Energy & Store Development Conference

E+SD 2013

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Refrigerants Update

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Emerson Climate Technologies

Agenda

- Regulations
  - European F-Gas
  - North American HFC Phase Down Proposal
  - EPA's SNAP
- Lower GWP Refrigerants
  - Options
  - Performance By Application
  - Choices By Application
- Summary

European F-Gas Regulation

- Nov 2012: European Commission Proposed Revisions With F-Gas Phase Down And Some Specific Bans
- June 2013: European Committee For Environment, Public Health And Food Safety (ENVI) Came Up With A Stricter Phase Down And Several Application Specific Bans
- European Parliament Likely To Take This Up In November With Possible Vote In Early 2014
- Why Is This Important For Us? First HFC Regulation (Excluding Taxes) Of Its Kind And Being Watched By All For Impact

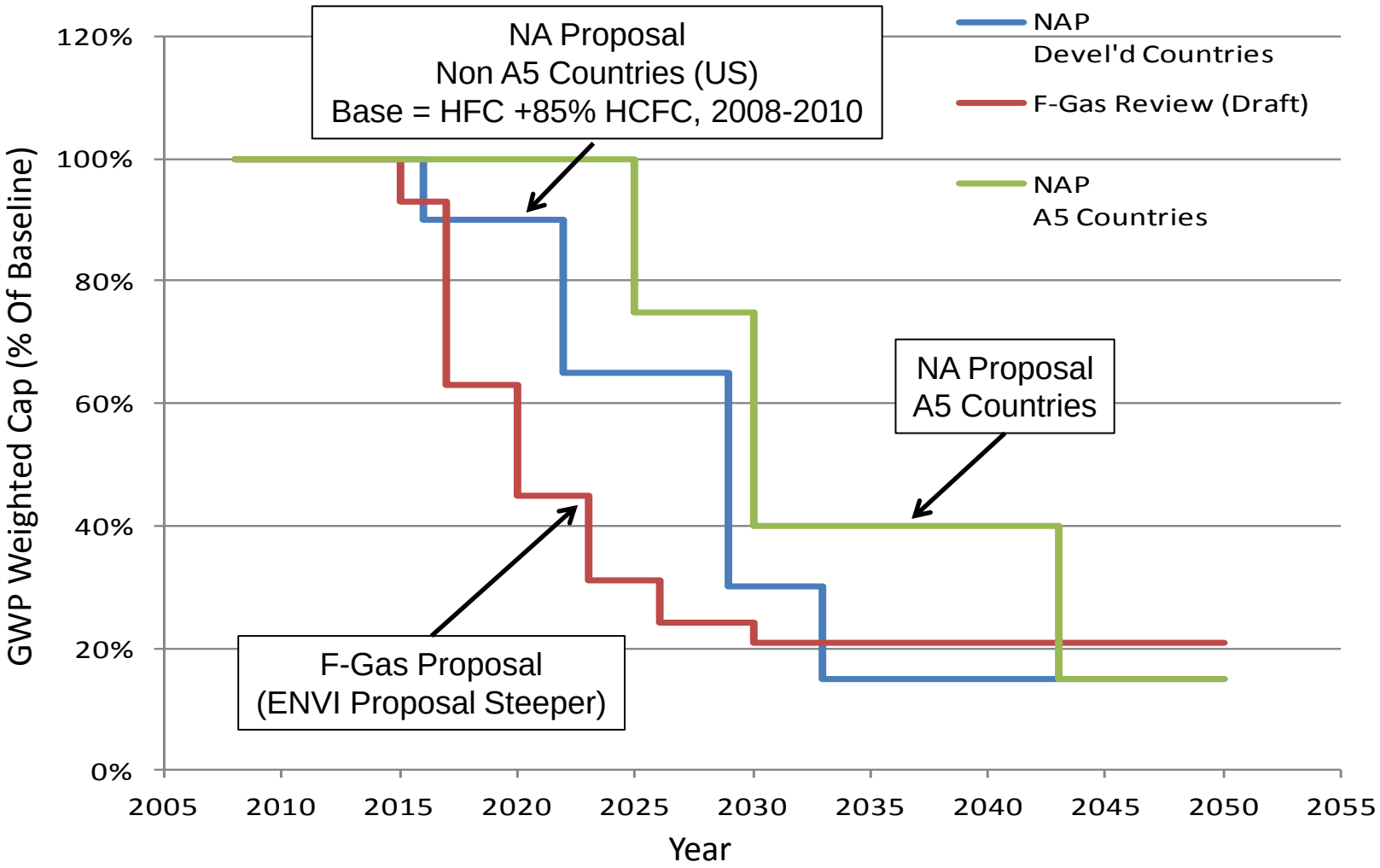
Refrigerant Bans Per ENVI Amendment - New Equipment

	Step 1									Step 2								
	Year	R404A	R407A/C/F	R410A	R32	HFO Blends	HFOs	CO2	HC's	Ammonia	Year	R404A	R407A/C/F	R410A	R32	HFO Blends	HFOs	CO2	HC's	Ammonia
Domestic Refrigeratiors/Freezers	2015																			
Commercial Refrigerators/Freezers (hermetically sealed)	2015										2018									
New Stationary Refrigeration Equipment (unless below -50ºC)	2016										2020									
New Mobile Refrigeration Equipment											2025									
Movable Room A/C (hermetically sealed)											2020									
Stationary A/C Equipment											2021									
A/C Equipment - Cargo Ships											2020									

*Residential & Commercial HP (Non-reversible Heat Pumps) Not In Scope

ENVI Amendment Severely Restrictive; Actual Rule Voted On May Be Compromise Between This And The EU Commission Proposal

