Incentives for natural refrigerants

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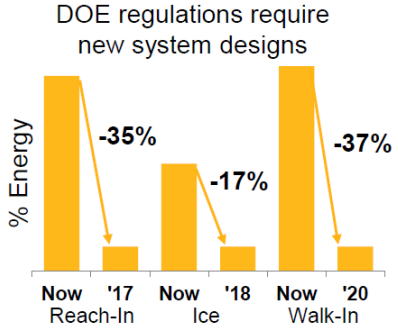
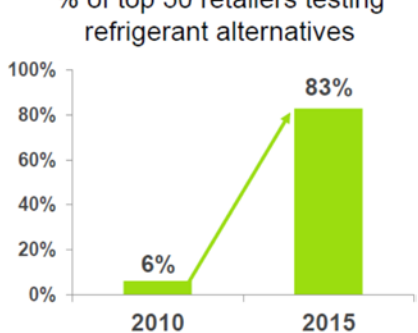
Understanding the Trends and Balancing the Variables

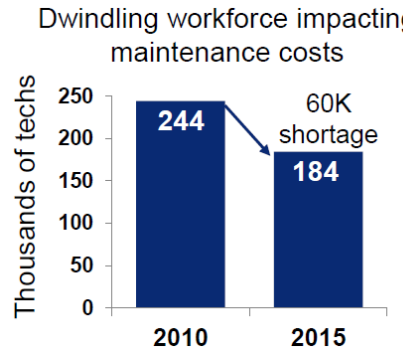
Energy



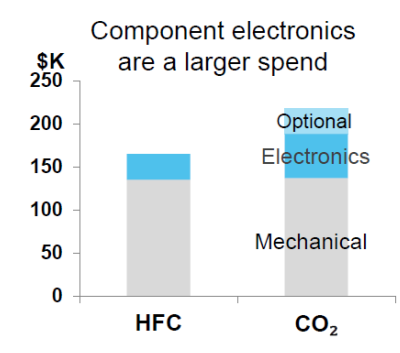
Environment



Economics



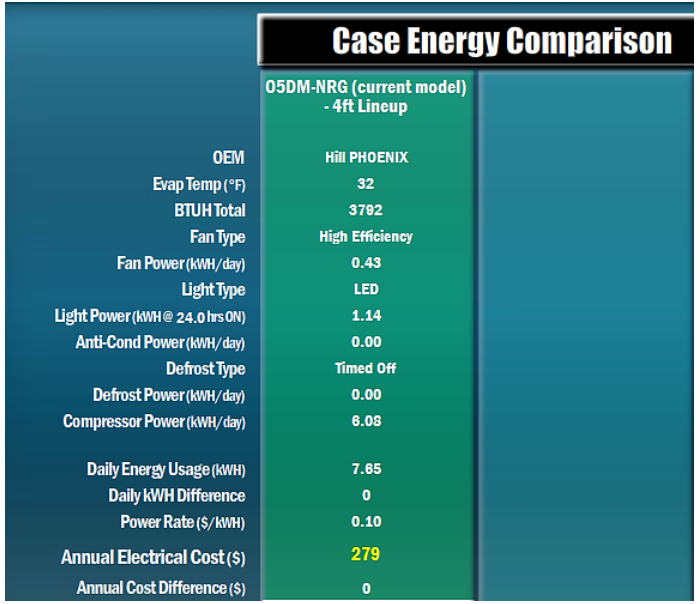
Equipment



How can we help push natural refrigerants?

Utility Incentives

- Pushed many energy savings technology including LED lighting, EC motors, anti-sweat controls, etc.
    - Energy savings in relation to incentives are high therefore pushing these technologies
        - EC motors per saving on average 100 kWh/ motor, this accounts for only a fraction of the total case energy. Less than 10% of case energy!!
- Regulations have pushed significant energy reductions made effective this year.
    - We now need to look to different technology to reduction the consumption…….Natural Refrigerants is one of the answers!

