Avoiding 0.1 degrees Celsius with “Green” Split Air Conditioners

COP28 side event

OZONE COOL ZONE

30 Nov–12 Dec
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Saturday, 9th December 2023, 12 - 1 pm (GST/UTC+4)
Ozone to Cool Zone (Montreal Protocol Pavilion)

Avoiding 0.1 degrees Celsius with „Green“ Split Air

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Opening Remarks (5’)	Balaji Natarajan, MLF Secretariate of the Montreal Protocol
Context and global mitigation potential of “Green” ACs (12’)	Philipp Denzinger, GIZ Proklima
Promoting R290 ACs under the Art. 6.2 Cooling Program for Southern Africa	Philipp Denzinger, GIZ Proklima
Promoting R290 ACs under the Carbon Market Art. 6.2 (8´)	Daniel Tutu Benefoh, EPA Ghana
Green Cooling Ghana project on R290 ACs (8’)	Ursula Flossmann-Kraus, KliK Foundation
AGORA R290 AC Project Ghana and Nigeria (8’)	Selimcan Azizoglu, UNDP
Q & A (10´)	Everyone

Our Speakers

Moderator: Philipp Denzinger, GIZ Proklima

Dr. Ursula Flossmann-Kraus

Carbon Procurement Manager at KliK Foundation

Philipp Denzinger

Project Manager

GIZ Proklima

Daniel Tutu Benefoh

Director Climate Change Unit

EPA Ghana

Selimcan Azizoglu

Regional Project Specialist

UNDP

Balaji Natarajan

Multilateral Fund for the Implementation of the Montreal Protocol

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Opening Remarks

Balaji Natarajan

Multilateral Fund for the Implementation of the Montreal Protocol

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Context and global mitigation potential of “Green” ACs

Philipp Denzinger, GIZ Proklima

german cooperation
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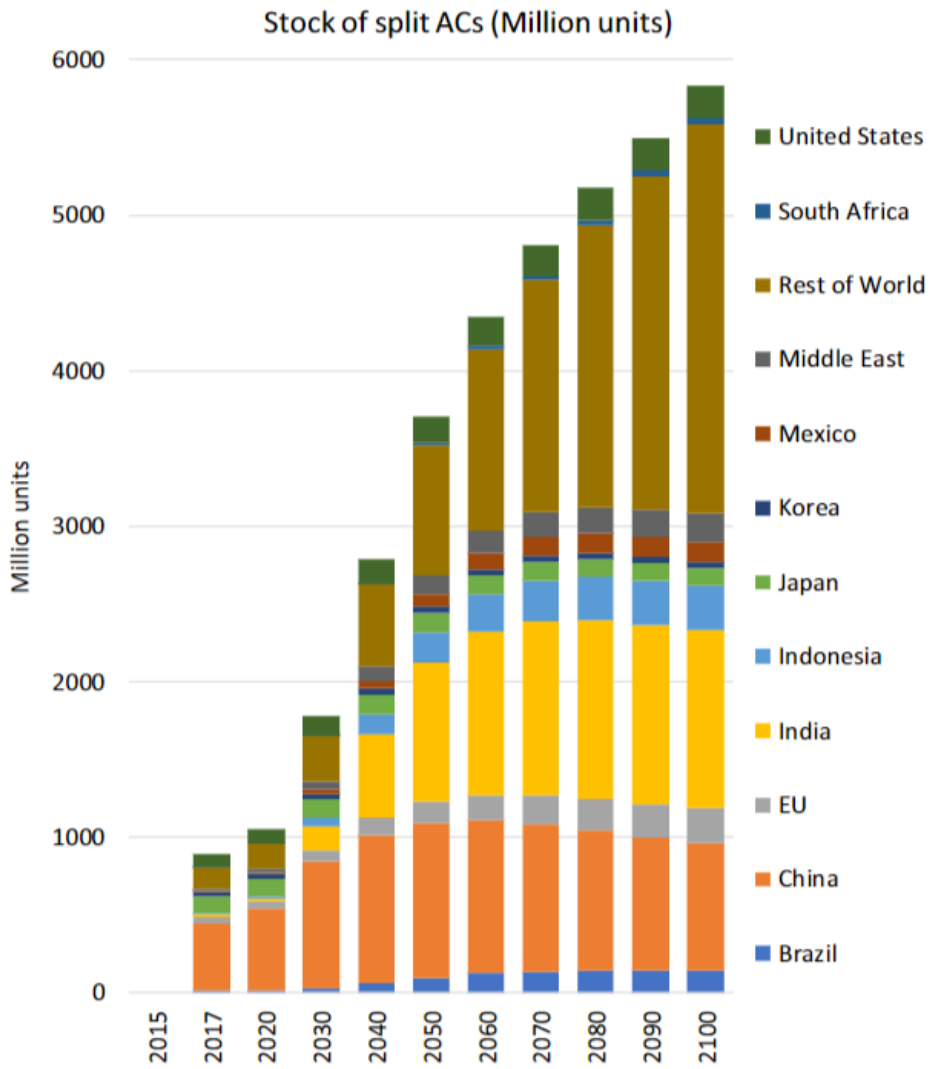
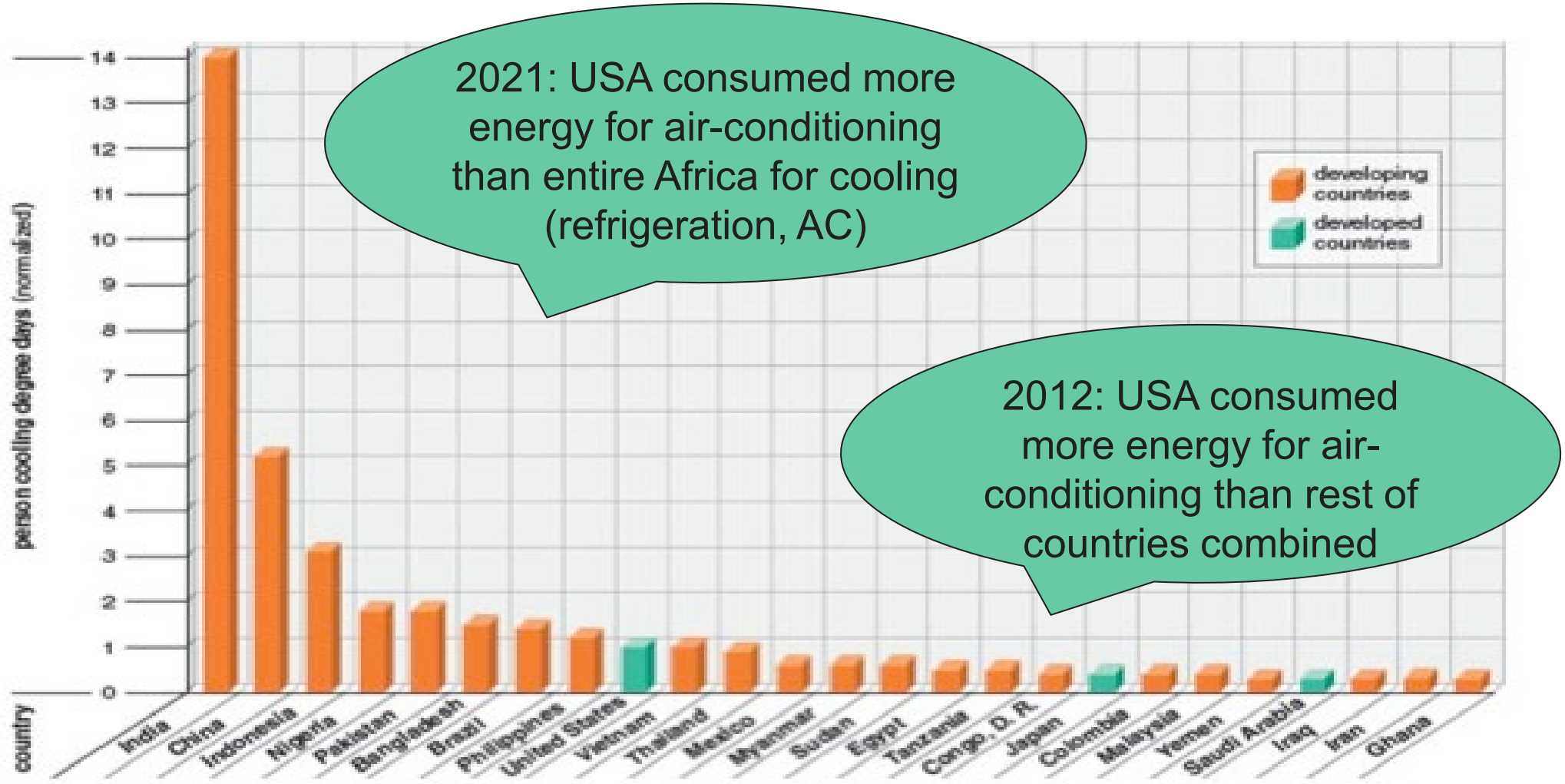
Growth of air-conditioning systems

