EUROKLIMAT®

Cooling System Solutions

Roberto Leucci

AGENDA

R290

Why Propane?
ODP/GWP/F-GAS road map
Composition and classification
Typical propane use
EU Directives

SAFETY

EUROKLIMAT Approach
Notified body and EK Certification
EUROKLIMAT solutions
Zero leak and real test
New project

EK KNOW-HOW

Units installed around EU
Most significant applications

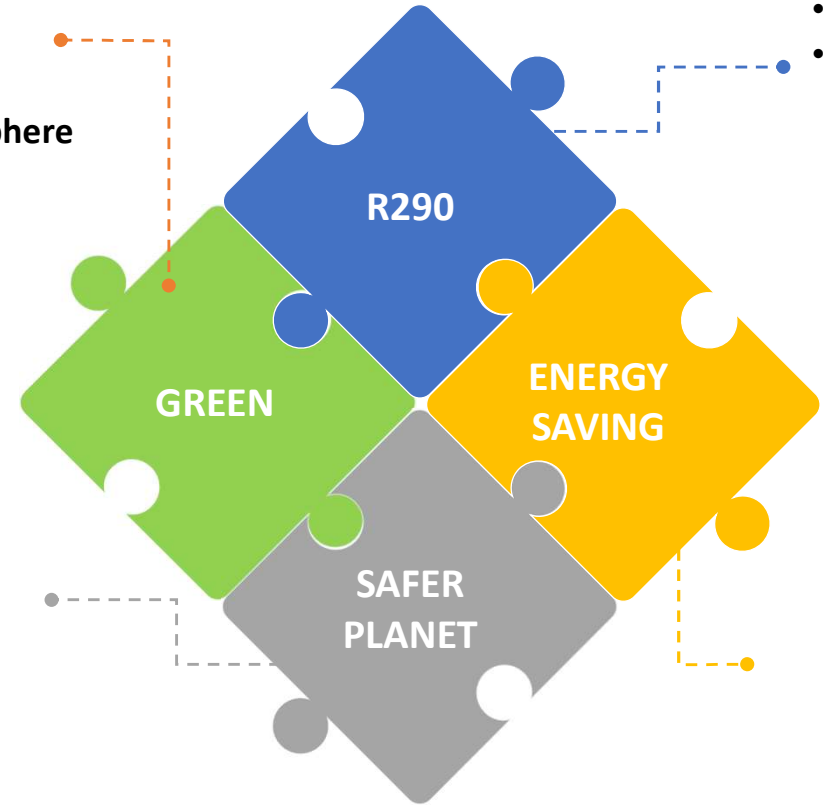
CHILLERS AND HEAT PUMPS

R290 – Air to water chillers and heat pumps
Thermodynamics advantages
HFC/HFO+HFC/HC performance comparison

WHY PROPANE?

PROPANE provides several benefits

- energy efficiency
- low GWP
- short-term persistence in the atmosphere
- low environmental impact



- It's an aliphatic hydrocarbon
- It belongs to the group of paraffins
- It's a by-product coming from:
  - oil refining
  - natural gas processing

- Low energy consumption
- Low CO2 emissions

The use of R290 reduces energy consumption considering both the production and use of refrigerants

WHY PROPANE?

- R290 was one of the most widely used refrigerants alongside ammonia in the early 20th century
- It was displaced by the early CFCs and disappeared from use as a refrigerant by the 1950's
- Today R290 is coming back world-wide being a natural refrigerant, widely available and efficient
- It's been used in domestic refrigerators and heat pumps since many years
- Increasing efficiency demands and stringent environmental legislation are driving its growth:
  - 20/20/20 = -20% CO2 emissions/+20% renewable sources/-20% energy consumption
  - Montreal Protocol (Kigali amendment)
  - Paris Agreement
  - **Decarbonization Programs**
    - **no fossil fuels**
    - **CO_2 footprint reduction**
    - **electrification of heating systems**

GWP – ODP - EER

3*

GWP

Global warming potential is a measure of how much heat a greenhouse gas traps in the atmosphere up to a specific time horizon, relative to CO_2

0

ODP

The Ozone Depletion Potential is the relative amount of degradation to the ozone layer a chemical compound can cause

+6%

EER

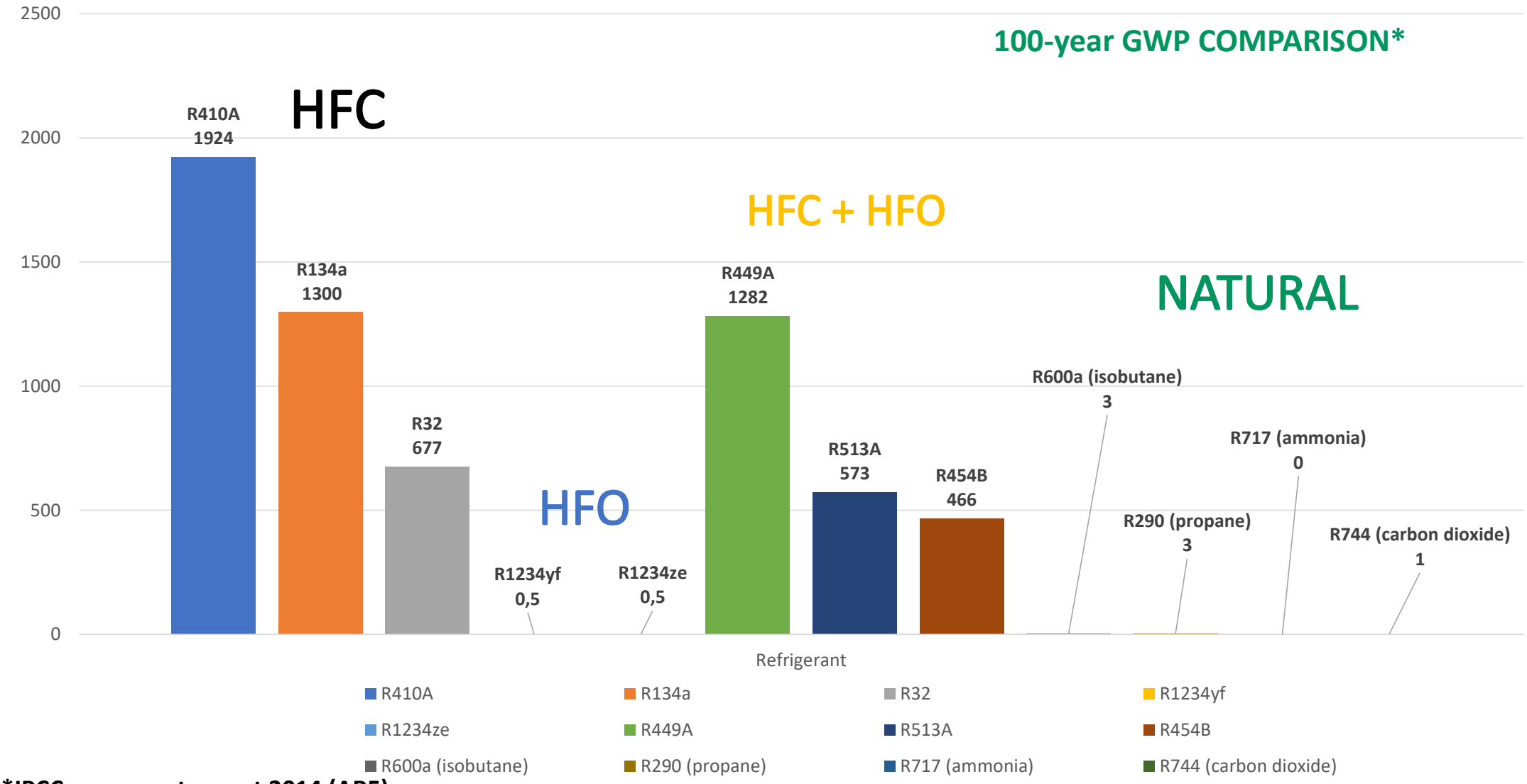
vs. an equivalent machine with R410A

The Energy Efficiency Ratio measure the cooling capacity to the energy consumed. The higher the EER, the more efficient the system

***Latest IPCC report 2021 (AR6) www.ipcc.ch (Intergovernmental Panel on Climate Change, a United Nations body to assess sciences on climate change)**

- **20 year: Propane => 0.072 / R32 => 2690**
- **100 year: Propane => 0,02 /R32 => 771 > 750 (limit for new single-split units coming into force in the EU from January 1, 2025)**

100-year GWP COMPARISON*



*IPCC assesment report 2014 (AR5)

REFRIGERANTS CLASSIFICATION

GWP Range	Common Name	Chemical Formula / Name and / or Type	Type / Origin	ASHRAE R#	Class	GWP_{100}	ODP	Typical Application	Current / Obsolete
Ultra-Low <30	Water	H_2O	Natural *Inorganic compound*	R-718	A1	0	0	Absorption chillers	Current
	Ammonia	NH_3	Natural *Inorganic compound*	R-717	B2L	0	0	Industrial chillers, esp. in food chain	Current
	Carbon Dioxide	CO_2	Natural *Inorganic compound*	R-744	A1	1	0	Industrial, low temperature with heat recovery	Current
	Care 40	Propane $CH_3CH_2CH_3$	Natural *Hydrocarbon*	R-290	A3	3	0	Small systems, medium temperature	Current
	Solstice yf	2,3,3,3-tetrafluoro-1-propene $CF_3CF=CH_2$	Synthetic *HFO, Unsaturated organic compound*	R-1234yf	A2L	4	0	Automotive industry	New
	Solstice ze	trans-1,3,3,3-tetrafluoro-1-propene $CF_3CH=CHF$	Synthetic *HFO, Unsaturated organic compound*	R-1234ze(E)	A2L	6	0	Medium to large HVAC chillers	New
Low <150	Opteon XL20	R-32 / R-1234yf 21.5 % / 78.5 %	Synthetic HFO, Azeotropic blend	R-454C	A2L	148	0	Split AC units Small to medium HVAC	Brand new - not yet commercially available
Moderate <1000	Opteon XL41	R-32 / R-1234yf 68.9 % / 31.1 %	Synthetic *HFO, Azeotropic blend*	R-454B	A2L	467	0	Small to medium HVAC chillers & condensers	New
	Opteon XP10	R-1234yf / R-134a 56 % / 44 %	Synthetic *HFO, Azeotropic blend*	R-513A	A1	631	0	Medium to large HVAC chillers	New
	R32	Difluoromethane CH_2F_2	Synthetic *HFC, Methane Series*	R-32	A2L	675	0	Split AC units Small to medium HVAC	New
	Opteon XL55	R-32 / R-125 / R-1234yf 67 % / 7 % / 26 %	Synthetic *HFC, Zeotropic blend*	R-452B	A2L	698	0	Small to medium HVAC chillers & condensers	New
	Solstice N41	R-32 / R-125 / CF_3I 49 % / 11.5 % / 39.5 %	Synthetic *HFC, Zeotropic blend*	R-466A	A1	733	0	Small to medium HVAC chillers & condensers	Brand new - not yet commercially available
High <3000	R134a	1,1,1,2-tetrafluoroethane CH_2FCF_3	Synthetic *HFC, Ethane Series*	R-134a	A1	1430	0	Medium to large HVAC chillers	Current
	R407C	R-32 / R-125 / R-134a 23 % / 25 % / 52 %	Synthetic *HFC, Zeotropic blend*	R-407C	A1	1774	0	Small to medium HVAC chillers & condensers	Obsolete but still serviceable
	R22	Chlorodifluoromethane $CHClF_2$	Synthetic *HCFC, Methane Series*	R-22	A1	1810	0.05	Small to medium HVAC chillers & condensers	**Obsolete and unserviceable**
	R410A	R-32 / R-125 50 % / 50 %	Synthetic *HFC, Zeotropic blend*	R-410A	A1	2088	0	Small to medium HVAC chillers & condensers	Current
Very High <10000	R404A	R-125 / R-143a / R-134a 44 % / 52 % / 4 %	Synthetic *HFC, Zeotropic blend*	R-404A	A1	3922	0	Low temperature systems	Recycled gases only from 2020; unserviceable from 2030

