RAC GHG Inventory
Methodological Approach
and HFC Emissions Reporting Tool
GIZ-Proklima side event
40th meeting of the Open Ended Working Group, Vienna 2018

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GIZ Proklima
RAC GHG Inventory
Methodological Approach and HFC Emissions Reporting Tool

Greenhouse gas emissions from the RAC Sector

Methodological approach to GHG inventories in the RAC sector

HFC Emissions Reporting Tool

Towards Sustainability: Institutionalizing Data Collection & Management
Greenhouse gas emissions from the RAC Sector

Direct emissions result from use of highly climate damaging refrigerants such as HFCs

Indirect emissions result from the energy consumption of the RAC appliances.

30%

70%

Production
Use
End-of-life
Greenhouse gas emissions from the RAC Sector

- Significant climate impact of the sector
- Emissions are released over lifetime; actual emissions are largely unknown
- National GHG reporting and NDCs (UNFCCC), Kigali Amendment

“You can’t manage what you can’t measure.”

HFCs are the fastest-growing non-CO2 greenhouse gas

RAC sector is responsible for about 40% of energy consumption in urban areas.

About 13-17 Gt CO2eq are found in ODS Banks.
Greenhouse gas emissions from the RAC Sector: THE GAP

1.5 Gt CO2eq
are emitted annually from global ODS banks

Equal to annual emissions from 441 coal power plants!

Neither the *Montreal Protocol* nor any other international environmental convention regulates the management and destruction of existing ODS banks.
RAC GHG Inventory: Methodological Approach

- Actual direct and indirect emissions
- Inventory established based on a disaggregated, subsector basis or **Tier 2 approach** acc. to IPCC 2006 Guidelines
RAC GHG Inventory: Methodological Approach

<table>
<thead>
<tr>
<th>Tier 2 (emission estimation at a disaggregated level)</th>
<th>Approach A (emission-factor approach)</th>
<th>Approach B (mass-balance approach)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Data on chemical sales and usage pattern by sub-application [country-specific or globally/regionally derived]</td>
<td>Data on chemical sales by sub-application [country-specific or globally/regionally derived]</td>
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<td>Emission factors by sub-application [country-specific or default]</td>
<td>Data on historic and current equipment sales adjusted for import/export by sub-application [country-specific or globally/regionally derived]</td>
</tr>
<tr>
<td>Tier 1 (emission estimation at an aggregated level)</td>
<td>Data on chemical sales by application [country-specific or globally/regionally derived]</td>
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<td>Emission factors by application [country-specific or (composite) default]</td>
<td>Data on historic and current equipment sales adjusted for import/export by application [country-specific or globally/regionally derived]</td>
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<tr>
<td>Sector</td>
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<td>Appliance systems</td>
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<td>Air conditioning/</td>
<td>Chillers</td>
<td>Air conditioning chillers</td>
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<td>Refrigeration</td>
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<td>Process chillers</td>
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<td>Air conditioning</td>
<td>Mobile AC</td>
<td>Car air conditioning</td>
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<td>Large vehicle air conditioning</td>
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<td>Domestic refrigeration</td>
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<td>Refrigeration</td>
<td>Commercial Refrigeration</td>
<td>Stand-alone equipment</td>
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<td>Condensing units</td>
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<td>Centralised systems for supermarkets</td>
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<td>Stand-alone equipment</td>
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<td>Condensing units</td>
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<td>Centralised systems</td>
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<td>Refrigeration</td>
<td>Transport Refrigeration</td>
<td>Refrigerated trucks/trailers</td>
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</tbody>
</table>

(UNEP RTOC, 2010, modified)
The equation is applied for each sub-application and per refrigerant in the inventory year, and all are summed to get the total emissions results.
RAC GHG Inventory: Methodological Approach

- Actual direct and indirect emissions
- Inventory established based on a disaggregated, subsector basis or Tier 2 approach acc. to IPCC 2006 Guidelines
- Appliance market data generates sound database with country-specific information (e.g. dominant capacity classes) and parameters (e.g. refrigerant charge)
The Tier 2 approach for the appliance market

