



TRANE®

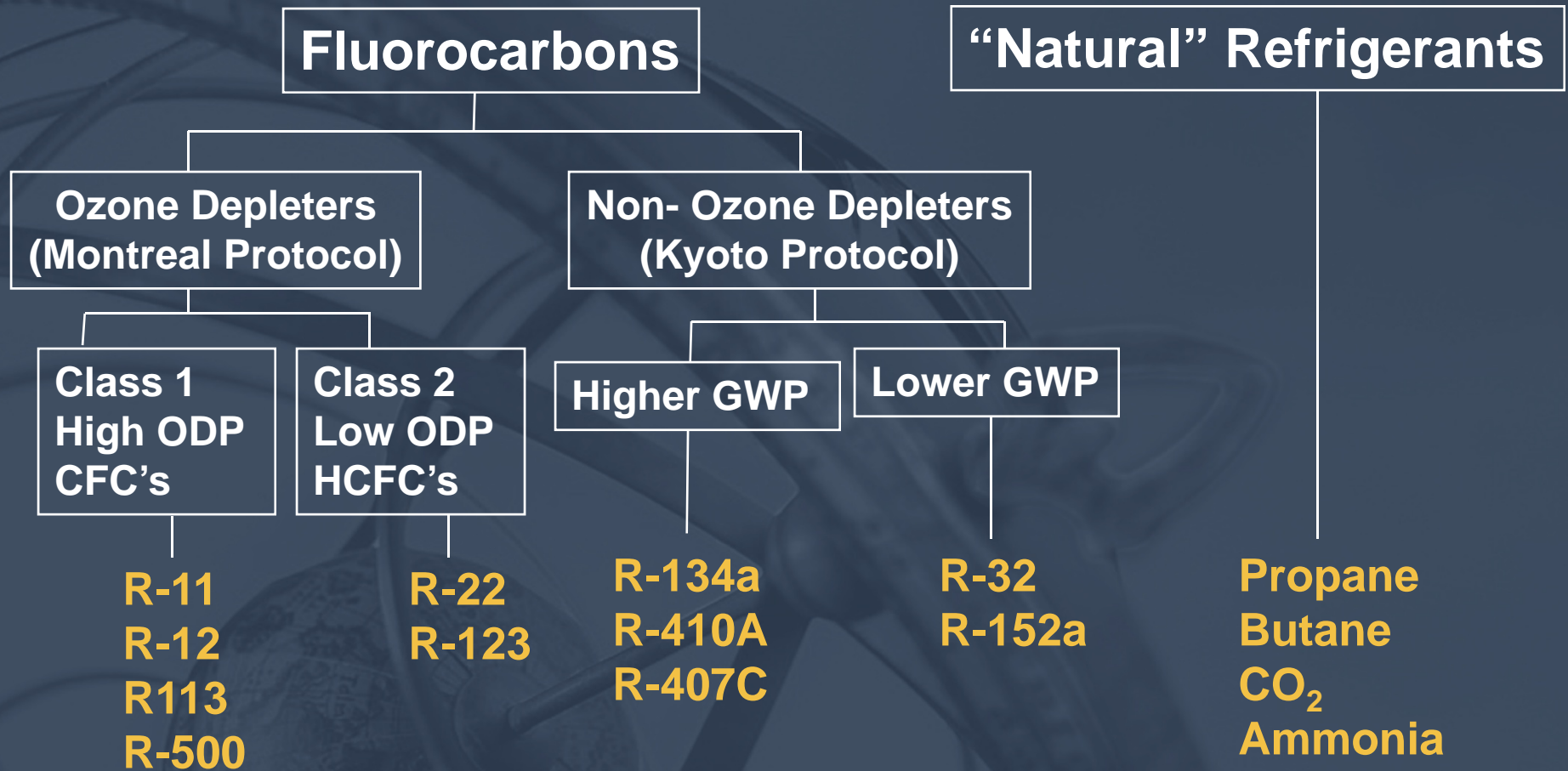
The Future of Refrigerants: Where Do We Go From Here?

