NEDO Projects Related to Fluorocarbon Countermeasures

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New Energy and Industrial Technology Development Organization (NEDO)

Today's Topics

1. Introduction of NEDO
2. Background and policy trends
3. R&D direction of NEDO
4. NEDO projects
    - 4-1. completed project
    - 4-2. on going project

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Introduction of NEDO

NEDO plays an important role in Japan's economic and industrial policies as one of the largest public R&D management organizations.

NEDO has two basic missions:

- Addressing energy and global environmental problems
- Enhancing industrial technology

Chairman: Mr. Hiroaki Ishizuka

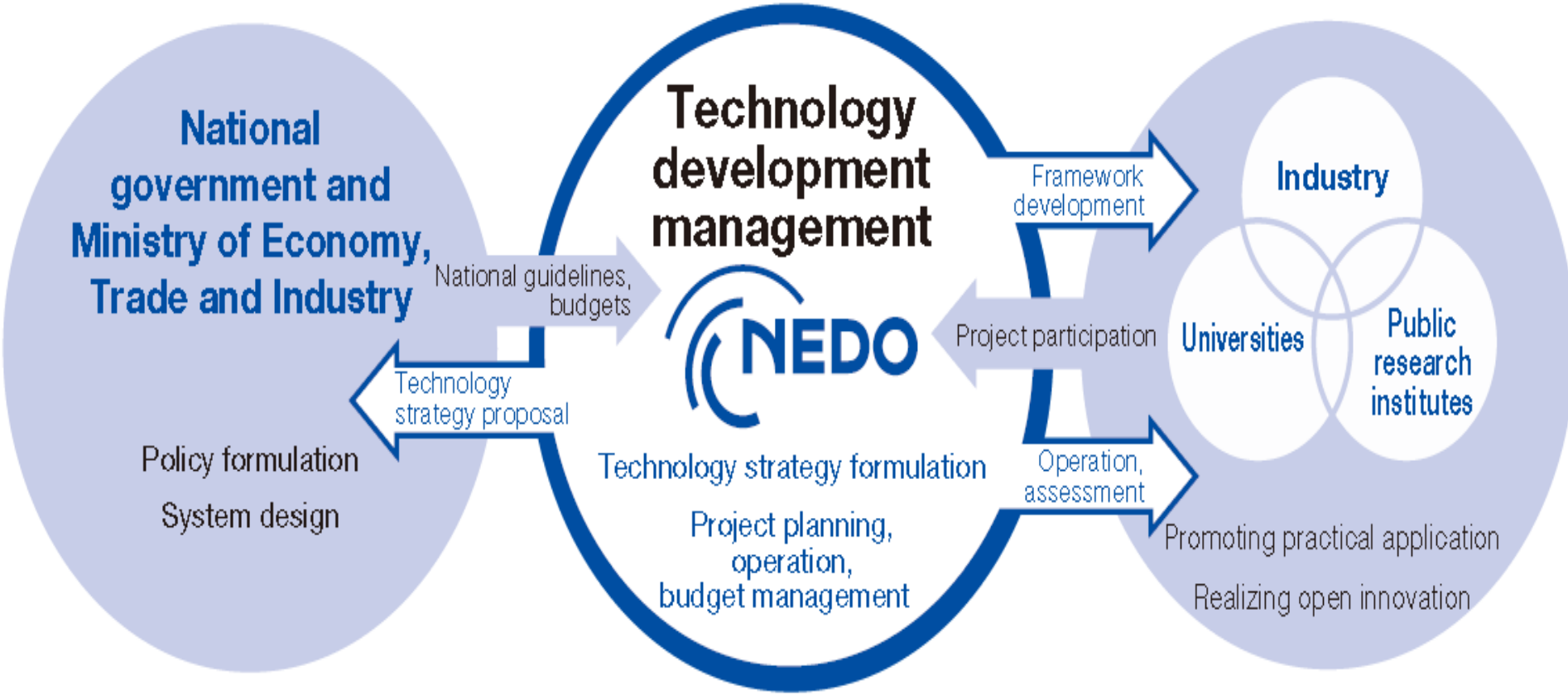
Organization: - Established in 1980

- Incorporated administrative agency under Japan's Ministry of Economy, Trade and Industry (METI)

Budget : 1.43 billion US dollars (fiscal year 2019)

Personal : 1,000

Positioning of NEDO



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Restrictions on fluorocarbons and potential alternatives

Ozone layer protection | **Global warming prevention**

- Discovery of ozone layer depletion mechanism
- Adoption of Vienna Convention in 1985
- Adoption of Montreal Protocol in 1987
- Adoption of Framework Convention on Climate Change in 1992
- Adoption of Kyoto Protocol in 1997
- Adoption of the Paris Agreement in 2015
- Adoption of the Kigali Amendment* to the Montreal Protocol in 2016

CFC: Completely abolished in developed and developing countries

HCFC: Scheduled to be completely abolished by 2020 in developed countries and by 2030 in developing countries.

