



United Technologies

Climate | Controls | Security

EPEE- CONFINDUSTRIA- CAREL Industry Event

Very Low GWP and Natural Refrigerants in HVAC Applications and the Cold Chain

May 9th, 2016

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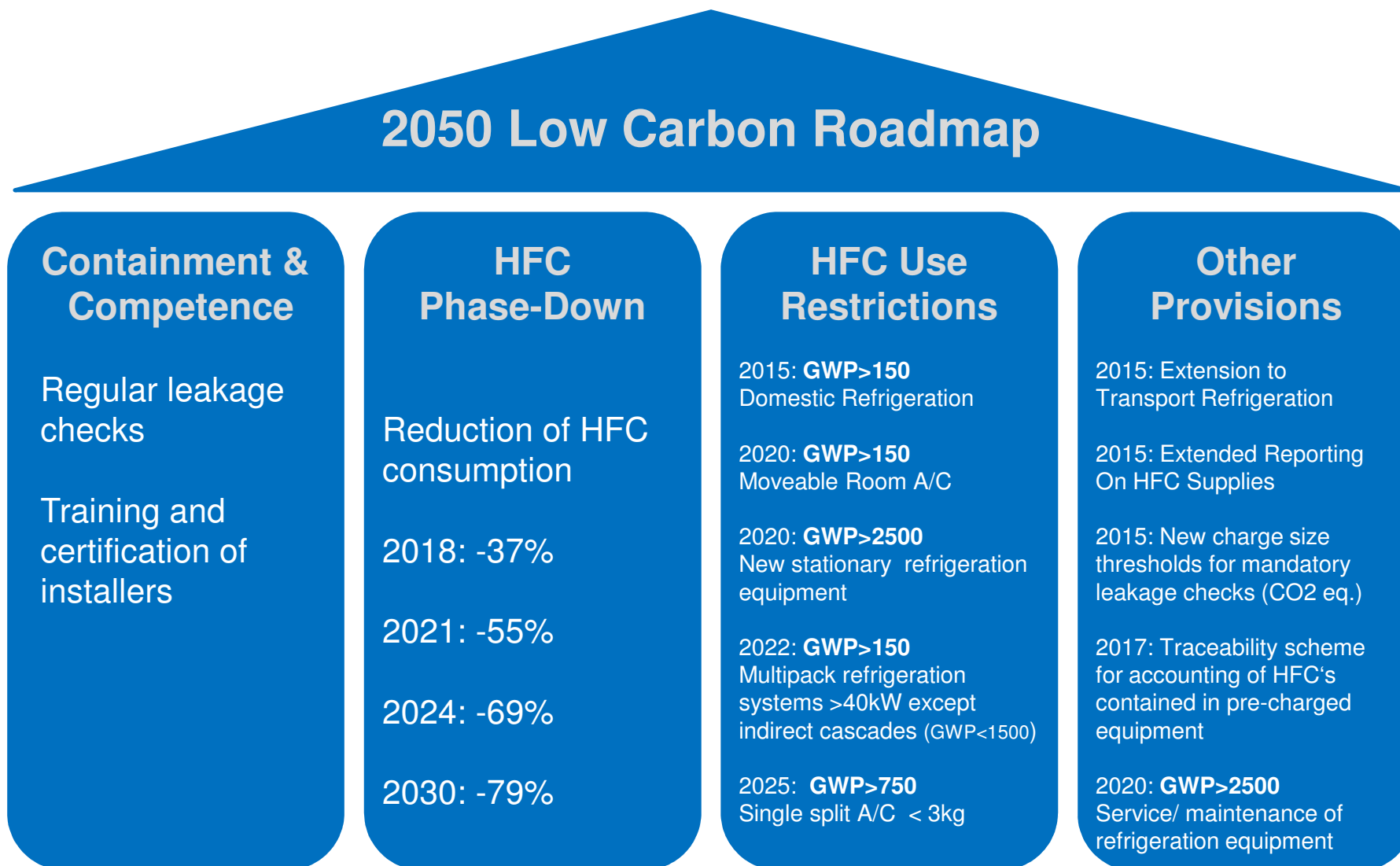


