

Technology and Economic Assessment Panel (TEAP) 2022 Progress Report

Bella Maranion, Marta Pizano, Ashley Woodcock
TEAP Co-chairs

Outline of Presentation

- TEAP 2022 Reports
- TEAP Activities
- Response to Dec XXVIII/2: Periodic assessment of HFC alternatives
- Per- and polyfluorinated alkyl substances (PFAS)
- Modelling Updates
- TOCs Progress Reports
- TEAP Organisational Matters

TEAP Membership 2022

Bella Maranion, TEAP Co-chair	USA	Kei-ichi Onishi, MCTOC Co-chair	JP
Marta Pizano, TEAP/MBTOC Co-chair	COL	Roberto Peixoto, RTOC Co-chair	BRA
Ashley Woodcock, TEAP Co-chair	UK	Fabio Polonara, RTOC Co-chair	IT
Omar Abdelaziz, RTOC co-chair	EGY	Ian Porter, MBTOC Co-chair	AUS
Paulo Altoe, FTOC Co-chair	BRA	Rajendra Shende, Senior Expert	IN
Suely Carvalho, Senior Expert	BRA	Helen Tope, MCTOC Co-chair	AUS
Adam Chattaway, HTOC Co-chair	UK	Dan Verdonik, HTOC Co-chair	USA
Ray Gluckman, Senior Expert	UK	Helen Walter-Terrinoni, FTOC Co-chair	USA
Marco Gonzalez, Senior Expert	CR	Shiqiu Zhang, Senior Expert	PRC
Sergey Kopylov, HTOC Co-chair	RF	Jianjun Zhang, MCTOC Co-chair	PRC

TEAP 2022 Reports

May 2022:

Volume 1: TEAP Progress Report

Volume 2: Evaluation of 2022 CUNs for methyl bromide and related issues - Interim Report

Volume 3: Decision XXXIII/5 Task Force Report on energy-efficient and low-global-warming-potential technologies

Sep 2022:

Volume 4: *Evaluation of 2022 CUNs – Final Report*

Volume 5: *Decision XXVIII/2 Working Group Report on alternatives to HFCs*

Dec 2022:

FTOC, HTOC, MBTOC, MCTOC, and RTOC 2022 Assessment Reports
TEAP 2022 Assessment Report (Synthesis Report in 2023)

TEAP Activities

- TEAP has provided **17 reports since 2020** and an **additional 8 reports** by the end of this year.
 - Since early 2020, all TEAP, TOCs, and TFs meetings have been held virtually – thanks to the support of the Ozone Secretariat.
 - We are grateful for the continued exceptional commitment of members of the TEAP, TOCs, and Task Forces (TFs) and the continued support of parties.
- This May, TEAP successfully held its first hybrid annual meeting in London with the support of the UK and the Ozone Secretariat.
- TEAP/TOCs are continuing to draft their 2022 Assessment Reports (to be presented in 2023) in coordination with the Scientific Assessment Panel (SAP) and the Environmental Effects and Assessment Panel (EEAP) on cross-cutting topics.
- Continued importance that both TEAP and parties consider the overall annual workload, the deadlines for delivery, and the support provided to TEAP, at the time of making decisions requesting work.

Decision XXVIII/2: Decision related to the amendment phasing down HFCs

- Decision XXVIII/2 requests TEAP to conduct periodic reviews of alternatives to HFCs in 2022 and every five years thereafter.
- The first requested periodic review in 2022 aligns with the preparation of TEAP's and its TOCs quadrennial assessment reports under Decision XXXI/2, and those reports are planned to be completed at the end of 2022.
- Given the coincidental timing of these two decisions in 2022, TEAP is convening a Working Group to prepare a report responding to decision XXVIII/2, drawing from the TOCs 2022 Assessment Reports, for submission to MOP-34.

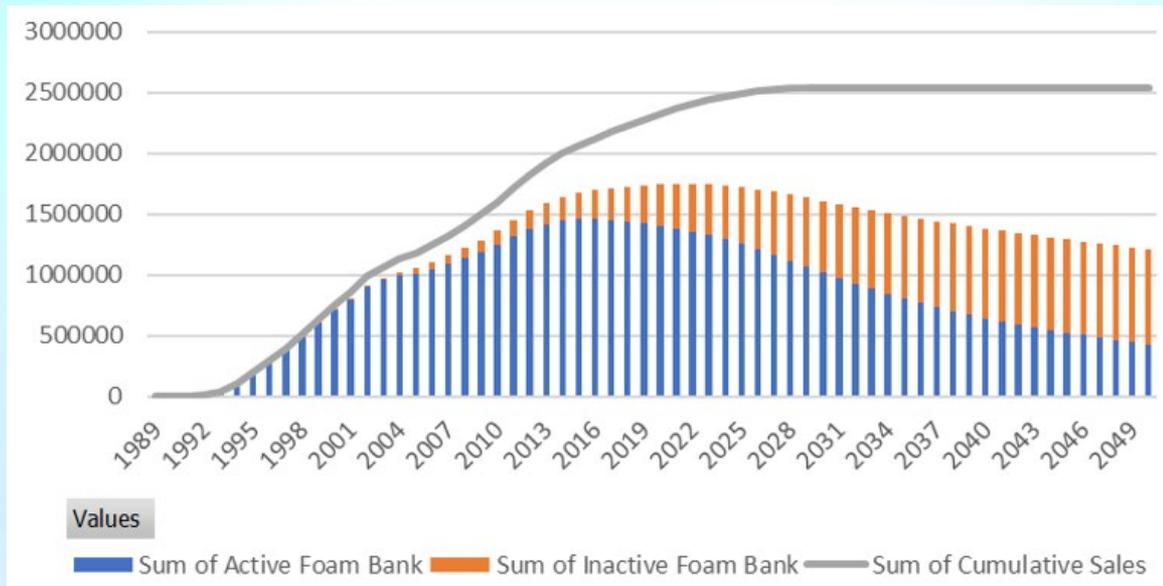
Per- and polyfluorinated alkyl substances (PFAS)

- Some governments are developing regulations related to PFAS which consist of definitions that may include some Montreal Protocol controlled substances and their alternatives.
- This is creating uncertainty for industry regarding long-term availability of some alternatives.
- Some companies and other stakeholders are delaying decisions regarding selection of alternatives with concerns about how “PFAS” might be limited as a result of new regulations.
- For example, in the Fire Protection sector, this could leave halons or in some cases also HFC-23 as the only viable non-PFAS options, e.g.,
 - Aviation portable extinguishers: 2-BTP vs halon 1211
 - Very low temperature oil and gas: HFC-23 vs halon 1301
 - Explosion suppression for ground combat vehicles: HFC-227ea vs halon 1301

TEAP Modelling Update

- TEAP is working to build a database of models of all controlled substances, estimating regional emissions and banks to better respond to parties' requests, supporting the work of the Assessment Panels. The 2022 Assessment Report will include initial work on a small number of substances.
- The model uses a variety of data to estimate banks and expected emissions from the historic, current, and projected usage of controlled substances.
 - The model can be refined over time as this knowledge expands or changes.
 - A consistent and transparent, published methodology ensures that the best available assumptions and method are incorporated.
- These expected annual emission estimates can be compared to estimated emissions from available atmospheric chemical concentrations, when available.
- The same methodology was used by the TEAP Task Force on the Unexpected Emissions of CFC-11 and TEAP Replenishment Task Force.

