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# HFC Dilemma - Solution for Montreal Protocol (Ozone Layer Depletion) but Problem under Kyoto Protocol (Global Warming)

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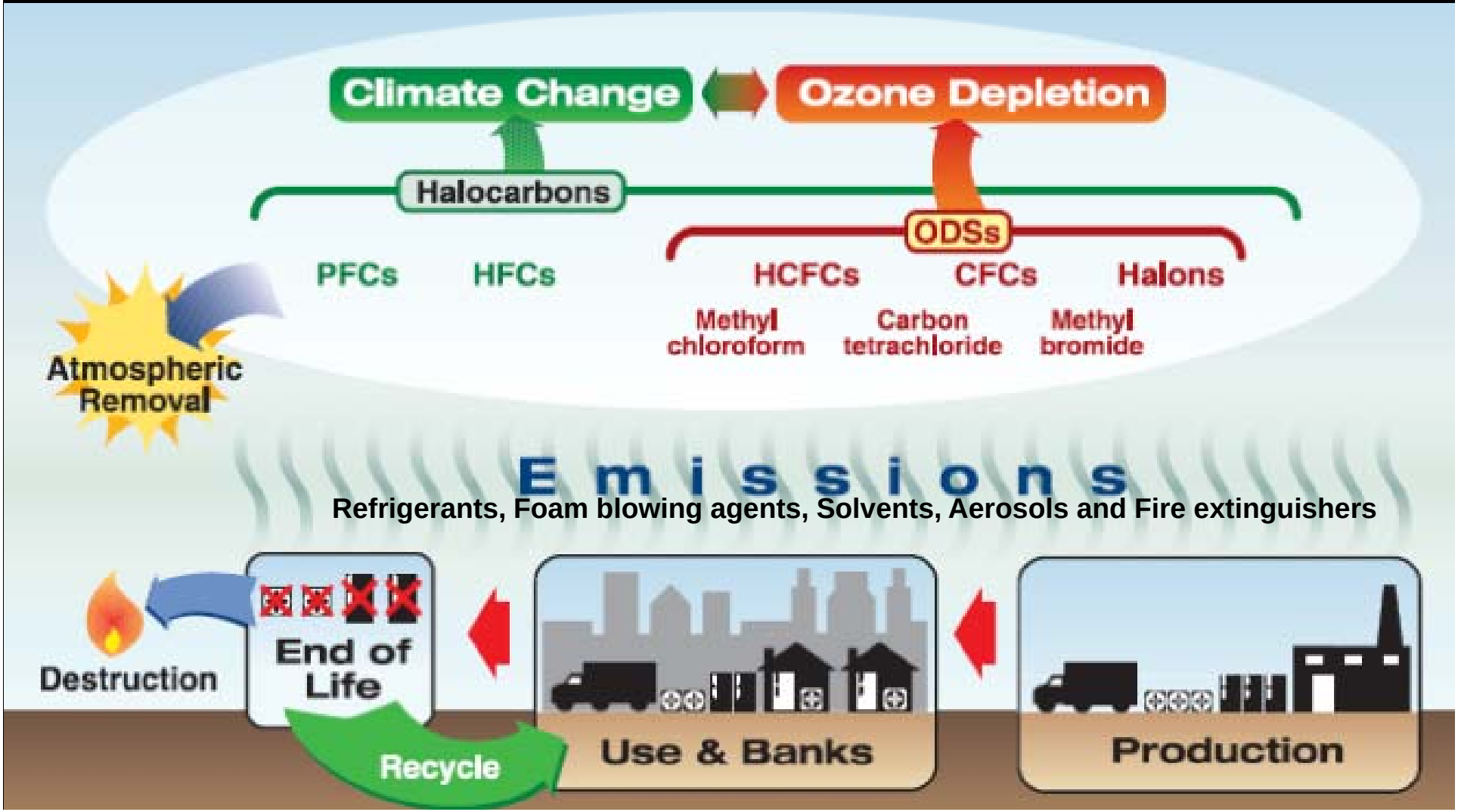
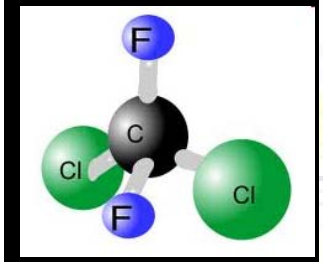
# Outline

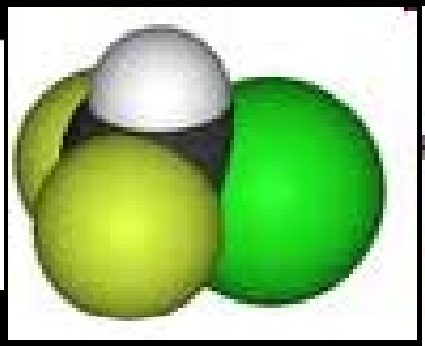
- Montreal Protocol & Kyoto Protocol
- HCFCs, HPMP and HFCs
- Alternative Refrigerants: Low GWP HFCs and Natural Refrigerants
- EU F-gas regulations
- Projected HFC Growth
- Proposals on HFCs Phase-down under MP
- Some Concerns of A5 countries on these Proposals

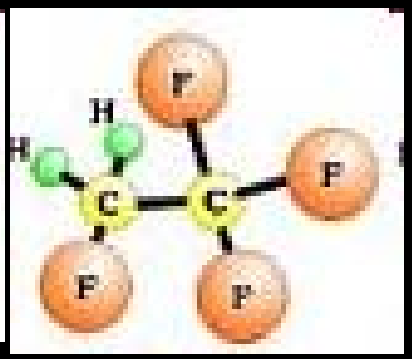
# Ozone Layer Depletion and Climate Change Linkages

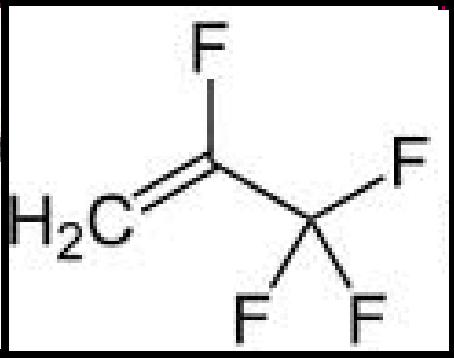


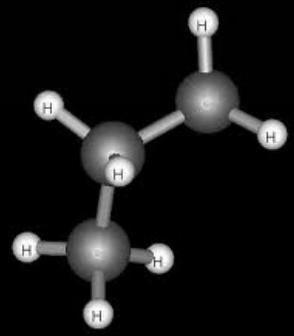
# CFCs, HCFCs, HFCs & HCs





**CFCs** **HCFC22** **HFC134a** **HFC1234yf** **HC290**

# ODP & GWP

**Refrigerants are evaluated on the basis of:**
**Ozone Depleting Potential (ODP) – Montreal Protocol and Global Warming Potential (GWP) – Kyoto Protocol (&MP?).**

