



OEWG48

Bangkok
13-17 July 2026

The Future is now!

Proved and Available F-gas Free
Cooling Technology



Agenda

Opening remarks

Sebastian Schnatz, BMUKN

(German Federal Ministry for the Environment, Climate Action,
Nature Conservation, and Nuclear Safety)

Off-grid Solar Cold Rooms with Propane

Examples from West & East Africa

Habib Bellagha, Afric Froid & Frigo Indus

Future Proof CO2 Solutions

Examples from Asia

Jefferson Li, CCR Asia

Active Cooling Textiles

Examples from Europe

Sabine Stein, E.COOLINE / Pervormance

Economic benefits from leapfrogging to F-
gas free solutions

Guntram Glasbrenner, GIZ Proklima

Q&A

Wrap up and Closing

Guntram Glasbrenner, GIZ Proklima

Facilitation: Kerstin Kress, GIZ Proklima



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Federal Ministry
for the Environment, Climate Action,
Nature Conservation and Nuclear Safety

Opening Remarks

Sebastian Schnatz, German Federal Ministry for the Environment, Climate Action, Nature Conservation, and Nuclear Safety (BMUKN)



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Off-grid Solar Cold Rooms with Propane – examples from West & East Africa

Habib Bellagha, Afric Froid & Frigo Indus



R290 NATURAL REFRIGERANT SOLUTIONS

Propane Cold Chain Projects with GIZ Proklima

Off-grid solar cold rooms and ice-making across West & East Africa

ETHIOPIA

SENEGAL

MALI

BURKINA FASO

GHANA

Who We Are

Afric Froid (Frigo Indus Group) is an industrial refrigeration specialist headquartered in Manouba, Tunisia, with an active presence in Senegal and Côte d'Ivoire.

We deliver turnkey cold-chain projects — from design and equipment fabrication to on-site installation and after-sales maintenance.

Over the past five years, we have shifted our refrigeration offer toward natural refrigerants, building a strong partnership with GIZ on cold-room and chiller projects across Africa.

1992
Company founded

3
Countries with offices

ISO 9001:2015
Certified quality management

5+ yrs
Natural-refrigerant partnership with GIZ

Why Propane (R290)?

ADVANTAGES

- ✓ High COP — superior energy efficiency vs. HFC alternatives
- ✓ Full range of compressor types and capacities available
- ✓ Ultra-low GWP = 0,072 — virtually no direct climate impact
- ✓ Widely available, low-cost commodity refrigerant

CONSIDERATIONS

- ⚠ A3 classification — flammable refrigerant by nature
- ⚠ Refrigerant charge is limited by the confinement volume of the space
- ⚠ ATEX-rated safety components required (gas sensors, ventilation)
- ⚠ Specialized equipment carries a higher upfront cost

R290 vs. R404A — Head to Head

GLOBAL WARMING POTENTIAL (GWP) 20 years

0,072 **7 208**

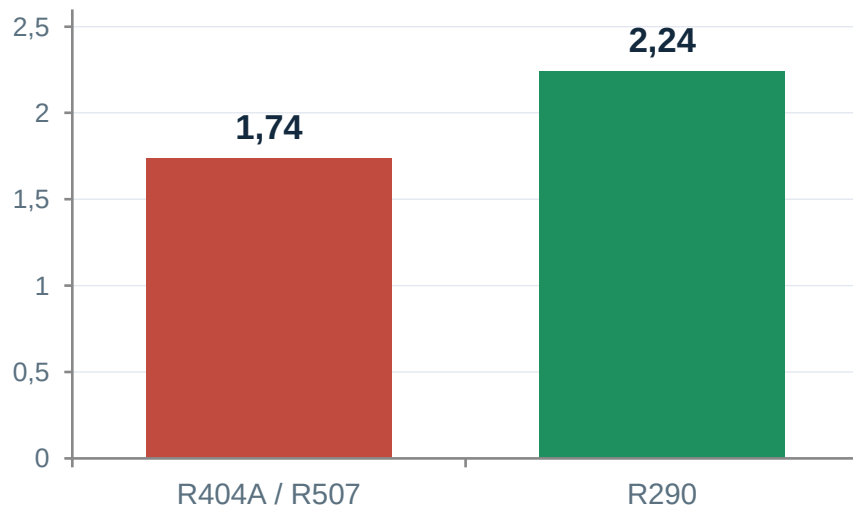
R290 (propane)

R404A

R290's climate impact is negligible by comparison — near-zero direct GWP contribution.

R404A remains a high-GWP HFC blend, phased down under F-Gas regulation.

COEFFICIENT OF PERFORMANCE (COP)



Bock HG12P/110-4S compressor · Te -10 °C / Tc 48 °C · manufacturer selection software

Our R290 Project Portfolio

1



ETHIOPIA

6 refrigerated containers, ice-accumulation chiller, off-grid solar power

2



SENEGAL

Ndioum cooperative cold room + ice maker, solar-assisted

3



MALI

Kayes dual-section cold room + ice maker, solar-assisted

4



BURKINA FASO

Ouagadougou municipal slaughterhouse, two cold rooms (ROCA Lot 3)

5



BURKINA FASO

SOGEAO slaughterhouse — centralized indirect R290 chiller

6



GHANA

Accra nZEB building — centralized chiller, 18 ceiling cassettes

All projects delivered in partnership with GIZ across West & East Africa.

Off-Grid Solar Cold Chain



-  GIZ partnership
Pilot project delivered in cooperation with GIZ
-  6× mobile cold rooms
Refrigerated 20-foot containers, fully self-contained
-  Ice-accumulation chiller
Chilled-water system cooled with R290 (propane)
-  Off-grid solar power
No connection to the electrical grid required

Smart Energy Management: Ice Accumulation



DAYTIME — Solar Available

- ✓ Solar PV powers the compressor and condenser directly
- ✓ System actively chills water / builds ice in the accumulator tank
- ✓ Batteries recharge simultaneously for overnight reserve



NIGHTTIME — Stored Energy

- ✓ Compressor stays OFF — a timer prevents nighttime operation
- ✓ Only the circulation pump and evaporator fans run, on battery power
- ✓ Stored ice keeps the chamber cold with minimal energy draw

Result: the compressor never runs at night, protecting battery autonomy while the chamber stays cold.

Managing Intermittent Solar Power



Inconsistent availability

Solar power is only available roughly 6:00–18:00, and fluctuates with cloud cover



Lithium battery bank

Buffers short-term fluctuations and powers night-time pump / fan loads



Frozen-water battery

The ice accumulator itself acts as a thermal battery, storing cooling capacity



Timer-controlled compressor

A time switch restricts compressor operation to daylight hours only



Daily power curve: PV output vs. battery SOC (%)

Field Installation



Solar array on container roof



Lithium battery bank



Solax inverter & control panel



R290 condensing unit



Refrigerated container interior



Ice-accumulator coil bank

Kayes Cooperative — Dual Cold Room

Beneficiary: agricultural cooperative, region of Kayes, Mali — processing and marketing produce and fish.

VEGETABLE SECTION

Product

Potatoes, onions

Room size

$6.6 \times 3.8 \times 2.4 \text{ m}$ (60.2 m³)

Storage temperature

-0.5 to +6 °C

Refrigeration unit

R290 monoblock, ≈ 8 kW

FISH STORAGE SECTION

Product

Fresh fish, iced on arrival

Room size

$6.6 \times 1.6 \times 2.4 \text{ m}$ (25.3 m³)

Storage temperature

+4 to +6 °C

Refrigeration unit

R290 monoblock, ≈ 4 kW

Both sections share a solar PV supply and a chipped-ice maker ($\geq 1,250 \text{ kg} / 5 \text{ days}$) for fish transport.