Example: Estimated Banks of HCFC-141b (tonnes)

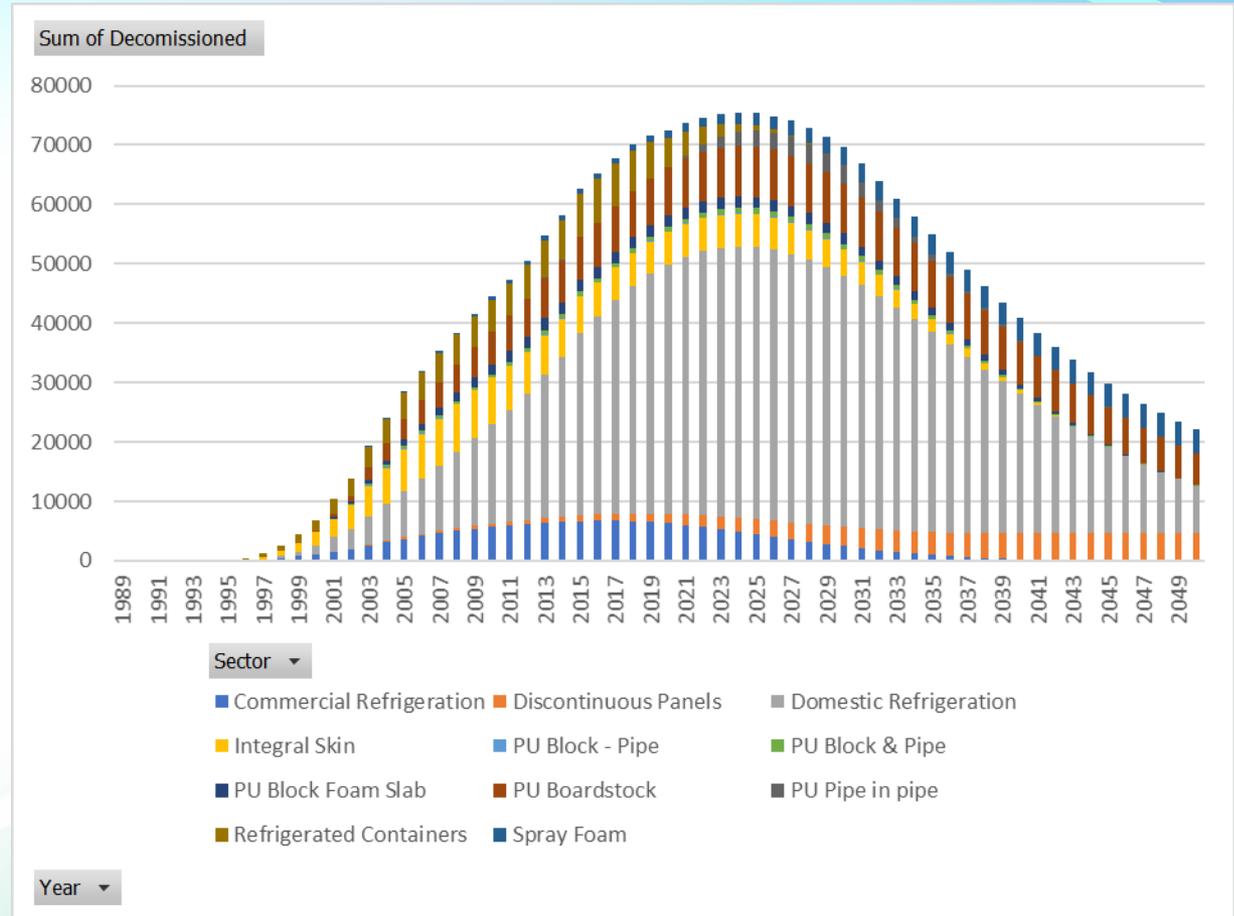


Model incorporates:

- Production and consumption
- Estimates of the lifetime of equipment and foams
- Emissions rates throughout the product lifecycle
- Market and economic influences

Example: Timing of HCFC-141b (tonnes) Decommissioning in Foams

Models also include estimates of the timing of decommissioning of various types of foam by region.



Flexible and Rigid Foams Technical Options Committee (FTOC)

Co-chairs

Paulo Altoe

Helen Walter-Terrinoni

FTOC 2022 Progress Report

Generally, transitions to non-ozone depleting substances (ODSs) and low global warming potential (GWP) alternatives has been successful and transitions continue to move forward.

- Foam systems used in refrigeration equipment
- Boardstock
- Significant extruded polystyrene (XPS)

FTOC Key Transition Challenges

- Low-GWP foam blowing agent shortages continue in both A5 and non-A5 parties
 - Pandemic-related supply chain issues, supply chain shortages, manufacturing issues, more demand than available capacity and severe weather cited as causes for shortages.
- Prices of HFCs have also increased during the pandemic.
- Patents have restricted options to address local supply chains.
- There has been a significant increase in the use of blends of HFC-365mfc/HFC-227ea or HFC-365mfc/HFC-245fa in some A5 parties and a reversion to HFC-365 blends and HFC-245fa in some non-A5 parties.