HFC Phase-Down Proposals: North American Proposal (NAP) And European F-Gas



EPA's SNAP Stakeholder Meeting

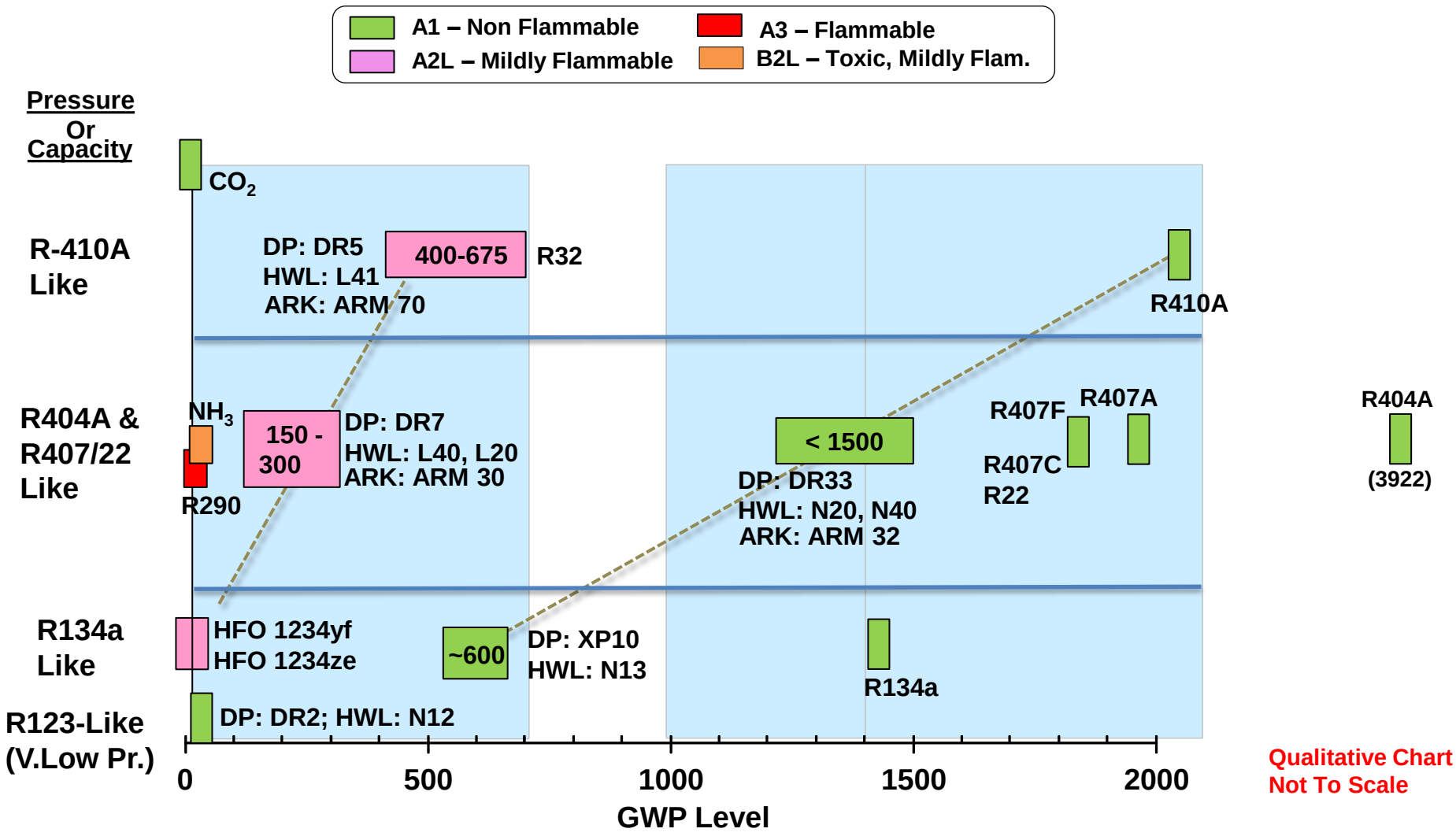
- Held On 8/22/13, In Washington, D.C. As Follow Up To US/China Presidents' Joint Statement, June 2013; About 80+ In Attendance
- Meeting Primarily To Hear Stakeholder Comments On Using SNAP Authority To Reduce High GWP HFC Use
- Comments From The Alliance For Responsible Atmospheric Policy, True Manufacturing, DuPont, Daikin, And Several NGOs Among Many
- EPA Promised Several More Discussions, Some Sector Focused To Discuss Proposals
- Rajan's Read:
  - Actions From The EPA On Some Foam, Aerosols, Auto AC (R134a) And Commercial Refrigeration (Focus On Supermarket And R404A Use In New Systems?)
  - Timing Unknown, But Enough Reduction To Contribute To HFC Phase-down Proposal Should Be Expected

Agenda

- Regulations
  - European F-Gas
  - North American HFC Phase Down Proposal
  - EPA's SNAP
- **Lower GWP Refrigerants**
  - **Options**
  - **Performance By Application**
  - **Choices By Application**
- **Summary**