## Ozone Depleting Potential (ODP):

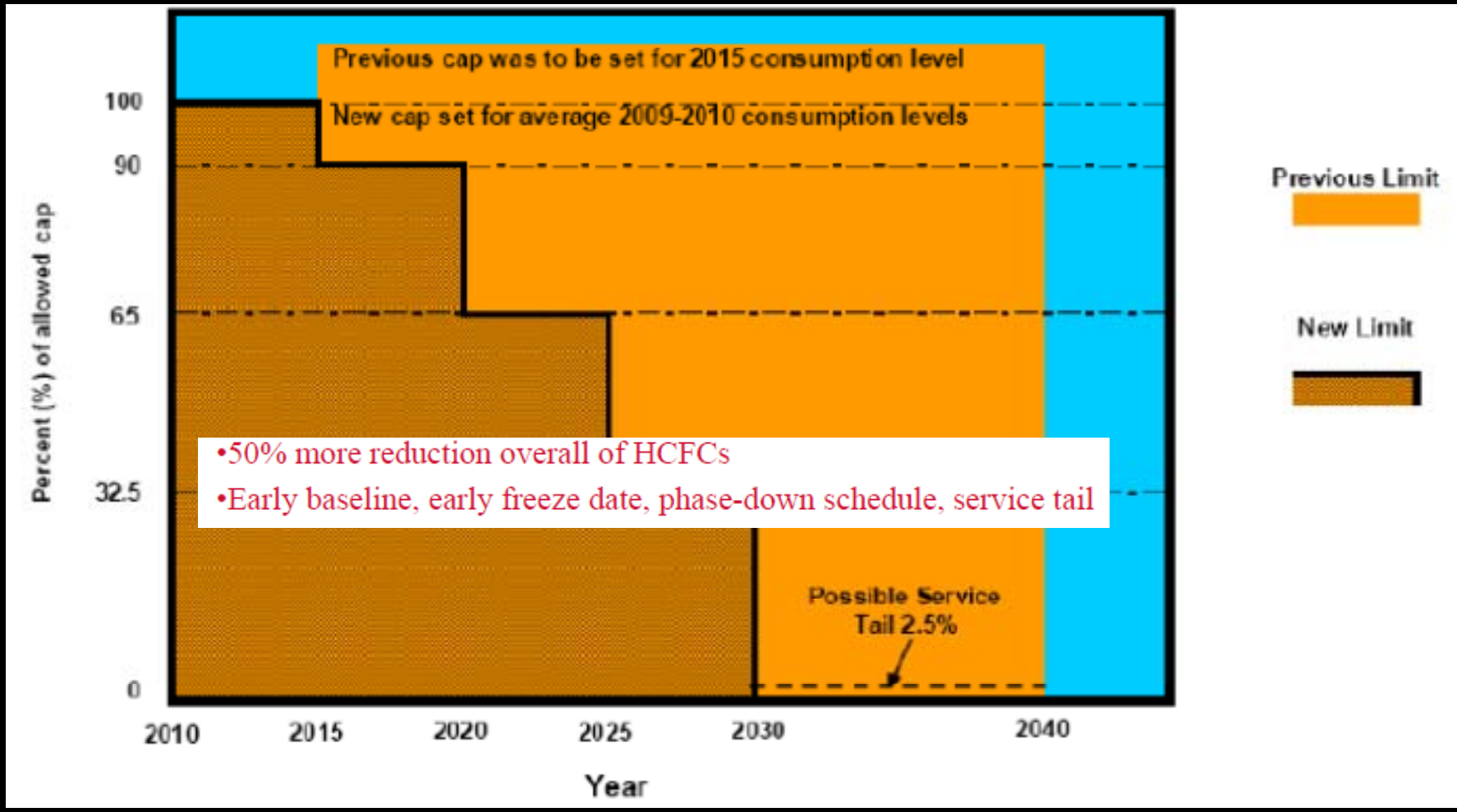
**It is the measure of the ozone depleting capability of a refrigerant as compared to that of CFC-11 (ODP of 1.0.)**

## Global Warming Potential (GWP):

**It is an index which compares the warming effect over time of different gases relative to equal emissions of $CO_2$ by weight.**

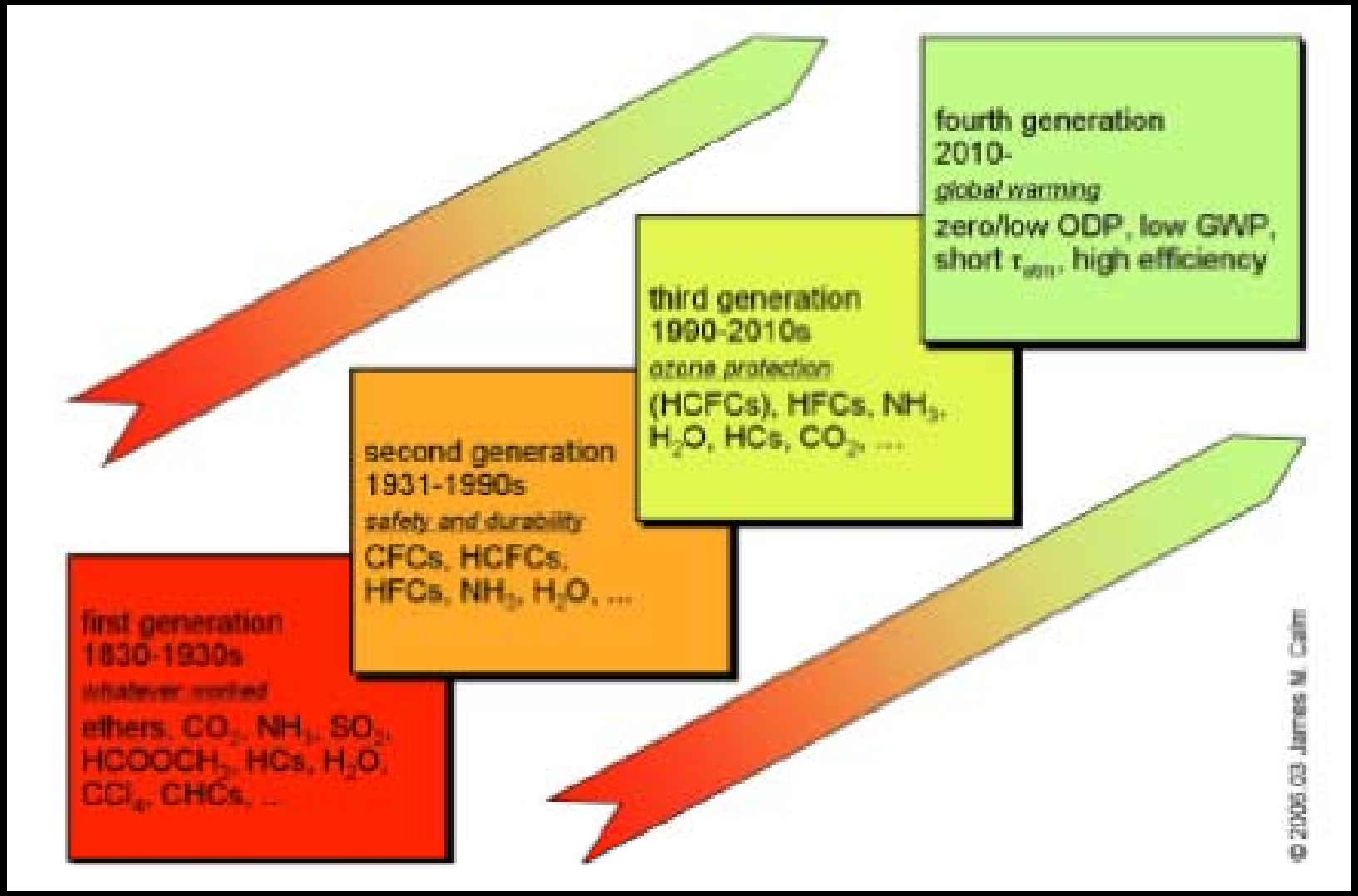
**e.g. CFC-12 : ODP= 0.82 and GWP= 8100**
**HFC-134a: ODP= 0.0 and GWP= 1300**
**HC-600a : ODP= 0.0 and GWP= 20**