- Sale of **10** new air-conditioning systems per second over the next 30 years
- According to the IPCC, global energy demand for air conditioning in residential buildings will increase **33-fold** between 2000 and 2100, especially in developing countries
- The number of air conditioning split residential systems worldwide is expected to increase from **0.85 billion in 2016** to over **3.7 billion in 2050**, and **5.9 billion in 2100**
- The cooling sector is responsible for around **40%** of electricity consumption in urban areas



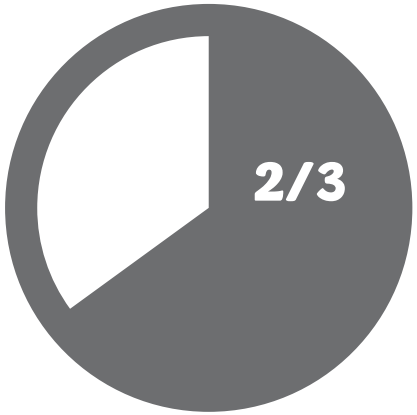
Sources: The Economist, Intelligence Unit, "The Cooling Imperative: Forecasting the Size and Source of Future Cooling Demand", 2019.
IEA, " The Future of Cooling", 2018.
P. Purohit, L. Höglund-Isaksson, N. Borgford-Parnell, Z. Klimont, and C. J. Smith, "The key role of propane in a sustainable cooling sector", 2022.

Potential AC demand [~2100]

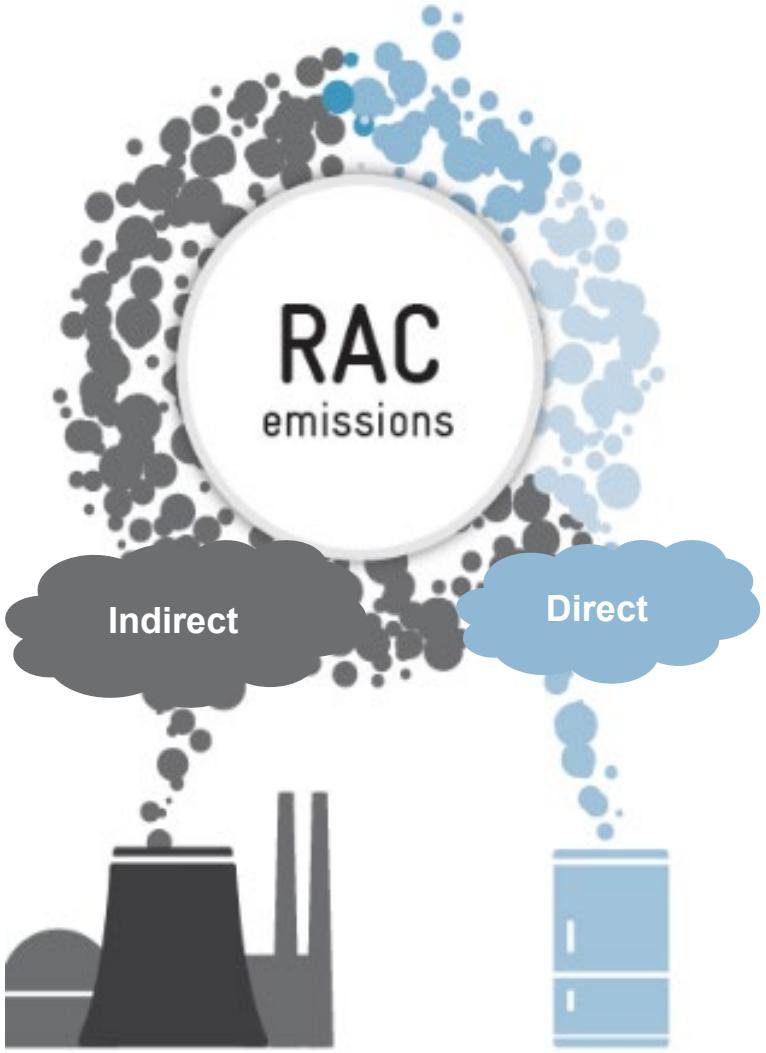


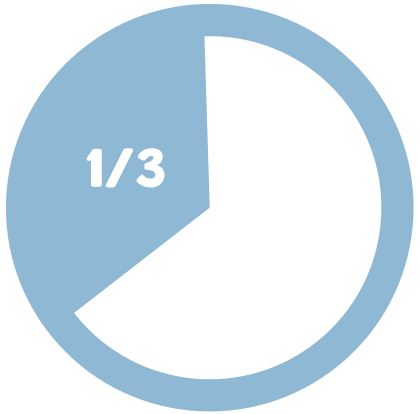
Sources: M. Sivak, “Will AC put a chill on the global energy supply?,” 2013.

Emissions from the RAC Sector



Indirect emissions are related to the energy consumption of cooling appliances.