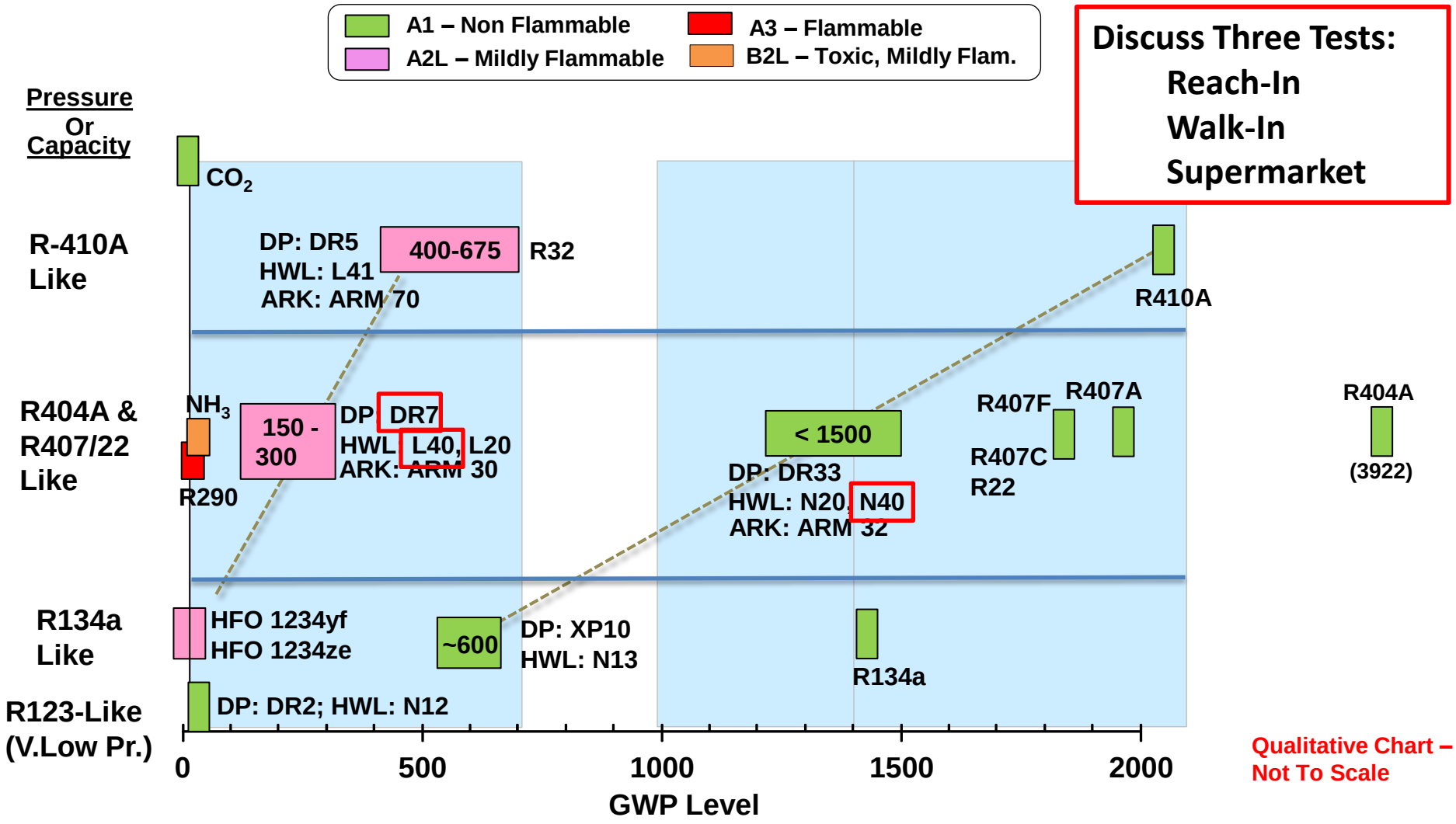
Lower GWP Refrigerant Landscape

Options For New & Existing Applications

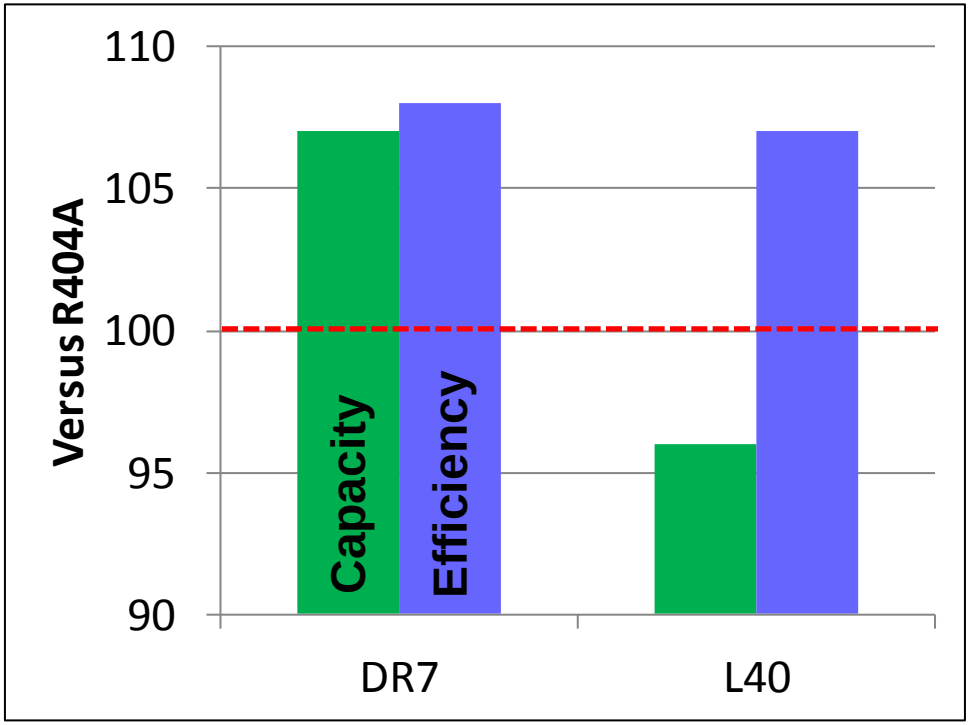


Lower GWP Refrigerant Landscape

Options For New & Existing Applications



Reach-In Application: L40/DR7 Vs R404A

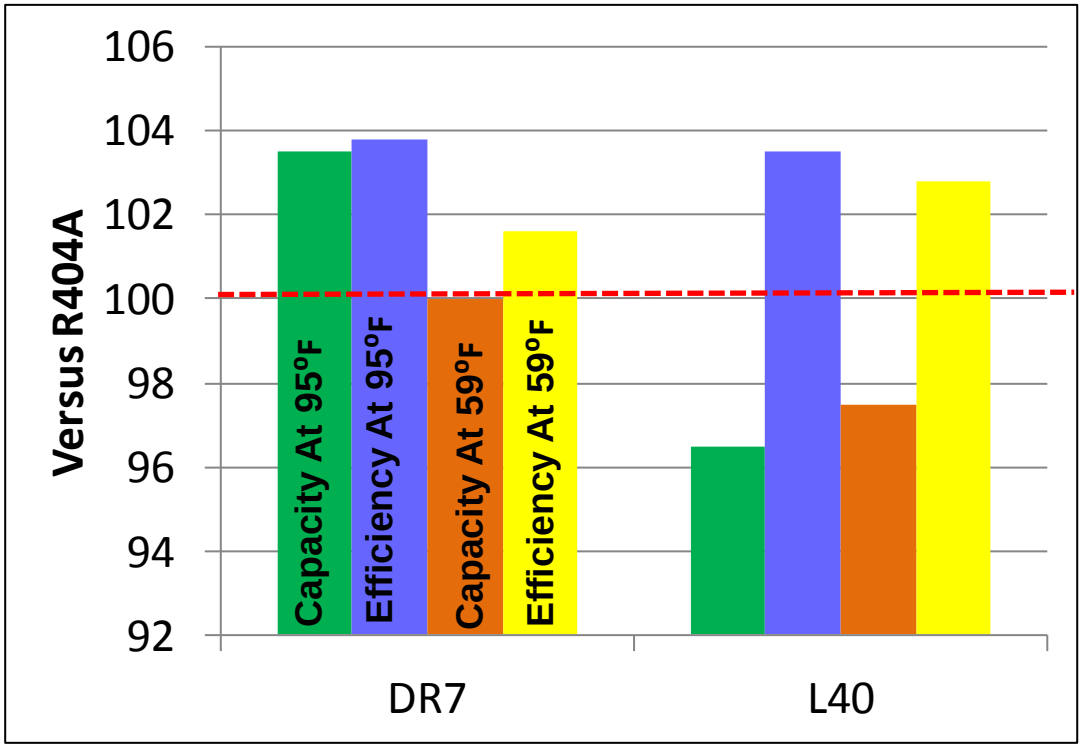


System Testing – Mid Point Performance

Tests Conducted In Emerson Facility

- 0.5 HP (Reciprocating Comp.), Freezer Application, Tested Per ASHRAE 72, Steady State With No Cycling Or Door Openings; Adjustment To Charge And TXV Setting Only
- Room Ambient: 23.9°C (75°F) And Reach-In Air Temperature: -17.8°C (0°F) With Product Simulators Loaded
- Note That Compressor And System Were Not Redesigned Or Optimized For These New Blends With Glide

Walk-In Application: L40/DR7 Vs R404A



- 3.0 HP (Scroll Comp.), Freezer Application, Tested Per AHRI 1250, Adjustment To Charge And TXV Setting Only
- Room Ambient: 35°C (95°F), 15°C (59°F) And Box Air Temperature: -23.3°C (-10°F)
- Again, Compressor And System Were Not Redesigned Or Optimized For These New Blends With Glide