Halons Technical Options Committee (HTOC)

Co-chairs

Adam Chattaway

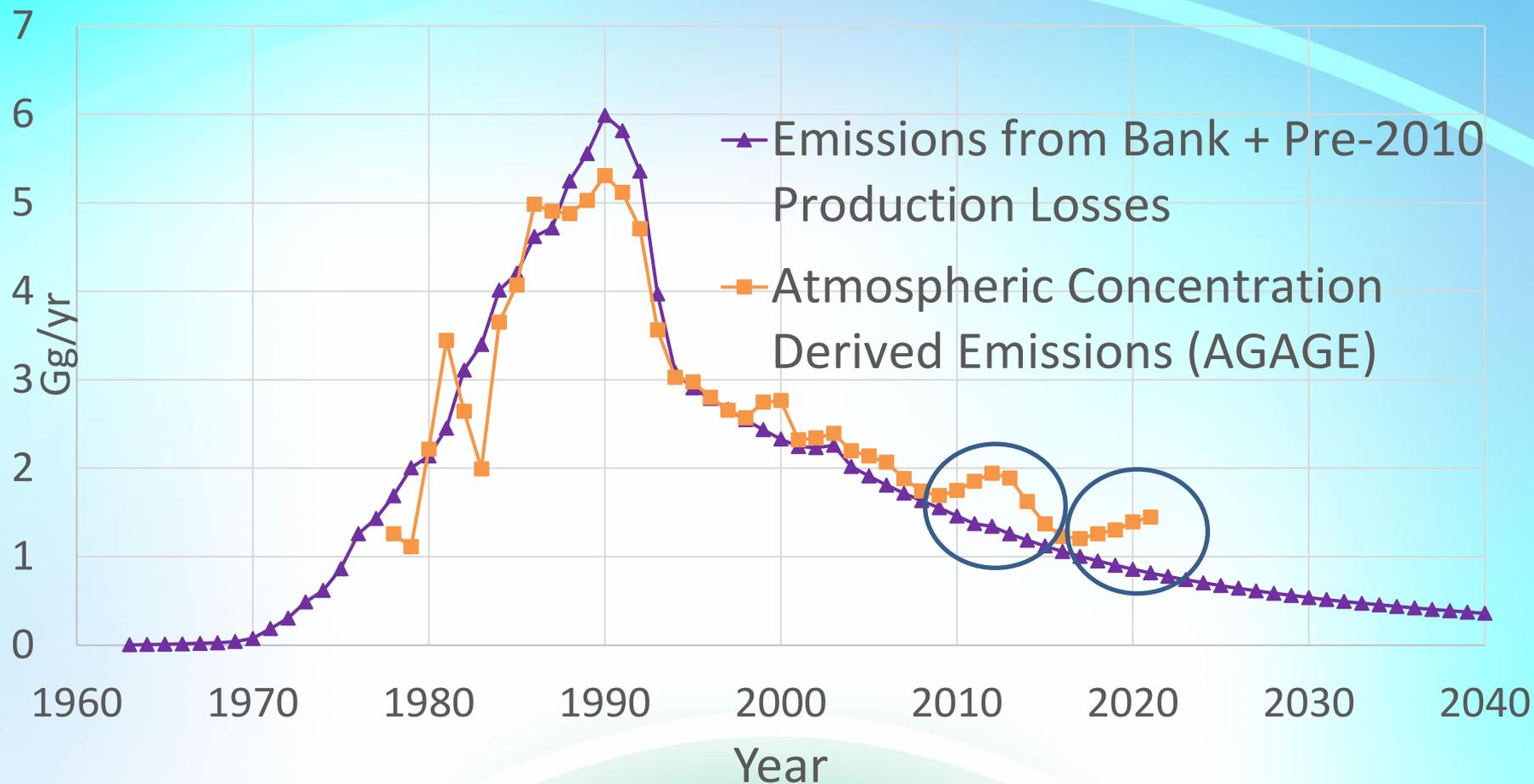
Sergey Kopylov

Dan Verdonik

HFC Phase-down

- In 2018, the HTOC was of the opinion that the initial 10% reduction in HFC production would not have a significant impact on the fire protection sector
 - Small part of overall HFC market
 - Low emissions
 - Stable or decreasing markets
 - In the US, there has already been significant impact in cost & availability
 - HFCs used for fire extinguishing are high-GWP, so the allocation mechanism has a disproportionate effect
 - Declining market
 - Commercial Decisions
- EU is seeing impacts
- This could / will reduce commercial viability of some HFC agents (could affect other market sectors too)
- Likely that the market will be relying on recovered HFCs sooner rather than later and therefore for longer

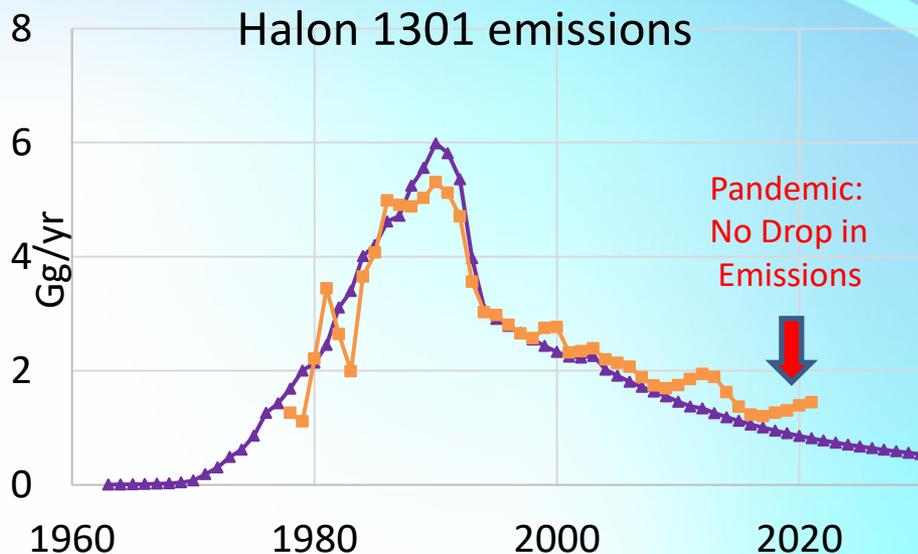
Halon 1301 Emissions



Emissions estimates appear to deviate post 2010 between the two different methods

Updated response to Decision XXX/7. Future availability of halons and their alternatives

- The 2020 AGAGE estimated emissions did not decrease in line with reductions in pandemic related aviation flight hours suggesting most aviation emissions are not occurring during flight operations
- HTOC continues to liaise with ICAO and other aviation stakeholders to better understand the sources of emissions and opportunities to reduce them.
- Halon Recycling Corporation has produced a guidance document on reducing emissions during servicing
- HTOC will be providing an additional update on the future availability of halons to support civil aviation in our 2022 Assessment report



Methyl Bromide Technical Options Committee (MBTOC)

Co-chairs

Marta Pizano

Ian Porter

Current situation: controlled vs exempted uses

- In 2021, reported MB consumption for controlled uses was only 43.6 t compared to the consumption in 2005 which was 16,050 t. However, substantially higher quantities of stocks may still be in use.
- Exempted QPS (Quarantine and Preshipment) consumption of MB remains at around 10,000 t/ year, however consumption is increasing in some A5 parties offsetting gains made with reductions in non-A5 parties.
- Research programs around the world continue finding successful alternatives to MB for QPS. For instance, the recent registration of ethane dinitrile (EDN) on timber in New Zealand and South Korea is providing a successful alternative for major Q uses globally (>600 t).