Sometimes alternative data is considered, e.g. the number of supermarkets to estimate the number of centralised systems.
### RAC GHG Inventory: Methodological Approach

**Product data collected**

<table>
<thead>
<tr>
<th>Direct emissions / refrigerant use</th>
<th>Indirect emissions / energy consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial refrigerant charge &amp; refrigerant distribution</td>
<td>Ave. cooling capacity (kW)</td>
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<td>Emission factors</td>
<td>Ave. coefficient of performance (COP)</td>
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<td>- manufacturing (%)</td>
<td>Ave. annual runtime hours</td>
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<td>- in-use / operating (%)</td>
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<td>- Disposal (%)</td>
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</table>

- Estimated product lifetime
- Sector growth rates
- Grid emission factor
Where to get relevant data?

- End-user surveys from supermarket chains/warehouses
- RAC&F manufacturers and importers
- Ministry of:
  - Industry
  - Economics
  - Trade
  - Transport
- Literature, reports (e.g. BSRIA, JARN)
- RAC&F associations
- F-gas traders and distributors
- OEM
- NOU
- Institutes & statistical bureaus
- Customs department
- Service sector
- HPMP
Where to get relevant data?

- Secondary statistical data are a valuable source for building an inventory (if available), however the technical characterisation of the equipment is missing.

- Technical details and additional market data can be derived by spreading questionnaires, however ....

<table>
<thead>
<tr>
<th>Manufacturer 1</th>
<th>Manufacturer 2</th>
<th>Manufacturer 3</th>
<th>Manufacturer 4</th>
<th>Manufacturer 5</th>
<th>Manufacturer 6</th>
<th>Manufacturer 7</th>
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</thead>
<tbody>
<tr>
<td>No response</td>
<td>No response</td>
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</tbody>
</table>

Manufacturer 1
Manufacturer 2
Manufacturer 3
Manufacturer 4
Manufacturer 5
Manufacturer 6
Manufacturer 7
RAC GHG Inventory: Methodological Approach

- Actual direct and indirect emissions
- Inventory established based on a disaggregated, subsector basis or **Tier 2 approach** acc. to IPCC 2006 Guidelines
- Appliance market data generates sound database with country-specific information (e.g. dominant capacity classes) and parameters (e.g. refrigerant charge)
- Data collection can be intensive and requires personnel or consultants on the ground
- Data processing and report preparation
Increasing number of RAC GHG Inventories

Further completed inventories: Namibia, Mauritius, Kenia and Iran
Further Development:
HFC Emissions Reporting Tool

<table>
<thead>
<tr>
<th>National Reports from Non-Annex I Parties to the UNFCCC</th>
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<tbody>
<tr>
<td><strong>National Communications (NC)</strong></td>
</tr>
<tr>
<td>- include relevant information on national circumstances, GHG inventories, a vulnerability and adaptation assessment, mitigation assessment, financial resources and transfer of technology, and education, training and public awareness</td>
</tr>
<tr>
<td>- First submission within 3 years of entering the convention; thereafter <strong>every 4 years</strong></td>
</tr>
<tr>
<td><strong>Biennial Update Reports (BUR)</strong></td>
</tr>
<tr>
<td>- update on their national GHG inventories, information on mitigation actions taken and their effects, and an outline of their needs and support received.</td>
</tr>
<tr>
<td>- 1st submission in December 2014; thereafter every 2 years</td>
</tr>
</tbody>
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1st submission in December 2014; thereafter every 2 years.

Further Development: HFC Emissions Reporting Tool

Tier 2 HFC Inventory Data

- IPCC 2006 Guidelines
- Using common reporting format (CRF)
- IPPU Sector: 2F (Products used as Substitutes for Ozone Depleting Substances)

About 13-17 Gt CO2eq are found in ODS Banks.
Further Development: HFC Emissions Reporting Tool

Instruction Guidelines for using the GIZ Proklima "HFC Inventory Tool" (IPCC Tier 2a approach) for the National Communications under the UNFCCC

The "HFC Inventory Tool" calculates HFC emissions under the "Vol. 3: Industrial Processes and Product Use" sector, Chapter 7 "Emissions of Fluorinated Substitutes for Ozone Depleting Substances". It follows the Tier 2a approach from the IPCC Guidelines for National Greenhouse Gas Inventories (1997, 2006), including manufacturing, operating and disposal emissions. For more "NAMAs in the refrigeration, air conditioning and foam sectors. A technical handbook.

