Current Situation of Energy Efficiency, Safety and Lower GWP Refrigerant

Refrigerant conversion Activities in Japan

Part 2: JRAIA's activities

The Japan Refrigeration and Air Conditioning Industry Association
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4. JRAIA's Key Activities

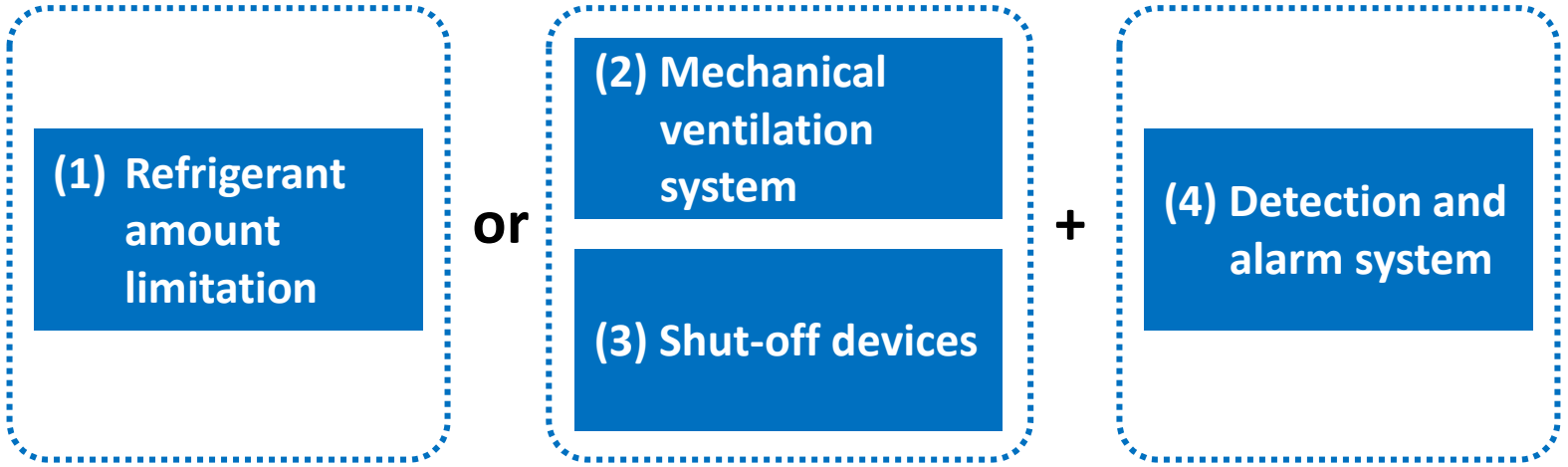
Energy Efficiency	・Active involvement in the technical group of ISO for next generation performance evaluation method ・Action for energy efficiency related regulations and standards in Japan (Top Runner Program), EU, etc.
Refrigerants	・Publish the guideline for the refrigerant leak detection monitoring for Japan market. ・Discussion for the next designated products of F-Gas Act in Japan
Environment	・Consideration of LCCP (Life Cycle Climate Performance) ・Action for environment related regulations especially in the EU; Ecodesign, F-Gas, PFAS, etc.
International Activities	・ICARHMA meeting (International Council of Air Conditioning, Refrigeration, and Heating Manufacturers' Associations): Collaborate with 11 international industrial associations and contributed as advisory committee member for UNEP's RDL (Refrigerant Driving License) ・Three Industry Association Meeting (China-Korea-Japan): Annual meeting to discuss common issues. ・ASEAN5＋J Workshop: Exchange information on energy saving and refrigerant conversion including global environmental issues among industry associations of 5 ASEAN countries ・Seasonal Energy Efficiency(CSPF)Evaluation Method: Promotion in ASEAN countries

5. VRF system using A2L refrigerant

1) The way for safety measures (i)

Appropriate measures to prevent ignition (Industry Guide line; GL-16, GL-20)

- To prevent ignition in the event of refrigerant gas leakage, one of the measures specified in (1) through (3) must be taken.
- If measures (2) or (3) is selected, (4) must be installed.
  (4) is not permitted as a stand alone measures in Japan.