System Testing – Mid Point Performance

Tests Conducted In Emerson Facility

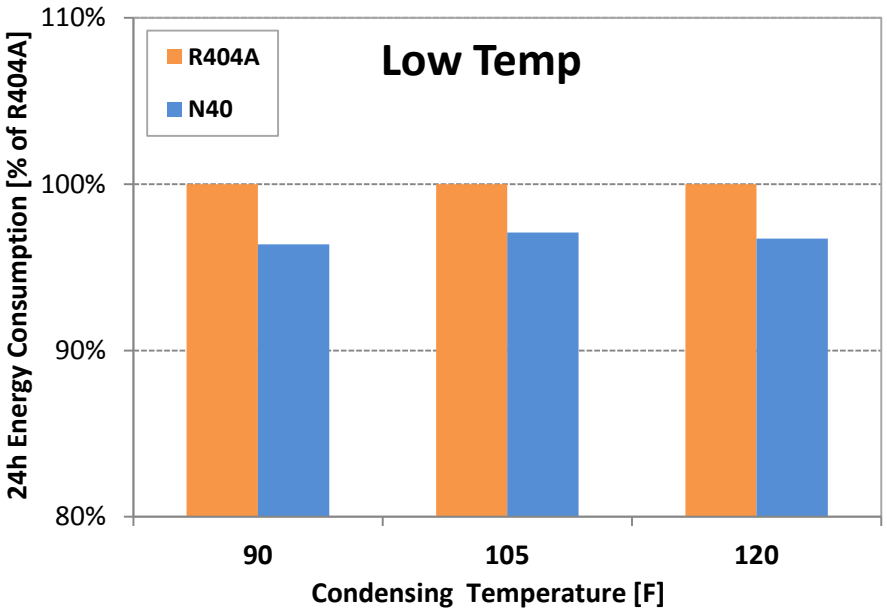
Supermarket Application – N40 vs R404A

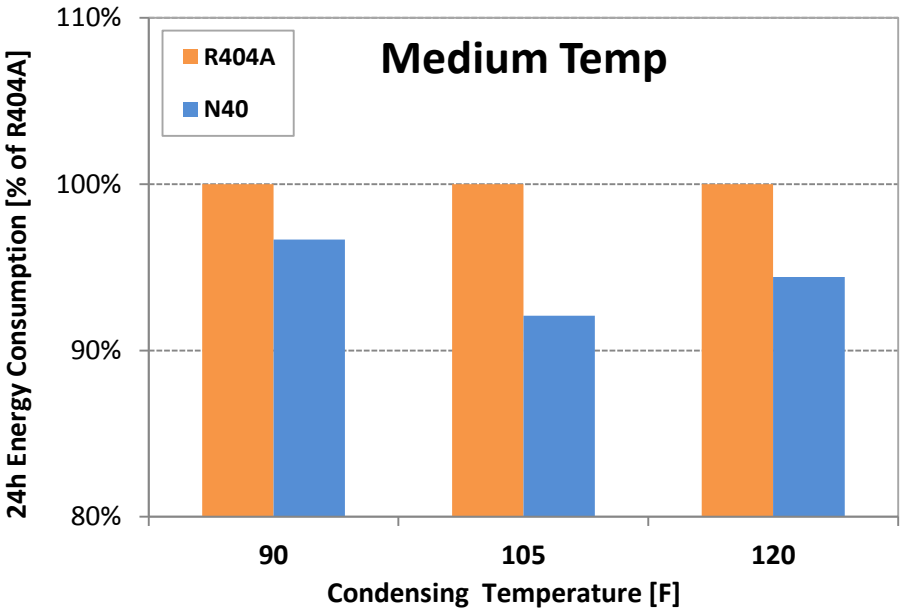
- Tests Conducted At Emerson Supermarket Facility
- Centralized DX System With Open And Closed Door Cases And Food Simulators Plus Make-Up Heater Load And Air-Cooled Condensers
- Low Temperature Rack: ZF25, ZF34, ZFD41 (Digital)
- Medium Temperature Rack: ZB95, ZBD76 (Digital)

