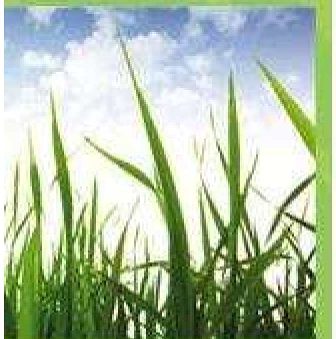
ATMOsphere EU
faster to Europe
natural refrigerants
11-12 October 2011 in Brussels

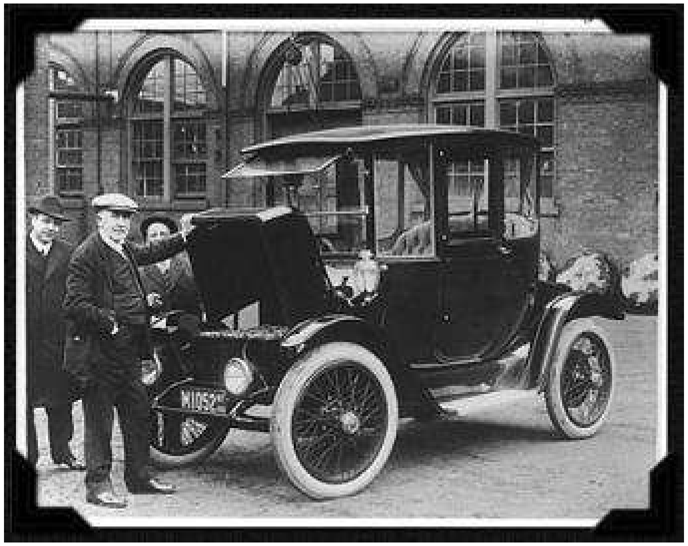





Efficient and sustainable container refrigeration applications using CO_2

J Michael Griffin, Carrier Transicold

TECHNOLOGY EVOLUTION

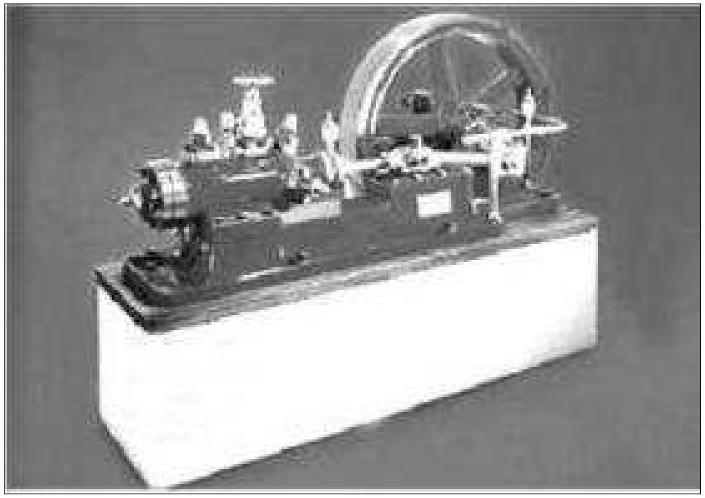


[Thomas Edison](#) and an electric car in 1913 (courtesy of the [National Museum of American History](#))

2011 – Electric car

“The electric car has long been recognized as ‘ideal’ because it was cleaner, quieter and much more economical than gasoline-powered cars.” – The New York Times, Nov. 12, 1911