# HCFC Phase-out Schedule for A5 Countries



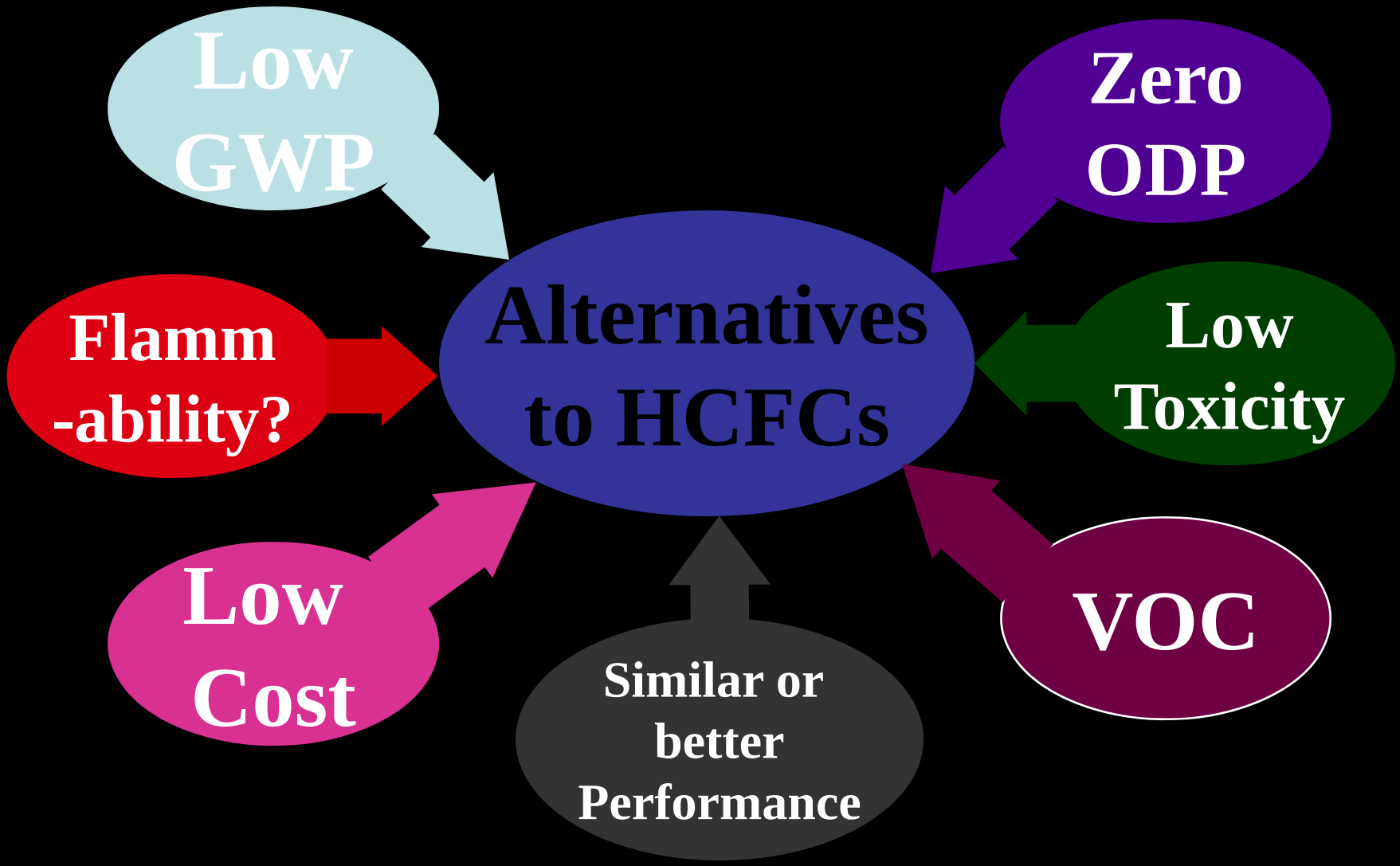

- **CFCs have been successfully phased out by 2010 or earlier as per Montreal Protocol**
- **Some developed countries follow much more stringent schedules e.g. Europe**