Merchandise Area


Mechanical Room

24-Hr Energy Comparison

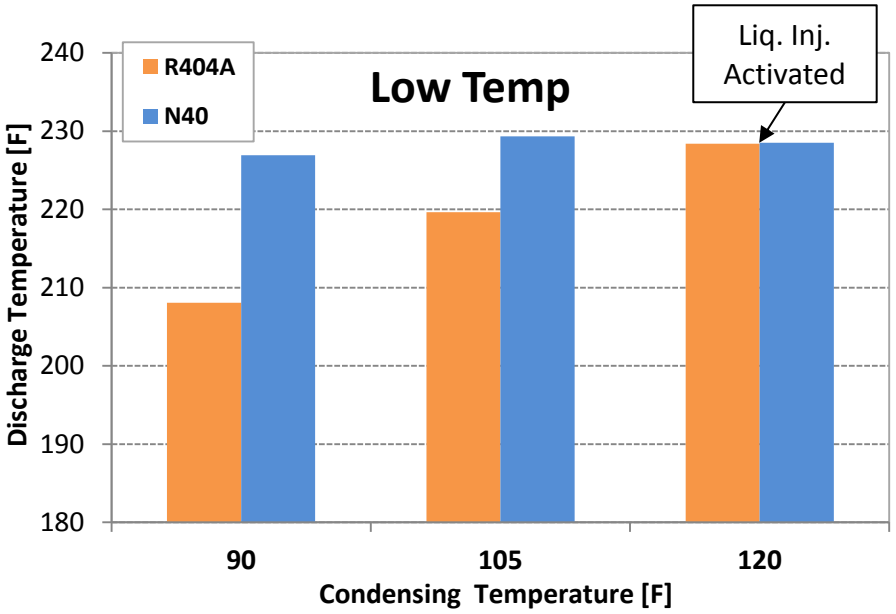


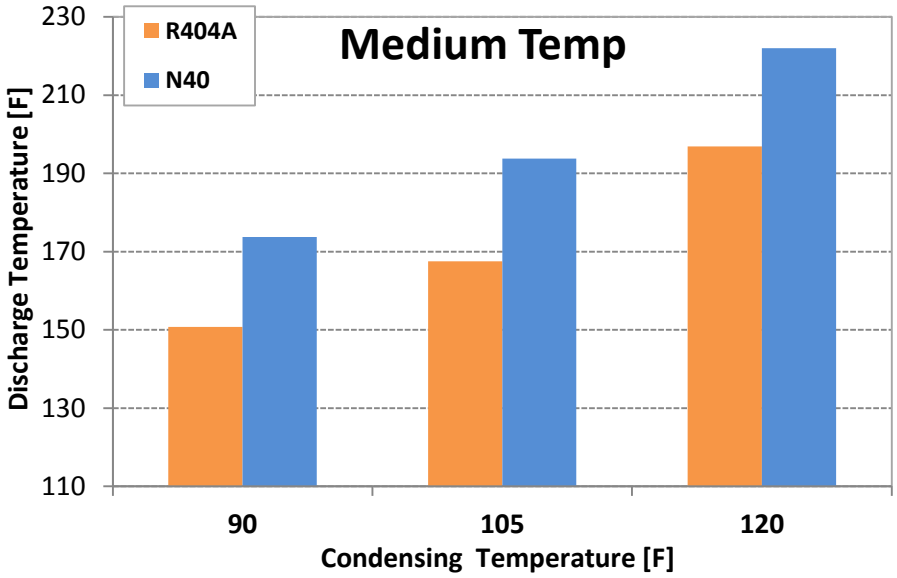


In These Tests, N40 Consumed Approx. 5% Lower Energy Than R404A

Discharge Temperature – R404A vs N40

Results From The Supermarket Test At Emerson





N40 Similar To R407A In Discharge Temperature Behavior
Measured Test Results Confirm Theory

Theoretical Discharge Temperature

Lower GWP Replacements To R404A Will Run Hotter

Medium Temperature: 20F Suction, 120F Condensing

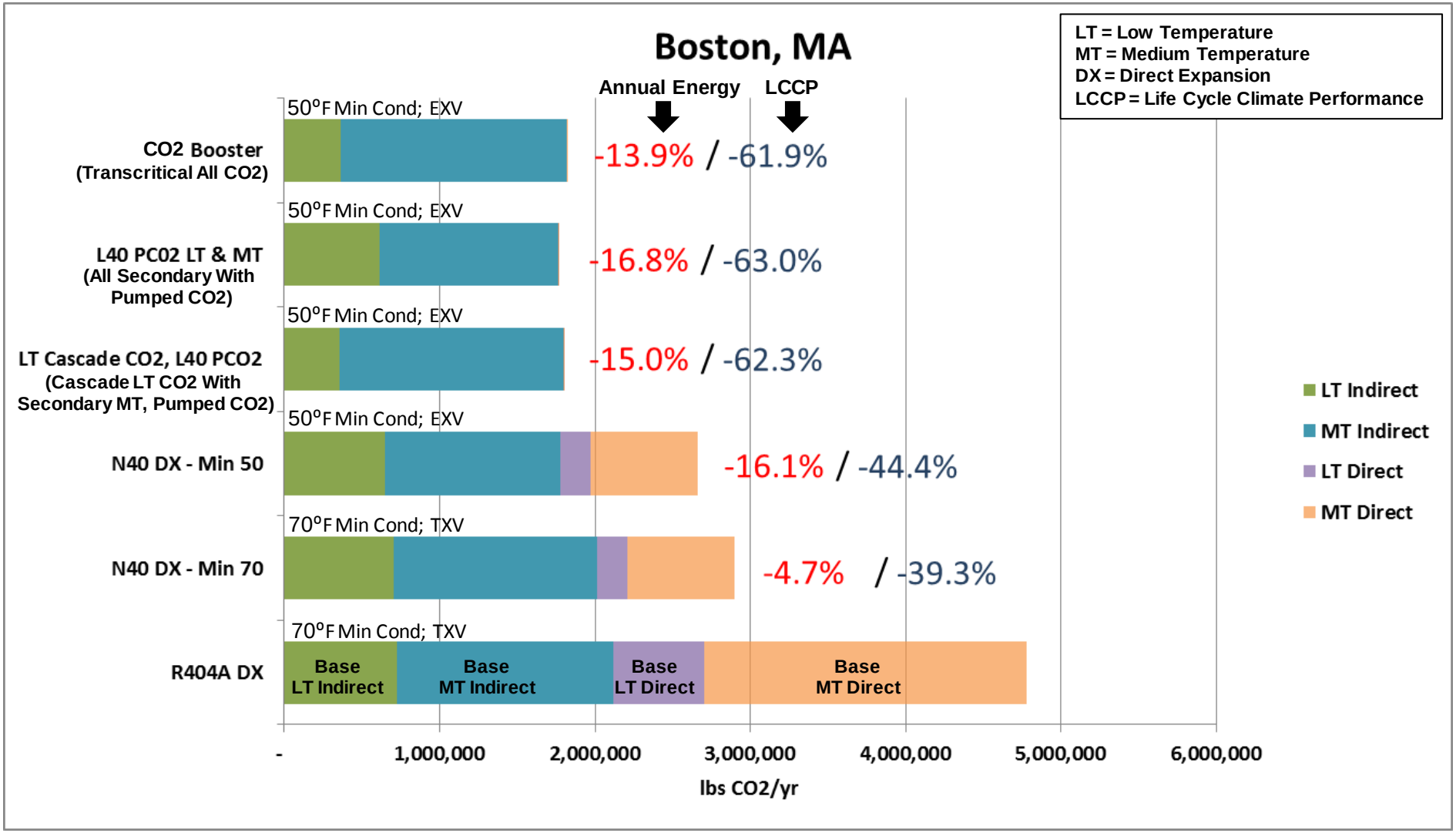
	20F SH	35F SH	40°F RG	65°F RG
R404A	149°F	162°F	149°F	172°F
R407A	165°F	179°F	165°F	189°F
R407F	174°F	188°F	174°F	198°F

