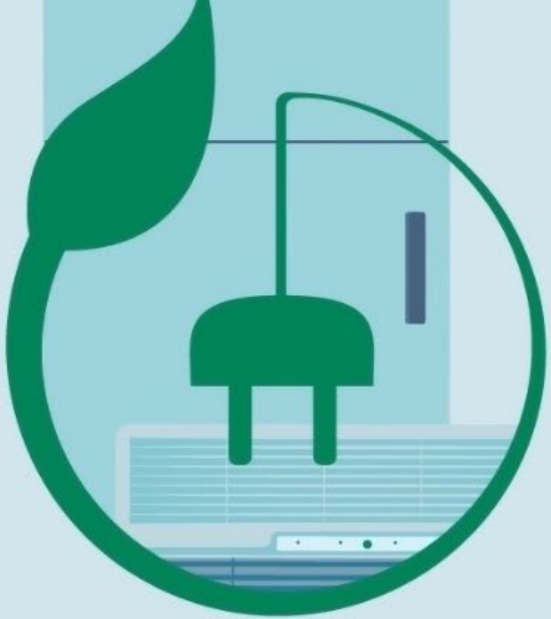


Effective Emission Reduction through Energy Efficiency

Wednesday, 05 July 2023, 6 pm
Bangkok, Room CR-4

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Supported by:

Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection

based on a decision of the German Bundestag

IKI INTERNATIONAL CLIMATE INITIATIVE

Agenda

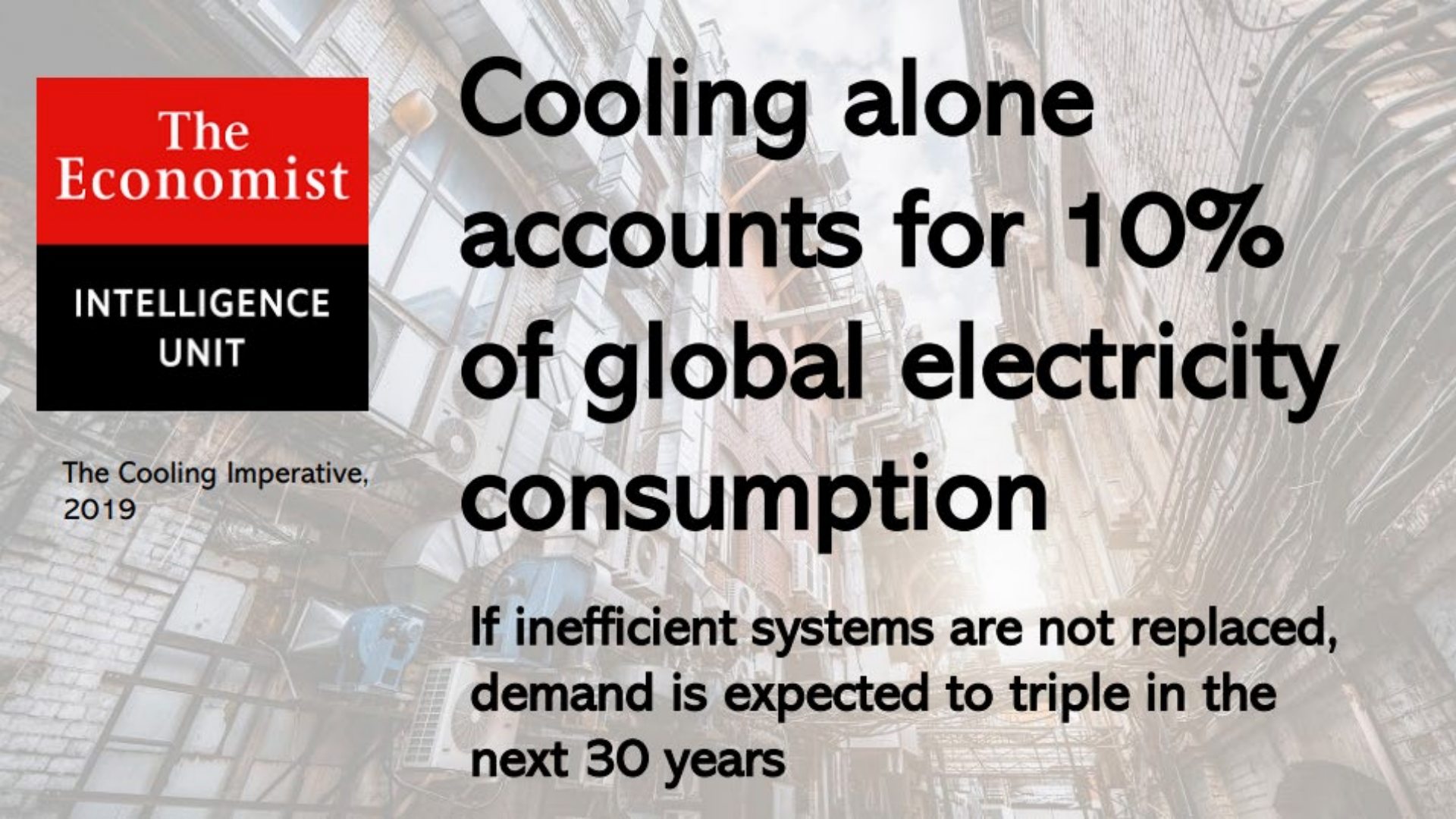
Welcome Remarks	**Sebastian Schnatz** German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV)
Setting the Scene: The Relevance of Energy Efficiency and How to Achieve it	**Franziska Schmittner** GIZ Proklima
The Energy Efficiency Funding Window of the Multilateral Fund of the Montreal Protocol	**Fukuya Iino** United Nations Industrial Development Organization (UNIDO)
Energy Efficiency in the context of the HFC phase down – manufacturing and servicing	**Tim Grabiel** Environmental Investigation Agency (EIA)
Country example: Grenada	**Leslie Smith** NOU Grenada
Questions & Answers	All participants
Conclusion and Closing Remarks	**Bernhard Siegele** GIZ Proklima

Welcome Remarks

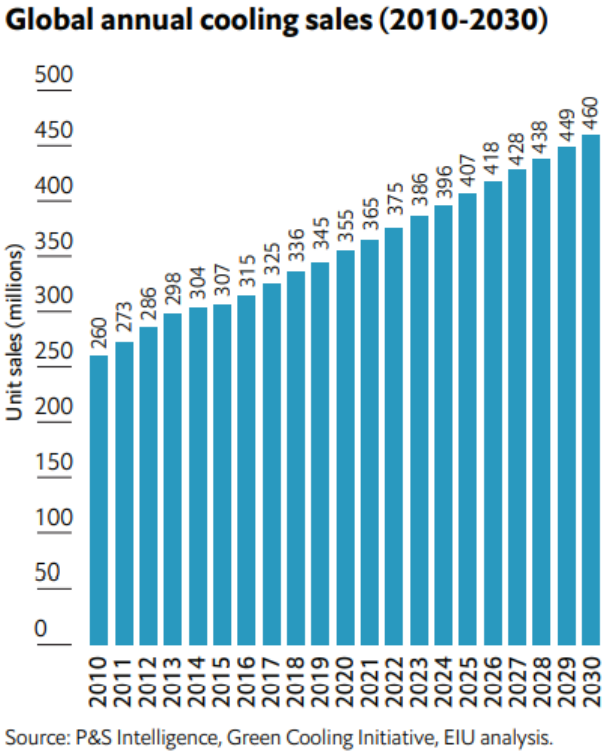
Sebastian Schnatz, German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV)