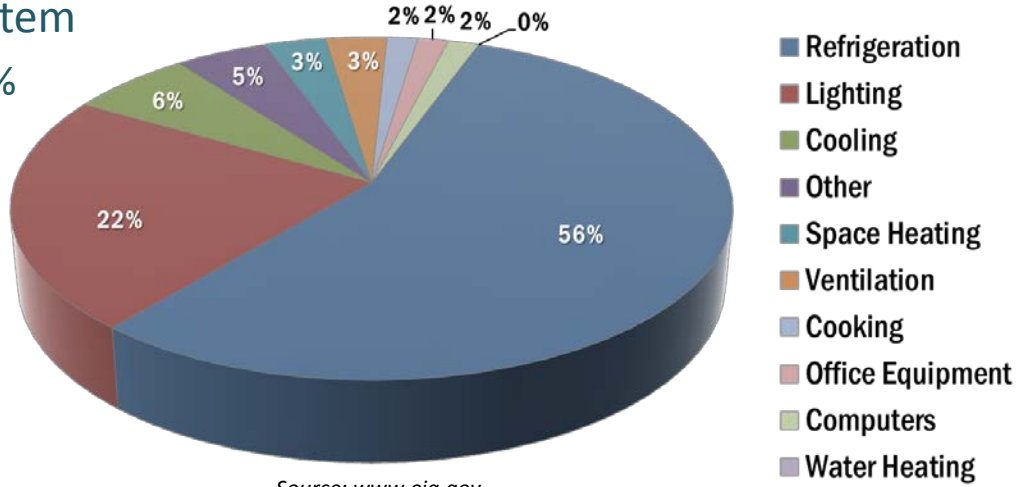


Case Energy Comparison	
	O5DM-NRG (current model) - 4ft Lineup
OEM	Hill PHOENIX
Evap Temp (°F)	32
BTUH Total	3792
Fan Type	High Efficiency
Fan Power (kWH/day)	0.43
Light Type	LED
Light Power (kWH @ 24.0 hrs ON)	1.14
Anti-Cond Power (kWH/day)	0.00
Defrost Type	Timed Off
Defrost Power (kWH/day)	0.00
Compressor Power (kWH/day)	6.08
Daily Energy Usage (kWH)	7.65
Daily kWH Difference	0
Power Rate ($/kWH)	0.10
Annual Electrical Cost ($)	279
Annual Cost Difference ($)	0

What is the pricing delta for CO_2 to overcome?

- On average there is a 50-60% cost increase for a natural refrigerant system
  - Energy savings are averaging 10-20%
- Creative thinking is needed for incentives for systems with natural refrigerants

Refrigeration accounts for 50-60% of a stores total electric consumption



Source: www.eia.gov

Sample savings (Grocery in Ohio)

Summary

	R407A (reference)	CO2 booster
Load fulfillment in % of time		
LT:	100.0	100.0
MT:	100.0	100.0
Total:	100.0	100.0
Load fulfillment in % of energy		
LT:	100.0	100.0
MT:	100.0	100.0
Total:	100.0	100.0
Average EER		
LT [BTU/(W·h)]:	7.93	22.58
MT [BTU/(W·h)]:	11.89	14.05
Total [BTU/(W·h)]:	10.85	12.14
Pumps and fans energy consumption		
LT [kWh]:	0	0
MT [kWh]:	46,177	15,782
Total [kWh]:	46,177	15,782
Compressor energy consumption		
LT [kWh]:	101,722	35,713
MT [kWh]:	239,001	294,202
Total [kWh]:	340,722	329,915
Total energy consumption		
LT [kWh]:	101,722	35,713
MT [kWh]:	285,177	309,984
Total [kWh]:	386,899	345,697
Savings		
Yearly energy savings [kWh]:	-	41,202
Yearly energy savings [%]:	-	10.6

Validation of the energy calculations needs to rely on transparency of the systems data and operational specifications for a true apples to apples comparison

10.6% Energy Reduction

Month to Month Energy Comparison (CT store)

Energy consumption table

	CO2 Adiabatic MT			R404A		
Month	Compressor [kWh]	Fans and Pumps [kWh]	Total [kWh]	Compressor [kWh]	Fans and Pumps [kWh]	Total [kWh]
January	66,172.4	3,191.0	69,363.4	86,077.4	18,888.4	104,965.8
February	59,869.3	2,987.7	62,857.0	77,708.1	17,068.8	94,776.9
March	67,511.0	4,882.5	72,393.5	86,231.9	18,879.6	105,111.5
April	70,551.6	6,814.6	77,366.2	85,126.7	18,180.6	103,307.2
May	86,416.7	8,096.6	94,513.3	92,375.7	18,594.3	110,970.0
June	105,042	7	8	4	17,839.3	128,044.7
July	121,37	8,102.7	129,47	127,288.5	18,453.9	145,742.5
August	118,999.0	8,096.7	127,095.7	124,035.9	18,440.2	142,476.1
September	100,949.0	7,837.4	108,786.4	103,623.6	17,834.0	121,457.6
October	86,191.8	8,092.3	94,284.0	91,758.4	18,606.4	110,364.8
November	70,724.6	6,193.6	76,918.2	84,537.9	18,210.3	102,748.2
December	67,295.6	4,002.2	71,297.8	86,052.0	18,891.6	104,943.6
Total	1,021,097.8	76,135.0	1,097,232.9	1,155,021.7	219,887.5	1,374,909.1
Average	85,091.5	6,344.6	91,436.1	96,251.8	18,324.0	114,575.8

20% reduction

The table above shows the energy consumption per month of the simulated systems. Additional equipment equals condenser and evaporator fans and pumps used in the system.

