Reunión de las Redes de Funcionarios de Ozono de México, Centro América, Sur América y el Caribe de habla hispana

Quito, Ecuador, agosto de 2014

Overview of Alternatives and Climate Impact Scenarios Report of Decision XXV/5 Montreal Protocol

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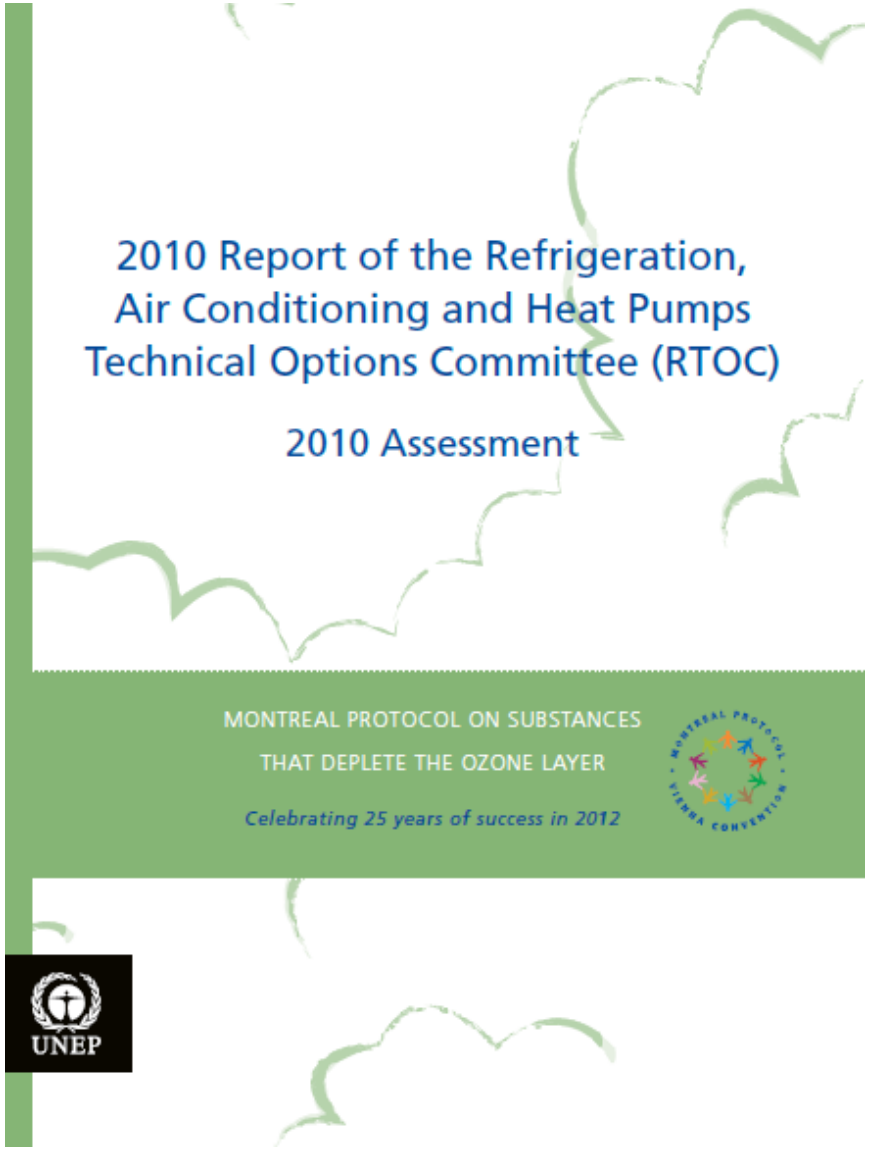
2010 Report of the Refrigeration,
Air Conditioning and Heat Pumps
Technical Options Committee (RTOC)
2010 Assessment
MONTREAL PROTOCOL ON SUBSTANCES
THAT DEPLETE THE OZONE LAYER
Celebrating 25 years of success in 2012
UNEP

Decision XXV/5 Task Force Report: Additional Information to Alternatives on ODS

- *Update information on alternatives to ozone-depleting substances in various sectors and subsectors and differentiating between Article 5 and non-Article 5 parties, considering regional differences, and assessing whether they are;*

Decision XXV/5
• Commercially available
• Technically proven
• Environmentally sound
• Easy to use
• Safe use – flammability & toxicity
• Economically viable & cost effective
• High ambient temperatures
• High urban densities

- *Estimate current and future demand for ODS alternatives, taking into account increased demand, particularly in the refrigeration and air conditioning sectors*

Draft Report available:

http://ozone.unep.org/new_site/en/assessment_panels_bodies.php?committee_id=6

Refrigeration/AC - alternatives

- *Alternatives listed (with comments to technology, commercialisation, energy efficiency, costs, barriers and restrictions)*
  - *6 low GWP pure fluids (R-717, R-744, HCs, HFC(HFCO)s) (GWP<300)*
  - *14 low GWP HFC(HFO) based blends plus HFC-32*
  - *3 HFC based blends (GWP>1000)*

- *Sub-sectors covered are:*

Domestic Refrigeration	*Air Conditioning*
Commercial Refrigeration	*Heat Pumps*
Transport Refrigeration	*Chillers*
Large-scale Refrigeration	*Mobile Air Conditioning*

For refrigerants there is differentiation between commercial use (C), limited use (L) and feasibility (F) by sector

Refrigeration/AC - alternatives

- *Low GWP options: natural refrigerants and unsaturated HFCs (or HFOs), with a very low GWP (GWP even smaller than <1);*
- *The application sectors targeted were, in a first instance, the MAC sector (HFC-1234yf)*
- *For many applications the use of these refrigerants would not be satisfactory as a replacement for the high-GWP HFCs.*
- *Chemical industry has been developing a number of blends consisting of high GWP HFCs and low GWP HFCs, HFC-32 and hydrocarbons (carbon dioxide)*
- *blends were characterised by certain acronyms, recently however, ASHRAE 34 approved a number of R-designations for a number of them.*

Refrigeration/AC - alternatives

- *Many of the blends developed have a GWP of about 300, sometimes slightly higher*
- *These refrigerants and refrigerant blends are supposed to be the synthetic low GWP chemical replacements in the next 5-10 year period at least.*
- *Developments are still ongoing, even where it concerns the testing and development of new pure low GWP synthetic refrigerants, and possible blends with these.*
- *The main question is which type of refrigerants will take over from the usual HFCs, or rather, which share of the usual high GWP HFC and HFC blends will be replaced by which type of low GWP refrigerants.*

Designation	Refrigerants	Composition	GWP	Replacement for
R-444A	HFC-32 /-152a/-1234ze	12/5/83	92	HFC-134a replacement MAC
R-444B	HFC-32/-152a/-1234ze	41.5/10/48.5	296	HCFC-22 replacement
R-445A	R-744/-134a/-1234ze	6/9/85	135	HFC-134a replacement MAC
R-446A	HFC-32/-1234ze/HC-600	68/29/3	461	R-410A replacement
R-447A	HFC-32/-125/-1234ze	68/3.5/28.5	583	R-410A replacement
R-450A	HFC-134a/-1234ze	42/58	605	HFC-134a replacement
R-513A	HFC-134a/-1234yf	44/56	630	HFC-134a replacement
R-448A	HFC-32/-125/-1234yf/ -134a/-1234ze	26/26/20/ 21 /7	1390	R-404A replacement
R-449A	HFC-32/-125/ -134a/-1234yf	24.3/24.7/ 25.3/25.7	1400	R-404A replacement
R-452A	HFC-32/-125/-1234yf	11/59/30	2140	R-404A replacement (transport refrigeration)

EU Regulations

Year	Specific measure
2015	Domestic appliances GWP < 150
2020	Mobile AC units GWP < 150
2020	Stationary refrigeration GWP < 2500
2022	Multipack systems GWP < 150
2025	Single split AC < 3 kg, GWP < 750

The aim of the regulation is a reduction of HFC emissions in climate terms of 79% by 2030, compared to 2015, to be achieved by the application of low GWP chemicals, quota systems and servicing practices.

Refrigeration/AC - alternatives

Commercial refrigeration

- HFC-134a and R-404A are still the dominant refrigerants for *stand-alone* (SA) equipment
- R-407F and R-407A are intermediate refrigerant blends to replace R-404A or HCFC-22.
- HC-600a and HC-290 are used for small SA equipment
- R-744 is mainly used in vending machines and bottle coolers
- HFC-134a, R-404A and, R-410A are HFCs of choice for *condensing units* (CU). R-407A or R-407F is chosen to replace R-404A in Europe

Refrigeration/AC - alternatives

- Low GWP blends have been developed to replace R-404A
- R-744 cascade systems (CS) have taken a significant uptake in *centralised systems* in Europe
- The preferred option for CS is HFC-134a with R-744. Low GWP HFC can be used as replacement of HFC-34a
- For cold climates, R744 is used in CS at both temperature levels.