Setting the Scene: The Relevance of Energy Efficiency and How to Achieve it

Franziska Schmittner, GIZ Proklima

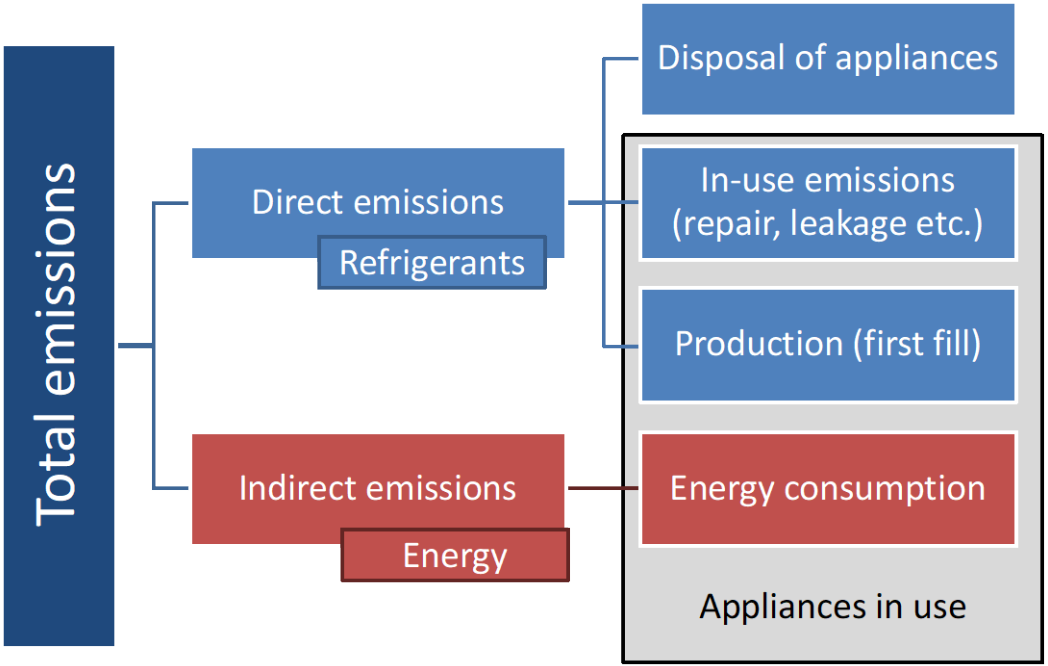

The Economist
INTELLIGENCE UNIT
Cooling alone accounts for 10% of global electricity consumption
The Cooling Imperative, 2019
If inefficient systems are not replaced, demand is expected to triple in the next 30 years

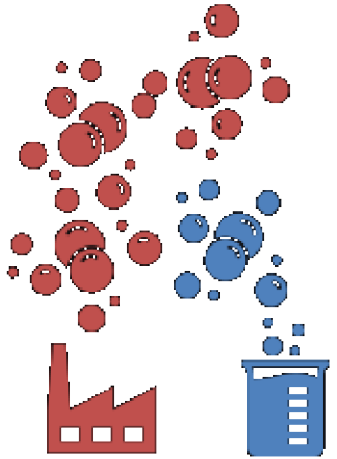
Why cooling concerns us all

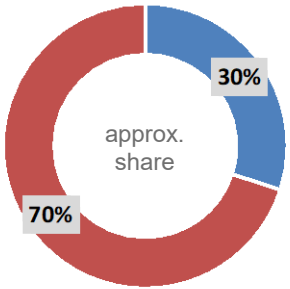


- 10 new air conditioners will be sold **every second** for the next thirty years. (IEA, 2018)
- The IPCC predicts that global energy demand from residential AC will grow **33-fold** between 2000 to 2100, mostly from developing countries. (EIU, 2019)
- Most of the currently used refrigerants (HCFCs, HFCs) have **very high global warming potentials** (some of them are up to ~13,000 times more climate-damaging than CO_2). (IPCC 6th AR)

Emissions from the RAC sector







Emissions from the RAC sector

RACHP systems have a significant impact on the climate crisis with two key sources of emissions:

- Direct emissions – Refrigerants leakage directly to the atmosphere with high GWP.
- Indirect emissions - From the energy consumed by RACHP systems

→ Energy efficiency is key to reduce indirect emissions

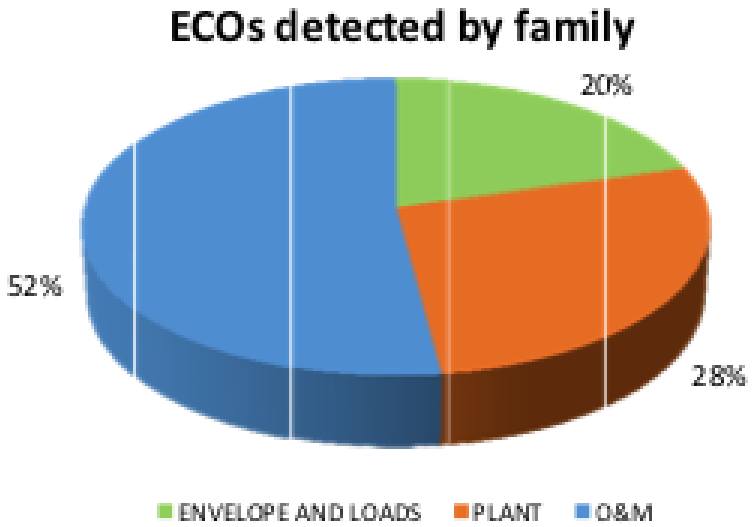
→ Reduction of energy consumption is a first step while energy infrastructure needs to be transformed to renewable energy to achieve decarbonisation

Avoiding emissions by "leapfrogging" to Green Cooling

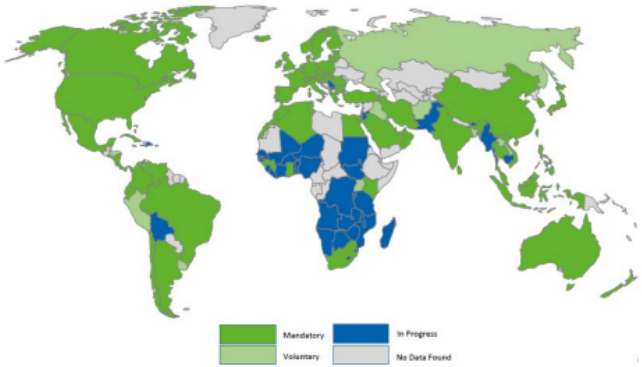
Instant switch to highly **energy-efficient** technologies wit **natural refrigerants** without relying on climate-damaging interim technologies.

Main Factors influencing energy efficiency of RACHP Applications

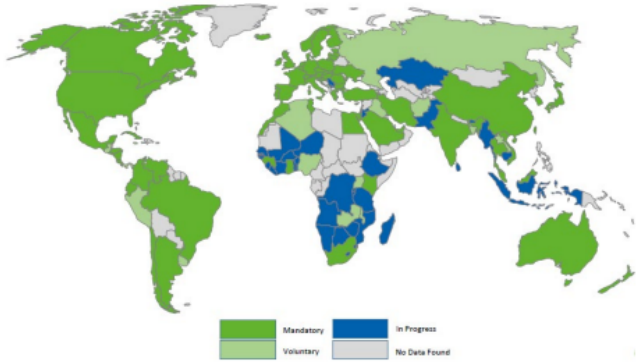
- Energy Efficiency of Appliances and installed Plants
- Operation and Maintenance
- Heat Loads and Envelope



Energy Efficiency of Appliances and installed Plants

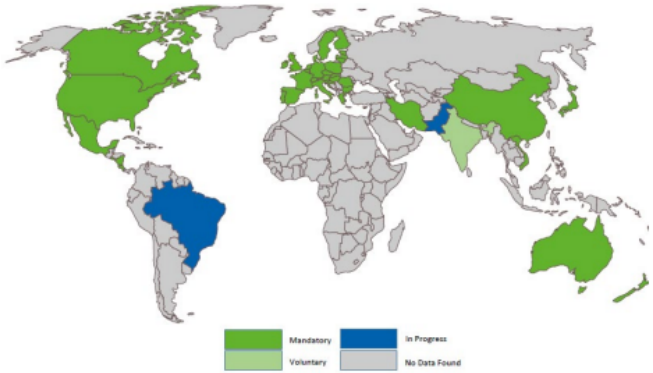


Room Air conditioner (RAC) MEPS programs



Domestic Refrigerator MEPS programs

MEPS =
Minimum Energy
Performance Standards



Commercial Refrigeration MEPS

Status of standards and labelling programs globally

Mandatory

Voluntary

In progress

Lack of data

Source: UNEP United for Efficiency (U4E) Initiative, TEAP report May 2023; TEAP-May2023-Progress-Report-Supplementary.pdf (unep.org)

