JRAIA

The Japan Refrigeration and Air Conditioning Industry Association

June 3, 2014

Tottori, Japan

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- Domestic Shipments
- Global Market
- Study of the Next Generation Refrigerants
- Main Points of the Revision of F-gases Recovery & Destruction Law in Japan
- Technical Prospects for HVAC&R Industry

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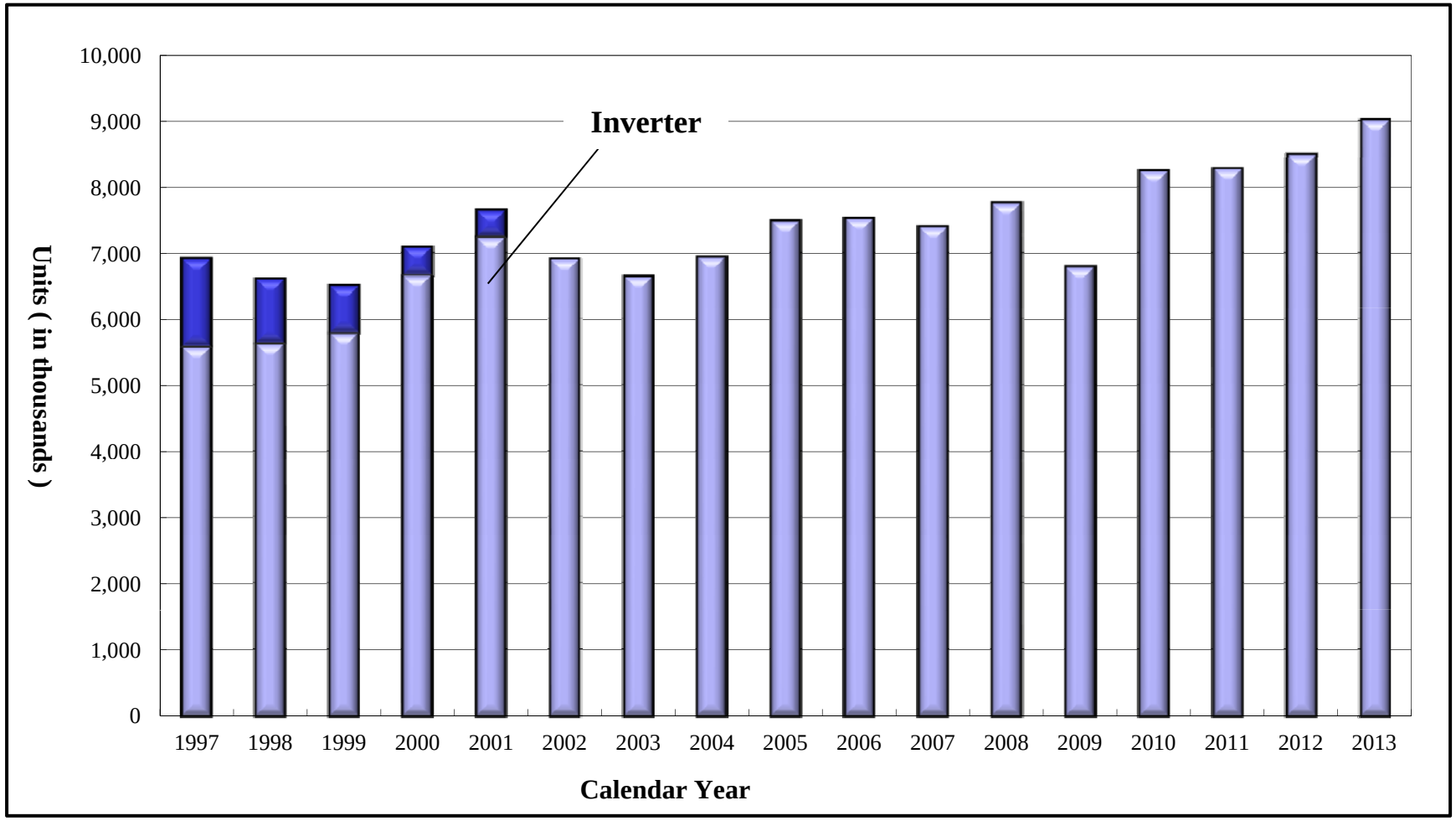
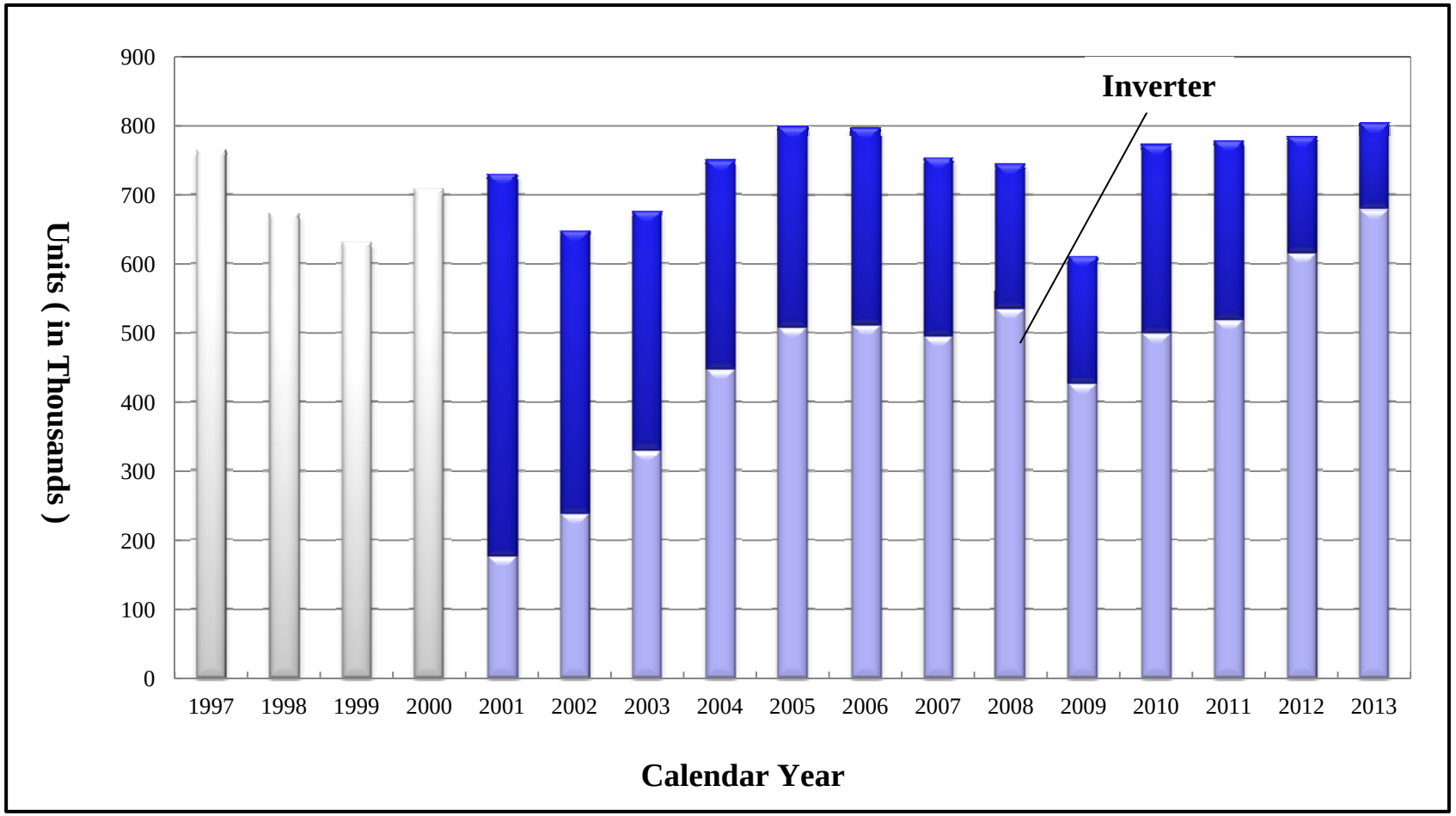
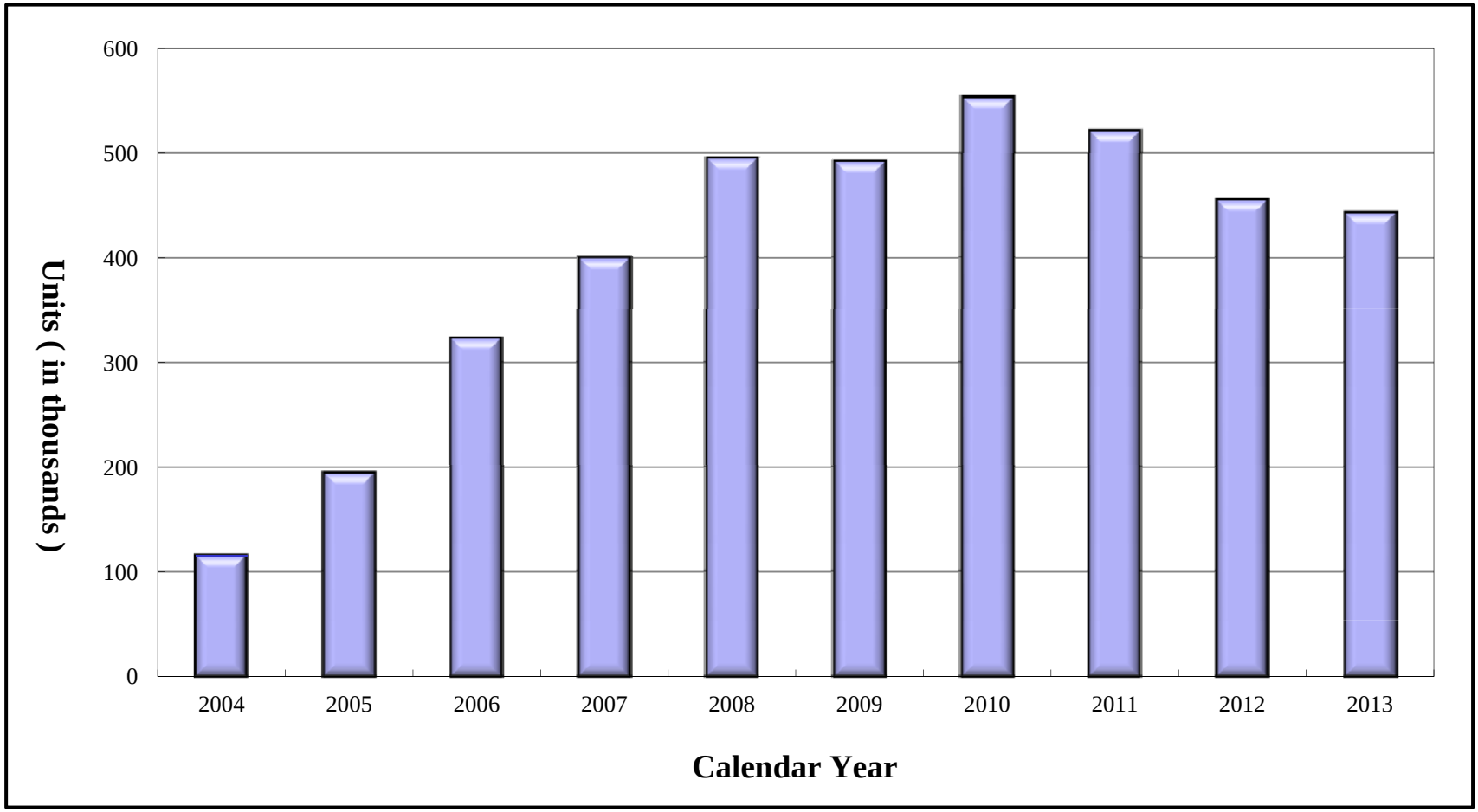
Transition of yearly shipments
Residential Air Conditioner



