



Existing Facilities Session

Explore options to transition existing facilities to refrigerants below 150 GWP.

Agenda

- ▶ Typical Existing Systems Encountered
- ▶ Typical Facility Improvements
- ▶ Paths to 150 GWP for Existing Systems
 - Costs
 - Schedules
 - Energy Statement
 - End User Panel Concerns and Comments
- ▶ Summary
 - Cost/Energy/Schedule Comparisons
 - Weighted GWP Impacts
 - Items to be Furthered

Motivation

- ▶ Pending Legislation
 - New Stores
 - Less than 150 GWP or less than 50 lbs charge per system
 - Existing Facilities
 - Less than 150 GWP or less than 50 lbs charge
 - Weighted Average GWP by 2030

Motivation

- ▶ Corporate Refrigerant Plan (Future Proofing)

- ▶ Corporate Responsibility
 - *Consumers Goods Forum*
 - <https://www.theconsumergoodsforum.com/>
 - *Business Roundtable*
 - <https://www.businessroundtable.org/>
 - *We Mean Business*
 - <https://www.wemeanbusinesscoalition.org/>
 - *Climate Pledge*
 - <https://blog.aboutamazon.com/sustainability/the-climate-pledge>
 - *Climate Action 100+*
 - <http://www.climateaction100.org>

Motivation



Existing System Types Encountered

- ▶ Centralized Racks
- ▶ Distributed Rack Systems
- ▶ Remote Condensing Units
- ▶ Misc. (Glycol, Cascade systems)

Facility Work Encountered

- ▶ Major Remodels
 - Majority of cases being replaced

- ▶ Minor Remodels
 - A portion of cases being replaced

- ▶ Capital Expenditures
 - Spot case replacements/additions
 - End of Life
 - Refrigerant Conversions

System Options

- ▶ Basic Refrigerant Conversion
- ▶ Full System Replacement
- ▶ Reuse High Side, Replace Low Side
 - Secondary or Cascade
- ▶ Reuse High Side, Retrofit Low Side
 - Secondary or Cascade
- ▶ Micro-Distributed
- ▶ Independent Applications
 - Self Contained
 - Condensing Units
 - Modular Capacity System

Basic System Conversion

- ▶ Initial Step: Convert to 448A/449A
- ▶ Future Step: Convert to an A2L as codes develop
- ▶ Considerations: Very well known initial transition. Existing fixtures and high side can be reused with standard retrofit procedures.

Basic System Conversion

- ▶ Cost (Roughly \$75,000 to \$125,000)
- ▶ Energy (Some System savings in the 3% to 5% range)
 - New Refrigerant properties
- ▶ Schedule (3 weeks)

Full System Replacement

- ▶ Initial Step: Replace both high side and low side with CO2 Transcritical
- ▶ Considerations: Expense is high, but technology is well developed. Appropriate Phasing Plans can typically be developed to allow this during a large scope remodel. Efficiency gains can generally be expected through the use of new fixtures and electronic controls

Full System Replacement

- ▶ With Equipment, Cases, and Labor, roughly \$2,100,000
 - \$600,000 Equipment
 - \$500,000 Cases
 - \$1,000,000 in Labor/Install
- ▶ Energy (Some savings in the 5% to 20% range)
 - Refrigerant Properties
 - New Case Efficiencies
 - New Controls
- ▶ Schedule (4 to 6 months)