Field Installation — Kayes



Rivacold R290 monoblocs on roof



Cold room + pre-room sliding doors



Flake ice production



Ground-mounted solar array



Solax inverter & control cabinet



Insulated sandwich-panel cold room

Solar Performance — Live Monitoring



8.6 kW
Peak solar production recorded

17.0 kWh
Best daily energy yield

90.8 kWh
Cumulative yield since commissioning

100%
Off-grid / generator-backed autonomy

Solar PV feeds the Solax hybrid inverter, which powers the R290 monoblocs, ice maker and electrical cabinet directly.

A generator input provides backup during extended low-sun periods, keeping the cold chain unbroken.

Ndioum Cooperative — Saint-Louis Region

Beneficiary: agricultural cooperative of over 11,000 members in the department of Podor, storing onions, tomatoes, eggplant and okra.



Cold room

$6.6 \times 3.8 \times 2.4$ m (60.2 m³), 150 mm PU panels



Storage temperature

-0.5 to +6 °C, 85% RH



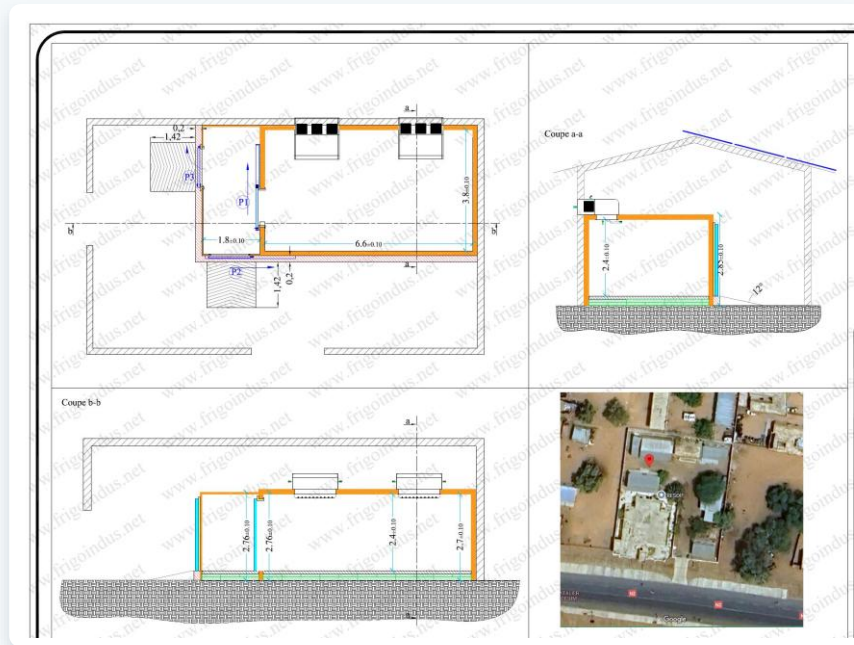
Refrigeration unit

1× R290 monoblock, ≈ 9 kW (COP 1.87 @ 35 °C)



Ice production

Chipped ice maker, ≥ 1,250 kg / 5 days



Frigo Indus execution plan — Ndioum, Lot 1

Municipal Slaughterhouse — ROCA Lot 3

Beneficiary: the main municipal slaughterhouse of Ouagadougou, processing roughly 40 carcasses (≈ 4 t) per day.



Two identical cold rooms

$7.2 \times 3.2 \times 2.6$ m each (59.9 m^3), 150 mm PU panels



Storage temperature

$+0.5$ to $+1.5$ °C for hanging carcasses



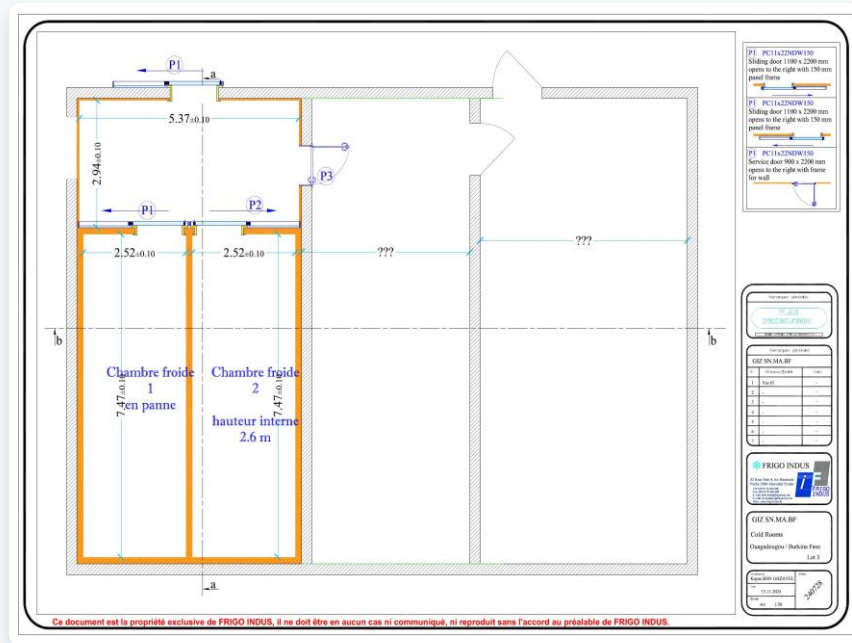
Refrigeration units

2× independent R290 monoblocks, ≈ 4 kW each



Ice production

Cube ice maker, $\geq 1,250$ kg / 5 days



Frigo Indus execution plan — Ouagadougou, Lot 3

Standardized Across the Cold-Room Projects



RIVACOLD SELECT 3.0 MONOBLOCK

- R290 charge · hot-gas defrost · ceiling-mount
- 3× hermetic Embraco compressors, 400V/3ph
- Sized 4–9 kW per project, air-cooled condenser

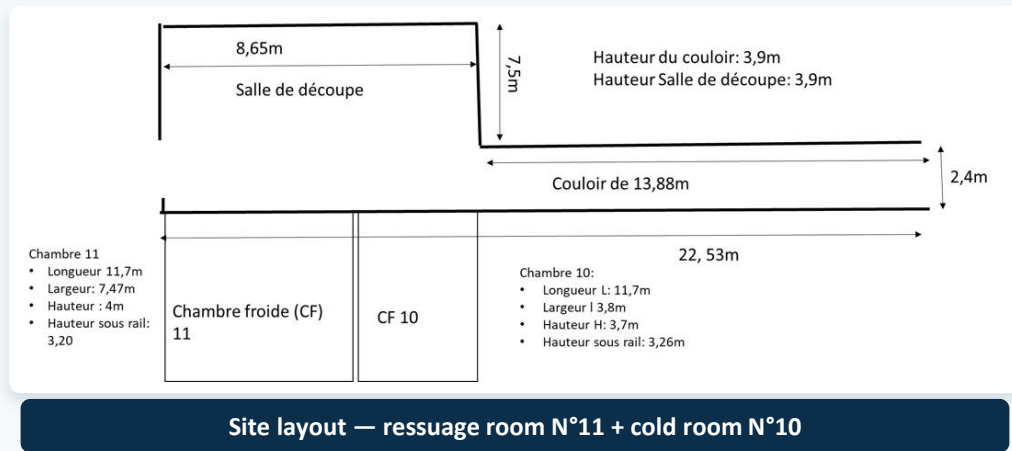


ZIEGRA COOLNAT ZBE 250 ICE MAKER

- 230 kg / 24 h flake ice, R290 charge (0.112 kg)
- Stainless-steel body (1.4301) · continuous duty 24/7
- Closed, hygienic water circuit — no ambient contamination

Used on the Senegal, Mali and Burkina Faso (ROCA Lot 3) cold rooms. Ethiopia, SOGEAO and Ghana run dedicated chiller systems — see their own slides.