Mike Thompson
Global Leader of Refrigerant Strategy
Trane, Thermo King, Hussman

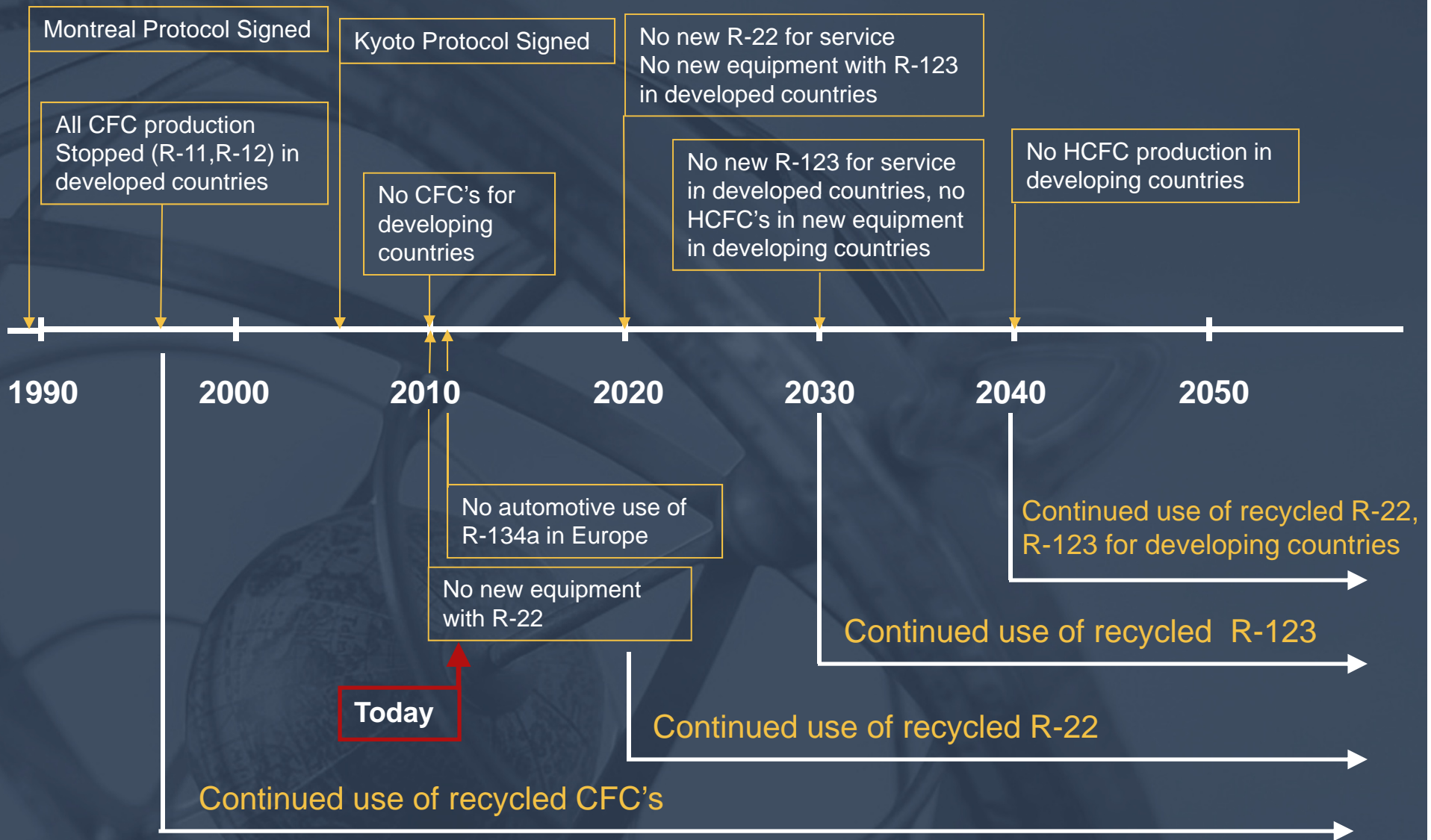


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Options For HVAC Refrigerants



