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Energy efficiency in servicing
Impacts of HPMP training and future potential

Thursday, 4th July 2019
Open-Ended Working Group 41, Bangkok
Agenda

1) Welcome Remarks

2) Overview of Proklima’s activities in the servicing sector

3) Proklima’s HPMP training concepts – impacts and future potential

4) Experiences from India - energy efficient practices in servicing and use

5) Discussion & Conclusion

Ulrike Haupt
Federal Ministry for Economic Cooperation and Development

Bernhard Siegele
Programme Manager GIZ Proklima

Juergen Usinger
Heat GmbH

Ankur Khandelwal
Technical Advisor (India)

All
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Type in your questions here!
Type in your questions here!

Questions of all participants appear here
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   Ulrike Haupt
   Federal Ministry for Economic Cooperation and Development (BMZ)

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Energy efficiency in Servicing
past impacts of HPMP training and
future potential

Juergen Usinger,
Rolf Huehren
OEWG Bangkok, July 2019
Table of Content

- General Assumptions on the impact of servicing sectors activities on energy efficiency

- Objectives of GIZ Capacity Building Activities under the MP

- Specific Impact in the past and in the future
General Assumptions on the impact of servicing sectors activities on energy efficiency
Main Factors influencing Energy efficiency of Refrigeration, Air Conditioning and Heat Pump (RACHP) Applications

- Energy Efficiency of Appliances and installed Plants

- Operation and Maintenance

- Heat Loads and Envelope
## Selected direct and indirect impacts of operational energy efficiency of A/C equipment

### Installation
- Controls could be modified
- Control Sensors better placed
- Units badly positioned/wrong application
- Non sequencing of multiple units
- Air leakage on ductwork
- Return air filter missing
- Restrictions in refrigerant transfer lines
- Poor insulation of refrigerant lines

### Building envelope
- Solar gain reduction (shading, blinds etc) to be considered
- No insulation in roof/wall voids
- Building envelope leaking
- Modify vegetation

### Operational
- Not using time schedules
- Windows open with air conditioning operating
- No manufacturer’s user instructions on site
- System operating when not required
- No maintenance contract
- No Filter cleaning regime

### Maintenance Servicing
- Dirty Filters
- Set point too low (\(\leq 22^\circ C\))
- Leaked or overcharged refrigerant
- Equipment needs replacing, worn compressor
- Grilles blanked off
- Not maintaining correct condensing temper.
- Condenser corrosion or fouling
- Evaporator filter fouling
- Lack of air flow through wrong fan rotation etc.

### Planning
- System oversized (30%>) > cooling load calculation
- Correct location of ODU & IDU
- Consider smaller system
- Free cooling could be considered
- Consider reducing room size area
Important facts when assessing the energy efficiency of RACHP appliances and installations
Minimum Energy Performance Standard (SEER) for split AC measures efficiency are set under national circumstances

Divers MEPs illustrate that the international availability of technology is not an issue – it is the national framework and energy pricing policies that drive demand for energy efficient equipment.

Comparing Minimum Energy Performance Standards SEER for split AC
Comparative MEPS Requirements by Economy under Each National Test Procedure, for Variable-Speed, Non-Ducted, Mini-Split AC Units for China, the EU, Japan, Korea and the US

<table>
<thead>
<tr>
<th></th>
<th>US</th>
<th>EU</th>
<th>China</th>
<th>Korea</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;19kW &lt;12kW, GWP&lt;150</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To US Norm</td>
<td>3.8</td>
<td>2.76</td>
<td>3.09</td>
<td>3.59</td>
<td>4.01</td>
</tr>
<tr>
<td>To Japan CSPF Norm</td>
<td>4.38</td>
<td>3.25</td>
<td>3.6</td>
<td>4.12</td>
<td>4.57</td>
</tr>
<tr>
<td>To China Norm</td>
<td>3.53</td>
<td>2.52</td>
<td>2.85</td>
<td>3.34</td>
<td>3.76</td>
</tr>
<tr>
<td>To Korea Norm</td>
<td>4.41</td>
<td>3.31</td>
<td>3.65</td>
<td>4.16</td>
<td>4.59</td>
</tr>
<tr>
<td>To EU Norm</td>
<td>4.39</td>
<td>3.24</td>
<td>3.6</td>
<td>4.14</td>
<td>4.6</td>
</tr>
<tr>
<td>To Japan APF Norm</td>
<td>4.02</td>
<td>3.13</td>
<td>3.41</td>
<td>3.84</td>
<td>4.2</td>
</tr>
</tbody>
</table>
Declared vs. measured Efficiency Values of RACHP equipment