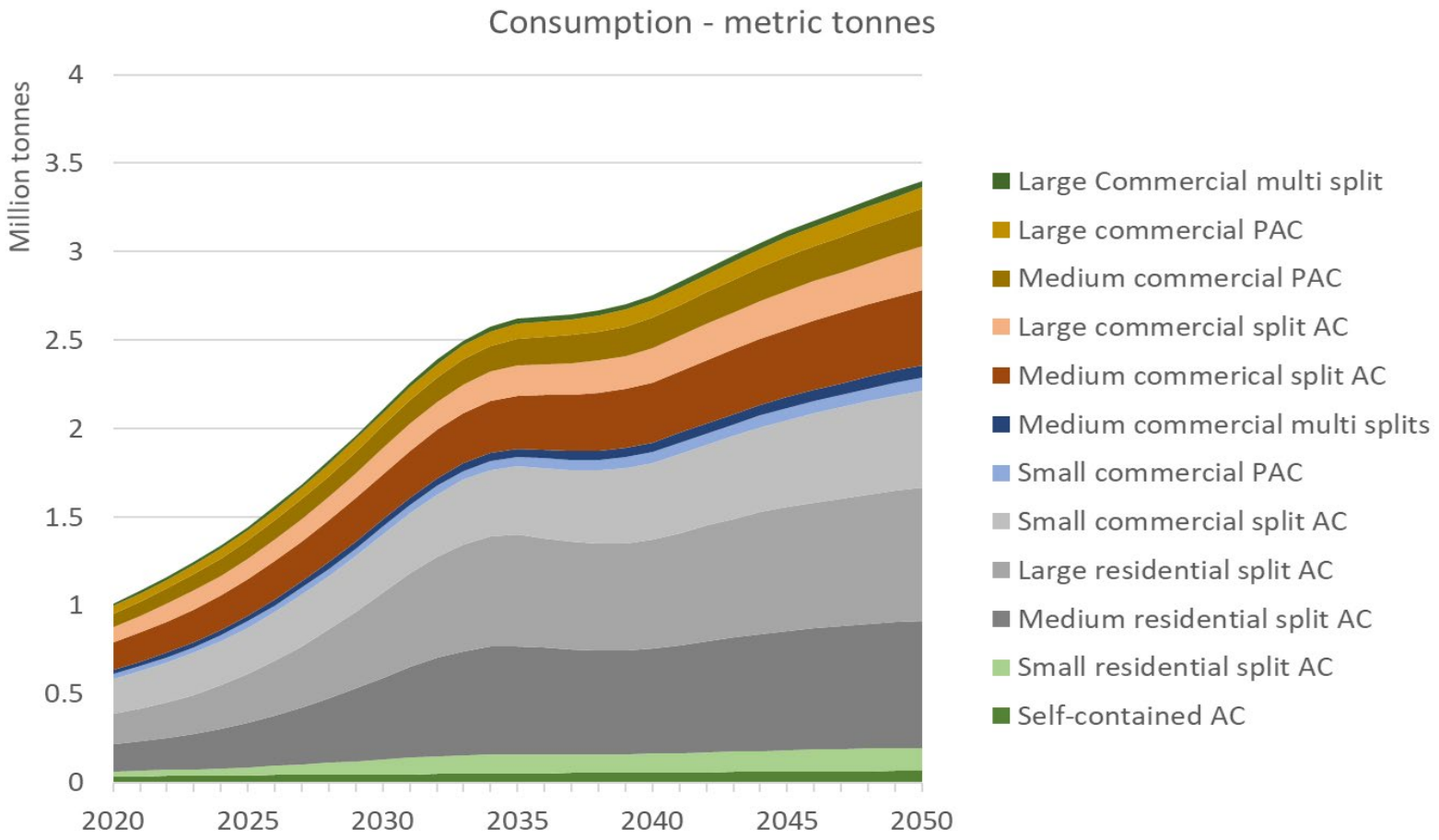


Direct emissions arise when refrigerants are released.

Sources: GIZ Proklima

Dramatic increase of refrigerant consumption for Unitary ACs

- Refrigerant consumption in increasing from 1 to 3.5 million tonnes from 2020 - 2050
- Small and medium sized equipment is the majority
- About 1/3 of the quantity of refrigerants is required for large equipment

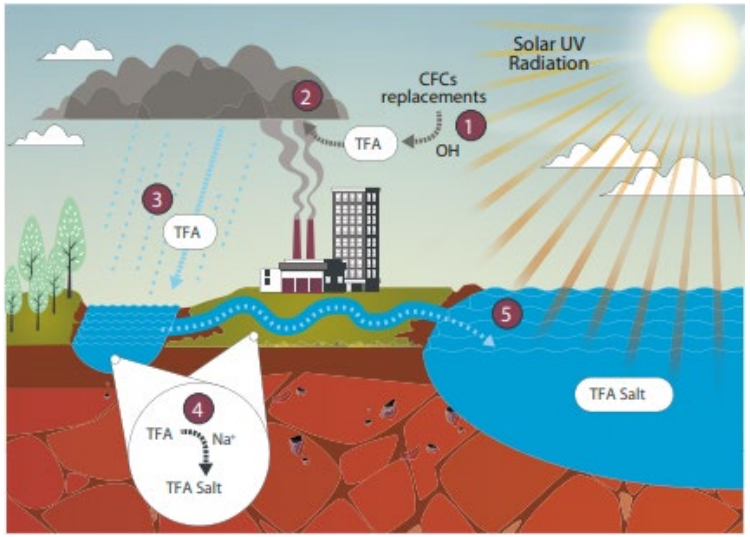


Sources: GIZ/HEAT projections based on IEA 2019

A brief on refrigerants

Present and future options for split air conditioning

Refrigerant	Type	GWP 20	GWP 100	PFAS	TFA
R22	HCFC	5690	1960	No	No
R410A	HFC blend	4850	2256	Yes (R125)	No
R407C	HFC blend	4519	1908	Yes	Up to 20% R134a (52%)
R32	HFC	2690	771	No	No
R454B	HFC/HFO blend	2040	531	Yes	Up to 100% R1234yf (31%)
R454C	HFC/HFO blend	638	166	Yes	Up to 100% R1234yf (79%)
R1234ze(E)	HFO	4.94	1.37	Yes	Up to 10%
R1234yf	HFO	1.81	0.501	Yes	Up to 100%
R744	Natural (CO_2)	1	1	No	No
R290	Natural (Propane)	0.072	0.02	No	No

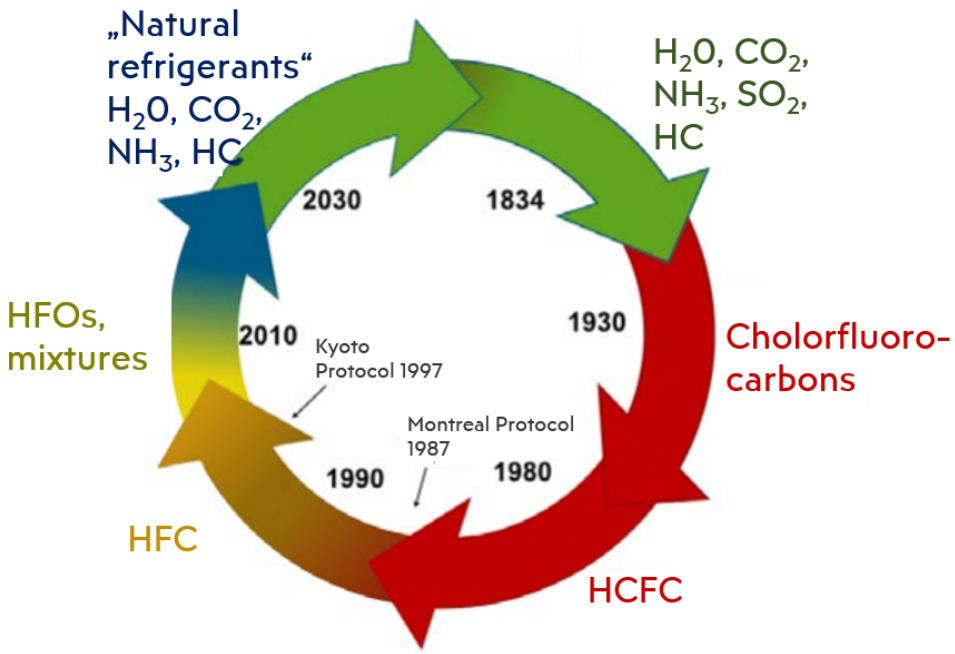


PFAS (forever chemicals) are not manageable, and all efforts should be undertaken to avoid them as completely as possible.

