

Daikin's Policy

and Comprehensive Actions on the Environmental Impact of Refrigerants

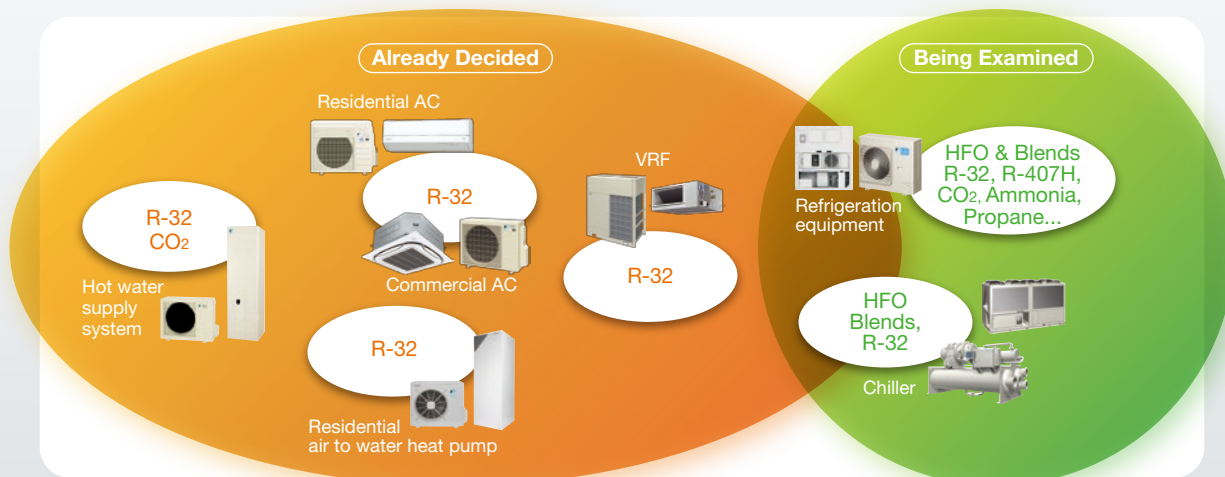
Daikin is constantly mindful of the environmental and climate change impact of our products and we are committed to delivering cost-effective solutions to meet these challenges.

For example, we have a long history of continuously and regularly improving the energy efficiency of our air conditioning and heat pump products as well as extensive experience in adopting refrigerants with a lower environmental impact.

Solving our environmental challenges will require innovation and various pathways which will enable us to provide environmentally progressive solutions. To reduce the environmental impact of a refrigerant throughout its lifecycle, we evaluate various aspects comprehensively to select the appropriate refrigerant for each application. Daikin also continues to move proactively to refrigerants with lower global warming potential, and Daikin also fully supports the historic agreement reached by the Parties to the Montreal Protocol in Kigali in 2016 for a global phase down of HFCs in total GWP volume.

Daikin's Refrigerant Direction

The following summary shows our direction of refrigerant choice for various products in the Daikin product portfolio.



Note: Other refrigerants not listed above are also applied in products outside of Daikin's portfolio, some examples include hydrocarbons (R-600a, R-290) for refrigerators and window air conditioners or HFO refrigerants for mobile air conditioners.



Key Considerations for Refrigerant Choice

At Daikin we assess four basic factors when making the best balanced refrigerant choice for each application: safety, environmental impact, energy efficiency and cost-effectiveness.

Daikin's View: Evaluation Index of Refrigerant Selection (common for all application)



Safety

A refrigerant must be safe to use through the entire lifecycle of the equipment. This includes transport, storage, installation, use, servicing, recovery and recycling.

This means that possible hazards such as toxicity or flammability characteristics, as well as the risk of human error, must be evaluated for each type of application. While non-flammable and low-toxicity refrigerants may have safety benefits, they may not be ideal from an environmental point of view. In addition, some refrigerants may be acceptably safe for one type of equipment but not sufficiently safe for others. Thorough risk assessments are therefore needed for each application.

