Industry co-operation on Natural Refrigerant technology development

JRAIA 一般社団法人 日本冷凍空調工業会
The Japan Refrigeration and Air Conditioning Industry Association

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About JRAIA

History

The Japan Refrigeration and Air Conditioning Industry Association (JRAIA) was originally established in February 1949.

Objective

JRAIA contributes to the steady development of Japanese industry and improvement in people's standard of living.

Membership

JRAIA members consist of regular and associate members.（123 ）

(1) Regular members: 76

(2) Associate members: 47

HITACHI
Inspire the Next

Panasonic
ideas for life

MITSUBISHI ELECTRIC
Changes for the Better

FUJITSU

MITSUBISHI HEAVY INDUSTRIES, LTD.

TOSHIBA
Carrier

MAYEKAWA MYCOM

DENSO

TOYO ENGINEERING WORKS,LTD.

SHARP

SANDEN
Delivering Excellence

EBARA

SAGINOMIYA

HOSHIZAKI ELECTRIC CO.,LTD.

YAZAKI

AISIN

Technology for Tomorrow

SINKO

dengen

Topre

Asada
ASADA CORPORATION

Calsonic Kansei

FUJIKOKI

FUSO Co., Ltd.
Sense and Measure the Environment

Valeo

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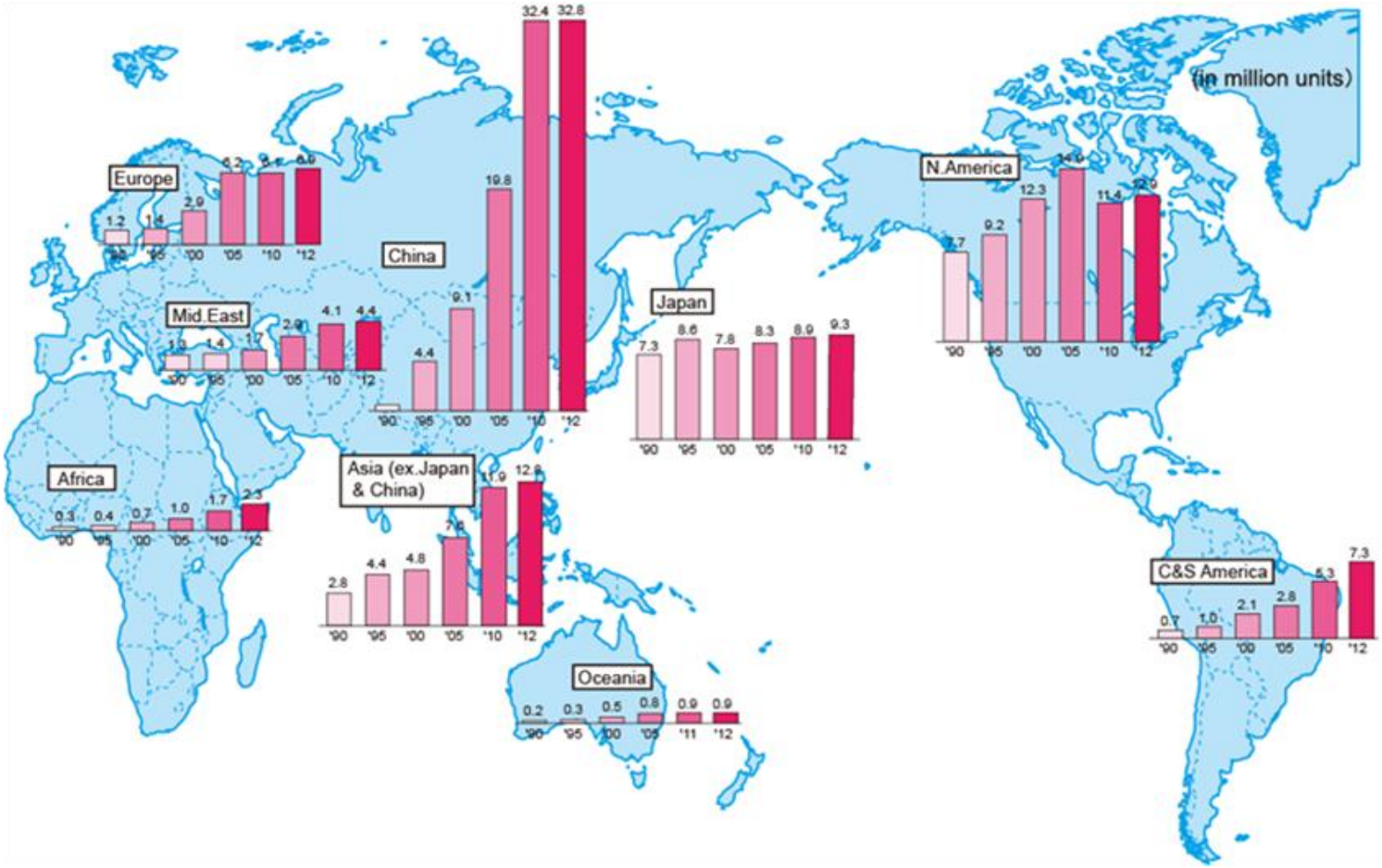
Worldwide Heat Pump Market

