



# Research and Development Toward Saving Energy for Direct Air Capture With Available Cold Energy

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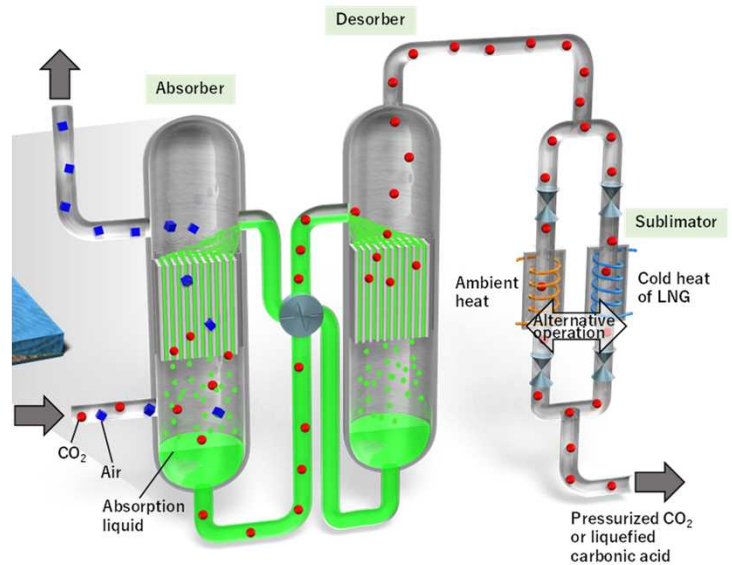
## Summary

We are going to develop a new technology that significantly improves the efficiency of Direct Air Capture (DAC) by utilizing unused cold heat from liquefied natural gas (LNG). A series of processes that recover CO<sub>2</sub> as dry ice are proposed and demonstrated. The underlying principle includes that heat generated by CO<sub>2</sub> sublimation is absorbed by the heat of vaporization of LNG.

In the absorption tower, the alkaline solution absorbs CO<sub>2</sub> in the atmosphere and subsequently flows into the regeneration tower. Sublimation tanks equipped with heat exchangers using LNG as a cooling medium are installed downstream, where CO<sub>2</sub> can be collected as dry ice. Due to the CO<sub>2</sub> sublimation in a closed system, the pressure of the regeneration tower can be reduced, and CO<sub>2</sub> is released from the absorption liquid. The feature is that CO<sub>2</sub> is recovered from the absorbent not by heating but by vacuum induced by cooling and CO<sub>2</sub> sublimation. As a consequence, both absorption and regeneration can be operated near the environmental temperature, and the input of thermal energy can be minimized. If the dry ice is heated in a closed tank, we can generate a fluid such as high-pressure CO<sub>2</sub> or liquid CO<sub>2</sub>, that can be directly delivered to the subsequent CO<sub>2</sub> storage (CCS) and utilization process (CCU).

### [Main R & D contents]

- Designs of absorber, regenerator, and sublimation tank (Nagoya University)
- Development of new absorbents that can drive the pressure swing DAC process (Nagoya University)
- Selection of steel grade for sublimation tank (Tokyo University of Science)
- Development of sublimation tank soundness monitoring technology (Toho Gas)
- Design of mounting system on LNG terminal, development of energy-saving technology and evaluation of economic efficiency and environmental friendliness (Toho Gas)
- Development of Cryo-DAC commercial facility and extraction of social implementation issues (All)



## KPI

### FY2022

Development of a new absorbent to drive the process.  
 Development of equipment materials and soundness diagnostic sensors that can be used in a temperature range of -196°C to room temperature and a pressure range of 10 Pa to 4 MPa.

### FY2024

Development of a bench scale facility (~ 1t-CO<sub>2</sub> / year) and implement continuous operation.

### FY2029

Conceptual design of the commercial plant and propose social implementation scenarios.

## Implementation

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