Energy Efficiency

Daikin carefully considers a refrigerant's potential to improve the energy efficiency of its equipment in both cooling and heating function across an extreme range of climate conditions including very hot and very cold environments. This is an important consideration as energy consumption for cooling, heating and refrigeration has a substantial impact on the total energy consumption of buildings and countries. Depending on how electricity is generated in each country, its efficient use also has a large indirect impact on climate change by reducing CO₂ emissions. Therefore, energy efficiency is critical in choosing the right refrigerant for a given application.

Environmental Impact

A core consideration in refrigerant choice is its environmental impact. This impact includes a refrigerant's ozone depleting potential (ODP^{*1}) and its potential global warming impact: this is expressed as its CO₂ equivalent, which is the refrigerant quantity multiplied with its global warming potential (GWP^{*2}). Heat transfer capacity and heat exchange efficiency of refrigerants are also important characteristics that result in reductions in refrigerant quantity and allow more compact equipment design. Environmental considerations also include the impact of the refrigerant production process and a refrigerant's potential to be recycled and reused.

Cost-Effectiveness

It is important to provide consumers access to affordable solutions for their homes and businesses. In addition, in order to reduce the environmental impact, cost effectiveness should be considered in terms of dissemination. For instance, is the refrigerant easy and inexpensive to install and maintain? Does the refrigerant allow for compact cost-efficient designs to minimize investment costs? Does a refrigerant contribute to reducing overall system operation and maintenance costs? Is recycling of the refrigerant feasible and cost-effective? Would possible risk mitigation measures be cost-effective? These are factors to consider when selecting cost effective refrigerants.

^{*1} ODP: "Ozone-depleting potential"– A value indicating the intensity of ozone layer destruction by various substances based on the ODP of CFC-11 as a standard.

^{*2} GWP: "Global warming potential"– A value indicating the degree of contribution to global warming of various GHGs based on CO₂ as a standard. (Example: R-410A: 2,090, R-32: 675)



Daikin's Challenge in Achieving a Sustainable Refrigerant and Equipment Lifecycle

In addition to refrigerant selection, how a refrigerant is managed through its lifecycle, including recovery and reclamation, is also very important. And while we strongly support the Kigali amendment, and the effort to phase down HFCs in CO₂ equivalent, GWP is not an only measure for evaluating refrigerants, even within the Kigali framework. A comprehensive approach, including leakage prevention and recovery, reclamation and destruction is required. We will also continue to improve the energy efficiency of each of our products to reduce their overall environmental footprint.