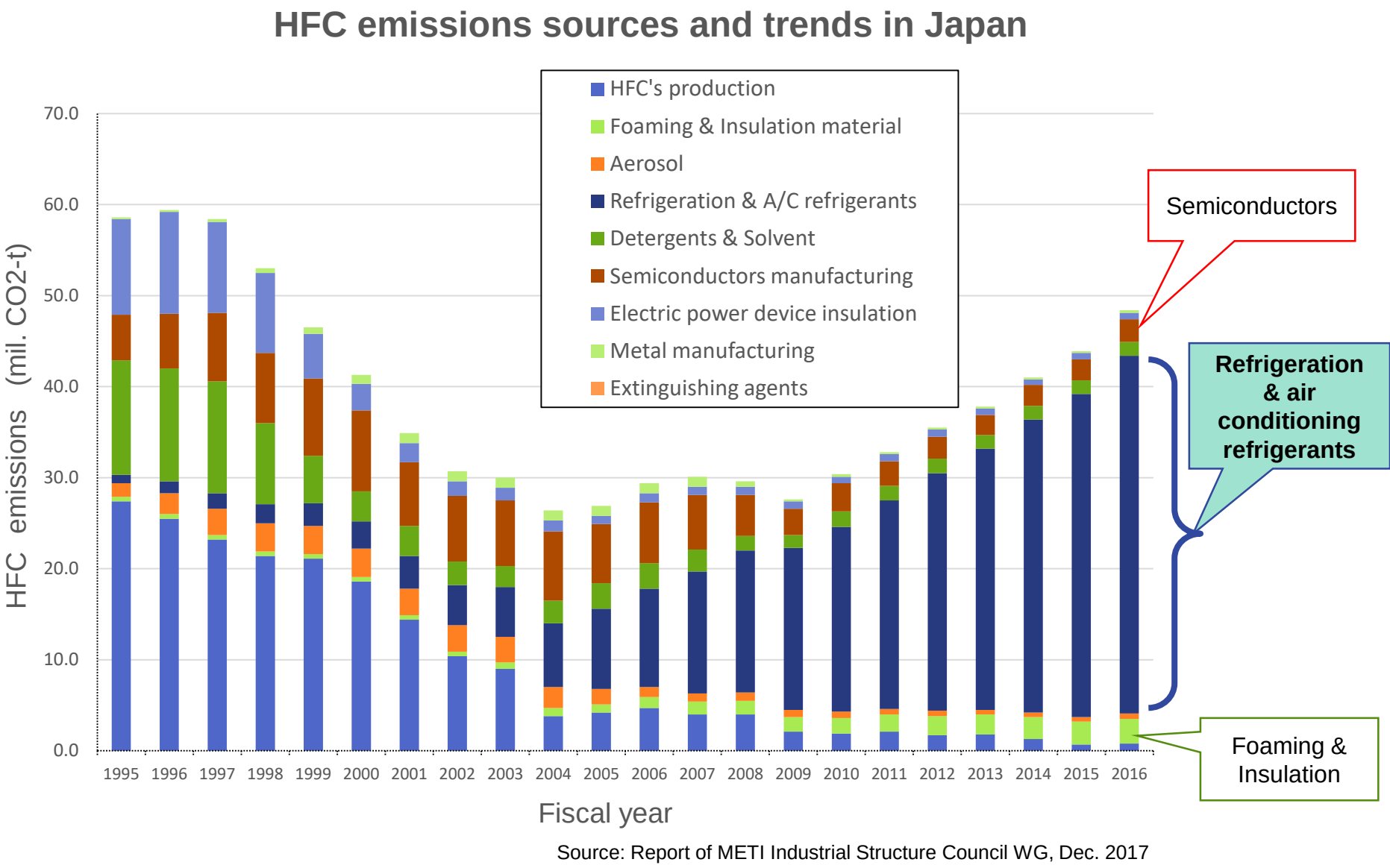
Reduction of HFC emissions is required

Conversion of refrigerants