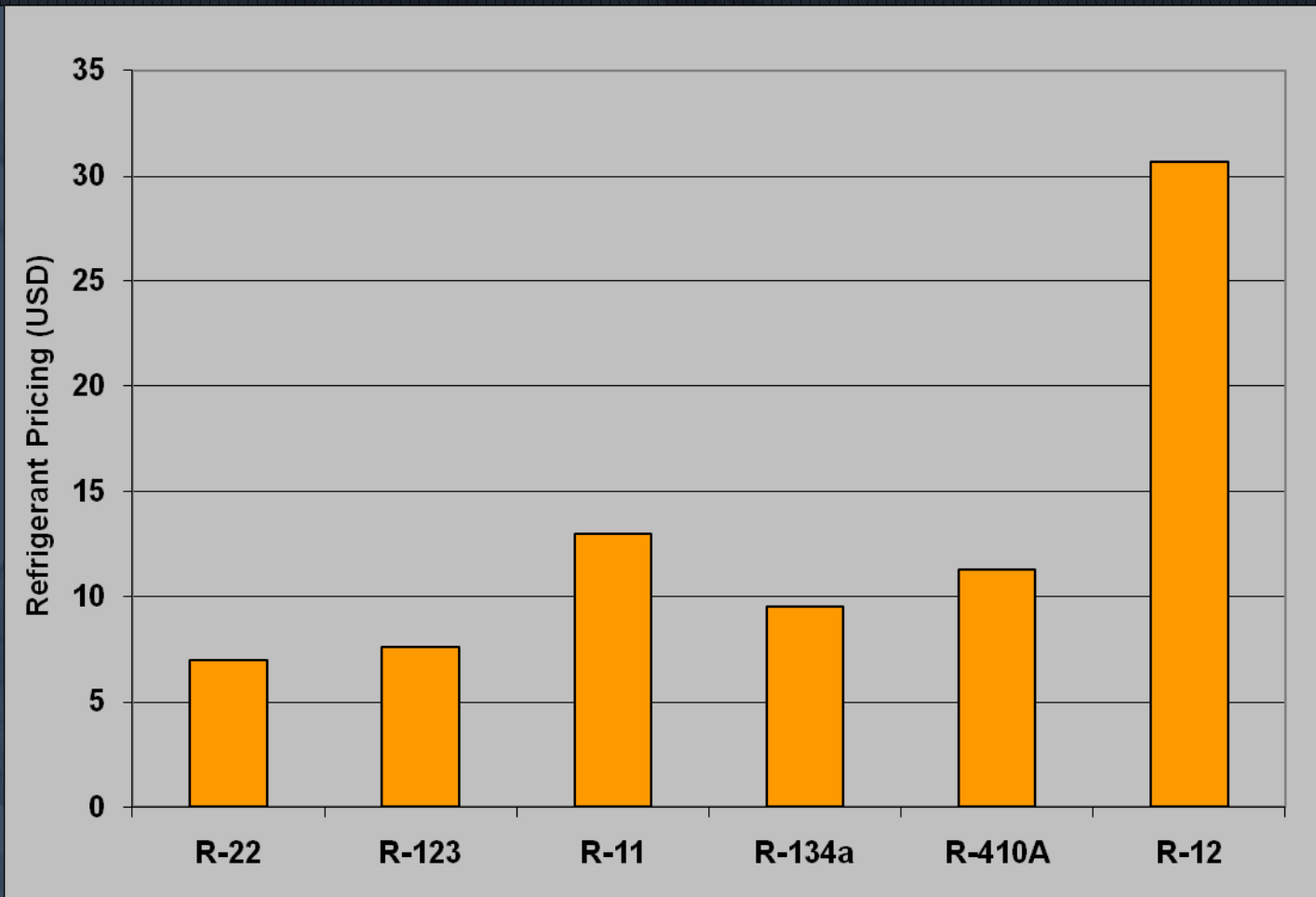
Timeline of Refrigerant Usage



Note: Included in the use of "recycled" refrigerants is also the use of stockpiled supplies of the refrigerant produced before the phase out date. In addition, there is no restriction on the importation of recycled and recovered supplies of refrigerants.

Current Refrigerant Pricing

January 2011



*Source: WWW.r22.org

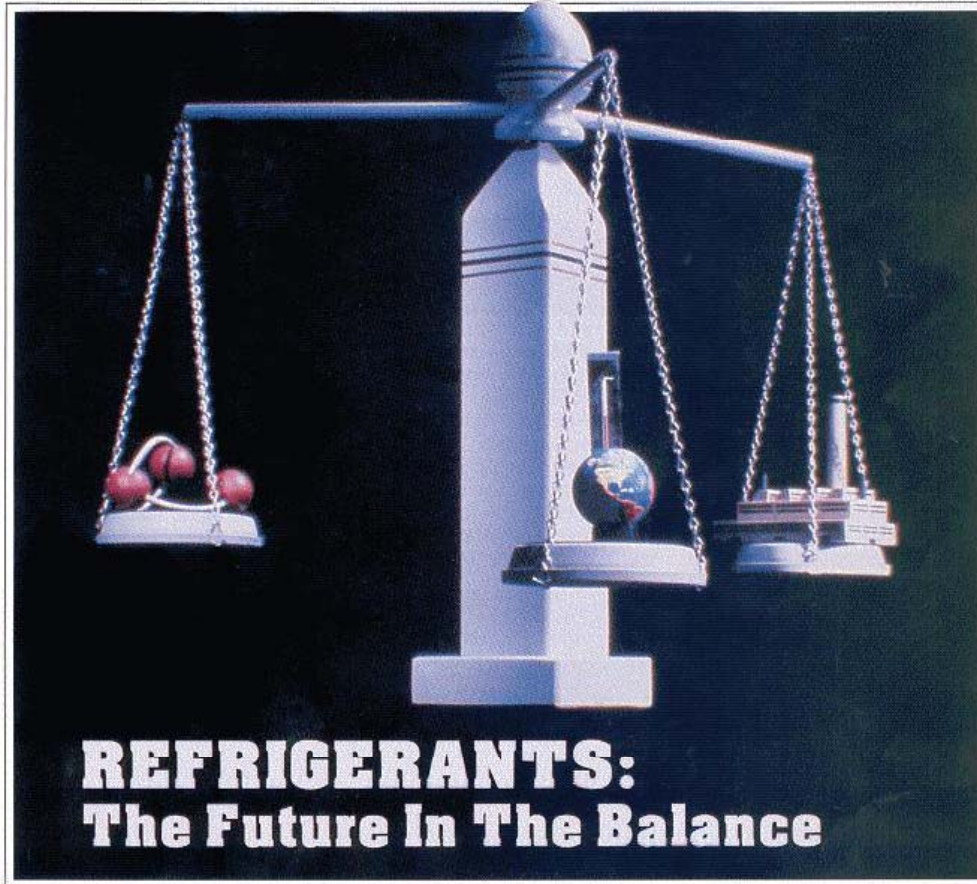
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APRIL 1994

