ODS Alternatives Surveys: Gaps, Challenges and Best practices

Montreal Protocol Division
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I. OUTCOMES FROM SURVEYS

II. PROJECTIONS, SCENARIOS AND EMISSIONS

III. UNIDO’S ANALYSIS AND BEST PRACTICES
Survey Scope & requirements

Before Kigali (75th ExCom)

• **Format:** UNEP/OzL.Pro/ExCom/75/77/Rev.1
• **Guide for preparation of the surveys** (23rd August 2016)

After Kigali Amendment - Article 5 countries

• Historical and predicted consumption trends for **ODS alternatives**
• **Aggregate** production and consumption of HFCs in Article 5 countries
Objective and Methodology

Estimate **current use** of ODS alternatives by substance, sector/sub-sector

I. OUTCOMES FROM SURVEYS

Methods applied
- Bottom-up
- Top-down
- Combination
  Bank and servicing demand
UNIDO’s Survey Analysis

Geographic coverage: 26 Countries

I. OUTCOMES FROM SURVEYS

- Submitted: 18
- Ongoing: 7
- Co-agency: 1
- Project CCAC: 1
### ODS alternatives

<table>
<thead>
<tr>
<th>Group</th>
<th>Substance</th>
<th>GWP* 100-year</th>
<th>Sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>RAC</td>
</tr>
<tr>
<td><strong>Pure hydrofluorocarbons</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HFC-23</td>
<td>14,800</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>HFC-32</td>
<td>675</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>HFC-43-10mee</td>
<td>1,640</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HFC-125</td>
<td>3,500</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>HFC-134</td>
<td>1,100</td>
<td>X (XPS)</td>
<td></td>
</tr>
<tr>
<td>HFC-134a</td>
<td>1,430</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>HFC-143a</td>
<td>4,470</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HFC-152a</td>
<td>124</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>HFC-227ea</td>
<td>3,220</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>HFC-236fa</td>
<td>9,810</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HFC-245fa</td>
<td>1,030</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>HFC-365mfc</td>
<td>794</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>HFC Blends</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(commonly used)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-407C</td>
<td>1,774</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>R-407F</td>
<td>1,825</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-410A</td>
<td>2,088</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-404A</td>
<td>3,922</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>R-507A</td>
<td>3,985</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HC</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Hydrocarbon)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propane R290</td>
<td>5</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Isobutane R-600a</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyclopentane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HCO</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Oxygenated hydrocarbon)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methyl formate</td>
<td>-</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Methylal</td>
<td>-</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>HFO</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Hydrofluoroolefin)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HFO-1234yf</td>
<td>&lt;1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>HFO-1233zd</td>
<td>&lt;1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HFO-1336mzzm</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Inorganic compounds</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO₂</td>
<td>1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>R-744</td>
<td>1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>R-717</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*GWP from Annex F of Kigali Amendment and AR5. HFC blends are not included, however once a component is listed, blend is controlled.
Distribution of ODS alternatives

By Region for (2015)

Latin American countries

- HFC pure: 49%
- HFC Blends: 34%
- HCs: 5%
- Inorganic compounds: 7%
- HFC/HCFC: 1%
- HFO - Unsaturated: 3%
- Others: 1%

Eastern European countries

- HFC pure: 31%
- HFC Blends: 29%
- HCs: 31%
- Inorganic compounds: 1%
- Others: 8%

African countries

- HFC pure: 70%
- HFC Blends: 17%
- HCs: 9%
- Others: 4%
- Inorganic compounds: <1%

Other alternatives reported
- PFCs: 1 country
- Methyl Chloride: 1 country
- Methyl-formate: 3 countries
HFC Production and Consumption

HFCs consumption for countries evaluated, period 2012 - 2015

TEAP (2015):
• Global production of HFCs (2015) 314,515 mt or 1220 Mt CO₂-eq
• HCFC baseline for production in Article 5 countries amounted to 501,266 mt
• Consumption for Art-5: 284,326 mt and 1,265 Megaton CO₂ equiv. in 2015
HFC estimated use by Region

Latin American Countries (2012 - 2015)

Consumption (mt)

Mexico
Uruguay
Nicaragua
Honduras
Guatemala
Ecuador
Chile
Bolivia
Argentina

I. OUTCOMES FROM SURVEYS
I. OUTCOMES FROM SURVEYS

HFC estimated use by Region

Eastern European Countries (2012 - 2015)

- Serbia
- Montenegro
- Macedonia
- Bosnia & Herzegovina
- Albania
HFC estimated use by Region


I. OUTCOMES FROM SURVEYS
HFC Reported by countries

- HFC-134a, R-404A, R-410A, R407C were reported by all countries
- HFC/HCFC blends reported by 4 countries