European Partnership for Energy
and the Environment



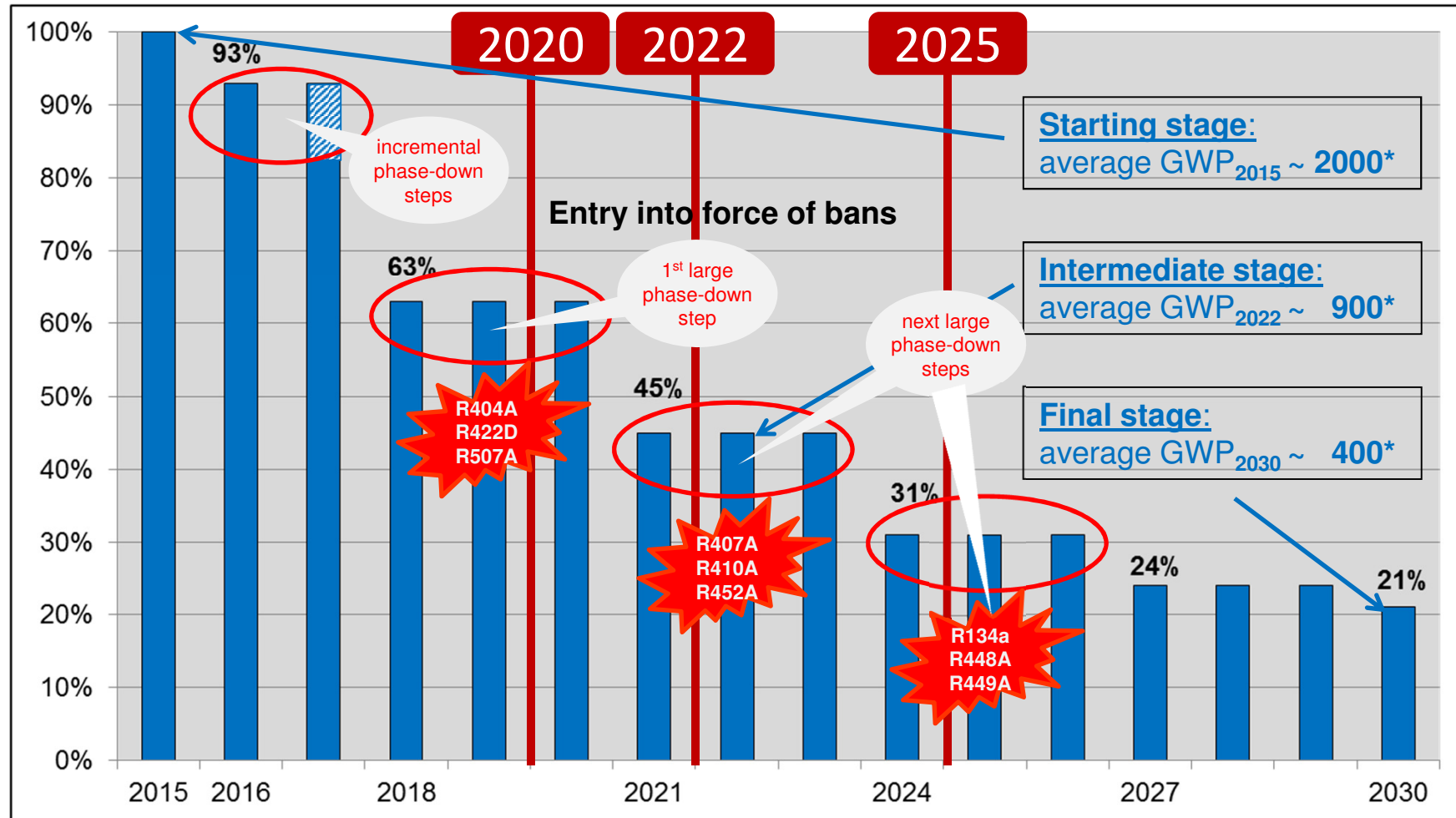
EU F-GAS REGULATION

Central elements



EU F-GAS REGULATION

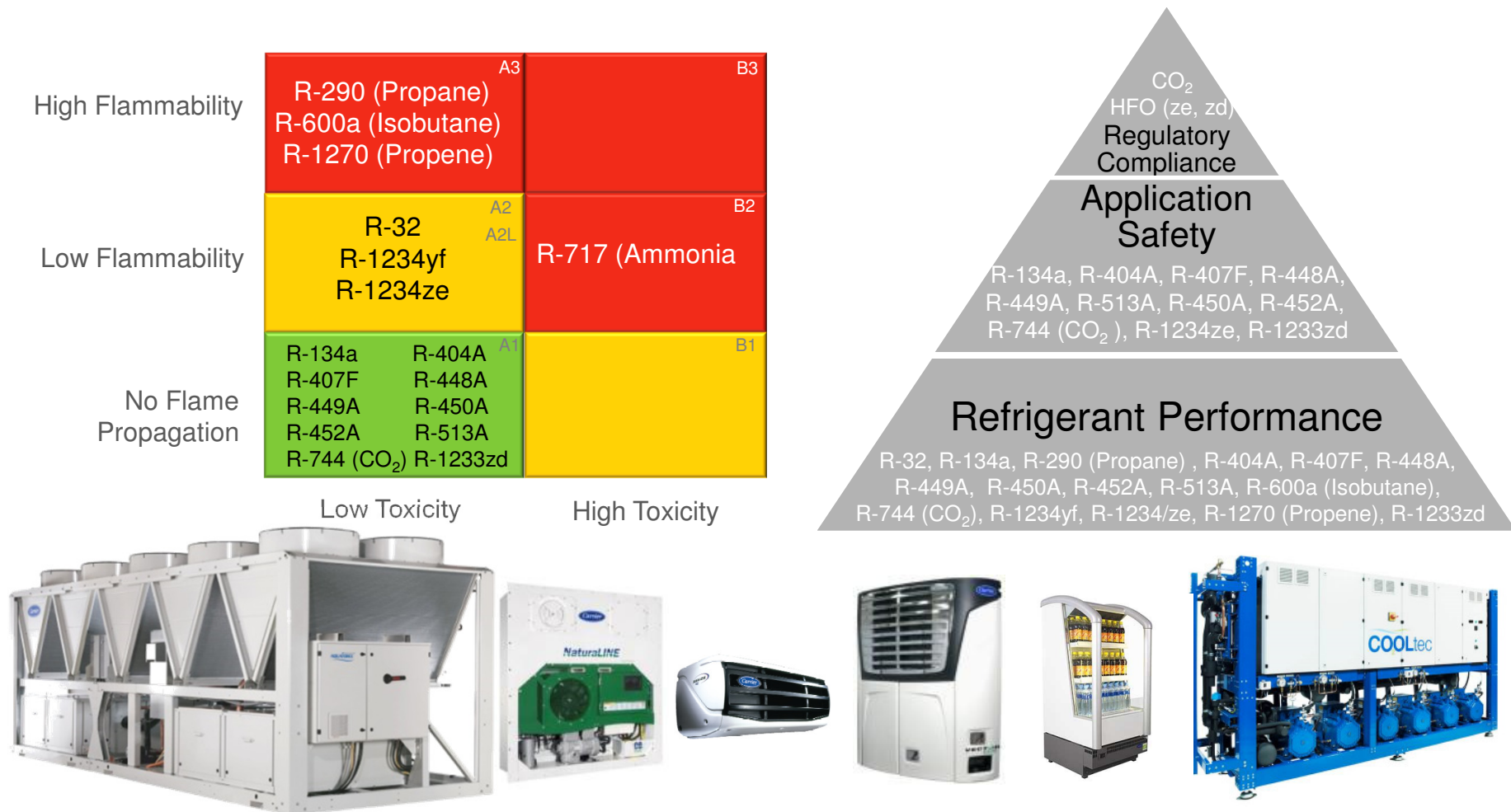
Main lever : HFC Cap and phase-down scheme



* Source : EU Commission

HVAC & FOOD COLD CHAIN APPLICATIONS

Carrier Refrigerants Selection

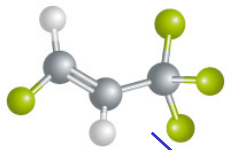


Carrier has the right refrigerant solution for every application, but every application will not have the right refrigerant solution