Air Conditioner Efficiency Rating
Recent tests of A/C in the EU illustrate the necessity for independency when it comes to test procedures as the technical foundation for MEPS and labels. The installation process and the performance test measurements need to be conducted independently from any additional (product-specific) data or requirements on the technical configuration of manufacturers.

<table>
<thead>
<tr>
<th></th>
<th>AC#1</th>
<th>AC#2</th>
<th>AC#3</th>
<th>AC#4</th>
<th>AC#5</th>
<th>AC#6</th>
<th>AC#7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declared</td>
<td>6.5</td>
<td>7.5</td>
<td>7.3</td>
<td>6.6</td>
<td>6.5</td>
<td>6.1</td>
<td>6.1</td>
</tr>
<tr>
<td>Tested</td>
<td>5.2</td>
<td>6.2</td>
<td>5.8</td>
<td>6.5</td>
<td>5.5</td>
<td>4.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Tested vs. Declared</td>
<td>80%</td>
<td>83%</td>
<td>79%</td>
<td>98%</td>
<td>85%</td>
<td>70%</td>
<td>61%</td>
</tr>
</tbody>
</table>

3 out of 7 below allowable MEPs, only one measured were matching declared value.

3) Regulation (EU) No 206/2012 (European Commission, 2012), split-type ACs with rated capacity < 6 kW, using a refrigerant with global warming potential (GWP) > 150 shall have a minimum seasonal energy efficiency ratio (SEER) of 4.6.

1) Palkowski et al., 2018, Seasonal cooling performance of air conditioners
Independent testing of RACHP appliances and installations under national circumstances is indispensable. Criteria for a well designed test method are:

(i) Repeatability,
(ii) Reproducibility,
(iii) Representativeness,
(iv) Affordability and
(v) Independency!!

Energy consumption values for the same models found in the manufacturer’s catalogue and tested according to EN 441-1995.

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Prevaling SEER levels in A5 sales settle around an SEER of 4

*TEAP, 2018, The Brazil figure (left, BRL = Brazilian Reals) is sourced from the data from Letschert et al., China (right, RMB = Chinese Yuan) data is from Park, Shah and Gerke, 2017 and the IDEA database (LBNL).*
Operation and Maintenance
- Causes for loss of efficiency

**Example from the EU - Energy Performance of Building Directive**

Findings on Energy Conservation Opportunities (ECO)*

**Plant**

involving more or less radical intervention on the AC system (to be carefully assessed in technical and economical terms);

**Operation & Maintenance**

the costs of such ECOs are generally limited if not negligible: application is therefore normally recommended, provided their technical feasibility is assessed.

**Envelope and Loads**

aimed at reducing the building cooling load;

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*Study in Energy Consumption in European Air Conditioning Systems and Energy Conservation Options* identified 52% of ECOs with Operation and Maintenance

---

*Knight et al, 2011, Energy Consumption in European Air Conditioning Systems and the Air Conditioning System Inspection Process*
Main Energy conservation opportunities (ECO) in existing HVAC equipment in the EU*

Energy use measured in kwh/m2

<table>
<thead>
<tr>
<th>ECO</th>
<th>Occurrence [%]</th>
<th>Average Primary Energy Savings potential [kWh/m2]</th>
<th>Average Expected Primary Energy Savings [kWh/m2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings</td>
<td>8%</td>
<td>292,80</td>
<td>19,80</td>
</tr>
<tr>
<td>Equipment</td>
<td>9%</td>
<td>301,00</td>
<td>29,23</td>
</tr>
<tr>
<td>O &amp; M</td>
<td>13%</td>
<td>196,20</td>
<td>37,90</td>
</tr>
</tbody>
</table>

Increasing Role for Servicing Companies and Technicians in advising on issues of Operation and Envelope during Acquisition, Installation and Envelope?