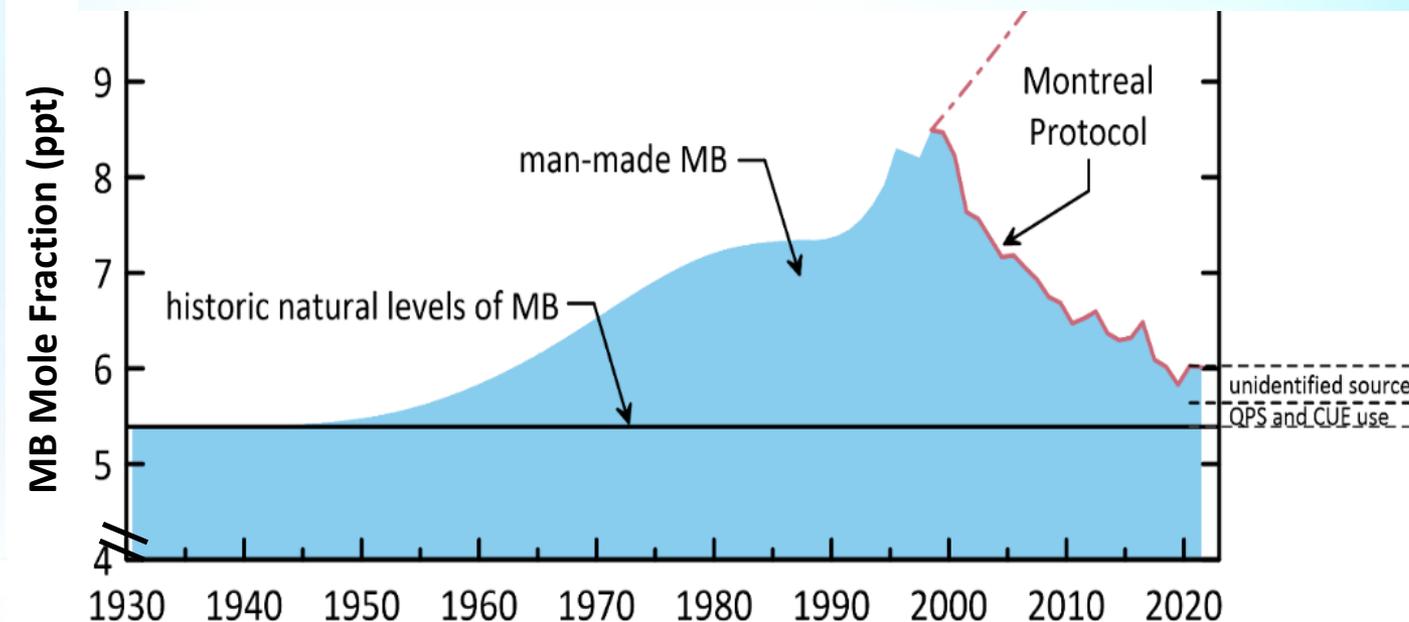
Suggested way forward (for MB)

- MBTOC reports have identified that there are available alternatives for 30-40% (i.e., 3000-4000 t) of Quarantine and Preshipment (QPS) use, almost predominantly PS uses.
- Parties may wish to request TEAP to:
 - i. Better differentiate and quantify use under Q versus PS,
 - ii. Provide a list of suitable alternatives for Q and PS uses,
 - iii. Provide an estimate of the possible impact on MB phase out over the short to medium term.
- An issue of concern: Sulfuryl fluoride (SF) is a key alternative to MB widely registered and adopted around the world for treatment of empty structures (e.g., flour mills, food premises, etc.),
 - i. Growing concern about the GWP value of SF (7510).
 - ii. Development and adoption of emission reduction technologies may reduce some of this concern.



MB Emissions

- Since 1999, substantial phase out of controlled MB uses and their emissions has led to >30% reduction in the concentration of MB in the atmosphere and a similar rapid benefit to its reduction in the stratosphere.
- In 2020-21, however, atmospheric levels of MB have stopped falling as emissions of MB from reported controlled uses have almost ceased, however emissions from QPS and some unreported uses continue.
- Near-term reduction of atmospheric concentrations of MB in the future now rely on reduction in these emissions.



Source: TEAP Progress Report 2022

Methyl Bromide Technical Options Committee (MBTOC)

Interim CUN Assessment
2022

Co-chairs

Marta Pizano

Ian Porter

CUNs submitted for use in 2023 and 2024

Uses and Main Reason	CUN 2023	CUN 2024
<i>Preplant Soil Uses</i>		
Strawberry nurseries - certification for non-QPS pathogens		Australia
Strawberry nurseries - certification for non-QPS pathogens	Canada	
<i>Commodity and Structural Uses</i>		
Houses	RSA	

Note: Argentina notified that no CUNS were being sought in this round

Reporting of Stocks (Dec XVI/6, para1)

	MB stocks (t) reported this year as of the end of 2021
Australia	0
Canada	0
RSA	6.1

- CUE recommendations are not adjusted to account for stocks

Summary of CUN Nominations for all Critical Uses of MB (t) for 2023 and 2024

Country and Sector	Nomination by the Parties in the previous year	Nomination by the Party for 2023 or 2024	Interim Recommendation
1. Australia (2024) Strawberry runners	14.49	14.49	Unable
2. Canada Strawberry runners (2023)	5.017	5.017	Unable
4. RSA (2023) Houses	No CUN	20.0	[19.0]
TOTAL	19.507	39.507	[19.0]

Interim CUE Recommendation for MB use (tonnes) in 2024 for Australian Strawberry Nurseries (Runners)

Sector	CUN for 2024	Interim Recommendation for 2024
Strawberry runners	14.49	[Unable to assess]

Interim Recommendation for 2024: Unable to assess

- MBTOC accepted that MI was the only alternative presently available for soil treatment, however as a decision on its registration would be available in July 2022, the committee considered that it was appropriate to wait until after July when time is available to make a final assessment prior to the MOP.