Low-GWP refrigerant

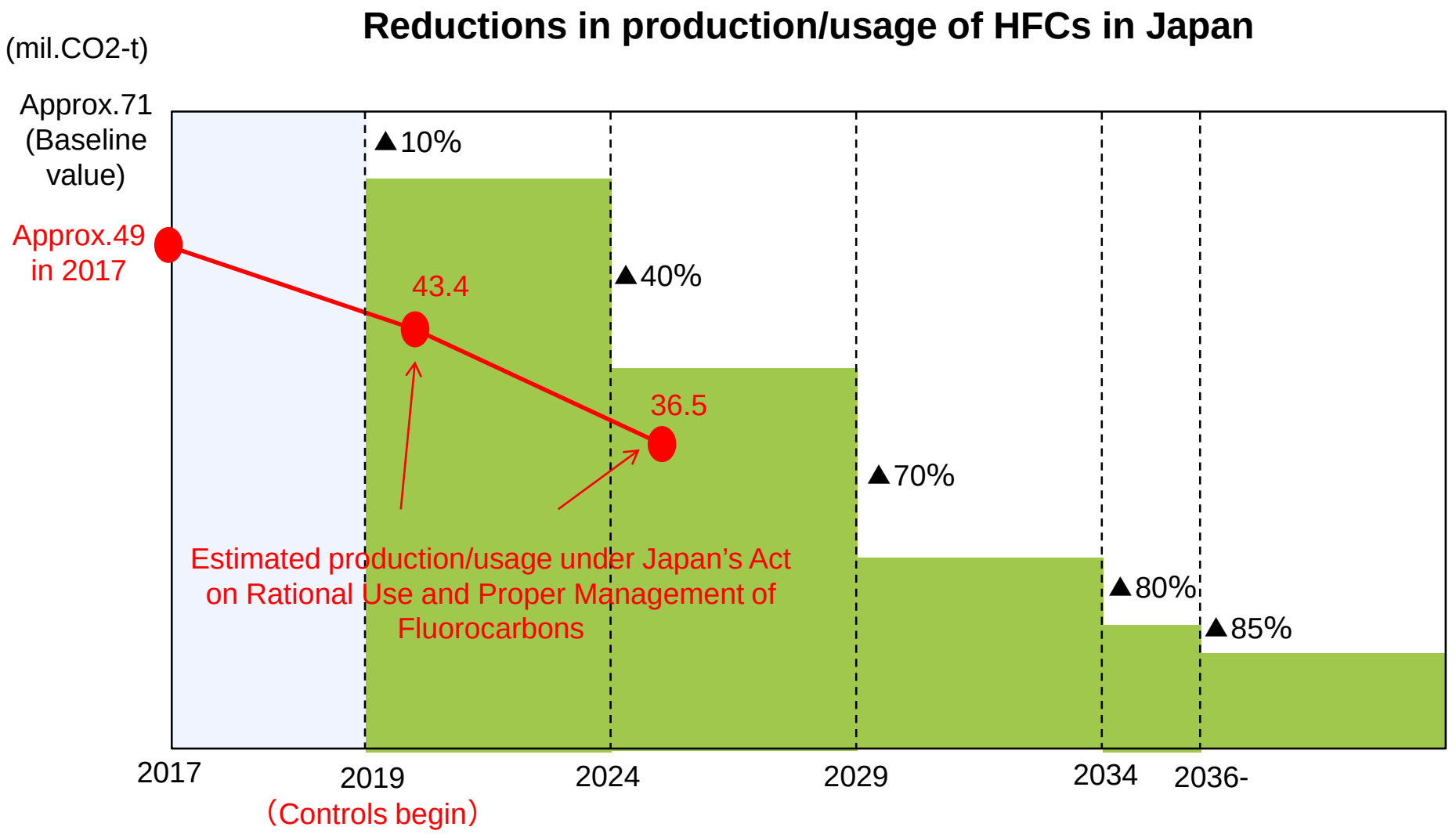
	Ozone layer depletion effect	Greenhouse effect
	No	Small