Action on Refrigerant and Goals

1 Role as a Refrigerant Manufacturer

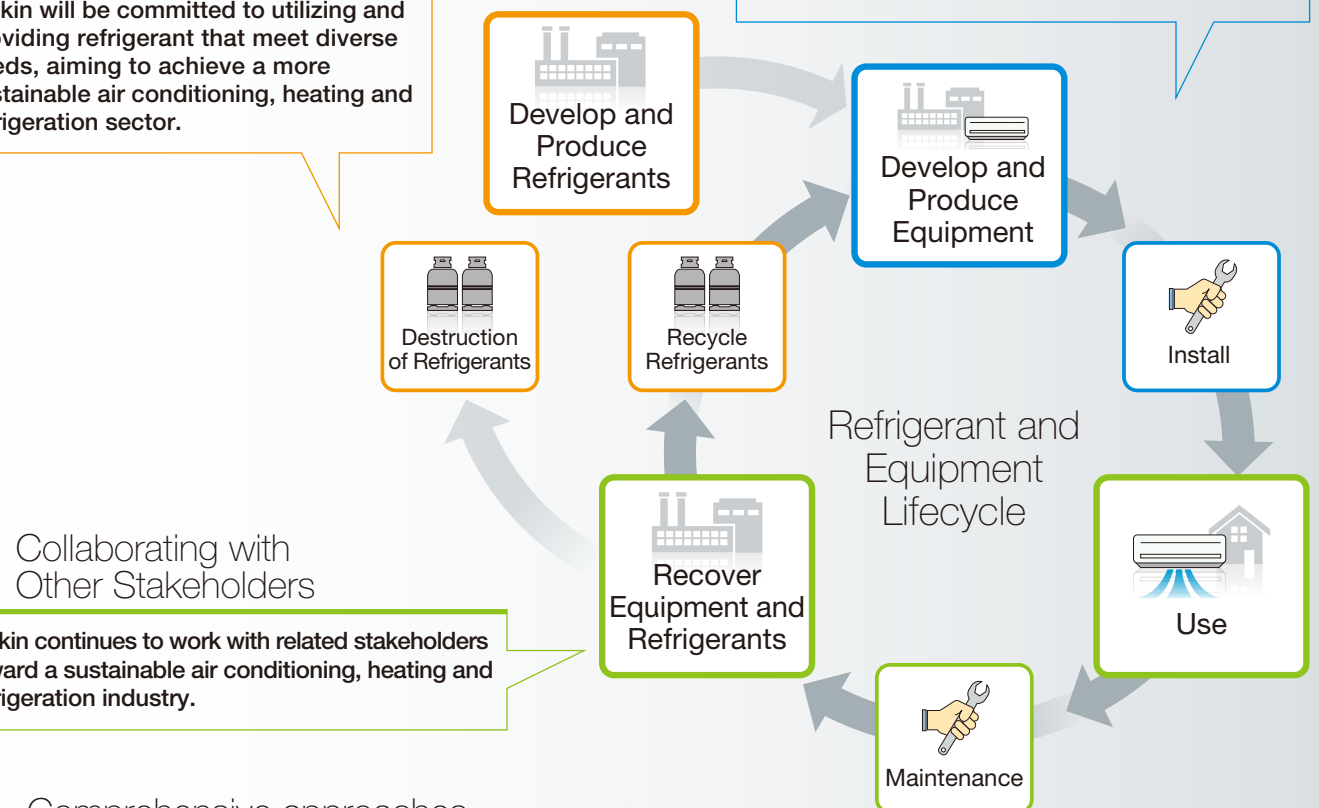
Daikin will be committed to utilizing and providing refrigerant that meet diverse needs, aiming to achieve a more sustainable air conditioning, heating and refrigeration sector.

2 Role as an Equipment Manufacturer

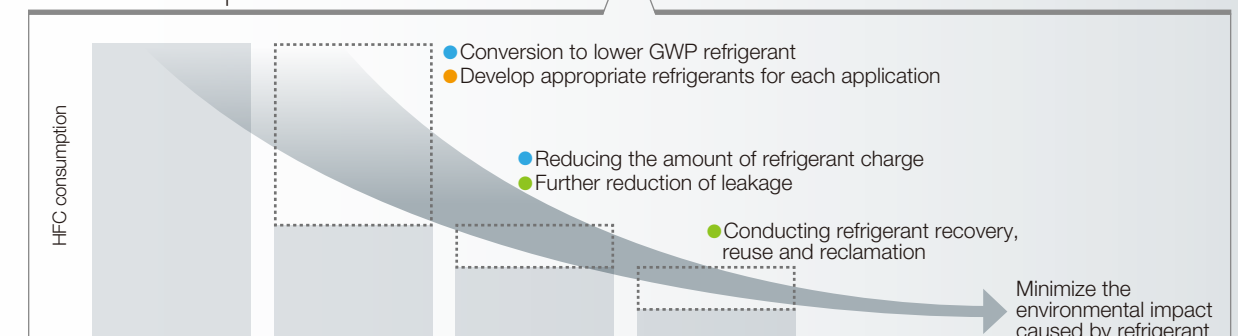
Daikin will continue to improve the energy efficiency of equipment and systems and we will continue to select optimal refrigerants that meet various needs.

3 Collaborating with Other Stakeholders

Daikin continues to work with related stakeholders toward a sustainable air conditioning, heating and refrigeration industry.