HFO HVAC TECHNOLOGY

Water-Cooled Chillers and Water-Source Heat Pumps

**R-1234ze(E)
refrigerant**

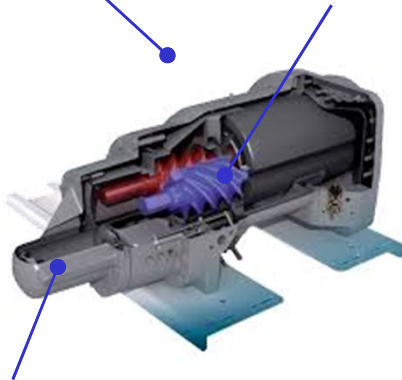


**New polyol ester oil
selected by Carrier**



**External oil tank and
oil line modification**

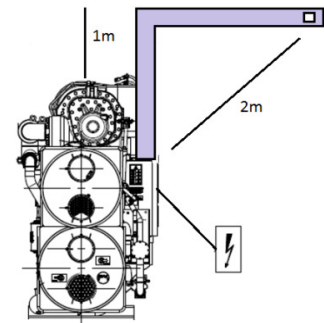
New pressurized electrical box:
- Enhanced air tightness
- Integrated blower
- Top connection for fresh air duct



**New suction & discharge
compressor gaskets**



And specific documentation for installation,