Per- and polyfluoroalkyl substances (PFAS) are a large class of synthetic chemicals that increasingly detected as environmental pollutants and linked to negative effects on human health. **Trifluoroacetic acid (TFA)** is an ultra short chain type of PFAS, commonly found in the breakdown of f-gases.

Sources: IPCC, 2021: 6th Assessment Report of the IPCC (Table 7.SM.7).
Behringer, D. et al. 2021: Persistent degradation products of halogenated refrigerants and blowing agents in the environment, Final report.
Climate-friendly alternatives to HFCs (europa.eu)
H. Brunn, et al., "PFAS: forever chemicals—persistent, bioaccumulative and mobile. Reviewing the status and the need for their phase out and remediation of contaminated sites," 2023.

Evolution of refrigerants



Ozone Depleting Substances (ODS): Artificially induced substances that deplete the ozone layer (-> the earth's protection against UV rays is reduced).

No ozone depletion potential (ODP) but high global warming potential (GWP)

Natural substances with low environmental impact, i.e. no ODP and low GWP

- Natural refrigerants were the first refrigerants to be used in cooling and heating systems.
- CFCs, HCFCs, HFCs, and HFOs have shown to have ozone, climate, multiple environmental and health effects (ODP, GWP, PFAS and TFA).
- Natural refrigerants do not have harmful impact to ozone layer, climate, environment, health and are very efficient.

Road map to Green Cooling – How to leapfrog?

Instant switch to highly **energy-efficient** split ACs with **natural refrigerants** (R290) without relying on climate and environmental damaging interim technologies.

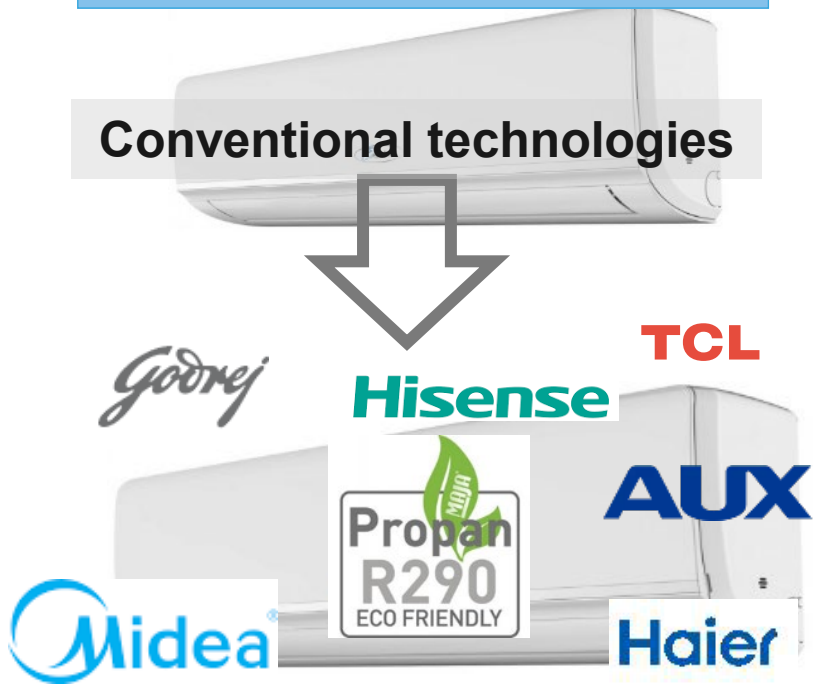
Exchange of conventional ACs by Green ACs (high energy efficiency and natural refrigerant (R290)

- **Over lifetime (10 years) per AC:**
  - Reduced energy consumption, on average by **5,000 kWh***
  - Significant cost reduction for consumers and government
  - Reduced emissions on average of **5-10 t CO_2eq***

- **Equivalent to emissions of:**
  - Approx. up to 3 return travels **South Africa - Frankfurt**
  - Approx. **15 - 30,000 km**

R22 (**GWP 1960/5690**)
1 kg = 1.9 / 5.6 tonnes CO_2eq

R410A (**GWP 2256/4850**)
1 kg = 2.3 / 4.9 tonnes CO_2eq



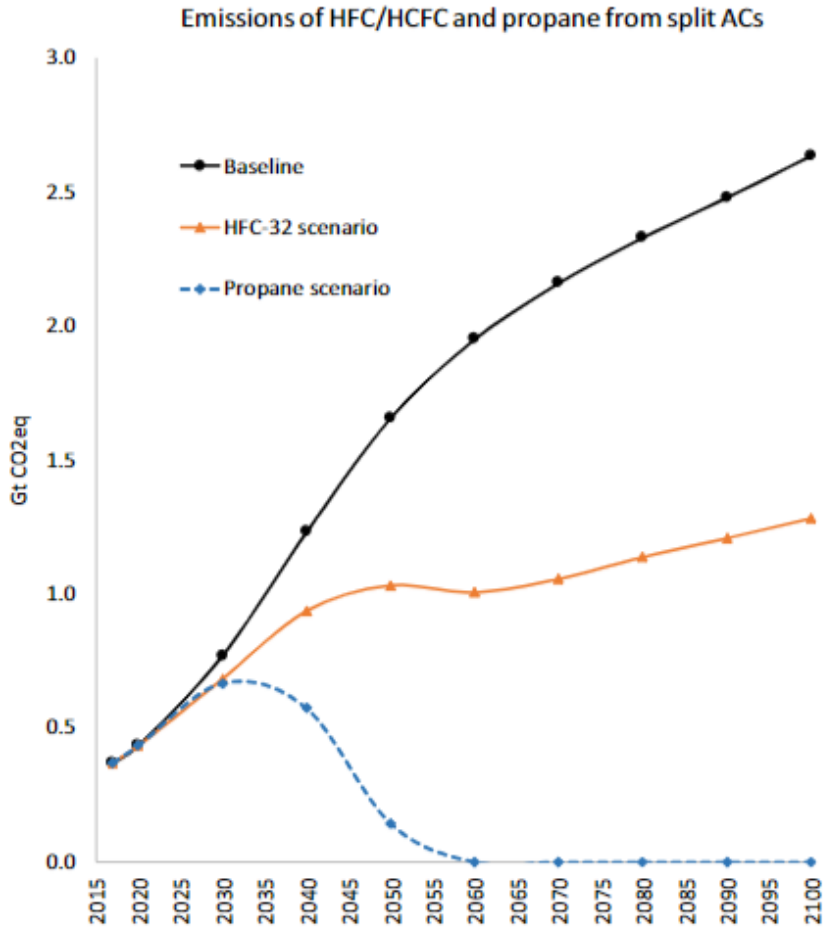
GWP 0.02/0.072
(1 kg = 0.02 / 0.072 kg CO_2eq)

Sources: IPCC 6th Assessment Report (GWP 100 or 20 years data) *depending on grid emission factor, running hours, etc.