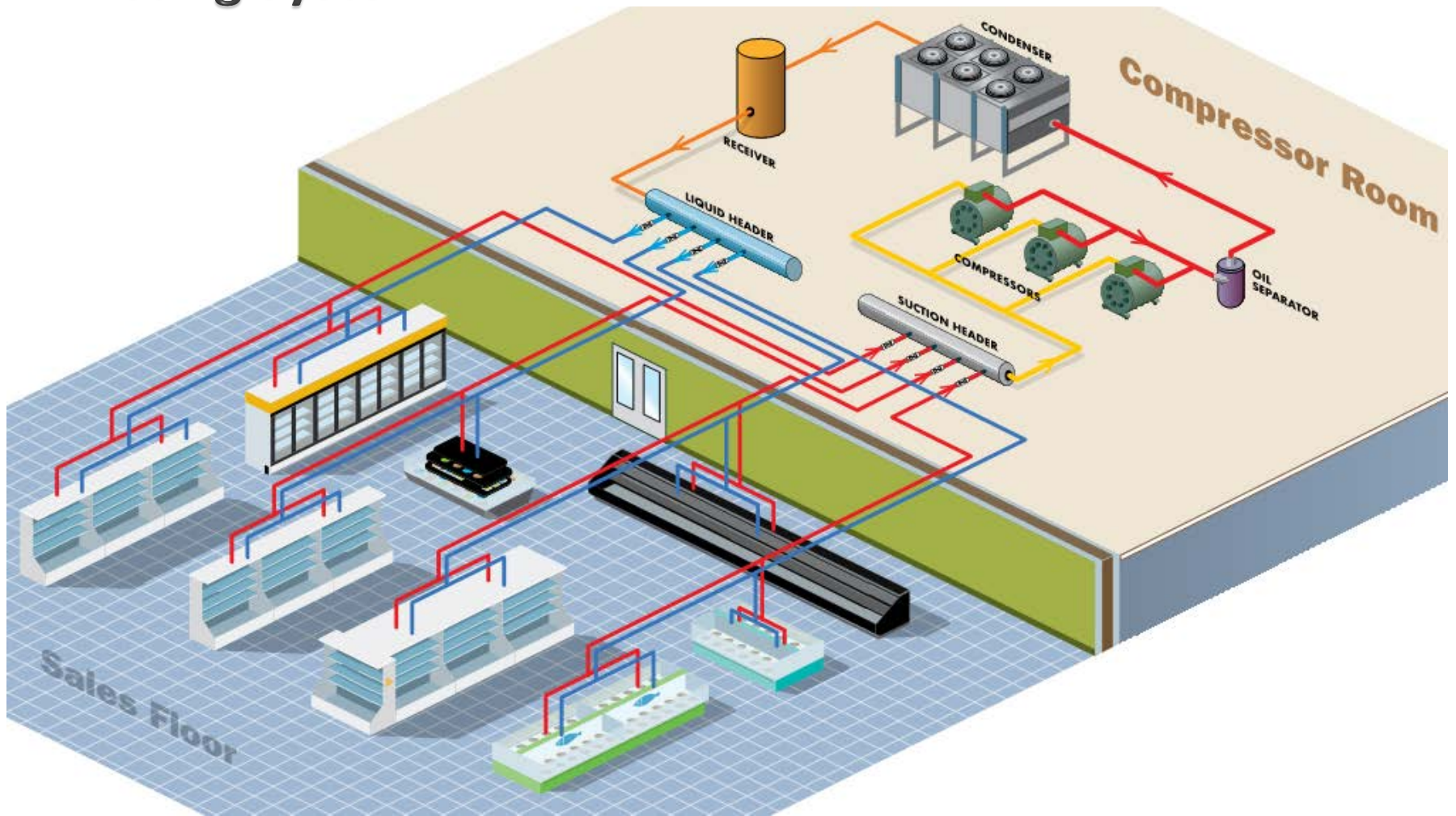
Re-Use High-side, Replace Low-side



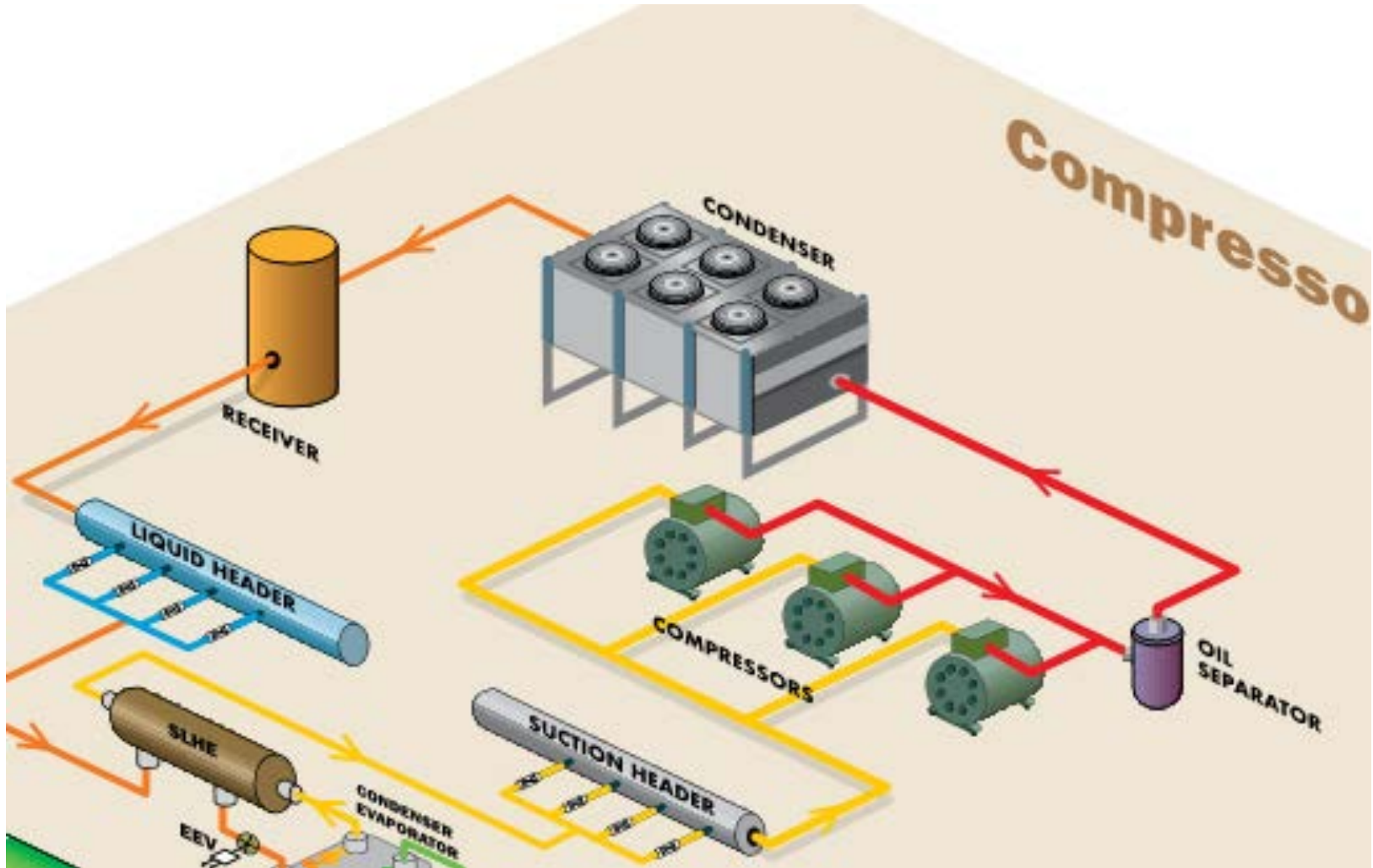
Re-Use High-side, Replace Low-side

- ▶ Initial Step: Utilize Existing high-side to provide Secondary or Cascade CO₂ to new fixtures. A location for a new CO₂ skid or skids would be required. Multiple systems could be piped to the same CO₂ skid depending on capacity and arrangement.
- ▶ Additional step: Convert high side to R-448A/449A or possibly an A2L in the future.
- ▶ Considerations: May be a good solution for facilities with older fixtures in need of updating, but whose space or utilities does not allow for a completely new refrigeration system. Arguably less expensive than a fully new system as less structural and electrical work is required. Phasing could be stretched over a significant time period as loads transition from DX over to the CO₂ skid