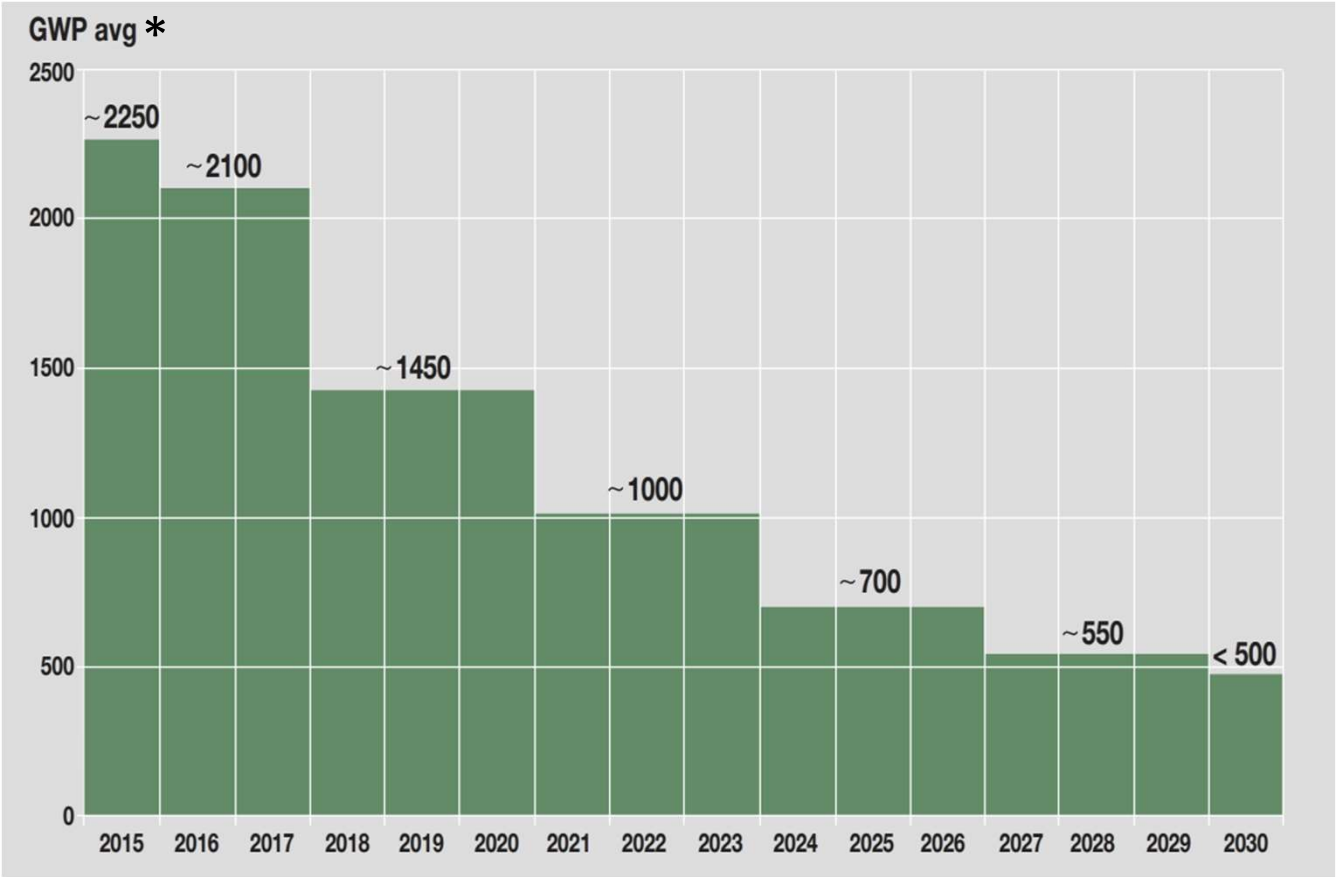
Notes:

1. All GWP values taken from IPCC 4th Assessment Report [AR4] except where values are not given therein, in which case they are calculated in accordance with it
2. The GWP band definitions of ultra-low (<30), very low (<100), low (<300), moderate (<1000), high (<3000) and very high (<10000) are taken from the UNEP *TEAP 2010 progress report, volume 1*

F-GAS REGULATION ROAD MAP

Regulation (EU) No 517/2014 on fluorinated greenhouse gases to cut CO2 emissions by 75% in 15 years (2015-2030)

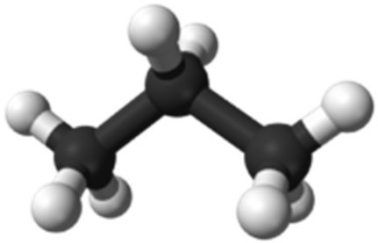
The Regulation (EU) No 517/2014 **strengthens existing measures** on fluorinated greenhouse gases (hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6)) and introduces a number of **far-reaching changes that will reduce emissions significantly**.

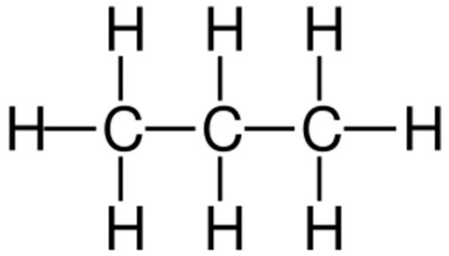


*GWP average based on Regulation No 517/2014

COMPOSITION AND CLASSIFICATION

- **Propane (C_3H_8)** is a by-product of **natural gas processing** and **oil refining**
- It is normally compressed and stored as a liquid
- **Nontoxic**, **colorless**, and virtually **odorless**
- An identifying odor can be added so it can be detected





PROPANE – R290	
ASHRAE Safety Group (2013)	A3
ASHRAE Flammability	Yes – Higher
ASHRAE Toxicity	No
DIRECTIVE 2014/68 (PED)	Group 1

ASHRAE Standard 34

Class A
Lower Toxicity
(No toxicity below 400 ppm by volume)

Class B
Higher Toxicity
(Toxicity below 400 ppm by volume)

Class 1
No Flammability

Class 2/2L
Lower Flammability

Class 3
Higher Flammability

	Lower Toxicity	Higher Toxicity
Higher Flammability	A3	B3
Lower Flammability	A2	B2
Mildly Flammable	A2L	B2L
No Flame Propagation	A1	B1

TYPICAL PROPANE USE

On-Road Vehicles

- **Third most popular vehicle fuel worldwide after gasoline and diesel**
- commonly used to fuel buses, light- and medium-duty trucks, vans, shuttles, taxicabs, and many more vehicles.

Professional Landscape Equipment

More than 130 models of propane-powered commercial lawn mowers are available today

Agricultural Equipment

More than 1.3 billion gallons of propane were sold for agricultural use in 2014 to

- run pumps and engines
- heat buildings/homes
- dry and process crops

CHEAP REFRIGERANT

EU DIRECTIVES

International Organizations

- Italian Standard Body
- European Committee for Standardization
- International Organization for Standardization
- International Electrotechnical Commission

UNI EN 378-1:2017	Refrigerating systems and heat pumps - Safety and environmental requirements - **Part 1: Basic requirements, definitions, classification and selection criteria**
UNI EN 378-2:2017	Refrigerating systems and heat pumps - Safety and environmental requirements - **Part 2: Design, construction, testing, marking and documentation**
UNI EN 378-3:2017	Refrigerating systems and heat pumps - Safety and environmental requirements - **Part 3: Installation site and personal protection**
UNI EN 378-4:2017	Refrigerating systems and heat pumps - Safety and environmental requirements - **Part 4: Operation, maintenance, repair and recovery**
ISO 5149-1:2014	Refrigerating systems and heat pumps -- Safety and environmental requirements -- Part 1: Definitions, classification and selection criteria
ISO 5149-2:2014	Refrigerating systems and heat pumps -- Safety and environmental requirements -- Part 2: Design, construction, testing, marking and documentation

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Zero leak and real test
New Project

EK EXPERIENCE

Units installed around EU
Most significant applications

CHILLERS AND HEAT PUMPS

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HFC/HFO+HFC/HC performance comparison

EUROKLIMAT APPROACH

- Basic safety with flammable refrigerants
- Safe design for HC refrigerants

- To ensure that a detailed safety evaluation has been carried out
- To improve the level of safety of the systems and equipment, by means of detailed investigations on all the factors which may affect the risk

- To ensure a certification path
- To validate the project before the market introduction

DNV Notified Body

DNV is registered as a PED Notified Body with no. 0496.

PED addresses manufacturers of pressure equipment who have to comply with the safety requirements on design, manufacture and final assessment.

DNV provide PED certification on a global basis, and also approve welders and welding procedures which are required by PED.

PED-related services as assessment of component and material manufacturers to the PED requirements, or general guidance and training are also offered.

EK - DNV

Euroklimat ws certified with the Notified Body DNV in **November 2011**

Euroklimat was the first company in Italy to obtain the PED certification for Propane products

Cert. No.:
106982-2011-CE-ITA-DNV
Rev. No.: **02**

Project No. :
PRJC-116913-2009-MSL-ITA

EUROKLIMAT CERTIFICATIONS

DNV

FULL QUALITY ASSURANCE CERTIFICATE

Certificate No.: 106982-2011-CE-ITA-ACCREDIA | Initial date: 09 January, 2006 | Validity: 03 May, 2021 – 07 April, 2024

This certificate consists of 3 pages

This is to certify that the quality system of:

EUROKLIMAT S.p.A.
Via Liguria, 8 – 27010 Siziano (PV) - Italy

has been assessed and found to comply with respect to the conformity assessment procedure described in:

ANNEX III MODULE H OF DIRECTIVE 2014/68/EU ON PRESSURE EQUIPMENT

This certificate is valid for the following scope:

Type of Pressure Equipment	**Assembly**
Product Name	**Air conditioning, liquid chillers and refrigeration system**

Place and date:
Vimercate, 19 May, 2021

ACCREDIA

For the issuing office:
Notified Body 0496, Italy
DNV GL Business Assurance Italia S.r.l.

Nicola Privato
Management Representative

Lack of fulfilment of conditions as set out in the Certification Agreement may render this Certificate invalid. ICP-4-5-I1-PED-I9 rev.0

NOTIFIED BODY 0496: DNV GL Business Assurance Italia S.r.l. Via Energy Park, 14, 20871 Vimercate (MB), Italy. Tel: 039 68 99 905., www.dnv.com

Jurisdiction

Application of Directive 2014/68/EU and Decreto Legislativo n. 26 of 15 February 2016.

Certificate history:

Revision	Description	Issue Date
00	CE PED.12.0001.06/2323 original certificate No.0496	09 Jannuary,2006
01	CE PED.12.0001.06/2323.1 Scope of extension	15 April, 2011
02	Scope extension - propane	28 November, 2011
03	Renewal	17 May, 2012
04	Renewal	24 April, 2015
05	Renewal	12 June, 2018
06	Scope extension: design pressure up to 45 bar, external design temperature -20°C/+55°C, new fluids added	09 May, 2019
07	Renewal	19 May, 2021

Products covered by this Certificate:

Product name	Product description
Air Conditioning package	With air cooled condenser With liquid cooled condenser With or without Heat pump (as required)
Liquid Chiller package	With air cooled condenser With liquid cooled condenser With or without Heat pump (as required)
Split Unit	With remote air cooled condenser With remote liquid cooled condenser With or without Heat pump (as required) Air handling unit

Sites covered by this certificate

Site name	Site Address	Audited by	Date	Report ref
EUROKLIMAT S.p.A.	Via Liguria,8 - 27010 Siziano (PV)- Italy	Massimo Rota Gelpi Milan Unit/PA	23-24 March, 2021	ML1173-20210323-RC-PED_Mod. H-H1-MRG

Applications/limitations

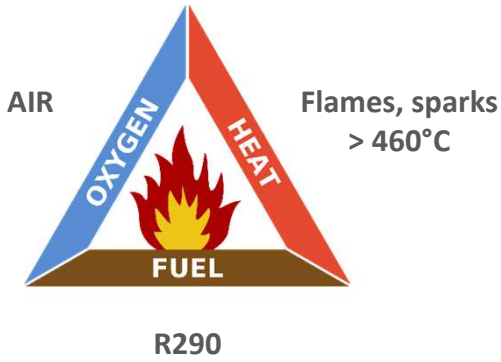
- Category : up to III
- Design pressure : up to 45 bar (for R410A)
- External design temperature : -20°C / +55 °C
- Fluids used on above packages:
  - > Family HC - Group 1 – Type R290 (propane)
  - > Family HFC – Group 1 -Type R32
  - > Family HFC – Group 2 -Type R134a, R404A, R407C, R410A, R449A, R513A
  - > Family HFO – Group 2 -Type R1234ze

Terms and conditions

Valid terms and conditions are found in the DNV´s PED Certification Requirements

End of Certificate

The fire triangle



R290

Basic concept of flammability

Three ingredients are needed to generate a fire:

1. a fuel at the right concentration
2. a supply of oxygen normally from the air
3. a source of ignition.