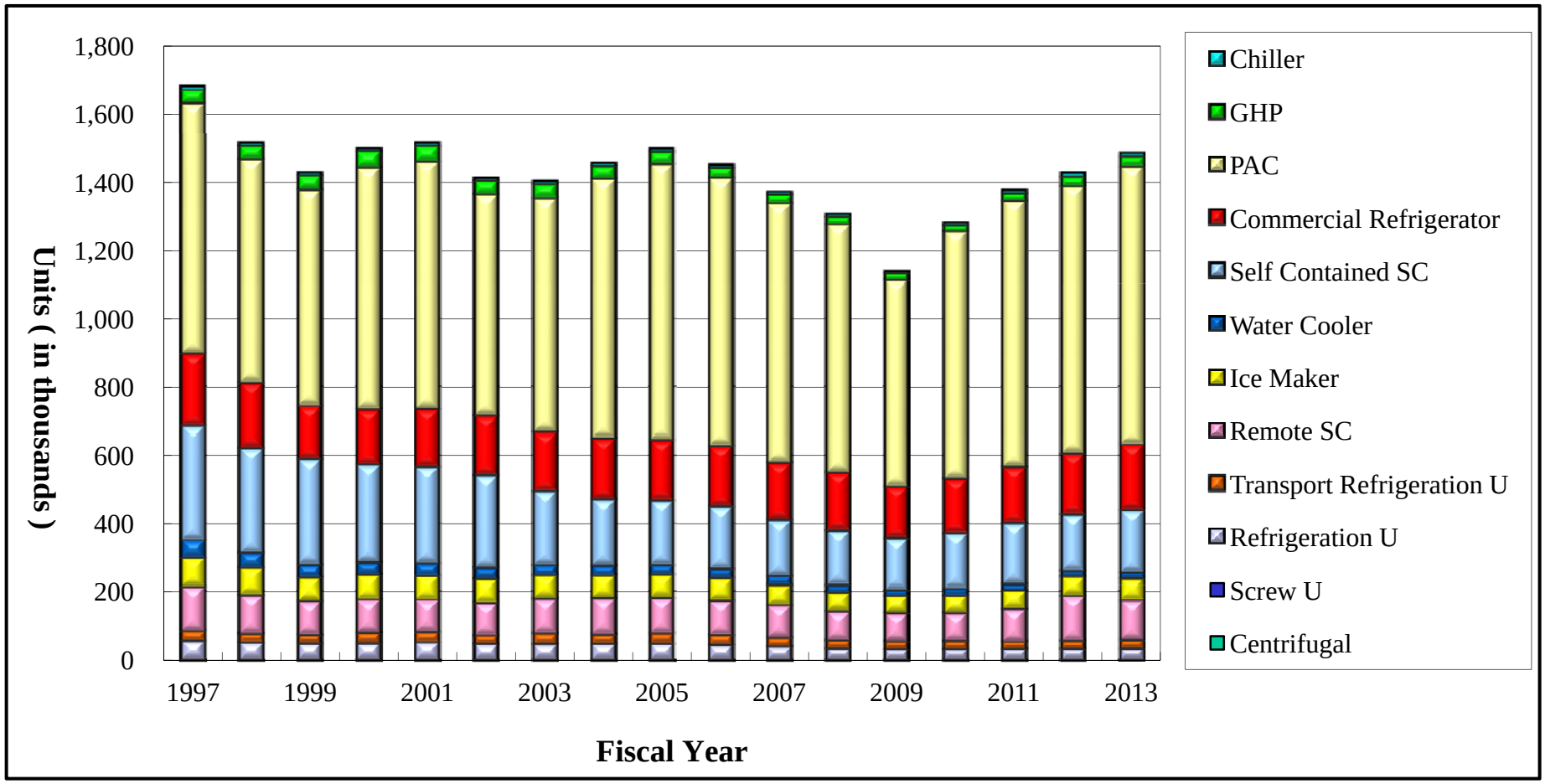
Transition of yearly shipments
Commercial Air Conditioner