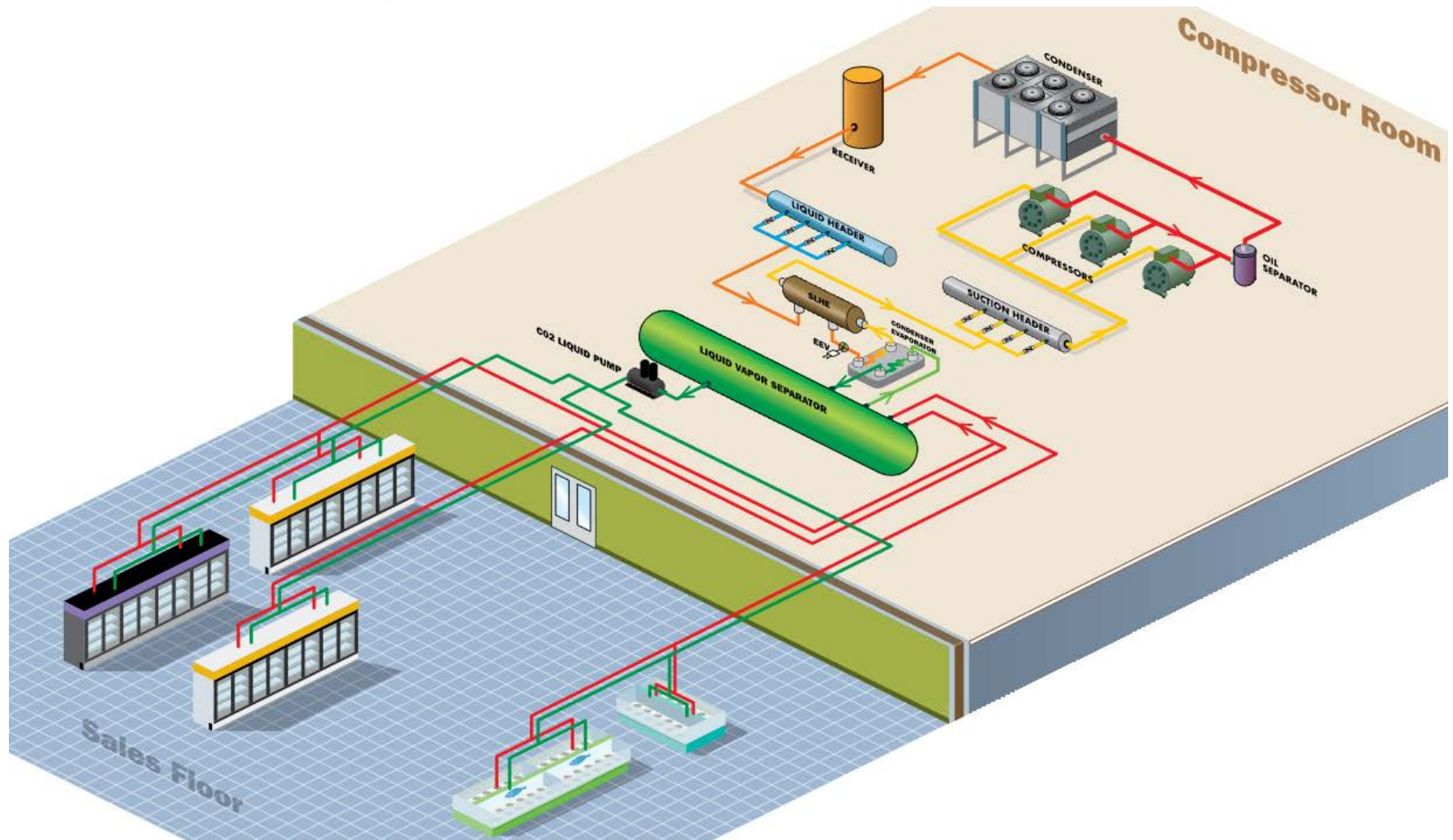
Existing System



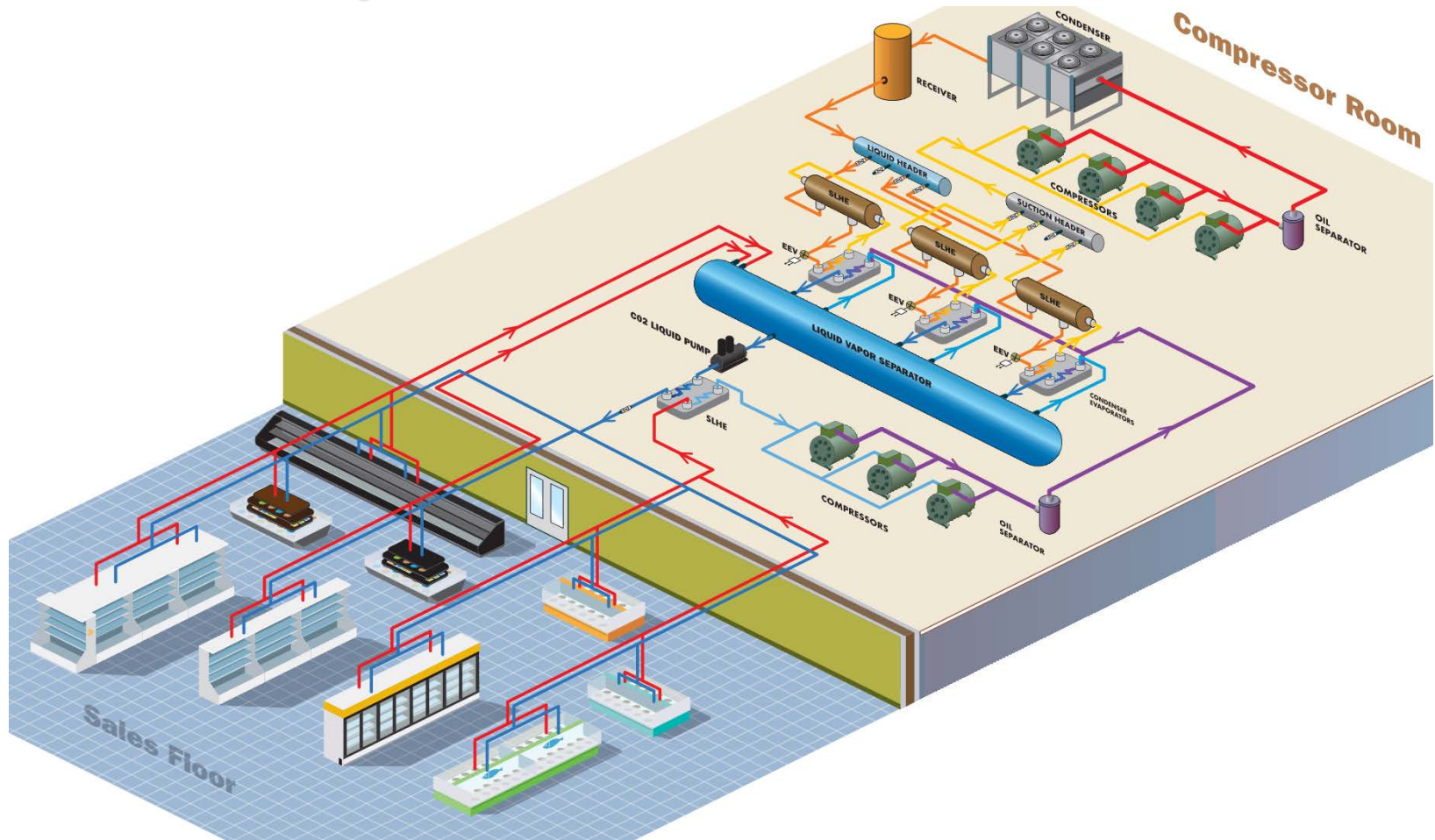
Equipment being Re-used



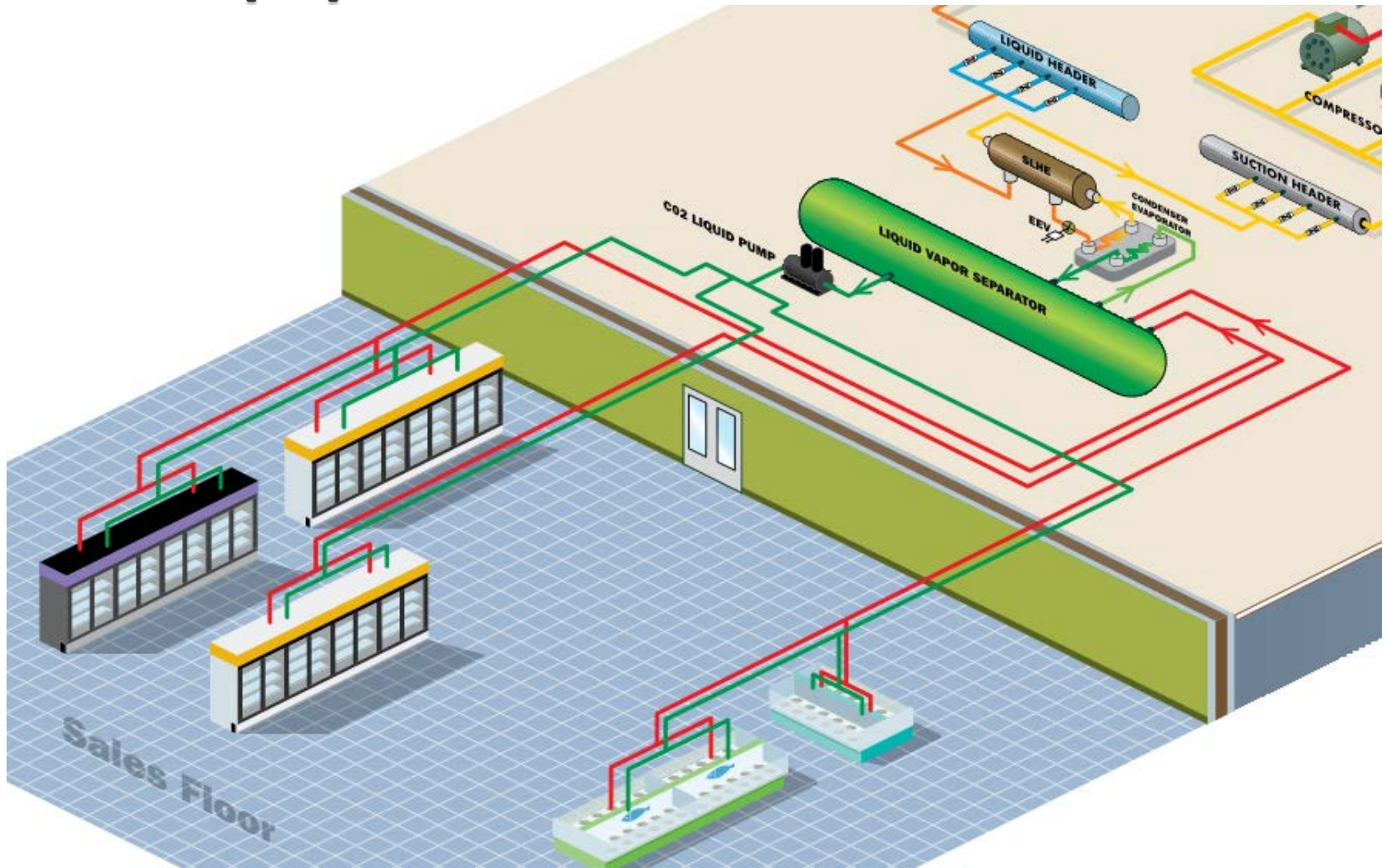
Modified System



Modified System



New Equipment



Re-Use High Side, Replace Low Side

- With Equipment, Cases, and Labor, roughly \$1,350,000
 - \$100,000 Equipment
 - \$500,000 Cases
 - \$750,000 in Labor/Install
- Energy (Some savings in the 0% to 10%)
 - Refrigerant Properties Efficiencies
 - Heat Exchange Penalty
 - New Case Efficiencies
- Schedule (3 to 5 months, but can be extended further if beneficial)