R290 Flammability

Lower limit:
1,7% by volume
[32 g/m^3]

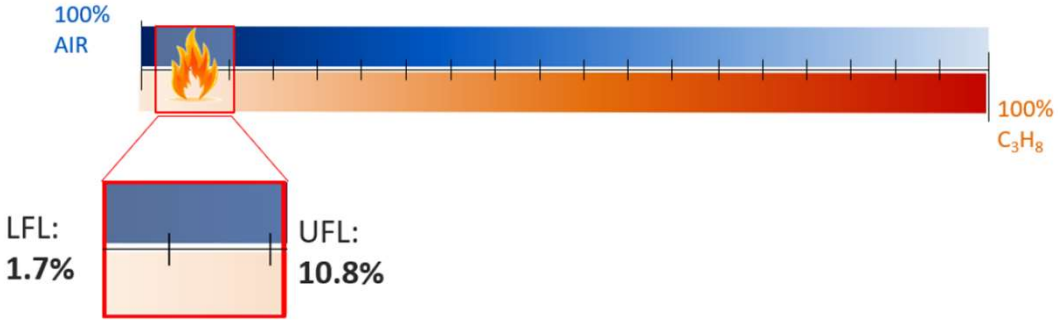
Upper limit:
10,8% by volume
[200 g/m^3]

Ignition temperature
470°C

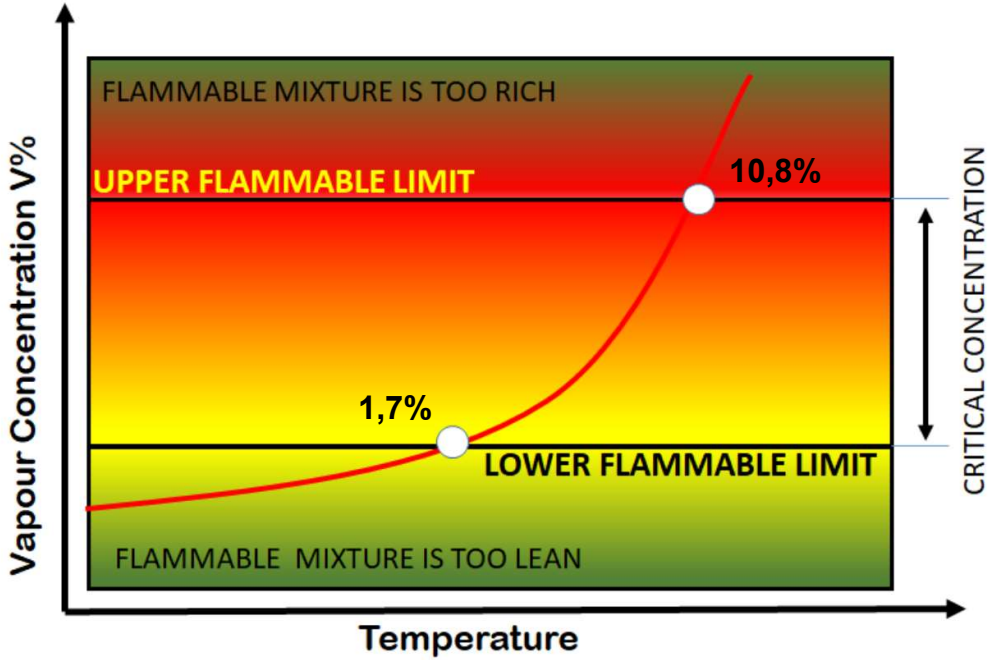
If you control these components, **fire can be prevented**

To achieve this, three general guidelines are followed:

1. containment of the substance (propane – R290)
2. avoidance of ignition sources
3. use of a leak detector



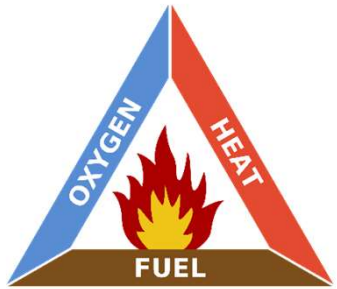
FLAMMABILITY LIMIT



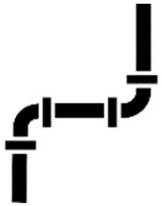
LFL (LEL): Lower Flammability Limit
is the lowest percentage by volume of gas in a gas-air mixture that will form an ignitable concentration. Below that concentration the mixture is too lean to be ignited.

UFL: Upper Flammability Limit
is the highest percentage by volume of gas in a gas-air mixture that will form an ignitable concentration. Above that concentration the mixture is too rich to be ignited.

CONTAINMENT OF THE SUBSTANCE

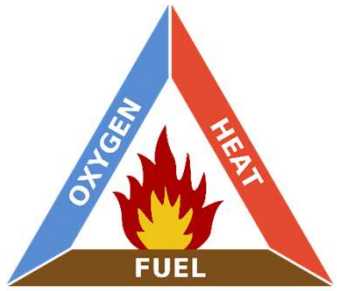


The refrigerant circuit is **sealed** and designed to avoid leaks:

Pipework is designed to have **as few joints** as possible.	
All the materials are fully **compatible** with the **HC** refrigerant.	
Use of components and joints that may be subject to leakages **is minimized**.	

* Depending on machine type

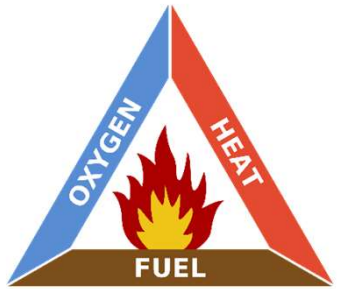
CONTAINMENT OF THE SUBSTANCE



1	Piping are installed in such a way that bends or joints are not stressed.
2	**Pipework and components are protected** against impact, weathering, external corrosion, and electrolytic corrosion at the junction of dissimilar metals.
3	**Piping are designed to minimize the effects of vibration.**
4	**Sufficient valves** are provided to ensure that **servicing and maintenance** can be carried out without causing significant loss of refrigerant.
5	**Seal caps** are always fitted on **all service valves**.
6	**Particular care** is taken to ensure that all joints are brazed correctly.

* Depending on machine type

CONTAINMENT OF IGNITION SOURCES

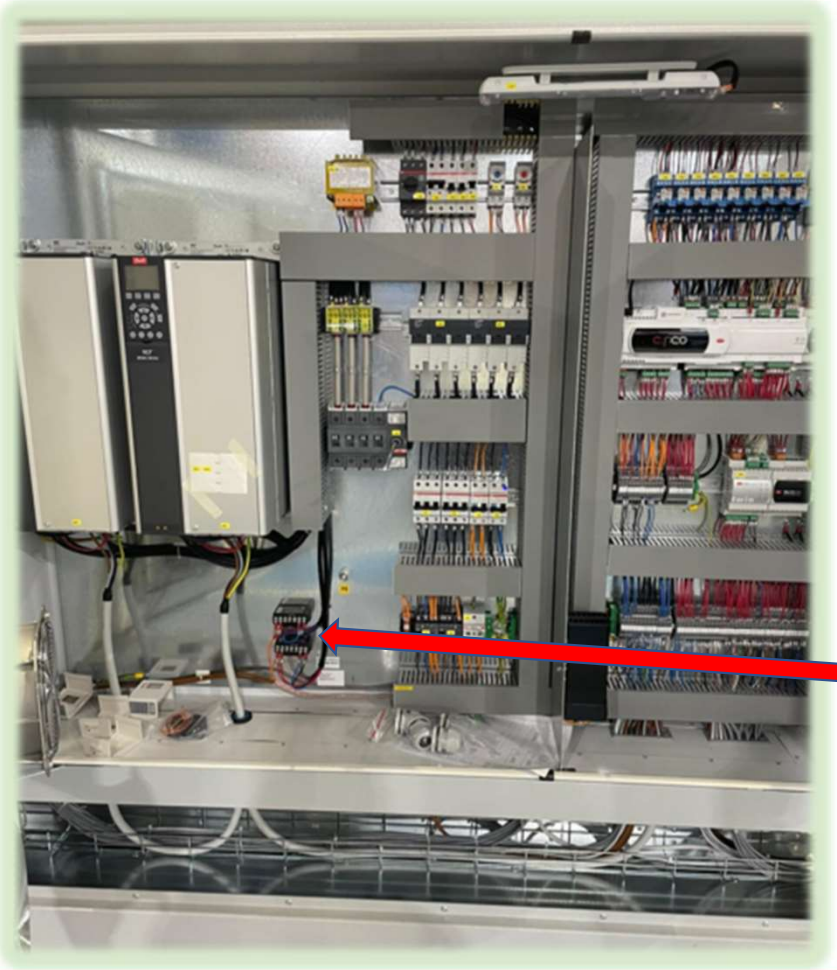


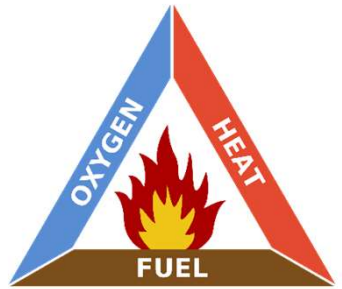
1. **Pressure switches and transmitters** are ATEX **certified***
2. **Electrical** panel is **IP54**
3. **Cable glands are IP66**
4. All other components are IP54 at least

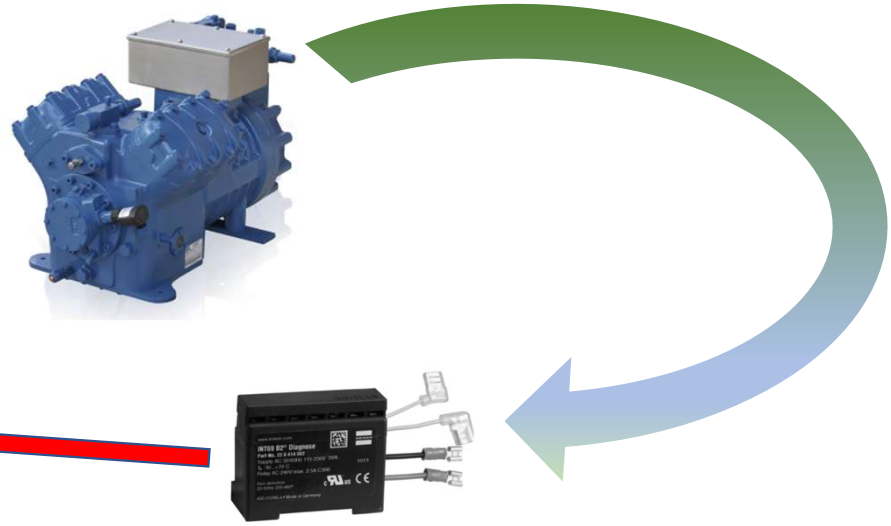
* Depending on machine type

OTHERS PRECAUTIONS TO AVOID IGNITION SOURCES

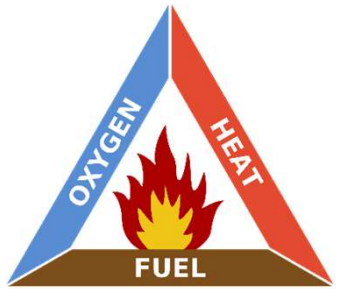
The electronic protection module (Kriwan) is taken out of the electrical compressor box and fitted into the unit electrical panel







OTHERS PRECAUTIONS TO AVOID IGNITION SOURCES



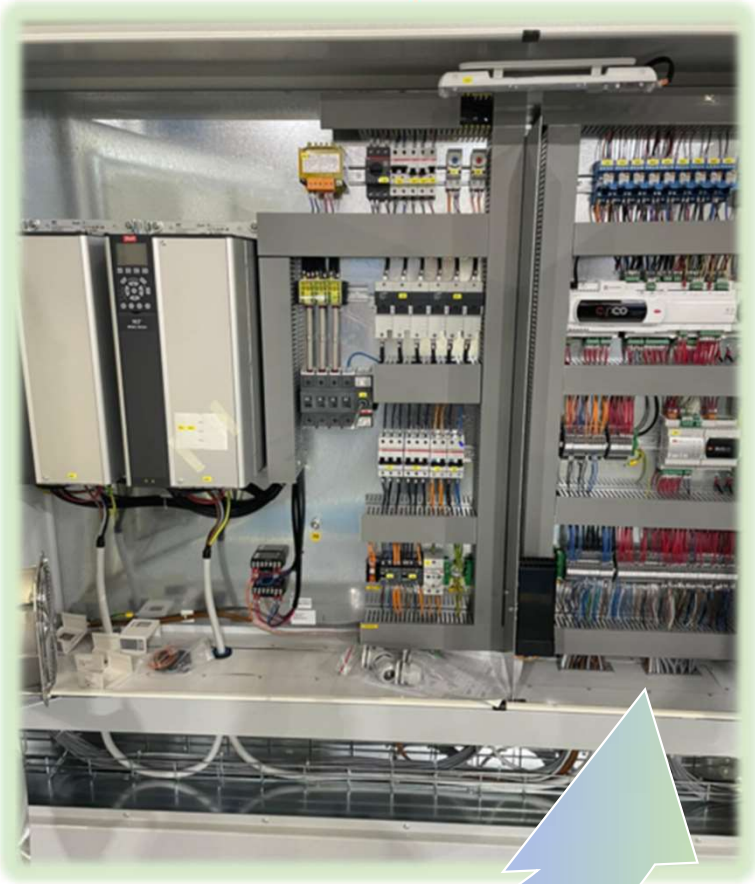
Pressure switches are **ATEX** certified or **IP54***

* Depending on machine type

ELECTRICAL PANEL WITH SPECIAL CABLE ENTRY SYSTEM

IP66

IP54



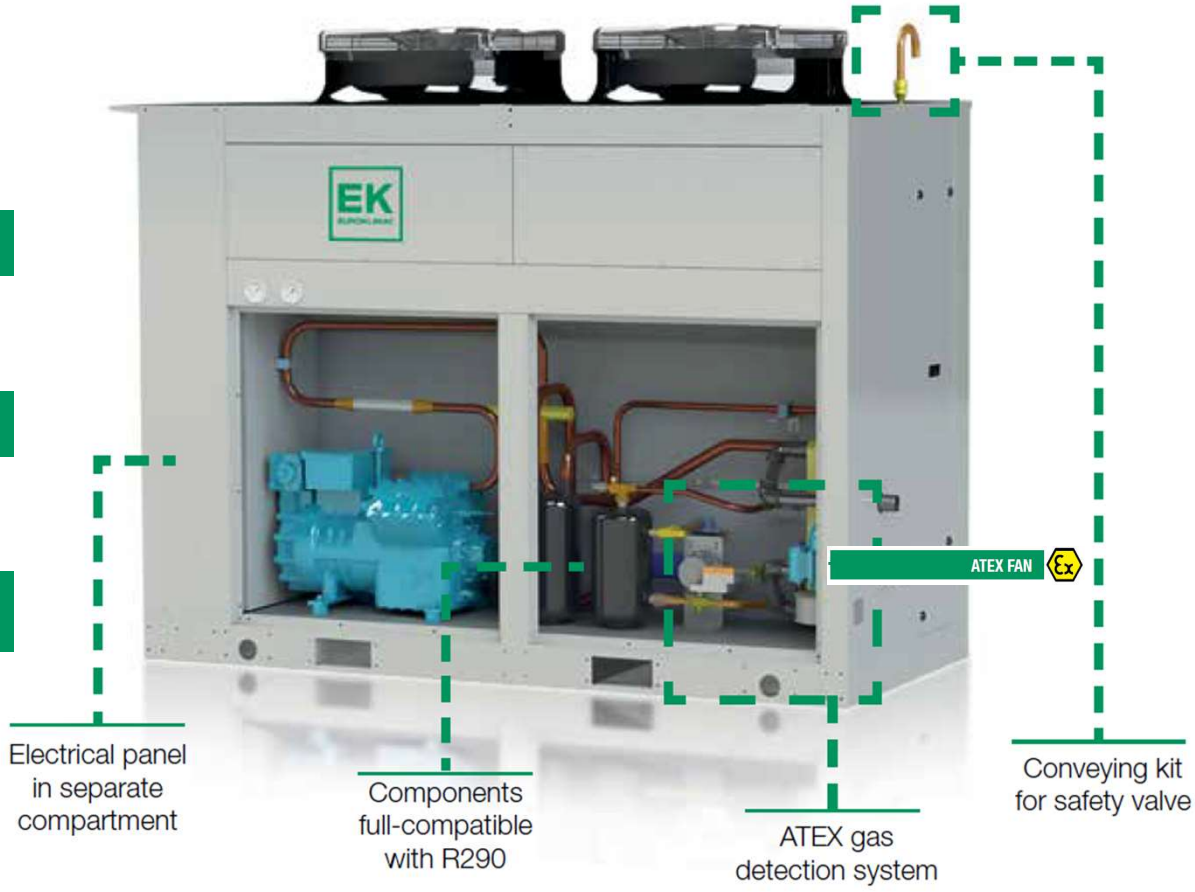
- Special cable entry system
- Pierceable membranes
- Conical cable sleeves
- “Double barrier”