# Refrigerant Progression

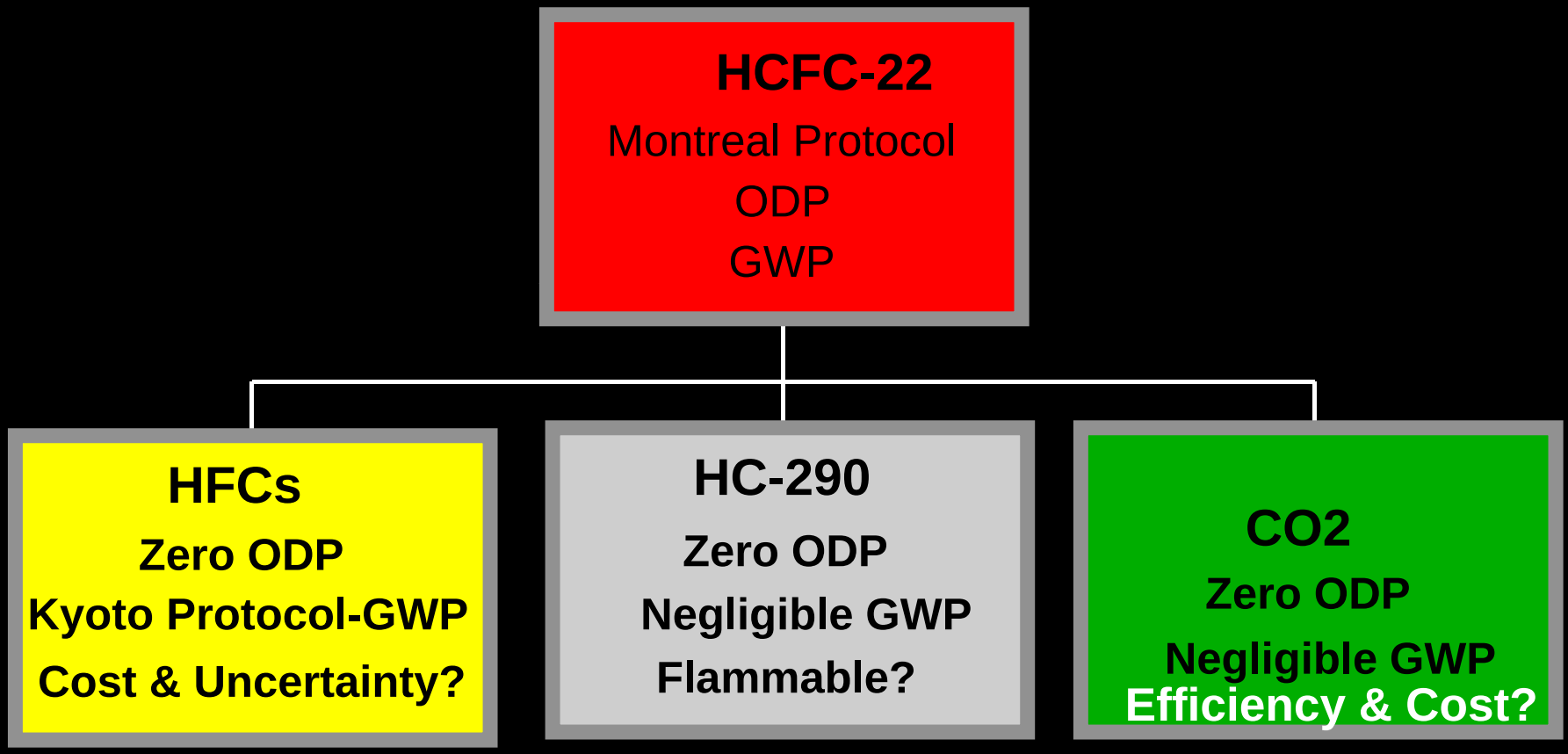



- **Low GWP HFCs are being explored**
- **Natural refrigerants are making a comeback!**

# Alternatives to HCFCs- Desirable Characteristics



# Alternatives to HCFC-22 for A/Cs




- **HCFC-22 production and consumption are the highest among HCFCs**
- **HCFC-22 is still being used in many exiting ACs in developed countries as well as in new units being manufactured in all A5 countries**
- **HPMP in many A5 countries focus on HCFC-22**
- **India and China have already launched HC-290 based ACs!**

# Alternative Refrigerants

| Refrigerant | GWP |
|---|---|
| HCFC-22 | 1700 |
| HFC-32 | 675 |
| R-404A | 3780 |
| R-407C | 1650 |
| R-410A | 1980 |
| HC-290 (propane) | 3 |
| R-717 (ammonia) | 0 |
| R-744 (Carbondioxide) | 0 |
| HFC-1234yf | 4 |
| HFC-1234ze | 6 |

**R-410A, the current most popular alternative, has higher GWP than HCFC-22!**

# HCFC Phase out Management Plan (HPMP) – Recommendations to MLF

- **HPMPs should also address climate change by using alternatives with lower GWP taking into account energy efficiencies, equipment, and climate circumstances.**
- **Conversion policy would consider discouraging the use of HCFC alternatives with high GWP.**
- **Strategic activities be identified between now and the establishment of the baseline (at the end of 2010). These might include, demonstration projects with no or very low GWP technology and effective energy conservation measures.**
- **The choice of technologies should also ensure that environmentally-safe substitutes and related technologies are transferred to Article 5 countries under fair and most favourable conditions.**

# GWP Classification

**In the XXI/9 report, TEAP proposed the following classification for refrigerant chemicals:**

- **Low-GWP: < 300**
  - **GWP < 100 very low**
  - **GWP < 30 ultra low**
- **MODERATE GWP: 300-1,000**
- **HIGH GWP: > 1,000**
  - **GWP > 3,000 very high**
  - **GWP > 10,000 ultra high**