Interim CUE Recommendation for MB use (tonnes) in 2023 for Canadian Strawberry Nurseries (Runners)

Sector	CUN for 2023	Interim Recommendation for 2023
Strawberry runners	5.017	[Unable to assess]

Interim Recommendation for 2023 - Unable to assess

- The party stated that further time was required to improve the number of plants produced from soilless substrates in order to replace MB use for tip production in soil. Presently the lower number meant soilless culture was considered uneconomical.
- MBTOC considered that more information was required on the National Management Strategy particularly a timeline to phase out MB before a recommendation could be made.



National Management Strategies

- **Decision XXXII/3** reminded parties that they are required to submit their NMSs in accordance with Decision Ex.I/4 (UNEPb).
- The NMS aims particularly to provide information on,**the potential market penetration of newly deployed alternatives and alternatives which may be used in the near future, to bring forward the time when it is estimated that methyl bromide consumption for such uses can be reduced and/or ultimately eliminated.....**

Interim CUE Recommendation for MB use (tonnes) in 2023 for South African Houses

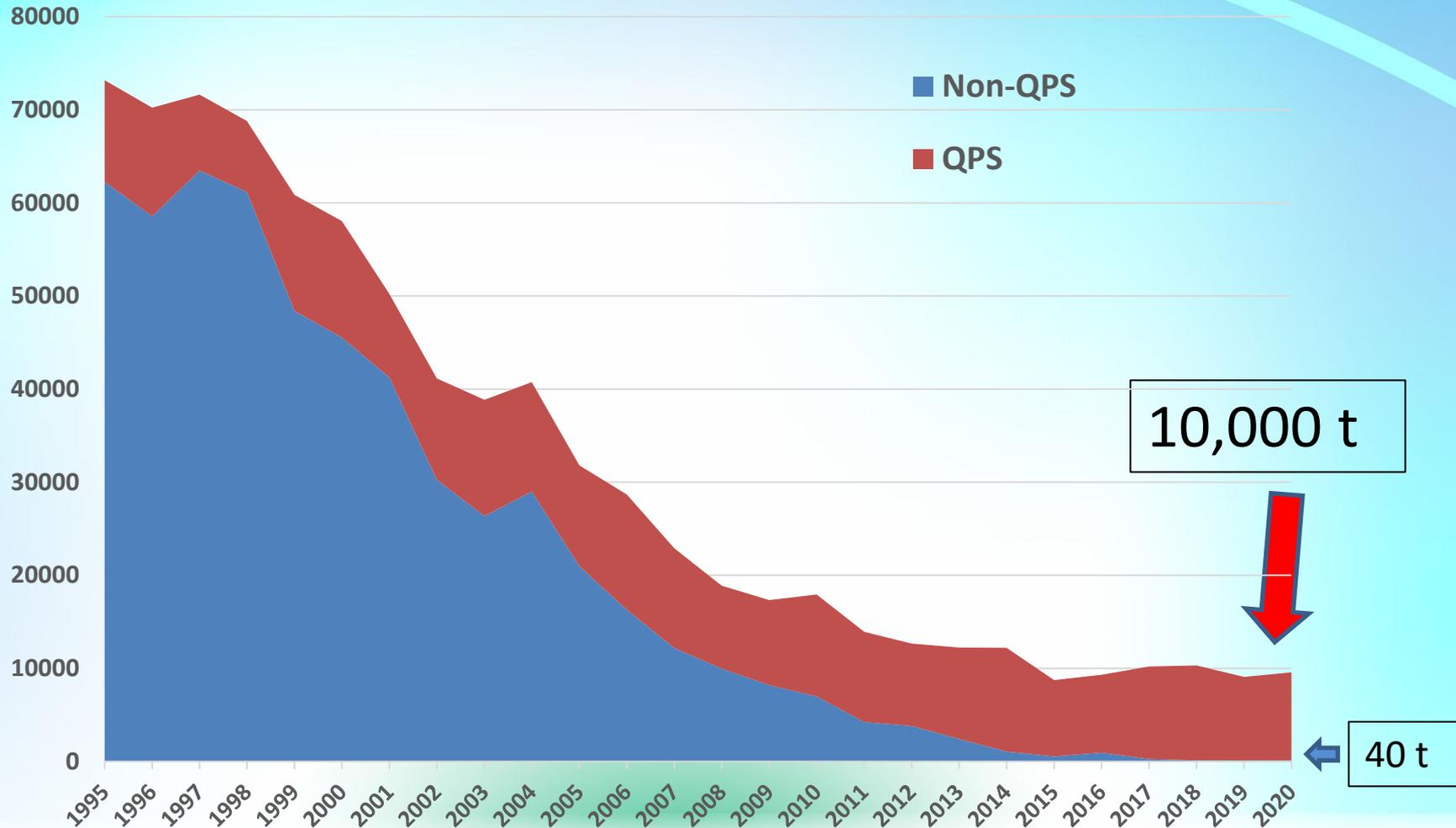
Sector	CUN Request for 2023	Interim Recommendation for 2023
Houses	20.0	19.0

Interim Recommendation for 2023 : Reduced Amount of 19 t

- The recommended amount was a 5% reduction (1 t) of the nomination for 2023.
- MBTOC considered alternatives, such as sulfuryl fluoride are available to preserve structural timber known to be infested by woodboring beetles. The remaining 19.0 t is recommended as it is for use for fumigation of houses being sold and require a Certificate of Compliance.
- MBTOC acknowledges that the Party has indicated that this is the last year for applying for a CUN for this sector.



Non QPS MB (reported CUNs) verses QPS MB (tonnes)



Medical and Chemicals Technical Options Committee (MCTOC)

Co-chairs

Keiichi Ohnishi

Helen Tope

Jianjun Zhang

MCTOC 2022 Progress Report

- The largest controlled ODS feedstocks in 2020 were HCFC-22 (48% of the total mass quantity), CTC (20%), and HCFC-142b (11%).
- HCFC-22 and HCFC-142b are mainly used to make tetrafluoroethylene and vinylidene fluoride respectively, both of which are used in fluoropolymer production.
- CTC feedstock use has increased in recent years with demand for HCFO/HFOs and perchloroethylene.