SAFETY FIRST

Pipework design

No ignition sources

Leak detection & ventilation



DNV·GL ISO 9001

CE 0496

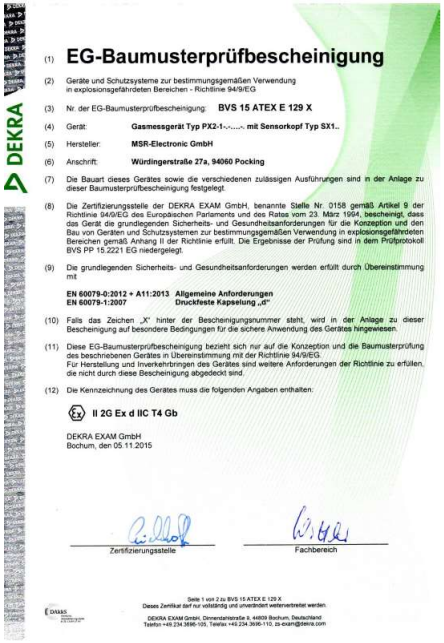
LEAK DETECTOR

PolyXeta System

- Every unit is equipped with a stand-alone gas detection sensor.
- The sensor is **ATEX Certified** and is pre-calibrated at the factory.
- Standard Alarm setting: **30% of LFL**

PolyXeta Systems - Main Features

- ATEX/IEC Ex certificates
- Type “Ex d” with flame-proof enclosure
- 4-20 mA output signal
- **RS485-Modbus** output signal
- Alarm and fault signal relay
- Continuous monitoring



DEKRA

(1) **EG-Baumusterprüfbescheinigung**

(2) Geräte und Schutzsysteme zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen - Richtlinie 94/9/EG

(3) Nr. der EG-Baumusterprüfbescheinigung: **BVS 15 ATEX E 129 X**

(4) Gerät: **Gasmessgerät Typ PX2-1-.....- mit Sensorkopf Typ SX1..**

(5) Hersteller: **MSR-Electronic GmbH**

(6) Anschrift: **Würdingerstraße 27a, 94060 Pocking**

(7) Die Bauart dieses Gerätes sowie die verschiedenen zulässigen Ausführungen sind in der Anlage zu dieser Baumusterprüfbescheinigung festgelegt.

(8) Die Zertifizierungsstelle der DEKRA EXAM GmbH, benannte Stelle Nr. 0158 gemäß Artikel 9 der Richtlinie 94/9/EG des Europäischen Parlaments und des Rates vom 23. März 1994, bescheinigt, dass das Gerät die grundlegenden Sicherheits- und Gesundheitsanforderungen für die Konzeption und den Bau von Geräten und Schutzsystemen zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen gemäß Anhang II der Richtlinie erfüllt. Die Ergebnisse der Prüfung sind in dem Prüfprotokoll BVS PP 15.2221 EG niedergelegt.

(9) Die grundlegenden Sicherheits- und Gesundheitsanforderungen werden erfüllt durch Übereinstimmung mit

EN 60079-0:2012 + A11:2013 Allgemeine Anforderungen
EN 60079-1:2007 Druckfeste Kapselung „d"

(10) Falls das Zeichen „X" hinter der Bescheinigungsnummer steht, wird in der Anlage zu dieser Bescheinigung auf besondere Bedingungen für die sichere Anwendung des Gerätes hingewiesen.

(11) Diese EG-Baumusterprüfbescheinigung bezieht sich nur auf die Konzeption und die Baumusterprüfung des beschriebenen Gerätes in Übereinstimmung mit der Richtlinie 94/9/EG. Für Herstellung und Inverkehrbringen des Gerätes sind weitere Anforderungen der Richtlinie zu erfüllen, die nicht durch diese Bescheinigung abgedeckt sind.

(12) Die Kennzeichnung des Gerätes muss die folgenden Angaben enthalten:

Ex II 2G Ex d IIC T4 Gb

DEKRA EXAM GmbH
Bochum, den 05.11.2015

Zertifizierungsstelle — Fachbereich

Seite 1 von 2 zu BVS 15 ATEX E 129 X
Dieses Zertifikat darf nur vollständig und unverändert weiterverbreitet werden.

DEKRA EXAM GmbH, Dinnendahlstraße 9, 44809 Bochum, Deutschland
Telefon +49 234 3696-105, Telefax +49 234 3696-110, zs-exam@dekra.com

IEC IECEx

IECEx Certificate of Conformity

INTERNATIONAL ELECTROTECHNICAL COMMISSION
IEC Certification Scheme for Explosive Atmospheres
for rules and details of the IECEx Scheme visit www.iecex.com

Certificate No.: IECEx BVS 16.0038X — Issue No.: 0 — Certificate history:

Status: Current

Date of Issue: 2016-06-08 — Page 1 of 4

Applicant: MSR-Electronic GmbH
Würdingerstraße 27a
94060 Pocking
Germany

Electrical Apparatus: Gas detector with sensor head type PX2-1-.....- sensor head type SX1..
Optional accessory:

Type of Protection: Equipment protection by flameproof enclosures "d"

Marking: Ex d IIC T4 Gb

Approved for issue on behalf of the IECEx Certification Body: H.-Ch. Simanski

Position: Head of Certification Body

Signature: (for printed version)

Date: 8.6.2016

1. This certificate and schedule may only be reproduced in full.
2. This certificate is not transferable and remains the property of the issuing body.
3. The Status and authenticity of this certificate may be verified by visiting the Official IECEx Website.

Certificate issued by:
DEKRA EXAM GmbH
Dinnendahlstrasse 9
44809 Bochum
Germany

DEKRA
On the safe side.

LEAK DETECTOR

Annual check

- To comply with the EN378-4:2016, sensors must be **checked and calibrated annually**.

Calibration kit

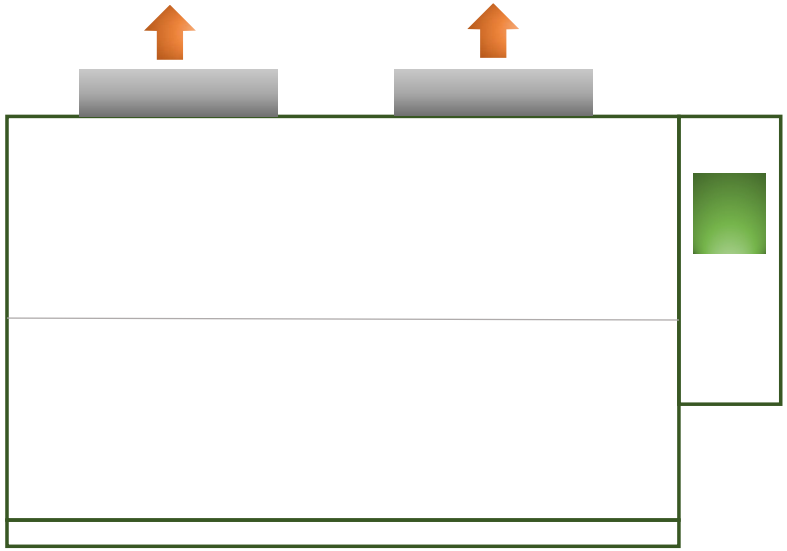
- Calibration kit for PolyXeta2 sensor head
- Portable Service Tool for check and calibration
- Calibration gas bottles available in the market

Dedicated power supply

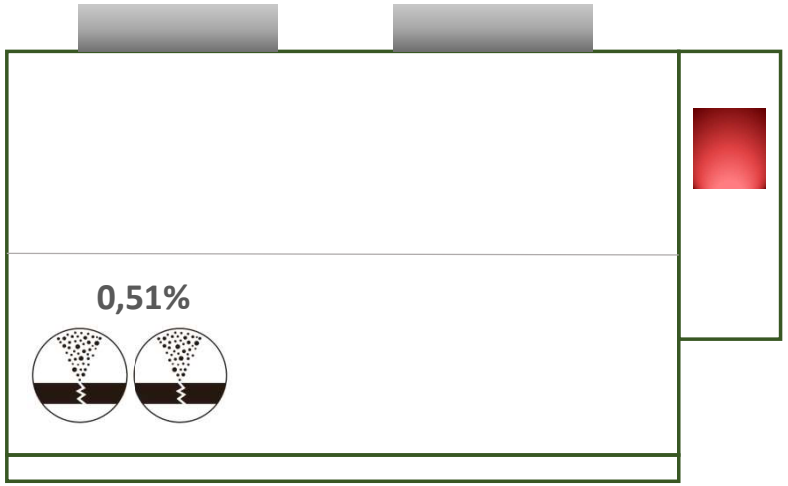
- The leak detector is provided with a separate power supply (230/1/50)
- In case of a black out, if UPS is not provided, any eventual leakage won’t be detected

USE OF LEAK DETECTOR

PolyXeta System



UNIT RUNNING



LEAK DETECTED

LED INDICATIONS

Propane **alarm**
(0,30%)

No power supply to microprocessor

Activation of extraction fan

LED INDICATIONS

Propane **alarm**
(0,51%)

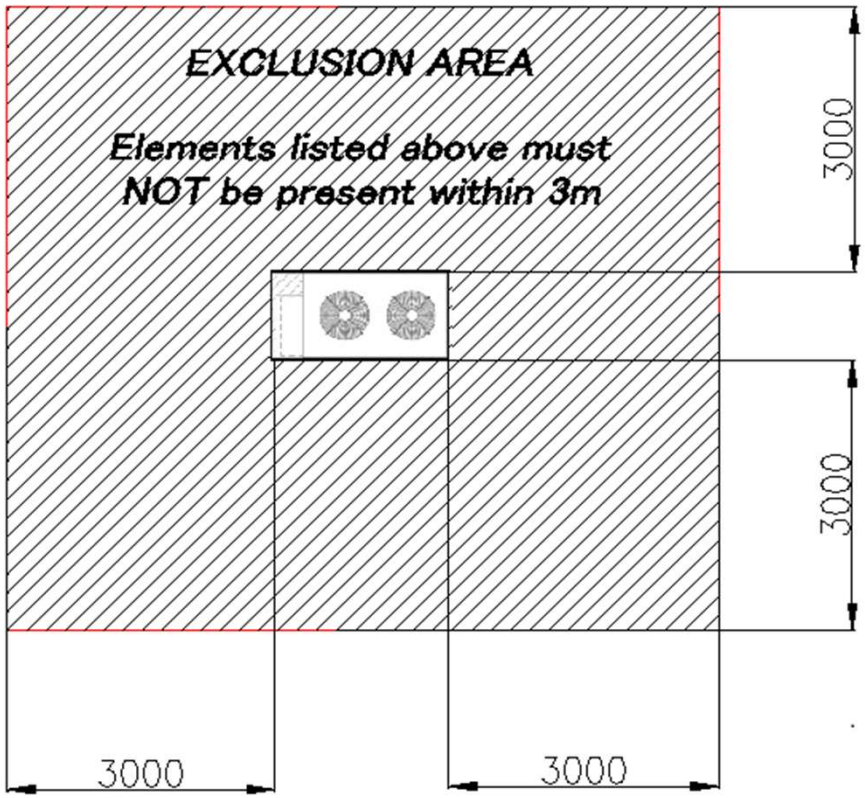
INSTALLATION SUGGESTIONS

- **IGNITIONS SOURCES:** keep them at about 3 mt distance

- The refrigerant must not be able to flow into any
  - ❑ Ventilation air intakes
  - ❑ Drains
  - ❑ Rainwater harvesting systems
  - ❑ Boiler rooms intakes

- **SAFETY VALVES**
  - ❑ ensure the discharge is piped out

- **DEDICATED POWER SUPPLY**
  - ❑ The leak detector is provided with a separate 230/1/50 power supply
  - ❑ If a UPS (uninterruptible power supply) is not provided, an eventual leakage won't be detected in case of a black out



INSTALLATION REQUIREMENTS

- **NO refrigerant charge** limit in case of an AUTHORISED access category area

Example of **Maximum Charge** evaluation (according to EN378-1)