5. VRF system using A2L refrigerant

1) The way for safety measures (ii)

Appropriate measures to prevent combustion (excluding refrigerant amount restrictions (1))

When refrigerant leak is detected, ((2) or (3)) and (4) shall be activated.

(2) Ventilator

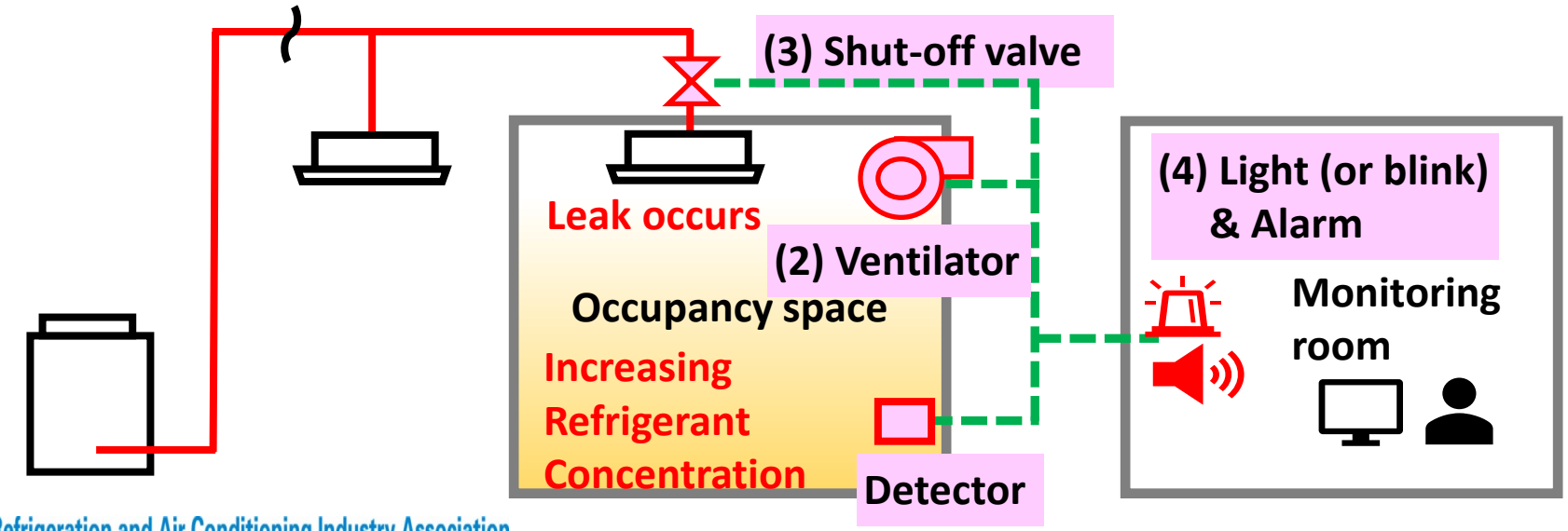
Continue operation at all times, or automatically operate when detects refrigerant leakage.

(3) Shut-off valve

Shut off the refrigerant circuit by signal from the detector.

(4) Alarm

Light or blink with alarm sound



5. VRF system using A2L refrigerant

2) Expansion of the maximum refrigerant amount

		Japan	International		International
Laws / Standards		High Pressure Gas Safety Act with JRA GL-20, GL-16, etc.	IEC 60335-2-40 Ed.7		ISO 5149-1
Installation height Air circulation		No Circulation if 1.5 m or more, with Circulation if less than 1.5 m	Less than 1.8 m, and No circulation	1.8 m or more, or With circulation	No circulation
Safety measure requirement (CF* vs LFL) * Concentration Factor	CF < 0.25	None	None	None	None
	0.25 - 0.5	2 measures	None	None	1 measure
	0.5 - 0.75	2 measures	1 measure	None	2 measures
	0.75 < CF	2 measures	2 measures	2 measures	2 measures
Refrigerant leak inspection	Simple	Once / 3 months	Not specified		Not specified
	Full	Once / 3 years			
Refrigerant charge limit(R32)		150 kg (same value to A1)	LFL * 260 = 79.8 kg		LFL * 195 = 59.8 kg (150 kg for A1)