Estimates of World Demand for Air Conditioners

89.5 million units (2012 calendar year)



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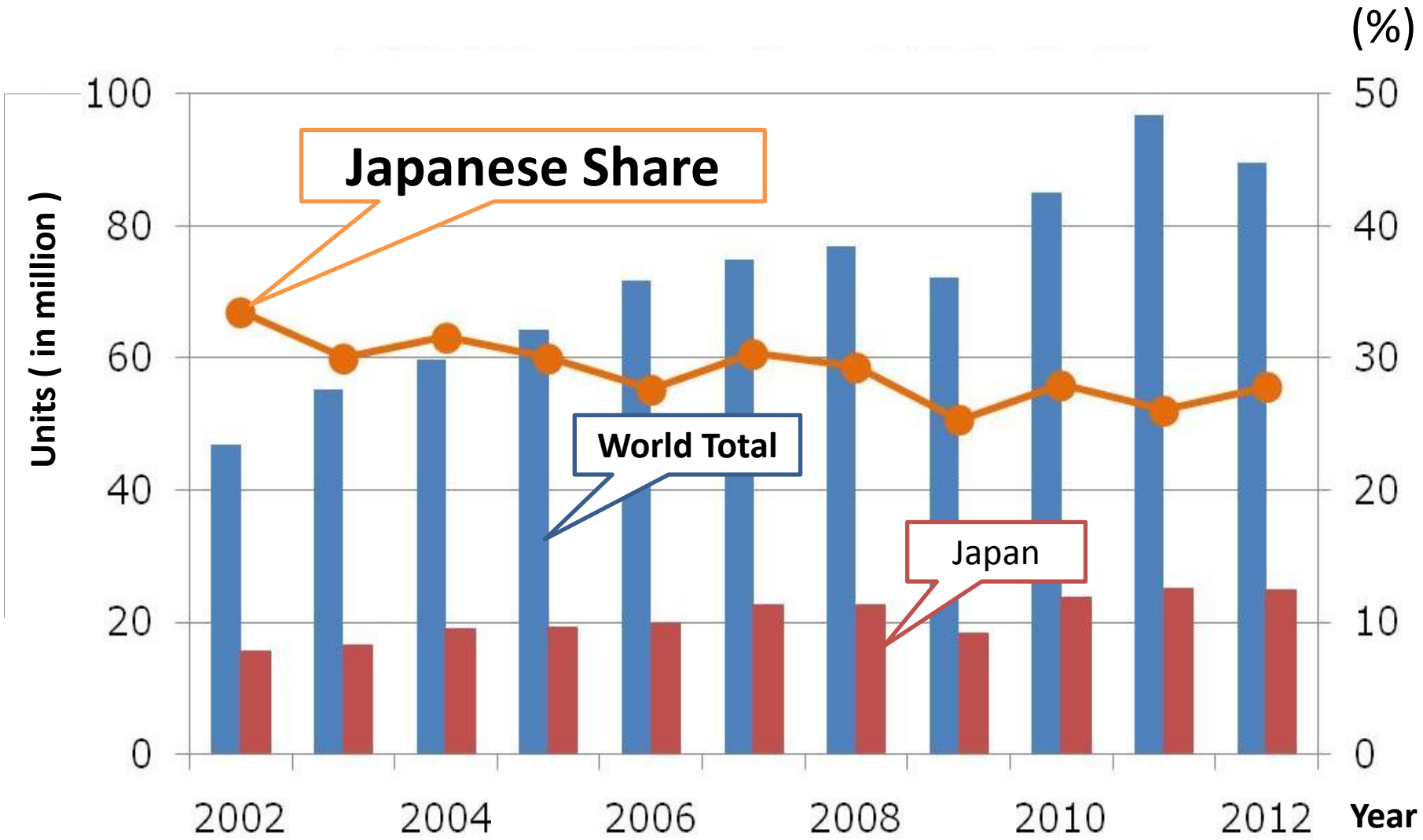
Japanese share of Heat Pump Market in the world