Mitigation potential of R290 ACs until 2100

Accumulated mitigation potential of up to **128 Gt CO_2eq.** Of R290 ACs until 2100

- Life Cycle Climate Performance (LCCP) approach includes direct, indirect, and refrigerant manufacture emissions
- Average capacity: 5.7 kW (18k BTU/h)
- Baseline scenario: Follows the schedule of HCFC Phase Out Plans. New equipment would use R410A. R32 reached 40% share in 2019 and maintains it as such after that. Schedules of F gas regulations are also considered.
- HFC 32 scenario: R32 substitutes R410A completely.
- Propane scenario: Propane substitutes R410A completely.
- Compared to HFC-32 scenario, the mitigation potential with propane could be **64 Gt CO_2eq.**

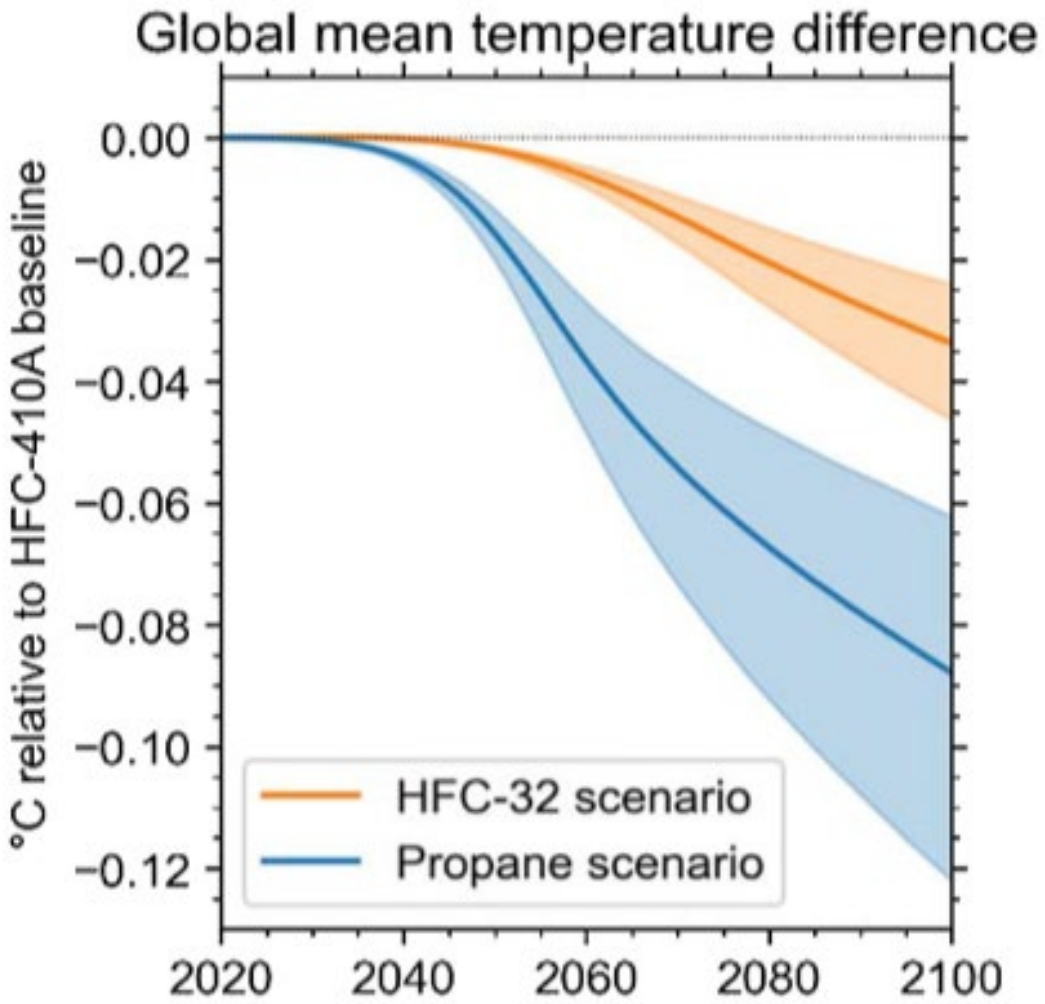


Sources: P. Purohit, L. Höglund-Isaksson, N. Borgford-Parnell, Z. Klimont, and C. J. Smith, “The key role of propane in a sustainable cooling sector”, 2022.

Untapping the potential of ultra-low GWP ACs

Up to a potential **0.12 °C avoidance** potential!

- HFC 32 scenario: R32 substitutes R410A completely.
  - -0,03 °C (0,02 – 0,05)
- **Propane (R290) scenario: Propane substitutes R410A completely.**
  - **-0,09 °C (0,06 – 0,12)**
- **Propane (R290) exhibits significant environmental advantages through good energy performance and a GWP close to zero**
- Leapfrogging from HCFC-22 or HFC-410A units to high-efficiency appliances using propane reduces energy consumption and GHG emissions and thus provides a significant opportunity to contribute to national climate action plans



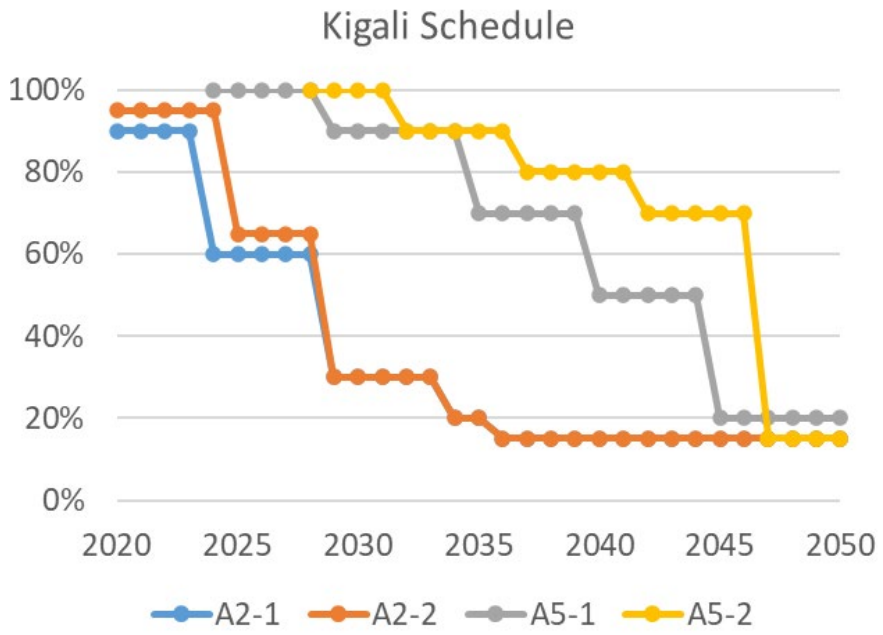
Sources: P. Purohit, L. Höglund-Isaksson, N. Borgford-Parnell, Z. Klimont, and C. J. Smith, “The key role of propane in a sustainable cooling sector”, 2022.