<table>
<thead>
<tr>
<th>HFC</th>
<th>% of total</th>
<th>Annual growth rate</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>HFC-134a</td>
<td>40</td>
<td>7</td>
<td>Domestic and commercial refrigeration and MAC; with small uses in other RAC applications, foam and MDIs</td>
</tr>
<tr>
<td>HFC-410A</td>
<td>26</td>
<td>23</td>
<td>Air-conditioning applications</td>
</tr>
<tr>
<td>R-404A</td>
<td>7</td>
<td>5</td>
<td>Low temperature refrigeration applications</td>
</tr>
<tr>
<td>R-507A</td>
<td>2</td>
<td>23</td>
<td>RAC sector</td>
</tr>
<tr>
<td>R-407C</td>
<td>1</td>
<td>11</td>
<td>Air-conditioning applications</td>
</tr>
<tr>
<td>HFC-152a</td>
<td>9</td>
<td>33</td>
<td>Industrial aerosol sector and extruded polystyrene foam</td>
</tr>
<tr>
<td>HFC-245fa</td>
<td>9</td>
<td>9</td>
<td>PU foam</td>
</tr>
<tr>
<td>Others</td>
<td>6</td>
<td>35</td>
<td>Small uses in all applications</td>
</tr>
</tbody>
</table>
I. OUTCOMES FROM SURVEYS

HFC Reported by countries for 2015

13 HFC pure

- HFC-125: 1%
- HFC-152a: 14%
- HFC-227ea: 1%
- HFC-245fa: 16%
- HFC-152a: 14%
- HFC-134: <1%
- HFC-143a: <1%
- HFC-236fa: <1%
- HFC-365mfc: <1%
- HFC-227ea/245fa: 4%

19 HFC Blends

- R-407A: 4%
- R-413A: 1%
- R-417A: 1%
- R-417B: 1%
- R-427A: <1%
- R-437A: 1%
- R-507: 4%
- R-404A: 15%
- R-410A: 71%
- R-407C: 19%

HFC Reported by countries for 2015

13 HFC pure

- HFC-134a: 67%
- HFC-32
- HFC-161
- HFC-227ea
- HFC-227ea/HFC-365mfc
- HFC-23
- HFC-143a
- HFC-236fa
- HFC-365mfc
- HFC-43-10mee
- HFC-134

19 HFC Blends

- R-404A
- R-410A
- R-422D
- R-407F
- R417A
- R417B
- R422
- R-424A
- R-427A
- R-437A
- R-508B
- R-407C
- R-407A
- R-417A
- R-417B
- R-427A
- R-436A
- R-438A
- R-427A
TEAP:
- R/AC sector: total demand **473.4 kilotonnes** (calculated for 2015) *(Article 5 Parties 272.9 kt)*

I. OUTCOMES FROM SURVEYS
I. OUTCOMES FROM SURVEYS

II. PROJECTIONS, SCENARIOS, EMISSIONS

III. UNIDO’s ANALYSIS AND BEST PRACTICES
Projections of future use (2016-2030)

II. PROJECTIONS, SCENARIOS & EMISSIONS

Figure 8: Detailed Comparison between top-down HFC consumption data (in metric tonnes) and the HFC consumption modelled in this study for R134a, R404a, R410A and R407C.
## Bank and Demand Estimation

### Assumptions and factors

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of vans on road in 2015</td>
<td>9.634</td>
</tr>
<tr>
<td>Charged with HFC-134a (in %) (cabin air-conditioning)</td>
<td>60%</td>
</tr>
<tr>
<td>Vans with refrigeration (in % from the vans with AC)</td>
<td>17%</td>
</tr>
<tr>
<td>Average charge per vehicle (in kg)</td>
<td>2</td>
</tr>
<tr>
<td>Charged with HFC-134a (in %) (refrigeration)</td>
<td>90%</td>
</tr>
<tr>
<td>Charged with R-404A (in %) (refrigeration)</td>
<td>10%</td>
</tr>
<tr>
<td>Leakage rate (in %) (refrigeration)</td>
<td>20%</td>
</tr>
<tr>
<td>Lifespan of vehicles (in years)</td>
<td>15-20</td>
</tr>
</tbody>
</table>

### Demand (consumption):
1. Supplied to existing bank
2. Added to the bank
3. Less recovered/reused

### Bank and services needs

<table>
<thead>
<tr>
<th>Year</th>
<th>HFC-134a</th>
<th>HFC-404A</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bank (mt)</td>
<td>Servicing needs (mt)</td>
<td>Bank (mt)</td>
</tr>
<tr>
<td>2015</td>
<td>1.77</td>
<td>0.35</td>
<td>0.20</td>
</tr>
<tr>
<td>2020</td>
<td>2.24</td>
<td>0.45</td>
<td>0.40</td>
</tr>
<tr>
<td>2025</td>
<td>2.70</td>
<td>0.54</td>
<td>0.60</td>
</tr>
<tr>
<td>2030</td>
<td>3.22</td>
<td>0.64</td>
<td>0.82</td>
</tr>
</tbody>
</table>
**BAU and mitigation Scenarios**

**TEAP:** Consumption of HFC in Art-5 will reach 1,021,216 mt in 2030 under a BAU (without Kigali amendment)

**Transition to low-GWP scenarios**

Conversion period is a key element in MIT scenarios estimation.