**This is not yet accepted by parties to MP!**

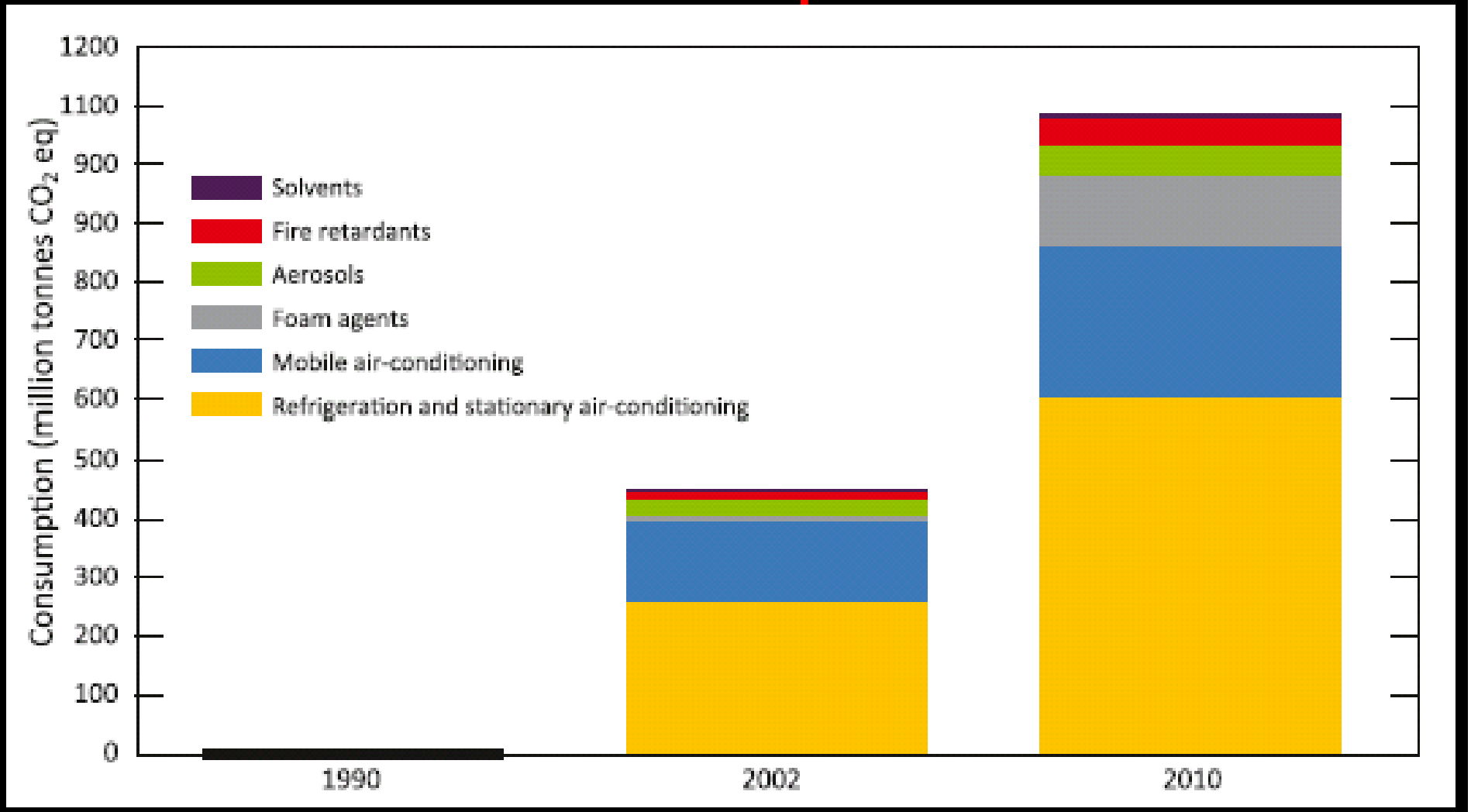
# EU – F Gase Regulations

- **F gas regulations, introduced in 2006, brought a series of measures to control the growth of HFCs in EU.**
- **This introduced a limit of GWP<150 for MAC to eliminated high GWP HFC-134a**
- **The draft revision proposes much more stringent measures, restricting the use of HFCs in certain RAC sectors as early as 2017!**

Additional prohibitions for the placing on the market of refrigerators and freezers operating with HFCs should be introduced for which sufficient alternatives to the use of HFCs are available. A placing on the market ban does not prohibit the use of existing HFC equipment. For domestic applications the ban should apply as of 2015, for hermetically sealed systems for commercial use as of 2017, for all commercial systems and for industrial systems with a capacity of >100 kW it should apply as of 2020. For commercial and industrial (>100 kW) systems using HFCs with very high GWPs (above 2150) these bans should apply earlier: as of 2015 for hermetically sealed systems and for industrial systems and as of 2016 for all commercial equipment. Also, HFCs in movable room air conditioning systems (hermetically sealed) should be banned as of 2020 to safeguard the intregretiy of the phase-down mechanismIn the light of future technical developments and the availability of cost-efficient alternatives to the use of F-Gases, the Commission should be empowered to include further applications in Annex II.

Draft European Commission Proposal for a Regulation of the European Parliament and of the Council on Fluorinated Greenhouse Gases: Chapter III Article 10 (2012)

# Global Growth in HFC Consumption




**This presentation focuses on HCFC-22 used in RAC sector**

# Alternative Refrigerants

## Fluorocarbons

### ODSs (Montreal Protocol)

**Class 1**
**High ODP**
**CFCs**

- CFC-11
- CFC-12
- CFC-113
- R-500

**Class 2**
**Low ODP**
**HCFCs**

- HCFC-22
- HCFC-123

### HFCs- GHGs (Kyoto Protocol)

**Higher GWP**

- HFC-134a
- R-410A
- R-407C

**Lower GWP**

- HFC-32
- HFC-152a
- HFC-1234yf

## "Natural" Refrigerants

- HC-290 (Propane)
- HC-600a, Isobutane
- $CO_2$
- Ammonia

-ODP
-GWP
-Flammability

-Toxicity
-Efficiency
-Cost

- There is no ideal Refrigerant!
- There is always some trade-off!!

Adapted from Honeywell

# Expanding Market for ACs in A5 Countries

- By 2020, market for air-conditioners in Asia-Pacific could reach >100 million units and sales >US$ 20 billion
- By 2025, ~1 billion city dwellers will “enter the global consuming class”: an air-conditioner would be their first purchase
- Most booming cities are in tropical climates
- Refrigerant charge volumes for new air-conditioners sold in Asia-Pacific (developing countries in 2011) estimated at **~50,000 MT** annually
- A5 countries do not want to lose out the market momentum by the changes

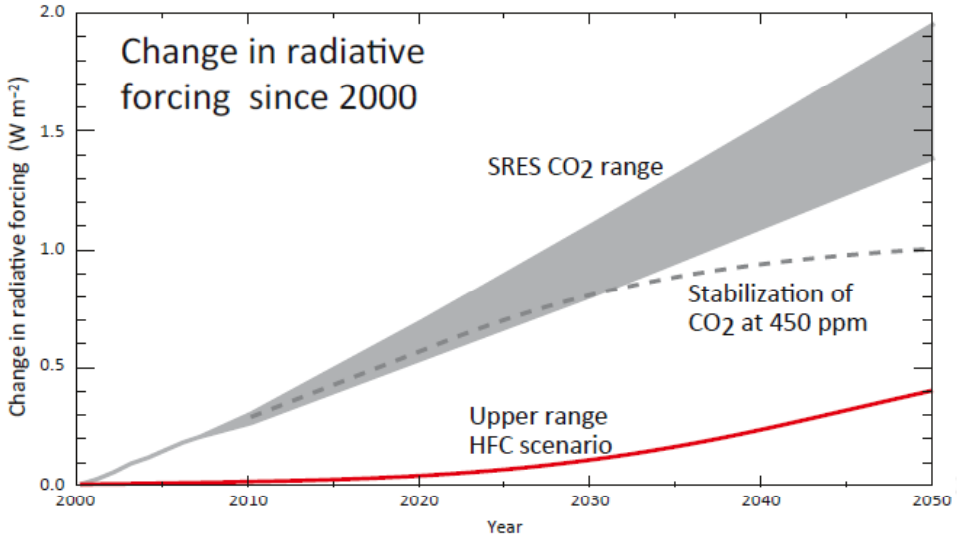
# Expanding Market for ACs in A5 Countries