Gas Classification	A3 (High Flammability, Low Toxicity)
Application Type	Human Comfort
Equipment Location	Machinery room or open air
Installation Characteristics 1	Other
Installation Characteristics 2	Above ground
Installation type	Floor location
Device type	Fixed system
Access Category	General, Supervised, Authorized

Access Category		Max. allowable R290 charge	
	General		5 Kg
	Supervised		10 Kg
	Authorized		NO LIMITS

SERVICE SUGGESTIONS

Flammable gas detector

HC recovery machine

ATEX ventilation fan

Dry powder or **CO_2 fire extinguisher**

EUROKLIMAT ZERO LEAK POLICY

- ✓ Permanent training program to improve quality and reduce leaks to **Zero**
- ✓ Real Zero project 20 of the **Institute of Refrigeration**
- ✓ **Code of Practice on Minimisation of Refrigerant Emissions**

realskills europe

BEST PRACTICES

EUROKLIMAT supported SHECCO drafting the World's First Comprehensive Natural Refrigerant Technical Textbook

AGENDA

R290

Why Propane?
ODP/GWP/F-GAS road map
Composition and classification
Typical propane use
EU Directives

SAFETY

EUROKLIMAT Approach
Notified body and EK Certification
EUROKLIMAT solutions
Zero leak and real test
New project

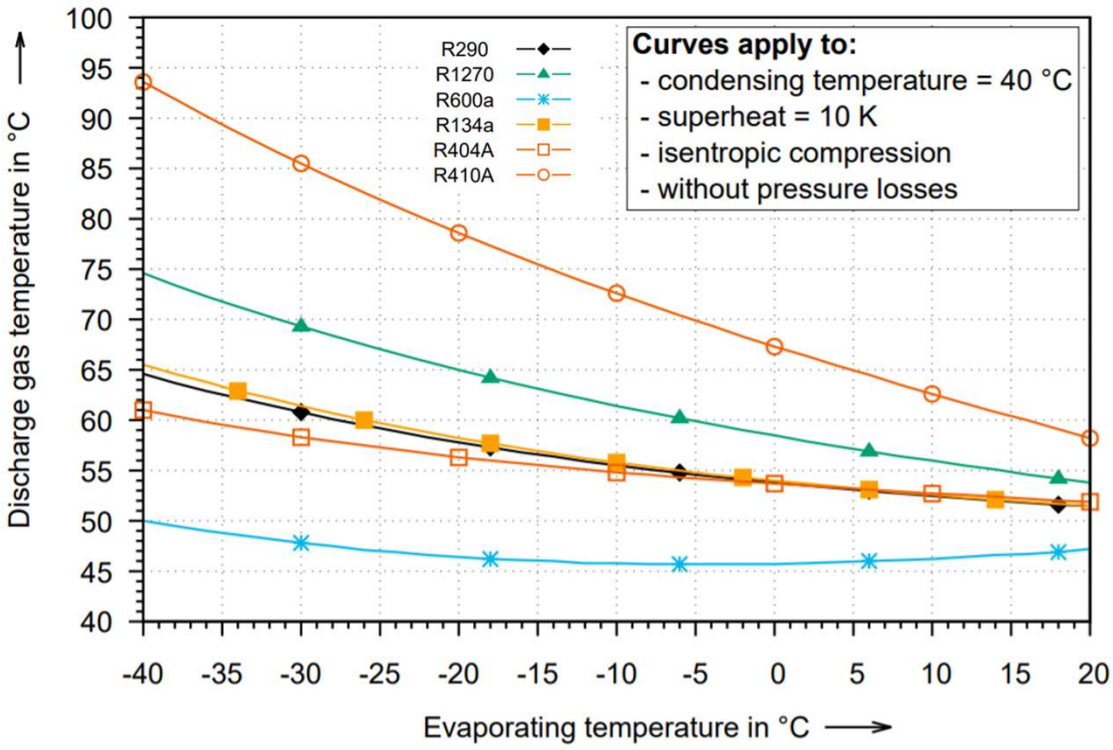
EK EXPERIENCE

Units installed around EU
Most significant applications

THERMODYNAMICS ADVANTAGES

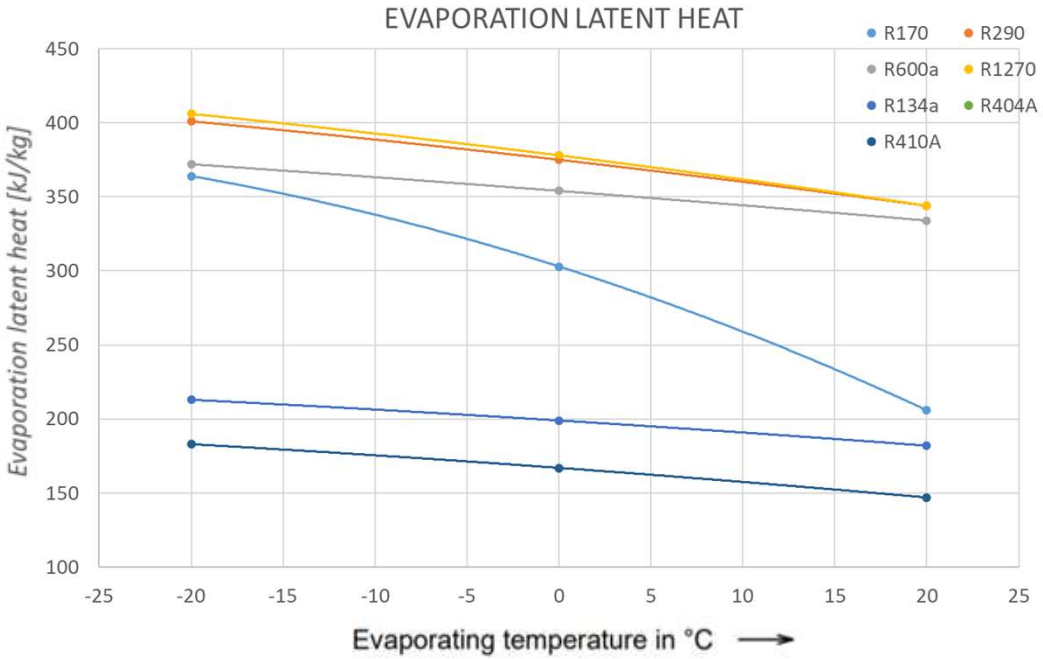
R290 – Thermodynamics advantages
HFC/HFC+HFO/HC performance comparison

COMPRESSOR'S GAS DISCHARGE TEMPERATURE – A COMPARISON



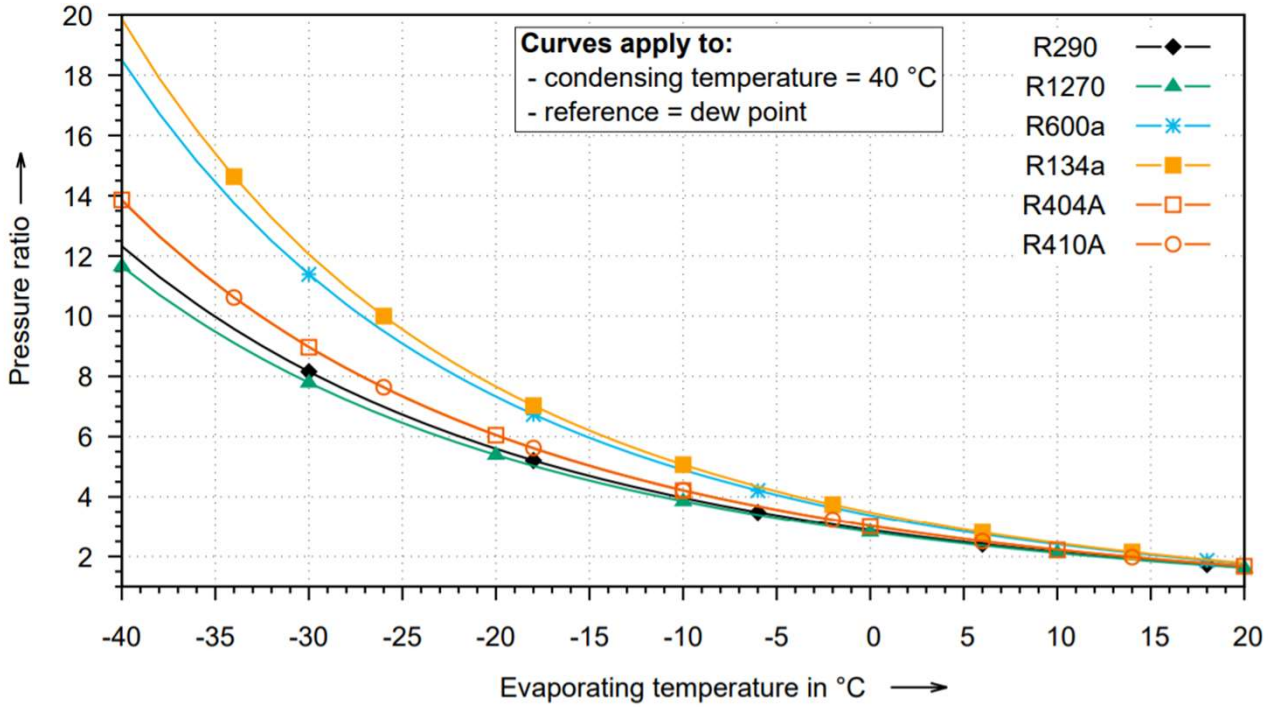
- If the discharge gas temperature is too high, decomposition of lubrification oil occurs
- Low discharge temperature has a positive effect on:
  - compressor parts
  - Components
  - Oil stability

THERMODYNAMICS ADVANTAGES



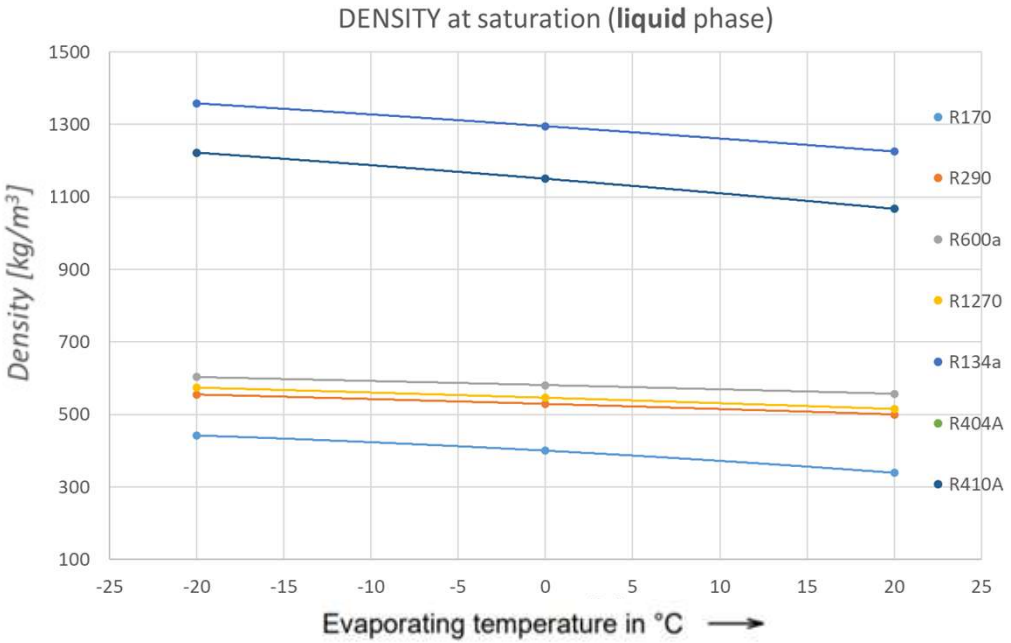
- **High latent heat**
- **High heat transfer performance**
  - R290 => 0,083 W/mK
  - R410A => 0,076 W/mK

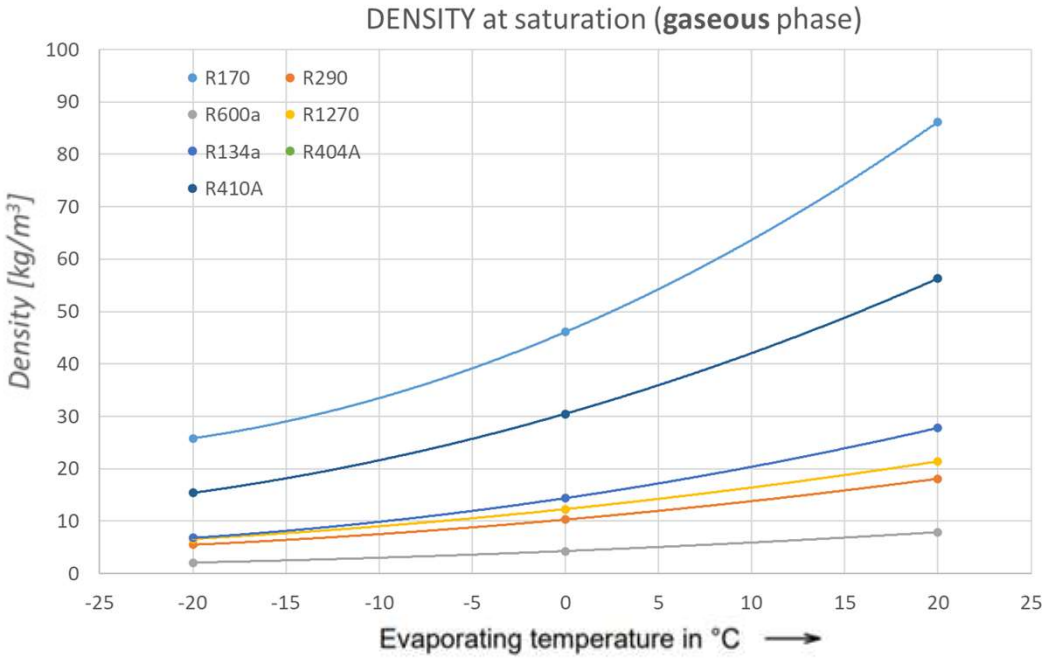
THERMODYNAMICS ADVANTAGES



- Low pressure ratio (condensation on evaporation pressure)
  - Positive effect on compressors parts (less stress, more duration)