*Knight et al, 2011, Energy Consumption in European Air Conditioning Systems and the Air Conditioning System Inspection Process
Most important measures for Maintenance

Maintain correct charge of refrigerant – with a measured average 29.4 % energy saving potential

Clean heat transfer surfaces and filters or replace them – with a measured average 24.9% energy saving potential,

Maintain proper system control set points – with a calculated average energy saving potential of 8.44%

Most important measures for Operation

Shut off A/C equipment when not needed – with an estimated average 30% energy saving potential

Train building (HVAC) operators in energy – efficient O&M activities

Contracting annual service and maintenance to competent person
## Share of proper Maintenance for realising maximum efficiency in A/C and consideration of Capacity Buidling activities

<table>
<thead>
<tr>
<th>Energy Conservation Opportunity</th>
<th>Average Energy Saving ((\eta)) found*</th>
<th>Notes</th>
<th>Coverage in past capacity building</th>
<th>Requirement for safe operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain proper evaporating and condensing temperatures</td>
<td>4%</td>
<td>MEASURED (condenser fan control)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean finned tube evaporator / condenser air side and straighten damaged fins</td>
<td>8%</td>
<td>MEASURED (condensers only)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintain proper system control set points</td>
<td>8%</td>
<td>CALCULATED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintain proper heat source/sink flow rates.</td>
<td>9%</td>
<td>ESTIMATED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce air flow rate to actual needs</td>
<td>10%</td>
<td>MEASURED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean or replace filters regularly</td>
<td>25%</td>
<td>MEASURED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintain full charge of refrigerant</td>
<td>29%</td>
<td>MEASURED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (not listed)</td>
<td>6%</td>
<td>ESTIMATED</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Capacity Building under the HPMPs covered already 66% of energy saving potentials. 34% were only partly covered, because of the different focus.

*Knight et al, 2011, Energy Consumption in European Air Conditioning Systems and the Air Conditioning System Inspection Process*
Relationship between annual running costs for energy and refrigerant undercharge/leakage for small air-conditioning and commercial systems.

In addition overcharging may reduce efficiency by up to 20%.

©Institute of Refrigeration Annual Conference 2013
Reported A5 leak rates per subsector:
On average between 22% to 44% /annum
(EXCOM document 7242)

<table>
<thead>
<tr>
<th>Subsector</th>
<th>Estimated annual emission rates in HPMPs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average (%)</td>
</tr>
<tr>
<td>Residential air-conditioning</td>
<td>29</td>
</tr>
<tr>
<td>Commercial air-conditioning</td>
<td>40</td>
</tr>
<tr>
<td>Industrial air-conditioning</td>
<td>40</td>
</tr>
<tr>
<td>Transport</td>
<td>23</td>
</tr>
<tr>
<td>Chillers</td>
<td>22</td>
</tr>
<tr>
<td>Commercial refrigeration</td>
<td>38</td>
</tr>
<tr>
<td>Industrial refrigeration</td>
<td>44</td>
</tr>
</tbody>
</table>

Source: A sample of 38 approved HPMPs in which this data is available. The data corresponds to estimations made by each country and the methods may differ between countries.
### Effect of poor maintenance on compressor power consumption

<table>
<thead>
<tr>
<th>Condition</th>
<th>Te (°C)</th>
<th>Tc (°C)</th>
<th>Refrigeration Capacity* (TR)</th>
<th>Specific Power Consumption (kW/TR)</th>
<th>Increase kW/TR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>7.2</td>
<td>40.5</td>
<td>17.0</td>
<td>0.69</td>
<td>-</td>
</tr>
<tr>
<td>Dirty condenser</td>
<td>7.2</td>
<td>46.1</td>
<td>15.6</td>
<td>0.84</td>
<td>20.4</td>
</tr>
<tr>
<td>Dirty evaporator</td>
<td>1.7</td>
<td>40.5</td>
<td>13.8</td>
<td>0.82</td>
<td>18.3</td>
</tr>
<tr>
<td>Dirty condenser and evaporator</td>
<td>1.7</td>
<td>46.1</td>
<td>12.7</td>
<td>0.96</td>
<td>38.7</td>
</tr>
</tbody>
</table>