Module 1 - Annex 1" (GIZ 2013)
For the coarser emission approach, the Tier 1, please see the Excel tool from the IPCC, Annex 1.

INPUT DATA

Please insert your country specific data in the purple shaded sheets "Sales figures RAC", "Stock figures RAC", "Input BAU Parameters", "ImpExp" and "Ref Distr".

Sales figures: Please enter the number of sold RAC appliances. A complete time series starting from the year 2000 is required. The time series must be complete. 
Stock figures: Please enter all data if available, otherwise the stock is automatically calculated from the sales figures and appliance lifetime.
Input BAU Parameters: This sheet delivers default values for parameters that are required to calculate HFC emissions. The default values were derived within the project "NAMAs in the refrigeration, air conditioning and foam sectors", GIZ 2014. However, country specific data is available these should be inserted in the purple shaded cells.
HFC Emissions Reporting Tool

### TABLE 2(II).B-H SECTORAL BACKGROUND DATA FOR INDUSTRIAL PROCESSES AND PRODUCT USE

**Sources of fluorinated substances**

*Sheet 2 of 2*

<table>
<thead>
<tr>
<th>GREENHOUSE GAS SOURCE AND SINK CATEGORIES</th>
<th>Gas (please specify)</th>
<th>ACTIVITY DATA</th>
<th>IMPLIED EMISSION FACTORS&lt;sup&gt;(t)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>One row per substance</strong></td>
<td><strong>Amount</strong></td>
<td><strong>Product manufacturing factor</strong></td>
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<td></td>
<td>Filled into new manufactured products</td>
<td>In operating systems (average annual stocks)</td>
<td>Remaining in products at decommissioning</td>
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<td>(t)</td>
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<td>%</td>
</tr>
</tbody>
</table>

#### F. Product uses as substitutes for ODS

1. Refrigeration and airconditioning
   - 3a, 152a, 227ea, 236fa

   **Commercial refrigeration**
   - HFC-23
   - HFC-32
   - HFC-125
   - HFC-134a
   - HFC-143a
   - HFC-152a
   - C2F6
   - C3F8

   **Domestic refrigeration**
   - HFC-134a

   **Industrial refrigeration**
   - HFC-32
   - HFC-23
   - HFC-143a
   - HFC-125

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**Note:**

- CRF 2016
- CRF 2017

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**Read me**

- Sales figures RAC
- Stock figures RAC
- Input BAU Parameters
- ImpExp
- Ref Distr
HFC Emissions Reporting Tool

### TABLE 2(II).B-H SECTORAL BACKGROUND DATA FOR INDUE

**Sources of fluorinated substances**

(Sheet 2 of 2)

<table>
<thead>
<tr>
<th>GREENHOUSE GAS SOURCE AND SINK CATEGORIES</th>
<th>Gas (please specify)</th>
<th>IMPLIED EMISSION FACTORS</th>
<th>EMISSIONS</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>One row per substance</td>
<td>Product manufacturing factor</td>
<td>Product life factor</td>
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<tr>
<td></td>
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<td>%</td>
<td>(t)</td>
</tr>
</tbody>
</table>