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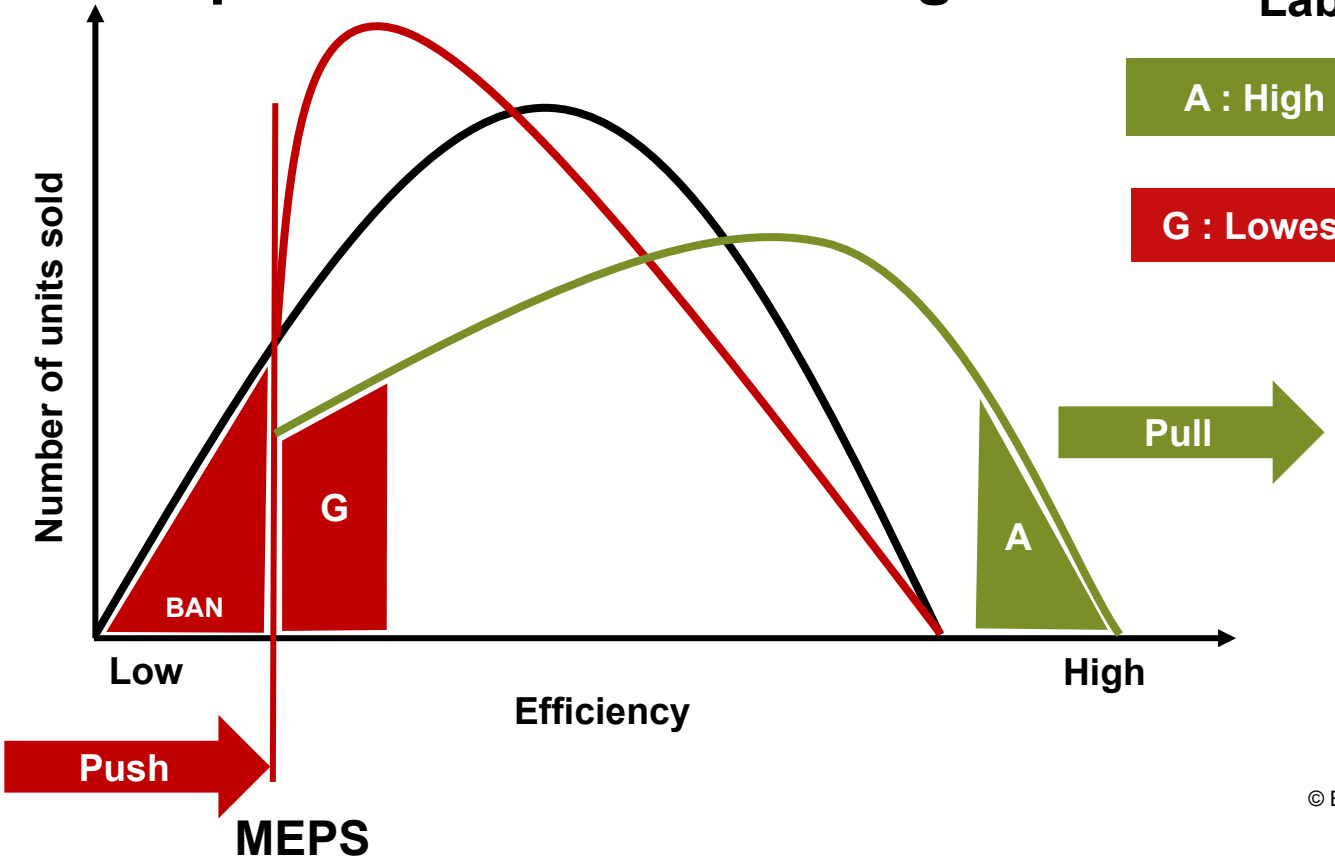
Basic concept of MEPS and labelling



Labels

A : High Efficiency

G : Lowest Efficiency

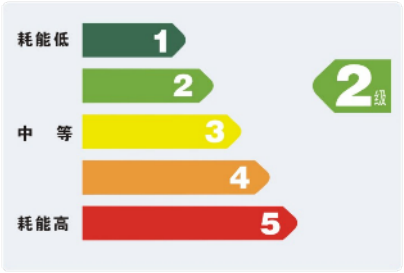
MEPS and labelling

- Policy measures to steer energy efficiency
- Many countries have implemented such policy measures
- MEPS and Labelling main measures next to taxes, tariffs and subsidies
- WTO principles require application of theses standards for domestically manufactured products and imported products
- Countries with high energy costs tend to have equipment intalled with higher EE

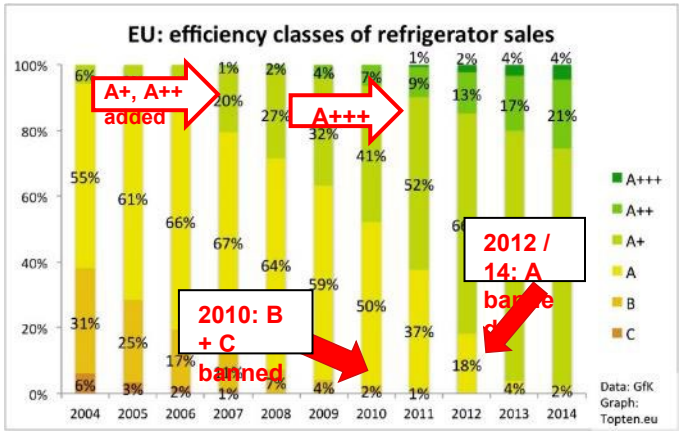
Example for energy efficiency labels: China: Mandatory MEPS and labels for chillers

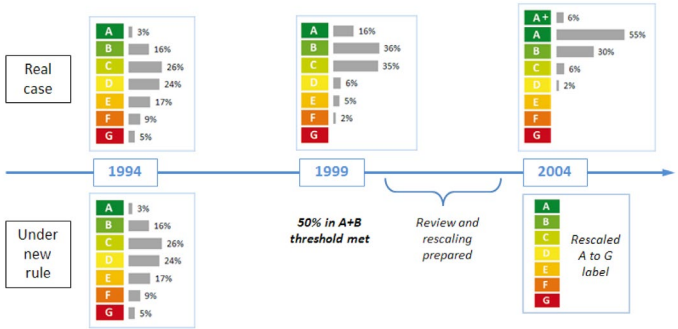
- 5 label categories
- No 5 = MEPS, No 1 = top label
- Lower than No 5 not allowed to sell in the market

Type	Rated Cooling Capacity (CC) [kW]	Energy Efficiency Grade (COP) [W/W]				
		1	2	3	4	5
Air-cooled or evaporatively-cooled	CC ≤ 50	3.20	3.00	2.80	2.60	2.40
	CC > 50	3.40	3.20	3.00	2.80	2.60
Water-cooled	CC ≤ 528	5.00	4.70	4.40	4.10	3.80
	528 < CC ≤ 1163	5.50	5.10	4.70	4.30	4.00
	CC > 1163	6.10	5.60	5.10	4.60	4.20



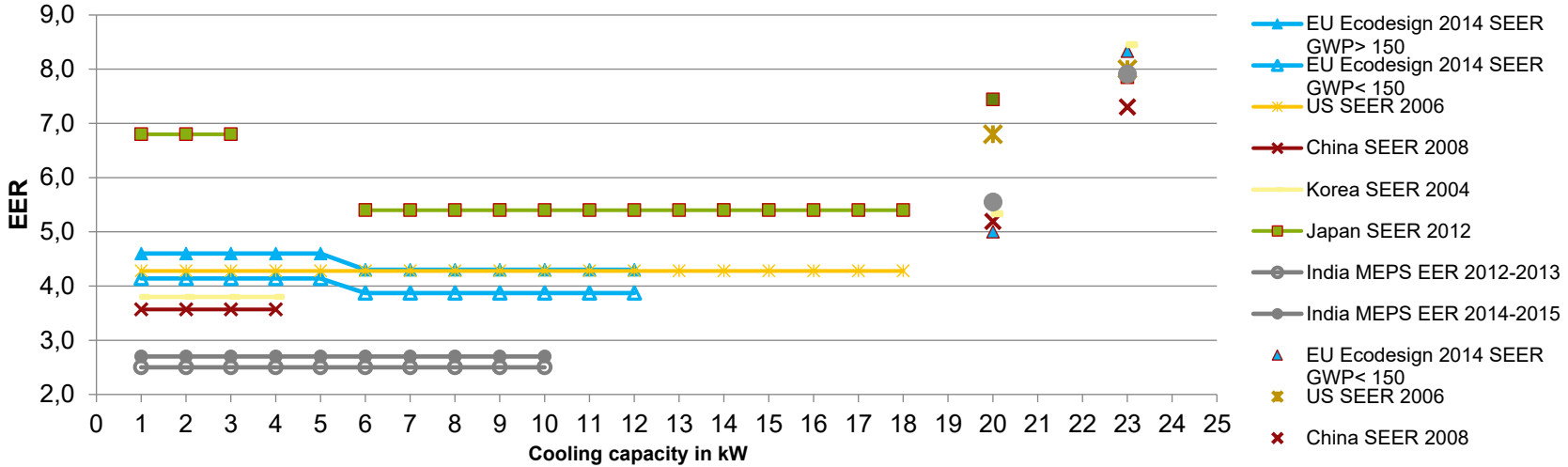
Energy efficiency labelling: Dynamic process for adding top label classes and banning lowest classes





- Top category for the top 5% performing products or even empty in the beginning.
- Lowest label category (lowest 5%) → if market share falls below threshold → ban
- Lowest category = MEPS
- Regular review (2 to 10 years)
- If category A is above 30% of the market, or A+B > 50%, a reclassification is needed.