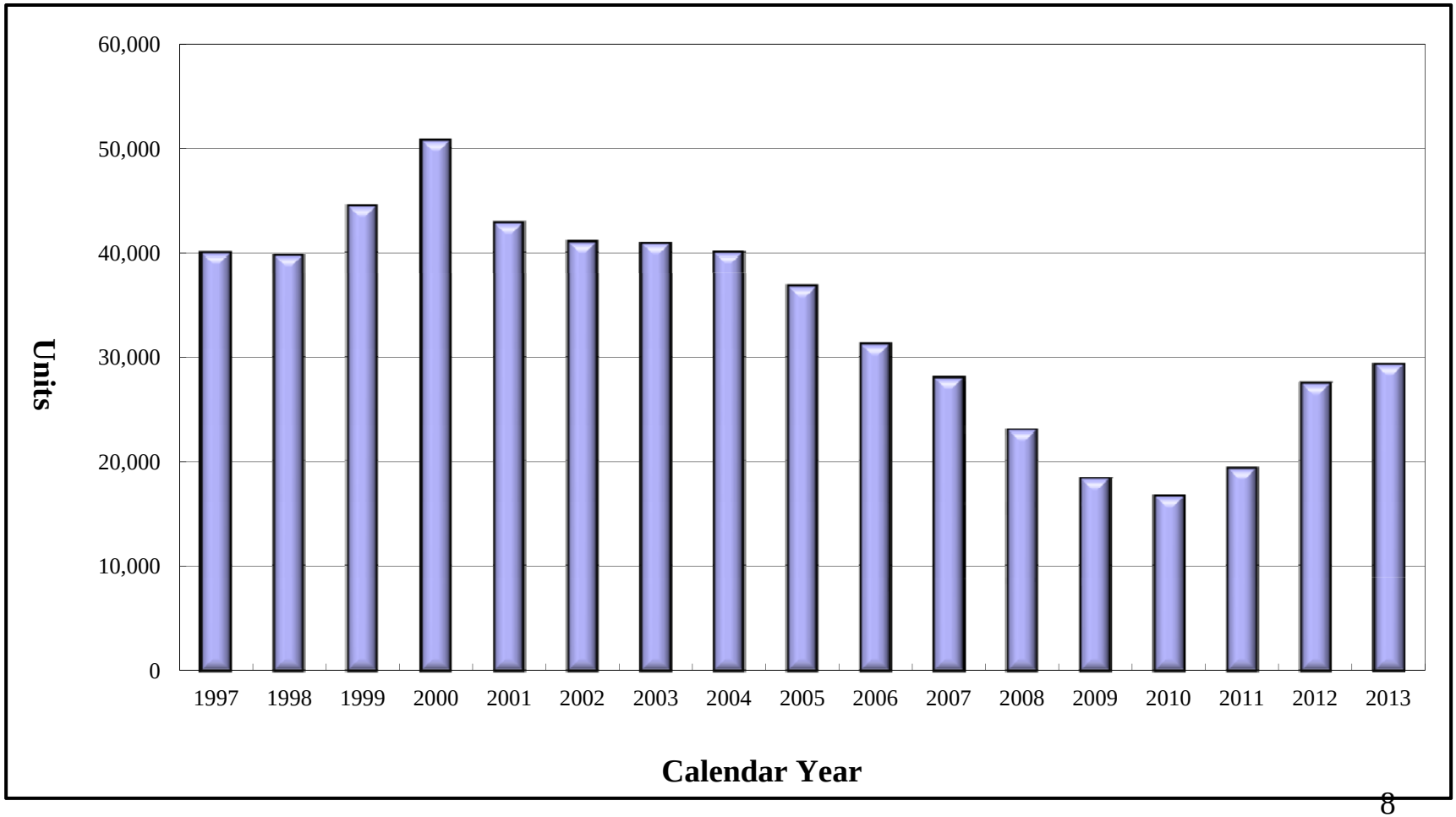
Transition of yearly shipments
Residential heat-pump water heater



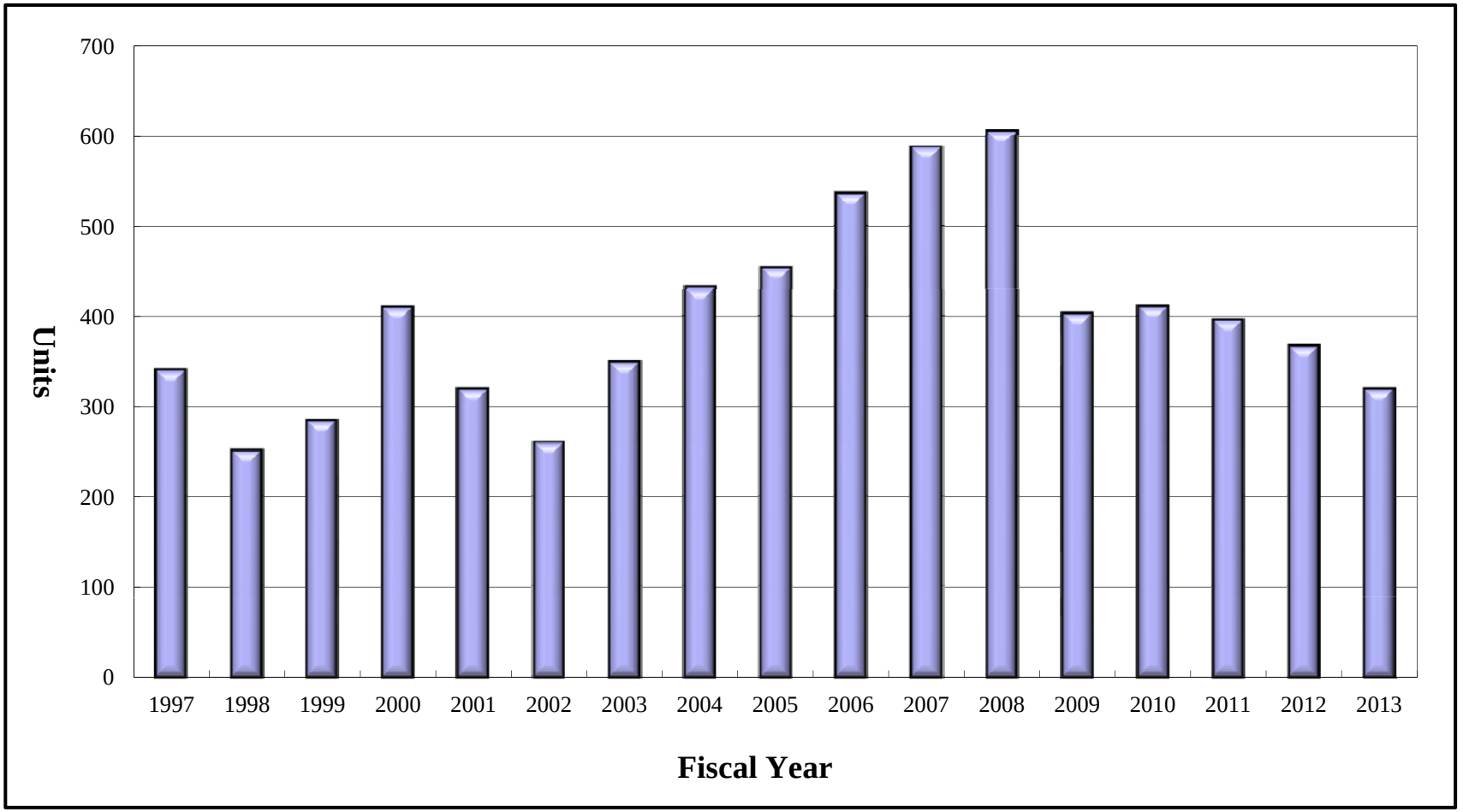
Transition of yearly shipments
Commercial Refrigerator & Air Conditioner



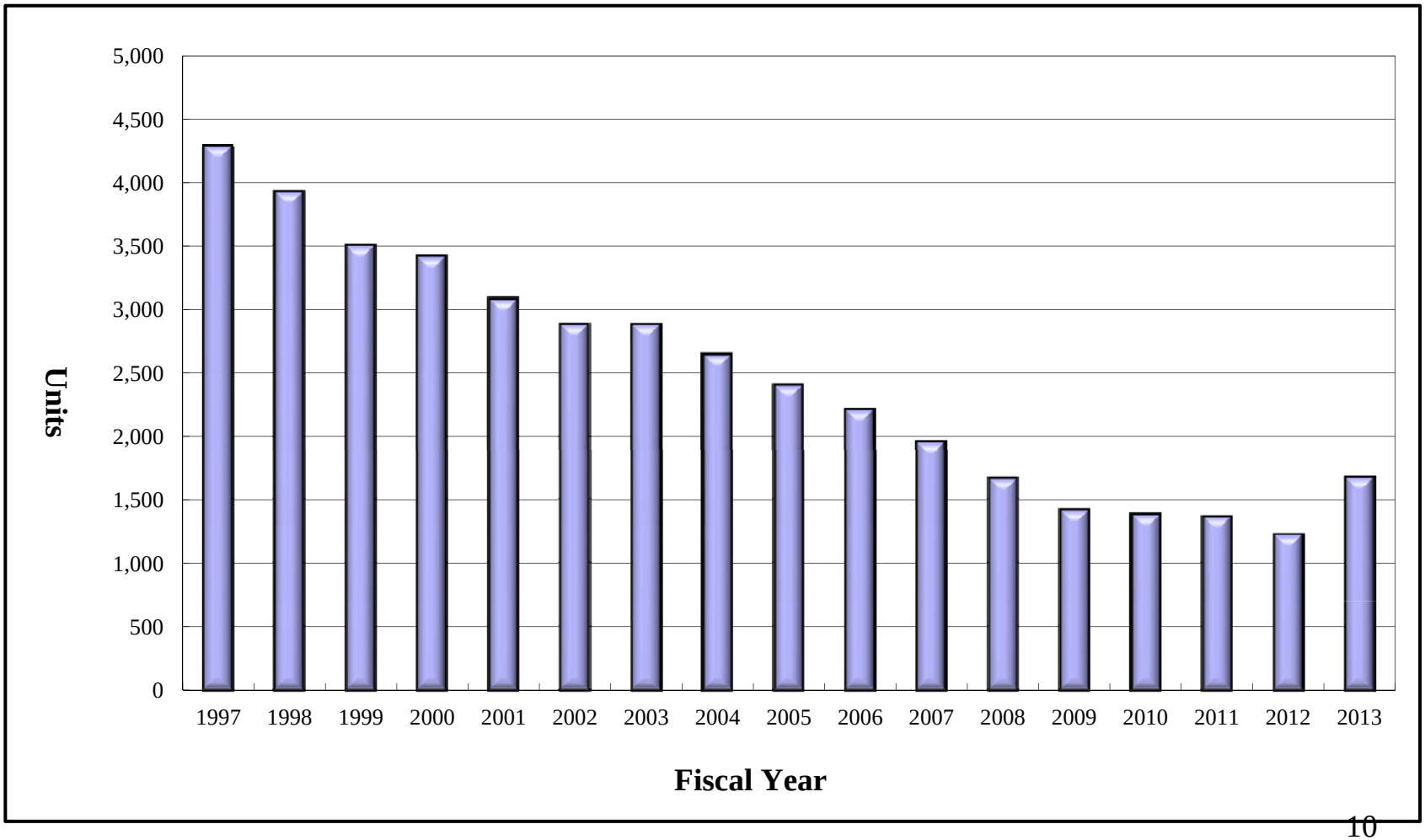
Transition of yearly shipments
Gas-engine driven Heat-pump Air Conditioner