SECOND CLASS POSTAGE PAID

THE MAGAZINE OF MECHANICAL SYSTEMS ENGINEERING

Heating Piping Air Conditioning



**REFRIGERANTS:
The Future In The Balance**

Kyoto Protocol Greenhouse Gas Coverage

- ◆ **Six (6) Gases**

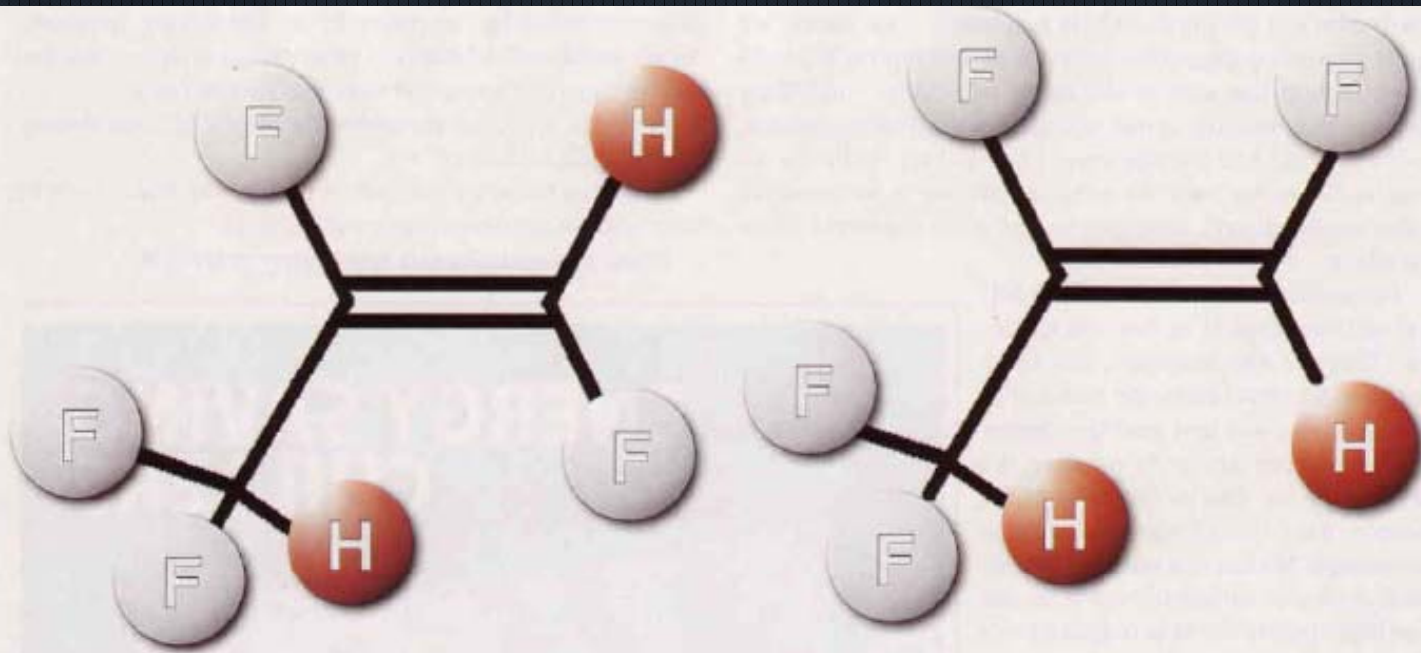
- ◆ Carbon Dioxide -- CO₂
- ◆ Methane -- CH₄
- ◆ Nitrous Oxide -- N₂O
- ◆ Hydrofluorocarbons -- HFCs
- ◆ Perfluorocarbons -- PFCs
- ◆ Sulfur hexafluoride -- SF₆

- ◆ **Base Period**

- ◆ 1990 for CO₂ , CH₄ , and N₂O
- ◆ 1990 or 1995 for HFCs, PFCs, and SF₆

European HFC Restrictions

- ◆ **Denmark**
 - ◆ General HFC ban in 2006
 - ◆ HFC ban on HVAC equipment in 2007, except if the factory refrigerant charge is <10kg for cooling applications or <50 kg for heat pump applications
- ◆ **Austria**
 - ◆ HFC ban on HVAC equipment, appliances and cars in 2008, except if factory charge is <20kg of refrigerant
- ◆ **Switzerland**
 - ◆ Domestic Refrigeration HFC Ban - 2003
 - ◆ Air Conditioners HFC Ban - 2005
 - ◆ Mobile Air Conditioning HFC Ban – 2008
- ◆ **F-Gases Directive on car air conditioning**
 - ◆ No new vehicles containing F-gases, with a GWP greater than 150, in 2011
 - ◆ Prohibit sale of vehicles containing F-gases, with a GWP greater than 150, in 2017



HFOs

New, Low Global Warming Potential Refrigerants

By J. Steven Brown, Ph.D., P.E., Member ASHRAE

and R-1234yf. R-152a, if used, would likely be implemented in an indirect system (secondary loop) because of