# HPMPs & HFCs

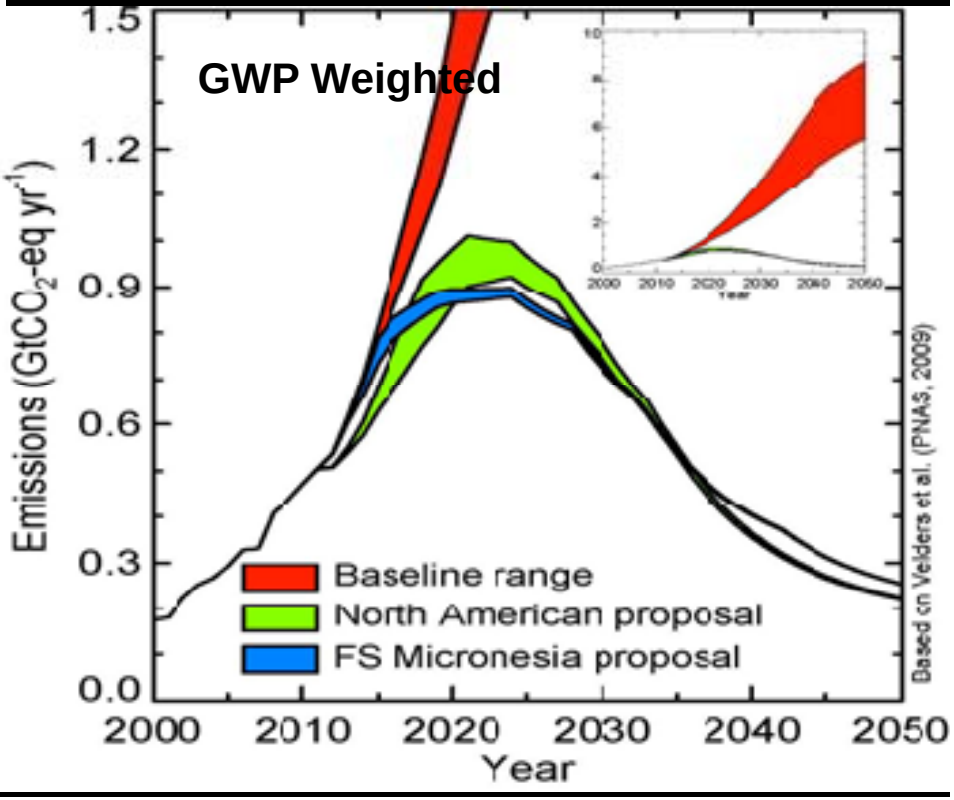
- HFCs currently are ~1% of global GHG emissions, but are the fastest growing GHG, expected to double by 2020
- Climate co-benefit of Montreal Protocol for ODS many times benefit of Kyoto Protocol
- Projected growth:
  - ~9% 2009-10 in U.S., doubling by 2020
  - 10%-15% per year world-wide, doubling 5 yr
- HFCs up to 27% of RF of $CO_2$ by 2050, and up to 40% if $CO_2$ limited to 450 ppm to prevent 2$^{o}$C
- Federated States of Micronesia (FSM) and U.S., Mexico, Canada (Trilateral) have proposed phasing down HFCs under MP; 107 Parties support

**Some major A5 countries, including China and India, are not agreeing for these proposals**

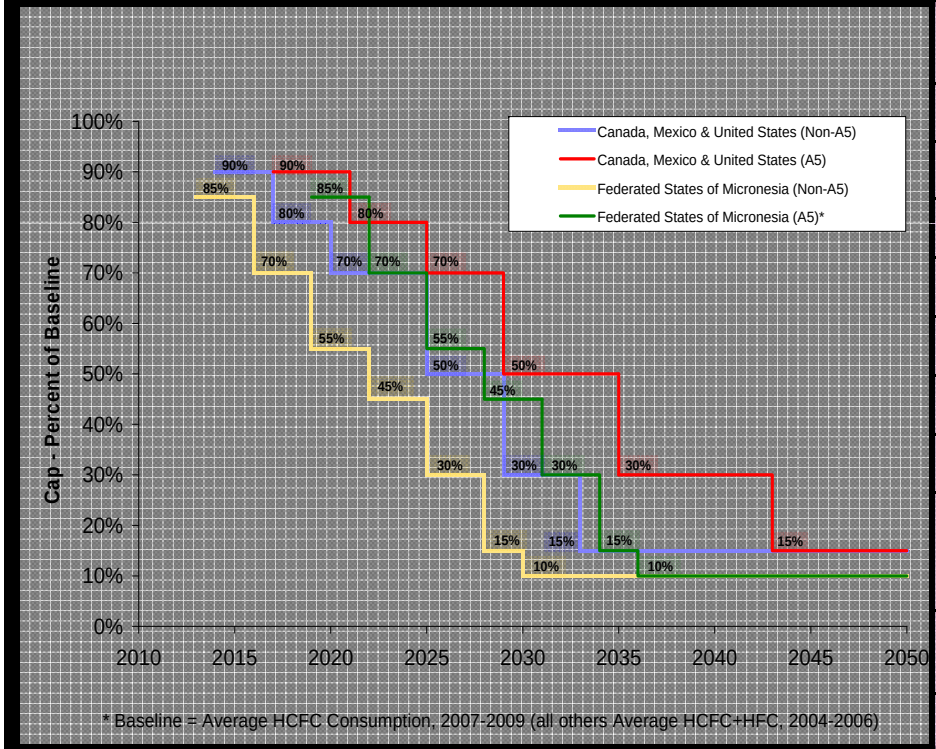
# HFCs Projected Emissions – US Studies




- **There are questions about some of the scientific, technical and commercial assumptions!**
- **IPCC and UNEP TEAP did a joint report on HFCs in 2005**
- **IPCC is yet to recognize these studies and call for any special report, why?**