Transition of yearly shipments
Centrifugal Chiller



Transition of yearly shipments
Absorption Chiller



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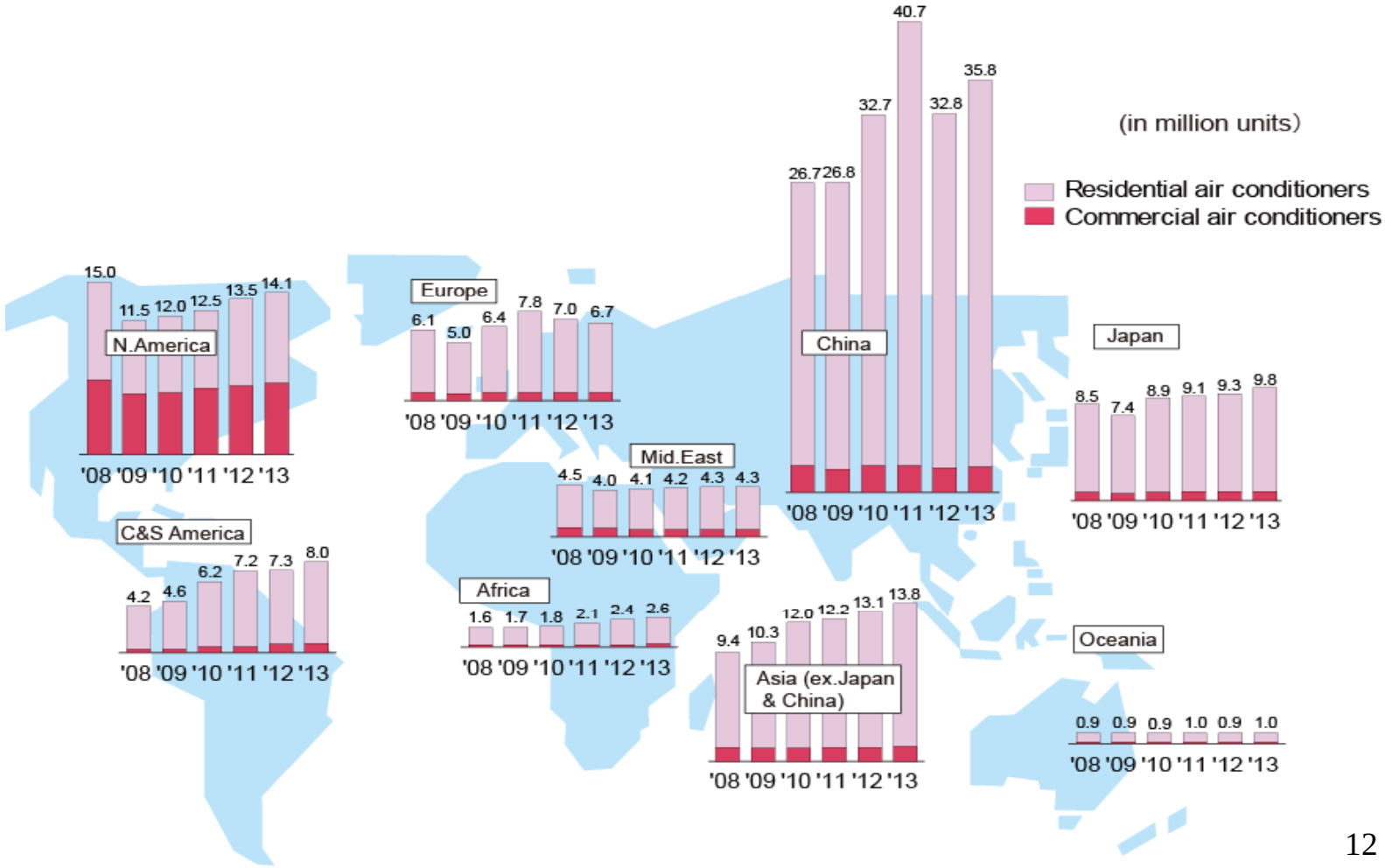
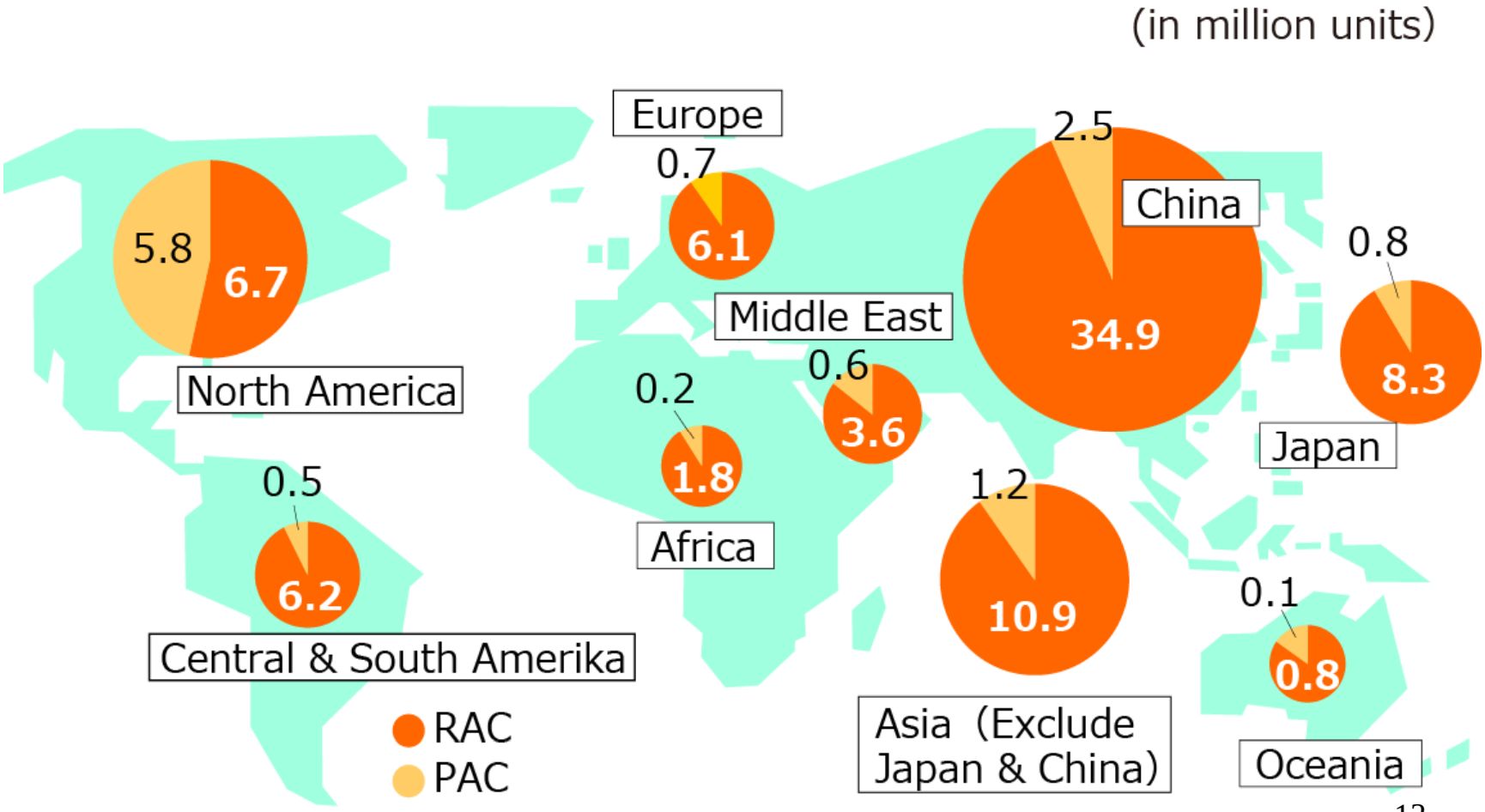
Estimates of World's Demand for Air-conditioners

