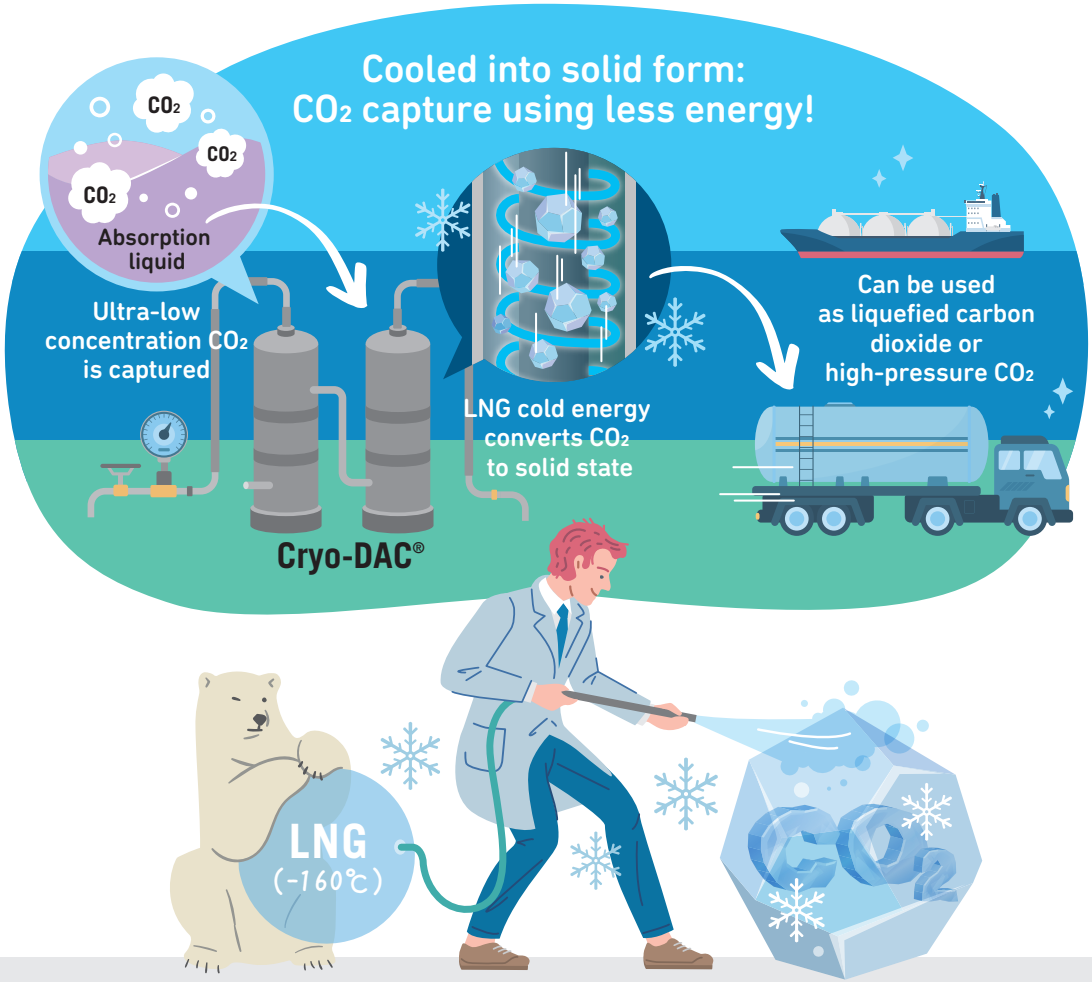
03 PROJECT

Using the "Power of Cold" to Convert Atmospheric CO_2 Into Dry Ice

Research and Development on Direct Air Capture With Available Cold Energy

CO_2 accounts for 75 percent of greenhouse gas emissions that cause global warming. However, the concentration of 400 parts per million means that only four out of every 10,000 molecules in the atmosphere are CO_2. One mechanism for efficiently capturing this low-concentration CO_2 is Direct Air Capture (DAC), but this requires a large amount of heat energy. To solve this problem, we are developing technologies that take the opposite approach: capturing CO_2 using ***cold energy***.