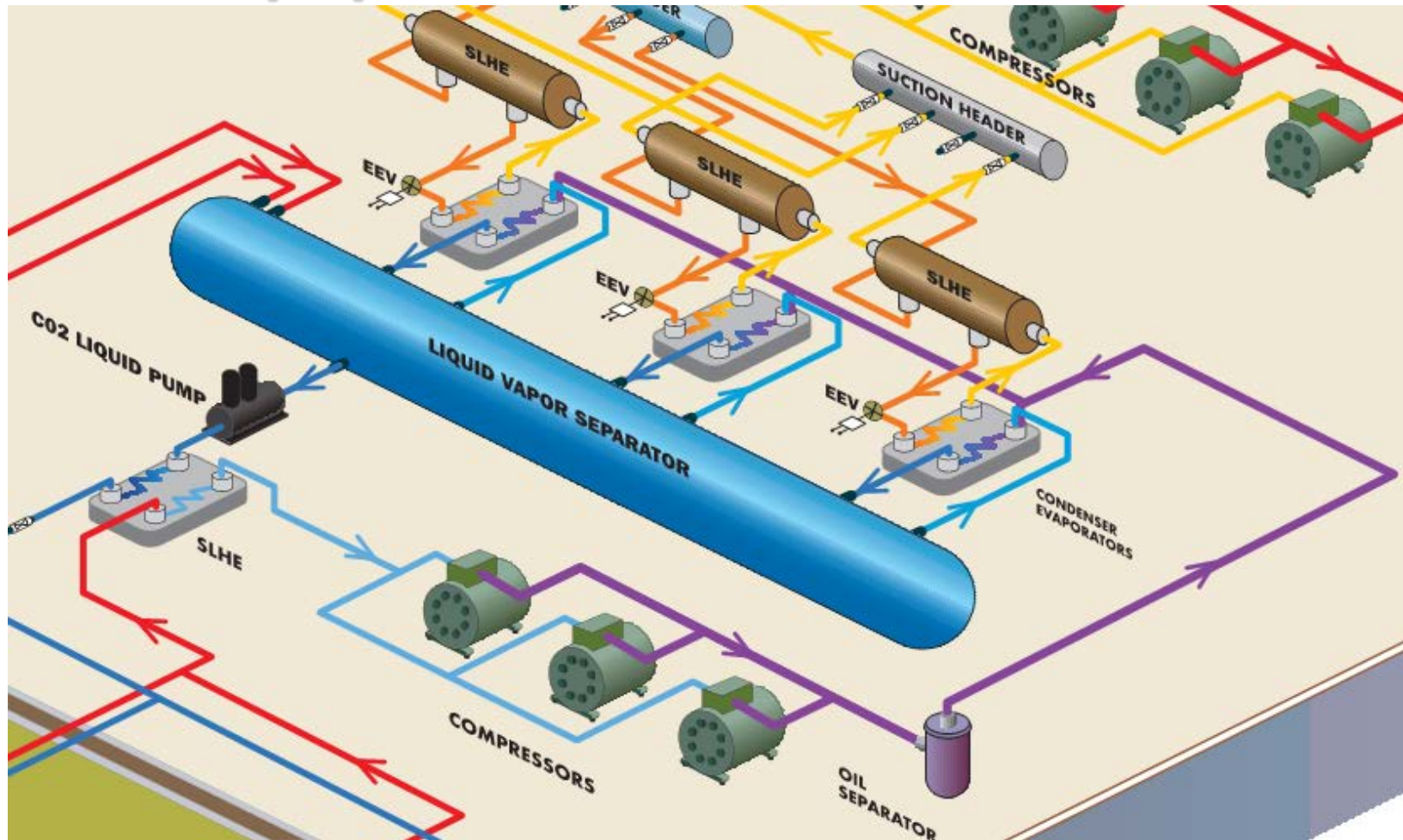
Re-Use High-side, Convert Low-side



Re-Use High Side, Convert Low-side

- ▶ Initial step: Utilize Existing high-side to provide Secondary or Cascade CO₂ to converted low-side fixtures. A location for a new CO₂ skid or skids would be required. Multiple systems could be piped to the same CO₂ skid depending on capacity and arrangement.
- ▶ Additional step: Convert high side to R-448A/449A or possibly an A2L in the future.
- ▶ Considerations: Data from one OEM indicated that there was not a design change required to re-rate the traditional HFC coils to the higher pressures required for CO₂. The End-User may be able to work with the OEMs to provide letters of acceptable use for the local jurisdictions to use CO₂ in the existing fixtures. Alternately, a new CO₂ coil could be installed. With appropriate planning, it may be achievable to retrofit existing line-ups with new coils for less than 50% of the cost of new fixtures installed. Some of the existing piping may be able to be reused depending on size. May be a good solution for retailers who want a longer term solution, but do not need to replace the fixtures.

New Equipment



Re-Use High Side, Convert Low Side

- ▶ With Equipment, Cases, and Labor, roughly \$1,100,000
 - \$100,000 Equipment
 - \$250,000 in Coils and Components
 - \$2,000 per coil, \$200 for EEV
 - \$750,000 in Labor/Install
 - Electrical Savings
 - Possible Piping Savings
 - Labor Penalty
- ▶ Energy (Minimal impact)
 - Refrigerant Property Efficiencies
 - Heat Exchange Penalty
- ▶ Schedule (3 to 5 months, but can be extended further if beneficial)