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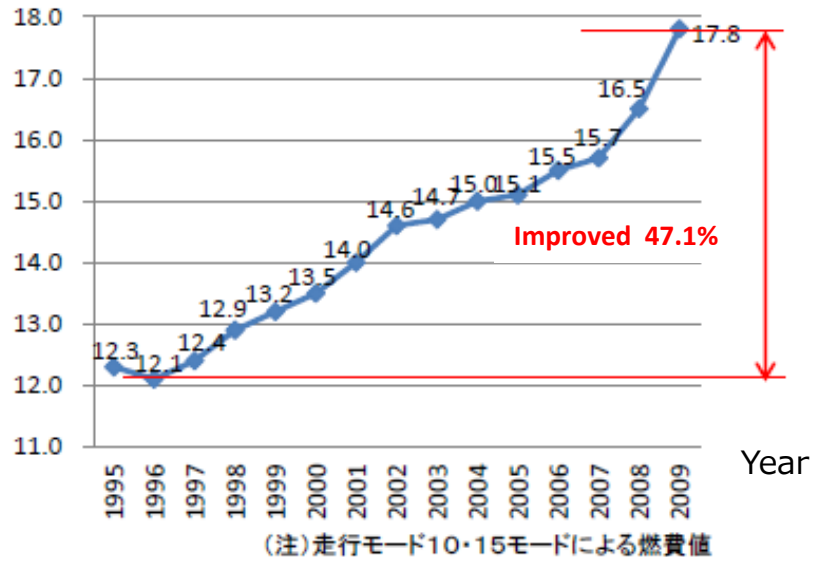
The effect of the Top Runner Program

Passenger vehicles

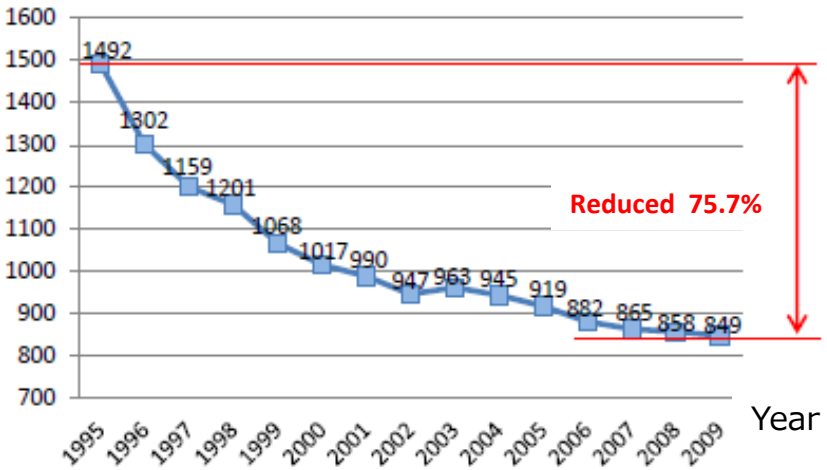
Fuel Consumption(km/L)



(注)走行モード10・15モードによる燃費値

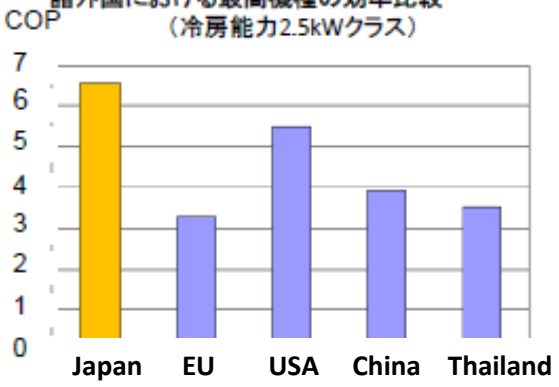
Air-conditioners

Seasonal Power Consumption(kW/h)