Daily Discoveries Drive Research

Dr. NORINAGA Koyo

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Removing CO_2 in the atmosphere caused by the mass consumption of fossil fuels since the Industrial Revolution is a pressing issue for humanity. The solution to this problem requires equipment and plants designed on a scale that matches society's infrastructure, and we believe that our engineering-centered research and development plays an important role in achieving that. When we deal with technical hurdles and unexpected challenges, when we employ unique technologies, when we feel the joy of working at the forefront of our field, and when we envision a future where these technologies are used every day—this is what motivates us as researchers.

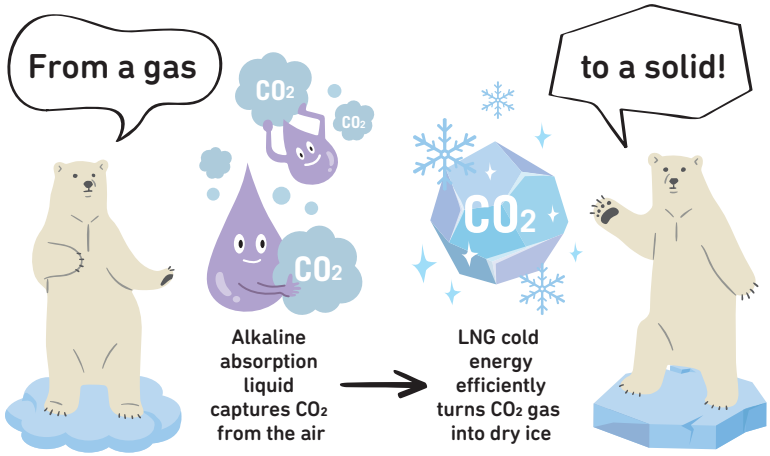
Using the "Power of Cold" to Convert Atmospheric CO_2 Into Dry Ice

» The Challenge of Creating a New Process

Cold...energy? These would usually be contradictory terms, as coldness is simply an absence of heat energy. The cold energy demonstrated here refers to the way liquefied natural gas (LNG) can draw heat from the surrounding space as it cools during evaporation. LNG chilled to -160°C is transported to a receiving terminal, and it generates this cold energy as it returns to a gaseous state. However, much of this cold is not used as energy but disposed of in seawater and elsewhere. We came up with the idea of carbon recycling centered on Cryo-DAC®, or low temperature direct air capture, as a means of both effectively utilizing this wasted energy and solving problems with DAC systems.

» Transformation From Solid to Liquid (Fluid)

With Cryo-DAC®, CO_2 is first absorbed and concentrated in an alkaline liquid. By reducing the pressure, the CO_2 is then recovered into a sublimation tank, where cold energy turns it into solid dry ice that can be collected. In addition, while CO_2 ordinarily is liquified through intense compression, Cryo-DAC® saves energy by eliminating the need for this. Simply bringing the dry ice back up to ambient temperature in a sealed environment enables the production of liquefied CO_2 suitable for transport and underground storage. And since LNG is shipped around the world in large quantities, using previously discarded cold as a new energy source can have a major impact. It is expected to contribute to about 30 percent of the international DAC CO_2 capture index.



KEYWORD

Cold Energy

This form of energy utilizes temperatures lower than the ambient temperature to absorb surrounding heat.

FUTURE VISION

2025

Demonstrate System at Expo 2025 in Osaka, Kansai, Japan

We will exhibit at the World Expo and conduct a six-month demonstration test to show that Cryo-DAC® can reliably capture CO_2 from the atmosphere. We also aim to bench test the system at the university to confirm successful operation and to widely share the results of this research.

2027

Produce Further Proof of Concept

In collaboration with business partners, we will proceed with testing for real-world social implementation. We will also confirm whether this technology can be competitive against others.

2029

Proceed to Commercialization Phase

We will complete the conceptual design of the commercial system and the plan for real-world social implementation. We will recruit companies domestically and internationally to implement DAC, and foster the development of the business environment.

Implementation Nagoya University, Toho Gas Co., Ltd., Tokyo University of Science

Project Introduction Video https://www.youtube.com/watch?v=qV1py3OZwIM&list=PLZH3AKTCrVsVm3UN1x40WW_QK-cEXaoo3