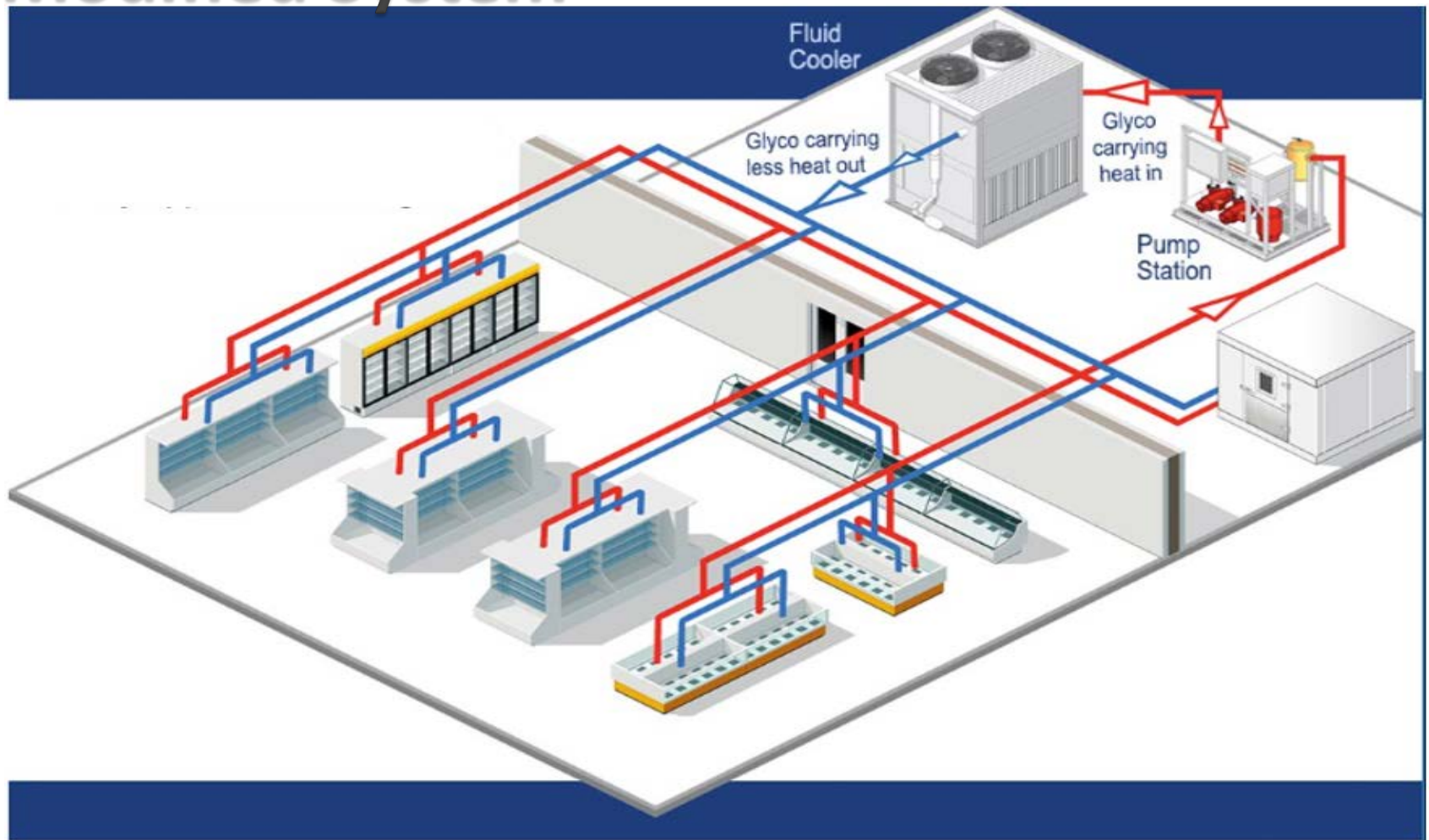
Convert to Micro-Distributed



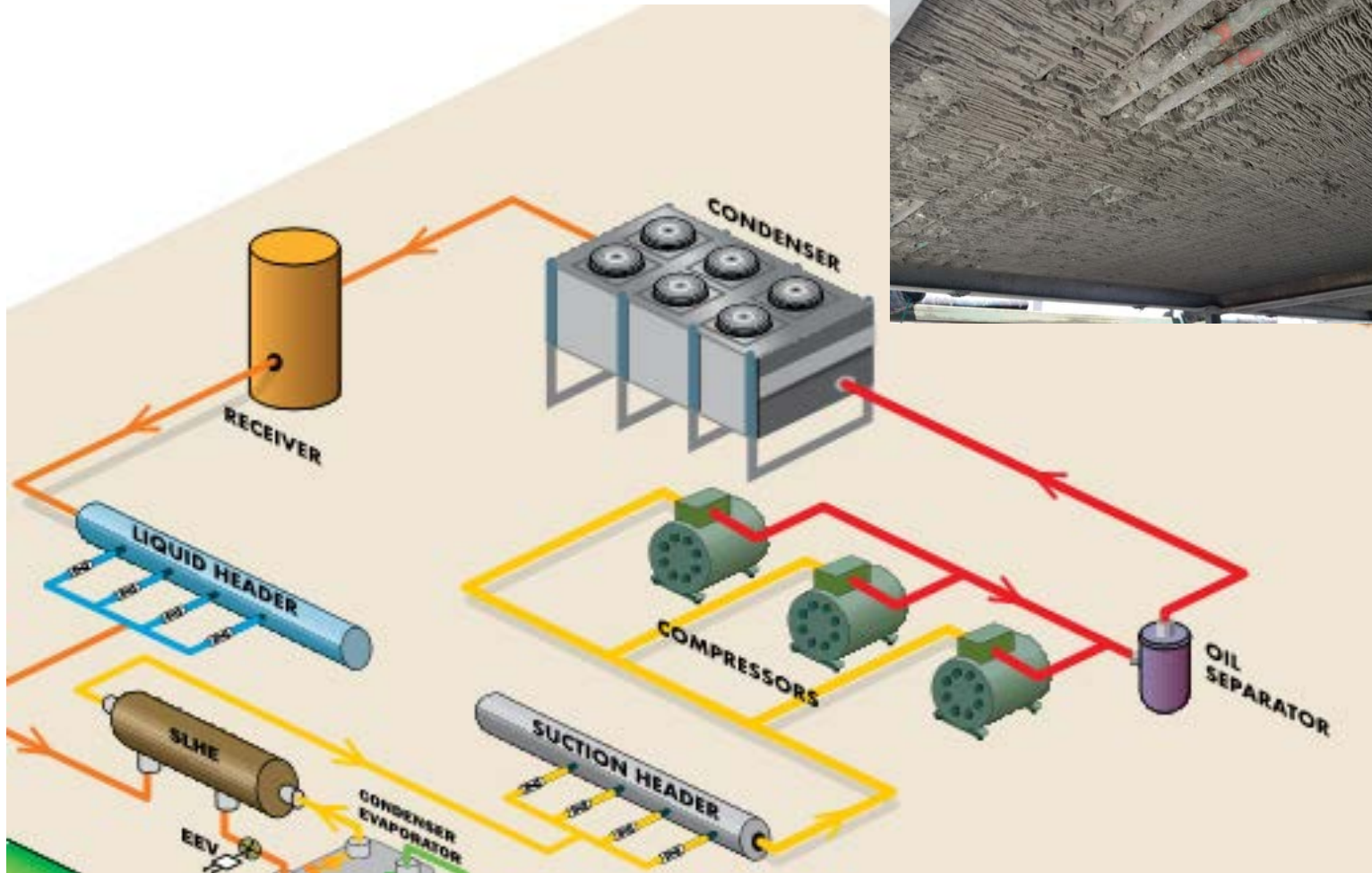
Convert to Micro-Distributed

- ▶ Initial Step: High-side condenser to be replaced with a Fluid Cooler and a pump skid. Installed brazed-plate heat exchangers on the existing racks to allow use with the Fluid Cooler. As fixtures are replaced, utilize micro-distributed units.
- ▶ Considerations: Fixtures can be replaced as budgets and merchandising needs support. Transition can be extended over an indefinite timeframe. It is noted there are minimum load requirements for stable operation of parallel racks, so at some point a balance of the store will need to be fully converted.

Modified System



Equipment being Re-used



Convert to Micro-Distributed

- ▶ With Equipment, Cases, and Labor, roughly \$2,300,000
 - \$200,000 Equipment
 - \$1,000,000 in Cases
 - \$1,100,000 in Labor/Install
- ▶ Energy (Minimal impact - TBD)
- ▶ Schedule (1 month for a line-up, can be extended to several years for full conversion as finances allow)

Independent Applications



Independent Applications

- ▶ Replacement/Added Fixtures to be less than 150 GWP
 - Self-Contained air cooled
 - CO2 Condensing Units
 - Micro-Distributed (Modular Infrastructure applied for future expansion)

Summary – Cost/Energy/Schedule

	Equipment	Cases	Labor/Install	Total	% Savings	Energy Savings	Duration