(注)壁掛け形冷暖房兼用・冷房能力2.8kWクラス・省エネ型代表機種の単純平均値

諸外国における最高機種の効率比較
(冷房能力2.5kWクラス)



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Agency for Natural Resources and Energy

Domestic and Overseas Situation of Refrigerants and Future View

- EU passed a resolution to ban refrigerants with GWP150 and above for automobile air-conditioners from 2011 onward.
- Phase-out of HFC is put on a discussion table due to global warming impact caused by HFC.
- Japanese Government will frame a new system of the GWP reduction.
- ASHRAE has created a new grade A2L for moderate flammable refrigerants in its classification. There is a movement worldwide toward moderate flammable refrigerants with a low GWP.

Montreal Protocol (1987)
Protection of the ozone layer

Specified Chlorofluorocarbon

CFC: R11, R12
Phase-out by 1996
HCFC: R22, R123
Phase-out by 2020

Depleting the ozone layer (due to chlorine)

Kyoto Protocol (1997)
Prevention of global warming

Alternative to Chlorofluorocarbon

HFC: R32, R125, R134a, R404A
R407C=R32+R125+R134a
R410A=R32+R125

Global warming impact
Increment of stock due to replacement to the alternatives in the future

Proper control of HFC
Responsible use

Low GWP refrigerants
Appearance of R1234yf
R1234ze
Mix

Other refrigerants
NH_3, CO_2, HC and so on
No ozone layer depleting and less global warming impact
Problem of performance and safety
Limited use to a few equipment

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Policy and Activities for Environmental Issues

EQUIPMENT

Energy Saving

・Emission control on a CO_2 basis

REFRIGERANTS

Direct Emission control

・Recovery activities

・Emission control in production

・Leakage reduction in use

ALTERNATE REFRIGERANTS

Switch to new refrigerants

・Research and investigation

・Low GWP refrigerants

・Other refrigerants

Fluorocarbon Recovery and Destruction Law ⇒New Law (2015)

Energy conservation law
Top Runner Program

Home Appliances Recycling Law

Automobile Recycling Law

The Act for Rationalized Use and Proper Management of Fluorocarbons.

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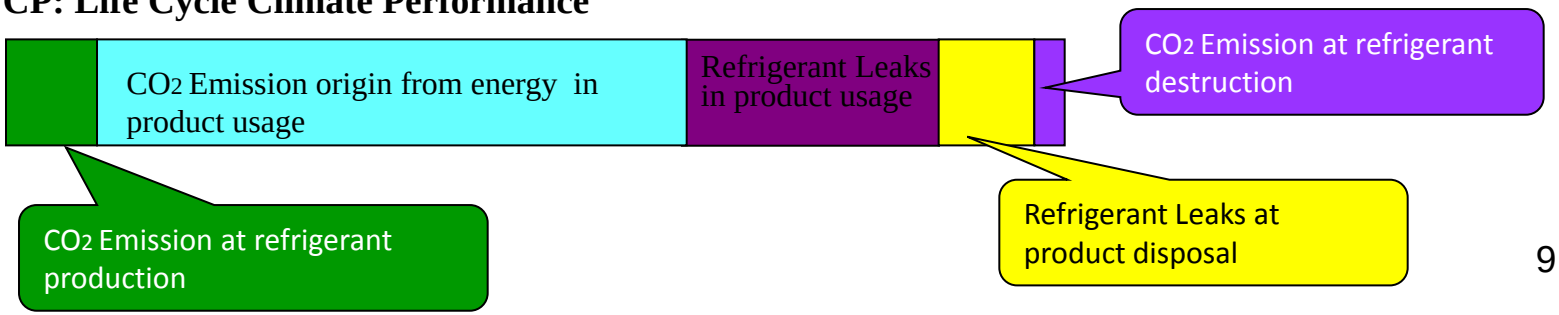
Requirements for next generation refrigerants

Conditions required for Alternatives

Safety	・Low Toxicity ・Low Risk of Flammability
Environment Performance	・Ozone Depletion Potential =0 ・Low Global Warming Potential
Energy Efficient	・Superior for LCCP* value ・Similar performance at high load cooling
Economic Feasibility	・Reasonable Cost ・Acceptable in Developing Countries