Minimum Energy Performance Standard (SEER) for split AC measures effciency are set under national circumstances



Comparable 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

	US	EU						China	Korea	Japan	
	2006	2013	2013	2014	2014	2014	2014	2008	2004	2012	2012
	<19kW	<12kW, GWP<150	<12kW, GWP>150	<6kW, GWP<150	<6kW, GWP>150	6–12kW, GWP<150	6–12kW, GWP>150	VSD < 4,5 kW	VSD <4kW	(free- dimension) <3,2kW	6–28 kW, wall
To US Norm	3,8	2,76	3,09	3,59	4,01	3,34	3,74	3,29	2,88	6,75	4,43
To Japan CSPF Norm	4,38	3,25	3,6	4,12	4,57	3,86	4,28	3,87	3,34	7,47	5,05
To China Norm	3,53	2,52	2,85	3,34	3,76	3,1	3,49	3	2,67	6,48	4,16
To Korea Norm	4,41	3,31	3,65	4,16	4,59	3,9	4,31	3,94	3,37	7,39	5,06
To EU Norm	4,39	3,24	3,6	4,14	4,6	3,87	4,3	3,86	3,34	7,57	5,08
To Japan APF Norm	4,02	3,13	3,41	3,84	4,2	3,62	3,97	3,57	3,24	6,6	4,5

SOURCE: IEA (2011), CLASP (2011), CLASP (2013)

Declared vs. measured Efficiency Values of RACHP equipment

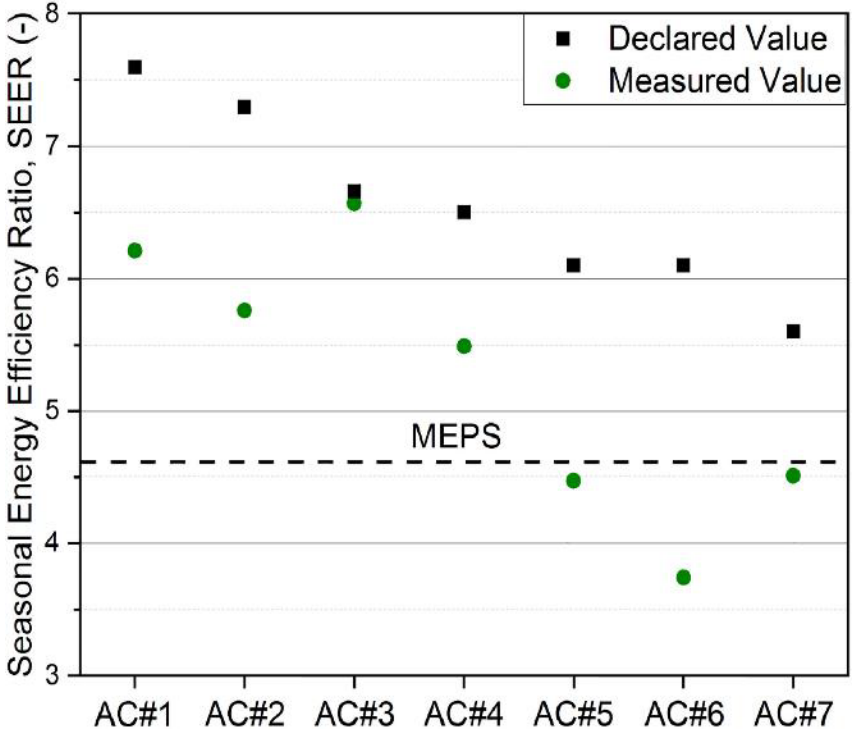
Air Conditioner Efficiency Rating

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[1].

1) Palkowski et al., 2018, Seasonal cooling performance of air conditioners

	Average	AC#1	AC#2	AC#3	AC#4	AC#5	AC#6	AC#7
Declared	6,5	7,5	7,3	6,6	6,5	6,1	6,1	5,5
Tested	5,2	6,2	5,8	6,5	5,5	4,3	3,8	4,6
Tested vs. Declared	80%	83%	79%	98%	85%	70%	61%	84%

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



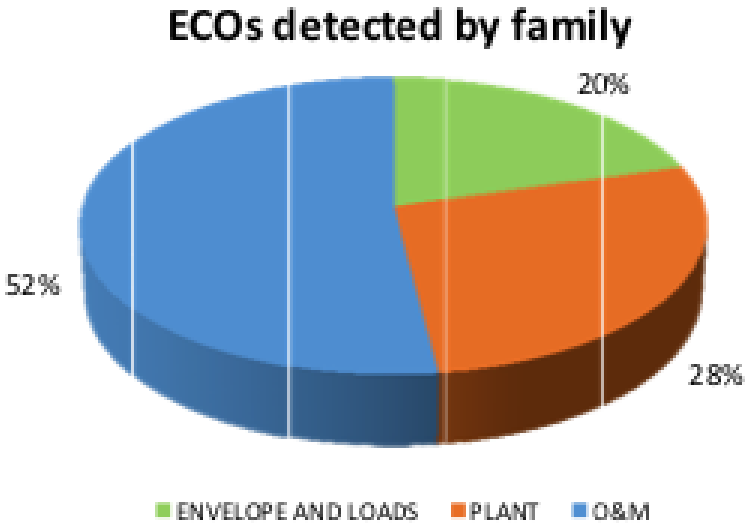
3) Regulation (EU) No 206/2012 (European Commission, 2012), split - type ACs with rated capacity < 6 kW, using a refrigerant with global warming potential (GWP) > 150 shall have a minimum seasonal energy efficiency ratio (SEER) of 4.6.

Operation and Maintenance

Energy Performance of Building Directive in the EU

Study of Energy Consumption in European Air Conditioning Systems and Energy Conservation Options (ECOs):

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

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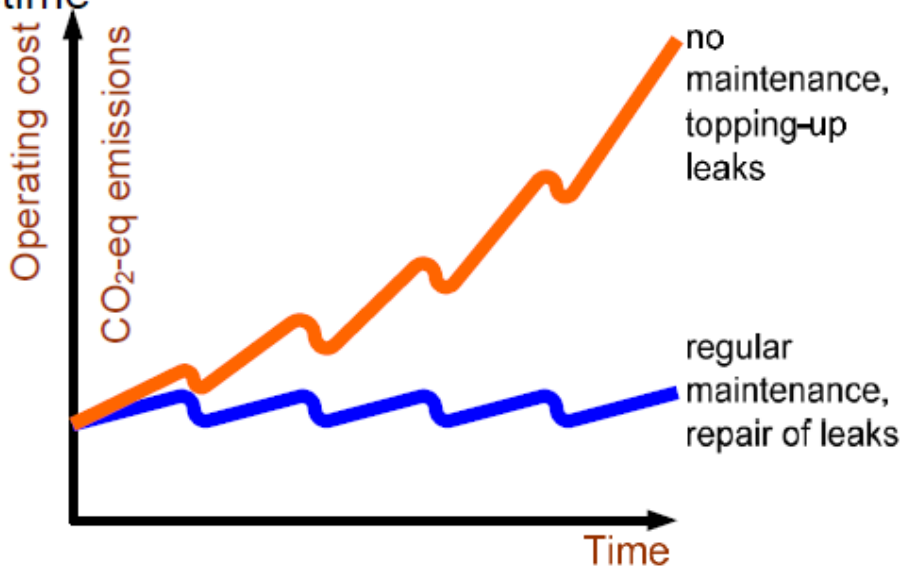
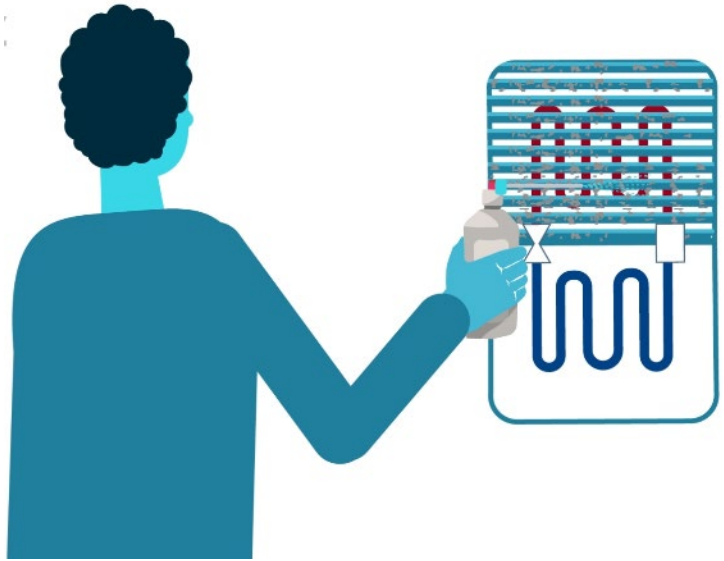
Implications of Service and Maintenance