Comprehensive approaches toward HFC phase down



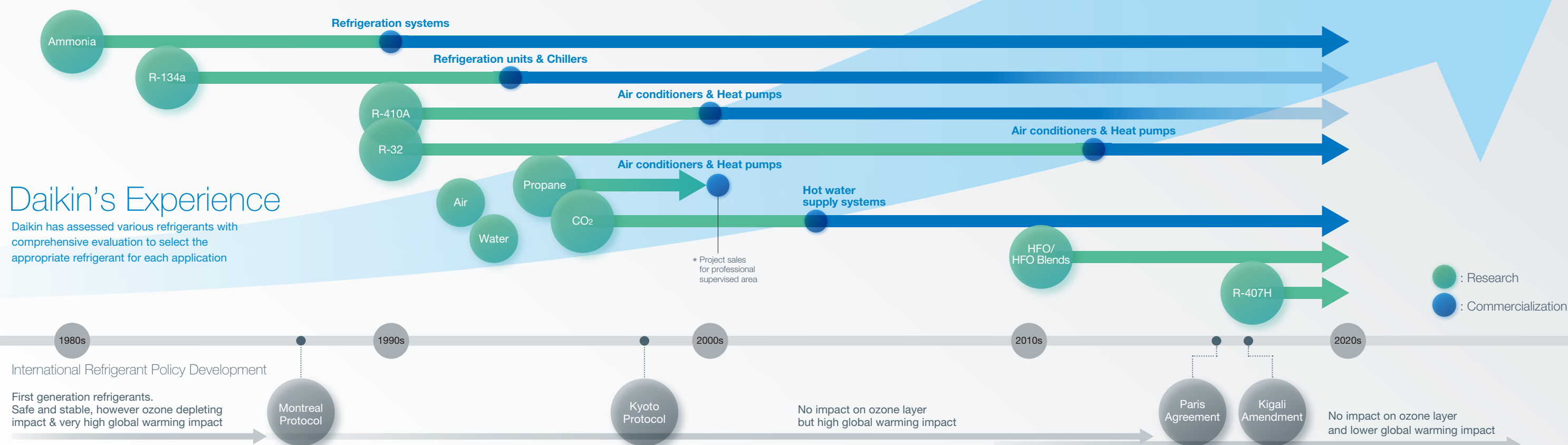


Daikin's Expertise in Reducing Environmental Impact of Cooling, Heating and Refrigerating Equipment

Daikin has a long history of global innovation leadership to reduce the environmental impact of cooling, heating and refrigeration, as well as a unique position and expertise that comes from both manufacturing equipment and refrigerants. Daikin will continue to work with governments, our business partners and stakeholders to continue to work to accelerate the move towards better environment.

Continue to Innovate

Refrigerant Changes – a History of Continuous Innovations



Daikin's Experience

Daikin has assessed various refrigerants with comprehensive evaluation to select the appropriate refrigerant for each application

Next Steps:

Through all of these efforts across the lifecycle of our products, and the careful balancing of environmental, safety and energy efficiency factors, Daikin is taking continuous action to minimize the impact of our products and refrigerants. While we embrace international and other efforts on phasing down HFCs, we also strive as a company to take leadership in seeking optimal choices and new technologies that will deliver sustainability as the demand for heating and cooling continues to expand around the globe.

The Kigali Amendment is a key step in the evolution of refrigerants to mitigate their impact on the environment. This landmark agreement mandates a global reduction in the production and consumption of HFCs in CO₂ equivalent. Once ratified, HFC reductions will begin in 2019 for Developed Countries which have to reduce 85% of HFCs in CO₂ equivalent by 2036 and 2024/2028 for Developing Countries, which have to achieve 80% of HFCs in CO₂ equivalent by 2045 or 85% of HFC in CO₂ equivalent by 2047.