World Total in 2013 : 95,877,000 units



World's Demand for Air-conditioners 91,600,000 units in 2011

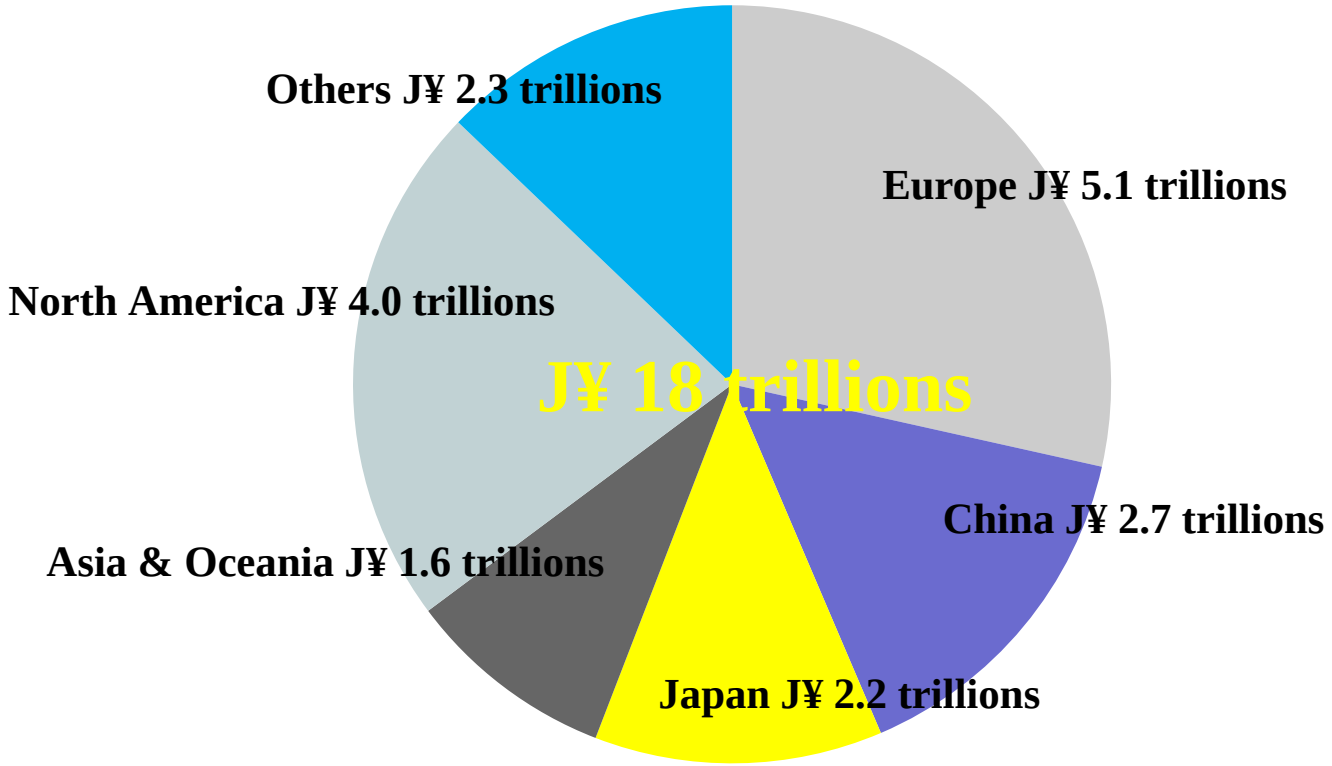
It is expected that the demand would exceed 200 million units about year 2030



Estimates of global market size for refrigerators, air conditioners and heat-pump heaters in 2010

Global market size in 2010 : about J¥ 18 trillions

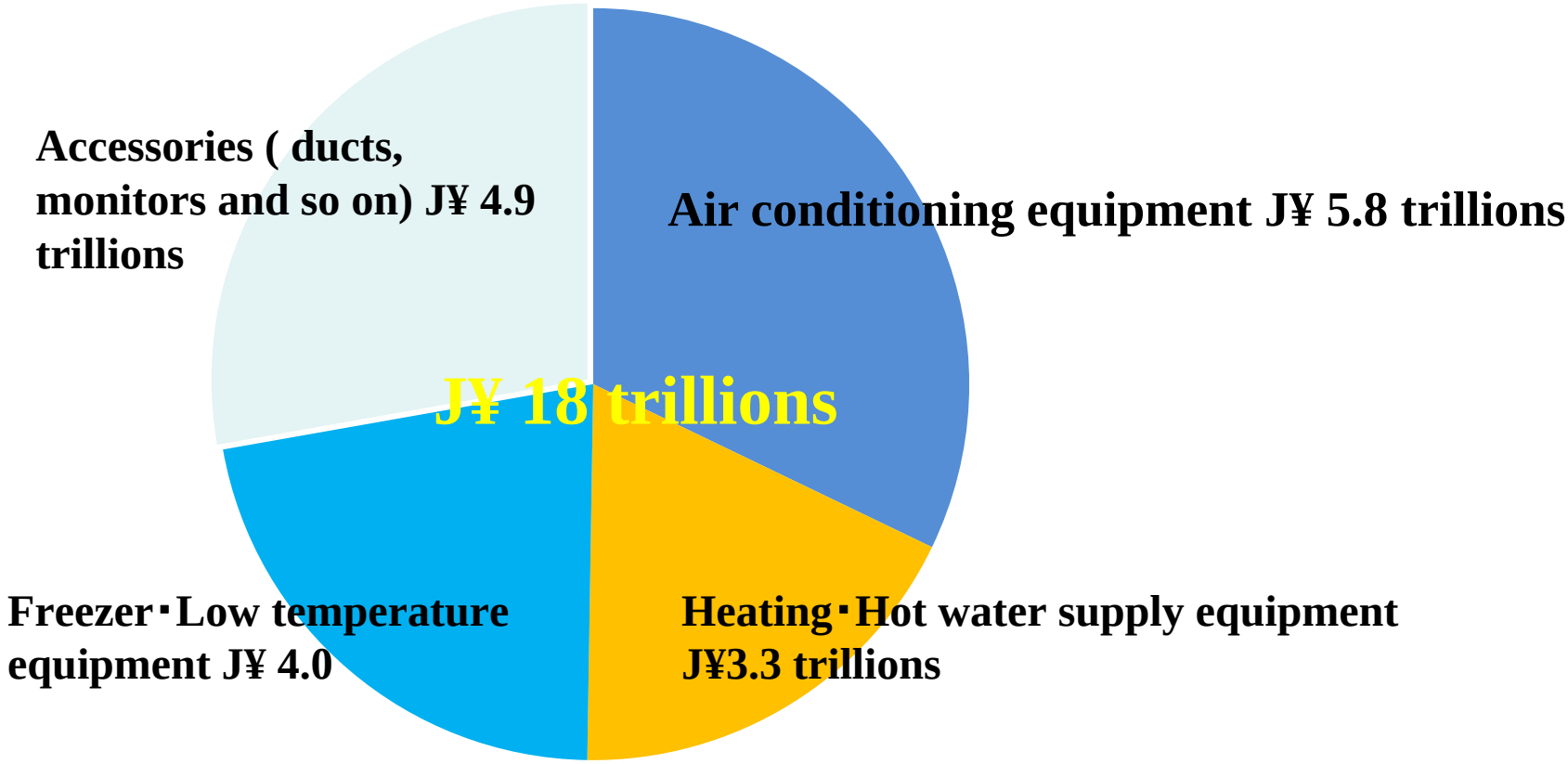
Global market size in 2030 : expanding to J¥ 35 trillions



Market expansion of South America, Middle East and Asia is expected.