MCTOC 2022 Progress Report

- Accurate, consistent, A7 reporting of production, including for feedstock uses, contributes to the understanding of atmospheric burdens.
 - In chemical production, a substance that is isolated, purified, and then used in a separate process, would be considered a finished product and subject to reporting as production.
 - A non-isolated intermediate in a chemical process is not considered as a finished product while it remains within the chemical process, and as such, is not commonly reported as production. However, these intermediates may also be emitted in low quantities and detected by atmospheric monitoring.
- As reported by FTOC, challenges with production and chemical supply of low-GWP HCFO and HFO foam blowing agents relate to several factors, including production constraints, restrictive patents, high prices relative to HCFC-141b and HFC blowing agents, and regional shortages of CTC used as raw material in the process to manufacture HCFO/HFOs. New production capacity for HCFO/HFOs is expected to be available in 2023.

MCTOC 2022 Progress Report

- An assessment of destruction technologies in response to decision XXX/6 will be included in MCTOC's 2022 Assessment Report based on available information.
- 2020 and 2021 TEAP Progress Reports invited parties to submit information on destruction technologies in response to decision XXX/6 paragraph 3. No information has been submitted.
- In future, parties may wish to consider providing any new information for TEAP assessment of destruction technologies in January of the same year in which its assessment would be reported either as part of annual TEAP Progress Reports or future quadrennial assessments.
- MDIs, dry powder inhalers (DPIs), aqueous soft mist inhalers (SMIs), and other delivery systems all play an important role in the treatment of asthma and COPD.
- New alternative propellant technologies to high-GWP HFC MDIs are under development. DPIs, soft mist inhalers and nebulisers are already available for most molecules and combinations as alternatives to high-GWP MDIs, offering a lower carbon footprint.

Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee (RTOC)

Co-chairs

Omar Abdelaziz

Roberto Peixoto

Fabio Polonara

RTOC 2022 Progress Report

- In the last 4 years, **1 new single component refrigerant** and **18 refrigerant blends** have received a designation/classification from the ASHRAE Standard 34 and/or from the ISO Standard 817
- Mitigation of RACHP climate impact, reducing direct and indirect CO_{2e} emissions, is gaining increasing attention during the HFC phase-down
- Growing importance of the sustainable design and operation of equipment taking into account the strong growth of the equipment base.
 - Improve of the equipment energy efficiency to reduce energy demand
 - Phasing down of equipment containing high-GWP HFCs
 - Training in the servicing and maintenance of RACHP equipment to reduce leaks

RTOC 2022 Progress Report

- There has been significant progress with the development of **safety standards** to support the transition towards lower GWP alternative refrigerants, that are mostly flammable.
- **IEC 60335-2-89** (applicable to **commercial refrigeration**) was revised to include larger charges of flammable refrigerants (up to 500 g – 1200 g given certain boundary conditions) and is currently being transferred to national standards.

RTOC 2022 Progress Report

- The new edition of the standard **IEC 60335-2-40** was approved in April 2022.
 - It will allow HC-290 (propane), and other flammable refrigerants, to be used in many **air conditioning systems and heat pumps** that were prohibited by the previous version of the standard.
 - It allows for the use of a larger charge of flammable refrigerants (up to 988g of HC-290 in a standard split AC).
 - New equipment with flammable refrigerant must have additional safety requirements to ensure the same high level of safety as equipment that does not use flammable refrigerants.
 - The use of flammable refrigerants in AC equipment will lead to a reduction in direct climate emissions compared to equipment using R410A.

TEAP Organisational Matters

Proposed organisational changes

- TEAP strives to maintain or have access to the expertise, experience, and capacity to provide the parties with the technical and economic information they need to further the goals and objectives of the Vienna Convention and Montreal Protocol
- To achieve this, TEAP structure and membership continuously evolve, particularly within its TOCs. In 2015, TEAP evaluated its structure, membership, and future direction and proposed to merge the Medical and Chemicals TOCs forming the MCTOC.
- Now, organizational changes to RTOC and FTOC are necessary to meet the changes taking place in the RACHP and foams sectors
 - Address and integrate trends affecting controlled substances
 - Foster emerging synergies, including system approaches
 - Maintain or enhance efficient and effective capabilities to support the parties

Evolving Trends Impact Choice of Refrigerants and Foam Blowing Agents

Currently RTOC and FTOC are addressing the impact of some of these trends separately; a synergistic approach would have benefits in providing integrated advice to parties

Cold Chain

- Preservation of Medicines
- Reducing food loss and waste
- More efficient equipment
- More appliances in homes
- Changes in food shopping behavior
- Increase in functioning cold chain equipment

Buildings (Space Cooling and Heating)

- Heating and cooling load reduction
- More efficient equipment
- Ventilation (air exchange)
- Building envelope (insulation)
- System efficiency
- Waste heat recovery
- Mobile air conditioning

Could a system approach to space cooling and heating provide a clearer integrated view of refrigerants, foam blowing agents, and energy efficiency?





Building & Indoor Climate Control TOC

- Sectors including:
 - Building air conditioning
 - Heat pumps
 - Building insulation foam
 - Refrigerants
 - Mobile air conditioning
- Equipment including:
 - Air conditioners
 - Chillers
 - Heat pumps
 - Building insulation foam
 - Mobile air conditioners
 - Not-in-kind technologies