- **The refrigerant charge limit is relaxed to 150 kg in Japan by double safety measures including ether ventilator or shut-off valve and mandatory refrigerant leak inspections.**
- **The refrigerant charge amount for equipment using existing refrigerant piping is expected to be over 80 kg.**

5. VRF system using A2L refrigerant

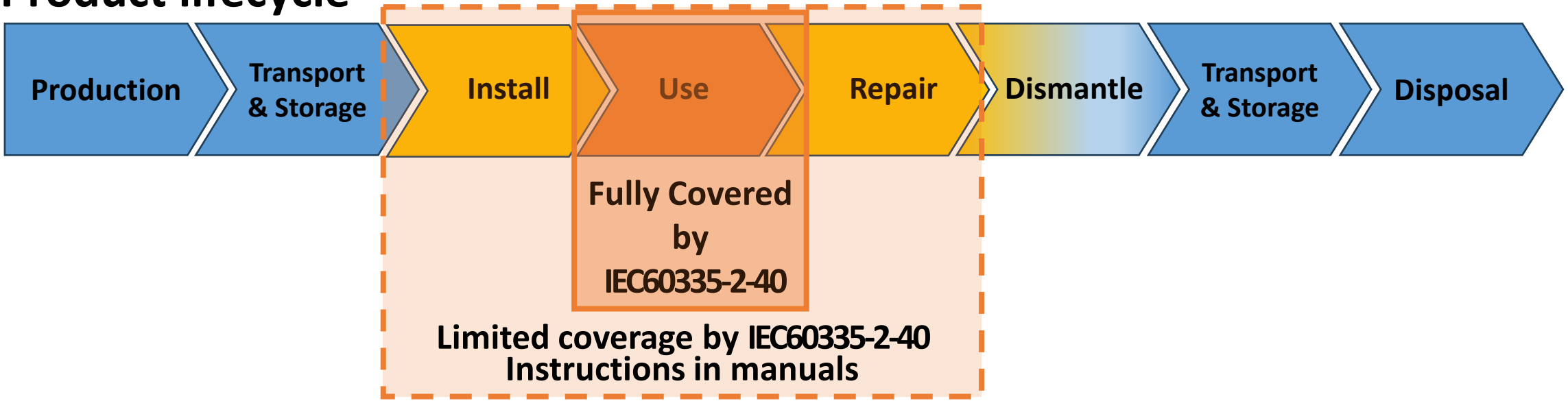
3) Products to be launched in Japan

DAIKIN	Johnson Controls Hitachi AC	Mitsubishi Electric
" VRV 7 " series	**" Flex Multi " series**	**" Grand Multi " series**
 ※Press release	 ※Press release	 ※Press release
To be launched in Nov. 2024	*Launched in Jun. 2024*	*To be launched in Sep. 2024*

6. Challenges to be tackled for the safe use of A3 refrigerant

1) Limited Coverage by the International Safety Standard (IEC 60335-2-40)

Product lifecycle



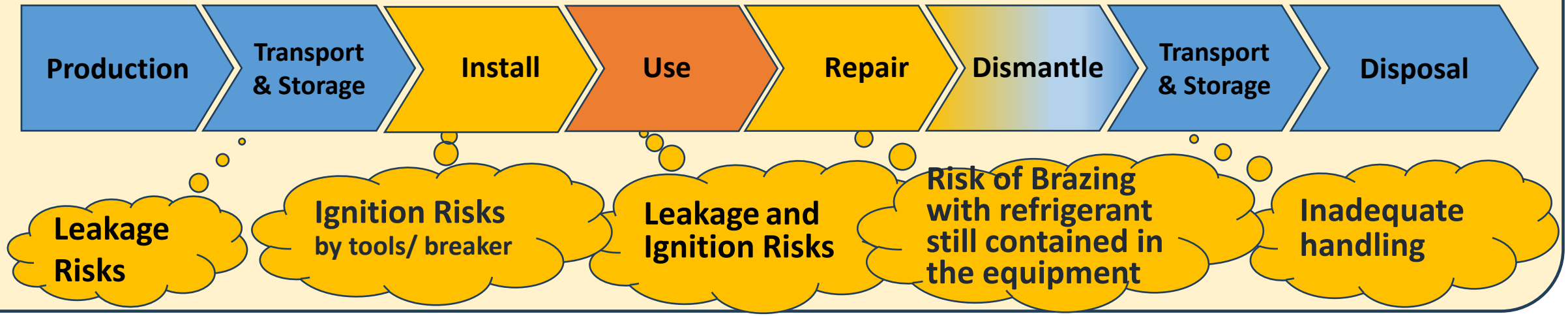
IEC 60335-2-40 DOES NOT COVER entire product life cycle!