Source : Daikin Industries

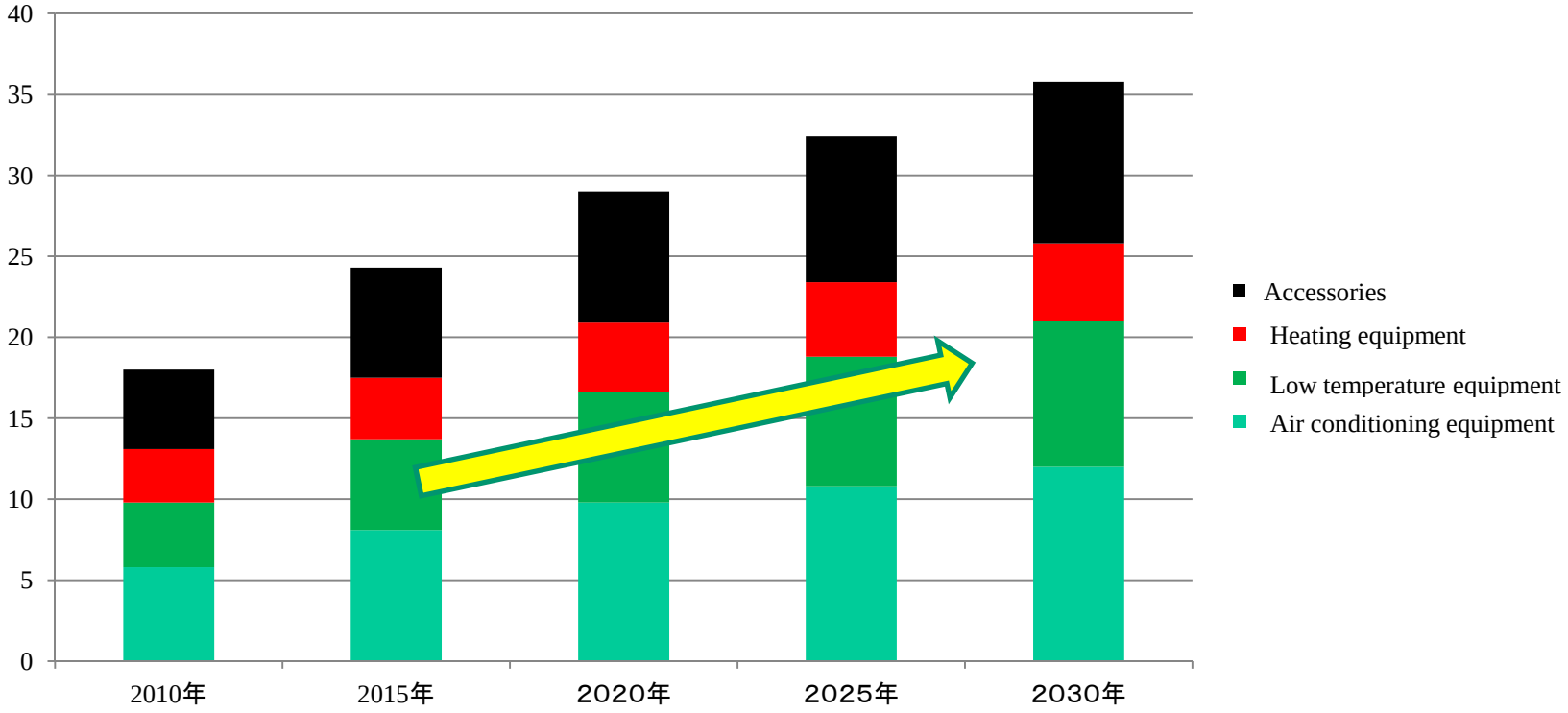
Estimates of global market size for refrigerators, air conditioners and heat-pump heaters in 2010



Market expansion of not only air conditioning equipment but also freezers and low temperature equipment is expected forward.

Global market

Market prediction of refrigeration and air conditioning equipment



- The market size of refrigeration and air conditioning equipment is predicted to be J¥ 35 trillions in 2030.
- The market for not only air conditioning equipment but also refrigeration equipment would be expanding, along with economic growth in emerging countries.
- Main market for heating equipment is developed countries in northern regions and these equipment are already in widespread use there. Therefore expansion of its market can not be expected much.

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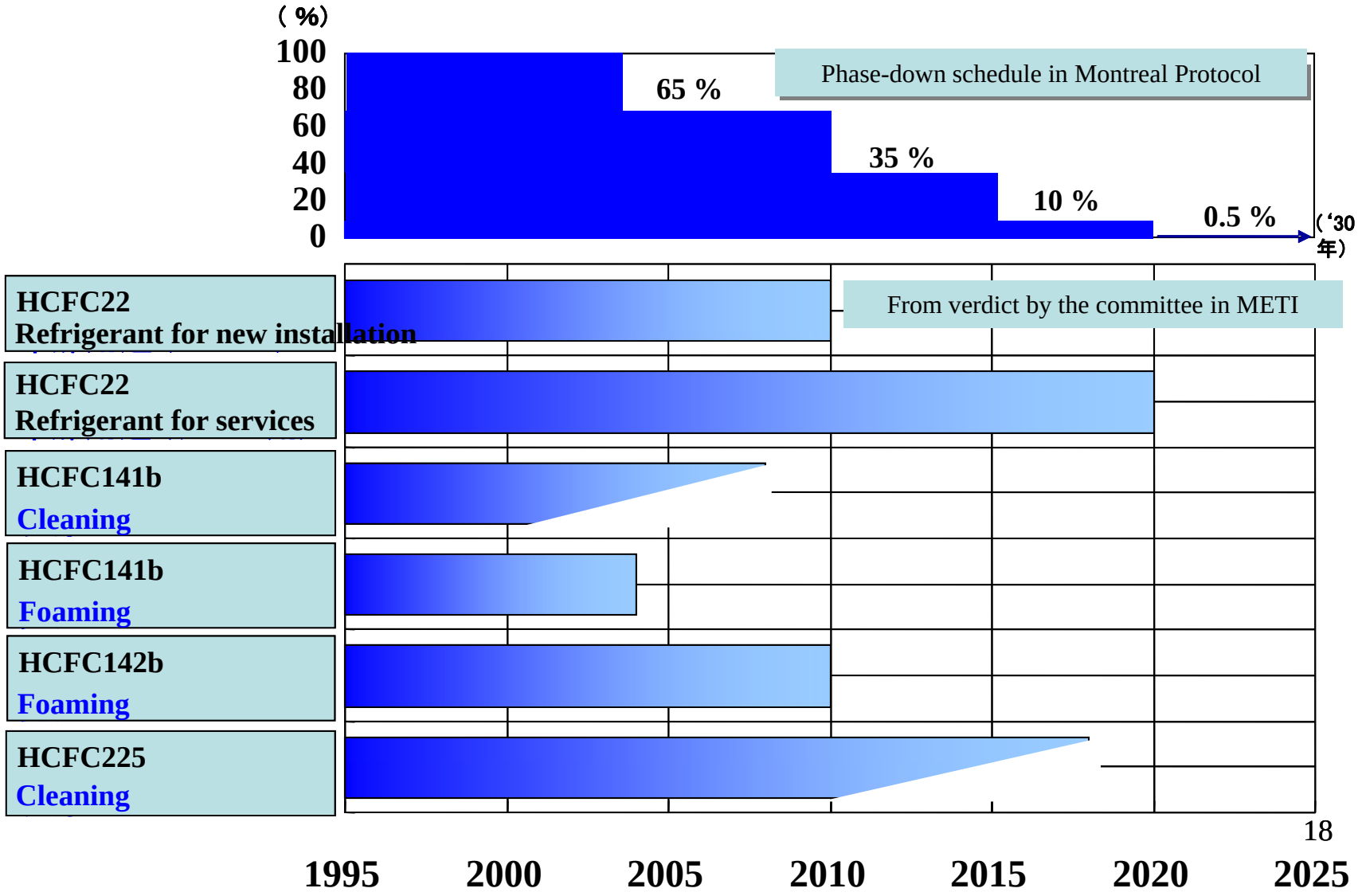
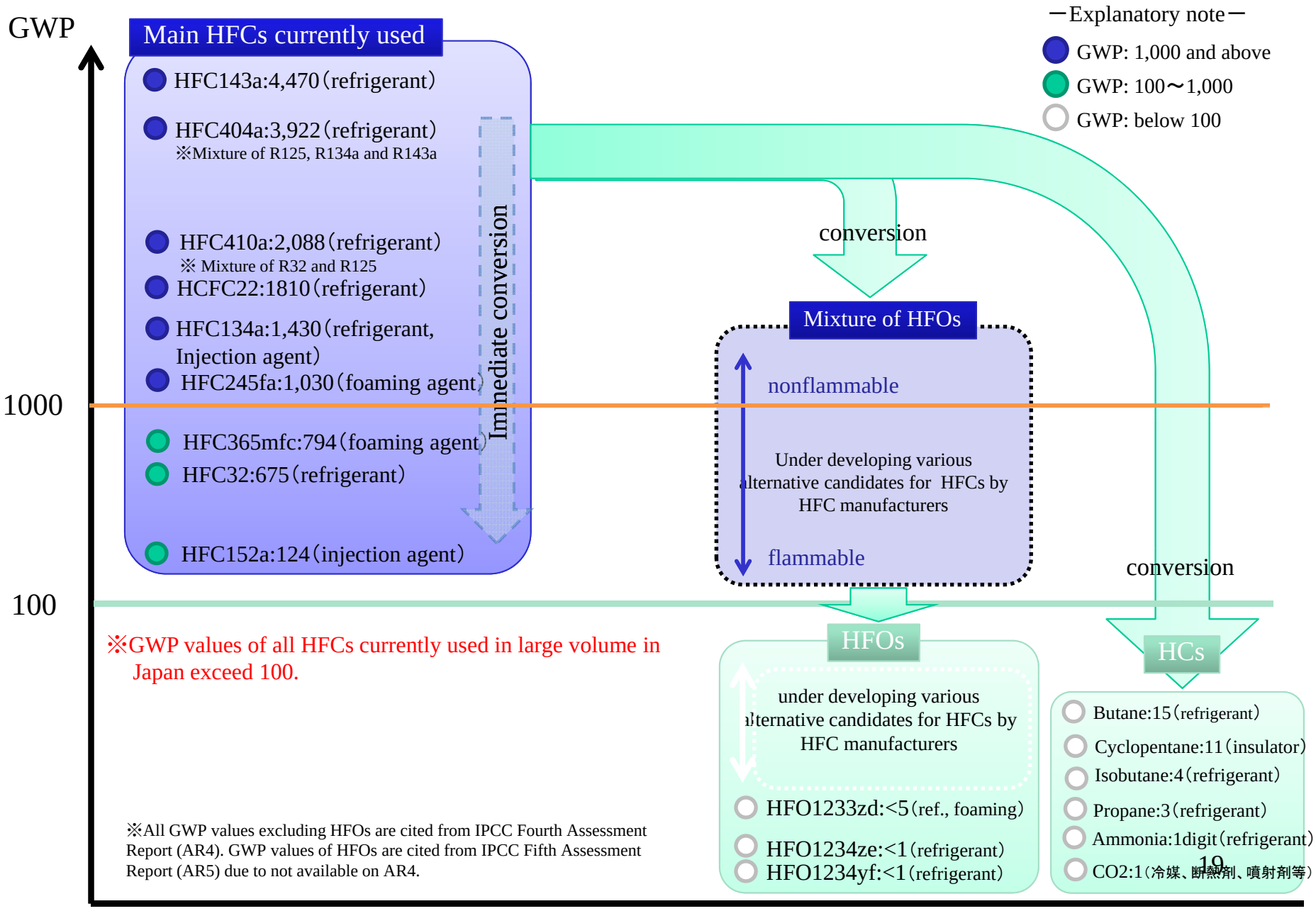
M. Protocol and HCFC Phase-down Schedule in Japan