F-gas product bans and phase downs

European f-gas Regulation (2023)

	Capacity	Ban	Year	
Splits AC	Single Split < 3kg charge	≥ 750 GWP	2025	
	Split air-water ≤ 12 kW	≥ 150 GWP	2027	Except when required for safety standards
	Split air-air ≤ 12kW	≥150 GWP	2029	
	Split ≤ 12 kW	no F-gas	2035	
	Split > 12 kW	≥ 750 GWP	2029	
		≥150 GWP	2033	

Kigali Amendment (2016)



Sources: EU f-gas regulation 2023
The Kigali Amendment (2016): The amendment to the Montreal Protocol agreed by the Twenty-Eighth Meeting of the Parties

Germany’s Eco Label

Good for me.
Good for the environment.

R290 split AC production capacities and installed units

- 2011 Conversion of R290 split AC production line in China (Gree) and in India (Godrej) – IKI BMU GIZ Projects
- 2013 conversion of 21 R290 split AC production lines of 8 AC Chinese manufacturer – HPMP China
- Many other production lines of different manufactures in different countries have been converted to R32/R290 according to ATEX safety requirements – HPMPs and financed by the manufacturers

→ **Global production capacities for R290 split ACs given!**

- Approx. 1,000,000 R290 split ACs installed in India and 500,000 in China
- Safety standard IEC 60335-2-40 (2022) permits up to 1 kg of R290 charge
- Training concepts and certification schemes exist and are crucial (only certified technicians are permitted to install R290 split ACs)

→ **Proven and safe technology, so let's start global upscaling now and avoid up to 0.12 °C and avoiding also the topic of end of life of old HCF / HFO refrigerants!**

Project examples of R290 split AC

CooPSA

Introduction of highly energy efficient R290 ACs and piloting of Article 6 as a funding mechanism in Botswana, Eswatini, Namibia and Aouth Africa

Ghana Green Cooling

Pioneering a KliK Foundation Article 6.2 project to introduce highly energy efficient R290 split ACs in Ghana

AGORA

Piloting highly energy efficient R290 split ACs in Ghana and Nigeria

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Promoting R290 ACs under the Art. 6.2 Cooling Program for Southern Africa

Philipp Denzinger, GIZ Proklima

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Context in the SADC region

Number of Air Conditioners (ACs) in the SADC region will **increase from 5.4 million to** around **17.7 million by 2030**

Increasing AC demand

Climate and energy plans of the SADC members **call for GHG emission reductions and energy efficiency improvements** in the cooling sector

Climate & energy needs

PARIS2015 UN CLIMATE CHANGE CONFERENCE COP21·CMP11

30 MONTREAL PROTOCOL for all life under the

AGENDA 2030

Higher costs and the inaccessibility of ACs using natural refrigerants with ultra-low GWP impact **are major obstacles** to a sustainable transformation of the sector

Obstacles for Green ACs

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Cooling Program for Southern Africa (CooPSA) – Overview

Objective: Exchange programme in which approx. 18,000 conventional Air Conditioners (ACs) are replaced by Green ACs and Internationally Transferrable Mitigation Outcome (ITMOS) under Art. 6 are piloted as a funding mechanism.

Project duration: Up to 12/2026

Project budget: 7 million EUR

Commissioned by:

Supported by:

Federal Ministry for Economic Affairs and Climate Action

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on the basis of a decision by the German Bundestag

Implemented by:

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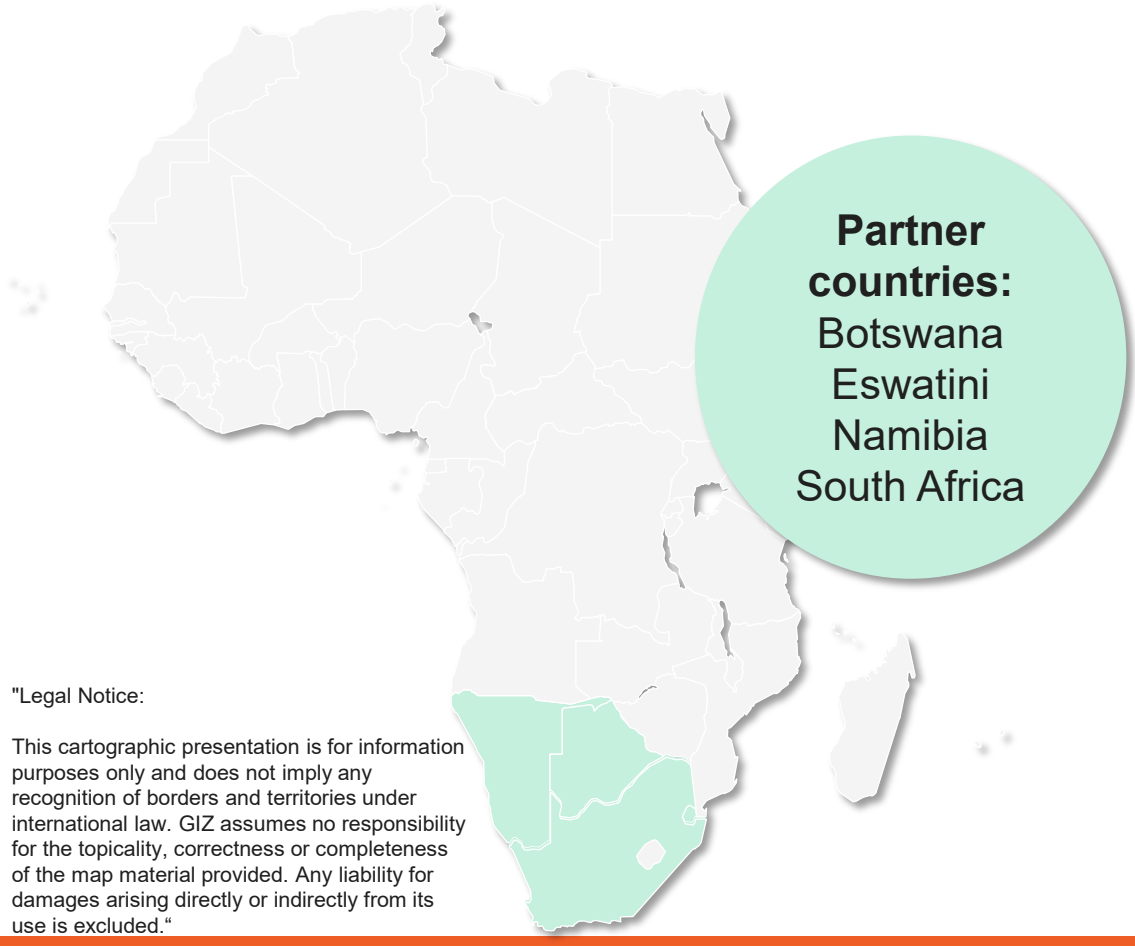
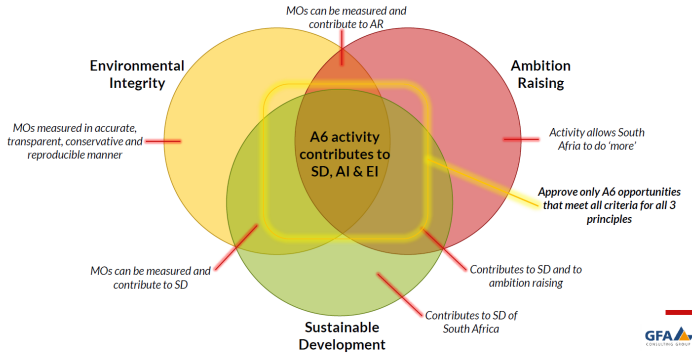