Country GHG Cap & Trade Legislation

- ◆ **Japan**
 - ◆ GHG emissions reduction target of 60-80% by 2050
 - ◆ Will start trial cap & trade program fall of 2009
 - ◆ Govt pressure on GHGs, including HFCs, against industries desires
- ◆ **New Zealand Cap & Trade (Legislation in process)**
 - ◆ Six gases including HFCs
 - ◆ All sectors
- ◆ **Australia Cap & Trade (Legislation in process)**
 - ◆ Five gases
 - ◆ Separate HFC regulation (25% below 2000 levels by 2020)
 - ◆ HFC regulations begin in 2011
- ◆ **European Union (27 countries) - 2008**
 - ◆ CO2 only cap and trade, utilities & large industrials
 - ◆ HFCs under regulatory pressure

Ways in Which HFC's Could be Phased Out/Down

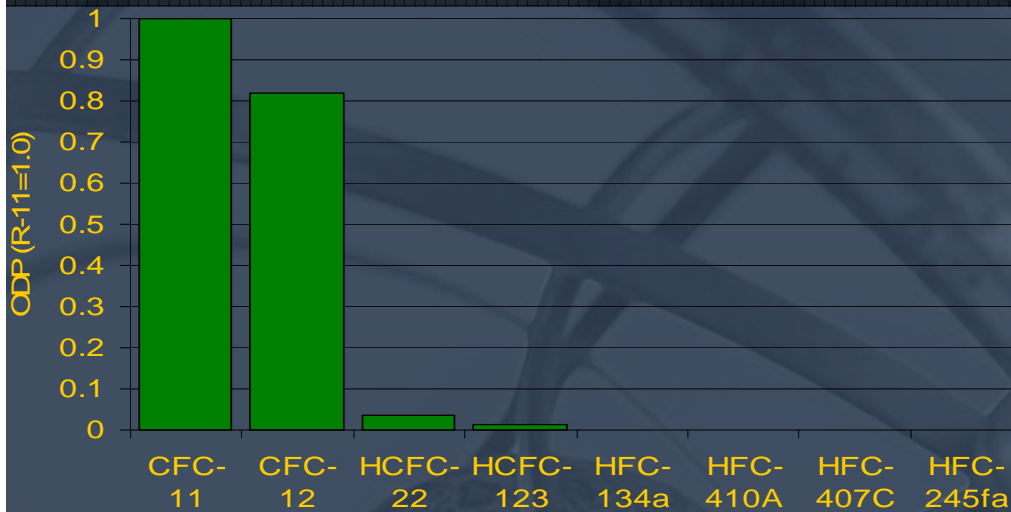
- ◆ **Climate Change Regulation (Kyoto Protocol)**
- ◆ **Montreal Protocol Modification**
- ◆ **US Cap and Trade Regulation**
- ◆ **Direct Implementation from US EPA**

Balance of Environmental Issues

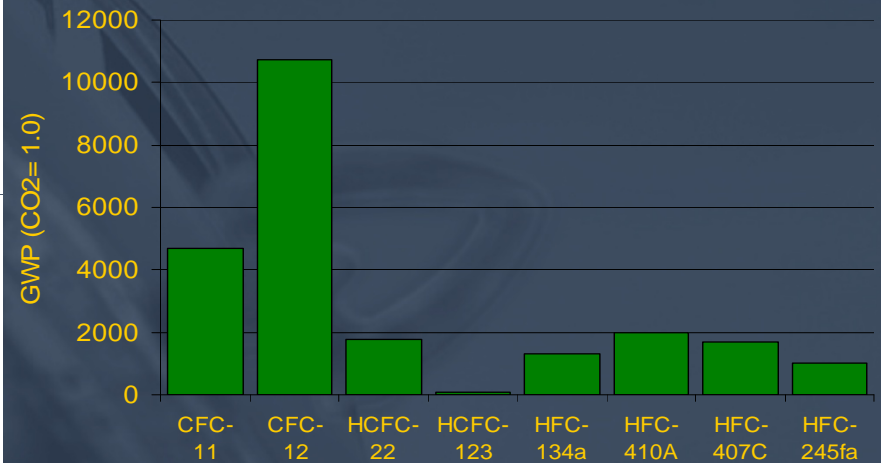
- ♦ Minimal Ozone Depletion (ODP)
- ♦ Minimal Global Warming potential (GWP)
- ♦ Best delivered efficiency (part and full load)
- ♦ Short atmospheric life
- ♦ Lowest possible leakage rate