Abolishment of HCFC in Japan is 10years earlier than Montreal Protocol Program



Reference 1

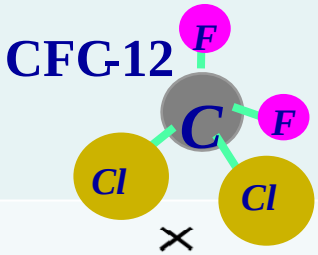
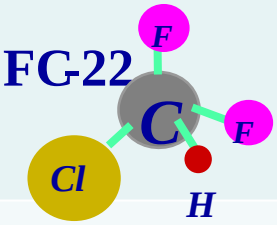
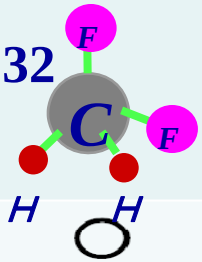
Main HFCs currently used and GWP of conversion candidates



※GWP values of all HFCs currently used in large volume in Japan exceed 100.

※All GWP values excluding HFOs are cited from IPCC Fourth Assessment Report (AR4). GWP values of HFOs are cited from IPCC Fifth Assessment Report (AR5) due to not available on AR4.

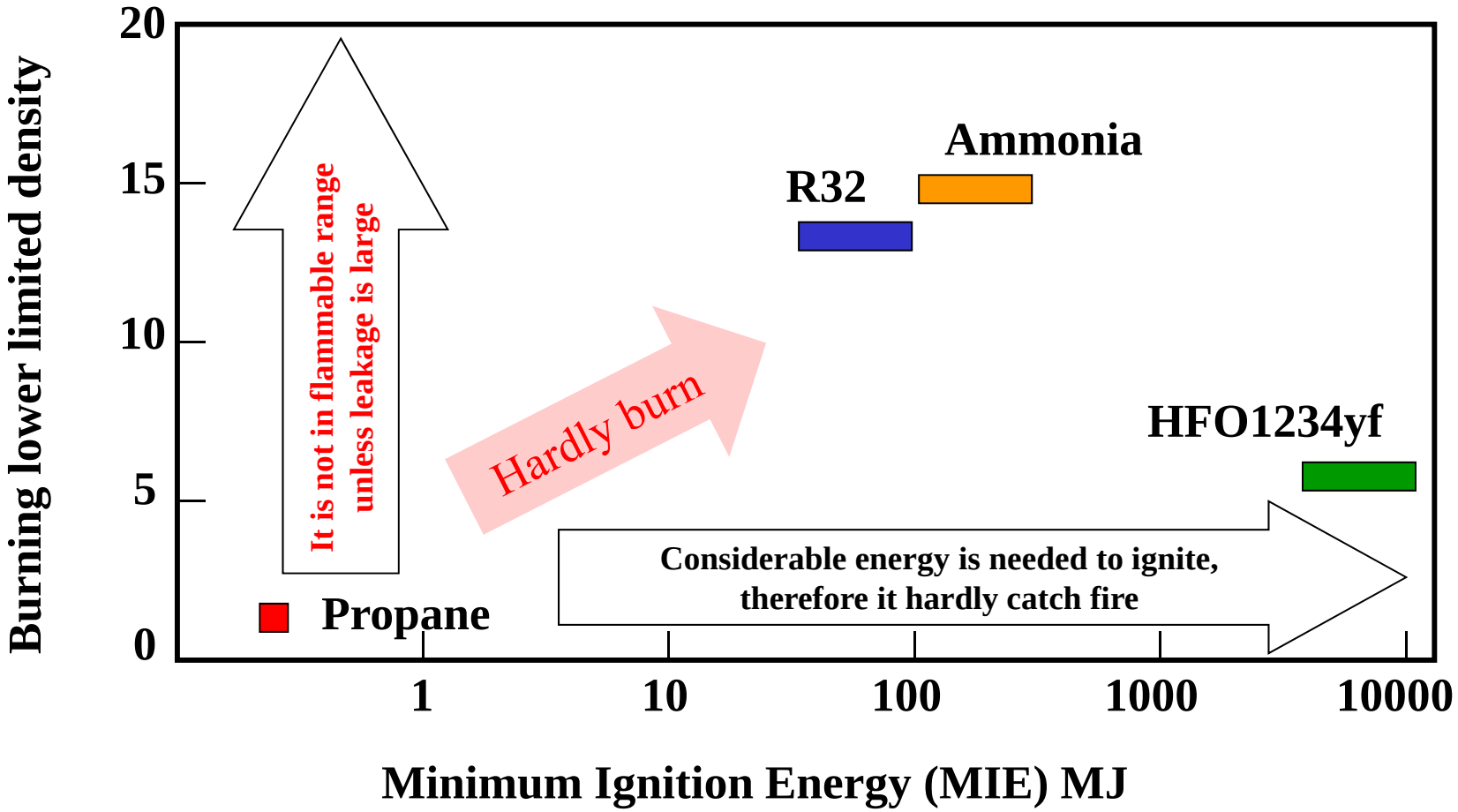
Molecular architecture & Refrigerants characteristics

	R12	R22	R32
molecular architecture			
ODP	×	×	○
GWP	× 10900	× 1810	△ 675
Flammability	○	○	△

CL (Chlorine) molecule depletes the ozone layer.
Increase of H (Hydrogen) molecule causes high flammability.
Increase of F (Fluorine) molecule results in stability, but GWP value becomes bigger.