@ UNEP 2006
Estimates of best practice for energy efficiency (Commercial equipment)

<table>
<thead>
<tr>
<th>Improvement</th>
<th>Type of improvement</th>
<th>Likely efficiency improvement</th>
<th>Cost level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check for correct level of refrigerant and oil</td>
<td>Maintenance</td>
<td>5 – 50%</td>
<td>Very low (£0 – £250)</td>
</tr>
<tr>
<td>Ensure correct thermal expansion valve (TEV) settings</td>
<td>Maintenance/ setpoint adjustment</td>
<td>10%</td>
<td>Very low (£0 – £250)</td>
</tr>
<tr>
<td>Reduce recirculation of air into condenser</td>
<td>Maintenance</td>
<td>25%</td>
<td>Low (£250 – £500)</td>
</tr>
<tr>
<td>Optimise condenser pressure control</td>
<td>Maintenance/ setpoint adjustment</td>
<td>10%</td>
<td>Low (£250 – £500)</td>
</tr>
</tbody>
</table>

Significant decrease in energy cost and carbon footprint by up to 50% can be achieved by increased quality of commissioning and service. Benefits such as decreased repair cost and minimized failures are also key drivers to implement improved maintenance for improved performance and functionality.
Implications of Service and Maintenance

- RACHP Systems can loose more than 50% of efficiency
  - Larger losses due to poor maintenance
  - Important to ensure equipment is maintained over lifetime

![Graph showing implications of service and maintenance](image-url)
Consultancy services provided by HEAT GmbH
Consultancy services provided by HEAT GmbH
Operation and Maintenance - Impact on Energy Efficiency

Assumption on annual loss of efficiency rating without maintenance accumulated for 3 and 5 years

<table>
<thead>
<tr>
<th>Air Conditioning*</th>
<th>Loss of rated efficiency per Annum</th>
<th>3 years</th>
<th>5 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVAC</td>
<td>5% -7% (4%-10%)</td>
<td>21%</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td>SEER</td>
<td>SEER</td>
<td>SEER</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>3,2</td>
<td>2,1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Refrigeration**</th>
<th>Loss of rated efficiency per Annum</th>
<th>3 years</th>
<th>5 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial</td>
<td>15%</td>
<td>45%</td>
<td>75%</td>
</tr>
<tr>
<td>Industrial</td>
<td>10%</td>
<td>30%</td>
<td>50%</td>
</tr>
</tbody>
</table>

* various expert opinions, own calculations from TEAP, UNEP, Excom reporting
** VDMA, 2018
Annual decrease of A/C energy efficiency without proper maintenance
Scenario based average loss of approx. 4 to 7% annually
Simple Exercise: Impact of Energy efficient maintenance on A/C in Asean countries

Backgrounds

Total A/C unit Population: 74 Mio.

AVERAGE SEER rating in 2020: 4

Average grid factor ASEAN: 0.984

Average increase for low maintained A/C: 140gCO2/KWh cooling

Average kW/unit: 3 kW

Average capacity/unit: 3kW
Specific average indirect emissions in gCO2/kW refrigeration with (grey) or without (red) proper maintenance for various SEERs

- a well maintained unit with SEER 3.8 could be more efficient than a badly maintained unit with SEER 5.