Daikin's position on the Kigali Amendment for HFC phase down

- Daikin welcomes the Kigali Amendment for an HFC phase down in CO₂ equivalent under the Montreal Protocol.
- The main tenet of Daikin's policy is "diversity of refrigerants." and reducing impacts through a "life cycle approach".
- Daikin has identified R-32 as a very beneficial refrigerant for single and multi-split type air conditioners and heat pumps. Daikin believes that the transition to R-32 will help to meet both the HFC phase down schedule and the HCFC phase out schedule. Daikin is now in the process of further study to identify a suitable refrigerant for other applications.

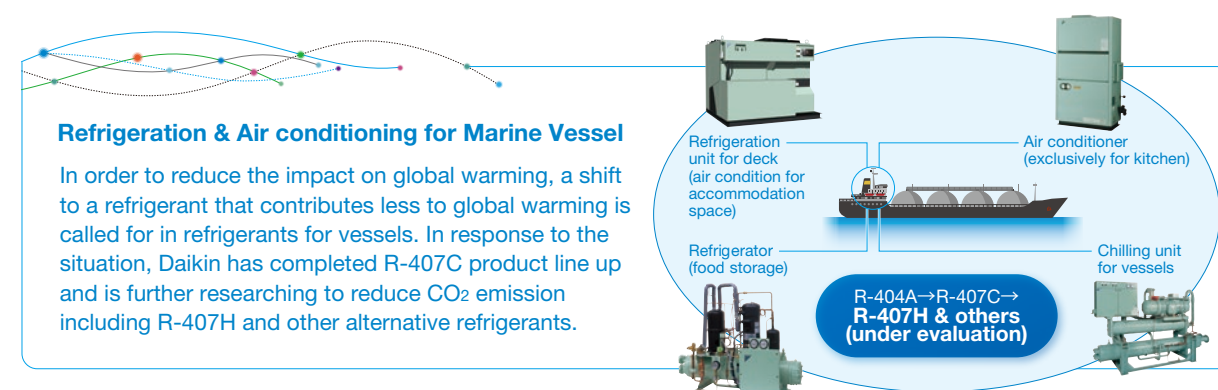
- To mitigate future global climate change, it is important to take a "Sooner, the Better" approach. As soon as the most balanced and feasible solution for an application is found, Daikin will commercialize and disseminate the technology to contribute to the efforts to mitigate global climate change.
- Also, while taking "the Sooner, the Better" approach, as a refrigerant manufacturer, Daikin will continue to seek the "optimal refrigerant" for every type of application for further mitigation of global climate change.

Refrigeration Equipment

Recently, many types of low GWP refrigerants are being promoted to reduce global warming in the global refrigeration market. As the optimal refrigerant for each application is different depending on application type, capacity and temperature range, and safety requirement, it is important to have diversity of refrigerant choice. Our refrigeration products realize the best performance to reduce the global warming impact from viewpoints of both direct emission due to refrigerant and indirect emission deriving from energy use. For further contribution to the mitigation of global warming impact, Daikin will continue to evaluate and change to the next best alternative refrigerant solution with the total assessment of Environment, Energy efficiency, Safety and Cost effectiveness.

Daikin is to find the appropriate solution realizing to reduce environmental impact and satisfy market needs

	Cold Chain	Daikin & Zanotti Products	Alternative Refrigerants
			Assessment with 4 core factors by each application Safety Environmental Energy efficiency Cost
Industrial Refrigeration	Producing site Food processing		<div> <div>Current</div> <div>Direction</div> </div> <div> R-404A R-410A R-134a R-448A R-449A CO₂ Ammonia Propane Isobutane </div> <div> Lower GWP HFCs(no flame) R-407H/448A / 449A etc R-32, HFOs etc (Lower flammability) CO₂ & Ammonia expand line up (natural) R-290*, R-600a* expand line up (Higher flammability) </div> <div>Now under Risk Assessment</div>
Commercial Refrigeration	Supermarket Restaurant		
Transport Refrigeration	Maritime Transport Land Transport		<div>Marine Container</div> <div>Truck & Trailer</div> <div> R-134a → R-513 R-404A → R-452A R-1234yf R-32 Low GWP Refrigerant </div> <div>Now under Risk Assessment</div>