Components of the Cooling Program for Southern Africa

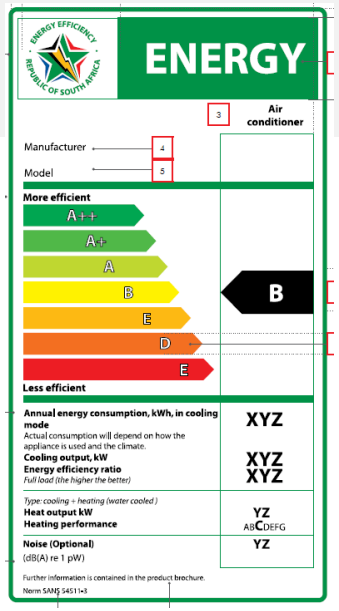
Carbon Finance

Partner countries applied Art.6 frameworks on the cooling program and apply monitoring, reporting and verification (MRV) and standard operating procedures (SOPs) for recording emission reductions and financial flows.



MEPS, Labels and Enforcement

Minimum Energy Performance Standards (MEPS) and energy labels for ACs have been established and enforced in the partner countries.

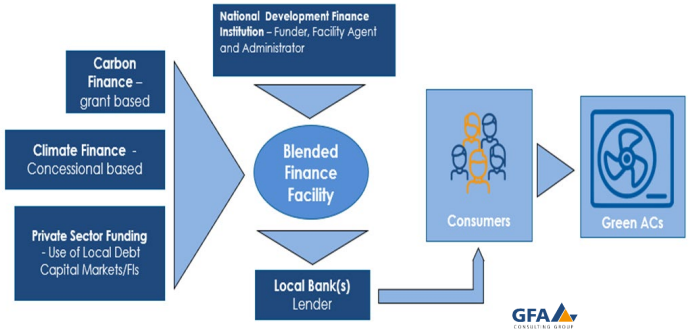


Replacement of current ACs by Green ACs

An AC replacement programme for Green ACs is operational for at least 18,000 Acs. The porgramme includes a comprehensive training component and also addresses End of Life of old equipment and refrigerants.

Financing instrument

A comprehensive blended finance instrument for the market launch of Green ACs is implemented in close coordination with suitable development banks, commercial banks and, where appropriate, private sector participants, e.g. electricity utilities, potential ITMO buyers.



QCR System is essential – only certified technicians are permitted to work on flammable refrigerants!

(1) Qualification

- We provide 14 modules - freely accessible and free of charge for partner countries
- We check refrigeration curricula according to international standards
- We support training institutes in revising their curricula and, if necessary, integrating modules into their curricula
- We conduct trainings for teachers (Trainings of Trainers)

(2) Certification

- We develop certification systems together with the national authorities
- We provide exemplary examination questions and "Competencies to assess“
- We cooperate with certification bodies and expand their capacities
- We develop systems to recognize prior learning experiences

(3) Registration

- We advise on national registration systems and identify needs
- We advise on licenses for technicians

Timeline

2021 2022 2023 2024 2025 2026 2027 2028

Preparation phase 1 million EUR

Preparation of framework conditions for an AC exchange program

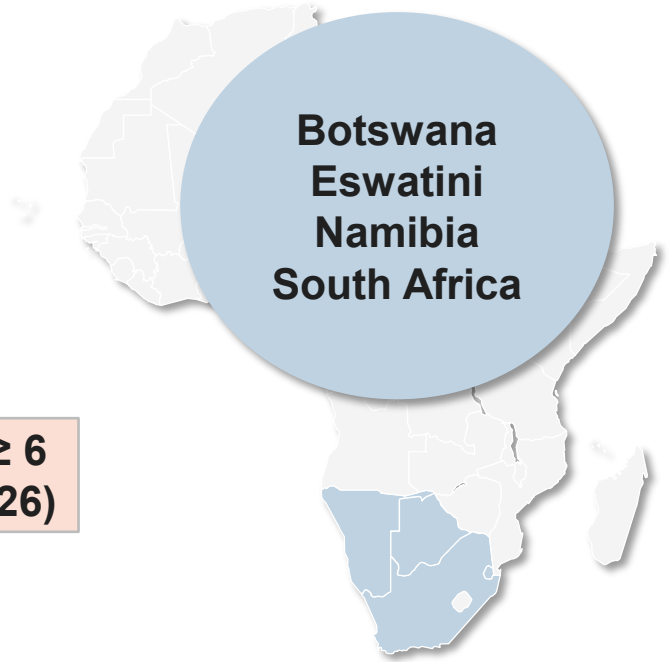
Pilot implementation phase ≥ 6 million EUR (01/2024 – 12/2026)