BREAK EVEN between a Cost for Good efficiency & Maintenance vs. a Cost for Best efficiency & low servicing as usual.
Objectives of GIZ Capacity building activities for RACHP Service Technicians

- **Self assessment** of competences (time constraints)

- Training of **competences** (skills and knowledge)
  (only partly achieved - depending on individual prior learning)

- Support national ownership of a **quality infrastructure**
  (institutionalize formalized training, certification, inspection and verification)
Context related Qualification in India

- Established need
- Project aim & Assessment
- Assessment Gaps Analysis
- Benchmark Achieved
- Capacity Building
- Rating Level of proficiency CoP (skills, education, tools)
- Competence Upgrade
- Certification
- Registration

% of proficiency level

Time axis
EN 13313
Energy efficiency practices entailed in generic fields of competences

According to EN 13313:2010 the generic fields of competences to be considered for RACHP assessment are listed as follows:

1. Basic thermo dynamics
2. Components & tests of refrigeration systems
3. Piping, joints and valves
4. Safety equipment
5. Fluids
6. Communication

All persons who demonstrate their practical (skills) and theoretical (knowledge) competence by being successfully assessed by an approved Certifying Body should receive a certificate of competence.

Here under the following work tasks are formulated:

1. Design
2. Pre-assembling
3. Installation
4. Putting into operation
5. Commissioning
6. Operating
7. In-service Inspection
8. Leakage checking
9. General Maintenance
10. Refrigerant circuit Maintenance
11. Decommissioning
12. Removing Refrigerant
13. Dismantling
14. Disposal
| Area                              | Topic                                                                 | Example                                                                 | Impact | Training Materials | Training Status | Remarks                   |
|----------------------------------|                                                                      |                                                                        |        |                   |                 |                           |
| RACHP system servicing           |                                                                       |                                                                         |        |                   |                 |                            |
| Inspections                      | Determination and evaluation of as-is state                          |                                                                         |        |                   |                 |                            |
| Maintenance                      | Conservation of target state                                         | Leak control, correct charging, wear and tear, heat exchanger fins, pollution, change of filter driers, non-condensable gases etc. |        |                   |                 |                            |
| Repair                           | Reconstitution of target state                                       | General damages, Leak repair, electrics/electronics/controls            |        |                   |                 |                            |
| Improvement                      | Adaption on state-of-the-art technologies                            | Expansion valves etc.                                                  |        |                   |                 |                            |
| Instrumentation Control          | Electronics                                                           |                                                                         |        |                   |                 |                            |
| Automation (ICA)                 | Optimal operation point                                               | Avoidance of false adjusted set-points                                 |        |                   |                 | Split AC according to OEM |
|                                  | Correct placement of sensors                                         | Simple or outdated control concept                                      |        |                   |                 |                            |
| Instrumentation Control          | Transparency, building automatisation, technical building management  | Optimisation of part-load conditions Switch off outside utilisation time |        |                   |                 |                            |

Consultancy services provided by HEAT GmbH
<table>
<thead>
<tr>
<th>Area</th>
<th>Topic</th>
<th>Example</th>
<th>Impact</th>
<th>Training Materials</th>
<th>Training Status</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>General RACHP system design layout and execution</td>
<td>Specification of purpose and state-of-the-art design</td>
<td>Standards</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooling load (heat load) calculation (CLC)</td>
<td></td>
<td></td>
<td></td>
<td>CLC not sufficiently (or not at all) trained</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Energy storage solutions</td>
<td>Latent heat storage, bridging peak loads</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Appropriate room / product temperature</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Charge and placement of goods</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Maintain low ΔT between the warm and the cold side of a system</td>
<td></td>
<td></td>
<td></td>
<td>Strict adherence to the cold chain (temperature and humidity of the goods to be loaded)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Determination of refrigerant circuit parameters</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Pressure drop Δp of components</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Optimal air-circulation within machinery room</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Provision of clean and free of contamination / refrigerant circuit</td>
<td>Brazing, evacuation, flushing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Optimal refrigerant charge and oil amount</td>
<td>Not optimal charged system, overcharged system, leaking system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Building, cold-room, occupied space envelop</td>
<td>Insulation, sun-shade, open doors, untight doors (cold-rooms), illumination,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressor &amp; Condensing unit</td>
<td>Accurate dimensioning (sizing) and selection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Selection according to best practices, catalogues &amp; software</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preferably small Δt, Δp at compressor</td>
<td></td>
<td></td>
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Consultancy services provided by HEAT GmbH
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<td>Correct adjustment of superheat controller</td>
<td>Use of alternative defrosting methods like hot gas, cold gas</td>
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<td>Covered frost</td>
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<td>Refrigerant transfer piping</td>
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<td>Individual</td>
<td>Split A/C</td>
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<td>Cooling load (heat load) calculation (CLC)</td>
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<td>Correct placement of sensors</td>
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<td>Transparency, building automisation, technical building management</td>
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<td>Total additional time new activities</td>
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<td>Estimated Amendment of existing activities</td>
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<td>Total Workshop (s) Timing EE + Best Practice</td>
<td>27</td>
<td>12</td>
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Challenges for Capacity Building including extended EE measures