Environmental Impact of Refrigerants

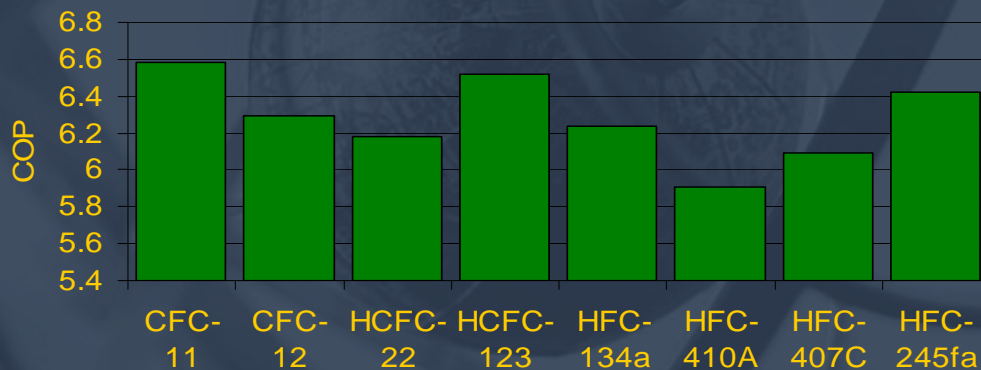
Ozone Depletion Potential (ODP)



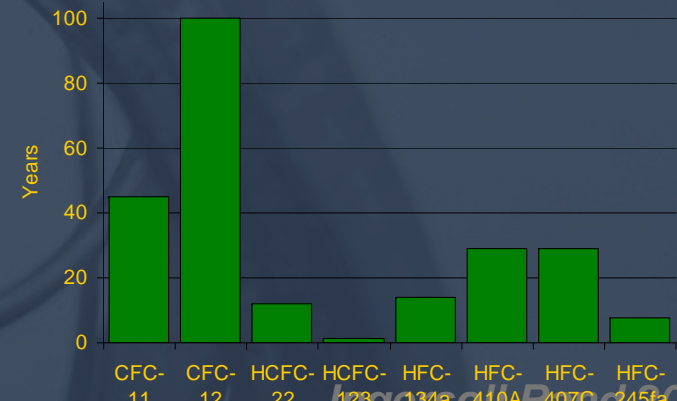
Global Warming Potential (GWP)



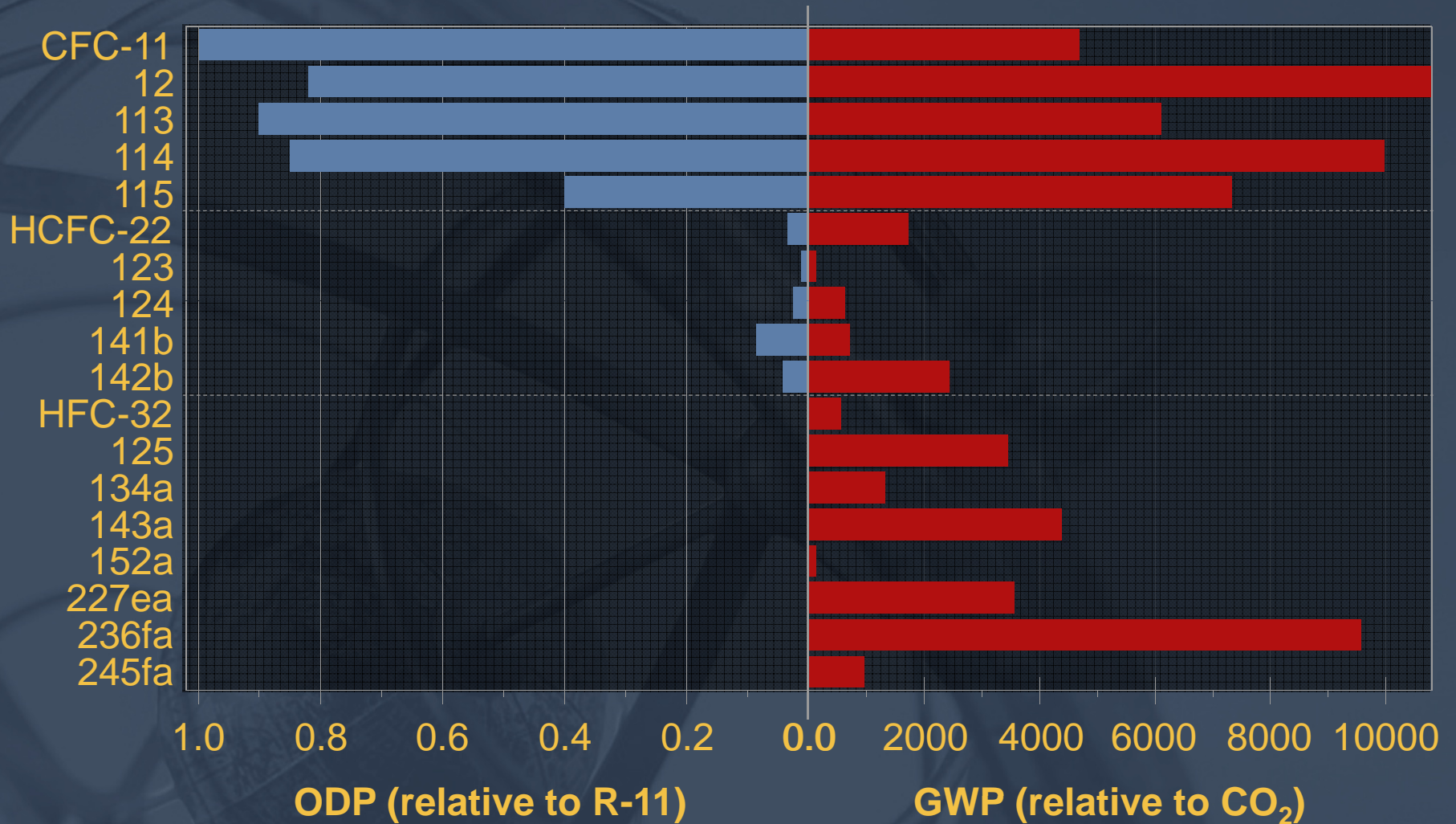
Energy Efficiency (COP)