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Refrigeration/AC - alternatives

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Transport refrigeration

- For Trucks, trailers and intermodal containers R-404A, R-407C, HFC-134a, and R-410A are the refrigerant of choice
- Initial field tests with small fleets of containers using R-744 have started

Large size (industrial) refrigeration)

- Over 90% of the large industrial refrigeration installations use R-717

Refrigeration/AC - alternatives

Water heating heat pumps

- R-410A, HFC-134a, R-407C, HC-290, HC-600a, R-717, R-744 have been used

Air conditioners

- R-407C and R-410A have been used in a large proportion in *small self-contained* units
- Portable type units are widely available using HC-290 and window units are now in production

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Refrigeration/AC - alternatives

Air conditioners (cont.)

- HFC-32 in SSC ACs and production is likely to begin soon
- The blends R-446A, R-447A, R-444B and "DR5" are feasible to use in SSC Acs
- Most Japanese companies have stopped manufacturing R-410A products and have commercialised R32 mini-split
- HC-290: some companies developing and producing units on a larger scale

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Refrigeration/AC - alternatives

Air conditioners (cont.)

- R-444B is feasible to use in split ACs, for example, to replace HCFC-22 or R-407C, trials are ongoing
- The use of R-744 in all of these sub-categories is limited to northern climates where temperatures

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Refrigeration/AC - alternatives

Chillers

- R-407C, R-410A and HFC-134a are widely used in chillers
- R-717 is used widely, R-744 is now used, HC-290 and HC-1270 chillers are produced
- HFC-1234yf and HFC-1234ze(E) are suitable for chillers and have been trialled
- The blends R-444B, R-446A, R-447A and DR-5 could be used as replacements for HCFC-22, R-407C or R-410A

Mobile Air Conditioning

Dependent on the country, the preferred option is to keep going with HFC-134a or to shift to HFC-1234yf.

Domestic Refrigeration

- HC-600a is increasing including many A 5 countries
- The USA market now includes several products with HC-600a
- HFC-1234yf could become a third candidate

Alternatives to HCFCs and high GWP HFCs

Sector	CFCs	HCFCs	HFCs Pure & Blends	HCs	CO2 Ammonia	Unsaturated HFCs Pure	Blends with Unsaturated HFCs
Domestic Refrigeration	CFC-12		HFC-134a	HC-600a		HFC-1234yf	R-450A, XP-10,
Commercial Refrigeration (SA, CU, CS)	CFC-12 R-502	HCFC-22	HFC-134a R-404A R-407A R-407F	HC-600a HC-290	CO2 Ammonia	HFC-1234yf HFC-1234ze(E)	R-450A, XP-10, "L-40", R-444B, "L-41" "DR-5", R-450A, "XP-10", R-448A, R-449A
Transport Refrigeration		HCFC-22	HFC-134a R-407C R-410A	HC-290 HC-1270	CO2	HFC-1234yf	R-450A, XP-10, "L-40", R-444B, "L-41" "DR-5", R-450A, "XP-10", R-448A, R-449A
Industrial refrigeration		HCFC-22		HC-1270 HC-290	Ammonia CO2	HFC-1234yf	R-450A, XP-10, "L-40", R-444B, "L-41" "DR-5", R-450A, "XP-10", R-448A, R-449A
Water heating heat pumps		HCFC-22	HFC-134a R-410A R-407C	HC-290 HC-600a	CO2 Ammonia	HFC-1234yf HFC-1234ze(E)	R-450A, XP-10, "L-40", R-444B, "L-41" "DR-5", R-450A, "XP-10", R-448A, R-449A
Air Conditioners		HCFC-22	HFC-134a HFC-32 R-410A R-407C	HC-290	CO2	HFC-1234yf	R-450A, XP-10, "L-40", R-444B, "L-41" "DR-5", R-450A, "XP-10", R-448A, R-449A
Chillers	CFC-12 CFC-11	HCFC-22 HCFC-123 HCFO-1233zd(E)	HFC-134a R-404A R-410A R-407C	HC-290 HC-1270	Ammonia CO2	HFC-1234yf HFC-1234ze(E)	R-450A, XP-10, "L-40", R-444B, "L-41" "DR-5", R-450A, "XP-10", R-448A, R-449A
Mobile Air Conditioner	CFC-12		HFC-134a R-410A R-407C		CO2	HFC-1234yf	R-450A, "XP-10"

XXX past use
XXX current use on a commercial-scale
XXX potentially feasible or limited use such as for demonstration, trials, niche applications, etc

RAC – BAU scenario

Based upon a bottom-up model for demand, banks and emissions

Timeframe chosen 2015-2030, because 2025 would not show enough changes in various scenarios

Incorporates current EU F-gas regulation

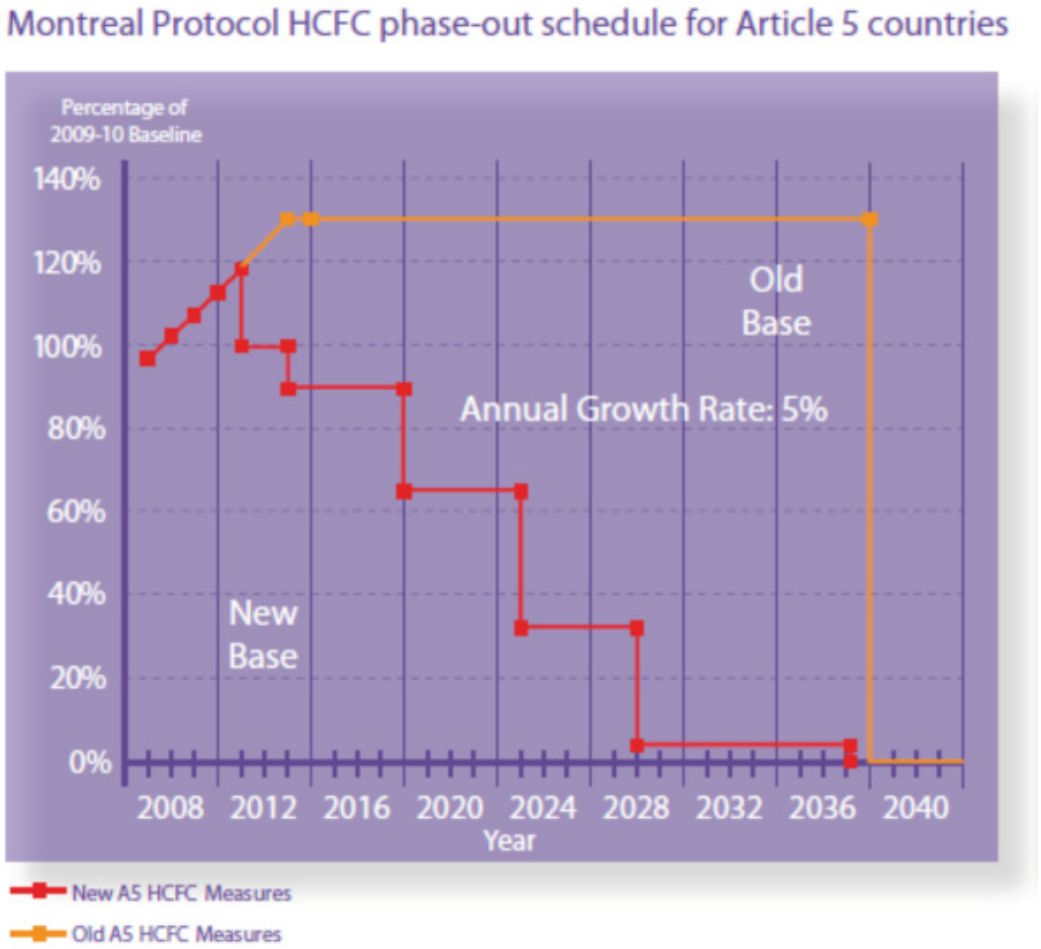
No measures or bans on HFCs in other countries

Economic growth by using recent growth parameters and extrapolating them into the future