* **LCCP: Life Cycle Climate Performance**



Next generation refrigerant candidates for air-conditioners

	ODP	GWP (IPCC 4AR)	ASHRAE safety classification	Ignition Point (℃)	Burning Quantity (kJ/kg)	Burning Velocity (cm/sec)	Pressure（MPa）
HCFC R22	0.055	1810	A1	-	-	-	1.72
R410A	0	2090	A1	-	-	-	2.72
R32	0	675	A2L	648	9.3	6.7	2.8
R1234yf	0	4	A2L	405	10.3	1.5	1.16
Mix	0	300~500 ?	?	?	?	?	?
New	0	?	?	?	?	?	?
R717 (NH_3)	0	0	B2L	651	18.6	7.2	1.78
R290 (Propane)	0	<3	A3	410	46.3	39	1.53
R744 (CO_2)	0	1	-	-	-	-	10.00

Several proposals from refrigerant maker

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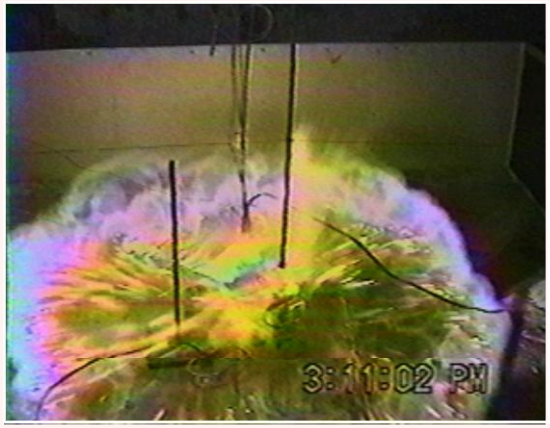
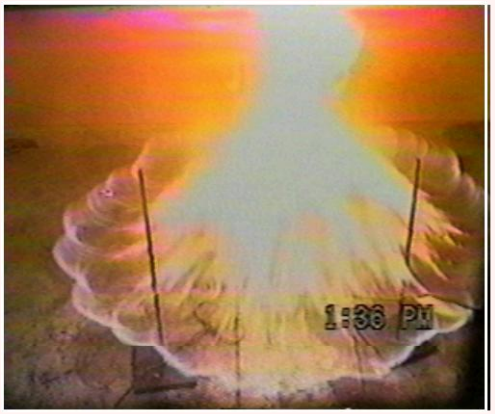
Combustion Test Results



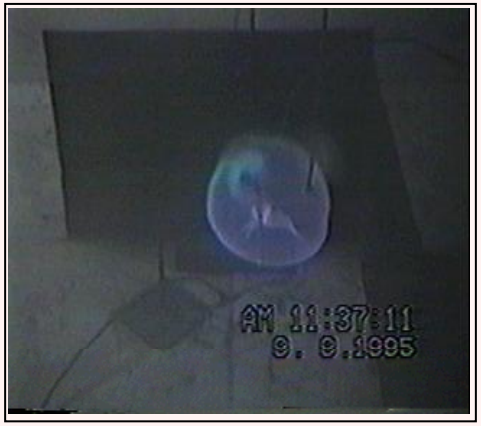
R290(A3) Propane

BV=39cm/s



R152a (A2)

BV=23cm/s



R32 (A2L) BV=6.7cm/s

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Candidates for the next generation refrigerants by applications

High temp.

Mid. Temp.

Low temp.

0℃

Residential HP water heater

R410A

▼

CO_2

Commercial HP water heater

▼

CO_2

Residential A/C

R410A

▼

R32etc

Automobile A

R134a

▼

R1234yf

PAC (shops)

R410A,R407C

▼

R32/R1234yf/etc

(refrigerant management)

Multi A/C Bldg.

