ATMOsphere

Business Case for Natural Refrigerants

Simplifying the convertion to R290

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Market influences

DOE 2017
Mandated legislation driving for higher efficiency

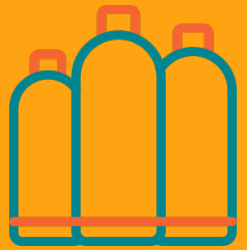
ENERGY STAR
Voluntary program for efficiency

EPA REFRIGERANT BAN
Eliminates current high GWP refrigerants

Impact

Re-design of the cabinets

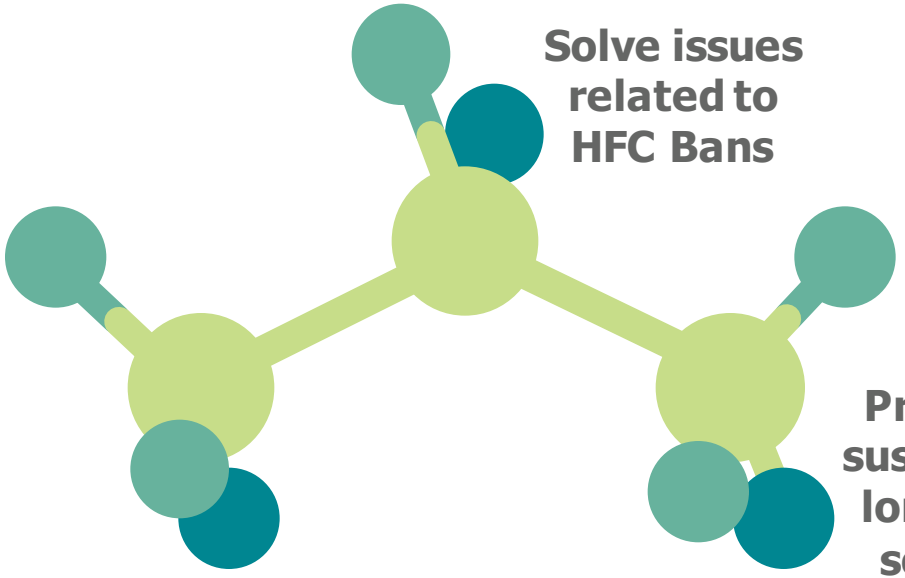
Improve efficiency



Look at Alternate Refrigerants

The R290 solution

Facilitates OEMs to Meet Energy Regulations
(DOE 2017 & E-Star)



Solve issues related to HFC Bans

Provide a sustainable long term solution

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Challenges of R290

FLAMMABLE

DEVELOPMENT RESOURCES

COMPONENT COSTS

CERTIFICATION COSTS

Capital Investments

Servicing Safety

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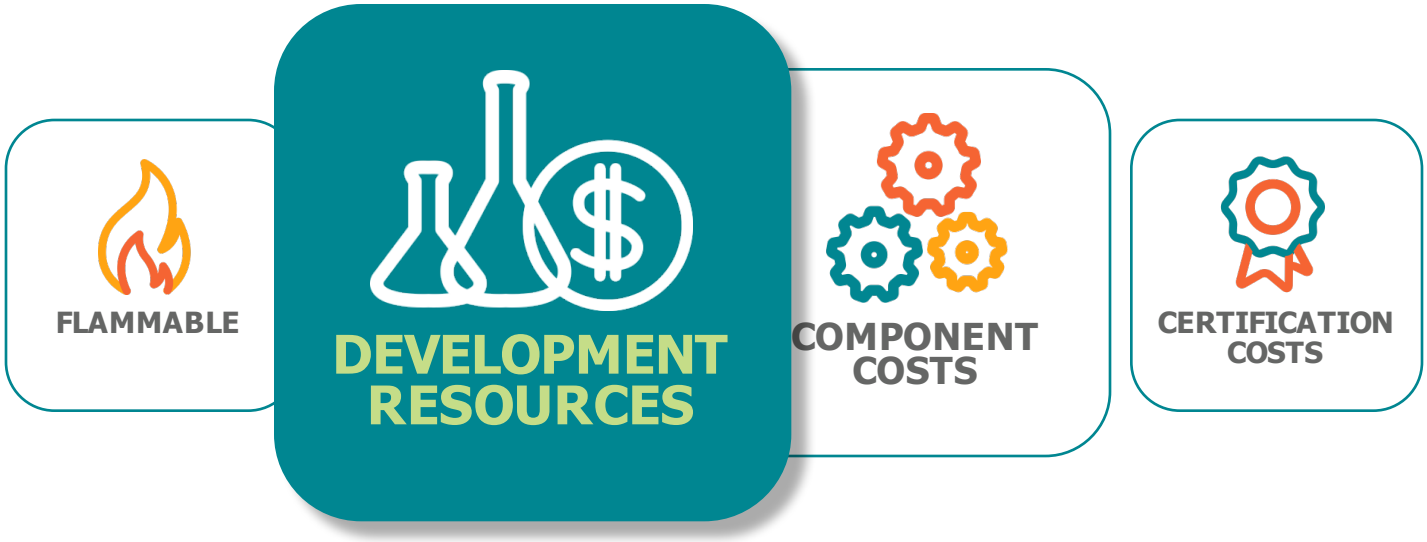
Challenges of R290