1. Originally generic capacity building required 3 to 6 days (15 to 24 building blocs), depending on the topics (Safety, HC, CO2, A/C, R&A/C, R, dom, com, ind) seasonal availability of Technicians.

2. Including additional EE aspects could require to extend activities by 1 to 3 days w/ 4 building blocs /day depending on the sector and specific aim representing roughly an increase by 30 to 50% of present activities.

3. This is already including intensification of some CP subjects that are already included in existing best practice exercises.
Conclusions

Past Activities

- Absence of maintenance makes investments in higher efficient equipment obsolete in comparison to well maintained less efficient equipment that is well understood by technicians and maintained regularly.

- Capacity Buidling on best practice potentially contributed significantly to increase or maintain efficiency in partners countries.

- In cases were skills and messages were applied, up to 35% of unnecessary emissions could have been avoided already, impact needs more specific research.

- Given the high leakage rates in A5, leak reduction appeared and maintains the most effective measure to ensure EE as well as safety and full benefit of cooling capacity. Monitoring needed.
Future Activities

- Potential energy reductions could be further enhanced specifically with view on design, planning and control option
- Framework for increased formalisation of maintenance could help to maximize benefits of energy reductions
- Servcing contracts for regular annual maintenance (PPT)
- Formalised traing and certifcation of trainees, companies and tested equipment
- Investigate into extended role of service companies and technicians to integrate elements of owner/consumer/operator eduction/advise on improving the operation and envelope

PPT = Planned Preventive Maintenance
Discussion

- Mitigation Potential of Best Practice Maintenance is not extensively exploited. Additional saving potentials may be as high as 20% per annum, accumulating over the years, e.g. in the Commercial sector.

- Depending on local practice and running hours, building a quality infrastructure and requiring mandatory annual inspections & maintenance are indispensable for achieving high efficiency of equipment where energy costs is low.

- Mandatory inspections and maintenance help to implement widely acceptable MEPSs, providing better economic benefits, lower costs for imports, material consumption, creating local employment, overall balance is positive providing a higher return than isolated investments in BAT with excessive costs (e.g. moving from SEER 6,x to 8,x).

- Servicing contracts help managing seasonal peaks, including building owners and operators in advisory, awareness and educational services may further multiply saving benefits.

- Need for upgrading of „technical training“ under MLF Activities is limited, many practices relating to EE already included in existing Best Practices, Electronics a problem, sound knowledge of controls needed.

- For realising the saving potentials, the compliance rate with proper maintenance is decisive, which is still very low in A5 countries at present. This needs mainstreaming best practice in training and education, certification schemes and mandatory schemes for annual maintenance and operators education.
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Registered offices
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GIZ Proklima
Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany
T +49 61 96 79-1022
F +49 61 96 79-80 1022

E proklima@giz.de
I www.giz.de/proklima

**Contact:**
Irene Papst
Policy adviser for GIZ Proklima, HEAT GmbH
E Irene.papst@heat-international.de

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Agenda

1) Welcome Remarks  
   Ulrike Haupt  
   Federal Ministry for Economic Cooperation and Development (BMZ)

2) Overview of Proklima’s activities in the servicing sector  
   Bernhard Siegele  
   Programme Manager GIZ Proklima

3) Proklima’s HPMP training concepts – impacts and future potential  
   Juergen Usinger  
   Heat GmbH

4) Experiences from India - energy efficient practices in servicing and use  
   Ankur Khandelwal  
   Technical Advisor (India)