SOGEAO Slaughterhouse — Centralized R290 Chiller



2

Cold rooms, one chiller

50 + 15 kW

Installed cooling capacity

12,000 kg/day

Combined meat intake

25%

Glycol secondary loop

Indirect system: 2× Bock HGX56e/995-4 HC semi-hermetic compressors, Danfoss glycol plate exchanger, GIZ Procedure 720005281.

A Purpose-Built Heat-Recovery Defrost System



Discharge heat reused

Hot discharge gas is reused via a dedicated plate exchanger — nothing wasted



Two independent glycol circuits

Separate loops for cooling and defrost heating, each with its own pump



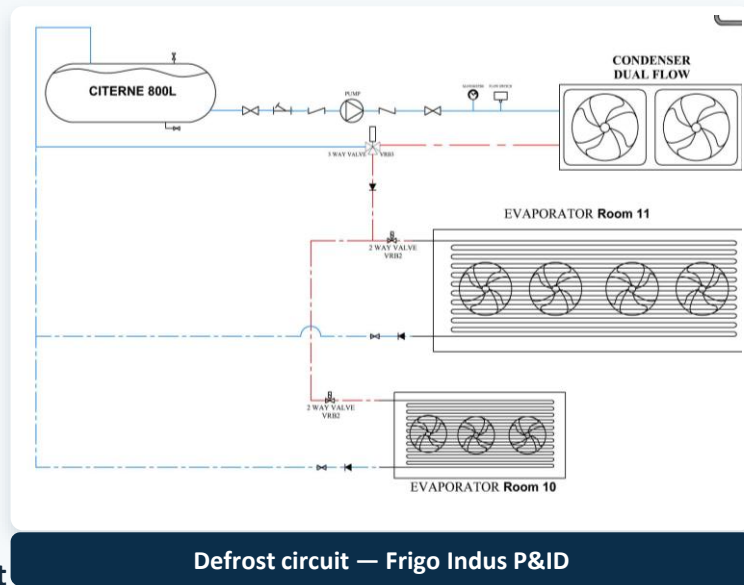
Warm-glycol defrost

Warm glycol defrosts the evaporators instead of electric heaters — faster cycles



Automatic mode switching

Two-way and check valves switch flow between cooling and defrost automatically



nZEB Building — Centralized Indirect R290 Chiller



Chiller + hydraulic module — factory rendering

114.6 kW

Total cooling capacity

COP 3.85

2× Bock HG56e/850-4S HC

18

Ceiling cassettes, G+1+2 floors

10 kg

R290 charge (5 kg / circuit)

Condenser: Thermokey JMKH 1280 B-90 microchannel, dual circuit · Plate exchanger: 120 kW, dual circuit · GIZ Procedure 7200075228.

Indirect Glycol System — 3-Floor Distribution



Indirect glycol loop

R290 stays in a single outdoor zone, cooling glycol water through a plate exchanger — no refrigerant piping inside occupied spaces



One centralized unit

A single outdoor chiller, with two independent circuits, covers the entire building's cooling load



18 ceiling cassettes

10× 7.1 kW + 8× 5 kW INTARCON units across Ground, 1st and 2nd floors



Full-inverter design

VFD on every compressor and on the secondary pump — capacity matches real load, saving energy



On-site installation — Accra,
Ghana



WHY AFRIC FROID

Your Trusted Partner for R290 Cold Chain Projects



Turnkey delivery

Design, fabrication, installation and commissioning under one roof



Trusted GIZ partner

Six R290 projects delivered for GIZ across four African countries



ISO 9001:2015

Certified quality management on every project



Local presence

Teams and after-sales support based in Tunisia, Senegal & Côte d'Ivoire

GET IN TOUCH



Z.I Ksar Said, 4 Rue Hamouda Pacha, Manouba, Tunisia



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Future Proof CO₂ Solutions – Examples from Asia

Jefferson Li, CCR Asia



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CCR – Future Proof CO₂ Solution for Global South

July 15, 2026 by Jefferson Li



CO₂ solution : future proof



United Nations
Climate Change

The
different

futures
that

lie
ahead.

+1.5°C

+2°C

+3°C

CCR: CO₂ leader in the industry (20 years+)



2700CO₂



Licensed by Carrier Corporation







1877 - 1961 The Birth of Refrigeration	1970 - 2000 Global Expansion and Key Innovations	2000- 2024 A New Era with Carrier	2025 - present A New Chapter: CCR Established
1877 Carl von Linde invents the world's first refrigeration machine (for beer cooling). 1926 Acquisition of Walb & Co., beginning the journey expansion 1954 Began building refrigerated display cases	1973 Supplied full range of display cabinets to German retailer Pinguin 1994 Installed over 60 NH₃ + HC with Indirect Brine Systems 1998 First experiments with CO₂ systems; acquisition of Profroid 1999 Acquisition of Electrolux Commercial Refrigeration business	2003 Linde's refrigeration business sold to UTC (Carrier) In the same year, installed the first transcritical CO₂ 2010 Acquisition of Green & Cool 2014 fully integrated into Profroid 2024 Carrier sold all commercial refrigeration businesses (Profroid, Green & Cool, and Celsior) to Haier	2025 CR established as the new Parent brand, bringing the entire portfolio together under a unified vision and set of values - Market Brands Global (except China): CCR Profroid Celsior Green & Cool - China: Haier Carrier Commercial Refrigeration

Core Legacy

From beer cooling → Transcritical CO₂ technology continuous innovation and sustainable refrigeration

Through the journey of Linde → Carrier → Haier CCR carries forward 150 years of industrial heritage

CO₂ LEADERSHIP 20~50% ENERGY SAVING & ZERO CARBON



R&D & Mfg.

150 years effort
German, France → China & Asia



Shanghai R&D



CO₂ lab

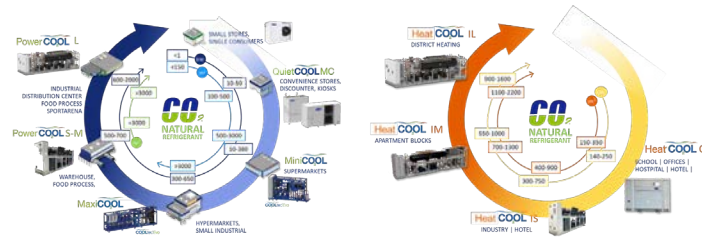


Qingdao high pressure CO₂ mfg. line



Products

Refrigeration & Heat Pump for all climate
Small to Large capacity, -40~90°C



Max. 1.5MW cooling

Max. 2.2MW heating



CO₂ product, solution, team in all continents

De-carbon. Economy

Cold Chain, Industrial, Sports, Public facility
Future Proof: Scalable, Affordable, Safe



Retail, Cold Storage



Food Cultivation



Food Processing



Bio & Pharma.



Ice & Snow



Hotel, Hospital, Airport



Robots, Data Center



Energy, District heating

CO₂ SOLUTION *CORE TECHNOLOGY*



Towards greater efficiency with **COOLtec[®]Evo**



¹ Annual energy saving, for rack only. Based on model store in mild climate, compared to 1st generation transcritical system.