R410A,R407C

▼

Screw, Chiller

R410A、R134a

▼

R1234ze/etc

Centrifugal

R134a、R123

▼

R1234ze/etc

Home refrigerator

R134a

▼

HC

Commercial refrigerated cabinet

R404A

▼

CO_2

Refrigerated warehouse

R22

▼

NH_3、NH_3/CO_2

Ultra-low temp. equipment

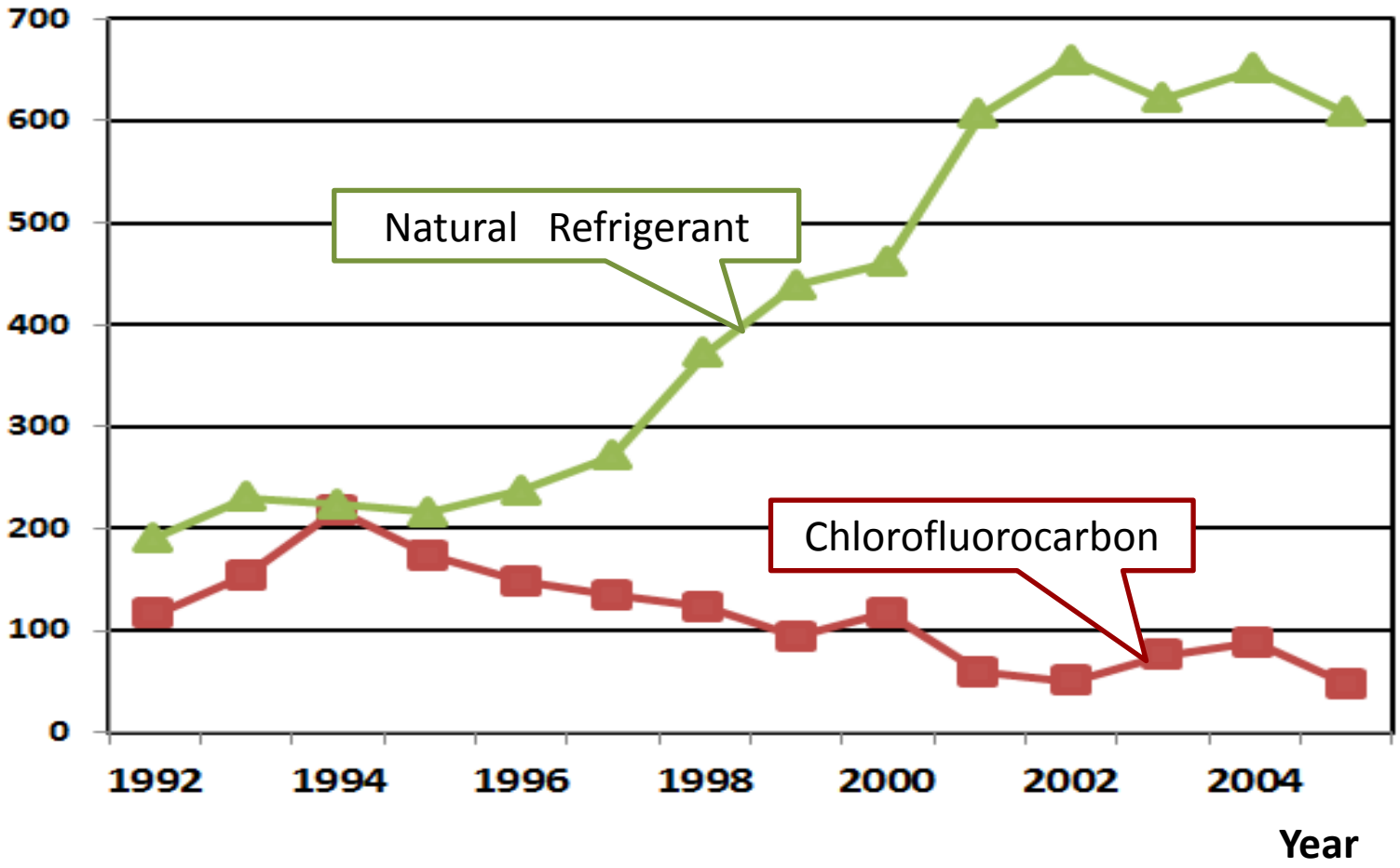
R22/R23

▼

—(Air)

Capacity 1KW | 10KW | 100KW | 1000KW

Trends in the number of Natural Refrigerant Patent



Example of Alternative Refrigerant Technology

SANDEN CO2 vending machines

MAYEKAWA Air Refrigeration System
ultra-low temperature (-50℃-100℃)

