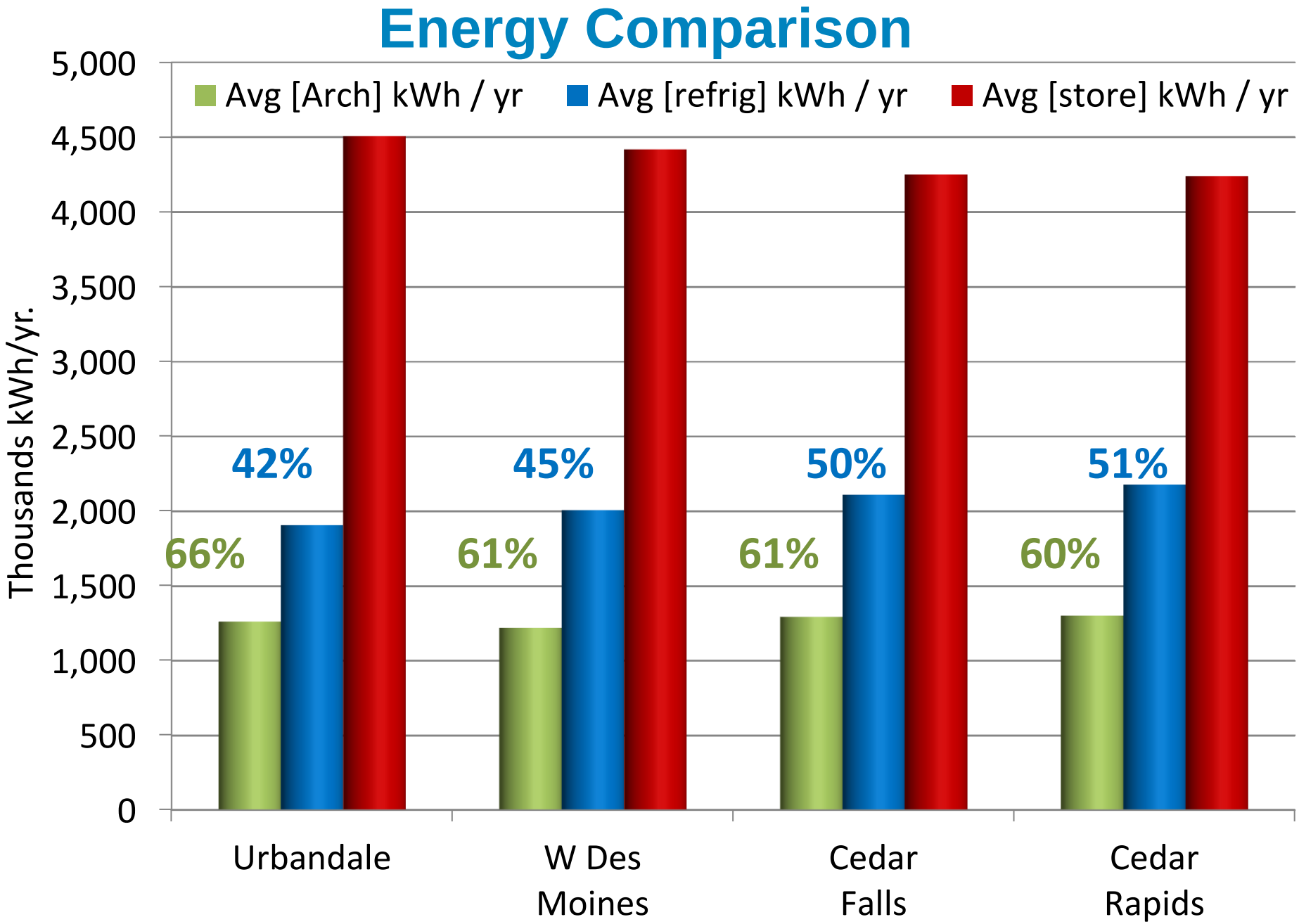
Location	Sq-ft of store	Case&WI sq.ft./ Store sq-ft	Total store energy kBTU/sq-ft	Linear Ft of case	Refrigeration Load *MBTU*	LT *% of load*	MT *% of load*
Urbandale	95,188	13.5%	223	1,942	1,463	19.2%	80.8%
W. Des Moines	82,982	12.3%	242	1,613	1,803	19.5%	80.5%
Cedar Falls	80,631	12.0%	264	1,787	1,767	21.2%	78.8%
Cedar Rapids	67,311	13.3%	315	1,508	1,799	18.2%	81.8%