Low Temperature: -25F Suction, 105F Condensing

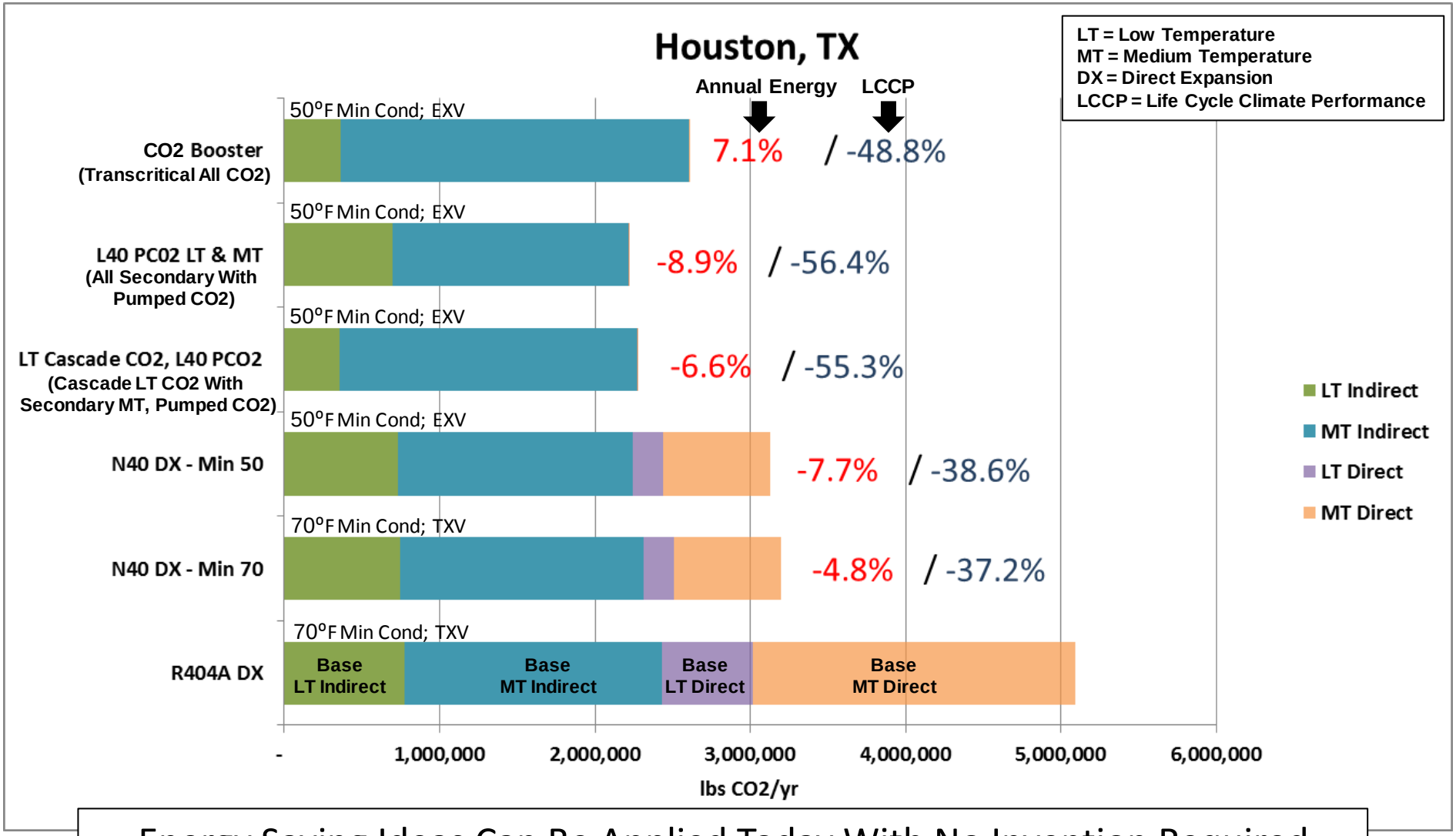
	20F SH	35F SH	40°F RG	65°F RG
R404A	141°F	154°F	183°F	208°F
R407A	166°F	181°F	212°F	237°F
R407F	179°F	195°F	226°F	252°F

Refrigeration System Architecture Needs To Be Looked At In Addition To Compressor And Refrigerants For This Next Change

Supermarket LCCP Analysis – Cool Climate



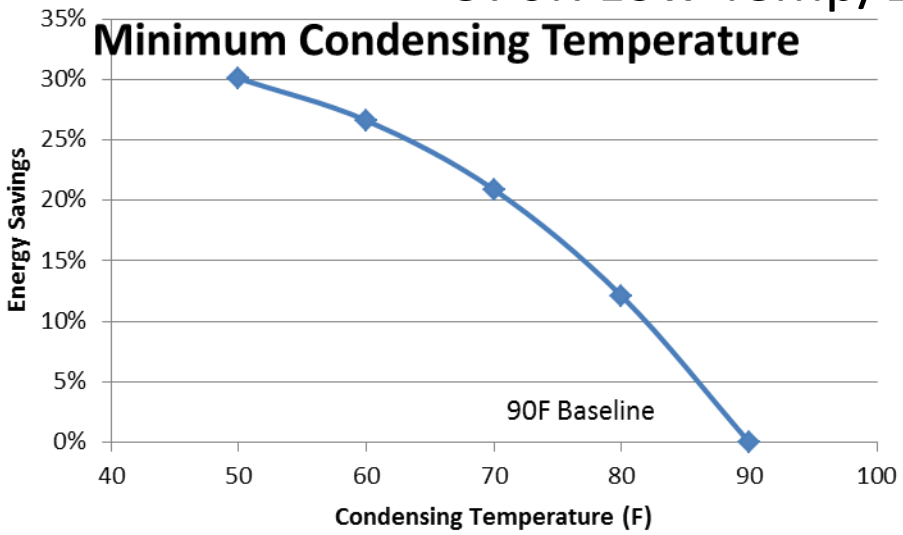
Supermarket LCCP Analysis – Warm Climate