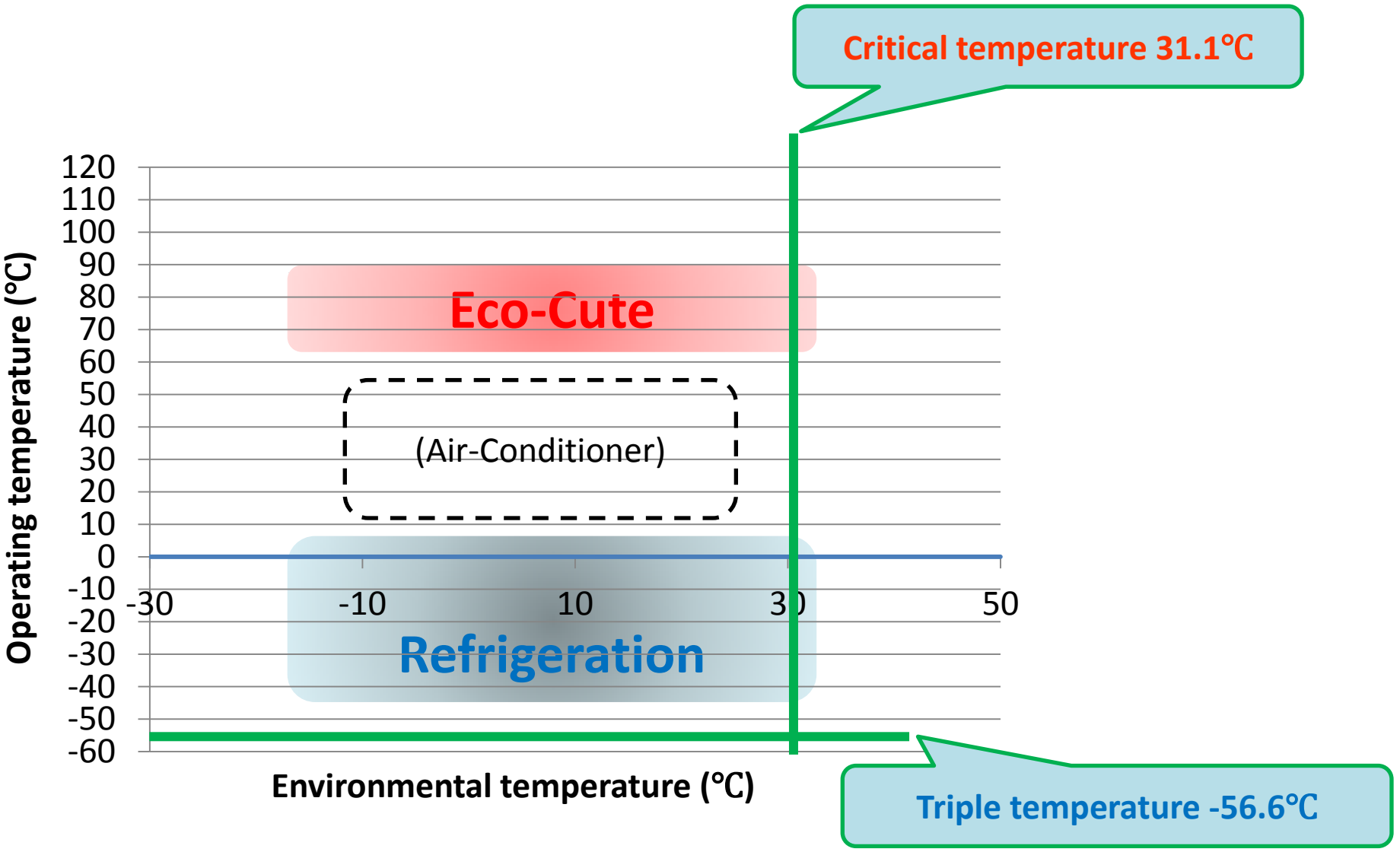
Panasonic CO2 Refrigeration Showcase

TOYO Engineering Works
CO2/NH^3 Secondary Refrigerant Circulation System

Issues of Natural Refrigerant

- Safety (Flammability ,Toxic)
- Performance (Low energy efficiency)
- Economy (production cost)
- Some products are already on the market, But they are not yet popular because of many challenges
- There is no suitable natural refrigerant in Air-conditioner use

Correlation diagram of ambient temperature and operating temperature on CO_2 refrigerant



Thank you for your kind attention!

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