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



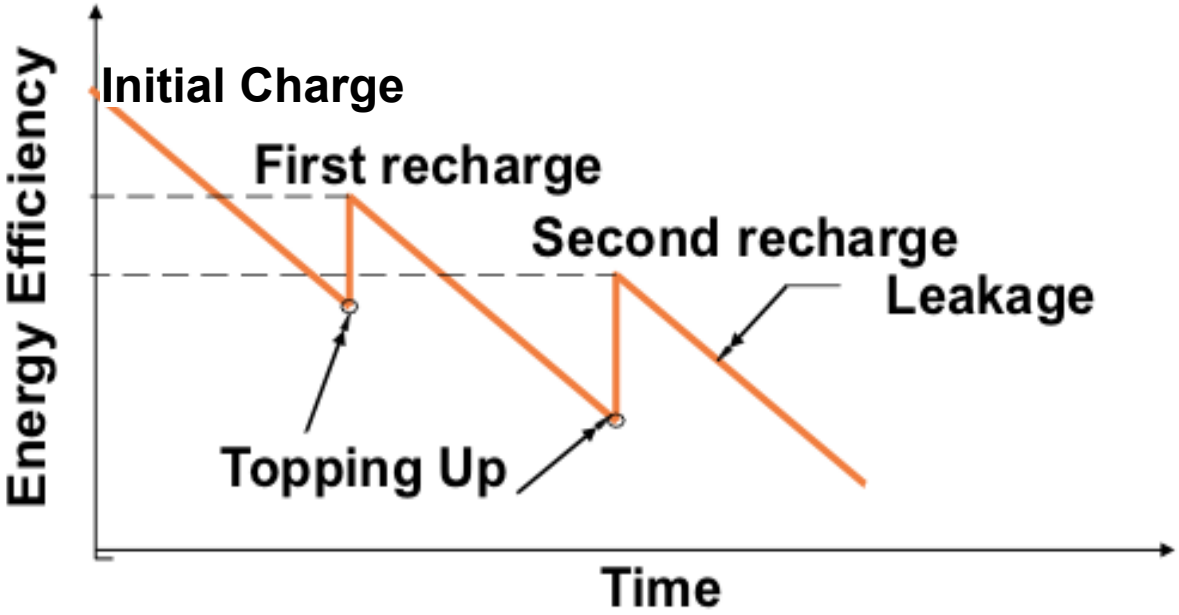
Most important measures to increase energy efficiency for maintenance

- **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%.



Source: HEAT GmbH, Jürgen Usinger

Relevance of equipment‘s charge level



*Topping up practices in A5 are leaving the cause of a leak un- checked and leads in many cases to rapid loss of efficiency **

**Energy efficient practices in services and use; Agarwal, Khandelwal, 2019 Presentation at OEWG 41*

Most important measures to increase energy efficiency 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

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

Maintenance Servicing

Dirty Filters
Set point too low (<=22°C)
Leaked or overcharged refrigerant
Equipment needs replacing, worn compressor
Grilles blanked off
Not maintaining correct condensing temperature
Condenser corrosion or fouling
Evaporator filter fouling
Lack of air flow through wrong fan rotation etc.

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

Planning

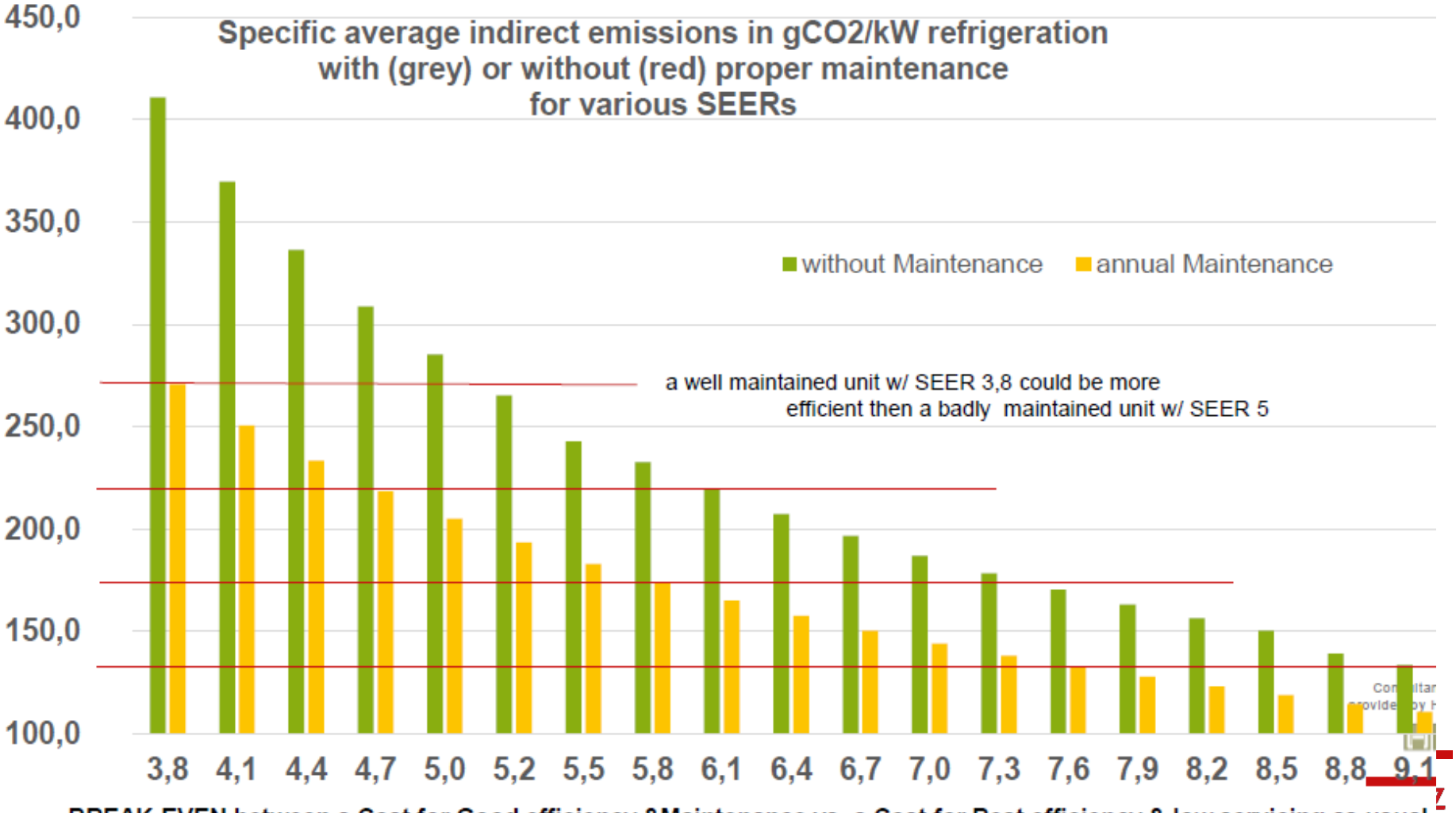
System oversized (30%>) > cooling load calculation
Correct location of ODU & IDU

Consider smaller system
Free cooling could be considered
Consider reducing room size area

Reported A5 leak rates per subsector : On average between 22% to 44% /annum (EXCOM document 7242)

Subsector	Estimated annual emission rates in HPMPs		
	Average (%)	Lowest value (%)	Highest value (%)
Residential air-conditioning	29	4	79
Commercial air-conditioning	40	3	70
Industrial air-conditioning	40	8	54
Transport	23	8	40
Chillers	22	14	30
Commercial refrigeration	38	2	82
Industrial refrigeration	44	7	100

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.