About moderate flammability

- It is not in flammable range unless leakage amount is considerable.
- Large energy is needed to ignite, therefore it hardly catch fire.



About safety of HFC-32

Reference 2

Chemical designation　HFC-32（Di-fluoro-methane）

1. Overview of hazardous nature and harmful effect

〈Hazardous nature〉

Non-corrosive and flammable liquefied gas

There is a possibility to get frostbite in the event that the gas touches directly skin, because liquid gas evaporates in the atmosphere by absorbing latent heat.

There is a possibility to choke on decreasing oxygen density in the event that the gas is discharged into hermetical space.

〈Harmful effect〉

Symptoms similar to general anesthesia appear when inhaling the high density gas.

Toxicity by inhalation is extremely low, and eruptions of choke, anesthesia, liver damage and so on are very few.

2. Hazard information

Acute toxicity	: Inhalation Rat ALC(Approximate Lethal Concentration)/4 hours	＞760,000ppm（＝76%）
Subchronic toxicity	: Inhalation Rat NOAEC(No observed adverse effect concentration)/90 days	50,000ppm
Reproductive toxicity	: Rat No teratogenicity	50,000ppm
Mutation toxicity	: Ames Test (Mutagenicity Test)	negative
	: Abnormal chromosome	negative
Acceptable concentration	: AIHA WEEL-TWA (Working atmosphere concentration)	1,000ppm

Table 1. Classification of Acute Toxicity（GHS classification）

Classification	LC_{50} [ppm] (50% of rats die within 4 hours)	Hazard & Harm Information
1	Below 100	**Risk of life when inhaling**
2	100 ～ below 500	**Risk of life when inhaling**
3	500 ～ below 2500	**Toxic when inhaling**
4	2500 ～ below 20000	**Harmful when inhaling**
5	Substances which may be harmful for impressible group under specific condition	**Possibility to be harmful when inhaling**

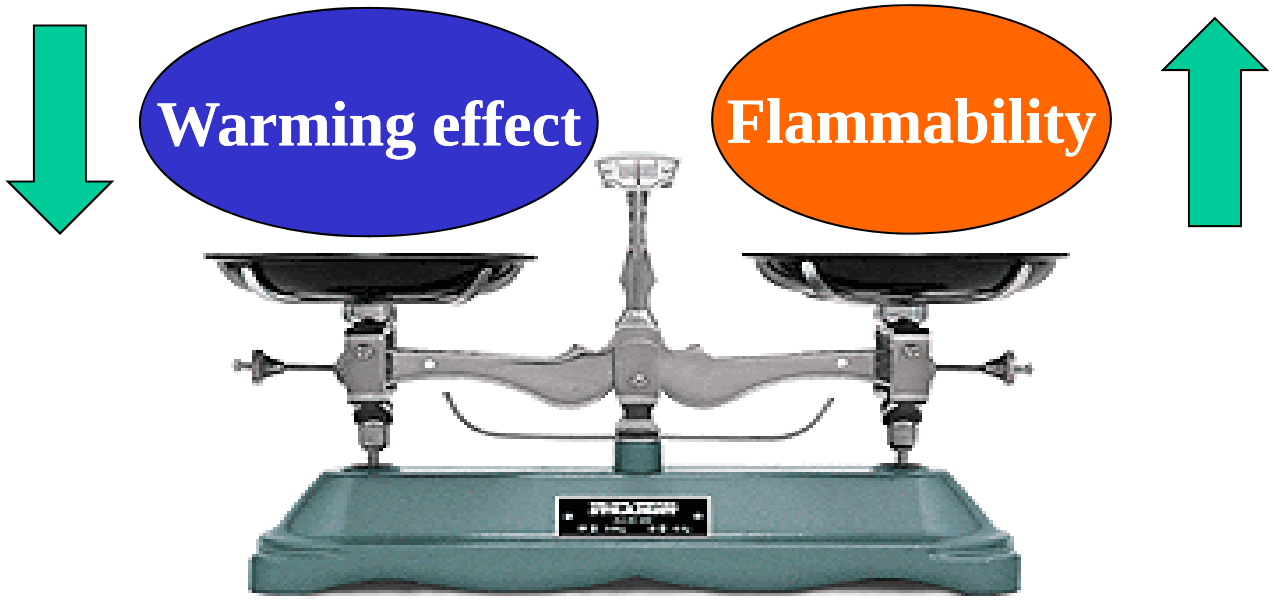
Table 2. Acute Toxicity of Gases（GHS classification）

Gases	Molecular formula	classification	LC_{50} [ppm] (50% of rats die within 4 hours)
Phosgene	CCl_2O	1	5.6
Formaldehyde	CH_2O	2	480
Sulfur dioxide	SO_2	3	593
Hydrogen fluoride (vapor)	HF	3	650
Bromomethane	CH_3Br	3	781
Carbon monoxide	CO	3	1660
Ammonia	NH_3	4	3670

Characteristics and issues of the next generation refrigerants

Global warming effect and flammability of refrigerants

There is conflicting relation between warming effect and flammability. For prevention of warming effect by refrigerants, there is no choice but to adopt moderately flammable refrigerants.



Possibility of natural refrigerants

Substances called natural refrigerants

NH3 (Ammonia), HC (Propane, Butane), Air, Water, CO2 (Carbon dioxide gas), Others

Issues on natural refrigerants

1. **HC has a risk in application other than hermetically sealed small equipment due to its high flammability.**
2. **NH3 is toxic.**
3. **Usable temperature range of CO2 is limited due to its high pressure.**
4. **Refrigeration efficiency of air and water is low, and power consumption increases.**

Use of natural refrigerants is limited in equipment for specific application.

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Main Points of the Revision of Fluorocarbons Recovery & Destruction Law (Approved in June 2013, Come into force on 1st April 2015)

Detailed rules are under consideration and will be determined by end of 2014

1. Manufacturers and importers of f-gases

The undertakings shall submit the phase-down plan of f-gases with GWP value and report the production and import volume of f-gases to the government authority.

2. Manufacturers and importers of equipment using f-gases

Government authority sets the target value of weighted average GWP and target year to accelerate use of low GWP refrigerants in specified equipment.

Specified equipment: Residential air conditioners, small commercial air conditioners, refrigeration display cases, large refrigeration warehouse, and so on.

The undertakings shall comply with the GWP target.

3. Owners of Class-1 specified equipment (commercial refrigeration and air conditioning equipment)

Regular check for equipment with certain output capacity of compressor is mandatory. Based on its capacity, frequency of check, such as 1 time per a year or 3 years, is specified.

The owners shall report the leakage amount exceeding certain level to the government authority(recharged refrigerant amount is considered as leakage).

Repeated refrigerant charge to the equipment is banned.

4. Charge and recovery of f-gases

Undertakings who carry on charging and recovering refrigerants to/from equipment shall report the charged and recovered amount of f-gases to the local governments. They shall issue a certificate of refrigerant charge and recovery to the equipment owner. To accelerate refrigerant recovery, it is made public that owners of equipment are responsible for refrigerant recovery.

5. Control of reclaiming operation for f-gases

Reclamation operators are licensed by government authority. They shall issue a certificate of reclamation to the equipment owner. Use of reclaimed refrigerants shall be accelerated.

6. Destruction operators for f-gases

Government authority together with the industry shall improve refrigerant process management slips for equipment at the end of life so that destruction operators can fully put them to practical use. Destruction operators shall issue a certificate of the destruction to recovery operators.

7. Labeling

Equipment manufacturers shall indicate on the label whether low GWP refrigerant is used in the equipment or not.

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Technical Prospects for HVAC&R Industry

1. Reduction of warming effect by HFCs

- Conversion of HFCs to natural refrigerants, low GWP refrigerants
- Use and assessment of moderately flammable refrigerants

2. Choice of the alternative refrigerants

- Development of the next generation refrigerants
- Elimination of highly flammable refrigerants

3. Issues on power supply along with market expansion

- Demand of energy-saving equipment
- Spread of inverter technologies

4. Market expansion of storage and distribution system for food

- Demand increase of refrigeration equipment

5. Issues on HFCs emission to atmosphere

- Establishment of refrigerant recovery system
- Tackling leakage prevention

Thank you for your attention