#### F. Product uses as substitutes for ODS

1. Refrigeration and airconditioning
   - 3a, 152a, 227ea, 236fa
     - **Commercial refrigeration**
     - HFC-23
       - HFC-23
       - 0.04
       - 0.24
       - 0.93
       - 0.00
       - 0.00
       - 0.00
       - NA
     - HFC-32
       - HFC-32
       - 0.04
       - 0.24
       - 0.93
       - 0.00
       - 0.00
       - 0.00
       - NA
     - HFC-125
       - HFC-125
       - 0.04
       - 0.24
       - 0.93
       - 0.00
       - 34.81
       - 6.73
       - NA
     - HFC-134a
       - HFC-134a
       - 0.04
       - 0.24
       - 0.93
       - 0.00
       - 63.59
       - 10.07
       - NA
     - HFC-143a
       - HFC-143a
       - 0.04
       - 0.24
       - 0.93
       - 0.00
       - 41.14
       - 10.33
       - NA
     - HFC-152a
       - HFC-152a
       - 0.04
       - 0.24
       - 0.93
       - 0.00
       - 0.00
       - 0.00
       - NA
     - C2F6
       - C2F6
       - 0.04
       - 0.24
       - 0.93
       - 0.00
       - 0.00
       - 0.00
       - NA
     - C3F8
       - C3F8
       - 0.04
       - 0.24
       - 0.93
       - 0.00
       - 0.00
       - 0.00
       - NA
   - **Domestic refrigeration**
     - HFC-134a
       - HFC-134a
       - 0.01
       - 0.02
       - 0.80
       - 0.00
       - 28.96
       - 81.68
       - NA
   - **Industrial refrigeration**
     - HFC-32
       - HFC-32
       - 0.04
       - 0.22
       - 0.93
       - 0.00
       - 0.00
       - 0.00
       - NA
     - HFC-23
       - HFC-23
       - 0.04
       - 0.22
       - 0.93
       - 0.00
       - 0.00
       - 0.00
       - NA
     - HFC-143a
       - HFC-143a
       - 0.04
       - 0.22
       - 0.93
       - 0.00
       - 0.63
       - 0.11
       - NA
     - HFC-125
       - HFC-125
       - 0.04
       - 0.22
       - 0.93
       - 0.00
       - 0.53
       - 0.08
       - NA

[Read me | Sales figures RAC | Stock figures RAC | CRF 2016 | CRF 2017 | CRF 2018 | CRF 2019 | CRF 2020 | CRF 2021 | ... | + | - | Page 26]
### HFC Emissions Reporting Tool

#### Direct and Indirect Emissions and Their Sum

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<td>2</td>
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<td>Split residential air conditioners</td>
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<td>278</td>
<td>581</td>
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<td>1,538</td>
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<td>Split commercial air conditioners</td>
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<td>Duct split residential air conditioners</td>
<td>136</td>
<td>432</td>
<td>892</td>
<td>1,521</td>
<td>2,327</td>
<td>3,231</td>
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<td>Multi-splits</td>
<td>430</td>
<td>1,067</td>
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<td>2,742</td>
<td>3,818</td>
<td>4,745</td>
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<td>Chillers</td>
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<td>Car air conditioning</td>
<td>3,863</td>
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<td>Refrigerated trucks/trailers</td>
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<td>Direct emissions (t CO2eq)</td>
<td>298,293</td>
<td>350,072</td>
<td>38,360</td>
<td>39,255</td>
<td>39,976</td>
<td>40,541</td>
<td>40,967</td>
<td>41,270</td>
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### Direct and Indirect Emissions and Their Sum

- Direct emissions (t CO2eq)
- Indirect emissions (t CO2eq)

### Emissions Reporting Tool Features

- ImpExp
- Ref Distr
- CRF 2016
- CRF 2017
- CRF 2018
- CRF 2019
- CRF 2020
- Input EC Parameters
- Energy Cons
- Emissions
- User
Towards Sustainability: Institutionalizing Data Collection & Management

Challenges
- Inventory process can be cumbersome
- Statistics data often do not contain the technical parameters needed
- Multiple data collection processes that tend to overlap
- Diverse stakeholders in the sector

Opportunities
- Support in policy design, implementation, and evaluation
- Support development and implementation plans for mitigation in the sector
- Instrument for aligning relevant national plans
- Forms a basis for a Measuring, Reporting and Verification (MRV) system
Paris Agreement, Kigali Amendment

GOAL

Opportunities

Challenges

Barriers
Guidelines on GHG inventories and policy planning
Thank you for your attention!

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or visit: www.giz.de/proklima