Financing mechanism

AC replacement

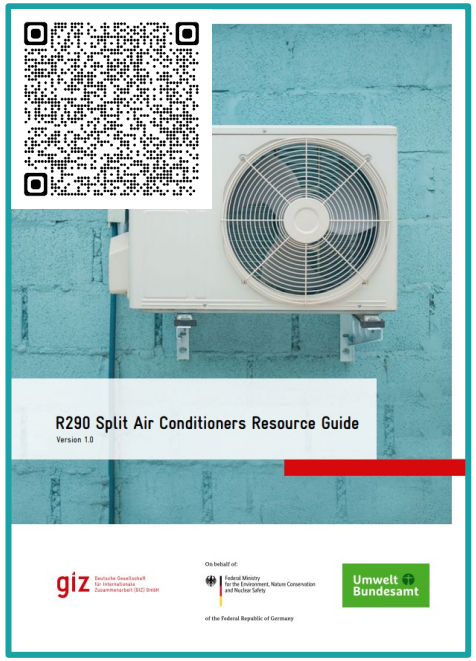
Replication / up-scaling phase

Global transition

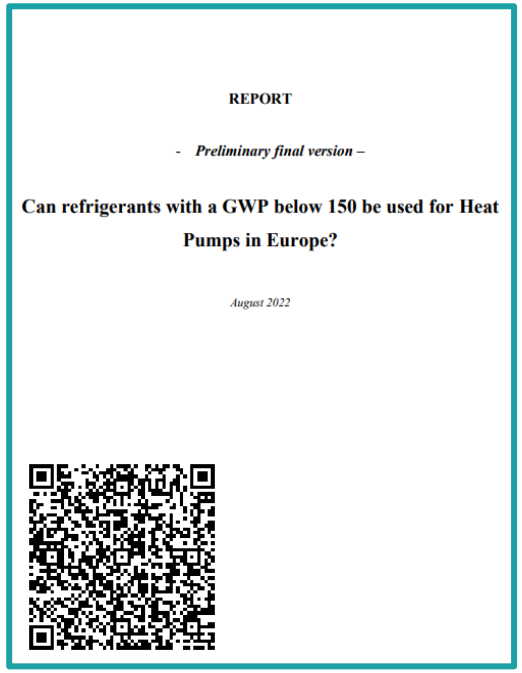


>150 million units/year << 1% climate-friendly

R290 split ACs – Read our publications

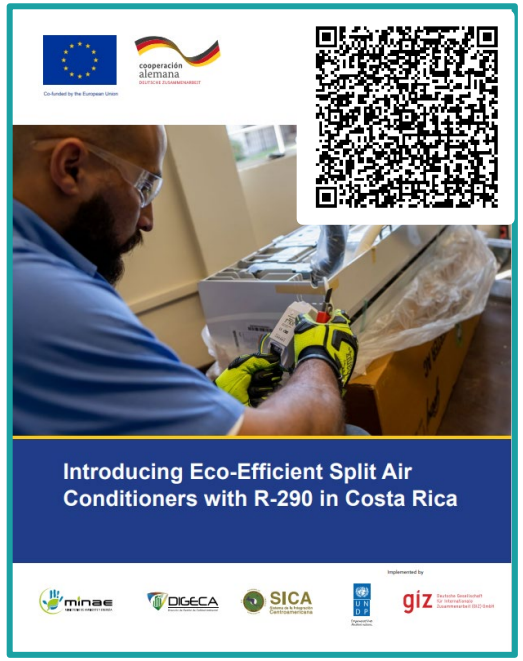


R290 Split Air Conditioners Resource Guide (Download)



Can refrigerants with a GWP below 150 be used for Heat Pumps in Europe? (Download)

International Safety Standards for RAC 2023 (Download)



Introducing Eco-Efficient Split Air Conditioners with R-290 in Costa Rica (Download)

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www.green-cooling-initiative.org

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Promoting R290 ACs under the Carbon Market Art. 6.2

Daniel Tutu Benefoh, EPA Ghana

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Green Cooling Ghana project on R290 ACs

Ursula Flossmann-Kraus, KliK Foundation

Green Cooling Ghana programme on R290 ACs

Article 6 programme with GIZ

Overview

- Ghana and Switzerland signed bilateral cooperation agreement on Article 6.2 cooperation in November 2020
- RAC sector emissions and trajectory are relevant

- ITMO programme **Market transformation through the introduction of Green split ACs** aims at:
  - Introducing 150’000 green ACs
  - Training
  - End of Life Treatment (EoL)
  - Reducing approx. 500’000 t CO2-eq

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Green Cooling Ghana programme on R290 ACs

Article 6 programme with GIZ

Structure

- Main players: AC importers, training institutes, GIZ, EoL facility manager, KliK Foundation, retailers
- KliK Foundation pays a subsidy (top up) through to the AC importers; importers use subsidy to enable market entry of green ACs
- Subsidy (top up) to importers will be paid out after proof of installation of AC
- Giz will set up a training programme for RAC technicians
- Technicians receive an incentive for every old AC / kg of refrigerant returned for recycling or destruction at destruction facility
- KliK Foundation pays for training of RAC technicians and destruction costs of old refrigerants at EoL facility

Green Cooling Ghana programme on R290 ACs

Article 6 programme with GIZ

Challenges

- Avoiding the lock in of high GWP refrigerants
- Kigali alignment and alignment of inventory calculation between Transferring Country and Buyer Country
- Capacity building and Results Based Finance (RBF)
- Monitoring of 150’000 ACs in households and businesses across the country

Green Cooling Ghana programme on R290 ACs

Article 6 programme with GIZ

Benefits beyond ERs

- Technology transfer and leapfrogging
- Energy savings
- Balance consumption spikes
- Capacity for the RAC sector (training and certification of at least 500 RAC technicians)
- Achievement of post 2030 Kigali commitments

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Ursula Flossmann-Kraus,

Carbon Procurement Manager

KliK
Foundation for
Climate Protection and
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FEDERAL MINISTRY OF ENVIRONMENT

ENERGY COMMISSION OF NIGERIA

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ENERGY COMMISSION
Securing Ghana's Energy Future Today

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AGORA R290 AC Project Ghana and Nigeria: updates and next steps

UNDP

U4E United for Efficiency

Selimcan Azizoglu, UNDP (virtually)

Funded by: Fonds Francais pour l'Environnement Mondial (FFEM)

Co-financed by: the Multilateral Fund for the implementation of The Montreal Protocol (MLF)

FONDS FRANÇAIS POUR L'ENVIRONNEMENT MONDIAL

Multilateral Fund for the Implementation of the Montreal Protocol

Proposed Agenda

- Presentation of the project & its partnerships
- Specific support to the R290 technology promotion
- Conditions of success and Next steps

AGORA genesis

Building on pre-existing experiences in Ghana and Nigeria and current work:

- Take-back mechanism with MLF and GEF in Ghana for refrigerators (completed)
- Air conditioner MEPS, labelling, MVE project by Nigeria EC and U4E (underway)
- Expanding the market-based EcoFridges project of Gvt of Ghana (Energy Commission-led) and U4E in Ghana and creating similar financial mechanism in Nigeria

  New report by U4E on EcoFridges launched in October at the MOP: Insights
- Complements initiatives supported by GIZ for refrigeration and e-waste, as well as Article 6 work by UNDP and bilaterals (Ghana/Switzerland/UNDP)
- Combines EE promotion, introduction of new technology (R290 in AC) and circular economy (recovery of old appliances)
- A call by FFEM on sustainable Cooling: project approved - Euros 2,484,600 total budget by the French Fund for Global Environment (FFEM), HPMPs as co-finance (Eur 7,355,000)

AGORA partnerships

- Funding: FFEM (and through the HPMPs, the MLF)
- Execution (global) : UNDP and UNEP U4E
- At national level:
  - Ghana EPA (NOO) and Energy Commission
  - Nigeria FMEnv (NOO) and Energy Commission
- Many partners to be involved (national private banks, suppliers / importers, retailers, standards organisations, customs…)
- Will address complementary dimensions: the recovery of refrigerants (HPMPs reclaim centres, end-of-life), the ban on second-hand equipment, the phase-down of HFCs (KIPs)

Promotion of R290-based AC units

- This complements the support to refrigerators with R600a
- Based on the challenges in having importers select R290 as technology in Ghana
- Based on priority in Ghana climate strategy of R290-based units for market penetration
- Based on priority for leapfrogging to natural refrigerants in Ghana and Nigeria
- Ambition of the 2 countries shown by being founding signatories of the Cooling Pledge at this COP
- Considering a subsidy mechanism for selection of R290-based energy-efficient units

Key activities

- Adoption and enforcement of a ban on the importation of second-hand RAC equipment
- Implementation of a financing and rebate mechanism, using the lessons learned from Ghana
- Strengthening the sustainability of end-of-life treatment of RAC equipment
- Strengthening of the programme monitoring, reporting and verification system
- Transfer of experiences between Ghana and Nigeria on used RAC equipment ban policies and discount schemes
- Initiating replication of the project at regional level

Conditions of success and next steps

- Good coordination with other ongoing activities in 2 countries (including with GIZ)
- Integration with MLF Activities
- Flexibility in designing the mechanism
- Developing a self-sustaining system to accelerate market-transformation
- Working closely with suppliers of R290 technology
- Effective communication plans and KM of lessons learnt
- Launch of the project planned in Q1 of 2024

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Selimcan Azizoglu,

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Q & A

● MONTREAL PROTOCOL
▶ ADVANCING
✱ CLIMATE ACTION

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Thank you for listening!