maintenance & safety instructions



Carrier design



Indoor Installation

HFO HVAC TECHNOLOGY

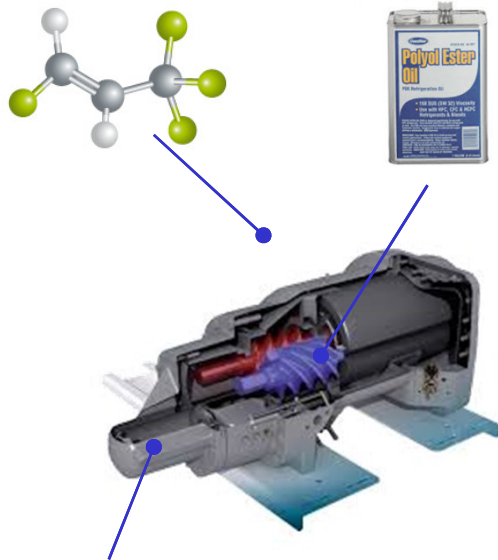
Air-Cooled Chillers

**R-1234ze(E)
refrigerant**

**New polyol ester oil
selected by Carrier**

**New relief valves for
evaporator**

**New high pressure
switches**



**New suction & discharge
compressor gaskets**



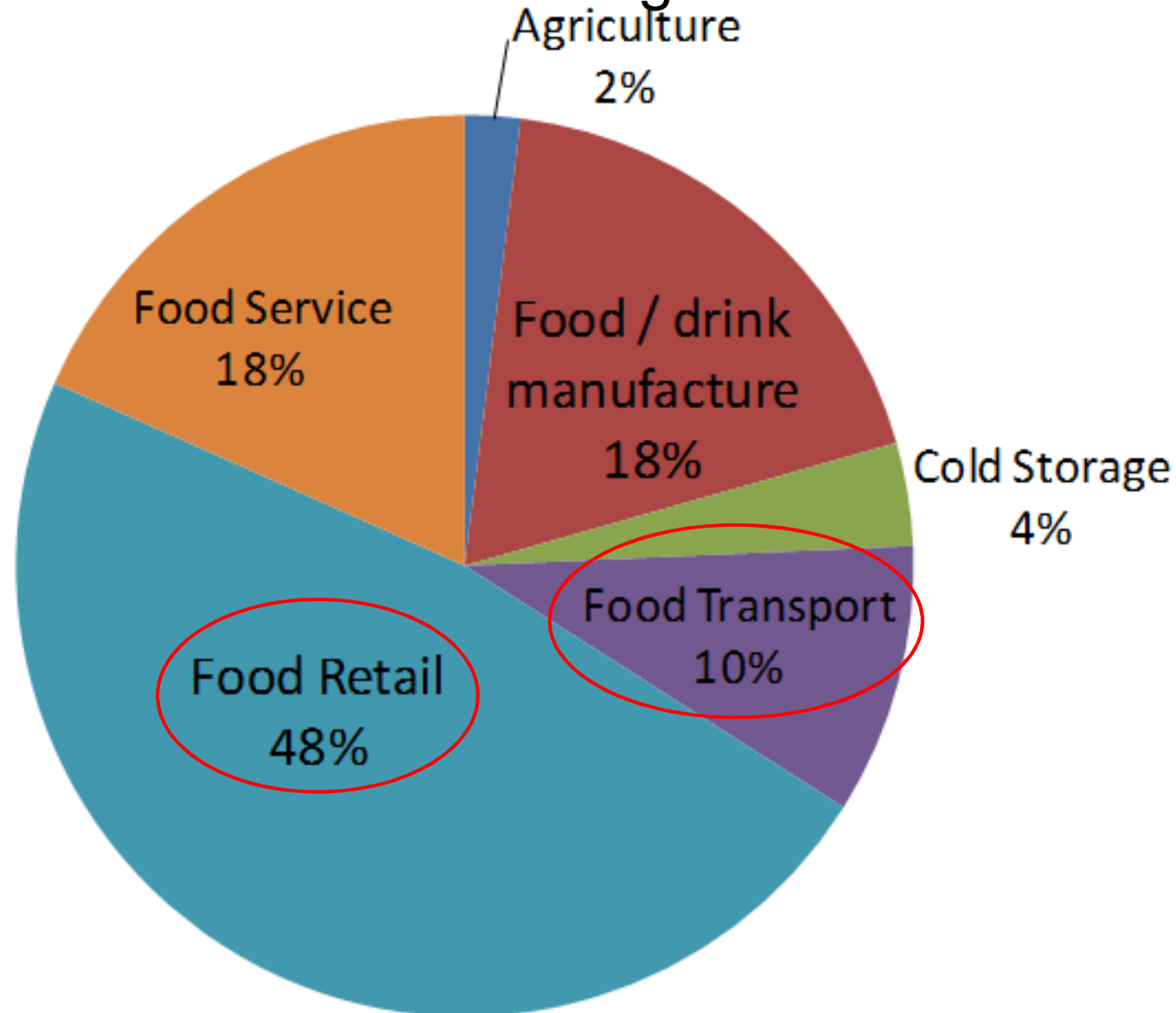
And specific documentation for installation,
maintenance & safety instructions