Specific average indirect emissions in gCO2/kW refrigeration
with (grey) or without (red) proper maintenance
for various SEERs
without Maintenance
annual Maintenance
a well maintained unit w/ SEER 3,8 could be more
efficient then a badly maintained unit w/ SEER 5
450,0
400,0
350,0
300,0
250,0
200,0
150,0
100,0
3,8
4,1
4,4
4,7
5,0
5,2
5,5
5,8
6,1
6,4
6,7
7,0
7,3
7,6
7,9
8,2
8,5
8,8
9,1
BREAK EVEN between a Cost for Good efficiency &Maintenance vs. a Cost for Best efficiency & low servicing as usual

Share of proper Maintenance for realising maximum efficiency in A/C and consideration of Capacity Buidling activities

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

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

Conclusions

- **Capacity building of technicians is a crucial element to improve energy efficiency** of equipment today and in the future.

- **Capacity building** in the past potentially **contributed significantly to increase or maintain efficiency** in partners countries.

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

Photos: GIZ Kenya

Conclusions

- **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

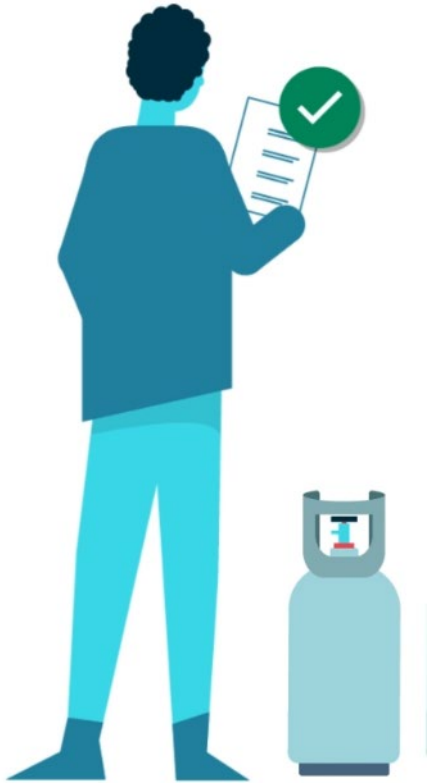
- U**p to 35% of unnecessary emissions could have been avoided already, if skills were applied properly,** impact needs more specific research.

- Monitoring and evaluation 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;

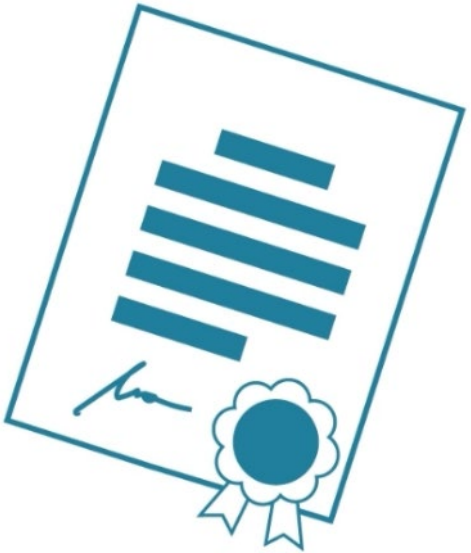


Future activities

- **Formalised training and certification** of trainees, companies and tested equipment is needed;

- **Servicing contracts for regular annual maintenance** would be an important element for good quality maintenance;

- Investigate more into extended role of service companies and technicians to **integrate elements of owner/consumer/operator education and advise on improving the operation and envelope** to reduce unnecessary energy consumption.



The Energy Efficiency Funding Window of the Multilateral Fund of the Montreal Protocol

Fukuya Iino, United Nations Industrial Development Organization (UNIDO)

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SUSTAINABLE DEVELOPMENT GOALS

GIZ Side Event
Effective Emission Reduction through Energy Efficiency
5 July 2023 Bangkok

UNITED NATIONS
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SUSTAINABLE DEVELOPMENT GOALS

Additional Funding for Energy efficiency

EE related EXCOM decisions	Criteria	Budget (USD)
Decision 89/6 (paragraph 16 of decision XXVIII/2 and paragraph 2 of decision XXX/5)	**Low volume consumption (LVC) countries (1) pilot projects for small RACHP (2) Updating training material (3) MEPS and labelling (4) Certification scheme (5) Awareness**	100k-120k
Decision 91/65 UNEP/OzL.Pro/ExCom/91/63 (Criteria for pilot projects)	(1) Manufacturers: EE components, MEPS, (2) Assemblers and installers: Capacity building (3) Servicing sector: capacity building for technicians, incentives (4) MEPS, testing and certification processes (5) Institutional coordination	

Ref) http://www.multilateralfund.org/89/Report%20of%20the%20eightyeighth%20meeting%20of%20the%20Executiv/1/8916.pdf

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Decision 89/6 (Servicing Sector for LVCs)

Sector	Criteria
End users	Projects targeting end users for EE small refrigeration, air-conditioning and heat-pump (RACHP) equipment with low-GWP tech. to facilitate market acceptance
Training material	Updating of training material to strengthen good practices, safety and energy efficiency during installation, maintenance and servicing of RACHP equipment
Coord. / collaboration	Coord. / collaboration betwn. national ozone units and relevant authorities including low-GWP ref. during the dev. of cooling / EE plans including MEPS
Certification	Development and implementation of competency-based certification schemes for technicians and the strengthening of national institutions
Awareness	Awareness and outreach programs to promote MEPS / labelling systems; certification; and energy-efficient RACHP equipment operating with low- or zero-GWP Refrigerants

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Decision 91/65 (93rd to 96th Excom)

Sector	Criteria
Manufacturing Sector	Conversion from HFC to maintain and/or enhance EE of Dom. Ref., stand-alone Com Ref., Dom And Com. AC/Heat Pumps
Assembly and installing Sector	Tech Assistance leading to the adoption of tech. to convert from HFCs and maintain and/or enhance EE
Servicing Sector	Same as Decision 89/6
Tech Assistance for SMEs	Tech Assis. For SMEs to adopt EE technologies and increasing

Ref) http://www.multilateralfund.org/91/Report%20of%20the%20ninetieth%20meeting%20of%20the%20Executive%20C/1/9172ri.pdf