Note: kBTU = gas & electric energy – total store

[LT, required load] BTU/cu-ft [of case]




[MT, required load] BTU/cu-ft [of case]
25
20
15
10
5
0
13
90,300
22
66,800
25
56,000
23
64,600
40%
47%
43%
Urbandale
W Des Moines
Cedar Falls
Cedar Rapids


Energy Comparison
Avg [Arch] kWh / yr
Avg [refrig] kWh / yr
Avg [store] kWh / yr
Thousands kWh/yr.
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
66%
42%
61%
45%
61%
50%
60%
51%
Urbandale
W Des Moines
Cedar Falls
Cedar Rapids

Outline

Intent & Data

Locations & Architectures

Store-level Metrics

Architecture Metrics

Conclusion & Closing

COP Impact & SSTs

	Urbandale		W. Des Moines		Cedar Falls		Cedar Rapids	
	Averaged Compressor COP & Saturated Suction Temps							
	CO_2 Secondary		Distributed		DX + Distributed		DX [OD] + E.Con.	
	COP	SST	COP	SST	COP	SST	COP	SST
LT	2.07	-27	2.45	-22	2.52	-24	2.61	-25
MT	3.18	13	4.33	19	4.46	18	5.26	18

	Architecture COP (includes comp, cond., fans, pumps) & Drop from Comp. COP							
	Urbandale		W. Des Moines		Cedar Falls		Cedar Rapids	
	CO_2 Recirc.		Distributed		DX + Distributed		DX [OD] + E.Con.	
	COP	% Drop	COP	% Drop	COP	% Drop	COP	% Drop
LT	1.79	14%	1.84	25%	1.83	27%	1.74	33%
MT	2.38	25%	2.92	32%	2.74	38%	3.61	31%

Condenser Efficiencies

% / °F	Urbandale	W. Des Moines	Cedar Falls	Cedar Rapids
	Air	Air	Air	Evaporative
LT	1.36%	1.93%	1.27%	1.13% (air)
MT	2.17%	2.51%	1.66%	0.87% (H2O)

If we have a 1 degree change in ambient outdoor temperature the % shown is the increase or decrease in energy used.

Outline

Intent & Data

Locations & Architectures

Store-level Metrics

Architecture Metrics

Conclusions & Closing

Case Study Conclusions

- There is not one solution for every application.
- Energy impact to the architecture and total store energy is significant when adding doors & LEDs on cases.
- The old assumption of 50% of the total electrical load is the refrigeration system is true, however, this can be reduced by paying close attention to the load structure (i.e. LED's, Doors, EEF, VFD).
- The impact to COP is negatively affected when adding the condenser and evaporator energy however, this can have a smaller impact by paying attention to loads such as fans (including VFD's on condensers), LED lights and doors.
- The original goal of determining the "best" architecture cannot be derived from this study. [Stay tuned for the sequel.]
- Leak management must be considered, yes even in an energy study.

Lessons Learned

- Determine scope and goals – make sure the infrastructure you have designed and have in place allows you to accomplish the goals
- Know your data and data points – consistency is key.
- Sensors, sensors, sensors! Calibration, calibration, calibration!
- Give ample time to evaluate – some “issues” don’t show up until the end
- There is no one system that is the silver bullet, each store design has specific needs and these must be addressed.
- Working in a vacuum – sucks!

Special thanks to all project teams…

HyVee
EMPLOYEE OWNED

Jon Scanlan
Store Directors
Maint. Techs

HUSSMANN®

Tobey Fowler
Danny Halel
Shannah Eitter
John Terry
Jeff Hosbond

EMERSON
Climate Technologies

Autumn Nicholson
Ben Rola

Myles Crubel
(of EMC)

Questions?

"limit of one per person per day"