Atmospheric Life (years)



ODP versus GWP

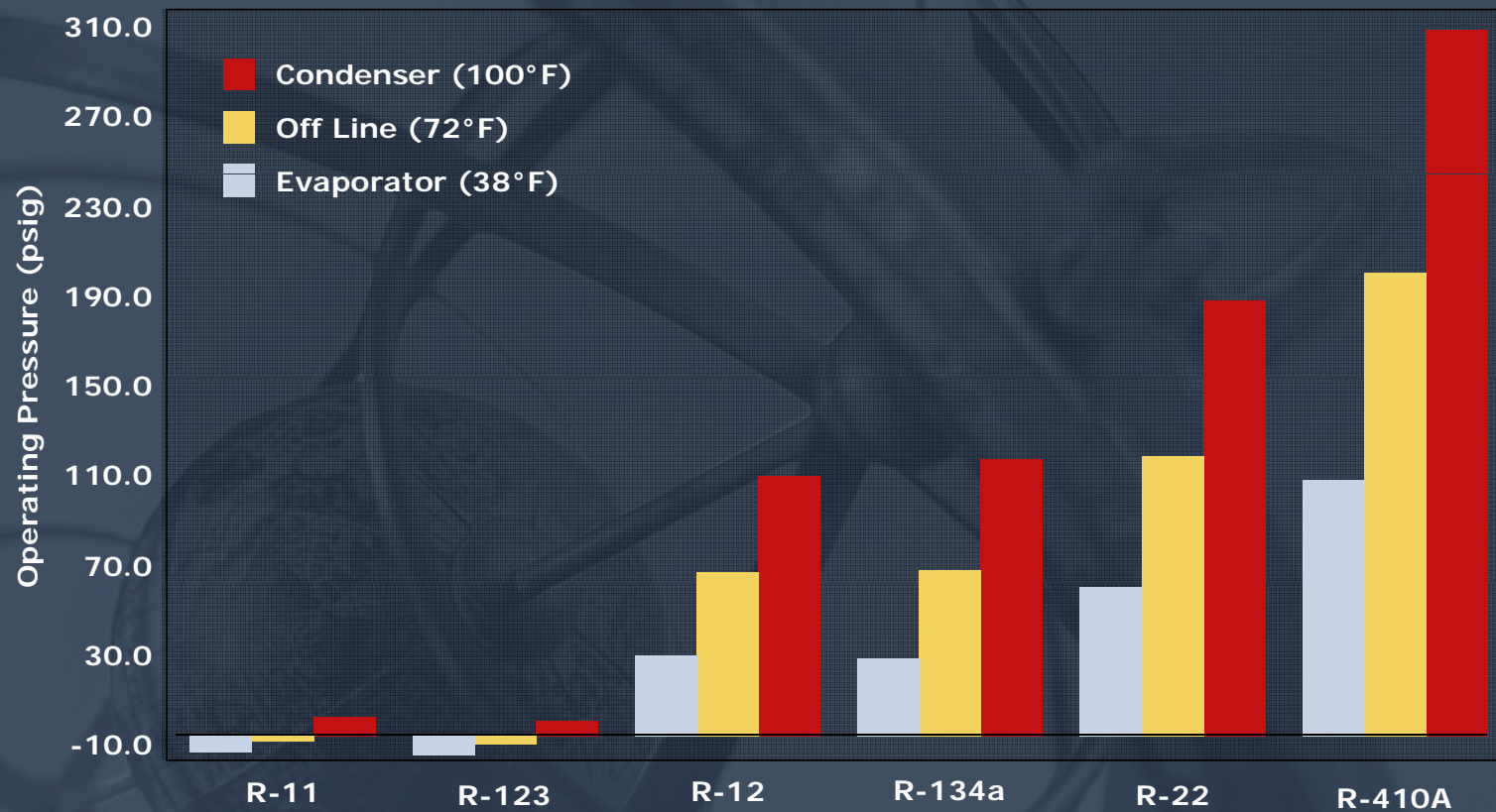


J. M. Calm and G. C. Hourahan, "Refrigerant Data Summary," *Engineered Systems*, 18(11):74-88, November 2001 (based on 1998 WMO and 2001 IPCC assessments)

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Chiller Operating Pressure



What Is Important Over the Life of a Chiller?