HFC emissions sources and trends in Japan



Source: Report of METI Industrial Structure Council WG, Dec. 2017

Obligations under Kigali Amendment in Japan



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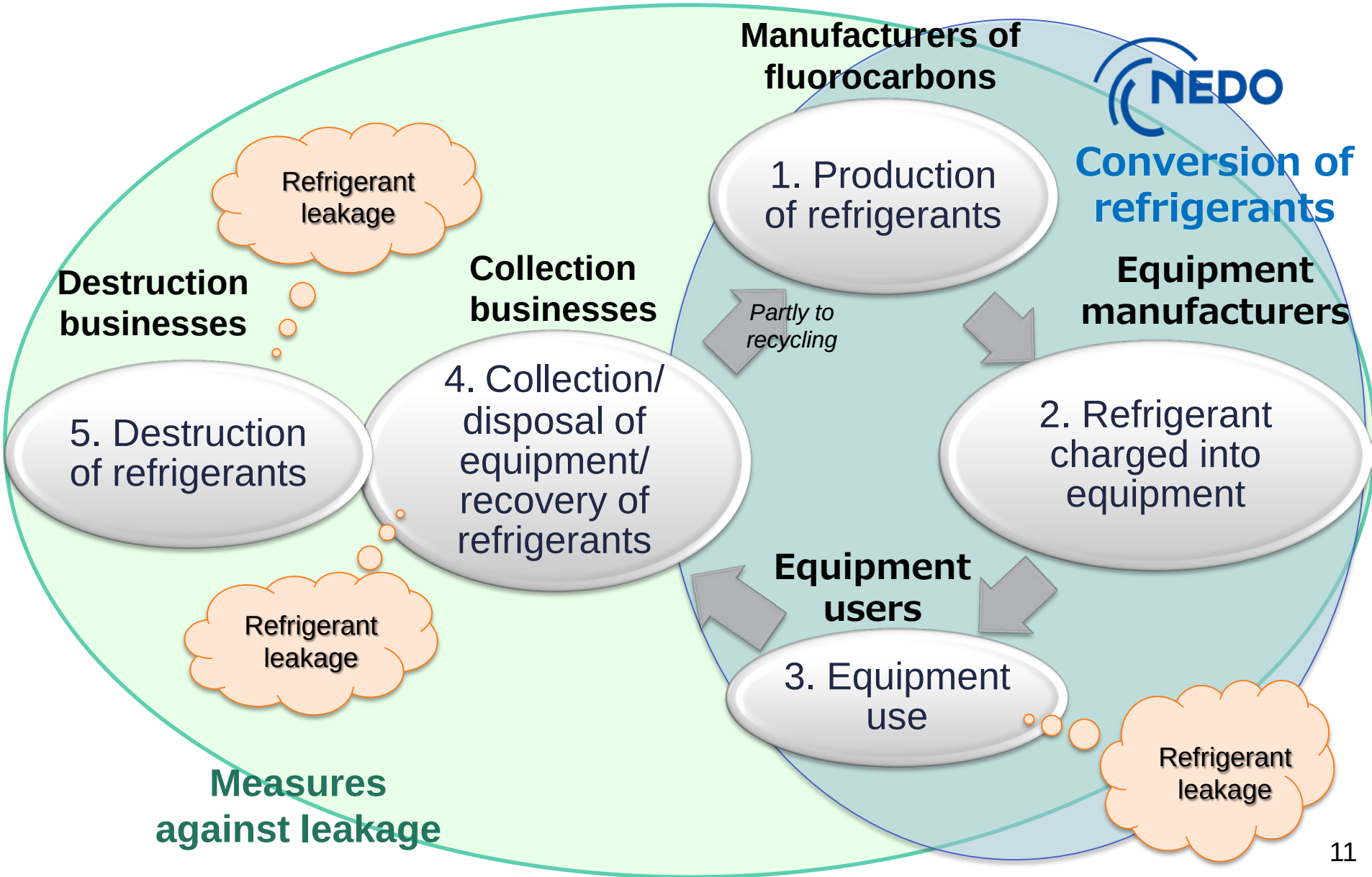
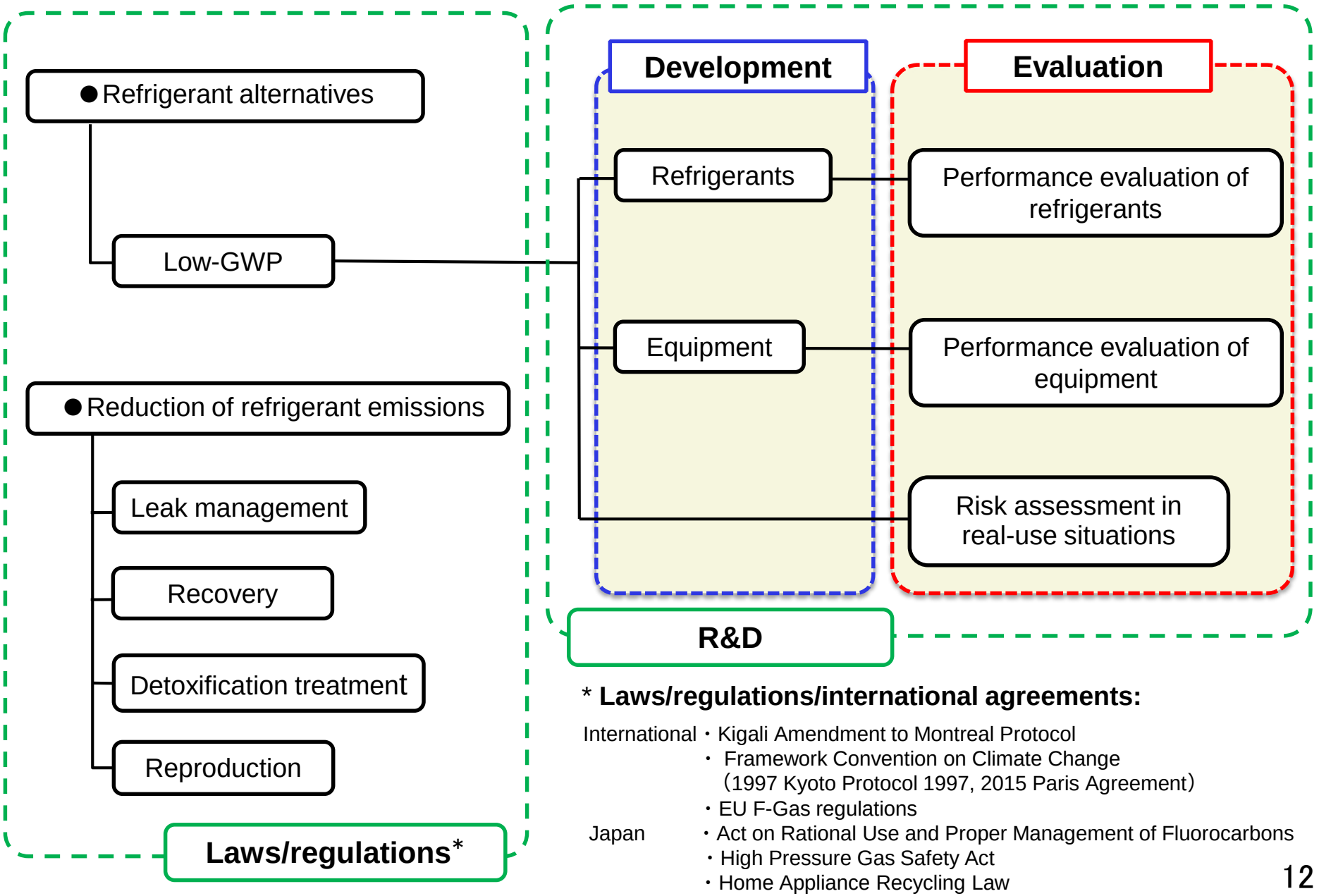
Refrigerant emissions and the life cycle for refrigerants and equipment