60+ Patents
Includes Modulating Ejector &
CO₂ Pump

Up to **30%**
Annual energy savings¹
vs initial transcritical CO₂
(mild climate)

+
***Integrated Cooling
& Heating***

Footprint
Reduction



CO₂ PROJECT EVOLUTION

- 1998**
1st Subcritical CO₂ Installation
- 2002**
1st Transcritical CO₂ Installation
- 2009**
CO₂OLtec[®] system launch
- 2014**
1st Ejector Unit
- 2019**
New CO₂OLtec[®] EVO systems
- 2020**
CO₂OLtec[®] EVO for small supermarkets <100KW
- 2023**
CO₂ Heat Pump launch
- 2024**
Crystal/Mistral CO₂ Refrigeration and Heat Pump Racks for Small/Medium Supermarkets and Light Industrial Applications launch
- 2025**
PowerCO₂OL UC / HeatCO₂OL UC Compact Industrial Refrigeration and Heat Pump Racks launch

1st manufacturer to reach 27,000 CO₂
compressor systems (until end of 2025)

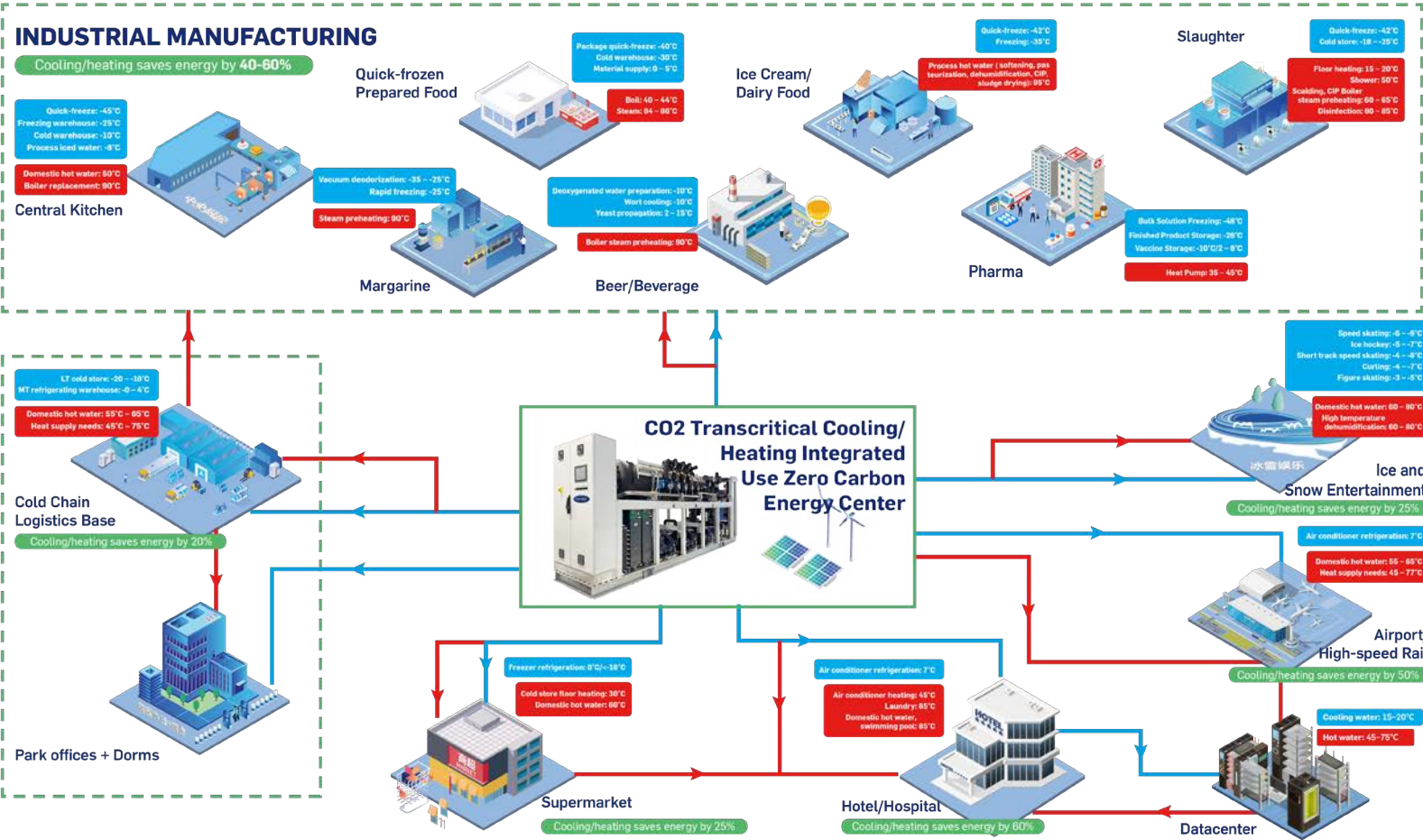
27000 CO₂



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CO₂ SOLUTION 5 IN 1 ENERGY STATION (Cooling & Heating)



CO₂ Project Footprint Map



CO₂ REFERENCE & APPLICATION OVERVIEW (ASIA)



FOOD RETAIL
(All Retail Formats)

CO₂ cooling,
avg. 25% energy saving



Metro China | Sam's Club China
| LAWSON China | NTUC Singapore
| DFI Hong Kong | Lotte Mart Korea

COLD STORAGE
(Cold Chain Bases)

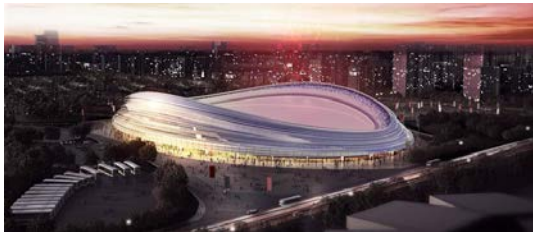
CO₂ cooling,
avg. 25% energy saving



Mars China | Nestlé Thailand
Sino-Ocean, Baoqing, Cold Chain Base

PUBLIC FACILITY
(Ice & Snow, Airports, Industrial Parks)

CO₂ cooling + heat recovery, heat pump, avg. 30~50% energy saving



National Speed Skating Oval | Ordos Airport
Beijing Logistics Park Office Heating

INDUSTRIAL
(Food, Pharmaceuticals, Textiles)

Integrated CO₂ cooling & heating,
heat pump, avg. 50%+ energy saving



Wilmar China | AstraZeneca China
Roche China | Sanofi Australia | H&M China

CO₂ REFERENCE & APPLICATION *RETAIL*



Sam's Club | 16 stores in China

Challenges

- › Dispersed equipment with high-volume merchandise in a store area exceeding 20,000 square meters
- › Massive quantities of high-value imported seafood, meat and other goods demanding extremely-stable systems
- › Precise temperature control requirements: refrigeration zone at 2°C to 6°C, and frozen zone below -18°C
- › Requiring extremely stable temperature, high energy efficiency and low carbon emissions

68,000m²

Total floor area

25%

Energy-efficient combined cooling & heating vs. conventional systems

56%

Carbon emission reduction

15,000 tons

Carbon emission avoided



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CO₂ REFERENCE & APPLICATION *FOOD*



Wilmar Kerry Oil Production – 4 process lines Tianjin, Guangzhou, Shanghai, China

Highlight

- › Non-flammable, non-toxic, and poses no contamination risk to food/products in processing facilities
- › Superior heat transfer efficiency enables faster cooling/freezing rates and higher frozen product quality
- › Eco-friendly refrigerant: Non-flammable and non-toxic properties ensure food safety compliance



300 kW

Installed
Cooling capacity



30%

Energy-saving



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Nestle Pet Food Factory cold storage