5) Discussion & Conclusion  
   All
Experiences from India – Energy efficient practices in servicing and use

Prof. R S Agarwal
&
Ankur Khandelwal
Refrigeration & Air-conditioning Service Sector - India

- 40% to 45% of the total refrigerants consumption in the servicing sector;
- offers **huge opportunity** for securing environmental benefits both from direct and indirect emissions;
- **good servicing practices:** reduction in refrigerant leakage and maintain energy efficiency
- Around **200,000 technicians** in the stationary air conditioning service sector.
- most of the technicians are from **unorganized sector** with No formal training and they have learned the skills on the job
- **unorganized sector** are own-account enterprises - they don’t have legal entity
- Unorganised sector technicians don’t have access to **social security benefits**, provident fund, workman’s compensation, etc.
Refrigeration & Air Conditioning Service Sector - India

Percentage of Trained Technicians in the informal sectors is less than 30%
Market growth: Relative Cooling Energy Consumption in India

- Very low penetration of per capita energy consumption for cooling is expected to grow at fast rate;
- Need for trained and certified servicing technicians will also grow

*Image Source: India Cooling Action Plan 2019*
The aggregated nationwide cooling demand, in Tonnage of Refrigeration (TR), is projected to grow around 8 times by 2037-38 as compared to the 2017-18 baseline.

The building sector cooling demand shows the most significant growth at nearly 11 times as compared to the baseline.

*Image Source: India Cooling Action Plan 2019*
Technicians Training & Certification – India

- Technical training is available for beginners through formal training and Short-duration refresher courses/recognition of prior learning programs:
  - HPMP project implemented by Multilateral agency like GIZ-Proklima.
  - Vocational Training/ Private Training Institutes,
  - Industry and associations (ISHRAE and RASSS),
  - Ministry of Skill Development and Entrepreneurship (ITIs, Polytechnics, National Skill Development Corporation – Electronic Sector Skill Council of India)

- Technicians in the organized sector are trained on job in the industry

- Certification scheme is implemented for technicians, though can be strengthen further.

- Certification is not mandatory for the technicians in India
Technicians Training – Past Experience

- Training programs under the Montreal protocol were completed successfully and continue to be conducted in the country.

- Training has lead to a positive impact on environment
  - Reduced refrigerant leakages,
  - Better performance of in-use air conditioning equipment
  - Livelihood opportunities of the service technicians;

- The short term (2 days) training programs for RAC service technicians in India was initiated in 1998 - (ECOFRIG) and (HIDECOR) and created the base for training facilities.

- The HIDECOR project was a pilot project for training of RAC technicians. It was followed by National CFC Consumption Phase-out Plan (NCCoPP) funded by the Multilateral fund (MLF).
Over 20,000 RAC technicians were trained on GSP under these projects.

HCFC Phase-Out Management Plan (HPMP) for the RAC technicians in Room AC sector plans to phase-out HCFCs in servicing sector, under Stage – I over 11,000 technicians were trained.
Technicians Training – Current Scenario

- Efforts to impart training continues as the existing count of technicians is huge especially in the informal sector;

- RAC technicians in Room AC sector plans to phase-out HCFCs in servicing sector, under Stage – II plan is to train 17000 technicians.

- The Ministry of Environment Forest and Climate Change and the Ministry of Skill Development and Entrepreneurship, Government of India, signed a Memorandum of Understanding to train 100,000 RAC service technicians in good servicing practices and new / alternative refrigerants under the Pradhan Mantri Kaushal Vikas Yojana (PMKVY) – Skill India Mission.

- Currently technicians are facing challenges in handling flammable refrigerants and high pressure systems as in case of R-32.