Converting Cabinet to R-290

Step 1

1 Converting cabinet to R-290

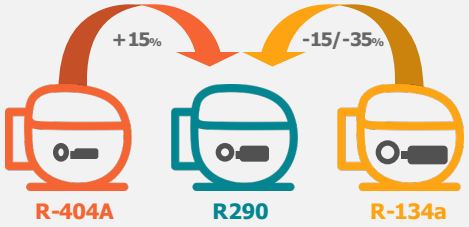
1

SELECT THE PROPER COMPRESSOR & SWAP

Match capacity of existing compressor:
+/- 5%

R-404A -> R290
Displacement increase

R-134a -> R290
Displacement decrease



2

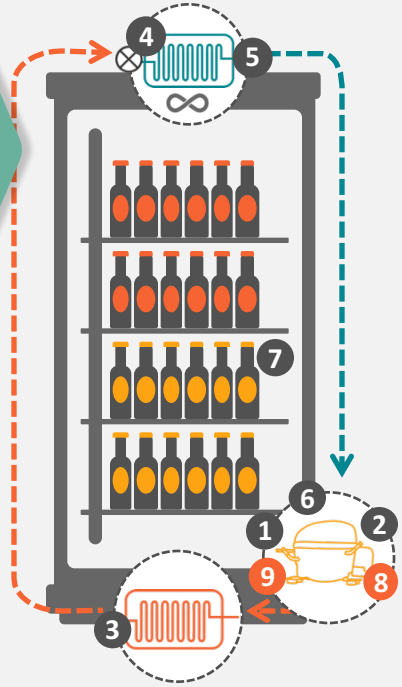
INSTRUMENT SYSTEM

Temperatures

1. *Suction Line*
2. *Discharge Line*
3. *Condenser Out*
4. *Evap In*
5. *Evap Out*
6. *Shell*
7. *Slugs*