II. PROJECTIONS, SCENARIOS & EMISSIONS
Potential Emissions and Emissions

- Total climate impact related to refrigerants consists of direct and indirect contributions.

- Data obtained from survey was a relevant contribution for the calculation of F-gas emissions, National communication of climate change (UNFCCC).

- The banks allow to calculate emissions using agreed emission parameters (IPCC).

- Amount of emissions (dependent on leakage assumptions).

- Potential emissions reduction due the impact of mitigation scenarios.

*Impact of mitigation scenarios compared to BAU for a sector in Article 5 parties: it should show the incremental climate savings achieved for Mitigation scenarios proposed against the BAU baseline.*
I. OUTCOMES FROM SURVEYS

II. PROJECTIONS, SCENARIOS AND EMISSIONS

III. UNIDO´s ANALYSIS AND BEST PRACTICES
Issues in the Surveys

• **Top-down** was the preferred option to estimate use of ODS alternatives (problems related to availability and updating of data in official sources)

• **Tendency** of ODS alternatives consumption in some countries was not clearly established (limited points to forecasting – early period of estimation)

• **More Blends** are becoming increasingly available commercially, some without clear composition information.

• **Servicing sector** demand estimation one of the biggest challenges
Legal and Regulatory Issues

- **Customs records**: data access, pre-charged was not consistently reported.
- **Tariff codes**: same code for alternatives (pure substances, blends)

**Suggested Actions**

Improve and strengthen HFCs and ODS alternatives control:

- Harmonized tariff codes according to HFCs commitments
- Regulations related to the use of HFCs and other ODS alternatives
- License system including HFCs (Article 4B) and other alternatives
- Training for customs officers in import trade control

- **Specific standards** for flammable/toxic low-GWP alternatives are urgent
Findings, Gaps and requirements (II)

Main substances available, key sectors and barriers were identified

Linkage between HCFC and HFC:
• Direct transition towards natural refrigerants preferable in some countries (Flexible implementation).

Energy Efficiency Information
• Detailed information was not available in the majority of the countries.

Data Reporting
• Improvement of current country data reporting (CP) on ODS to report HFC consumption (Decision 76/7d)
Findings, Gaps and requirements (III)

Manufacturing sector
• Technical assistance, research, safe introduction of flammable/toxic alternatives: conversions

ODS Production sector
• HFC-23 (cost-effective options for destruction).

Service sector
• Refrigeration technicians lack awareness, proper knowledge or skills.
• Certification programme, training & servicing tool
• Increase rate of recovery and reuse of HFCs, in particular in end-sectors.

End-user
• Consumption information
• Technical assistance, safe introduction of flammable/toxic alternatives.
Opportunities and Challenges

Estimation and relevant information
• Methodologies available - need of their transfer to the NOUs

Availability of ODS alternatives in local market
• Adopting lower GWP options, which may not always be feasible in some markets or for some products.
• HFC phase-down: review of alternatives to HFCs (existing technologies and not-in-kind)
• Effective replacement in RAC sector, if significant EE improvement possible

Stockpile management and destruction facilities (HFC-23 by-product).
• Cost-effective solution for all substances
Experience 1. Cameroon: Survey Outputs
Experience 2. Chile: Tariff Codes for appliances and control of HFC
Experience 3. Bosnia & Herzegovina: Bank and demand estimation
Experience 4. México: Potential emission reductions for HFC by sector
Distribution for ODS alternatives consumption in Mexico during 2015.

28,600 metric tons

- **HFCs**: HFC-134a
- **HFC Blends**: HFC-245fa, R-410A
- **Natural refrigerants**: NH₃, CO₂, R-290, R-600a, C-Pen
- **HFOs**: HFO-1233zd & HFO 1234yf
Potential emission (consumption in metric tons of CO\textsubscript{2}e) trend of main HFCs to 2030.

- Growth rates for each substance.
- HPMP Implementation Impact
- Aerosol Sector
- Foam Sector
- AC Sector
Potential Mitigation Scenarios
Regional GAPs and Challenges have been identified. Should they be faced the same way?