Cost of Energy (94.5%)

First Cost of Chiller (5.18%)

**Cost of Initial Charge
Of Refrigerant (0.25%)**

**Refrigerant Added
Over 30 years (0.04%)**

The Future

Emissions

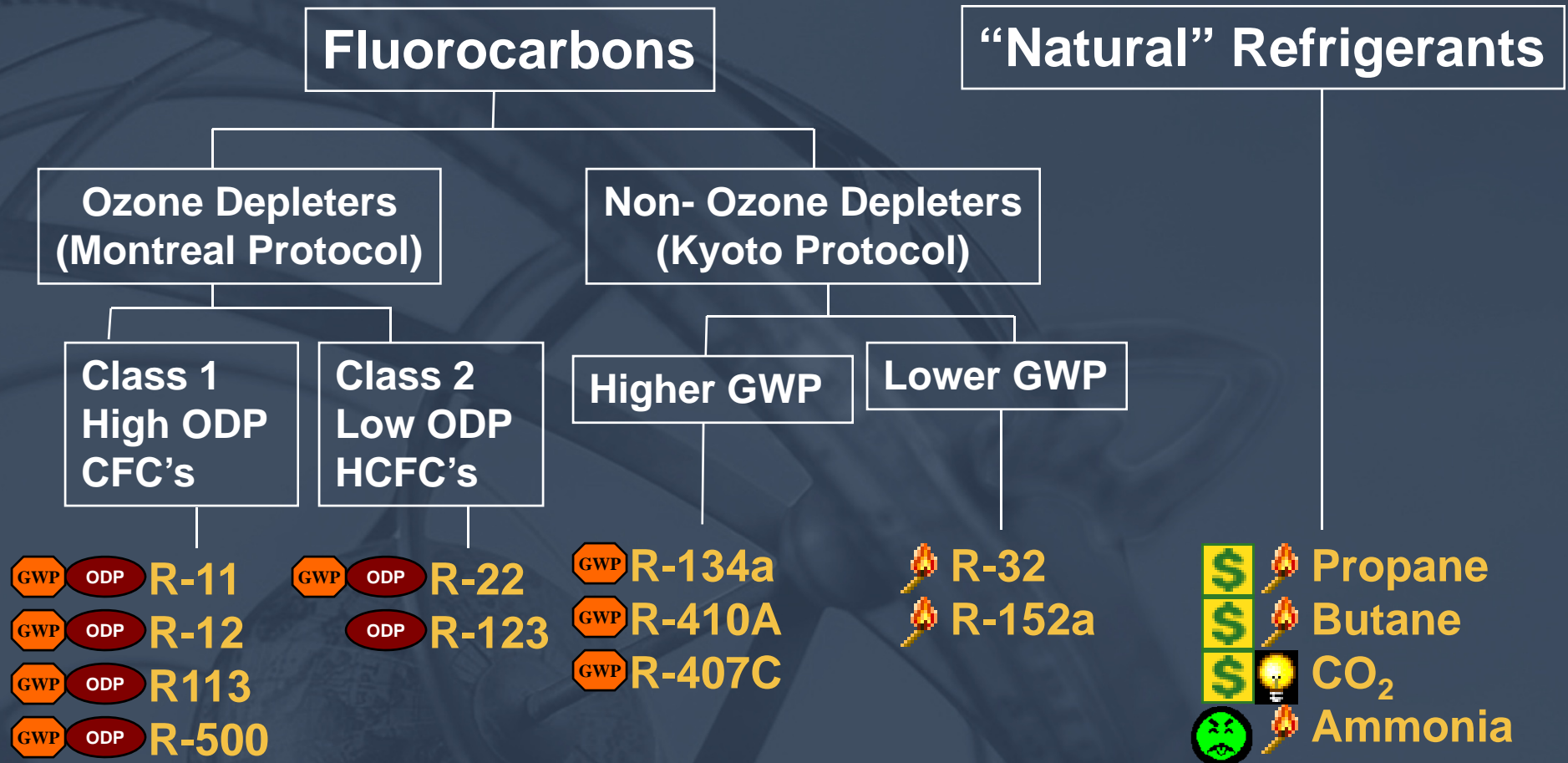


**Energy
Efficiency**



***Focusing on Emissions and Efficiency
is fundamental to doing what's right***

Options For HVAC Refrigerants



 -ODP Concerns
 -GWP Concerns
 - Flammable

 -Toxicity Concerns
 -Efficiency Concerns
 -Cost Concerns

Summary

- ◆ **All fluorocarbon refrigerants in use today are under legislative jeopardy**
- ◆ **The balanced approach to refrigerant selection is the best way to protect the environment**
 - ◆ Ozone Depletion
 - ◆ Global Warming
 - ◆ Energy Efficiency
 - ◆ Short atmospheric life
 - ◆ Low pressure (low tendency for leakage)
- ◆ **Chiller selection should focus on:**
 - ◆ High Energy Efficiency
 - ◆ Minimal leakage rates
 - ◆ Superior technical design

The background features a dark blue, semi-transparent overlay with a faint, light blue image of a globe and several intersecting orbital paths or trajectories. The globe is positioned in the lower-left quadrant, and the orbital paths are scattered across the frame, creating a sense of motion and complexity.

Questions?