Conversion			\$ 125,000	\$ 125,000		3% -5%	3 weeks
Full System Replacement	\$ 600,000	\$ 500,000	\$ 1,000,000	\$2,100,000	0%	5% - 20%	6 months
Re-Use High Side, Replace Low Side	\$ 100,000	\$ 500,000	\$ 750,000	\$1,350,000	36%	0% -10%	5 months
Re-Use High Side, Convert Low Side	\$ 100,000	\$ 250,000	\$ 750,000	\$1,100,000	48%	Minimal	5 months
Convert to Micro- Distributed	\$ 200,000	\$1,000,000	\$ 1,100,000	\$2,300,000	-10%	TBD	6 months
Independent Applications							1+ months

Summary - Weighted GWP Impacts

- Major reduction in Average GWP of System

- Baseline traditional system 4000 lbs. system
- Modified system is 1000 lbs of Original Refrigerant over 2000 lbs. of CO2 Cascade or Secondary

<u>Refrigerant</u>	<u>Traditional Sys Avg GWP</u>	<u>Modified Sys Avg GWP</u>
• R-22	GWP-1810 (ODP-.055)	GWP-604
• R-404A/507	GWP-3922	GWP-1308
• R-407A	GWP-2107	GWP-703
• R-448A/449A	GWP-1273	GWP-425
• R-513a	GWP-631	GWP-211
• R-455A/454C(A2L)	GWP-148	GWP-50
• R-744 CO2 Transcritical	GWP-1	
• R-290 Micro Distributed	GWP-3	

Summary – Items to be Furthered

- ▶ A2L Code Development
- ▶ OEM Coil Analysis (Pressure and Performance)
- ▶ Contractor Coil Replacement Costs/Time Savings
- ▶ Piping Re-Use Analysis
- ▶ System Modification Guidelines
- ▶ Equipment Skid Specifications
- ▶ Maintenance Costs
- ▶ Additional Items per Panel Discussions

Questions

Thank You

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