# Proposed HFC Reduction Steps for A5 and Non-A5 Countries



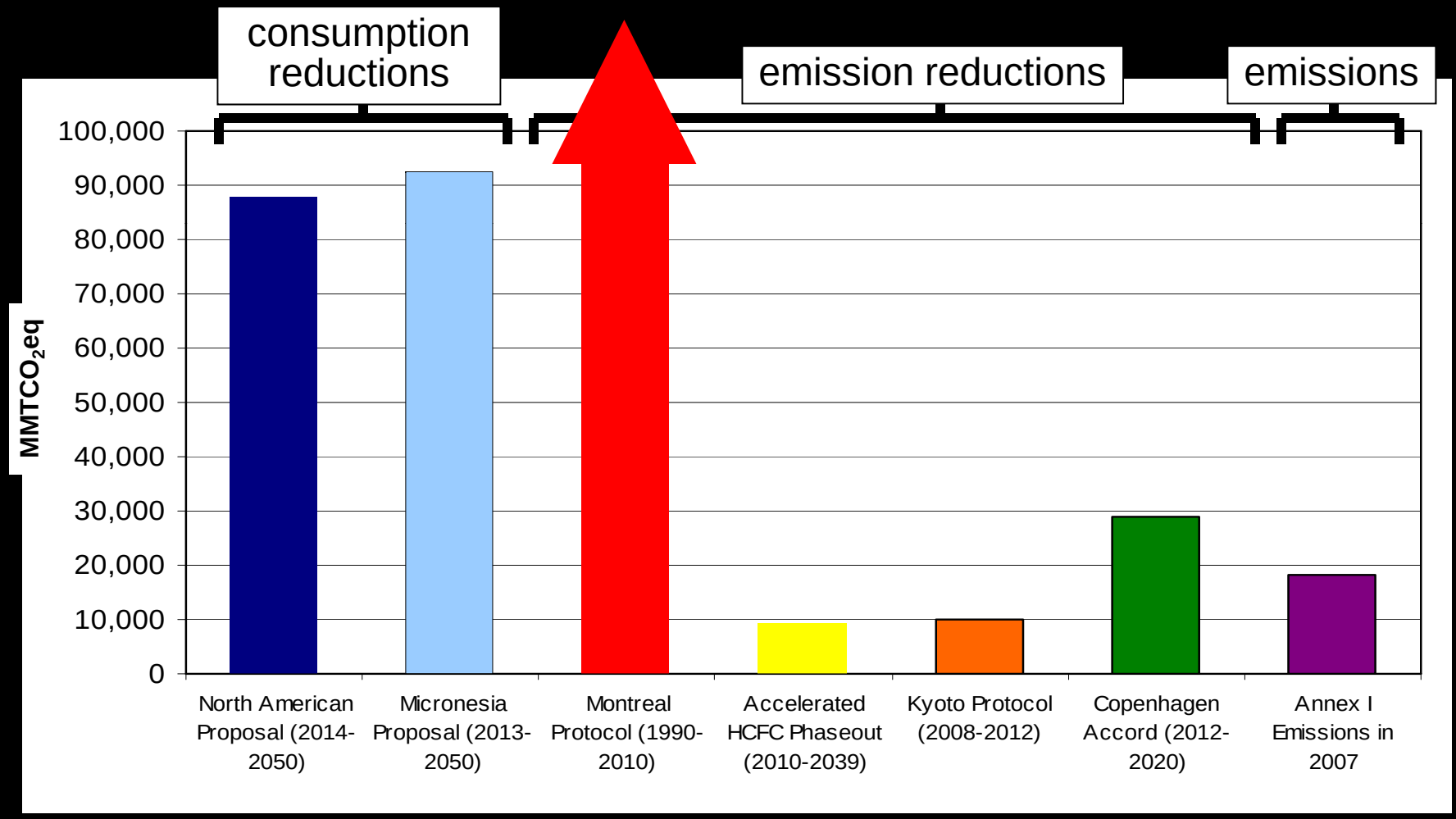

| Trilateral Proposal | | | | Micronesia Proposal | | | |
|---|---|---|---|---|---|---|---|
| Non-A5 Schedule | | A5 Schedule | | Non-A5 Schedule | | A5 Schedule | |
| Year | Cap | Year | Cap | Year | Cap | Year | Cap |
| 2014 | 90% | 2017 | 90% | 2013 | 85% | 2019 | 85% |
| 2017 | 80% | 2021 | 80% | 2016 | 70% | 2022 | 70% |
| 2020 | 70% | 2025 | 70% | 2019 | 55% | 2025 | 55% |
| 2025 | 50% | 2029 | 50% | 2022 | 45% | 2028 | 45% |
| 2029 | 30% | 2035 | 30% | 2025 | 30% | 2031 | 30% |
| 2033 | 15% | 2043 | 15% | 2028 | 15% | 2034 | 15% |
| Plateau | 15% | Plateau | 15% | 2030 | 10% | 2036 | 10% |
| | | | | Plateau | 10% | Plateau | 10% |
| Non-A5 Baseline | | A5 Baseline | | Non-A5 Baseline | | A5 Baseline | |
| HFC+HCFC from 2004-2006 | | HFC+HCFC from 2004-2006 | | HFC+HCFC from 2004-2006 | | HCFC from 2007-2009 | |

- Some of the proposed baselines are unrealistic for A5 countries to meet both HPMP and HFC amendment
- Refrigerant producing A5 countries like China and India may face constraints as they have to import both refrigerants and hardware

# HFC Proposals to Amend MP for HFC Phase-down

- Both proposals would add HFCs to the controlled substances under the Montreal Protocol.
- Both proposals would establish control measures (i.e. phase-down schedule) for HFCs with a grace period for developing countries
- Both proposals will require full incremental cost funding through the MLF to assist developing countries to phase-down HFCs
- Both proposals would require all HFC-23 emissions be destroyed (no new HFC-23 CDM projects); however, NAP excludes HFC-23 from MLF funding
- Does not include ODS Banks for destruction
- HFC remain in the Kyoto Protocol basket of gases
- Leaves UNFCCC Obligations Unchanged