HFC countermeasures



*** Laws/regulations/international agreements:**

International
- Kigali Amendment to Montreal Protocol
- Framework Convention on Climate Change (1997 Kyoto Protocol 1997, 2015 Paris Agreement)
- EU F-Gas regulations

Japan
- Act on Rational Use and Proper Management of Fluorocarbons
- High Pressure Gas Safety Act
- Home Appliance Recycling Law

R&D direction of NEDO

- ✓ The international fluorocarbon emission control has two objectives;
  - the protection of the ozone layer (HCFCs, CFCs)
  - the reduction of greenhouse gases (HFCs)
- ✓ In Japan, to achieve the HFC reduction target of the Kigali Amendment, development of low GWP refrigerant and applicable equipment are required in the refrigeration and air conditioning field.
- ✓ On the other hand, when the GWP is lowered, many refrigerants have characteristic properties such as increased flammability. In order to spread low GWP refrigerants to the market, it is extremely important to risk assessment and to establish safety evaluation methods when applying combustible refrigerants to equipment, in addition to evaluating refrigerant physical properties.

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4-1. completed project;
Development of Non-Fluorinated Energy- Saving Refrigeration and Air-Conditioning Equipment Systems

- Project period: FY2011-FY2015
- Project budget: 1.8 billion yen
- Target:
  Commercial air-conditioning equipment which uses low-GWP refrigerants having high efficiency and significantly lower greenhouse effects than existing HFC refrigerants

NEDO supported development in the following three areas:

1. Development of equipment capable of high-efficiency operations when using low-GWP refrigerants

2. Development of low-GWP refrigerants

3. Evaluation of performance and safety of low-GWP refrigerants

Especially, mildly flammable (lower flammable) refrigerants

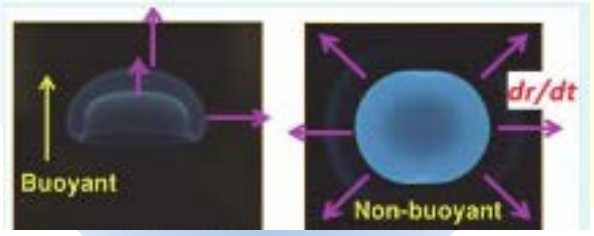
4-1. completed project;
Corporation in evaluation of the safety of mildly flammable refrigerants

✓ Under this project, NEDO constructed the structure that academic sector and industrial sector were able to corporate to evaluate the safety of mild flammable refrigerants.

NEDO

R&D Project

Universities
Research Institutes



Under regular buoyancy test, flame exhibits large distortion

Experiment in microgravity environment accurately measured risks

World's first example of flammability measurement for mildly-flammable refrigerants

JSRAE
(Japan Society of Refrigerating and Air Conditioning Engineers)

Research Group

Information exchange
Discussion

Final Report

JRAIA
(Japan Refrigeration and Air Conditioning Industry Association)

Working Groups

4-1. completed project; Project achievements-1 (Domestic)

- ✓ Final report contributed to the amendment of Japan's High Pressure Gas Safety Act, where the use of mildly flammable refrigerants refrigerants was newly stipulated.
- ✓ As a result of this amendment, the commercialization of large-capacity centrifugal chillers using mildly flammable refrigerant was realized.

Result of NEDO Project

Safety assessment of mildly flammable refrigerants

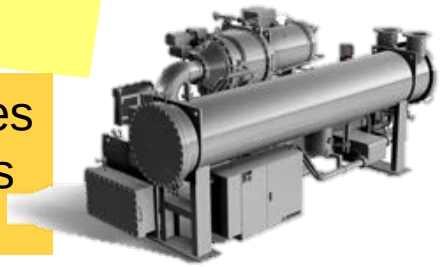
Final Report of Research Group

https://www.jsrae.or.jp/committee/binensei/final_report_2016r1_en.pdf

Amendment of High Pressure Gas Safety Act

The use of mildly-flammable refrigerants was newly stipulated

Commercialization of devices using low-GWP refrigerants (HFO-1234ze(E))



Source: Mitsubishi Heavy Industries Thermal Systems, Ltd. Press Information no. 5840 dated February 16, 2017

4-1. completed project;
Project achievements-2 (Internationally)

Safety evaluation under real-use conditions

Result of NEDO Project

Development of test and quantitative measurement methods that consider impact of humidity on burning velocity of mildly flammable refrigerants

Created a new concept "the quenching diameter" and revealed that of mildly flammable refrigerants

→ It was found the flame does not escape enclosure, even if spark occurs in electromagnetic switch