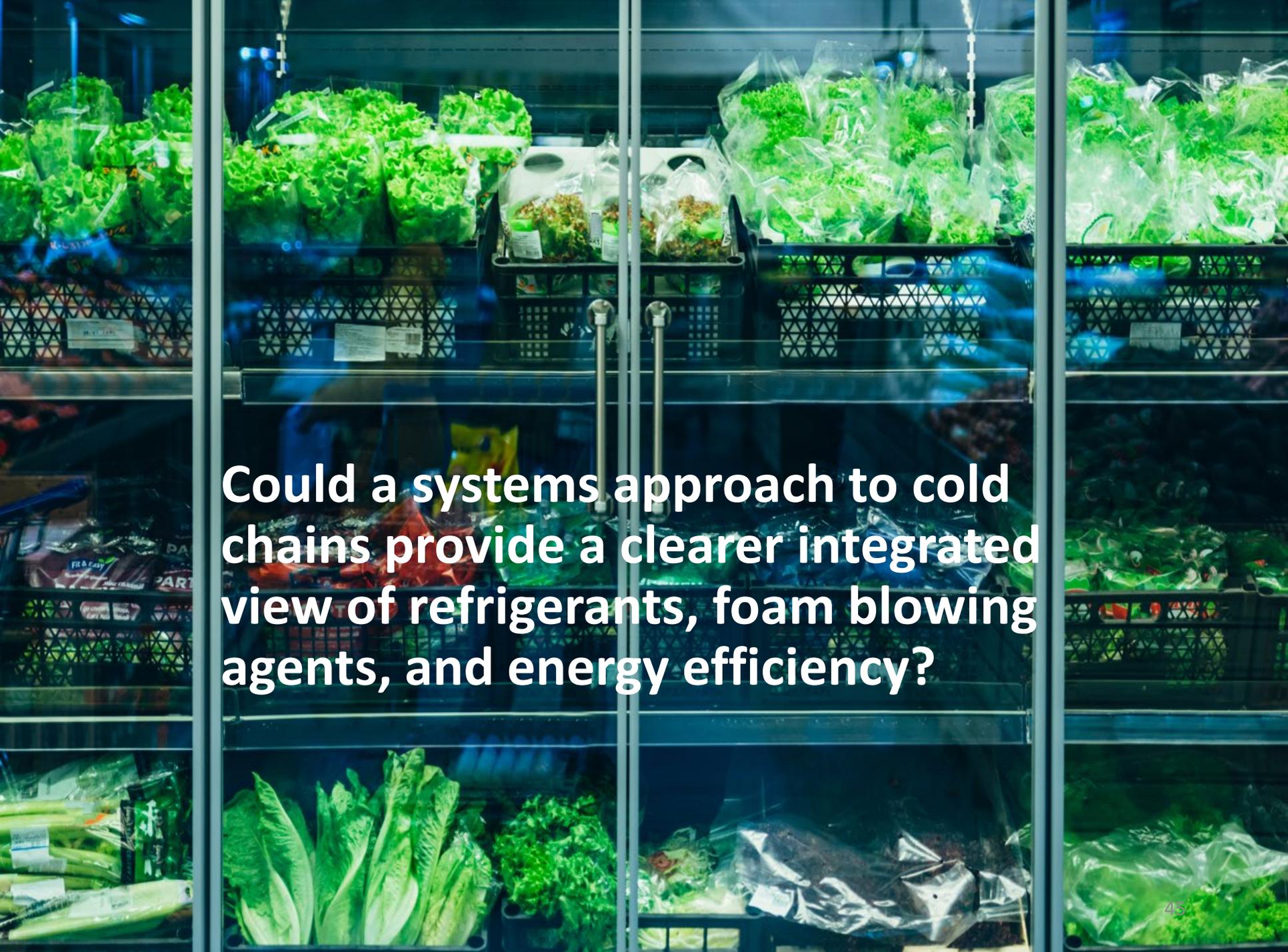
Buildings & Indoor Climate Control Technical Options Committee

Existing Scope

- Refrigerants used in space heating and cooling equipment
- Foam blowing agents used in foams in buildings
- Energy efficiency

Potential Additional Scope

- System efficiency
- Sustainability including load reduction and building design
- Thermal load reduction due to insulation
- Humidity and ventilation impacts

A photograph of a supermarket refrigerated display case. The shelves are filled with various fresh produce items, including bags of lettuce, broccoli, and other vegetables. The lighting is bright, highlighting the freshness of the goods. A central text overlay is present, asking a question about cold chain systems.

Could a systems approach to cold chains provide a clearer integrated view of refrigerants, foam blowing agents, and energy efficiency?

Cold Chain TOC



- Domestic Refrigeration
- Commercial refrigeration
- Transport refrigeration
- Food processing
- Cold storage (warehouses)
- Industrial Process Refrigeration
- Agricultural refrigeration
- Pharmaceutical refrigeration
- Foams used in refrigeration products
- Other non-building foams
- Fisheries
- Organic Rankine Cycles