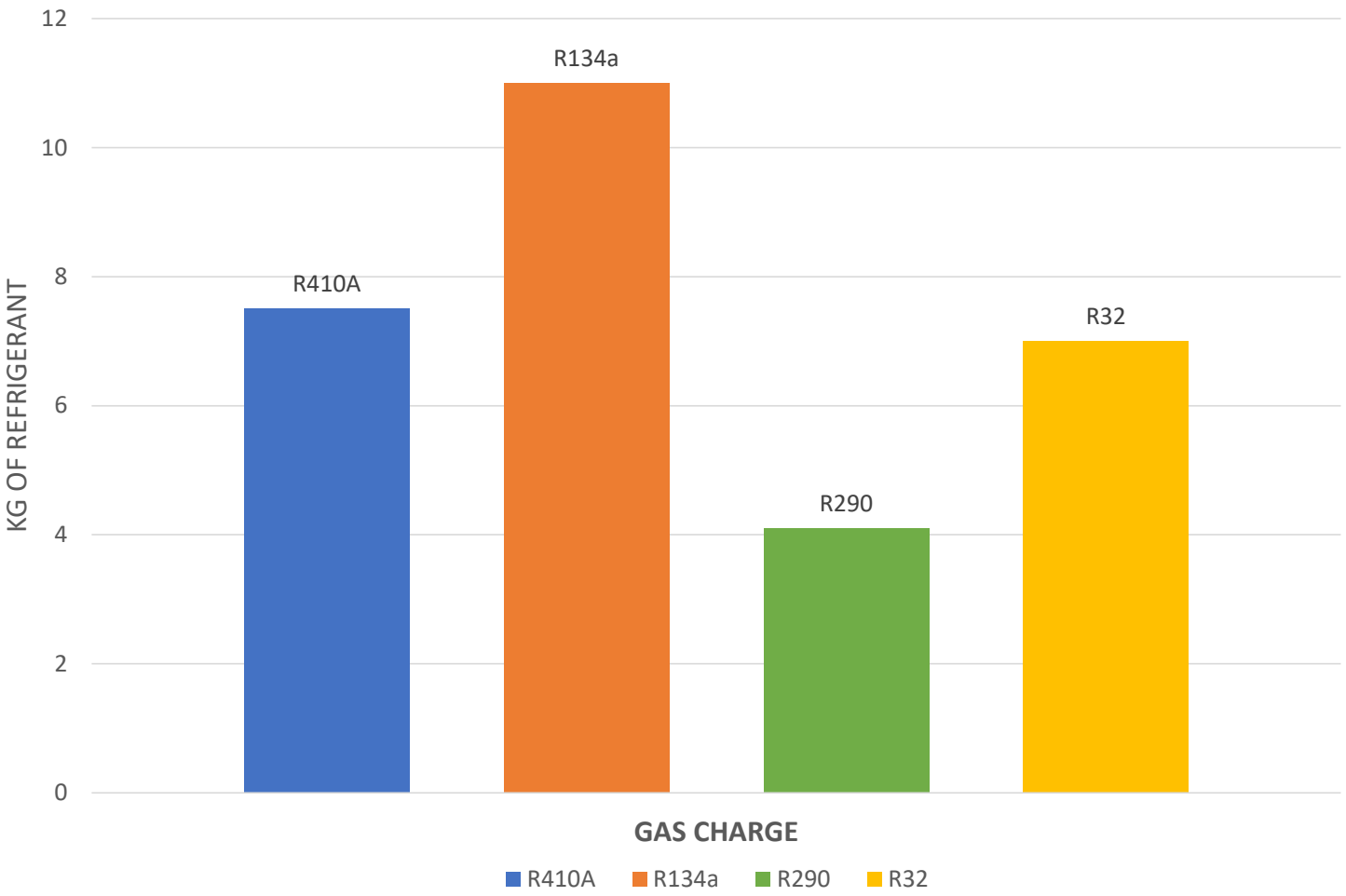
LESS REFRIGERANT CHARGE





- **Density** of R290 is **less than half** compared to that of fluorocarbons
  - R290 => 448,6 Kg/m^3
  - R410A => 906,8 Kg/m^3
- Thanks to low density and high heat transfer performance, **refrigerant charges for propane are very low**

GAS CHARGE COMPARISON

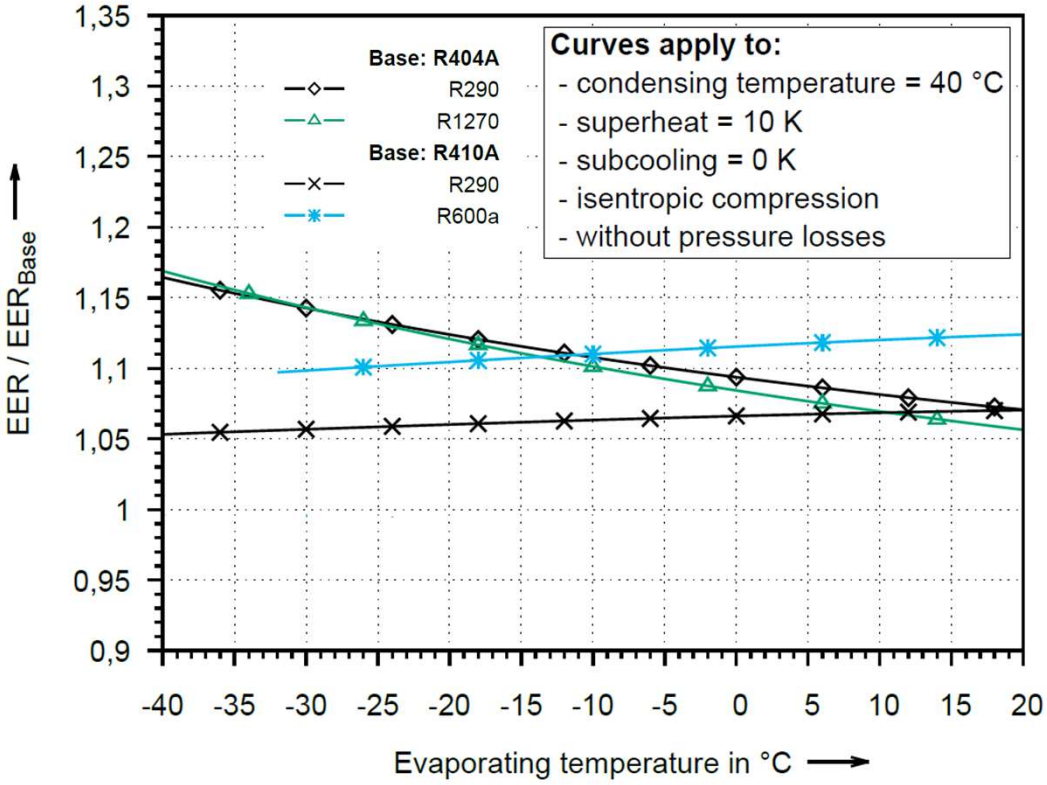


INPUT CONDITION

Cooling capacity: 50 kW
User temperature: HT
Application: process

Every unit that operates with natural refrigerant **R290** instead of **R410A** allows to save CO_2 emission equivalent to an average car journey of 42.000 km, a complete trip around the world!

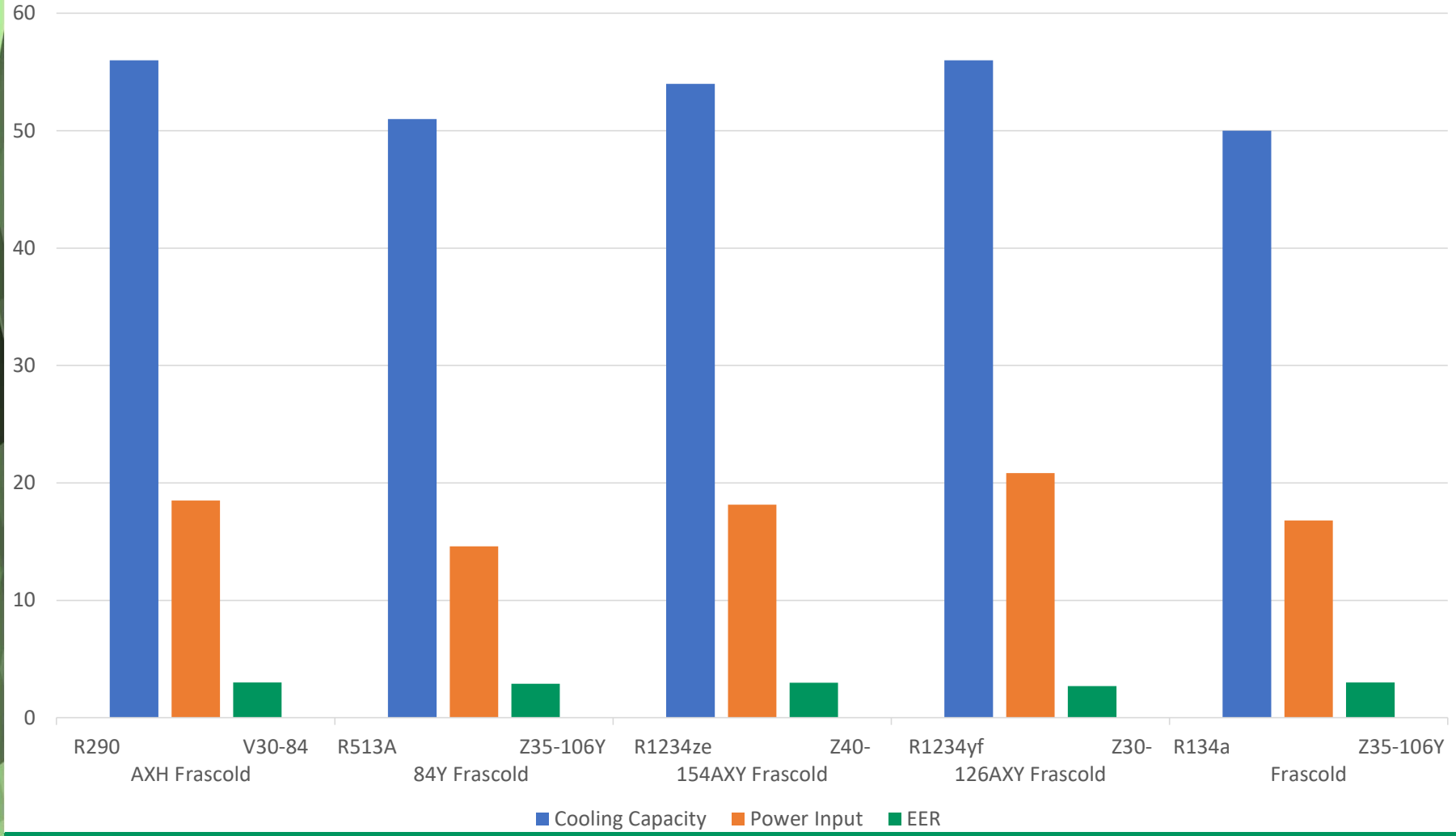
EER COMPARISON



- Ratios of refrigeration capacity to required compressor power **for an ideal cycle**.
- Hydrocarbons EER relative to those of the fluorocarbon baseline refrigerants.
- **Compared to R410A** EERs for R290 and R600a are **between 5% and 12% higher**.
- This simplistic comparison of EERs is indicative of the **strong potential for energy efficient operation of HC systems**.