New software

Outdoor Installation

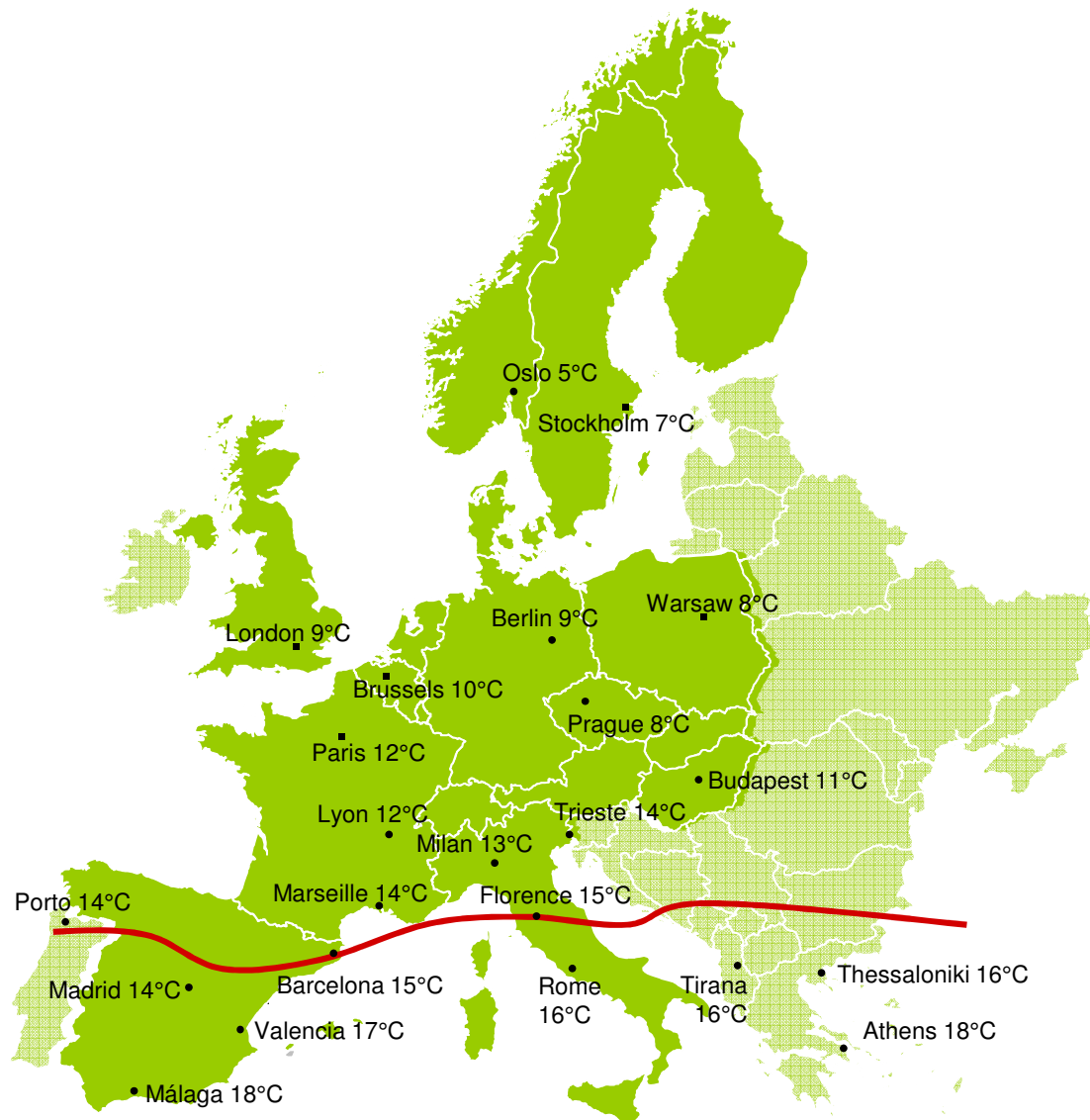
FOOD COLD CHAIN

Total GHG Emissions in Refrigeration Market Sectors⁶



CO₂ SYSTEMS FOR SOUTHERN EUROPE

CO₂ trans-critical solutions for warm climates



Standard Efficiency

Proven energy efficiency of trans-critical CO₂ DX systems in cold and moderate climates

High Efficiency Innovation

Next generation of trans-critical CO₂ DX systems developed and field tested for warm climates

Targeting attractive energy performance across all of Europe, eliminating current

“CO₂ equator”

Source: www.eurometeo.com- yearly climate averages

CO₂ SYSTEMS INNOVATION

CO₂ trans-critical solutions for warm climates

Installations:

Economizer

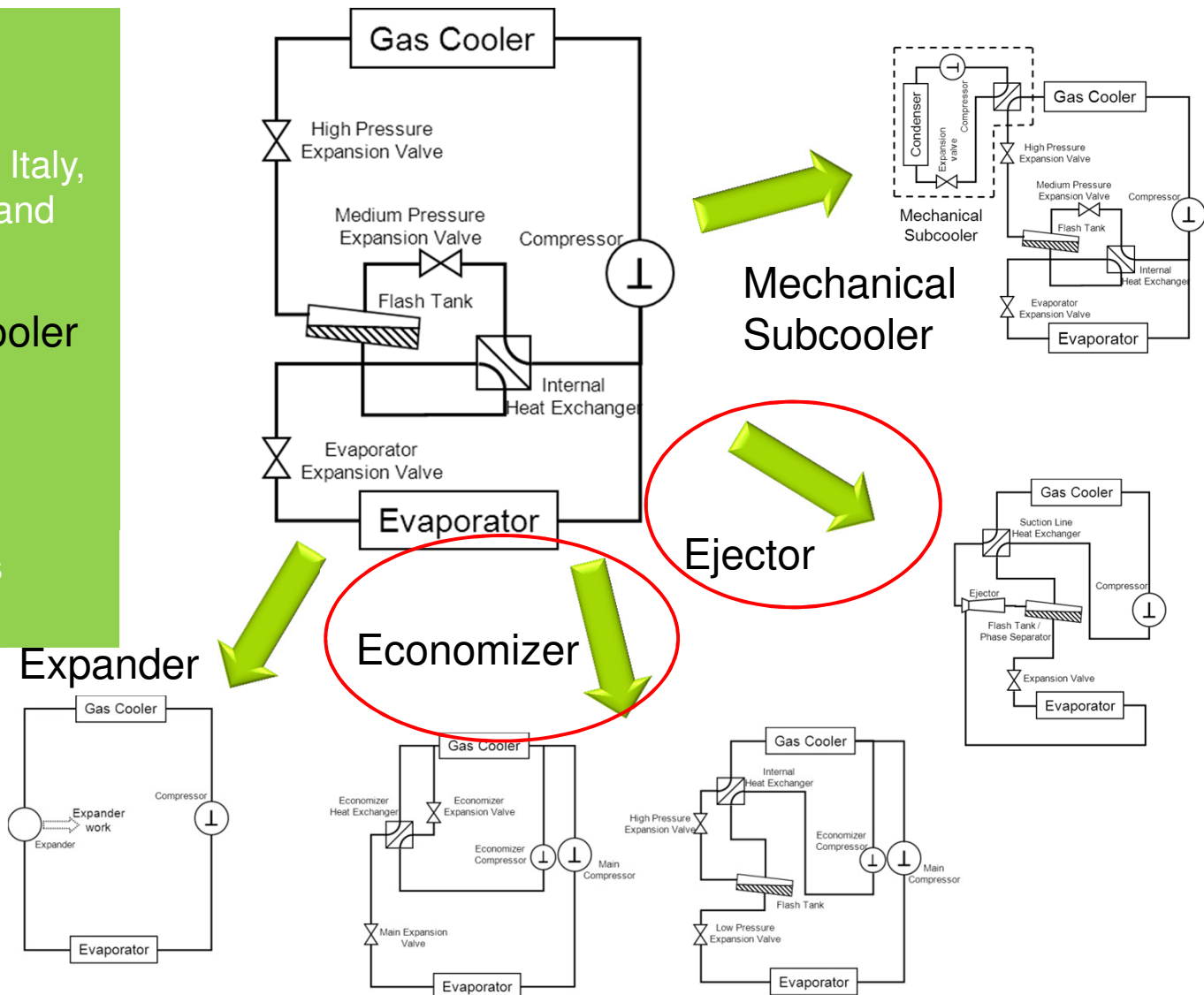
Denmark, Germany, Italy,
Netherlands, Spain and
Switzerland

Mechanical Subcooler

Spain
Portugal

Ejector

France, Netherlands
Spain, Switzerland

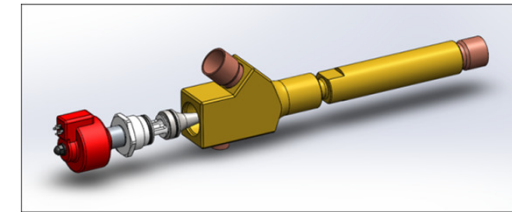


CO₂ SYSTEMS INNOVATION

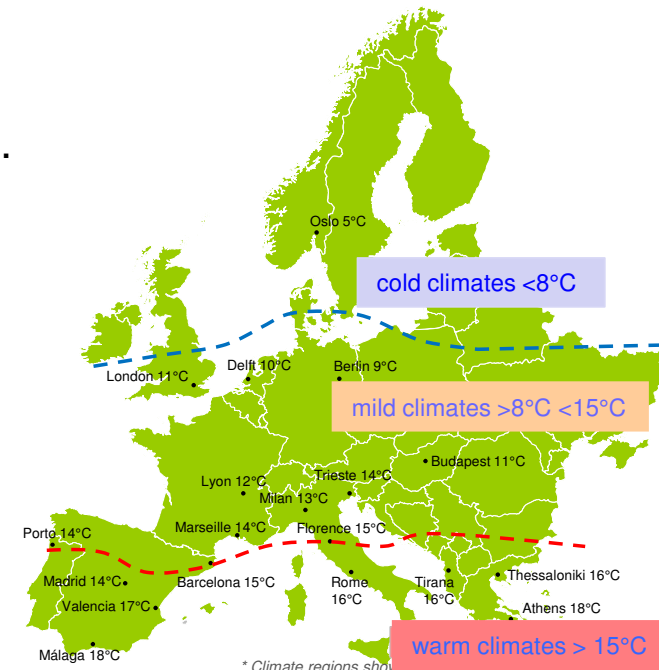
CO₂ trans-critical system with adjustable ejector⁹