Source: UNEP

Cold Chain Technical Options Committee

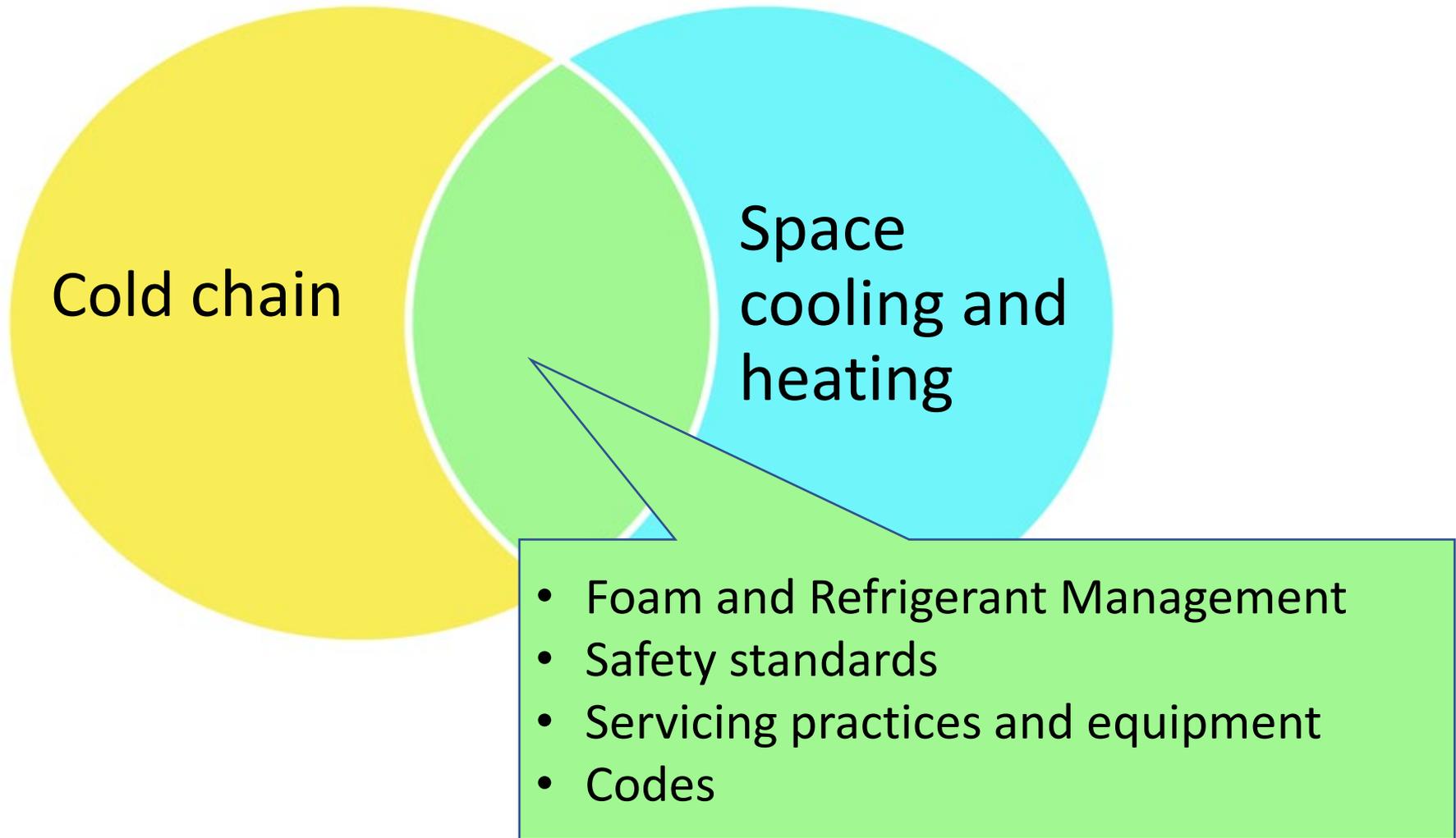
Existing Scope

- Refrigerants used in cold chain equipment in scope
- Foam blowing agents used in foams in the cold chain and other uses
- Energy efficiency

Potential Additional Scope

- System efficiency
- Sustainability including food loss and waste
- Retail refrigeration system architecture
- Thermal load reduction due to insulation

Examples of Integration and Cross-Cutting Issues



Proposed path forward

- Experienced, current RTOC/FTOC co-chairs appointed as new TOCs co-chairs
 - Ensuring continuity and integration in new structure
 - Meeting standards for reports, presentations, and committee management
 - Providing increased capabilities for parties in effective and efficient manner
- Updated matrix for new TOCs membership nominations (by MOP-34)
- New appointments to start in 2023, following the Terms of Reference while considering improvement in TOC balance



HTOC renamed as Fire Protection TOC

Reflecting the broadening scope of HTOC in assessing

- No/low-GWP alternatives to HFCs (and halons, HCFCs)
- Flammability concerns of refrigerants, foam blowing agents and solvents

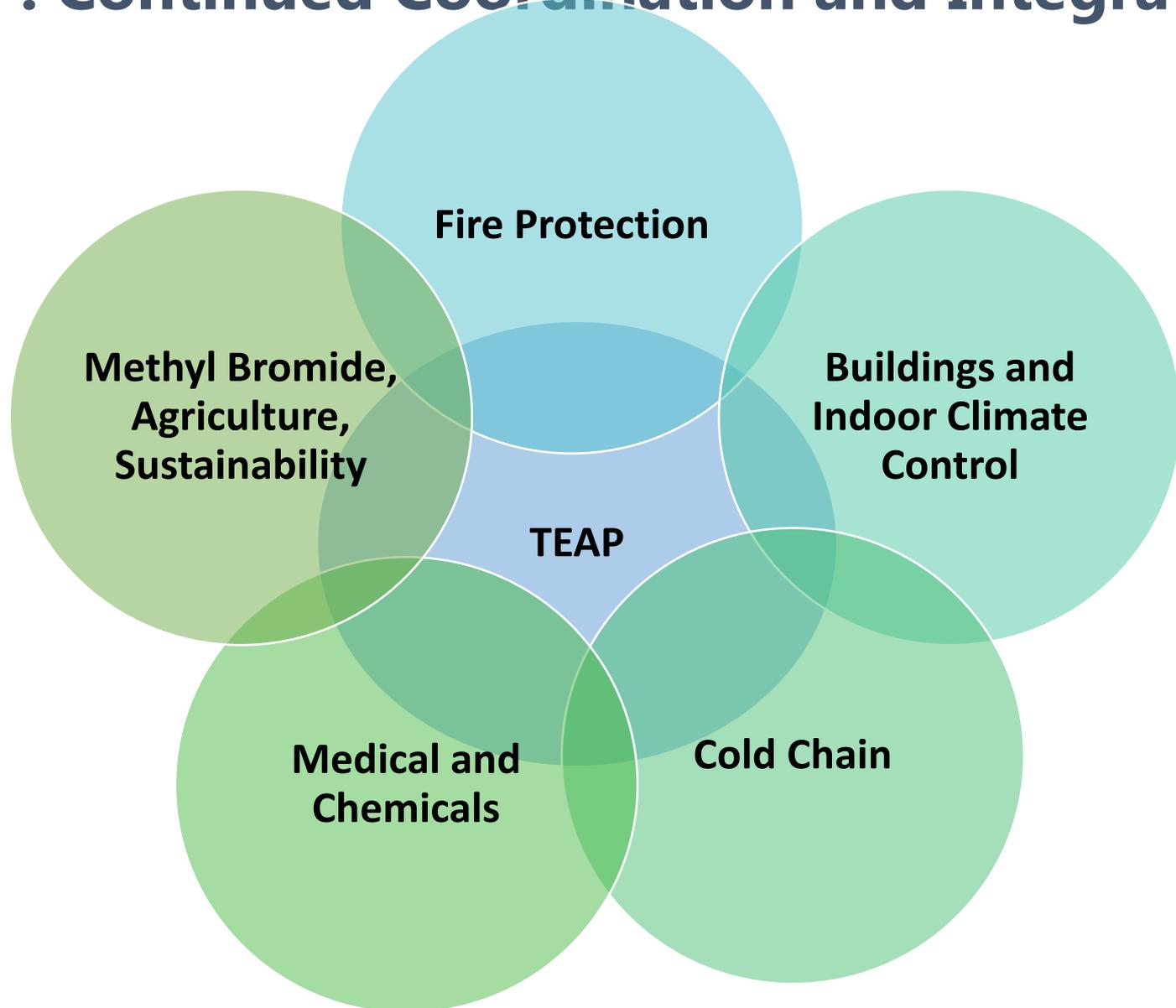


MBTOC renamed as the Methyl Bromide, Agriculture and Sustainability TOC

- Reflecting the importance of sustainability in food production and food safety in agriculture beyond MB
- TOC still addresses MB uses - controlled (CUNs) and exempted (QPS) and their alternatives
- Scope of work could be expanded to issues affecting sustainable production in agriculture (e.g., fertilizer, compost)
- Cross-cutting issues can also be addressed with other TOCs (e.g., the impact of the cold chain on food security)



TEAP: Continued Coordination and Integration



TEAP: Continued Coordination and Integration

- Modeling emissions, banks, etc.
- End-of-life reclamation and destruction of ODS and HFCs
- Assessment Panels cross-cutting issues
- Economic issues
- HFC alternatives
- Safety and training