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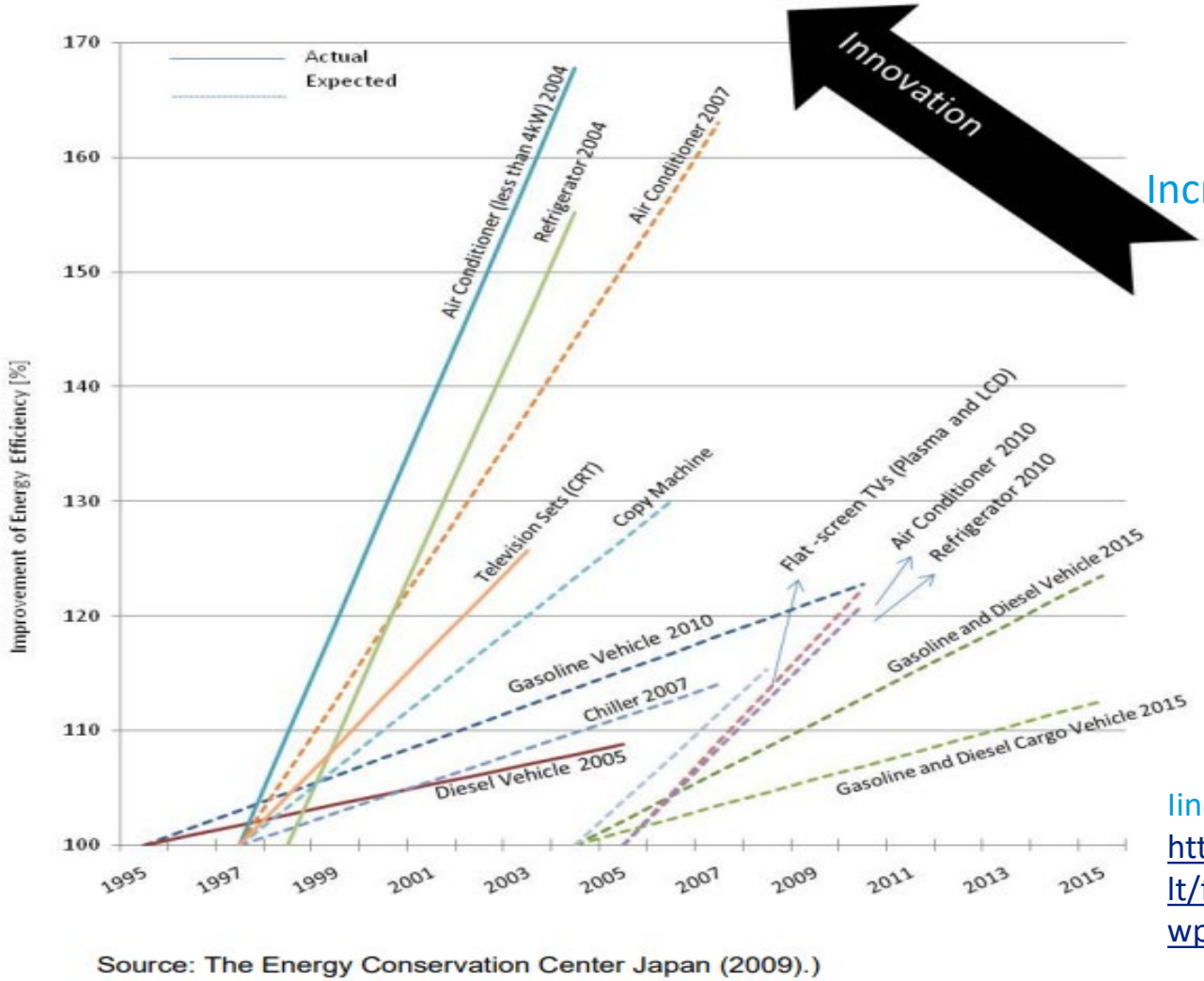
SUSTAINABLE DEVELOPMENT GOALS

Decision 91/65, cont.

Sector	Criteria
Confirmation	MEPS put in place for the manufacturing sector
MEPS	national and/or regional MEPS, including a process or mechanism to monitor and assess their implementation in relation to the relevant sector/application
Confirmation for inter-agency coordination	NOU would coordinate with relevant EE authorities and national standard bodies
No overlapping with other funding sources	The project activities funded by other funding sources would not result in the duplication.

Ref) http://www.multilateralfund.org/91/Report%20of%20the%20ninetieth%20meeting%20of%20the%20Executive%20C/1/9172ri.pdf



Source: The Energy Conservation Center Japan (2009).)

Incremental or Breakthrough?

- Gasoline Vehicle 2010
- Diesel Vehicle 2005
- Gasoline and Diesel Vehicle 2015
- Gasoline and Diesel Cargo Vehicle 2015
- Air Conditioner (less than 4kW) 2004
- Air Conditioner 2007
- Chiller 2007
- Air Conditioner 2010
- Refrigerator 2004
- Refrigerator 2010
- Copy Machine
- Television Sets (CRT)
- Flat-screen TVs (Plasma and LCD)

Iino and Lim, ADB Institute 2010, https://www.adb.org/sites/default/files/publication/156083/adbi-wp228.pdf

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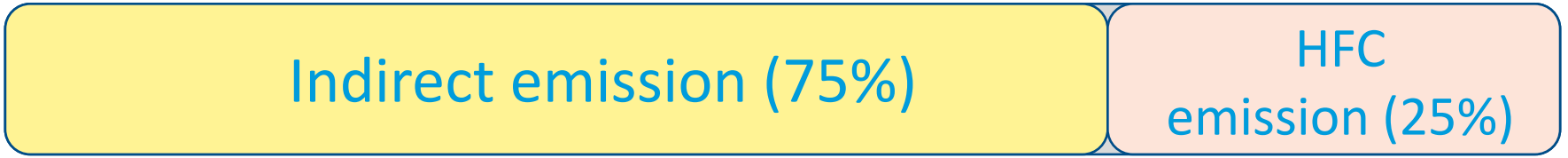
SUSTAINABLE DEVELOPMENT GOALS

GHG Emission from Refrigeration, Air Conditioning, and Heat Pump



Electricity Consumption for Cooling

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

To be reviewed by experts

SUSTAINABLE DEVELOPMENT GOALS

EE opportunities in A5 countries in the RACHP sector

	Indirect Emission	HFC Emission
Residential AC (import driven, assembling) Ref (local manuf.)	• Promotion of residential AC with R32/R290 • Minimum Energy Performance Standards (MEPS) often at a regional level • Green Procurement Policy • Positive and negative incentives for replacement of old equipment (Life Cycle Assessment) • Blowing agents for affordable and accessible lower conductivity and dimensional stability	• Low/zero GWP ref • Proper reuse and reassembling • Sound e-waste management • Recovery, recycling and reclamation
Commercial AC Ref (parts imported, local assemb.)	• Building codes • Passive and traditional cooling • Architectural design (nat.vent. solar heat, etc) • District cooling/City design (Colombia) • Fully exploiting Ammonia/CO2	• Proper assembling and instalment • Regular maintenance

Ref) https://ozone.unep.org/system/files/documents/TEAP-May2023-Progress-Report-Supplementary.pdf

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INDUSTRIAL DEVELOPMENT ORGANIZATION

SUSTAINABLE DEVELOPMENT GOALS

Thank you

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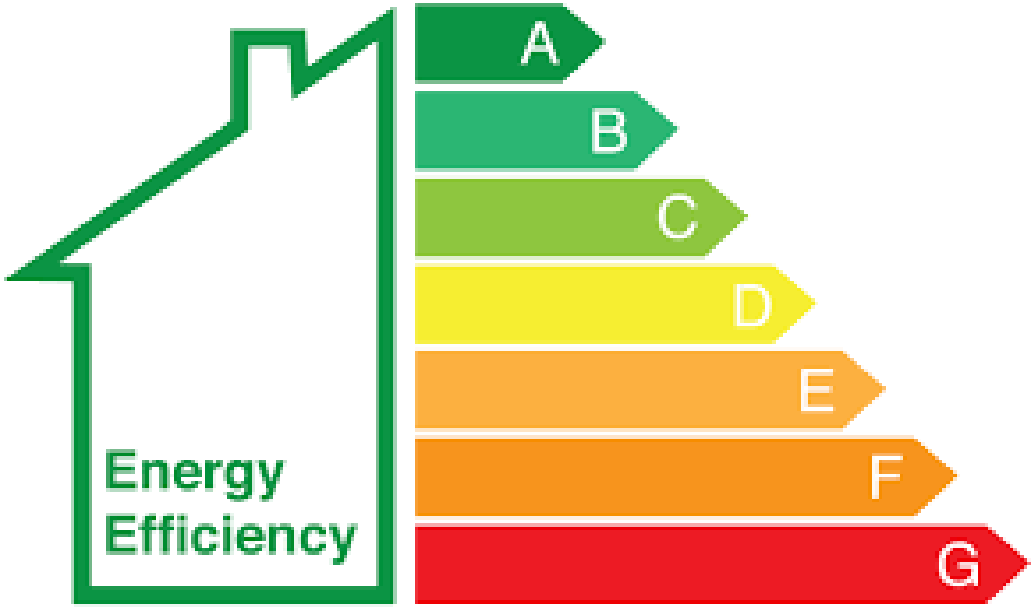
Fukuya IINO
Industrial Development Officer, UN Industrial Development Organization

Energy Efficiency in the context of the HFC phase down – manufacturing and servicing

Tim Grabiel, Environmental Investigation Agency (EIA)