TECHNOLOGY EVOLUTION



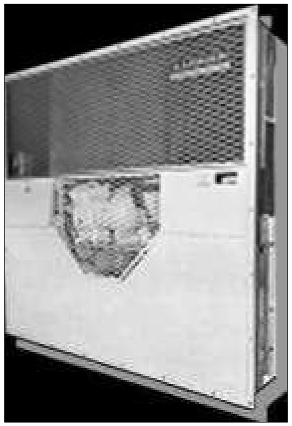
Early CO_2 refrigeration compressor

2011 – CO_2 supermarket system

HISTORY OF CONTAINERIZATION

Pre-1950s

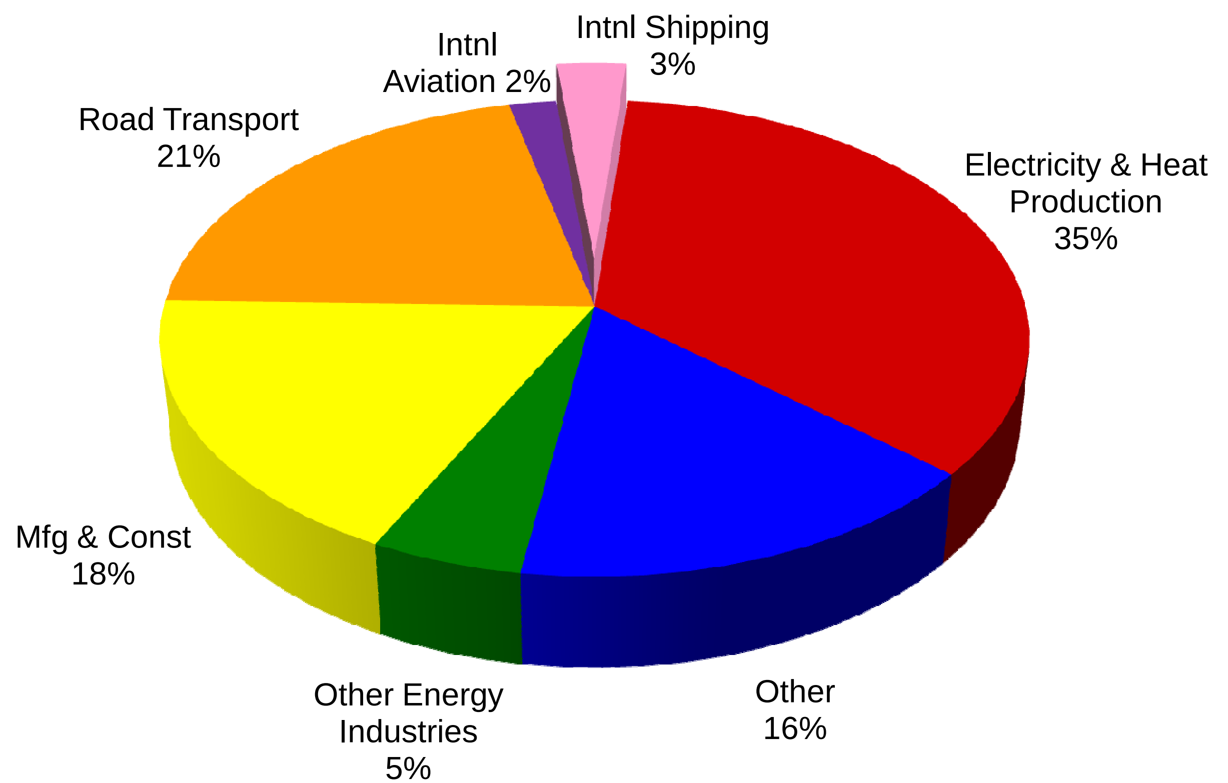
1956



1968

2006 -

CO_2e FROM SHIPPING