Looking at all RAC subsectors

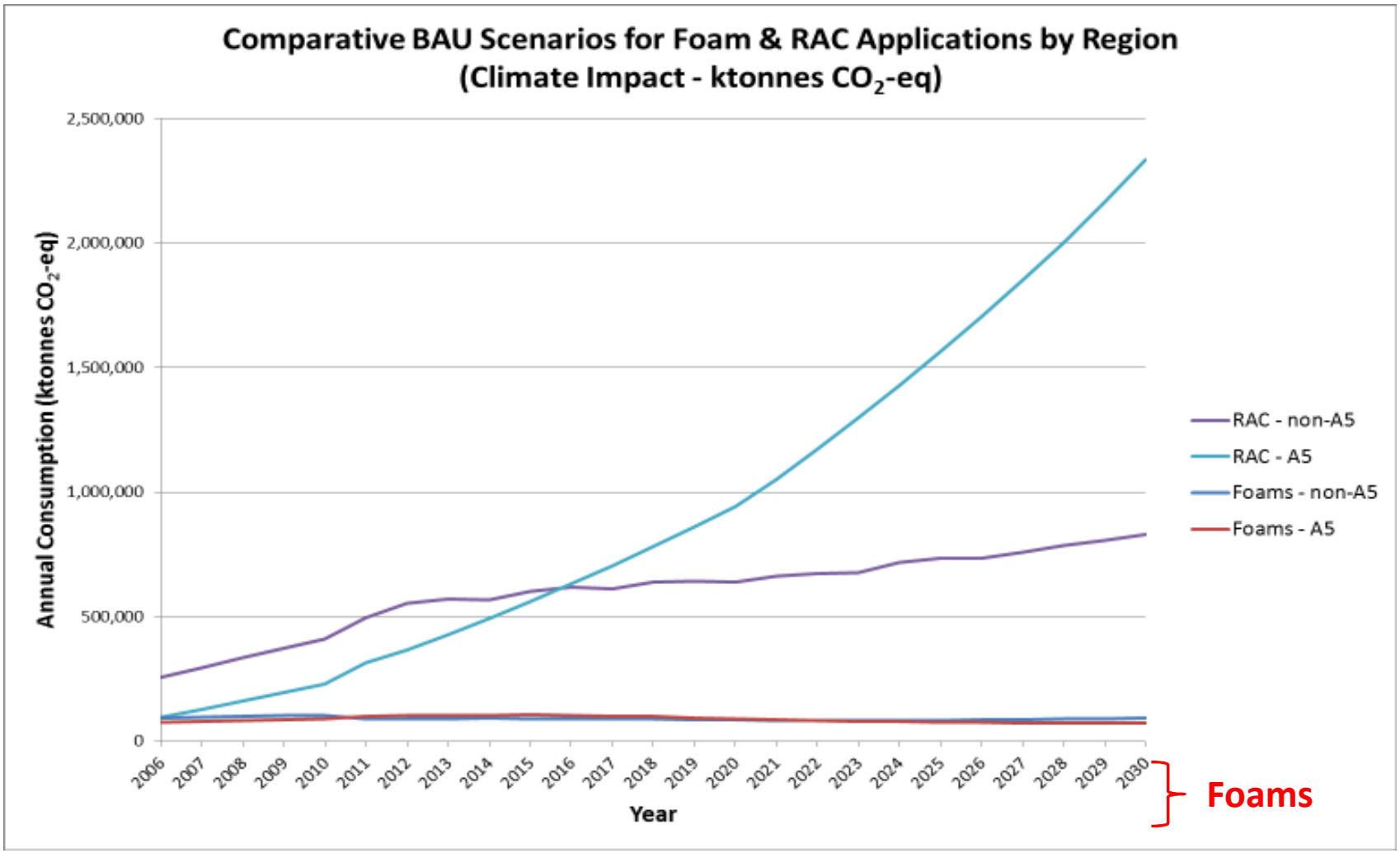
Results of the demand for the period 2015-30 in tonnes of certain refrigerants or blends as well as in tonnes CO2-eq (including low GWP in the BAU approach)

RAC – BAU scenario

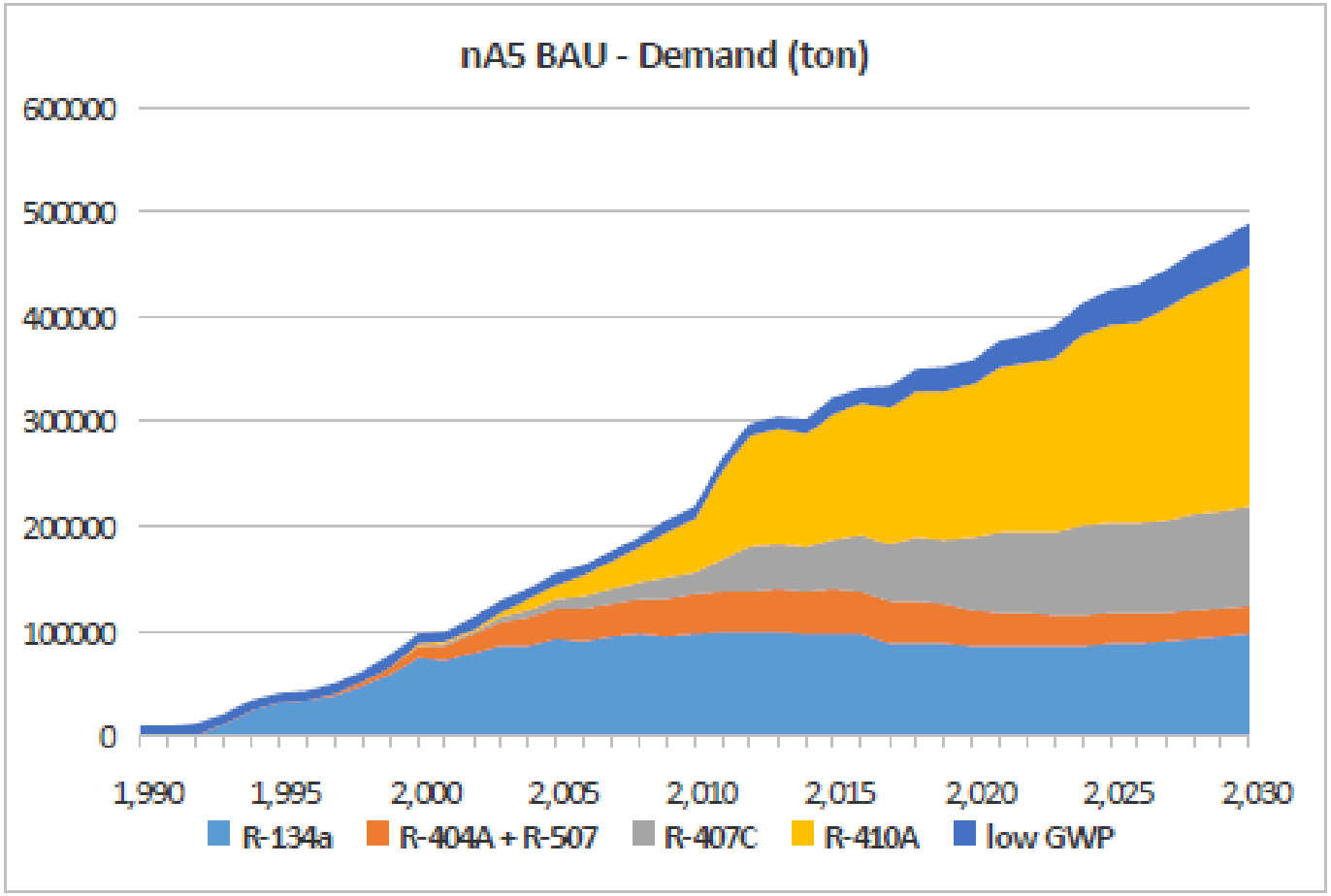


A major challenge created by the terms of Decision XIX/6 is that the freeze in 2013 is based on the average of the 2009 and 2010 consumption. This means that growth in the period from 2010 to 2012 needs to be offset in 2013