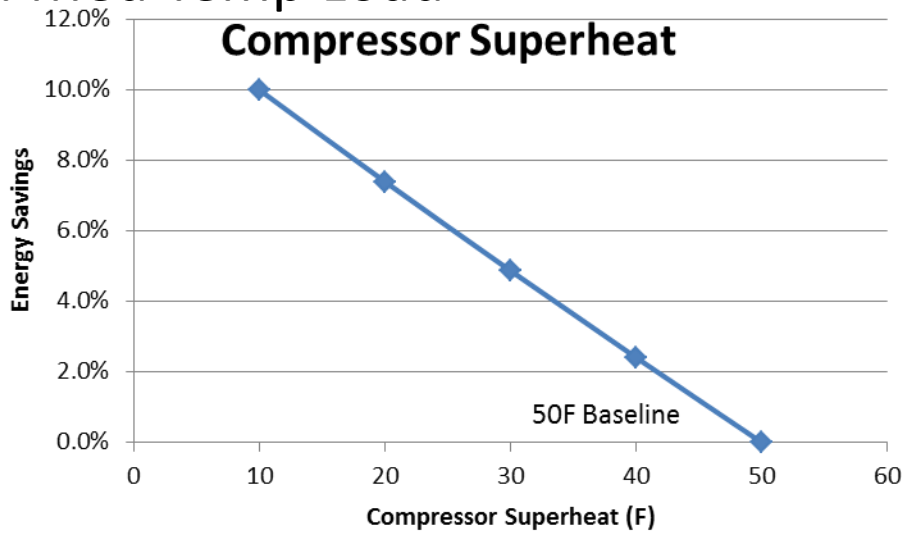


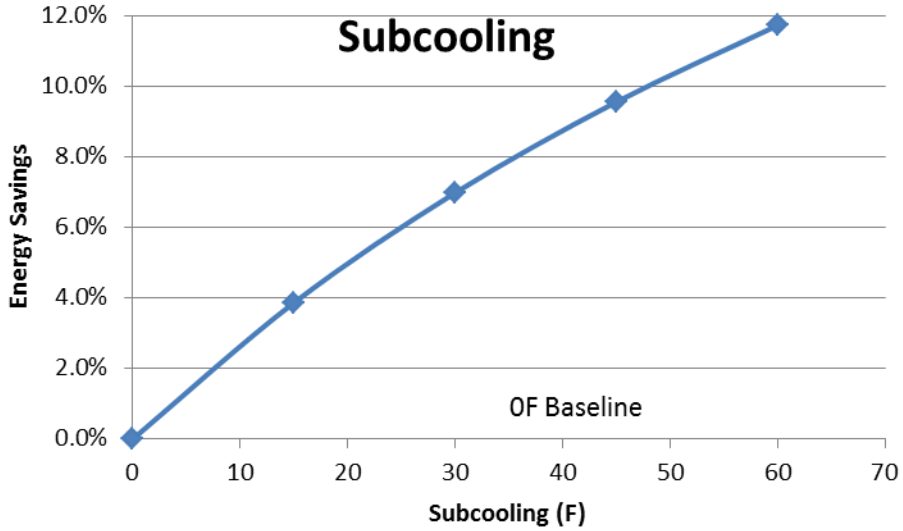
Energy Saving Ideas Can Be Applied Today With No Invention Required

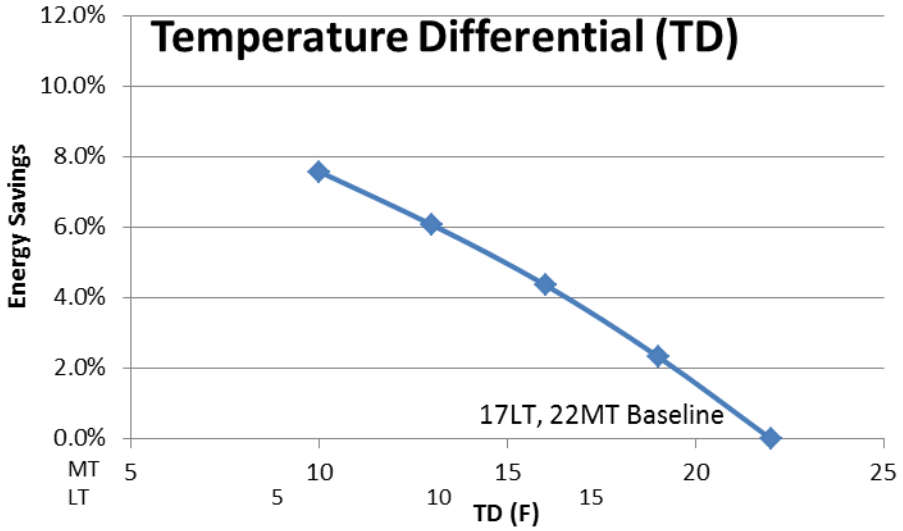
DX System Sensitivity Annual Analysis - Boston