PERFORMANCE COMPARISON

SAME COOLING CAPACITY – RECIPROCATING COMPRESSORS



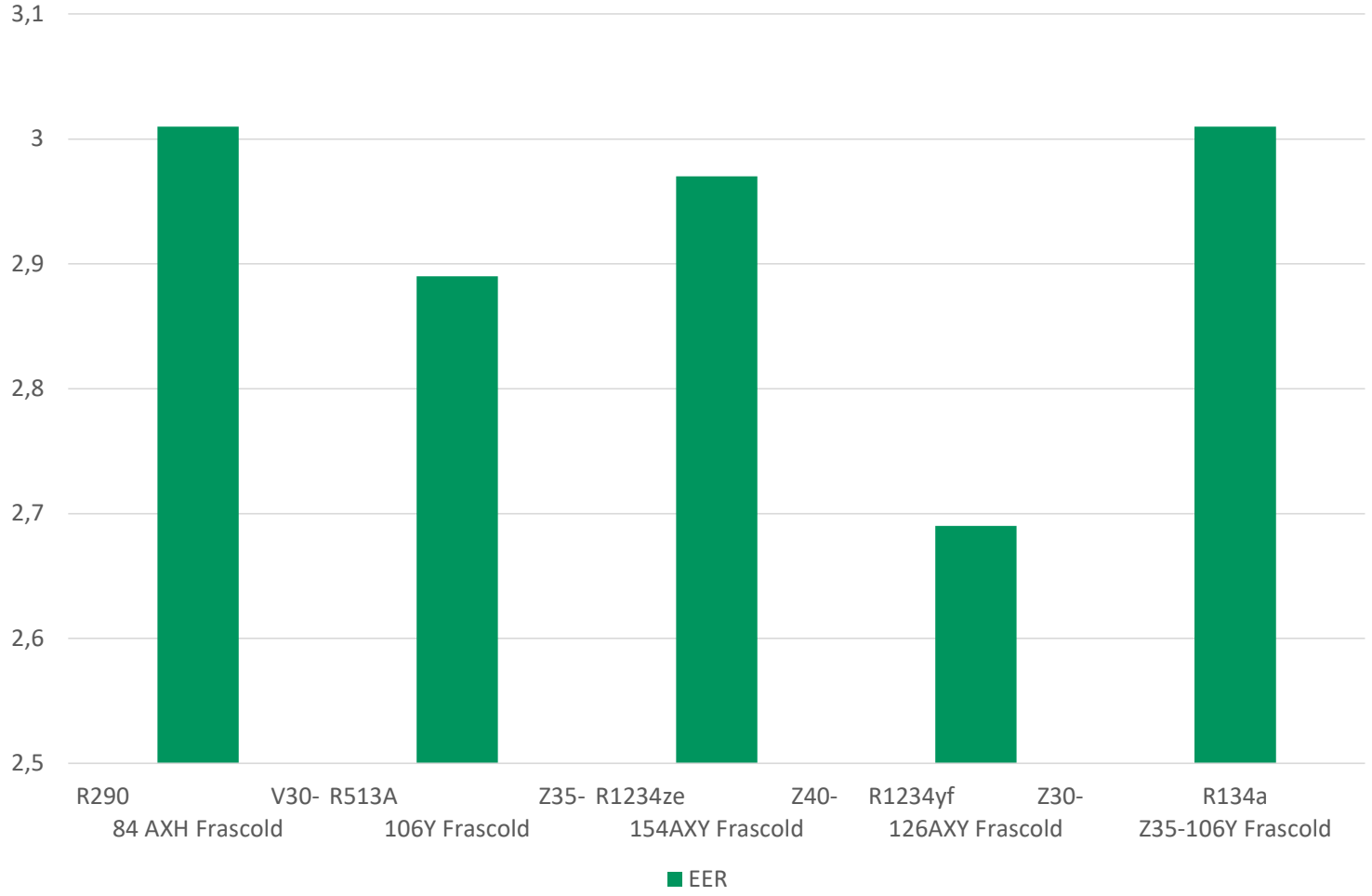
INPUT CONDITION

Evaporating temp: 2°C
Condensing temp: 50°C
Subcooling: 5 K
Superheat: 5 K

EER COMPARISON - SAME COOLING CAPACITY

INPUT CONDITION

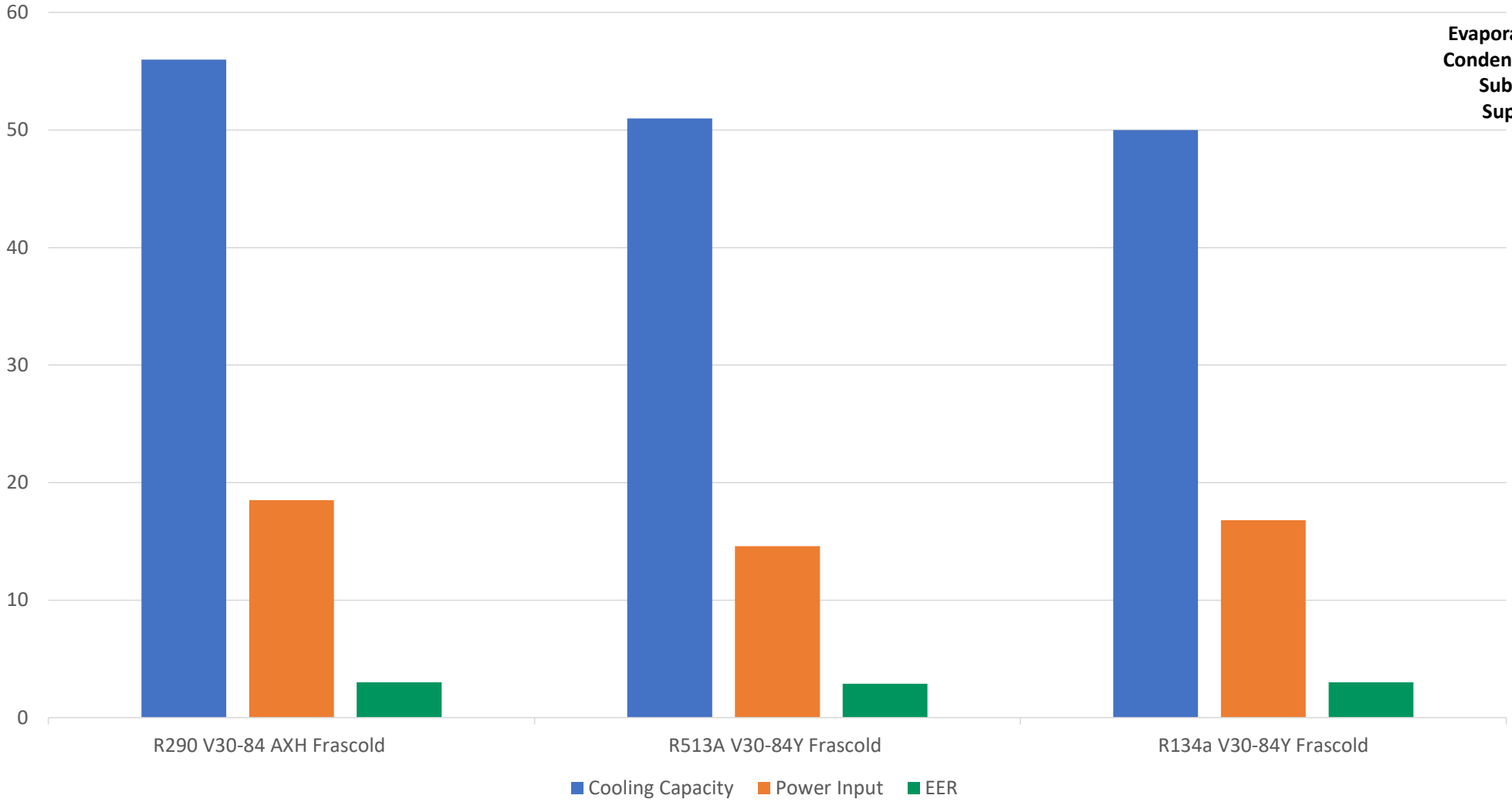
Evaporating temp: 2°C
Condensing temp: 50°C
Subcooling: 5 K
Superheat: 5 K



PERFORMANCE COMPARISON – SAME RECIPROCATING COMPRESSOR MODEL

INPUT CONDITION

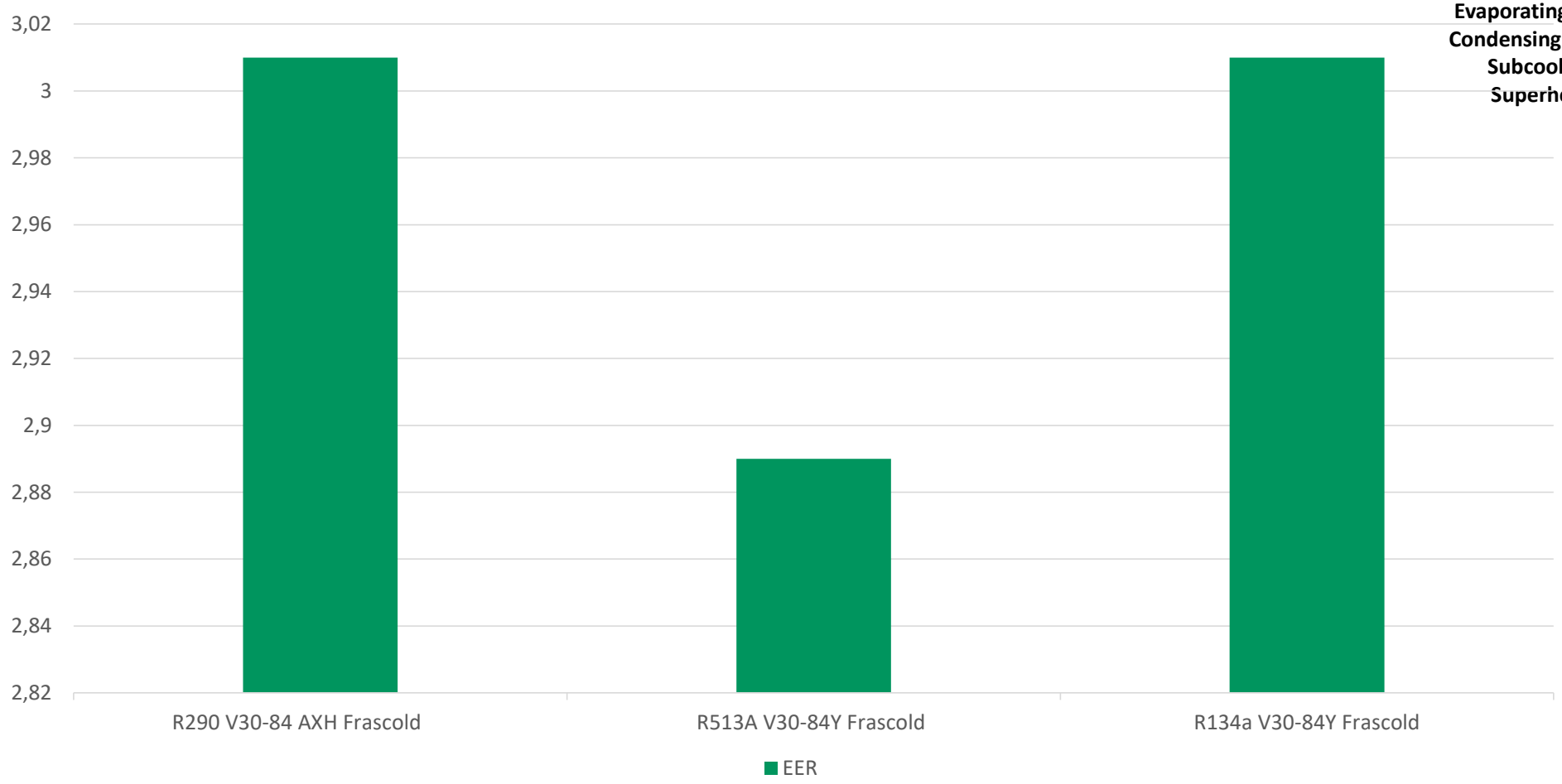
Evaporating temp: 2°C
Condensing temp: 50°C
Subcooling: 5 K
Superheat: 5 K



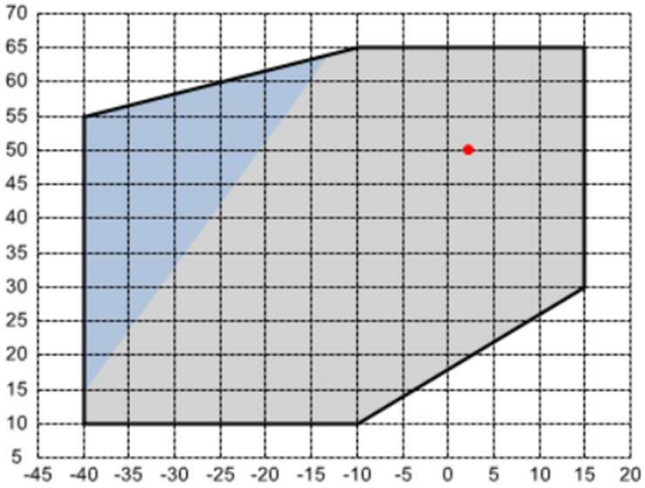
PERFORMANCE COMPARISON – SAME RECIPROCATING COMPRESSOR MODEL

INPUT CONDITION

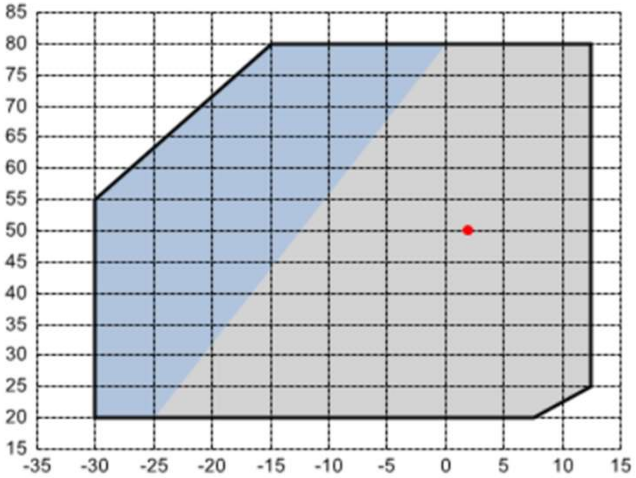
Evaporating temp: 2°C
Condensing temp: 50°C
Subcooling: 5 K
Superheat: 5 K