International standards

ISO

- Testing method for combustion speed of mildly flammable refrigerants

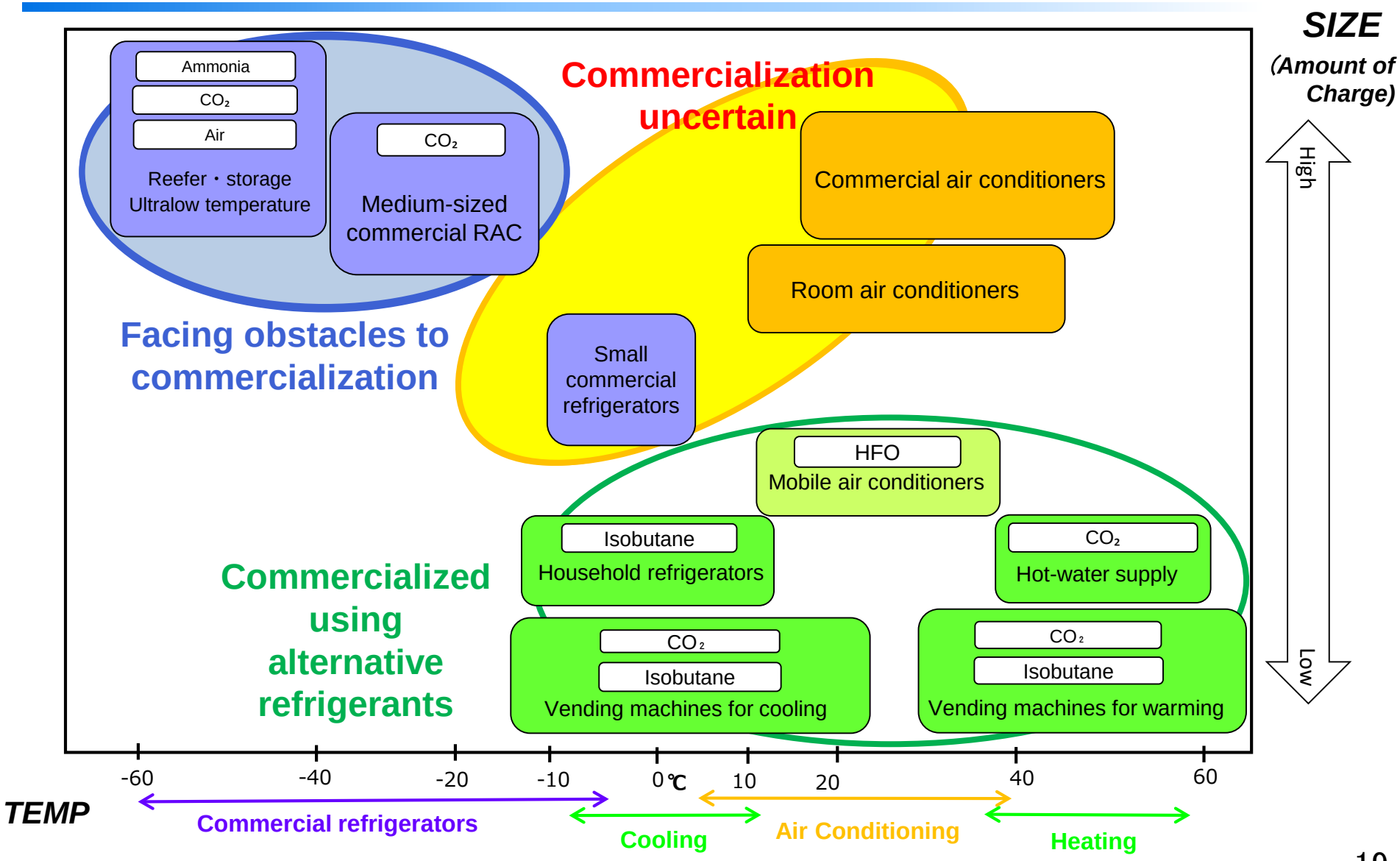
Testing method for combustion speed of mildly flammable refrigerants was proposed

IEC

- Revision of humidity-related safety requirements for electric relays

IEC standard 60335-2-40 regarding the safety of household and similar electrical appliances was revised.

4-2. on going project:
Status of equipment with low-GWP refrigerants in Japan



4-2. on going project:
Development of Technology and Assessment Techniques for Next-Generation Refrigerants with a Low GWP Value

- Target refrigerants:
  Next-generation low-GWP refrigerants such as HCs, HFOs and HFO hybrids
- Project period: FY2018-FY2022
- Project budget: 6.5 billion yen (FY2019)

NEDO supported development in the following three areas:

1. Acquisition and evaluation of data regarding basic characteristics of next-generation refrigerants

2. Development of safety measures and risk assessment methods for next-generation refrigerants

3. Development of new refrigerant and equipment

4-2. on going project;
Corporation in evaluation of the safety Next-generation low-GWP refrigerants

- ✓ Under this project, NEDO constructed the same structure to evaluate the safety of Next-generation low-GWP refrigerants.