370K Low Temp/1M Med Temp Load



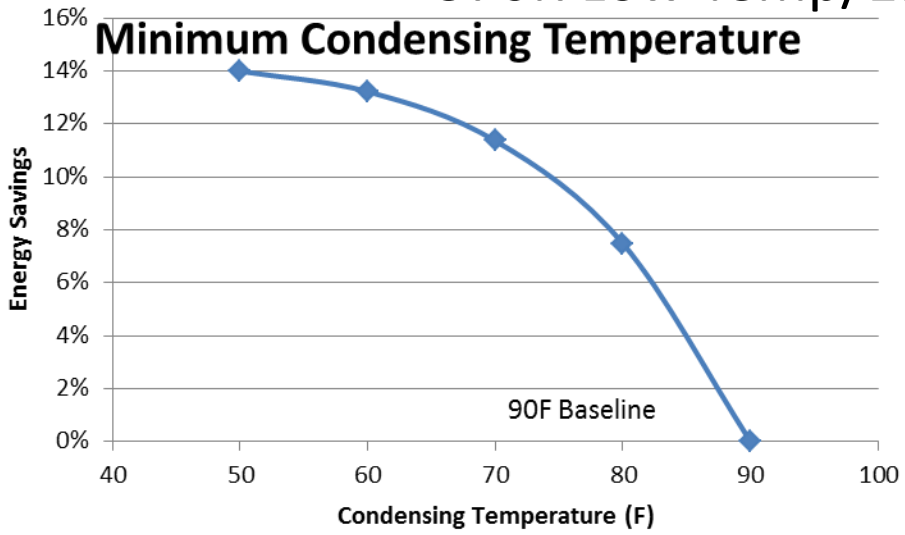


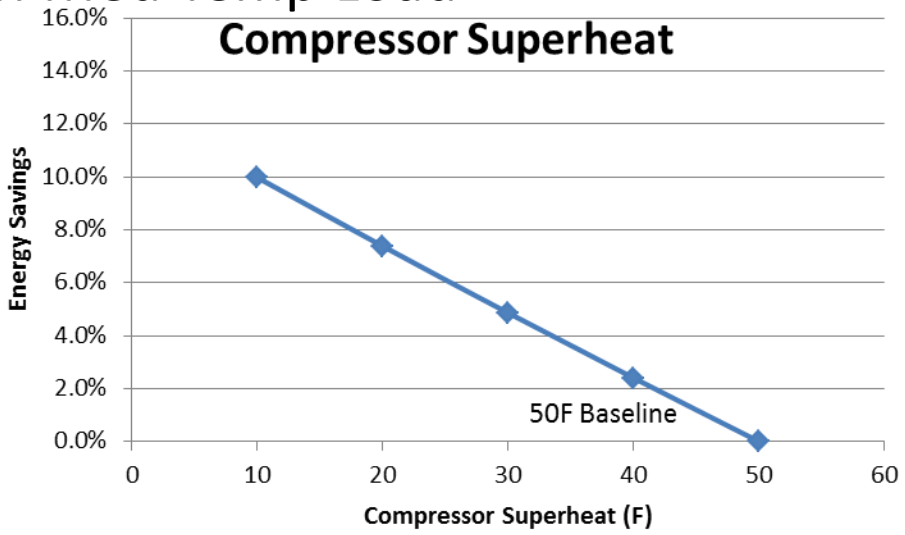


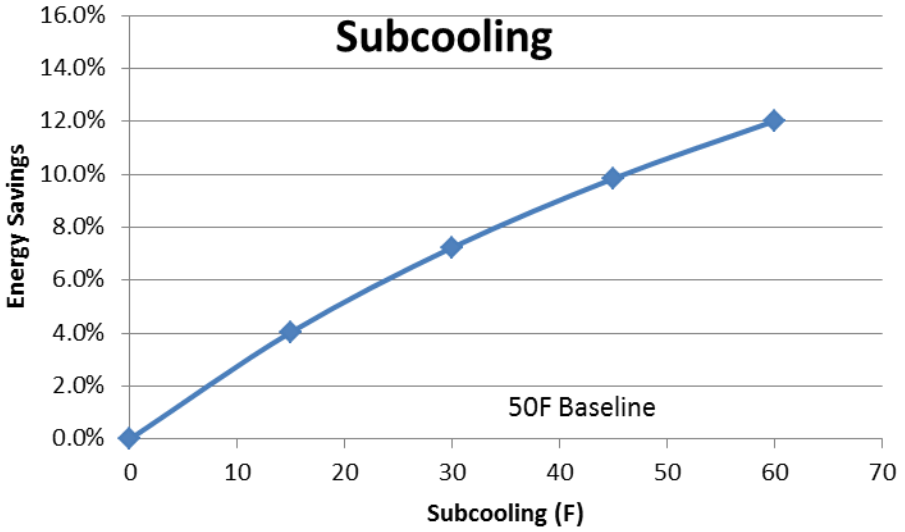


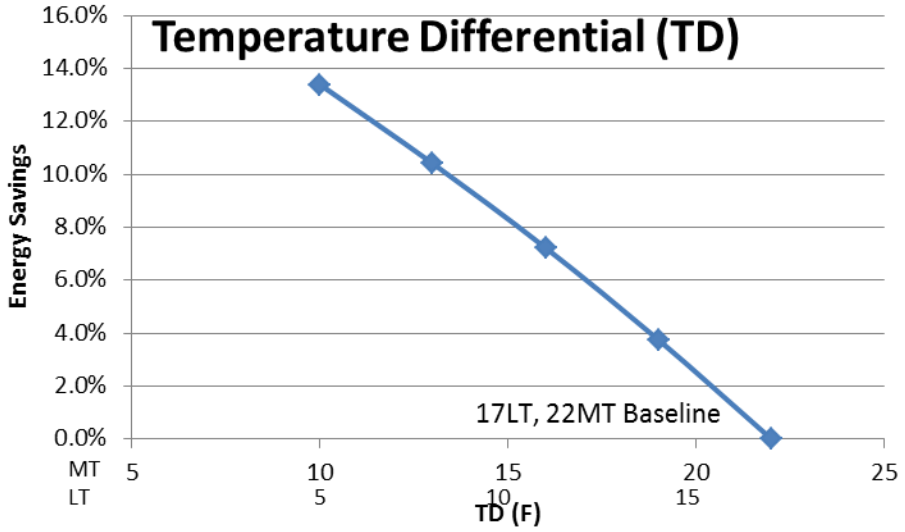
DX System Sensitivity Annual Analysis - Houston

370K Low Temp/1M Med Temp Load









Current Lower GWP Choices For Stationary Refrigeration

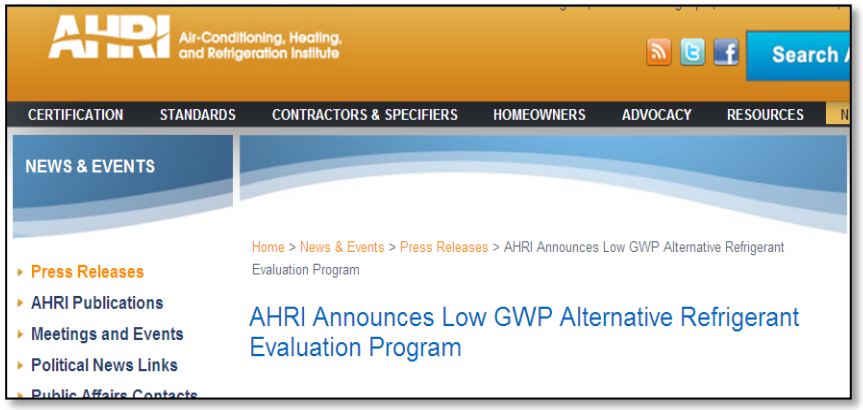
	Supermarket	Walk-In	Reach-In	Challenges
R404A	Base	Base	Base	GWP
R407A/F	✓	✓	✓	GWP Not Low Enough?
N40/DR33	✓	✓	✓	A1 – GWP Compromise
L40/DR7	Limited DX; Secondary Distributed Self Contained	✓	✓	A2L
1234ze(E)	Med Temp With Cascade CO2 Distributed Self Contained		✓	A2L
CO2	Cascade; Cool Climate Transcritical		Bottle Coolers	High Ambient Performance
Propane	Secondary Distributed Self Contained	Limited Sizes	✓ Bottle Coolers	A3 Flammability

Low GWP Alternative Refrigerants Evaluation Program (Low GWP AREP)

- Objectives
  - Identify Potential Replacements For Today's High GWP HFCs
  - Test & Present Performance In A Consistent & Standard Manner
  - A/C, Heat Pumps, Dehumidifiers, Chillers, Water Heaters, Ice Makers, Refrigeration
  - Include Compressor Calorimeter, System Drop-In And Soft Optimized Systems

- Low GWP AREP Conference On January 16, 2014 In NYC

HFCs AREP Results In The 90's Led To Adoption Of R134a, R404A, R407C & R410A In Various Applications Globally



http://www.ahrinet.org/ahri+low_gwp+alternative+refrigerants+evaluation+program.aspx

Summary

- **Minimize LCCP With Available Options To Meet Your Needs***
  - Early Tests Show A1 Substitutes Like N40/DR7 Are Promising
  - Lower GWP A2Ls Like L40/DR7 Good Candidates For Low Charge Systems
  - Careful And Limited Field Evaluation Of These Candidates Should Be Next Step
- **Natural Refrigerants Like NH_3, CO_2 And R290 Should Be Considered When They Make Sense***
  - Regulations, Safety, Economics And Performance Have To Favor Choice Over All Alternatives
  - For CO_2 Transcritical, System Enhancements Will Improve High Ambient Efficiency
  - R290 Could Be Attractive In Reach-Ins And Self Contained Systems With Charge Less Than 150 gm

* Check With Equipment, Compressor And Component Manufacturers For Compatibility

Edited for clarity, 9/17/12

Summary

- **Many Benefits Can Be Had Now With Existing Technology***
  - Maintenance: Energy Efficiency (Set Point Control, Retrofit Old With New, Low Condensing etc.) And Refrigerant Containment (Target Reduction In Service Refrigerant Use)
  - Lower GWP R404A Alternatives Available Now – R407A/R407F Are Good Choices
  - Revisit System Architecture (Vs Business Needs) – Central Rack, Secondary, Distributed, Distributed Self Contained, Transcritical And Cascade CO_2
    - System Architecture Has Most Impact On Energy, Maintenance, Total Cost And The Environment (LCCP)
- **End Users Balance Energy Efficiency, Environment Goals, Capital Investment/Risk, And Reliability/Safety In Their Decisions: We Are Here To Help**

* Check With Equipment, Compressor And Component Manufacturers For Compatibility

Questions?

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