Pressure

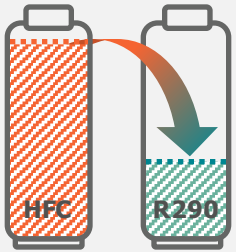
8. *Discharge*
9. *Suction*



3

CHARGE SYSTEM

Start with 35% of original HFC charge or no more than 150g



4

RUN SYSTEM TO SEE RESULTS

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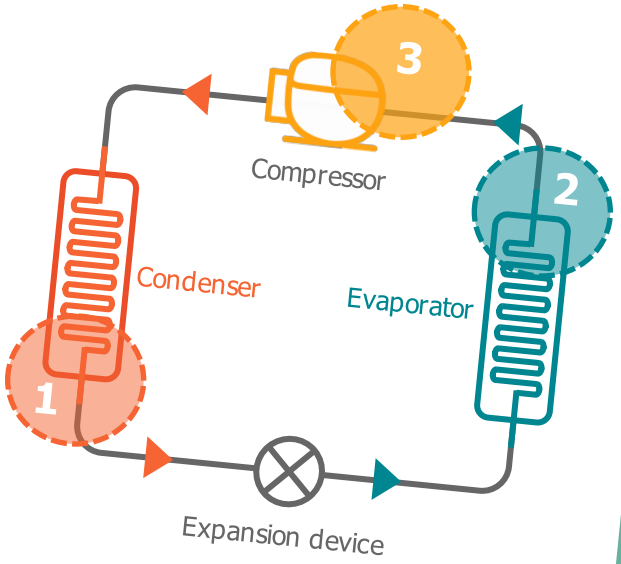
Results

Step 2

- **Was pull down time adequate?**
- **Check if slugs meet NSF temperature requirements**
- **1. Subcooling**
  Should be between ~2-5°F
- **2. Evaporator Superheat**
  Should be between ~5-7°F
- **3. Compressor Superheat**
  Should be ~10-15°F above SST at minimum



Converting Cabinet to R-290

Step 3

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3 Converting cabinet to R-290

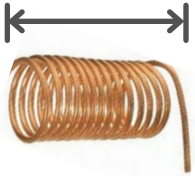
1

REFRIGERANT CHARGE DETERMINATION

Increment the charge in 2-5g intervals

2

EXPANSION DEVICE OPTIMIZATION



Adjust length and/or diameter of capillary tube

TXV: ¼ turn increments

3

RE-RUN TESTS AND READJUST AS NEEDED

NOTE: adjusting refrigerant charge and cap tube length will fight with each other - Balance is critical (also for Energy efficiency)

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Converting Cabinet to R-290

Step 4

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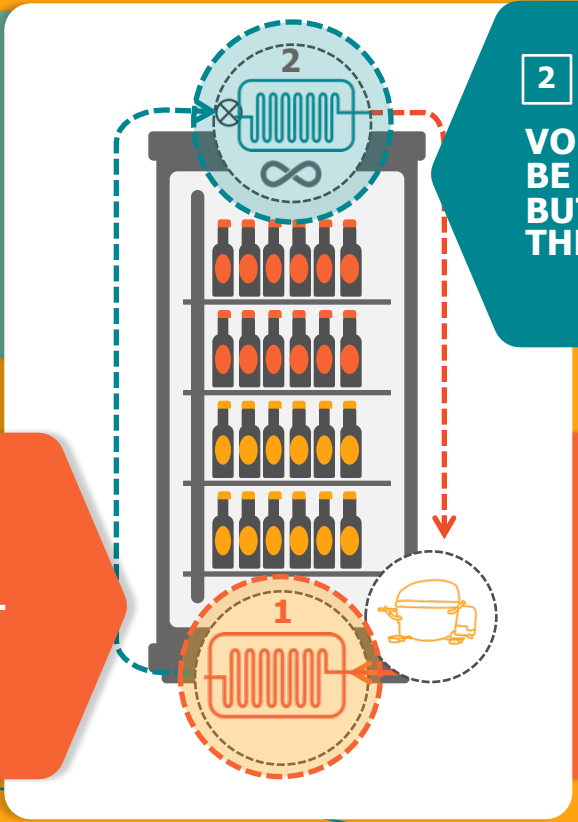
ISSUE: NOT ABLE TO ACHIEVE 150g CHARGE LIMIT

3

RE-RUN TESTS



2

VOLUME REDUCTION SHOULD BE PURSUED ALSO ON THE EVAP, BUT THIS CAN HAVE IMPACT ON THE CAPACITY AND EFFICIENCY

1

REDUCE THE INTERNAL VOLUME OF YOUR CIRCUIT

SELECT A SMALLER INTERNAL VOLUME CONDENSER

REDUCE TUBE DIAMETER (e.g. ¼" tubes)