Safety measures are required for the entire product lifecycle

6. Challenges to be tackled for the safe use of A3 refrigerant

2) Need Further Consideration for the use in Room Air Conditioners (RAC)

Safety Risks in each Product lifecycle Phase of RAC



Further Consideration is needed for various Safety Measures

①Safety Measures for equipment and facilities

JRAIA is considering measures to minimize the occurrence of accidents to a once-in-a-century level

②Sharing information with stakeholders and raising awareness

Coordination with over 50 stakeholders will be necessary, and it is expected to take a lot of time.

③Training

JRAIA is considering possible certification scheme for operators in Japan

7. Development of Alternative Refrigerants

1) Japan Government funded NEDO Project

NEDO Project (New Energy and Industrial Technology Development Organization)

Aim: Development of high-efficiency refrigeration and air conditioning technology for the practical use of next-generation low-GWP refrigerants

1) Duration： 2023 - 2027
2) Budget ： 500 million yen (fiscal 2023)
3) Objective: Development of next-generation low-GWP refrigerants
4) Project Details：
   - Narrow down the HFO mixed alternatives mainly for residential-use air conditioners.
   - Develop fundamental technologies to utilize HFO alternatives in key components (heat exchangers and compressors)
   - Develop models and evaluation methods to assess safety and environmental impact

Selection of the candidate alternatives	**Set guideline for the design of heat exchanger**	**Set guideline for the design of compressor & R&D of Refrigeration Oil**	**Develop Evaluation Equipment & Impact Assessment**	**Develop Models and Evaluation Method**	**Product R&D by private sector**

7. Development of alternative refrigerants

2) Property of alternative refrigerants – Funded by NEDO※

※NEDO: New Energy and Industrial Technology Development Organization

New Refrigerants are under development – by end of 2027

- In the NEDO project, new refrigerants, HFO-1123 and HFO-1132(E), have been under development.
- Blends of HFO-1132(E)/1234yf and R32 have already been registered as R474A and R479A under ASHRAE and ISO. Those blends of HFO-1132(E) have been under further investigation for safety and various applications.

Properties of alternative refrigerants

	HFO-1132(E) Blends		HC	HFC	HFC
Refrigerant	R474A	R479A	R290	R32	R410A
Components	R1132(E)/ R1234yf	R1132(E)/R32/ R1234yf	Single	Single	R125/R32
Flammability	A2L	A2L	A3	A2L	A1
GWP	3	147	3	675	2088
COP(R410A=100)	103	102	106	102	100
Capacity (R410A=100)	59	82	58	110	100
Glide Eva./Cond.[K]	4.7/5.8	5.0/5.2	-	-	0.1/0.1
Discharge Temp.[℃]	63	73	63.2	95	77
Discharge Pres.[MPa]	1.6	2.2	1.53	2.8	2.7

Possible applications

Current	Lower GWP (A2L)	New Alternative	Usage e.g.
R410A GWP=2088	R32 GWP=675	1132(E) blend	RAC, PAC, VRV
R404A GWP=3920 R407C GWP=1770 R22 GWP=1810	R454C R455A GWP=148		Showcase Refrigeration storage AC for vehicle etc
R134a GWP=1430	R1234yf R1234ze		MAC, Chiller
R245fa R123			Low Pressure Chiller, ORC

7. Development of alternative refrigerants

3) LCCP: New environmental performance indicator

JRAIA LCCP Evaluation WG

LCCP(Life Cycle Climate Performance) evaluation for residential ACs using R22, R290, R410A, R32, R454C