System Features

- › CO₂ CDU x3
- › CO₂'s enhanced heat transfer characteristics accelerate cooling/freezing cycles, improving goods quality
- › Optional hot-gas or electric defrosting maintains stable food temperatures



25%

Energy-saving



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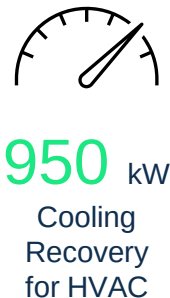
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AstraZeneca | QINGDAO, CHINA

Industrial Park

- › Commissioning: Q3 2025
- › Footprint **54,000m²**
- › Zero-carbon cooling/heating, **40%** energy savings



EQUIPMENT

4 HeatCO₂OL



Space heating



35°C → 45°C

AC chiller



12 → 6°C



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CO₂ REFERENCE & APPLICATION *TEXTILE*



H&M | SHANGHAI, CHINA

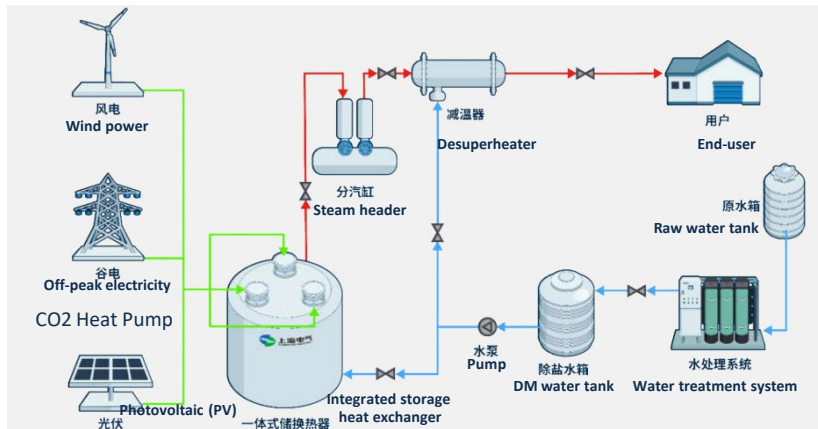
- › All-electric zero-carbon heating
- › Low maintenance, easy installation, unattended fully automated operation
- › Modular design for easy expansion
- › Low cost and easy layout, ideal for small/medium steam supply scenarios
- › Wide load range (0 - 150%) with stable operation
- › Steam temperature range: 100 - 300°C
- › Integrated with Shanghai Electric's patented molten salt technology
- › Proven applications in food & apparel industries



100.9 kW
Heat Pump



38% | 1080 Tons
Energy-saving & Carbon reduction



Items	Molten Salt Storage Heat Exchange Integrated Steam Boiler	Electric Boiler	Gas Boiler
Daily Steam Demand (Tons)		16	
Energy Price (In Shanghai)	0.281 RMB/kWh (off-peak)	0.8725 RMB/kWh (peak and flat)	4.23 RMB/Nm ³ (natural gas)
Steam Cost (RMB/Ton)	234.5	669.34	401.98
Annual Cost Savings When Adopting Molten Salt Heat Storage (Million RMB)	40%-64% savings	2.08	0.8
Carbon Emission	Near Zero	Near Zero	Medium



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CO₂ REFERENCE & APPLICATION *SPORTS*



National Speed Skating Oval | Beijing, CHINA

Transcritical CO₂ direct cooling ice making technology

- › Applied in *Olympic* Games for the very first time
- › "Near-zero" carbon emissions

Largest artificial ice surface in Asia

- › Ice area 12,000 m²
- › Ice areas are refrigerated and controlled separately
- › Realizing "operating together for different usages"

Beijing
Science and
Technology
Award



≈4 MW

Installed
Cooling capacity



≈2M kWh

Annual Energy
Saving



90% | 3000 Tons

Annual Carbon Reduction



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LT

10~30°C

Anti-freeze floor

MT

30~60°C

Ice melting pool

HT

240kW

Domestic hot water
Ice pouring truck
HT dehumidification

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THANK YOU

Jefferson.li@ccr.com

Welcome to the
Climate Control Revolution

ccr.com

Active Cooling Textiles – Examples from Europe

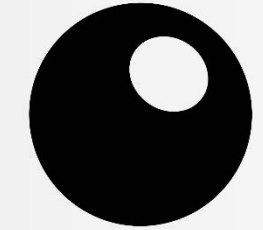
Sabine Stein, E.COOLINE / Pervormance



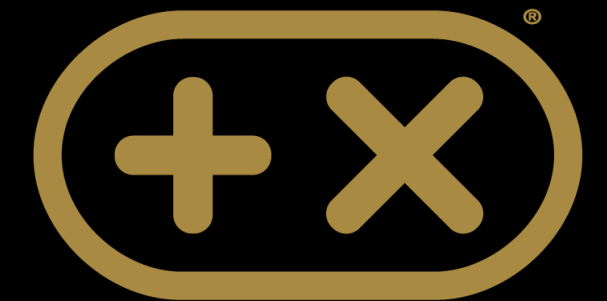
ACTIVE COOLING TEXTILES

SABINE STEIN, SPORTSSCIENTIST, CEO

WINNER



German
Sustainability Award
Products 2025



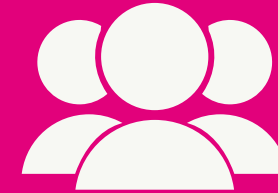
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honoured as:

BEST
BRAND
OF THE YEAR
2023

www.plusxaward.com

HEATSTRESS DANGERS HEALTH



EXHAUSTION, FATIGUE

WELL-BEING



CONCENTRATION, PERFORMANCE

ACCIDENT HAZARD – PRODUCTIVITY?

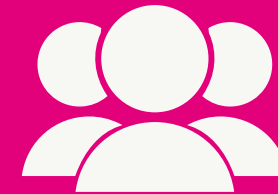


HEAT CRAMPS, COLLAPSE, ...

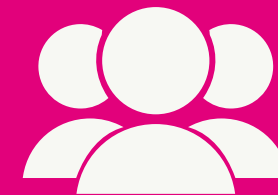
HEALTH – DANGER OF LIFE?