≈30% REDUCTION CAN BE EXPECTED

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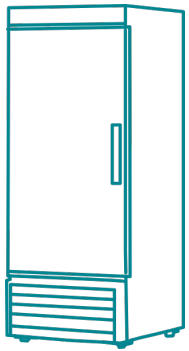
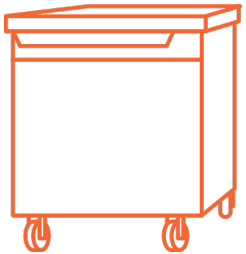
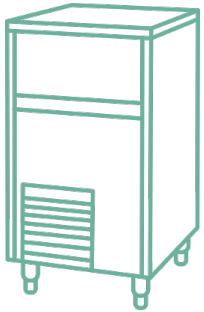
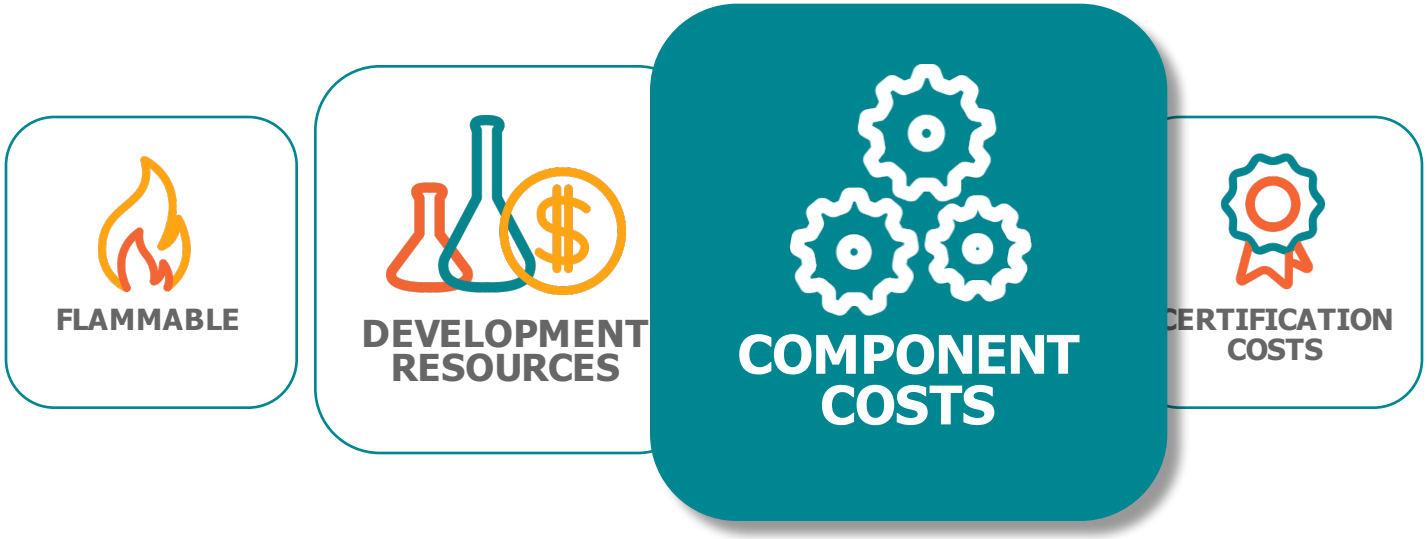
Examples of cabinet conversion

APPLICATION TYPE	COOLER VERTICAL 25cu.ft		FREEZER 7cu.ft		ICE MAKER 100lb/day	
Compressor Model	EMT6160Z	EMC3119U	FFU130HAX	EMC3130U	NEK6181GK	FFU160UAX
Compressor displ. [cm3]	6.76	4.5	10.61	6.93	7.28	7.95
Refrigerant	R134a	R290	R134a	R290	R404A	R290
Refr charge [g]	200g	70g	370	90	240	100
Energy Saving [%]	+20%		+32%		+30%	
Condenser volume [%]	-20%		=		-50%	
Evaporator volume [%]	=		=		=	
Exp device/mass flow [%]	-15%		TXV	Cap tube.	=	
						