- Evaluate the followings in addition to evaluation based on IEA Annex 54
  i. System performance simulation with accurate test verification of refrigerants
  ii. Equipment operation time (calculated from IoT, big data, and outside air temperature)
  iii. Amount of refrigerant leakage
- Evaluate electricity demand scenarios for each temperature regions in order to be utilized globally
  (Covering tropical / subtropical / moderate / cold region)

Action items

May, 2023	14th IEA Heat Pump Conference Paper Submission, Presentation
Nov, 2023	Progress report at Kobe International Symposium
Jul, 2024	**Paper presentation at IIR conference @Purdue univ.**

8. HFC Recovery and Reclamation
1) Current status of reclamation of HFC in Japan

Latest information and analysis
(Information published on February 1st)

Rapid expansion of HFC reclamation
- **Approximately 1200 tons were reclaimed in 2022**
- **51% increase from the previous year**
- **2.2 times increase in 2 years**

Estimation of the reasons

(1) Improved recovery rate

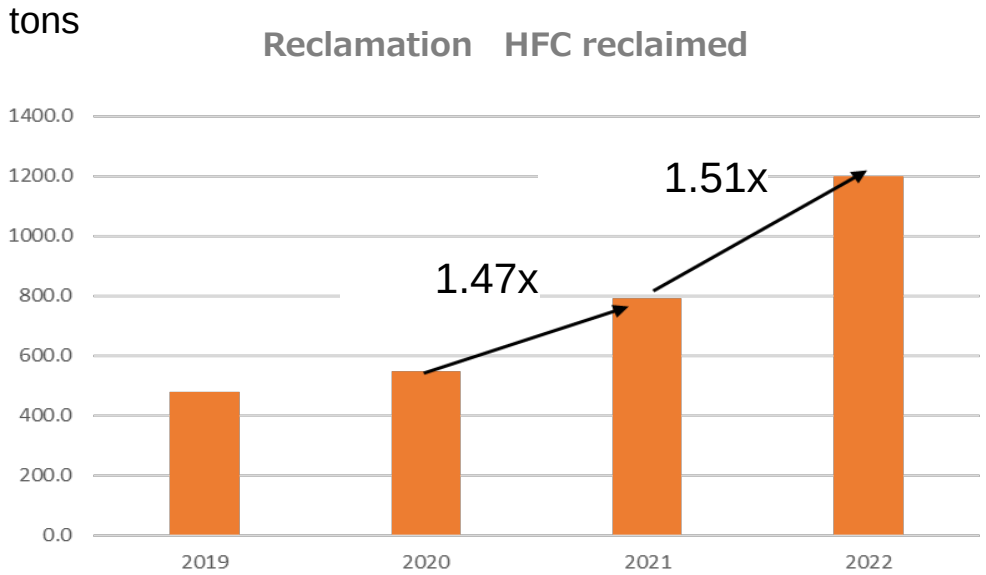
Improved from 40% to 44%. This might be the effect of the revised Act on Rational Use and Proper Management of Fluorocarbons?

(2) HFC ratio expands in the recovery

(Expanded from 52% to 63% in 2 years; natural flow)

(3) Recovered refrigerant is reclaimed

(Increased from 20% to 35% in 2 years. Awareness-raising activities have been successful??)