Applied Products

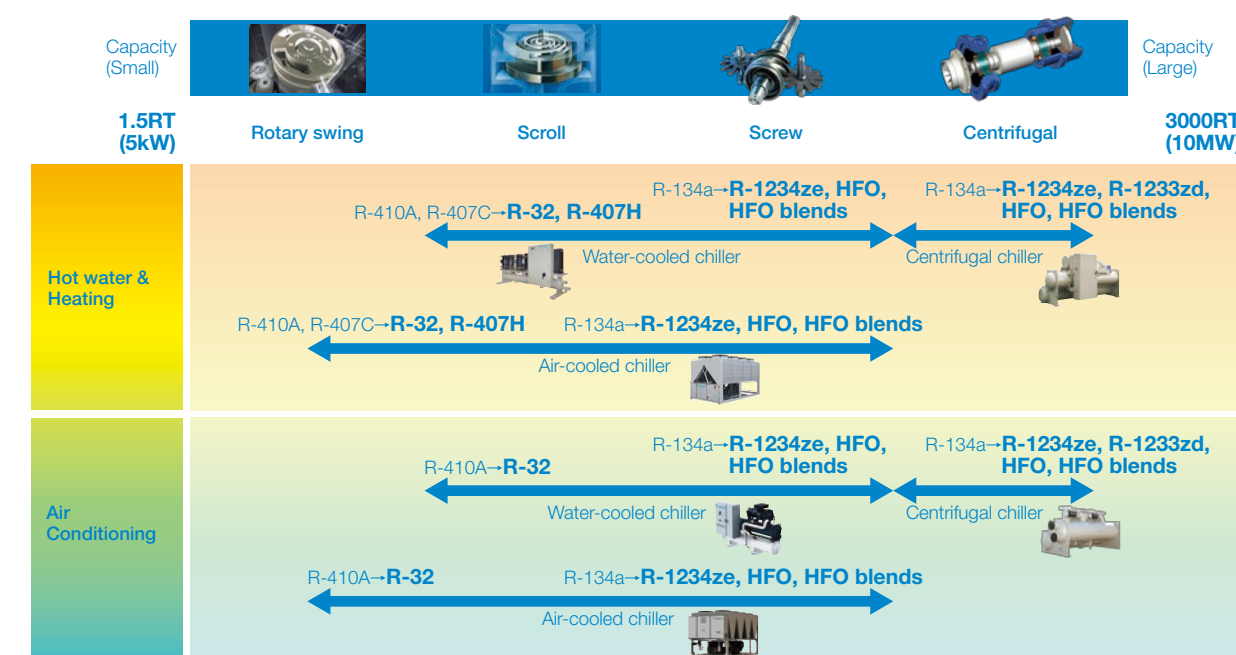
(Chillers)



Daikin, as the only company both HVAC and Refrigerant businesses, continues to offer the best solution for refrigerant choice.

In terms of applied products, Daikin will provide equipment with proper refrigerant for each application that satisfies both function and performance requirements, while keeping focus on environmental friendliness and safety. Furthermore, we will maximize our contribution to the mitigation of global warming by considering total product life-cycle in our development efforts.

Applied product applications and new refrigerant candidates



In considering new refrigerants from the viewpoint of global warming mitigation, it is key to take into account not only GWP, but also energy efficiency. Aside from low-GWP refrigerants, reducing refrigerant charge, minimizing refrigerant leaks and minimizing indirect CO₂ emissions (from power consumption during operations) also have great positive environmental impact. To further our contributions to the mitigation of global warming in regards to total life-cycle environmental impacts, Daikin will press on with undertakings such as the following:

<Hardware>

- Develop refrigerants and chillers tailored to each application
- Develop new heat exchanger designs that can reduce refrigerant charge
- Improve technologies such as inverter that realize energy savings

<Service Solutions>

The period of use of applied products is relatively longer than other equipment types, thus the maintenance service solution is important factor to contribute to reducing environmental impact.