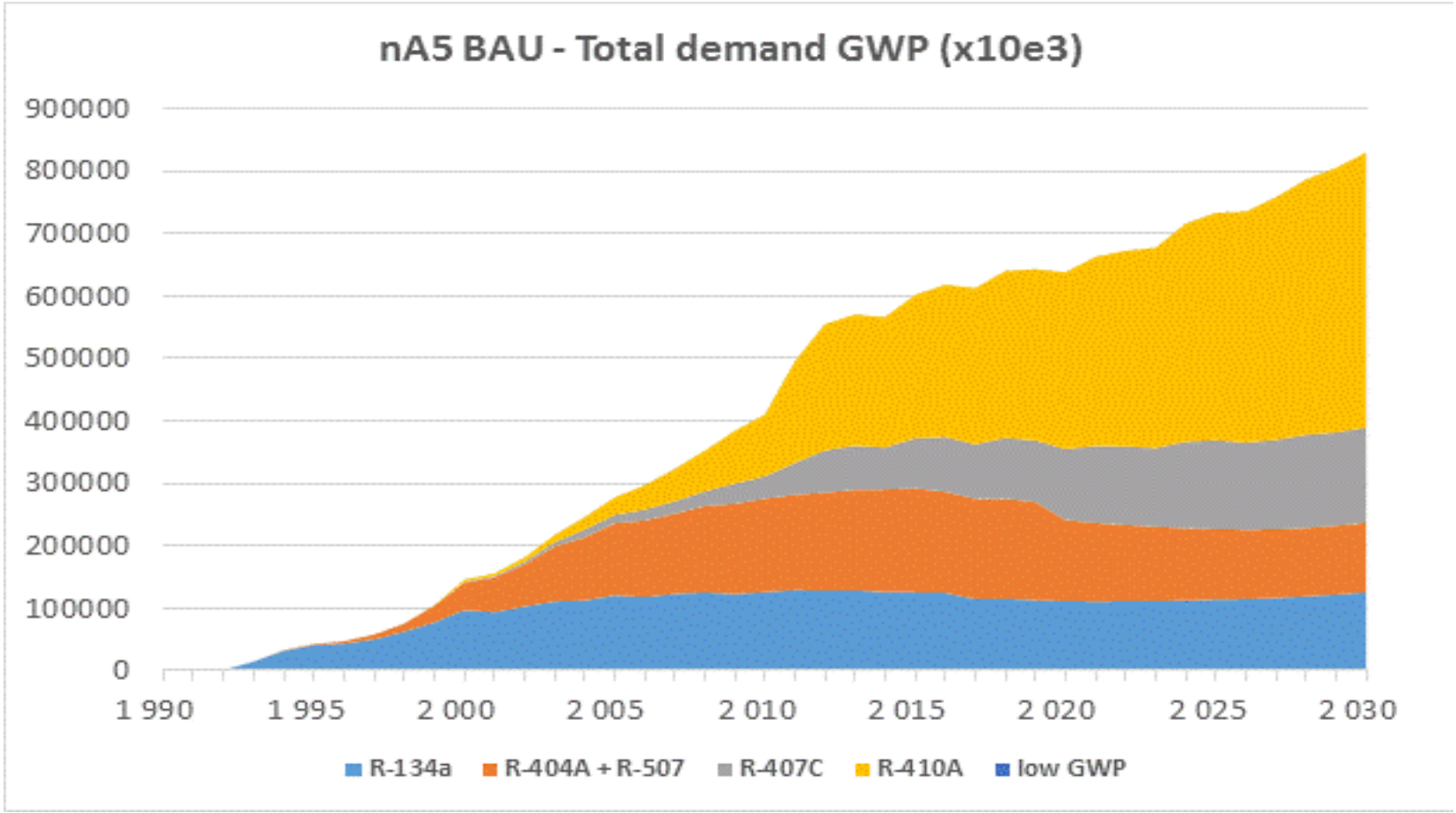
Refrigeration/AC demand



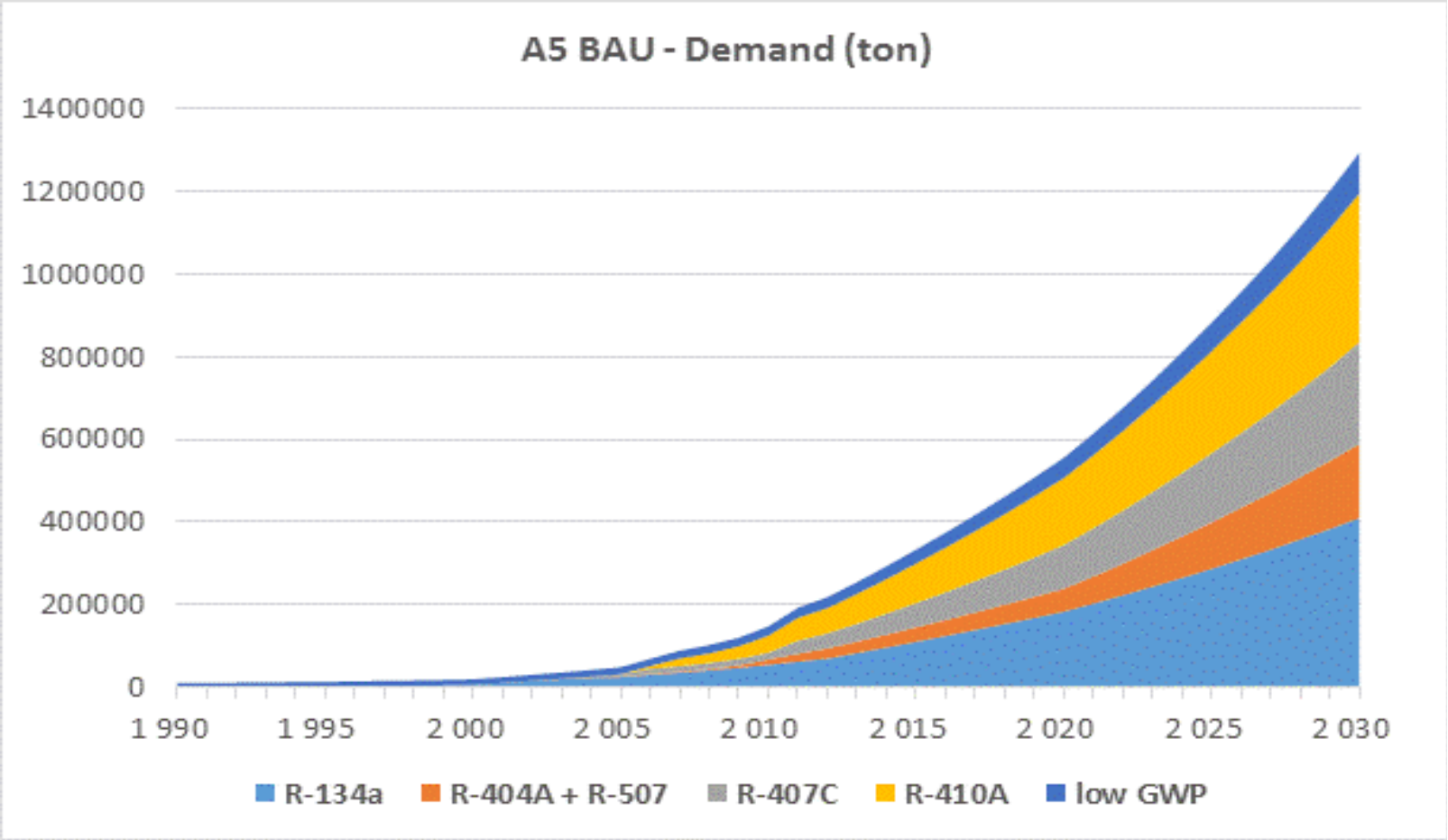
Refrigeration/AC - BAU Non-A5



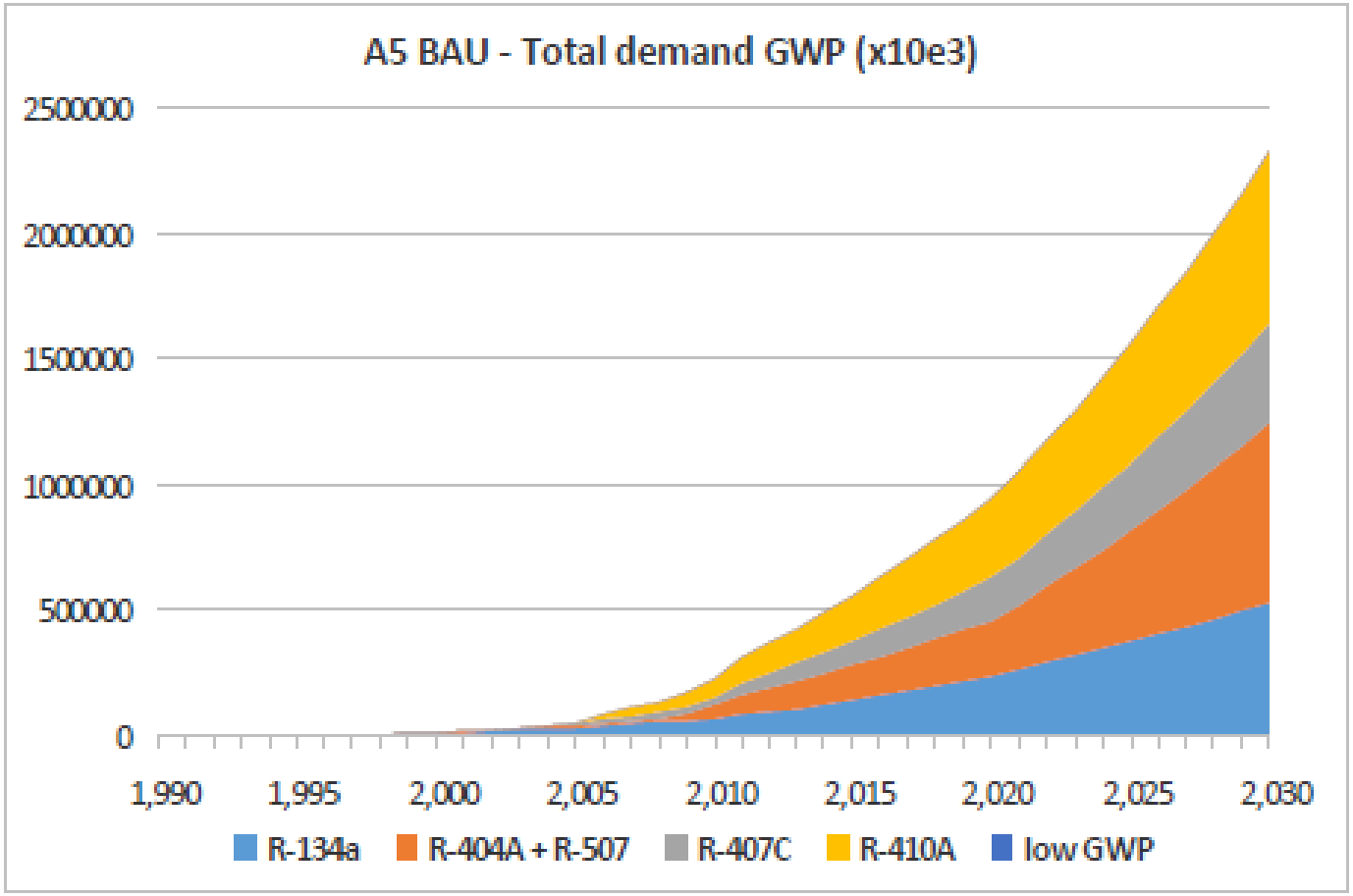
Refrigeration/AC - BAU Non-A5



Refrigeration/AC - BAU A5



Refrigeration/AC - BAU A5



RAC – MIT- scenarios

- *Purpose is to show the importance of MAC and commercial refrigeration first*
- *Introduction years (of the "ban") in Non- Article 5 and Article 5 are different for these sectors*