BEAT THE HEAT

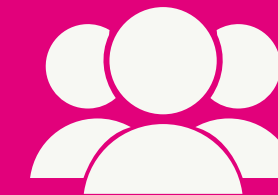
AIR CONDITIONING SYSTEMS HEAT THE WORLD



1 GIGATON CO₂ PER YEAR



OVER 8% OF ELECTRIC ENERGY
WORLDWIDE

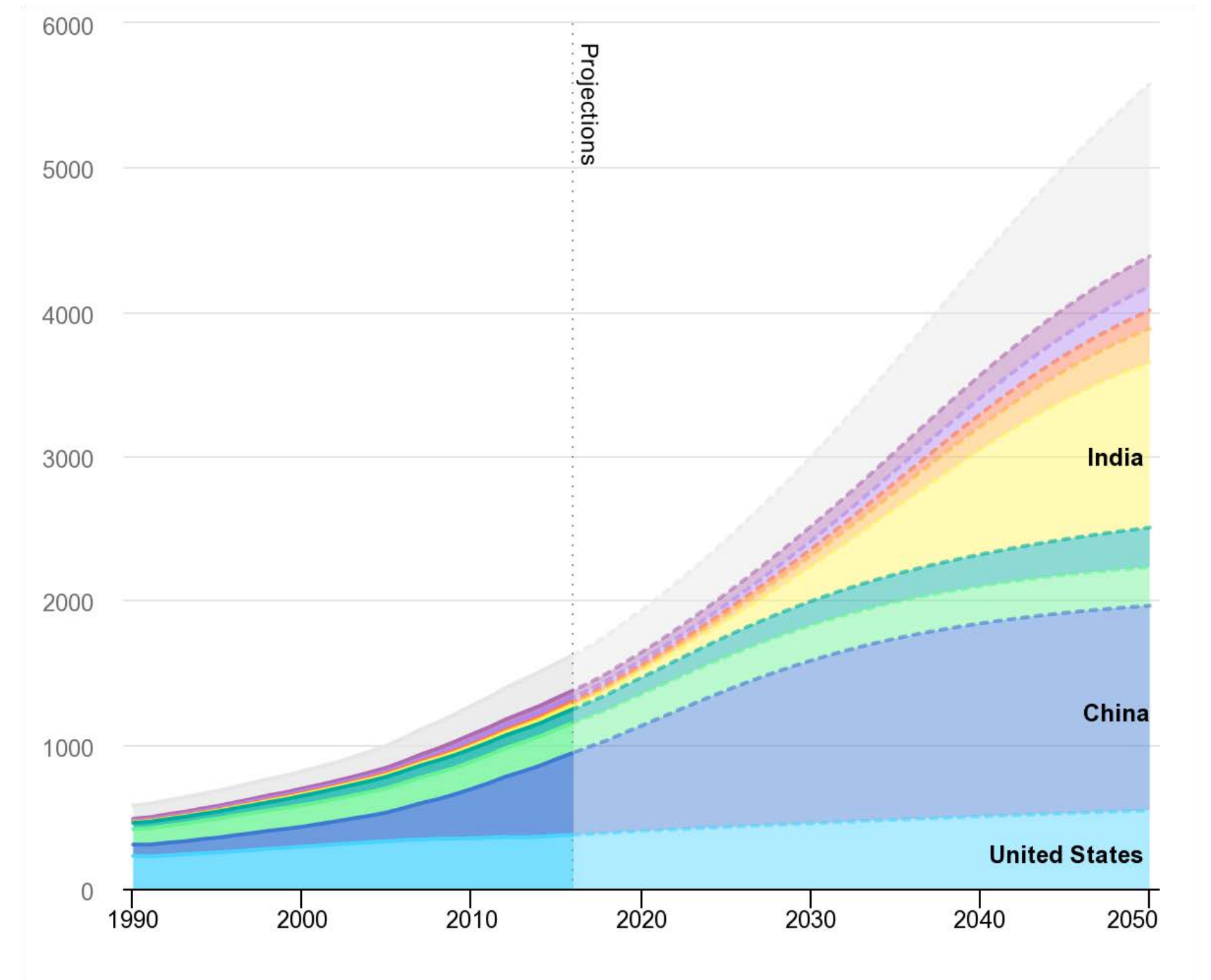


REFRIGERANTS ARE DANGEROUS
FOR CLIMATE AND ECOLOGY

*“ WE COOL THE WHOLE
ROOMS ALTHOUGH WE
ONLY WANT TO COOL THE
PEOPLE”*

THE FUTURE OF COOLING WITH AC'S

*RISING ENERGY
CONSUMPTION FOR
COOLING IN BUILDINGS*



Source: International Energy Agency (IEA), Chart Library / Data & Statistics –
“Global air conditioner stock, 1990–2050”