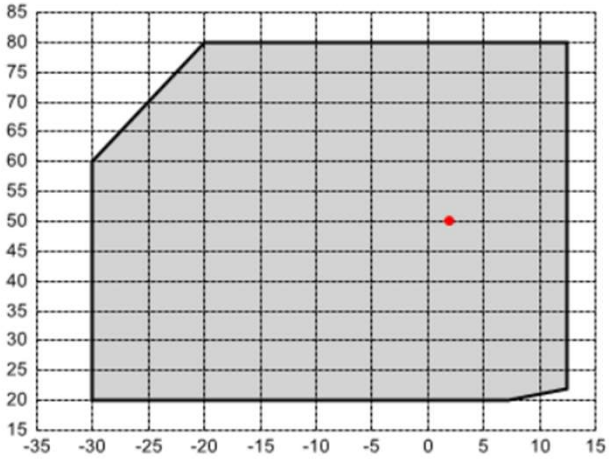
Envelope Comparison



R290
FRASCOLD V30-84AXH



R513A
FRASCOLD V30-84Y



R134a
FRASCOLD V30-84Y

AGENDA

R290

Why Propane?
ODP/GWP/F-GAS road map
Composition
R290 classification
Propane use
EU Directives

SAFETY

EUROKLIMAT Approach
Notified body and EK Certification
EUROKLIMAT solutions
Zero leak and real test
New Project

EK EXPERIENCE

Units installed around EU
Most significant applications

CHILLERS AND HEAT PUMPS

R290 – Air to water chillers and heat pumps
Thermodynamics advantages
HFC/HFC+HFO/HC performance comparison

R290 – AIR TO WATER CHILLERS AND HEAT PUMPS

- **PROCESS HT**

  WATER
  20°C/15°C
  12°C/7°C

- **HVAC**

  WATER
  12°C/7°C
  40°C/45°C

- **PROCESS MT**

  WATER + GLYCOL
  -4°C/-8°C

- **PROCESS LT**

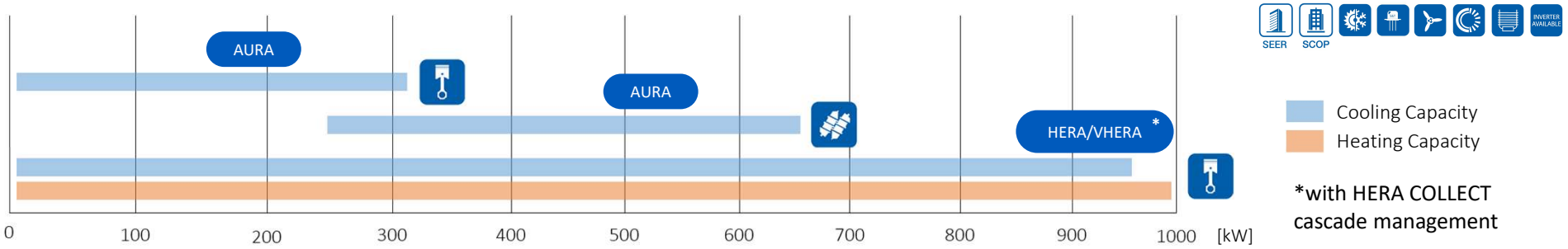
  WATER + GLYCOL
  lower than -8°C

Natural Cooling/Heating

Product range Air/water

- Chillers and Heat pumps for COMFORT applications

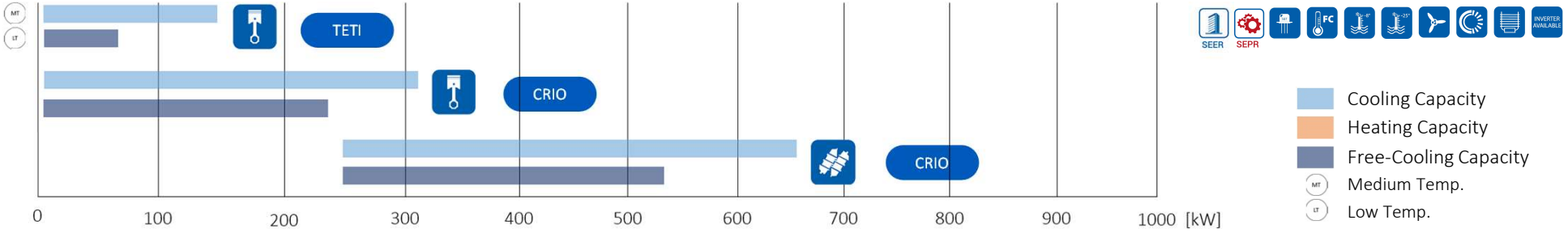
Air / water



*with HERA COLLECT cascade management

- Chillers and Heat pumps for PROCESS applications

Air / water

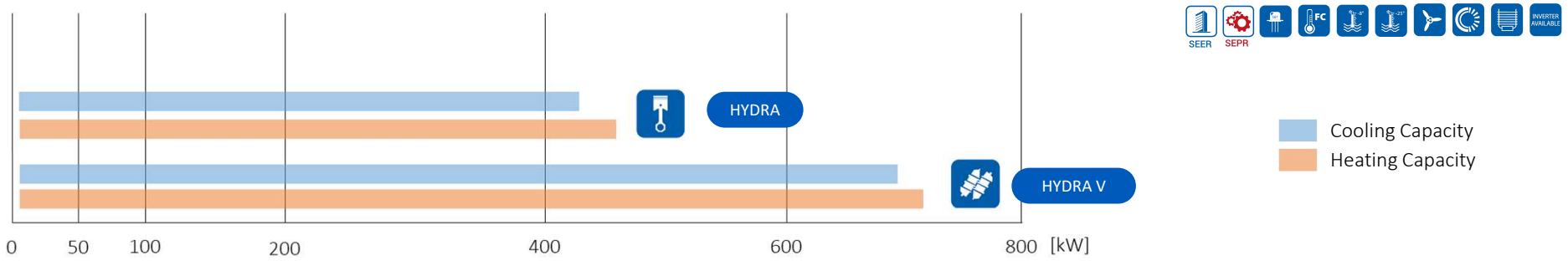


Natural Cooling/Heating

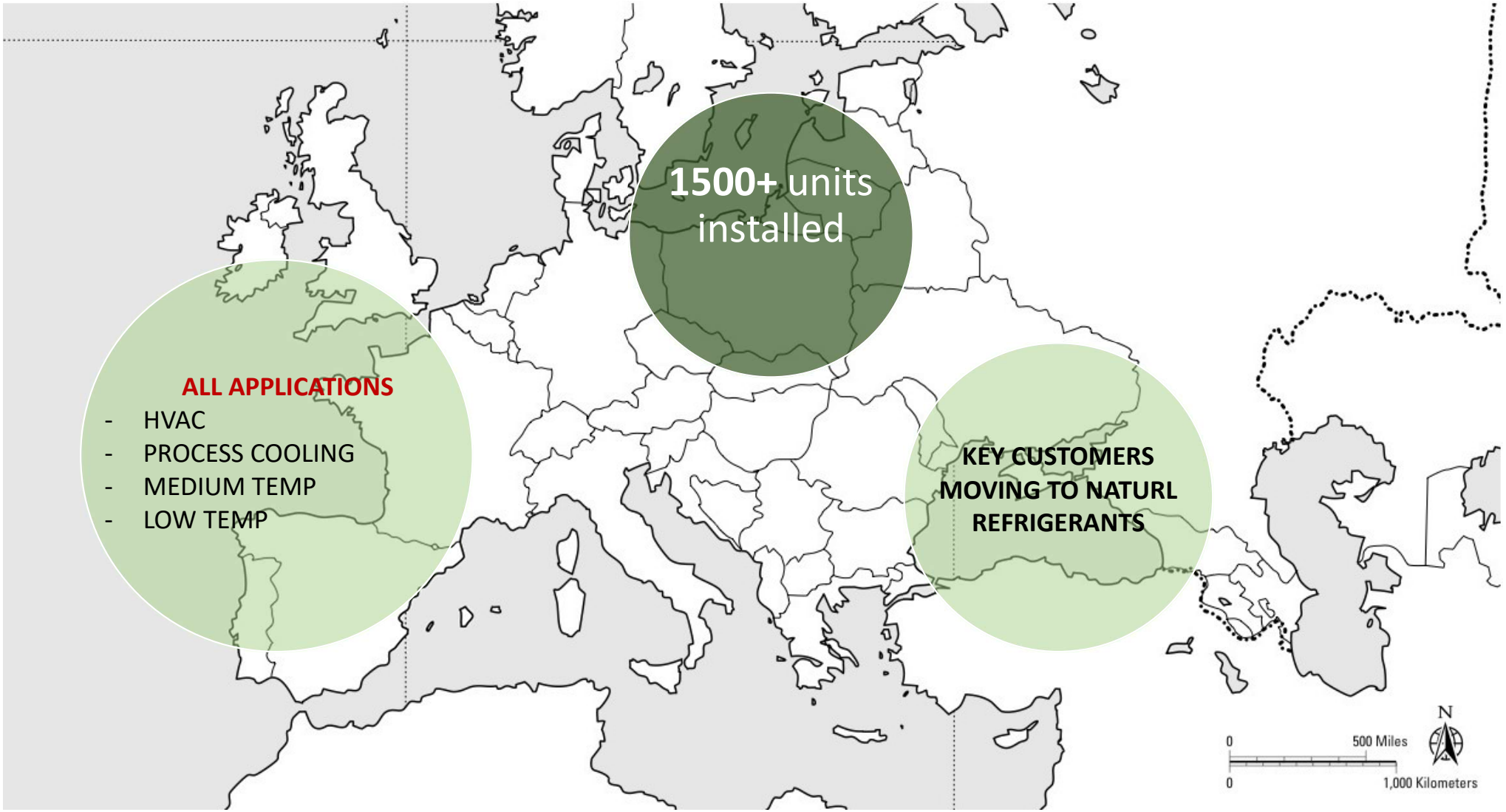
Product range Water/water

- Chillers and Heat pumps for COMFORT and PROCESS applications

Water / water



UNITS INSTALLED AROUND EUROPE



Customer/Application:	Landhaus Sankt Poelten
Country:	Austria
Year:	2008-2011-2014
System:	Air Cooled chiller with R290
Units:	4
Model:	TETI IP/ST/AS 201 – 251 - 351

Customer/ Application:	Hovedstadens Akutcenter Hillerød Hospital
Country:	Denmark
Year:	2013
System:	Air Cooled chiller with R290
Units:	2
Model:	TETI BS/ST/AS 301 (Old TETI series)

Customer/Application:	DLR – Institute of Space Systems
Country:	Germany
Year:	2013
System:	Air Cooled Free cooling chiller
Units:	3
Model:	TETI FC B/ST/SP 402

DANISH TECHNOLOGICAL INSTITUTE

Customer/Application:	Danish Technological Institute
Country:	Denmark
Year:	2014
System:	Air Cooled chiller with R290
Units:	1
Model:	TETI IP/ST/SP 402

Customer/Application:	Novartis
Country:	Switzerland
Year:	2014
System:	Air Cooled chiller with R290
Units:	2
Model:	AURA HE IP/ST/AS 351

Customer/Application:	Carrefour
Country:	Romania
Year:	2013
System:	Air Cooled chiller with R290
Units:	3
Model:	AURA HE IP/ST/AS 1402

Application: Shopping center

Country: Switzerland

Year: 2020

System: Air Cooled heat pump with R290

Units: 4

Model: HERA BP/SL/AS/EC/II 65-1-1 R290

Customer/Application:	Logistic Centre
Country:	Norway
Year:	2021
System:	Air Cooled heat pump with R290
Units:	2
Model:	HERA BP/SL/AS/EC/II 95-1-1 R290

Customer/Application:	Supermarket
Country:	Netherlands
Year:	2020
System:	Air Cooled heat pump with R290
Units:	1
Model:	HERA IP/LN/AS/EC/II 190-2-2 R290

Application:	Industrial process
Country:	Denmark
Year:	2020
System:	Air Cooled chiller with R290
Units:	2
Model:	CRIO HE BP/SL/DS 1402S VFD

Customer/Application:	Logistic centre/Warehouse
Country:	Netherlands
Year:	2021
System:	Air Cooled heat pump with R290
Units:	5
Model:	HERA IP/LN/AS/EC/II 160-2-2 R290

Application:	Comfort cooling
Country:	Switzerland
Year:	2020
System:	Air Cooled chiller with R290
Units:	2
Model:	AURA HEI BP/LN/AS 1202S R290

Customer/Application:	Comfort cooling
Country:	Germany
Year:	2018
System:	Air Cooled chiller with R290
Units:	1
Model:	AURA HE BP/LN/AS 1202S R290

Application:	Industry
Country:	Latvia
Year:	2019
System:	Air Cooled chiller R290
Units:	1
Model:	TETI IP/ST/AS 201 R290

Customer/Application:	Warehouse
Country:	Switzerland
Year:	2016
System:	Air Cooled chiller R290
Units:	1
Model:	CRIO HE BP/SL/HR 1602 R290

Customer/Application:	Roche
Country:	Slovenia
Year:	2018
System:	Air Cooled chiller R290
Units:	1
Model:	AURA HEI BP/ST/AS 2502V R290

Customer/Application:	Office building
Country:	Germany
Year:	2015
System:	Air Cooled chiller R290
Units:	1
Model:	TETI IP/ST/SP 2X41 R290

Customer/Application:	COOP Supermarket
Country:	Italy
Year:	2020
System:	Air Cooled heat pump with R290
Units:	1
Model:	HERA IP/LN/AS/EC/II 55-1-1 R290

Customer/Application:	Industry
Country:	Switzerland
Year:	2021
System:	Air Cooled chiller R290
Units:	1
Model:	AURA HE A BP/SL/AS/EC/4S 291-2-2 PV R290

EUROKLIMAT®

Cooling System Solutions

Natural Cooling

Process Cooling

Precision Air Conditioning

Comfort Cooling

EUROKLIMAT
Cooling System Solutions

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THANK YOU