- *Secondly, in the MIT-2 scenario, the importance of the use of HFCs and the conversion to low GWP in stationary AC is the big issue*

RAC – MIT-1 scenario

- *Subsector and "ban" approach*

Non Article 5 countries

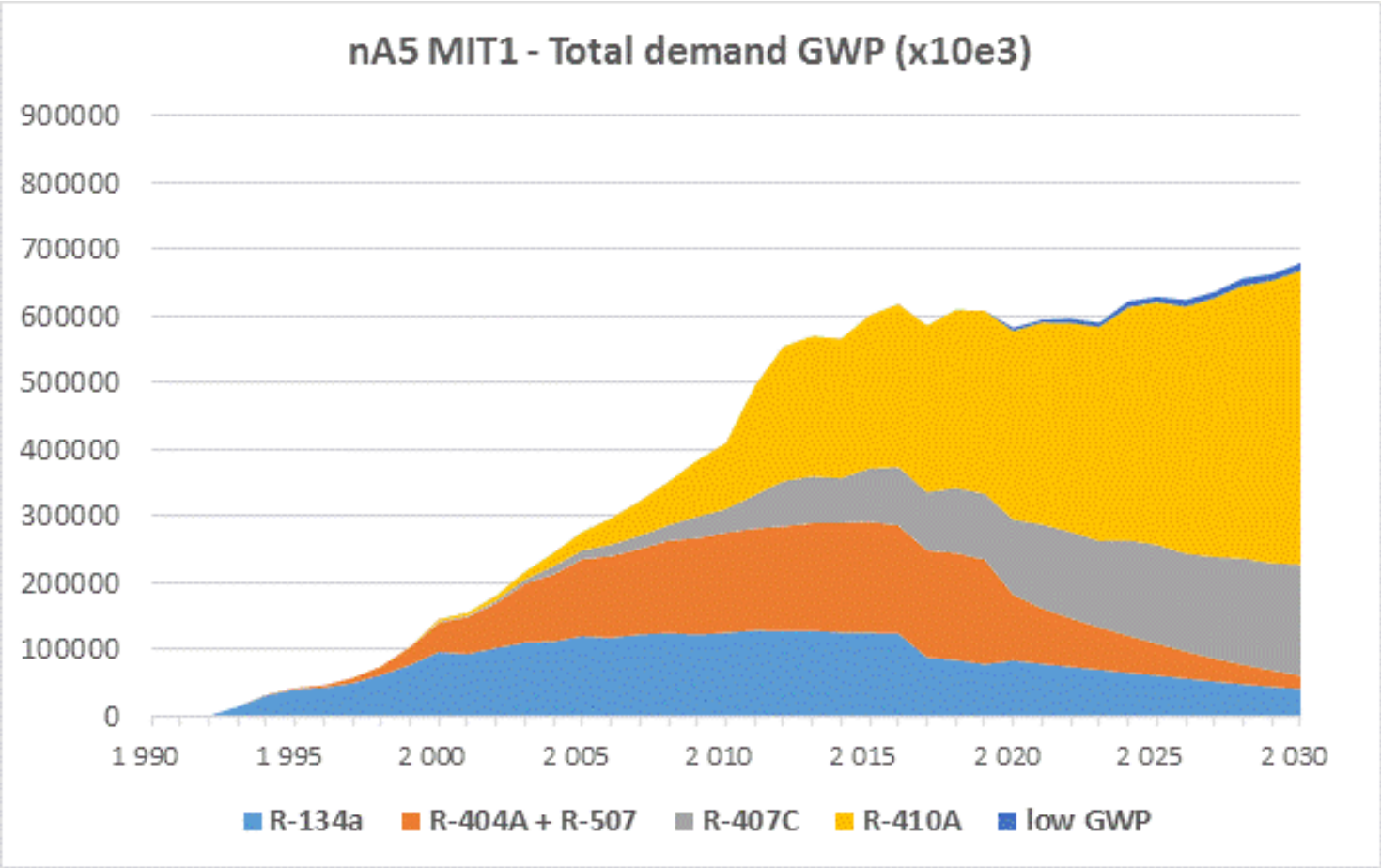
- *EU regulation*
- *Ban on MAC new 134a equipment by 2017 in all countries*
- *Domestic refrigeration out of HFC-134a*
- *No R-404A in new equipment by 2020 in all countries (R-407C)*

Article 5 countries

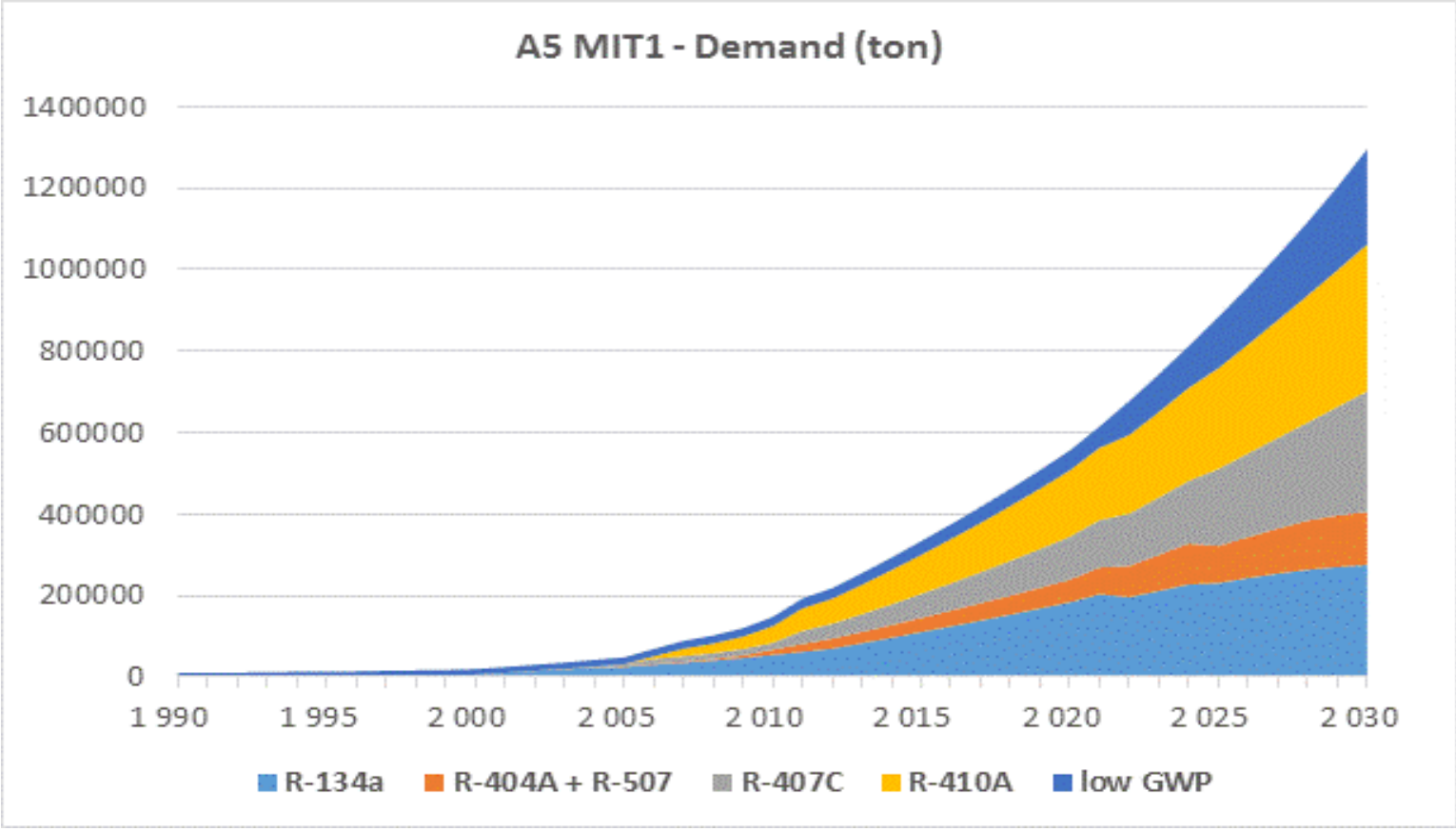
- *Same measures as above for non-A5, five years later*