Continuous Advancement in CO2 Booster Technology

CO2 Warm Climate Technologies

High pressure sub-coolers

- Removes additional heat after air cooled gas cooler
- Requires chilled water; likely HVAC water Enables booster system operation in the highest dry bulb ambient temperatures (as does Adiabatic)

Adiabatic gas coolers

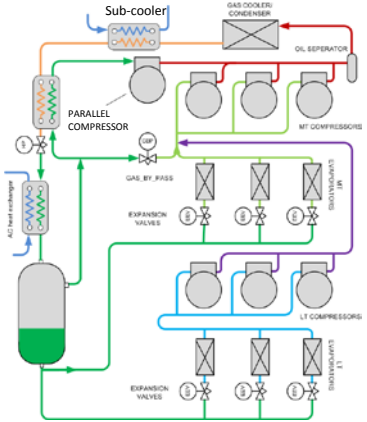
- **Peak savings 20-30+%**
- **Annual savings 8-12%**

Parallel Compression systems

- Peak savings 12-20%, Annual savings 6-8%
- Operational in test lab with Danfoss 781 controls.
- Seeking target customer for beta site 2016 w/ Danfoss Controls
- 2016 Commercialization with Danfoss controls.
- Parallel Compression systems

Gas Ejector Systems

- Works in combination with parallel compression
- Peak savings 15-23%, annual savings 8-10%



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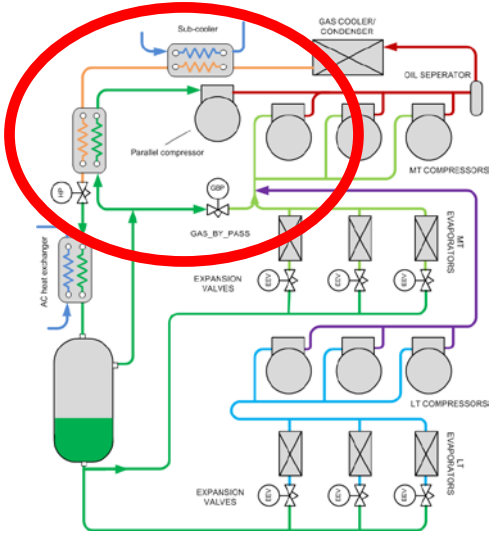

- Parallel Compression of Flash Gas
  - Dedicated compressors piped to operate in parallel compression mode
  - Forms a higher SST satellite compressor group with the MT transcritical compressor group
  - Dedicated to flash tank pressure control

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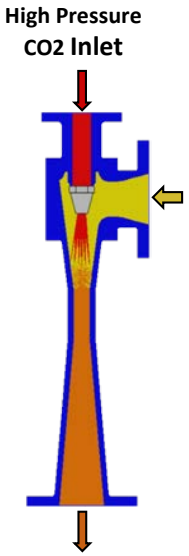
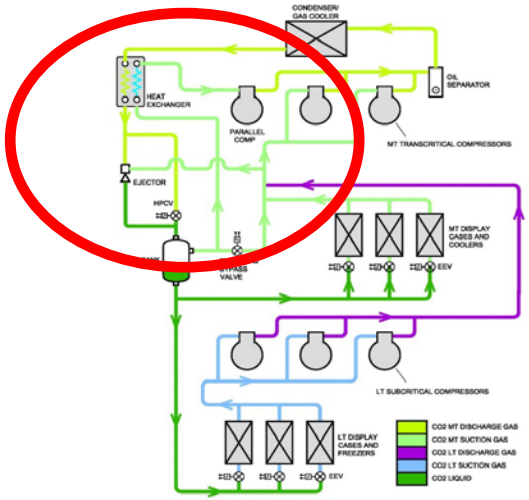


The Sugar Engineers,
East Cape South Africa



Ejectors

- High pressure CO2 sprays through an internal nozzle
- Low pressure CO2 is pulled into the stream from the high pressure nozzle
- The resulting mixed exiting CO2 is at an intermediate pressure

The Struggle is REAL

There is cost for new Technology, but the cost of CO_2 Booster systems are coming down

Need to look at Total Cost of Ownership versus First Cost

Great opportunity for utility incentives to off set additional cost and improve the ROI to support the move to natural refrigerant solutions.

What Now?

Spark further discussions and training to overcome the initial reaction that a natural refrigerant system will inherently consume more energy.

How should we calculate the baseline and what should that baseline be?

Is there a way to give financial credit for the greenhouse gas reduction.

Power plants are mandated to reduce their greenhouse gas emissions, therefore could there be a trickle down to the end user who reduces their greenhouse gas emissions?

Potentially rethinking the way incentives are granted for systems.

Potential for buying down the project, not merely an incentive based on per kWh/kW reduced.

AMERICA

ATMO sphere

Thank you very much!