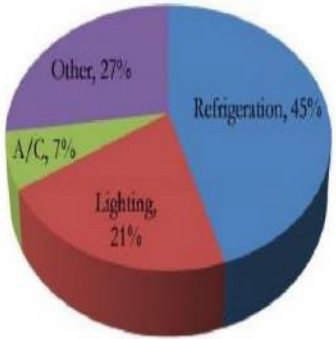


How VLVCs can best make use of the EE Funding Window

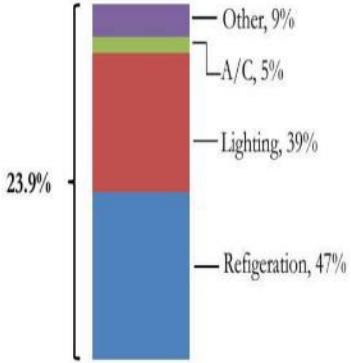
Typical Energy Use in Caribbean Buildings

Residential Sector

Electricity end-use, residential



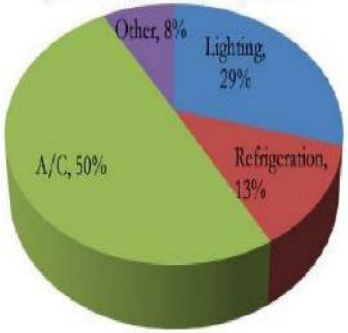
Estimated savings potential, %



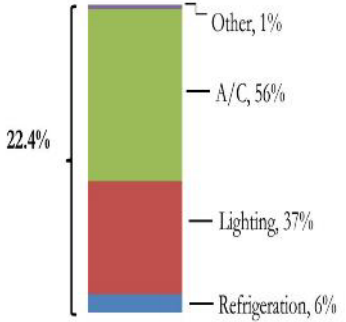
RAC - 52%

Commercial (including hotels) and public sector

Electricity end-use, commercial (including hotels) & public

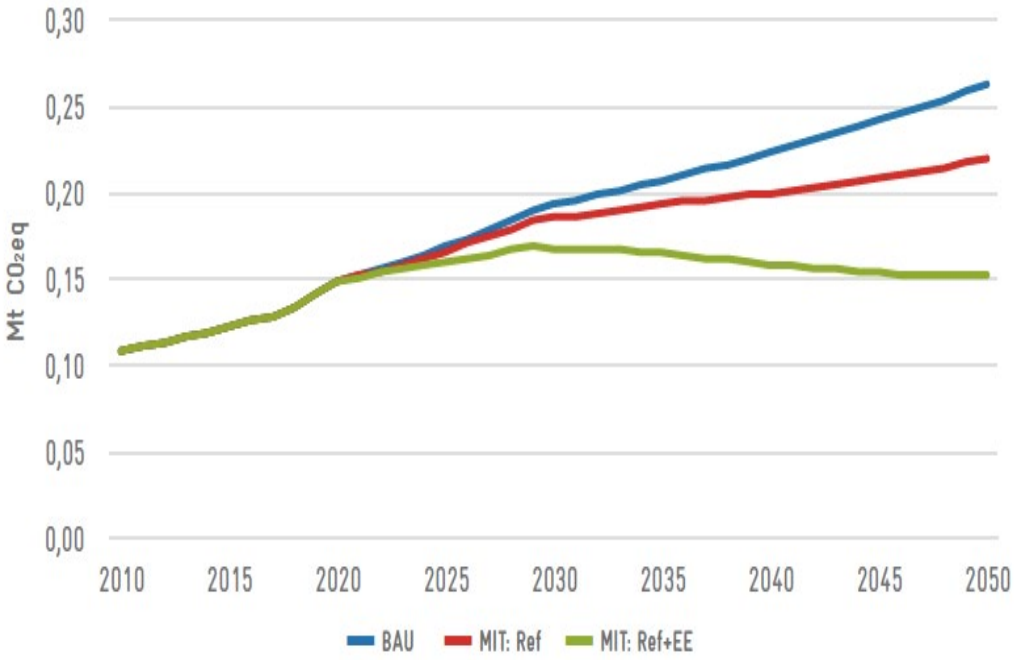


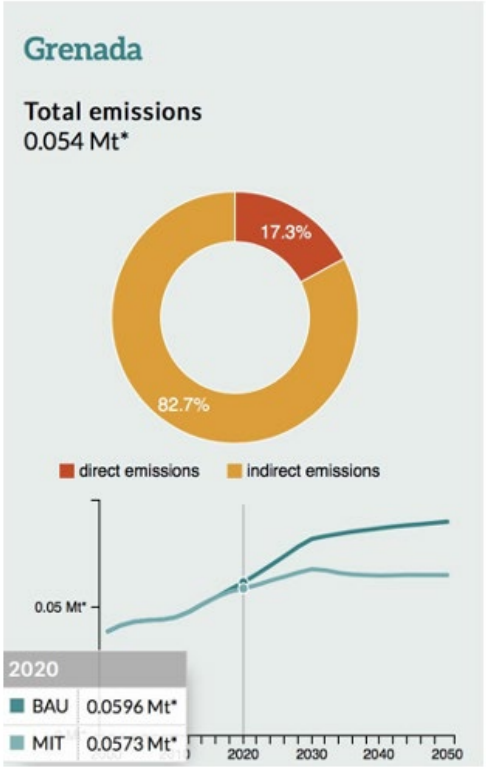
Estimated savings potential (commercial, hotels, public), %



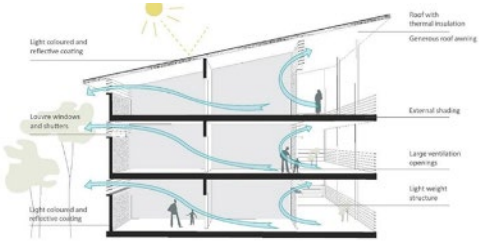
RAC - 63%

Total Annual Emissions
BAU and MIT Scenarios for Grenada





Energy Efficiency is not only about the RAC Equipment



Building Design

Choice of Equipment

Behaviour

Building Performance Standards

Policy and Legislation

Operation and Maintenance

Energy Efficiency Opportunities

- Promulgation of EE Legislation
- MEPS
- EE labelling Standards
- Building performance Standards
- Incentive Schemes and Market Transformation
- SMART Investment Projects
- Public Awareness and Education
- Capacity Development, technology and knowledge transfer

Questions & Answers

All Speakers

Conclusion and Closing Remarks

Bernhard Siegele, GIZ Proklima

Proklima publications (selection)

All Proklima materials: www.green-cooling-initiative.org

SCAN ME

Become an ally!

The members of the

Green Cooling Network

are all committed to energy-efficient and climate-friendly refrigeration & air conditioning.

Join the network and become part of the Green Cooling community today!

www.green-cooling-initiative.org/network

EU-Climate Dialogues:
HFC phase down – inspirations for the joint effort of NOUs, energy efficiency and climate change departments

20/ 21 September 2023 - online

EUCD Workshop 1: Status quo and Best Practices

Mid-November 2023 - online

EUCD Workshop 2: Tools and Strategy

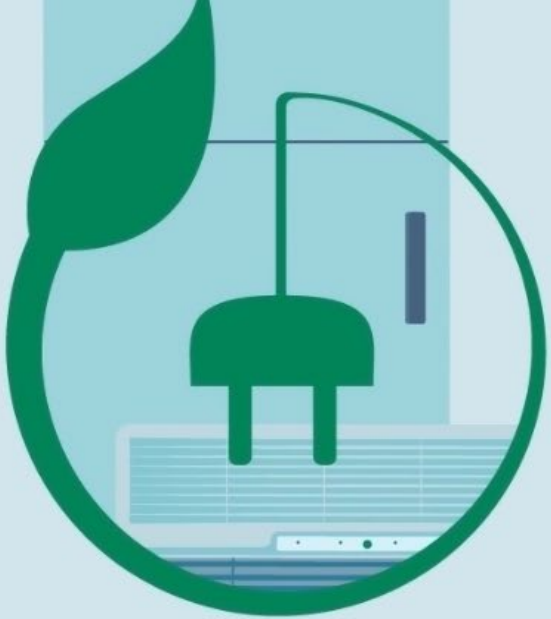
Back to back to the MOP 2023, Nairobi

Informal Exchange of participating NOUs

EU Climate Dialogues Project

Support to the EU's Bilateral Relations with Strategic Partners on climate-related policies and investments - FPI/2021/428-692

Project funded by the European Union



THANK YOU

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Supported by:

Federal Ministry
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