**WE TRANSFORM HEAT CLIMATE
FRIENDLY INTO HEALTH,
PERFORMANCE AND WELLBEING**

660 WATT
EVAPORATIVE COOLING

3D SYSTEM TECHNOLOGY

3D-NET OF SMART FIBERS

**PATENTED
TECHNOLOGY**
MADE IN GERMANY



BIONIC HYBRID SYSTEM

EVAPORATIVE COOLING



Cooling effect confirmed by
HOHENSTEIN
Test No.: 25.1.11.0307
DIN SPEC 60015



EFFECTIVE WITH 660 WATT
EVAPORATIVE COOLING

BOOSTER 1



BOOSTER 2



100% H₂O

SAVES UP TO

97 %

CO₂



CLIMATE PARTNERS
MÜNCHEN

IN COMPARISON TO AIR
CONDITIONING SYSTEMS



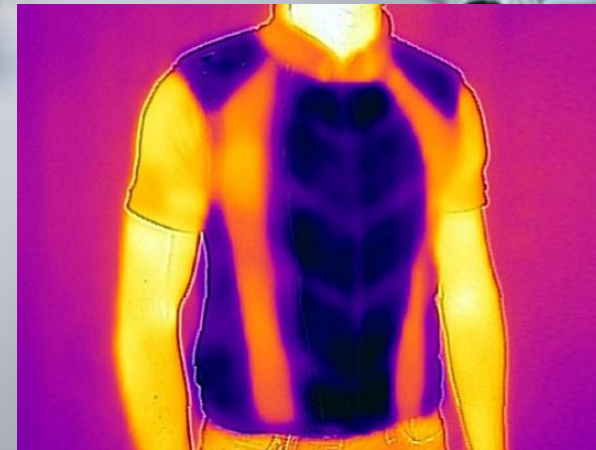
ARM COOLERS



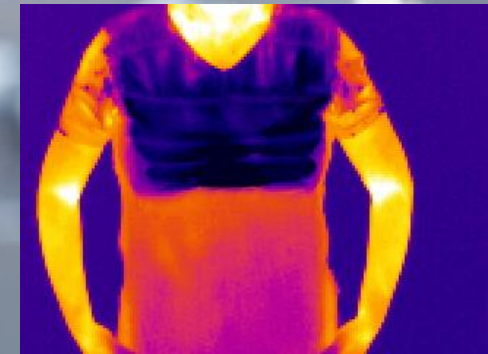
COOLING HEADGEAR



LEG COOLING



COOLING VESTS



COOLING SHIRTS



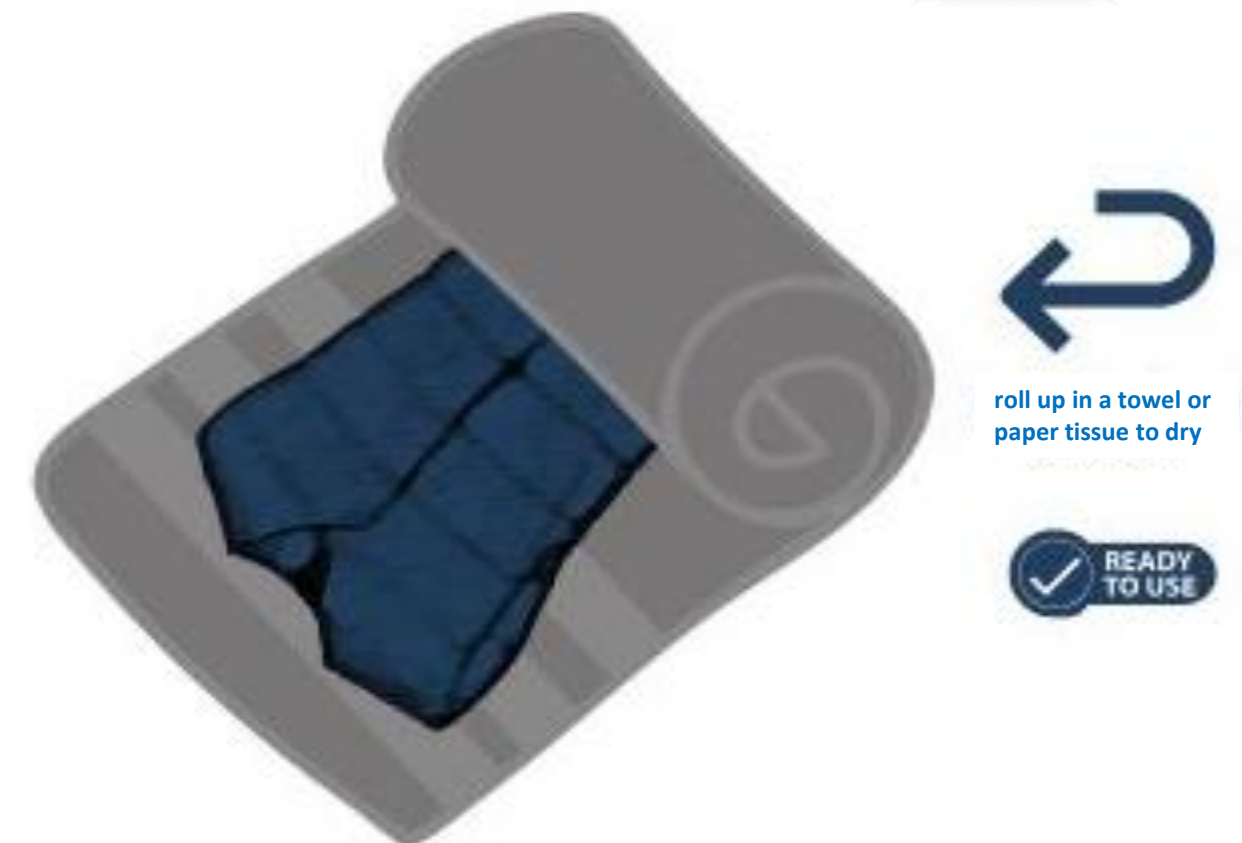
INDOOR & OUTDOOR



HOW TO ACTIVATE E.COOLINE

Activate in max. 2-3 sec. with max. 0,5 – 1 l water on both sides or simply use a water bottle

Press slightly, squeeze water out and roll into a towel – or paper towel - if needed – ready to wear!





WORKING

INDUSTRY , CONSTRUCTION & CRAFTS



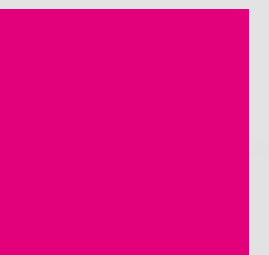
IR CAMERA

MEDICAL

CARDIAC SYSTEM, C O P D , MULTIPLE SCLEROSIS, PARKINSON, HEADACHE, MIGRAINE,



IR CAMERA

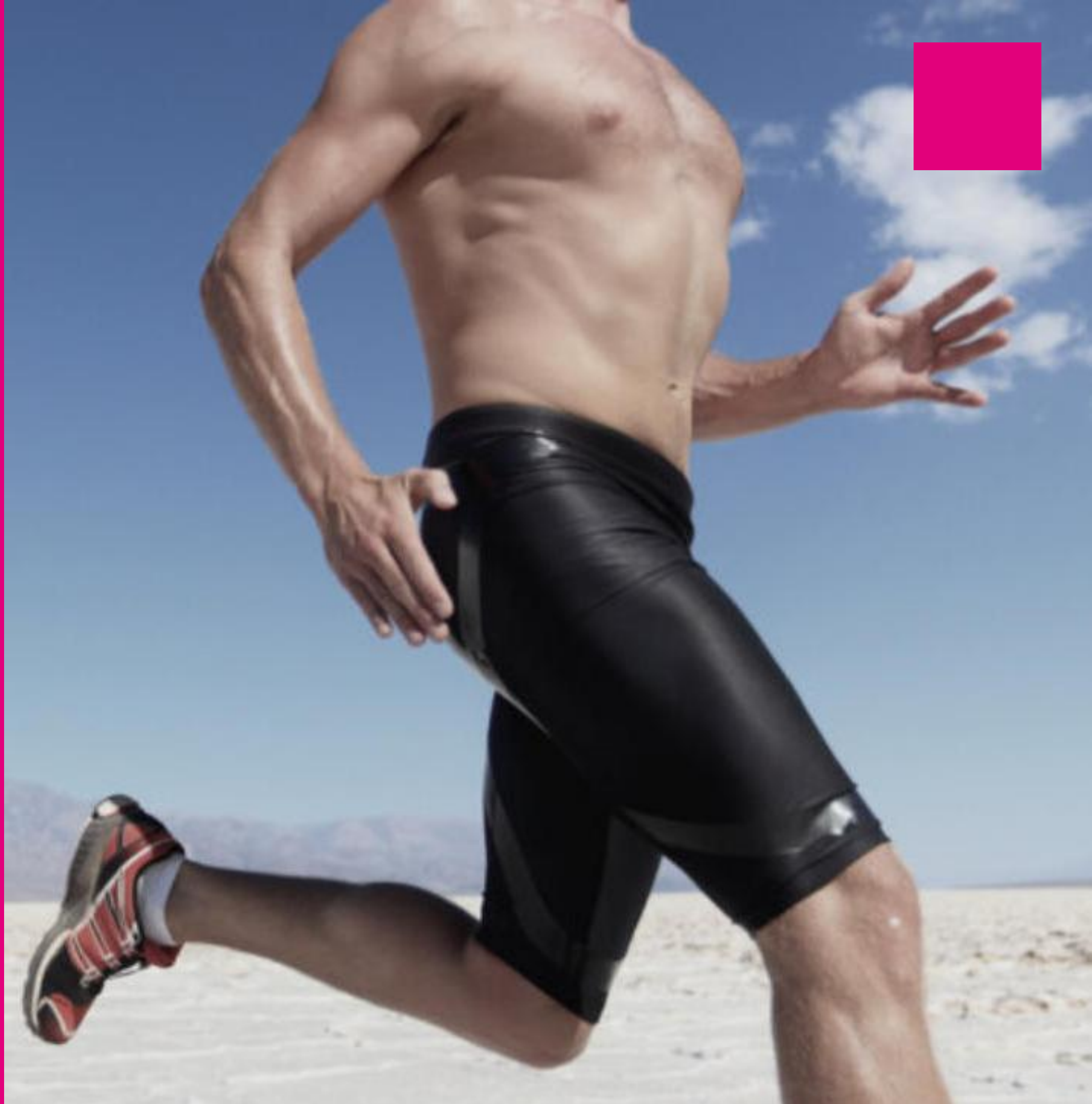




IR CAMERA

SPORTS

PERFORMANCE, CONCENTRATION



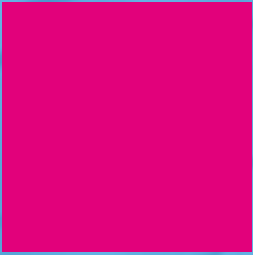
LIVING

LIFE, HOME, LEISURE TIME



IR CAMERA





HOME

COOLING BLANKETS —
COOLING SLIDERS

BUILDING

COOLING SLIDERS



Project:

- office area of 125 m² and a ceiling height of 2.85 m
 - South-facing window area, measuring 8 m²
 - 5 cooling sliders featuring COOLINE SX3 technology (cooling surface area of 0.7 m²)
 - The cooling sliders were sprayed with water for 10 minutes.
 - No moisture build-up due to the technology's immediate water-binding effect on the fibres
 - One 50-watt fan was placed on the floor to distribute the cooled air throughout the room.
- **Result:** The temperature was reduced by 3–5 degrees within 30 minutes.