# HFC Proposal's US Projected Benefits

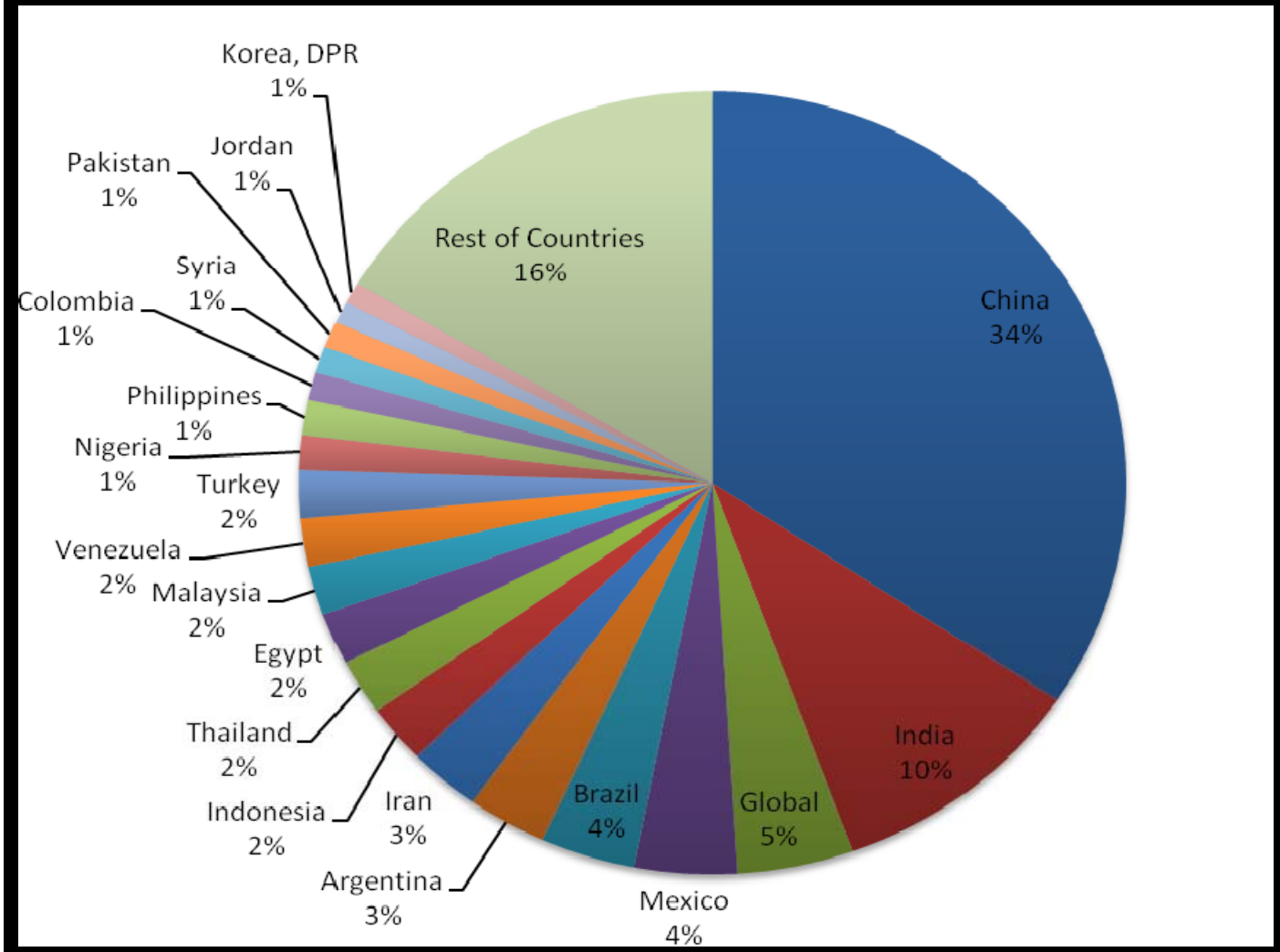


# Projected Climate Benefits – US Studies

- Global Trilateral Proposal Cumulative Benefits:
  - ~3,000 MMT$CO_2$eq through 2020
    - Non-Article 5 Parties = 3,000 MMT$CO_2$eq
    - Article 5 Parties = 150 MMT$CO_2$eq
  - ~88,000 MMT$CO_2$eq through 2050
    - Non-Article 5 Parties = 43,000 MMT$CO_2$eq
    - Article 5 Parties = 45,000 MMT$CO_2$eq
- FSM Proposal cumulative benefits:
  - ~4,000 MMTCO2eq through 2020
  - ~93,000 MMTCO2eq through 2050
- EPA's *Analysis of HFC Production and Consumption Controls*:

  **http://www.epa.gov/ozone/downloads/Analysis_of_HFC_Production_and_Consumption_Controls.pdf**

# MLF Funding:
# Top 20 & Other Countries (by %)




- **China is the biggest beneficiary of MLF and will be much more under HPMP**
- **It is not yet clear about funding mechanism under MP for HFC phase down**

# HFC Proposal under MP: Some Issues & Concerns of A5 Countries

- MP is for substances that deplete the ozone layer and KP deals with gases that are not controlled under MP. How can we combine these two independent protocols?
- The proposed HFC amendments allow some growth for A5 countries only for a short period until 2017.
- A5 countries are reluctant to agree for regulations that would create a precedent for all other GHGs as they have not yet agreed for any binding regimes
- A5 countries are concerned that funding issues are not still clear (including the current funding under HPMP). There are still differences in the funding principles for A5 countries and several developed countries.
- MLF barely sufficient to meet incremental cost of phasing out HCFCs as replenishments are based on specific agreed targets
- HFC proposals does not provide additional funding for A5 country conversions  to low GWP options via CDM?

# HFC Proposal under MP: Some Issues & Concerns of A5 Countries

- Will HFC producing developed countries guarantee affordable prices for low GWP HFCs and avoid promoting high GWP HFCs?
- Funding mechanism under KP is still under negotiation.
- There are still many uncertainties about low GWP HFCs (cost, timeline, safety, atmospheric chemistry and performance).
- Some HFCs have been just used to replace ODSs controlled under MP
- US and Japan appear to be more leaning to synthetic refrigerants citing safety as the constraint while EU is more towards natural refrigerants
- Some EU countries have introduced high C tax; EU F-gas revision is already planning to prohibit using HFCs in many RAC sectors.
- What is the cut-off GWP to be avoided in the short-term? China is the only country taking its own path as it has capability to make HFCs and it caters to all market segment. It is extremely difficult for other A5 countries to emulate China.
- It is inevitable to use flammable refrigerants and the rules should not be too restrictive like the ones proposed in the recently rejected draft ISO.
- Some experts opine that HFC Phase-down should be similar to that of ODS (i.e. consumption & production rather than emissions)
- Why developed countries are still massively introducing HFCs in retrofits and in new equipment and cannot avoid the high GWP HFC route immediately?

# HFC Proposal under MP: Some Issues & Concerns of A5 Countries...

- If developed are so concerned why are they not setting trends first? Why only synthetic refrigerants are preferred over natural refrigerants except in some European countries and Australia? Is this not an opportunity for increasing the share of the natural refrigerants globally to settle this environmental issue once for all?
- Some counties e.g. Norway, Denmark and Australia have introduced C tax on HFCs making them unviable to use in many applications
- It is a myth that MNCs are committed to environment! If so, why are they selling low energy efficient products along with high efficient products?
- Significant changes can be expected in RAC sector in the near future
- The recent decision by a German auto manufacturer's adverse decision based on safety of using HFC-1234yf puts a big question mark on the future of low GWP HFCs?
- Very limited A5 country experience on low GWP HFCs and very little open literature data! This does not boost A5 countries confidence.
- If blends are used, this may lead to large pile of contaminated HFCs for destruction. This is not cheap or easy!
- Why IPCC is not taking cognizance of projected high HFC growth?

Thank you!

Any questions?