Challenges of R290



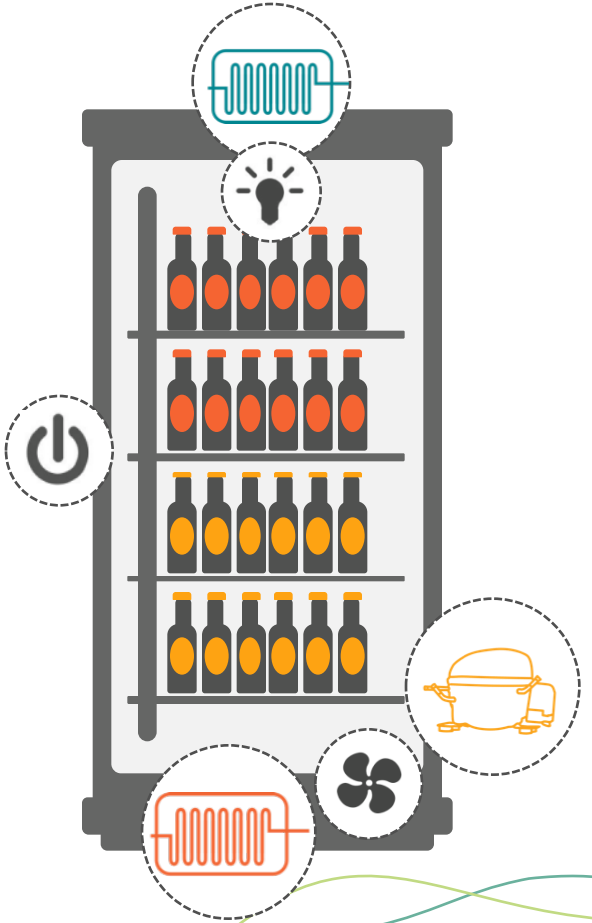
Material Cost Impact

1. **Non sparking type components**
   Fan Motors and blades
   Switches
   Lights
   Miscellaneous Devices

2. **Compressor cost**
   Multiple efficiency levels
   R-290 compressors can be a frame break

3. **Smaller heat exchangers >>> costs**

4. **Refrigerant cost tends to lower**



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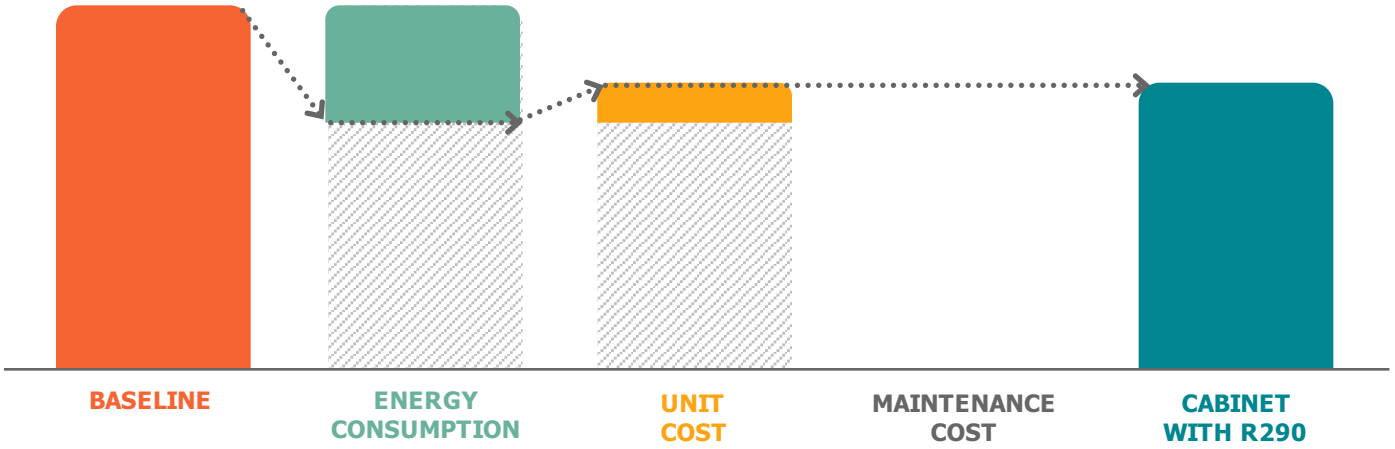
End-users TCO Breakdown



Thank you

Questions