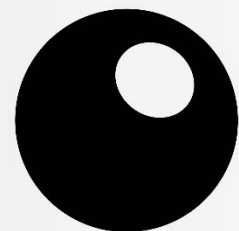
DESIGNING THE FUTURE



100% CLIMATENEUTRAL

"The first
climate-neutral
cooling"

WINNER



German
Sustainability Award
Products 2025



NO ENERGY SOURCE— NO CO2

UPCYCLING OF WASTE FIBERS

UNISEX COLLECTION – LESS WASTE



SUSTAINABLE PRODUCTION

NATURAL ELECTRICITY IN ULM

RECYCLABLE PRODUCTS



RESTCOMPENSATION WITH FOREST
PROTECTION PROJECTS IN PAPUA
NEUGUINEA (GOLDSTANDARD), PARA
BRASIL (VCS, SCS)

SUSTAINABLE
DEVELOPMENT GOALS



“
THANK YOU SO MUCH MY LIFE SAVERS IN HEAT
”

Dirk Brünig, MS patient

PERFORMANCE INTERNATIONAL GMBH
HÖRVELSINGER WEG 66
89081 ULM
GERMANY
WWW.PERFORMANCE.COM
WWW.E-COOLINE.COM





Economic benefits from leapfrogging to F-gas free solutions

Guntram Glasbrenner, GIZ Proklima



Leapfrogging to R290 in split air conditioning

First results of a study in preparation by Ökorecherche

15 July 2026

OEWG48

Continued Investigation carried out by Öko-Recherche: Evidence base and analytical method

Top-down analysis

Updates CCAC/TEAP findings using recent UNEP reporting and baseline information.



Bottom-up analysis

Case studies reconstructing split-AC HFC demand.

Cost analysis

Compares a direct R290 pathway with a sequential R32 route

Interpretation

The results are market-type dependent:

FINAL RESULTS will be presented at MOP

Compliance pressure → Small AC is a priority sector in A5 countries

- ❄ > **half of HFC consumption in A5 countries** used for AC manufacturing & Servicing (54%)
- ❄ > **90% of ACs in Group 1 countries is imported.**
 - Import regulations, local capacity building, standards and training most effective to reduce HFC consumption
- ❄ Kigali phase-down obligations: manufacturers moved from HFC-410A to lower **HFC-32**, but
 - **effects are short-term and mostly insufficient** to manage the reduction step in 2029 and beyond.
- ❄ 2021/22 study by **CCAC/TEAP**: **early transition of small AC to R290 as priority** measure for A5 to meet compliance targets.

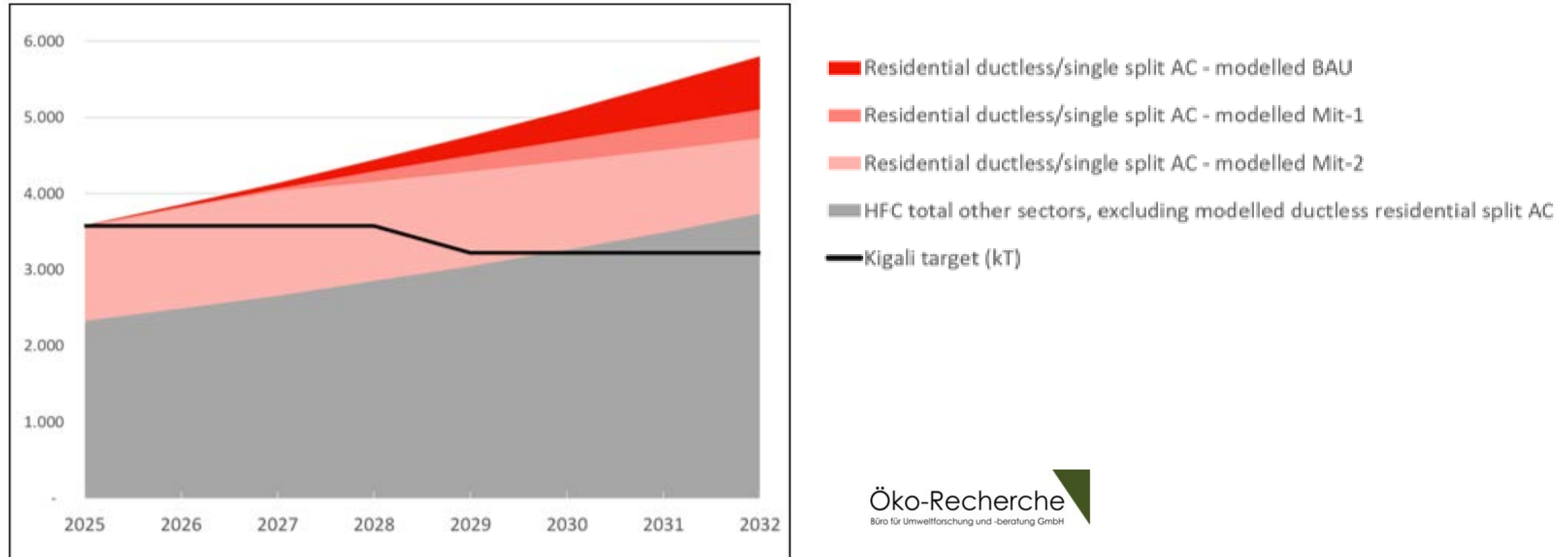
Compliance pressure → Small AC is a priority sector in A5 countries

Key findings:

- ❄ A5 Group 1 HFC consumption as a whole **will surpass allowed consumption level around 2029**, even under the updated, higher baseline consumption values 2024.
- ❄ **Own 2026 review of CCAC projections confirms:** LVCs, the largest group in number, are heavily affected by a fast growth

Category 3, LVC Import Market

Individual country analysis



Why R290 is the best available solution



Climate-friendly: GWP of < 1



Highly efficient



Not counted as consumption under the Kigali Amendment

→ no quota risk for compliance

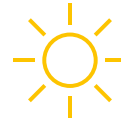


Long-term alternative for ACs and other applications (domestic + commercial)



Not tied to any patents

→ can strengthen local value chains



Works best under high ambient temperature conditions



High market readiness and growing demand

Cost logic: direct R290 pathway vs. interim R32 route

**Public
authorities /
MLF / donors**

**Industry /
manufacturers**

**Consumers /
service market**

Direct R410A → R290:
Costs occur once.

R410A → R32 → R290:
first step cheaper → higher costs in the long term.



Net Cost Balance:

Leapfrogging to R290

- avoiding repetitive regulation / standards / training
- avoiding stranded R32 investment and costs for redesign
- long term solution with lower consumer operating costs

Safety relevant issues of R290 and R32

R290	R32
Highly flammable (A3) → Strict control of ventilation and ignition sources	Flammable (A2L) → Can create a false sense of safety
Often hermetic designs → Less leakages, less fire risks	High operating pressure
	Higher discharge temperature / thermal stress
→ Both require trained and certified technicians	



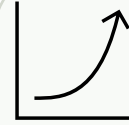
Real-world customer safety depends on both the refrigerant hazard and the quality of design, installation, and servicing.

Recognised high-hazard systems can be safer in practice when they are tightly controlled.

Takeaways for the discussion



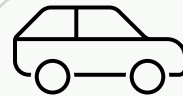
R290 leapfrogging is a real mitigation option, ensuring Kigali compliance



Mitigation options depend on development of AC market



LVC markets can be attractive policy cases



AC transition must be complemented with HFC phase-down in other sectors

Q&A



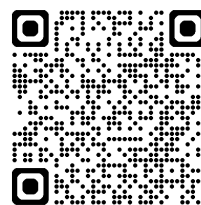
Wrap up and Closing

Guntram Glasbrenner, GIZ Proklima





Thank you!



www.green-cooling-initiative.org

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