High efficiency solutions for all of Europe

- Proven efficiency of transcritical DX CO₂ systems in cold to mild climates
- Carrier adjustable ejector developed, contributing to attractive energy performance also in **warm climates**
- Variable flow to ensure optimal part load performance
- May be combined with economiser cycle, liquid pump...
- > 20% energy savings possible in warm climates¹
- Also offers energy savings:
 - in **mild climates**
 - in **cold climates** during heat recovery mode



Carrier adjustable vapour ejector



Efficient trans-critical CO₂ solutions available for all European climates

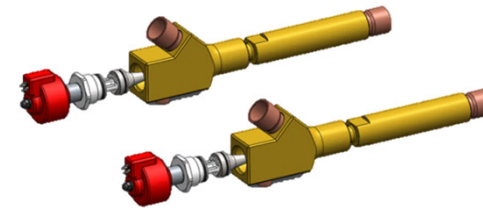
¹ 'High Efficiency' rack configuration including ejector, vs standard CO2OLtec trans-critical booster system. Rack only.

CO₂ SYSTEMS INNOVATION

CO₂ trans-critical system with adjustable ejector¹⁰

Field trial status

- Measuring operational performance, efficiency and reliability
- > 20 ejector systems delivered to date
- Field trials in operation since October 2014
- Projects in France, Netherlands, Spain and Switzerland



CARRIER TRANSPORT TECHNOLOGY

NaturaLINE CO₂ reefer field experience 2012-2013



CARRIER TRANSPORT TECHNOLOGY

Flammable refrigerants in transport refrigeration

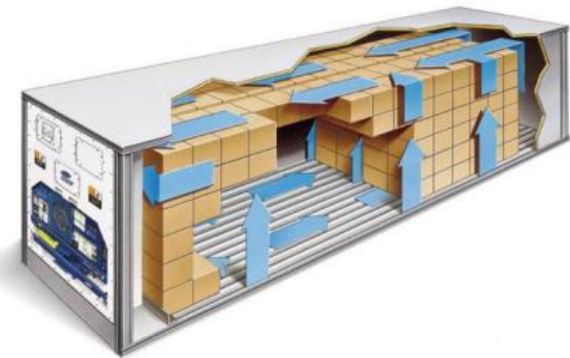
40 ft. container / 80% loaded: available volume: 25 m³

- a) R-1234yf: LFL is 75 g / m³.

For 25 m³, a leak of $25 \text{ m}^3 * 75 \text{ g / m}^3 = 1.8 \text{ kg}$ of refrigerant needed. It is less then nominal charge => **RISK**

- b) Propane: LFL is 9.5 g / m³.

For 25 m³, a leak of $25 \text{ m}^3 * 9.5 \text{ g / m}^3 = 0.23 \text{ kg}$ of refrigerant needed to make the mixture flammable. It is much less then nominal charge => **HIGH RISK**



NOTE: The risk doubles for a 20 ft container.

For A2, A2L and A3 refrigerants, a leak can make the atmosphere inside the container flammable.

Possible countermeasures:

- (1) install alarm / ventilation / interlock system – (our assessment: complex and does not eliminate the risk completely); and/or
- (2) prevent leaks via indirect cycle – (our assessment: complex, reduces significantly system efficiency, does not eliminate the risk completely)

CARRIER CO₂ TECHNOLOGY EVOLUTION

CO₂ in Commercial and Transport Refrigeration

COOLtec



Commercial Refrigeration segment uptake :
1900+ trans-critical and 900+ sub-critical CO₂
refrigeration system installations in Europe
with significant efficiency improvements

NaturaLINE



Container Refrigeration solution commercially
available after 2 years of extensive field trials
(training, reliability, performance, efficiency)

AdvanTEC³

United Technologies

Transport



Road Transport Refrigeration systems, first
tests started end of 2013, customer technical
field tests start in April 2016

MONTREAL PROTOCOL

OEWG 35 and OEWG 36 Conferences 2015





Thank you for your attention!
For further information please visit our website
www.carrier.com

***Carrier has the right refrigerant for every application, but
every application will not have the same refrigerant solution***

Innovative solutions,
naturally...