- Develop sensing technology for early detection of refrigerant leaks to prevent large amounts of refrigerant venting to the atmosphere
- Maintenance support for sustaining higher efficiency operation, utilizing latest technologies to analyze operating data over time



Air Conditioners and Heat Pumps

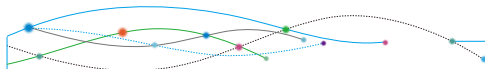
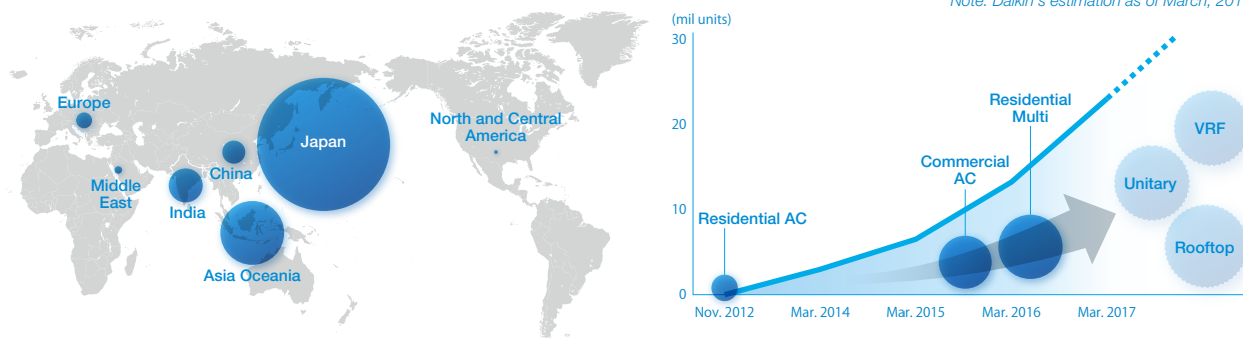
(Split type and single package type AC/HP for cooling, heating and residential hot water supply)

Daikin has assessed various refrigerants (R-32, blends, natural refrigerants, HFO, etc) based on four criteria (environmental impact, energy efficiency, safety and cost-effectiveness), and we have applied some of these refrigerants in selected applications. After examining its key properties, Daikin has concluded that R-32 is a better refrigerant than others for direct expansion type cooling and heating equipment (including single package products), and we have been launching R-32 products into the worldwide market region-by-region. Daikin was the first to introduce air-conditioning and heat pump technology utilizing the refrigerant R-32, starting in Japan in November 2012. As of March 2017, we have sold approximately 10 million units in more than 50 countries. Together with other manufactures, more than 27 million units of R-32 equipment are estimated to be sold globally. If all presently used R-410A refrigerant were replaced by R-32, the total CO₂ equivalent impact of HFCs could be reduced by up to approximately 800 million tons-CO₂ compared to business as usual scenarios, along with a significantly reduced amount of indirect CO₂ emissions due to lower energy consumption. This is the equivalent of 50% to annual carbon absorption provided by the Amazon rain forest.

We will continue to challenge ourselves in the technical development and contribute to standard making to expand range of our products using R-32.

Total 27 million units of R-32 Residential AC are on the Market in more than 50 countries

Note: Daikin's estimation as of March, 2017



For the Residential Hot Water Supply Unit, the amount and temperature of hot water that is required for domestic use varies depending on weather conditions, housing environment and lifestyle. For example, where a large amount of hot water is necessary, CO₂, which can produce higher temperature water, is more appropriate; in systems combined with a heating unit that uses less hot water, R-32 is more appropriate. We are proactively promoting development of a variety of products by selecting suitable refrigerants that meet different needs for various applications.

DAIKIN INDUSTRIES, LTD.

Inquiries

CSR & Global Environment Center

Umeda-Center Bldg., 2-4-12, Nakazaki-Nishi, Kita-ku, Osaka, 530-8323 Japan

PHONE: +81-6-6374-9325 FAX: +81-6-6374-9321 E-mail: refrigerant.project@daikin.co.jp

Published May 2017



Certificated in Japan