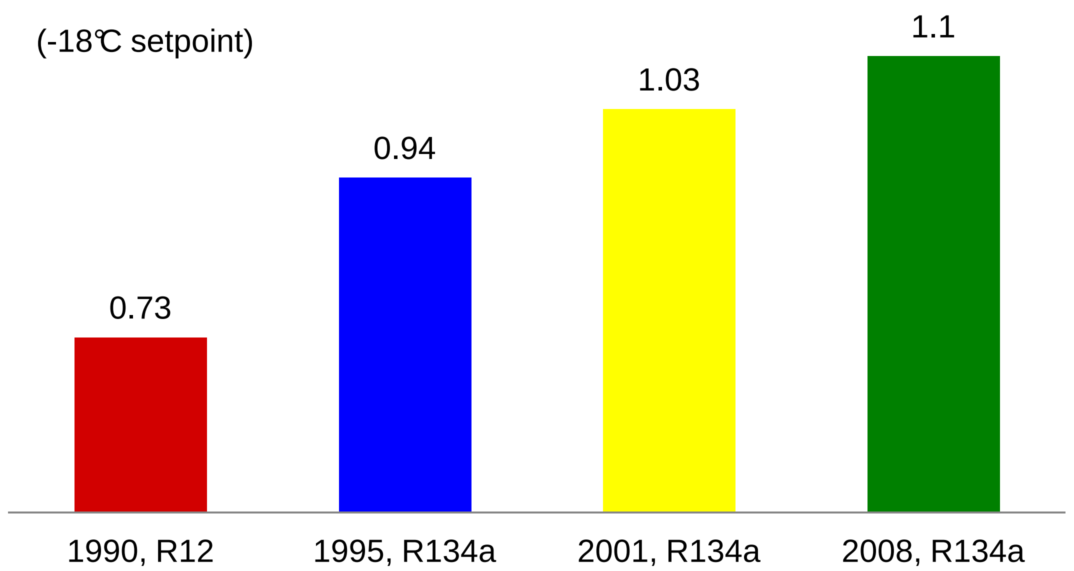
Source: IMO GHG Study, 2009

International shipping emissions total estimated 3% of global CO_2e.

Reefer container estimated contribution is >10 million metric tons/yr

EFFICIENCY EVOLUTION

Energy efficiency improvement (@ 38°C/100°F ambient)