NEDO

R&D Project

Universities
(University of Tokyo, Suwa University of Science, Kyushu University, Waseda University)

Research Institutes
(AIST; National Institute of Advanced Industrial Science and Technology)

JSRAE
(Japan Society of Refrigerating and Air Conditioning Engineers)

Research Group

Information exchange
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JRAIA
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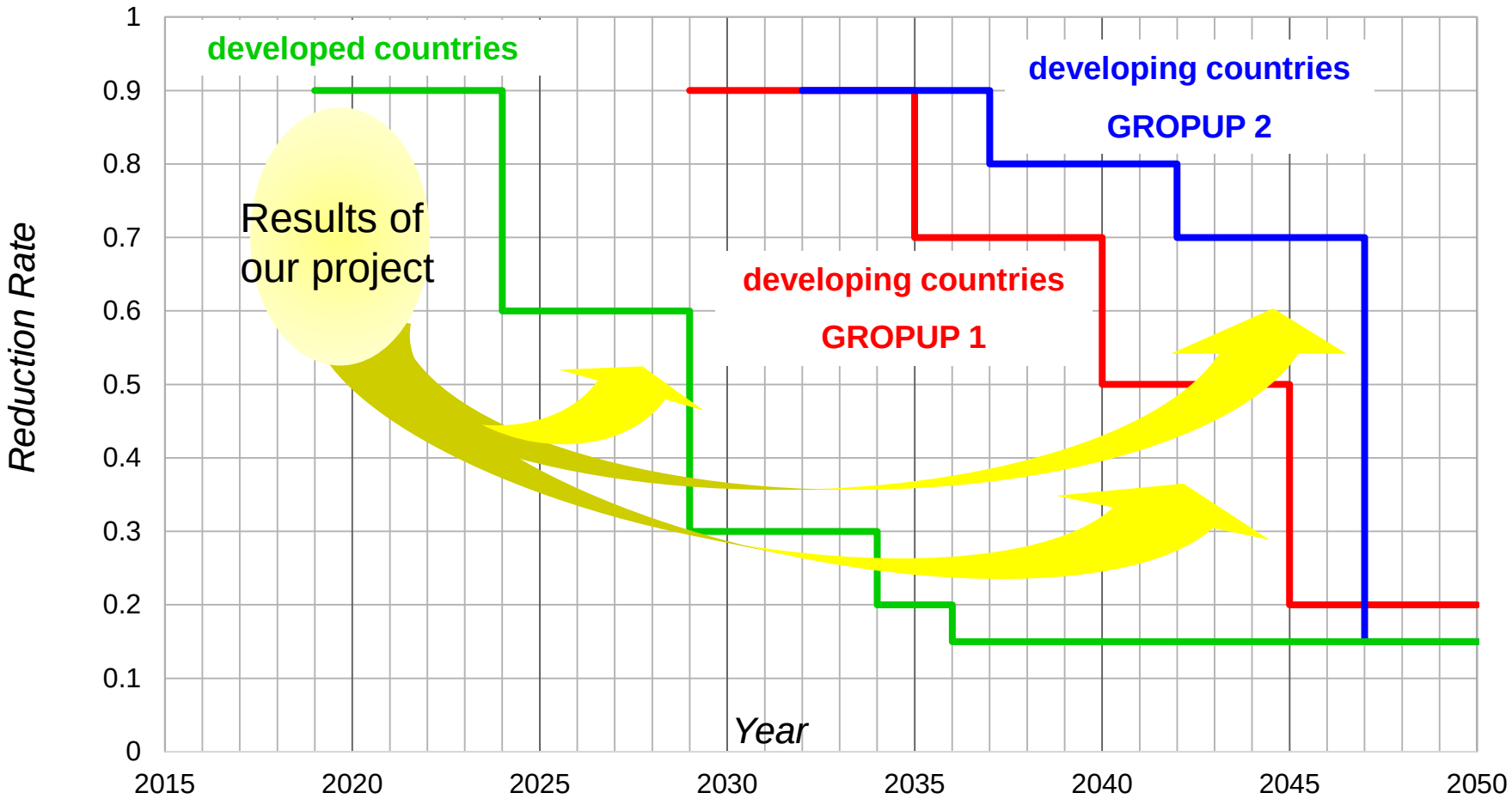
Working Groups

Disseminate information internationally

Future Direction



HFC Phase-down Schedule Under Kigali Amendment

Thank you for your attention !

https://www.nedo.go.jp/english/index.html