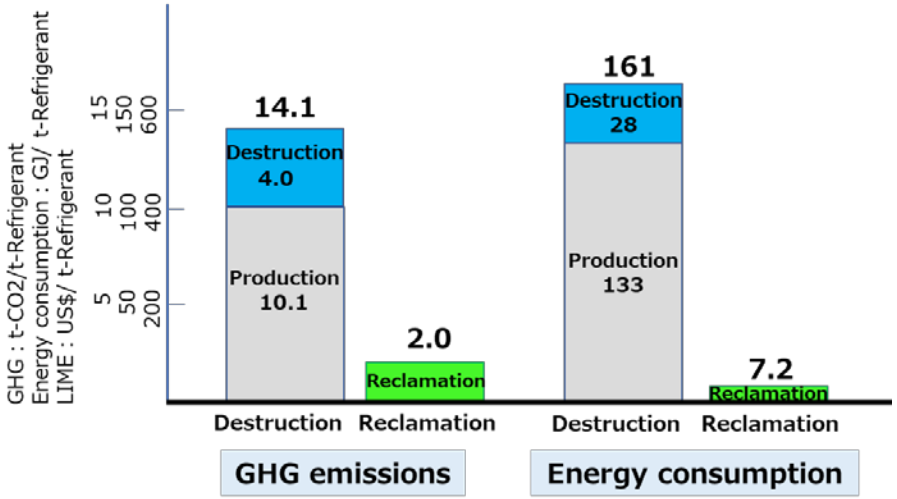
There is a possibility that the ratio of reclamation will increase to around 60% as a trend from the current situation.
Refrigerant reclamation is expected to increase from 480 tons in 2019 to 3,234 tons in 2029.
In that case, just under 30% of the consumption can be covered by the refrigerant reclaimed. While realizing a refrigerant circular economy, it also contributes to promoting the recovery of high-GWP refrigerants that are already on the market.

8. HFC Recovery and Reclamation
2) Environmental Impact – Reclamation vs Destruction

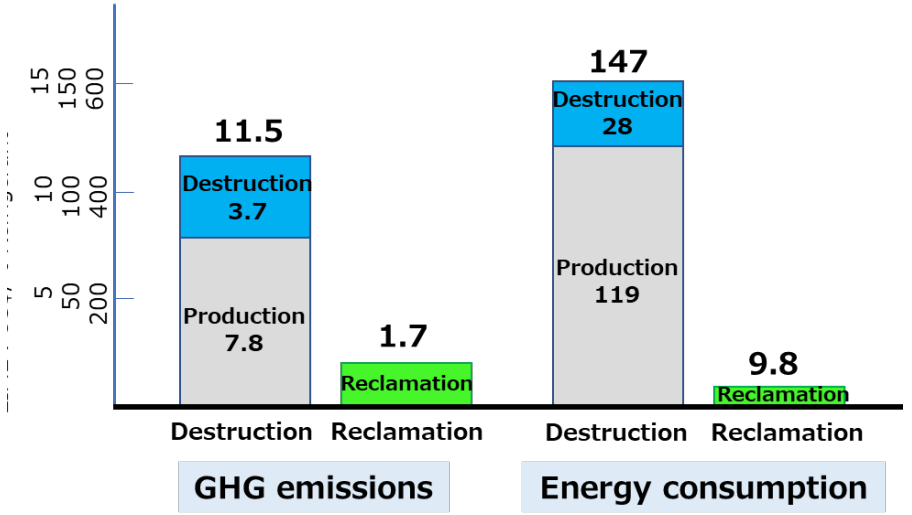
- Environmental impact is less for reclamation than for destruction
- Avoiding the production of new refrigerants contributes significantly to reduce impact

(per produced refrigerant)

R410A



R32



Source: Norihiro Itsubo et.al.Life-Cycle Assessment of Refrigerants for Air Conditioners Considering Reclamation and Destruction, Sustainability,Volume15,Issue11,2023, https://doi.org/10.3390/su15010473

9. Summery – The way forward to achieve the Kigali Target

- In Japan, **industry, academia and government are working together** to achieve the Kigali Targets.
- JRAIA developed a **guideline for VRF to use A2L** and companies are going to sell VRF systems with A2L following residential and light commercial products.
- **Thorough lifecycle risk assessment is required for A3 refrigerants,** and infrastructure should be established to mitigate the associated risks**.** **Product standards** such as IEC60335-2-40 **are not comprehensive enough**.
- Japan is developing **new HFO refrigerants with low to ultra-low GWP**.
- **Reclamation plays an important role** to achieve the target with less GHG emissions and energy than destruction.

Thank you for your attention

HVAC/R industry will contribute to the sustainable improvement of people‘s lives and wellfare through cooling / heating / freezing / hot water supply using the refrigeration cycle

JRAIA will continue to work together with the government and academia toward the realization of a carbon neutral society while considering S+3Es

(safety, environmental performance, energy conservation, and economic efficiency)

JRAIA The Japan Refrigeration and Air Conditioning Industry Association