No measures in stationary air conditioning, nowhere

RAC – MIT-1 for Non-A5



RAC – MIT-1 for A5



RAC – MIT-2 scenario

- *Subsector and "ban" approach*

Non Article 5 countries

- *EU regulation*
- *Ban on MAC new 134a equipment by 2017 in all countries*
- *Domestic refrigeration out of HFC-134a*
- *No R-404A in new equipment by 2020 in all countries (only low GWP)*
- *Stationary AC new manufacturing to low GWP (GWP<300) as of 2020*

Article 5 countries

- *Same measures as above for non-A5, with the same years*

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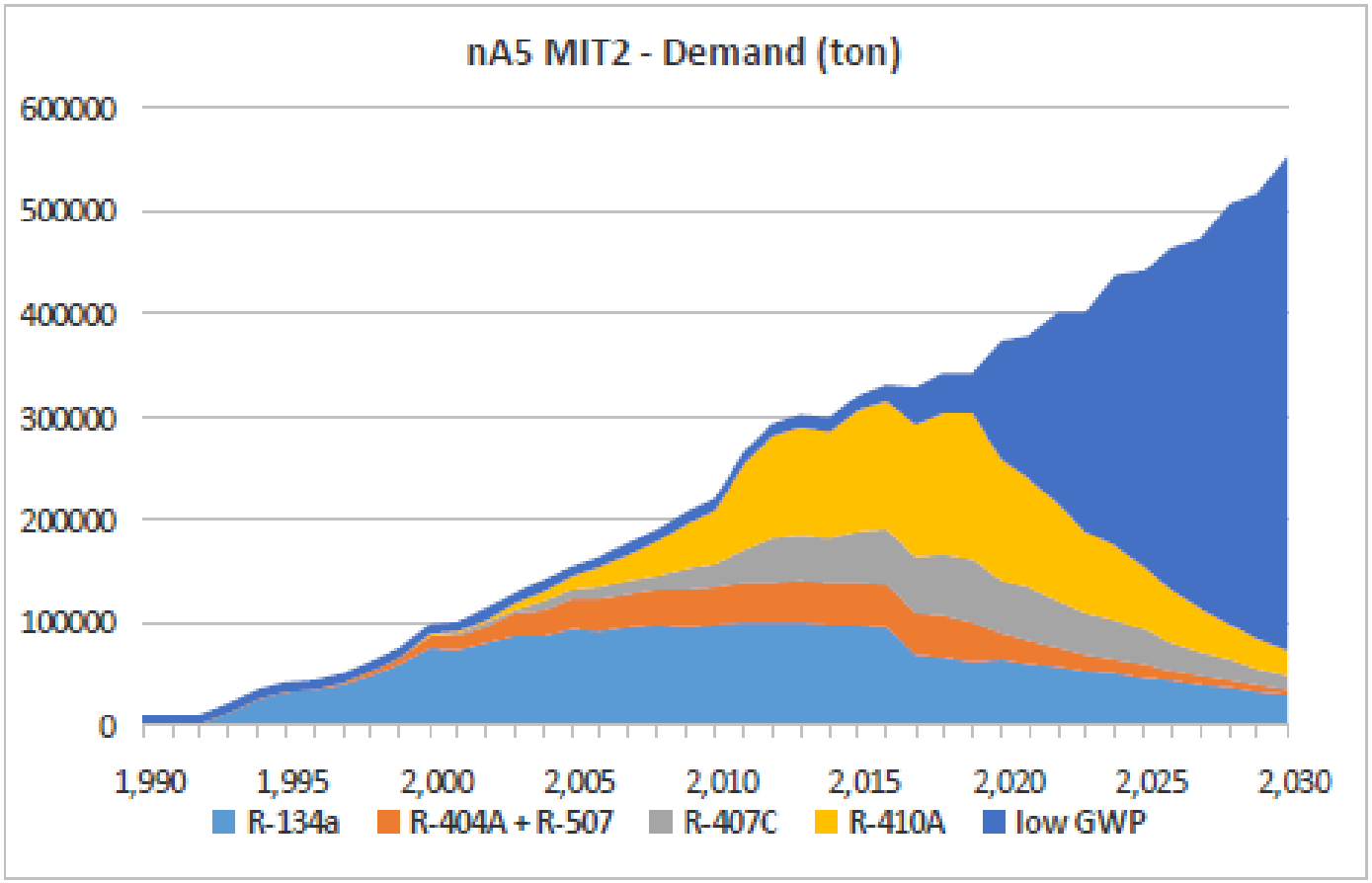
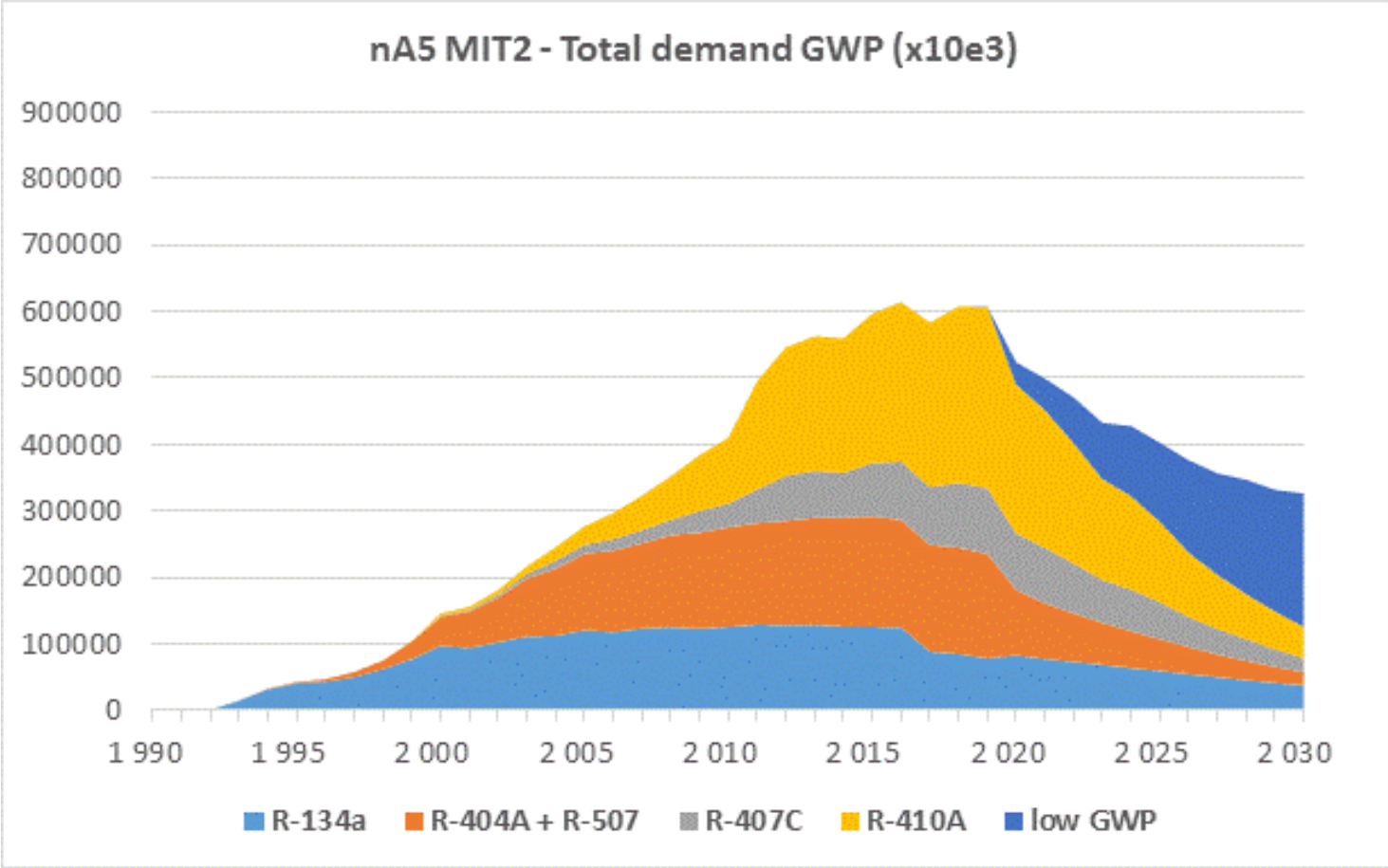
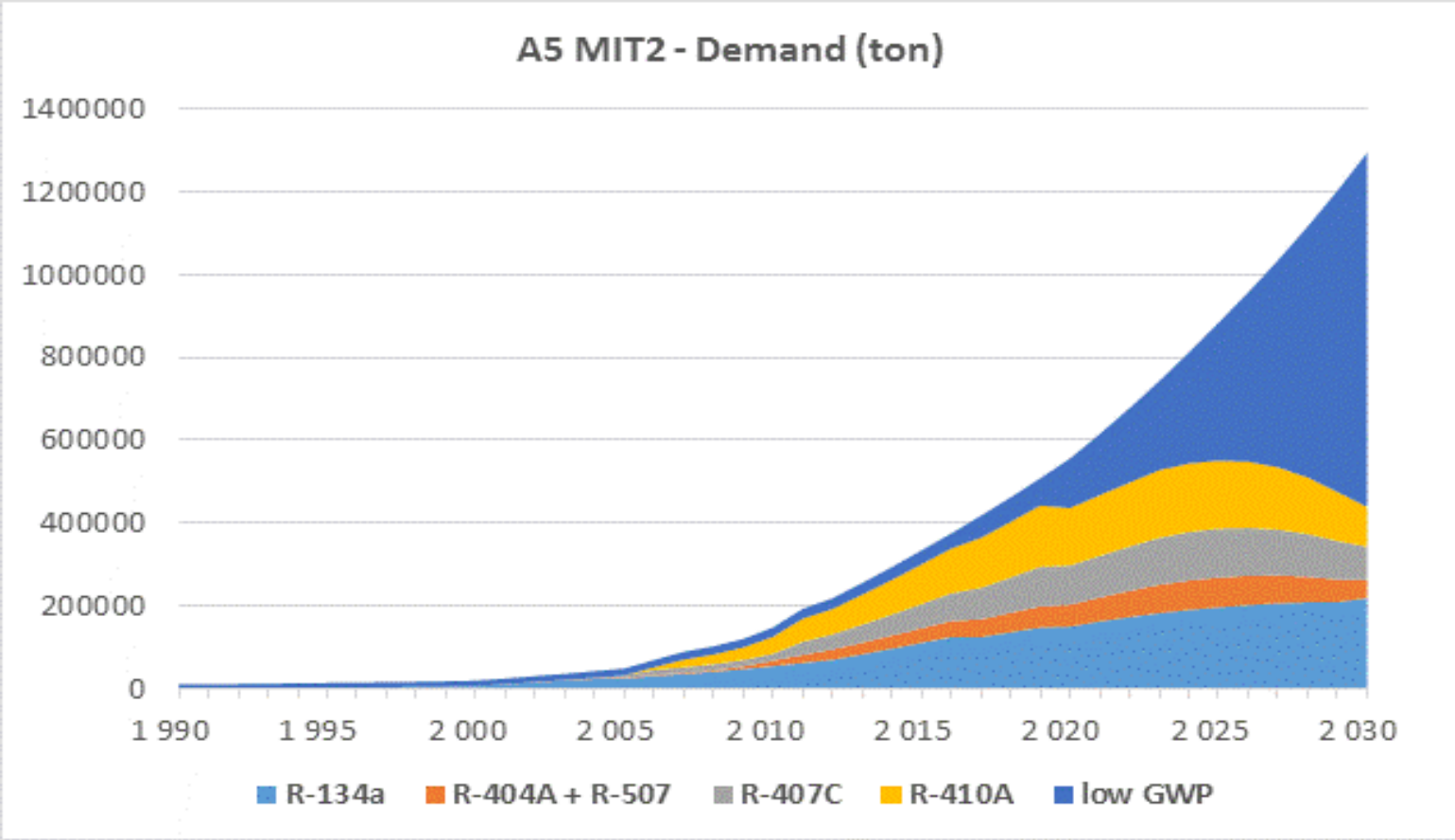
RAC – MIT-2 for Non-A5