Coefficient of Performance (COP)= net cooling / energy consumed

Progressive attention to environment and energy efficiency

Efficiency gains in container refrigeration machinery since mid-1990s

CONTINUOUS IMPROVEMENT

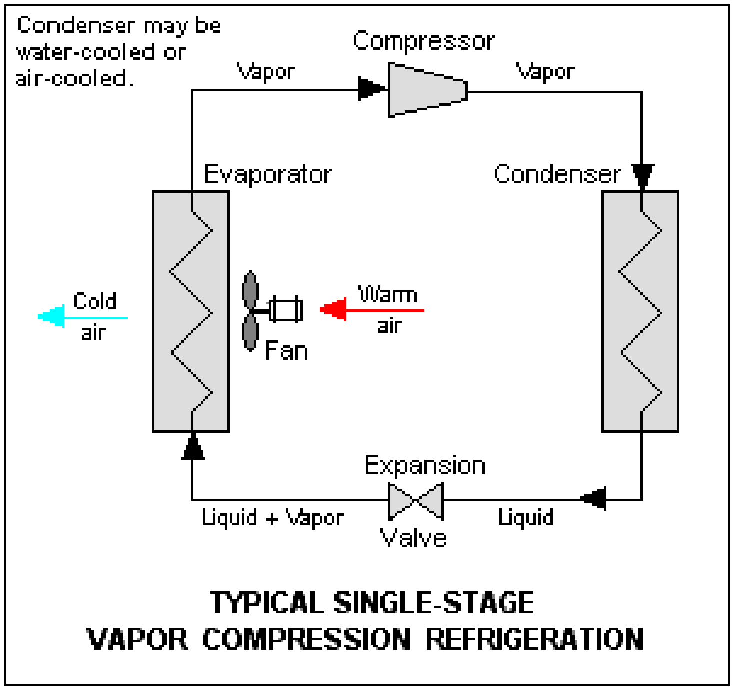
Reduce GWP

- Direct
- Indirect

Consider total carbon footprint

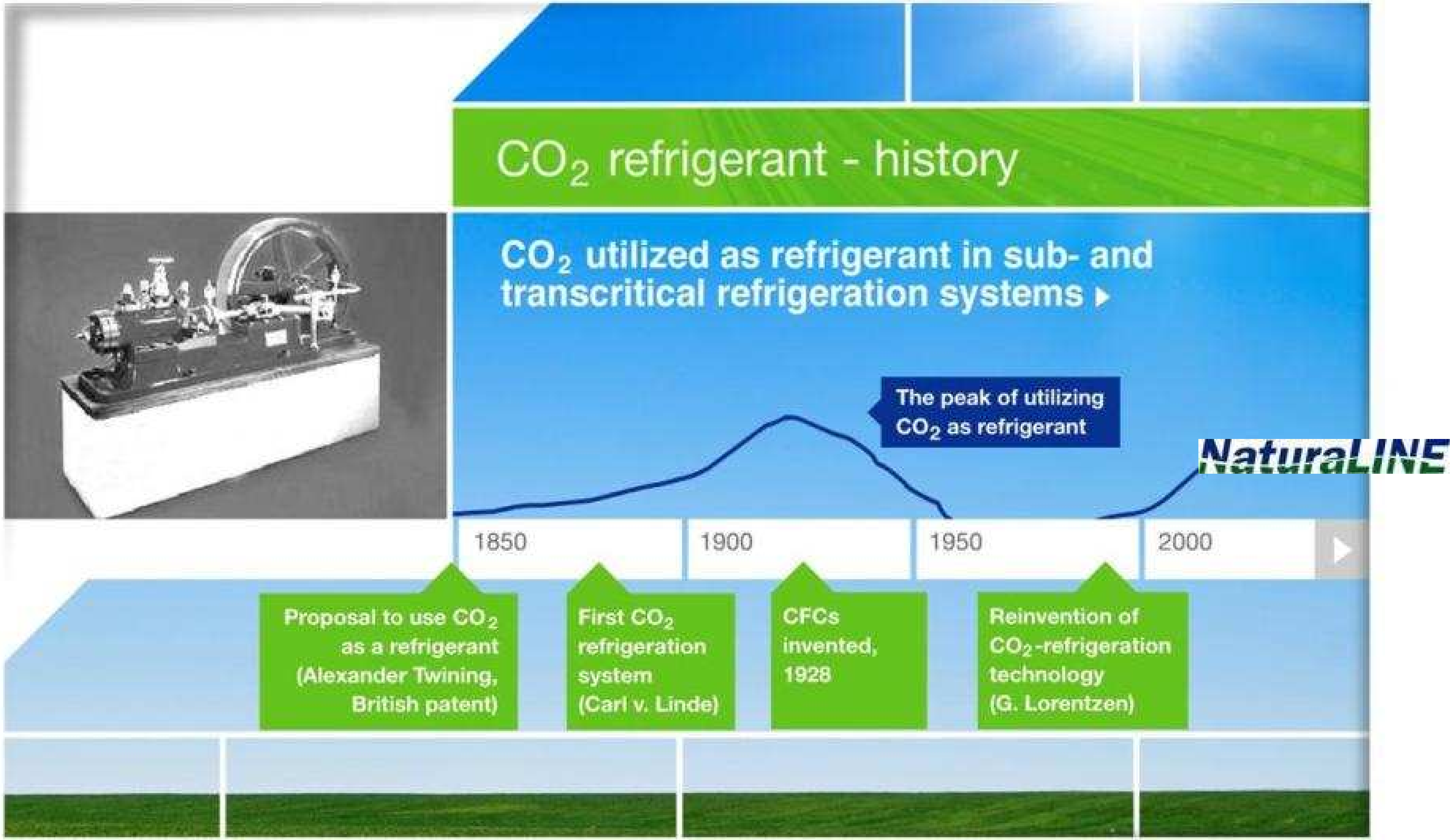
- Production processes
- Materials

Vapor compression cycle



Refrigerated shipping containers leverage
a basic vapor compression cycle and components