- HPMP-II has detailed training module for R-290 split units
Energy Efficiency and climate impact challenges

- Awareness within technicians for energy efficiency is very minimal.
- GIZ-Proklima HPMP-II training program has a module for the Good Service Practices for Energy Efficient Operation of Room Air-conditioners
- BEE star labelled/inverter ACs/efficient centralized systems are common
- The energy efficient building design - Energy Conservation Building Code (ECBC) and Green Building norms.
- Energy Audit - Due to awareness and cost of energy, but no regulation for audit
- Operation and maintenance for centralized plants are managed and carried out by trained staff
- For unitary ACs the manufacturer during warranty period provide about three free AC services
- Most of the ACs are serviced by technicians from the unorganized sector who have limited understanding on new technologies and safety
Good Services Practices for Energy Efficient Operation

Importance of Good Services Practices

Minimize the emission of refrigerants from air conditioners
- The potential release/leakage of refrigerants from air-conditioners during installation, servicing, operation has a significant impact on the energy, environment and climate.

Maintain the original performance of the Air-conditioner
- Maintain the system efficiency as designed and do not deteriorate the performance of AC while performing service and repair

Costumer Satisfaction
- Save energy bill
- Improved occupant comfort and Achieve job satisfaction
- Better working relationships and Win repeat business
Good Services Practices for Energy Efficient Operation

- Cleaning of condenser and evaporator coils
- Energy Efficiency Consideration on Electrical components
- Avoid restrictions of Airflow over
- Keep Out door units in shaded area
- Aim for Zero refrigerant emission
- Replace with only clean and correct size of Copper Tubes
- Leak and Pressure Testing - Use Oxygen-Free Dry Nitrogen
- Avoid Sludge and Oxide formation
- Proper evacuation of system
- Use Quality Refrigerants
- Use Clean and Recommended Lubrication
- Preventive Maintenance
Good Services Practices for Energy Efficient Operation

- Refrigerant Charge Quantity as specified on the outdoor unit of the Air-conditioner
  - Over charge of refrigerant increases the compressor power consumption
  - Under charge of refrigerant decreases the cooling capacity
- Avoid Refrigerant top-Up
Advices for efficient operations
Educate for importance of timely services for maintenance
Educate them about availing services from trained / certified technicians
Maintain room AC set point at 26 Degree or above

Education to Customer on Energy Saving

- COOLING ENERGY-USE REDUCTION WITH INCREASING ROOM TEMPERATURE SET

Energy Savings 25-30%
Challenges faced by RAC servicing Technicians

➢ **Time or price sensitive Customer**
   - Sub-par/partially-skilled technicians, reduce the average price of the market as they offer services at the lower price
   - Buyer is ready to pay the price that reflects only the average quality of the market

➢ **Owing complete set of equipment and tools** required for following GSPs is low:
   - Due to their high cost - especially for informal sector.
   - Handling their transportation to servicing site, given that most technicians travel on two-wheelers
   - Moreover there are challenges in handling flammable refrigerants as high pressure OFDN and flammable refrigerants cylinders are not allowed to carry in single vehicle

➢ **Refrigerant Recovery**:
   - Cost of the recovery equipment,
   - Time spent in the process,
   - Lack of reclamation facilities

➢ **Alternative non-ODS lower GWP refrigerants** are mostly flammable. This possess challenges in servicing as **well safety security of the service technicians** as mostly the units are serviced on site and have to be installed in high rise buildings;
What can we do to meet the green challenge?

- Proper maintenance and servicing can curtail up to significant reduction in energy performance and maintain rated performance over lifetime;

- **Technicians rigorous training and certification** is the key for harnessing climate benefits as well as for safe operation and safety of the service personnel.

- **Customer Awareness** pertaining to quality servicing and its impact on energy efficiency, it will increase demand for proper maintenance and keeping AC set Point at 26 Degree or above.

- **Planning and policy formulation** for the servicing sector viz. social security system, occupational safety, health insurance and retirement benefits.
  - This can be an important **incentive for servicing technicians to invest in their education and training, in proper tools and equipment’s.**

- **Rigorous** Safety Trainings for technicians, as most of the refrigerants alternatives to HCFCs and HFCs are flammables and high pressure.
Thank You

For further information please contact:

Ankur Khandelwal: Consultant, GIZ – Proklima
ankur@enviroref.com
EnviroRef Technologies & Training Solutions Pvt. Ltd
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*All*
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- Any further queries?
- Please contact Julia Schabel (Julia.Schabel@giz.de) or
- Sofia Nuernberger (Sofia.Nuernberger@giz.de)