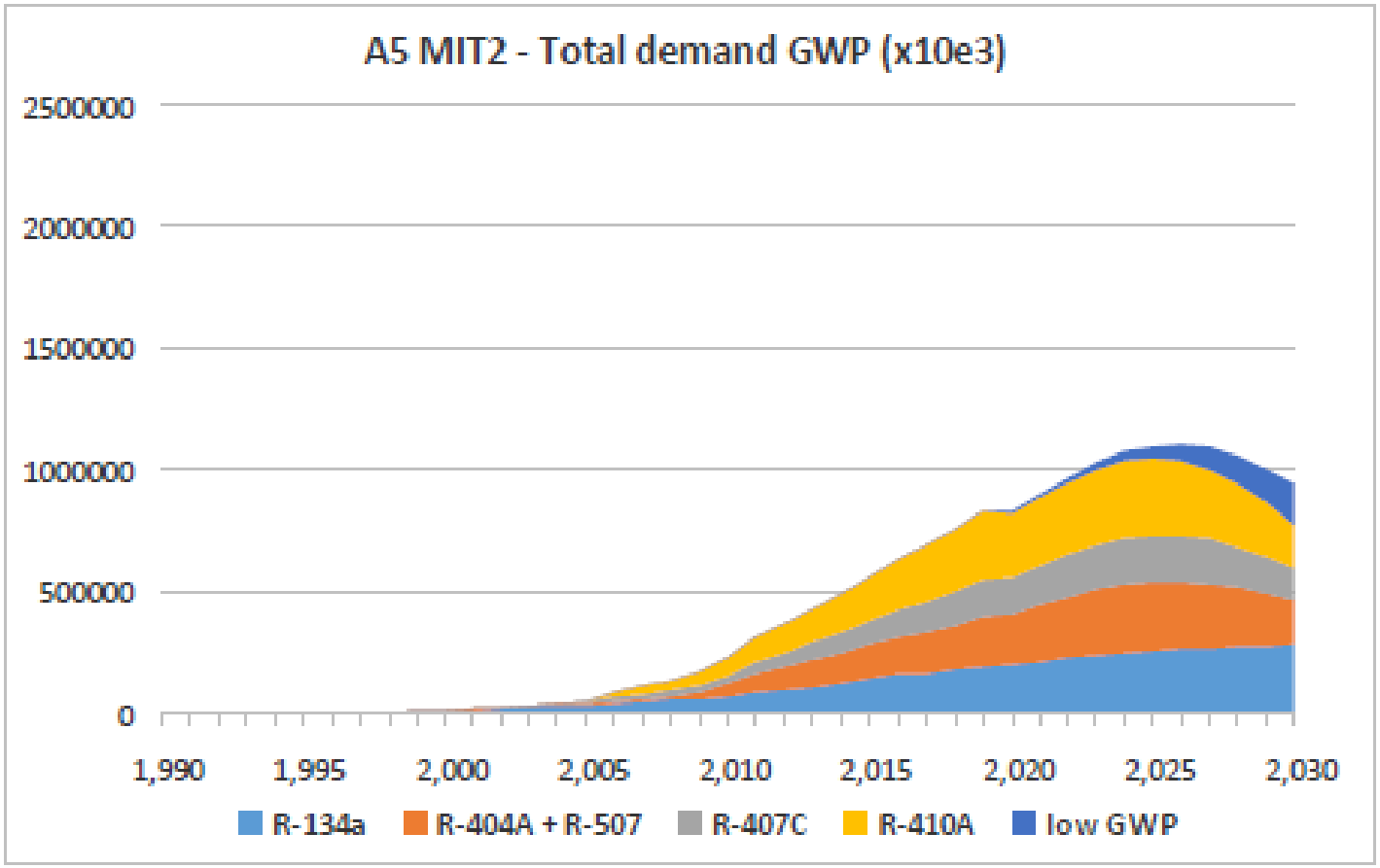
RAC – MIT-2 for Non-A5



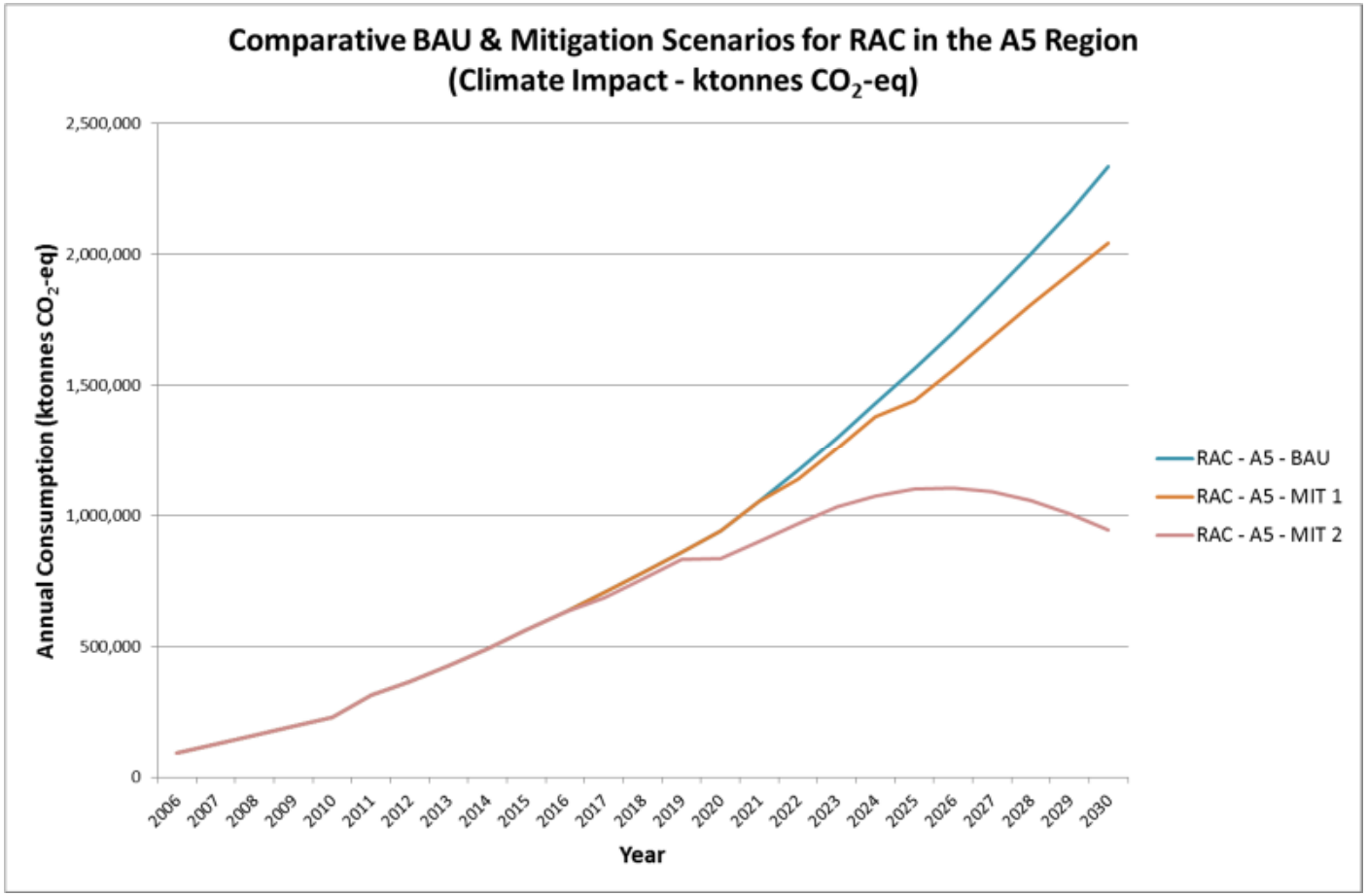
RAC – MIT-2 for A5



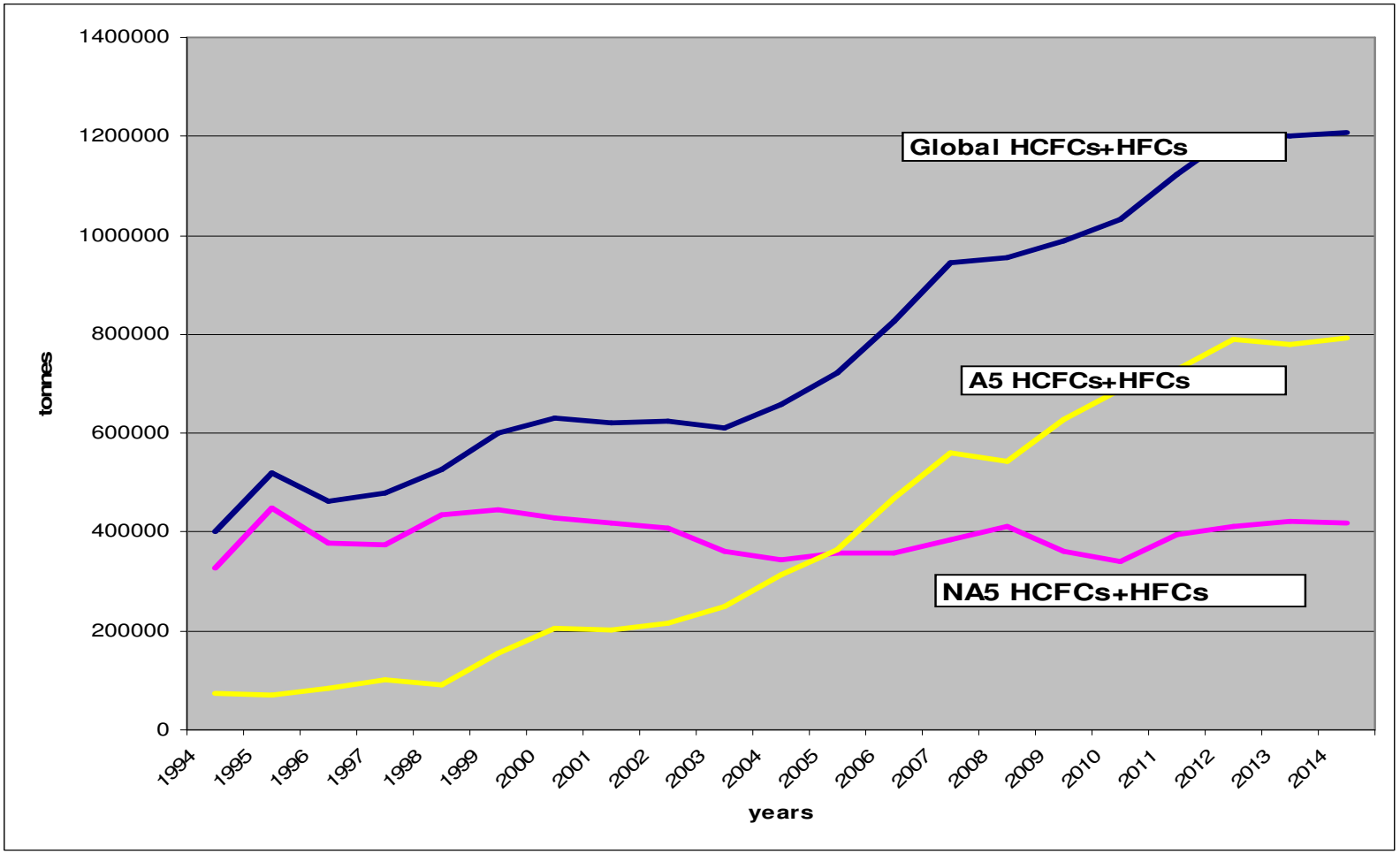
RAC – MIT-2 for A5



Impact of Mit Scenarios for RAC in the A-5 Region



HCFC and HFC demand in tonnes



Summary of Findings

- *Information about the available alternatives continues to evolve and the capabilities and limits of technologies are being further characterised*
- *Business-as-Usual scenarios have been defined through to 2030 for both A5 and non-A5 parties*
- *Refrigeration and Air Conditioning is the dominant sector in terms of BAU consumption*
- *It has been possible to identify plausible measures that support two further mitigation scenarios beyond the current BAU assumptions*
- *MIT-1 could cumulatively deliver 3,000 Mtonnes CO_2-eq saving by 2030 with MIT-2 delivering 11,000 Mtonnes CO_2-eq in the same time period*