NEW TECHNOLOGY



ALTERNATE REFRIGERANT

R744

GWP = 1, ODP = 0, Non-toxic

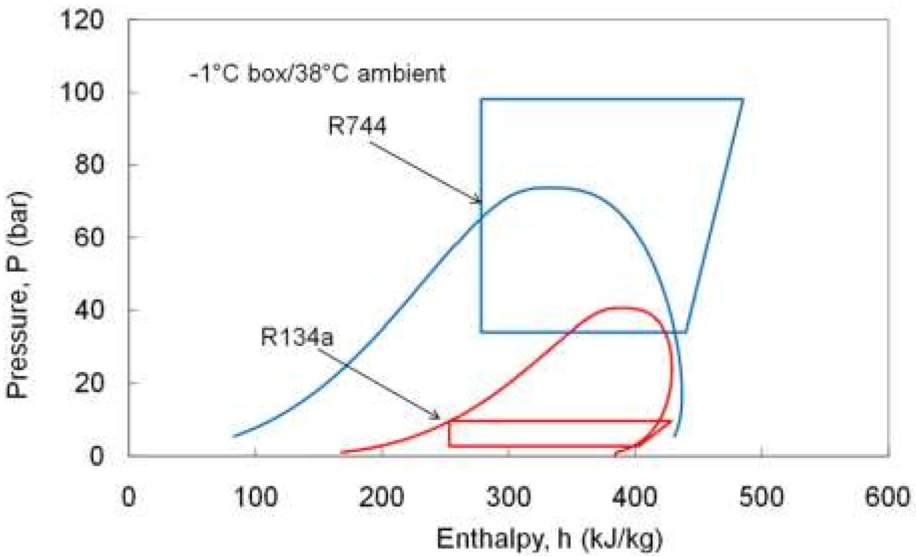
Cost effective and available

Protected against phase outs, taxes, and F-gas regulations

Component suppliers optimizing designs for CO2

Applications demonstrating efficient systems

R744 operating envelope



Pressure level : 100 bar versus10 bar
Trans-critical operation: when ambient >20ºC

NEW TECHNOLOGY

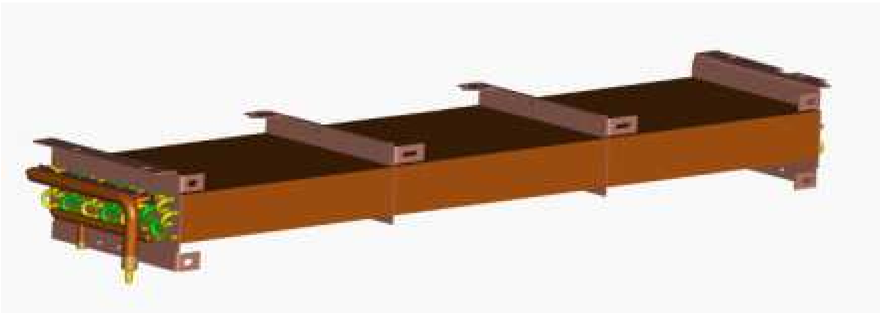
Compressors

Variable speed

Multi-stage

Purpose-built

Heat exchangers



Conventional flat coil

Optimized formed coil

Maximize heat transfer surface area to improve capacity and efficiency.

FIELD TRIALS

Strategic partnership

2008: sub-critical demonstration

2010: trans-critical demonstration

2011: expanding field trials; global service training

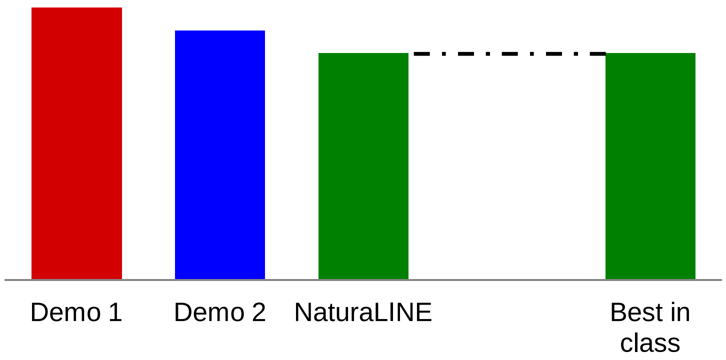
Trans-critical results

All ambients = **OK**

Maintain frozen & perishable set points up to 32°C (90°F) = **OK**

Design life multiple voyages = **OK**

Carrier CO_2 compressor designed for container application = **OK**



ACTION PLAN

Service training

Product design introduction

Field trials

CONCLUSIONS

Environmental stewardship means OEMs must work to combine the best components in a carefully designed system.

Support 2020 / 2025 targets by product category

Support transport refrigeration in EU F-gas regulations

GWP = 1

Minimize environmental impact

Improve energy efficiency