Integrated Electrochemical Systems for Scalable CO2 Conversion to Chemical Feedstocks

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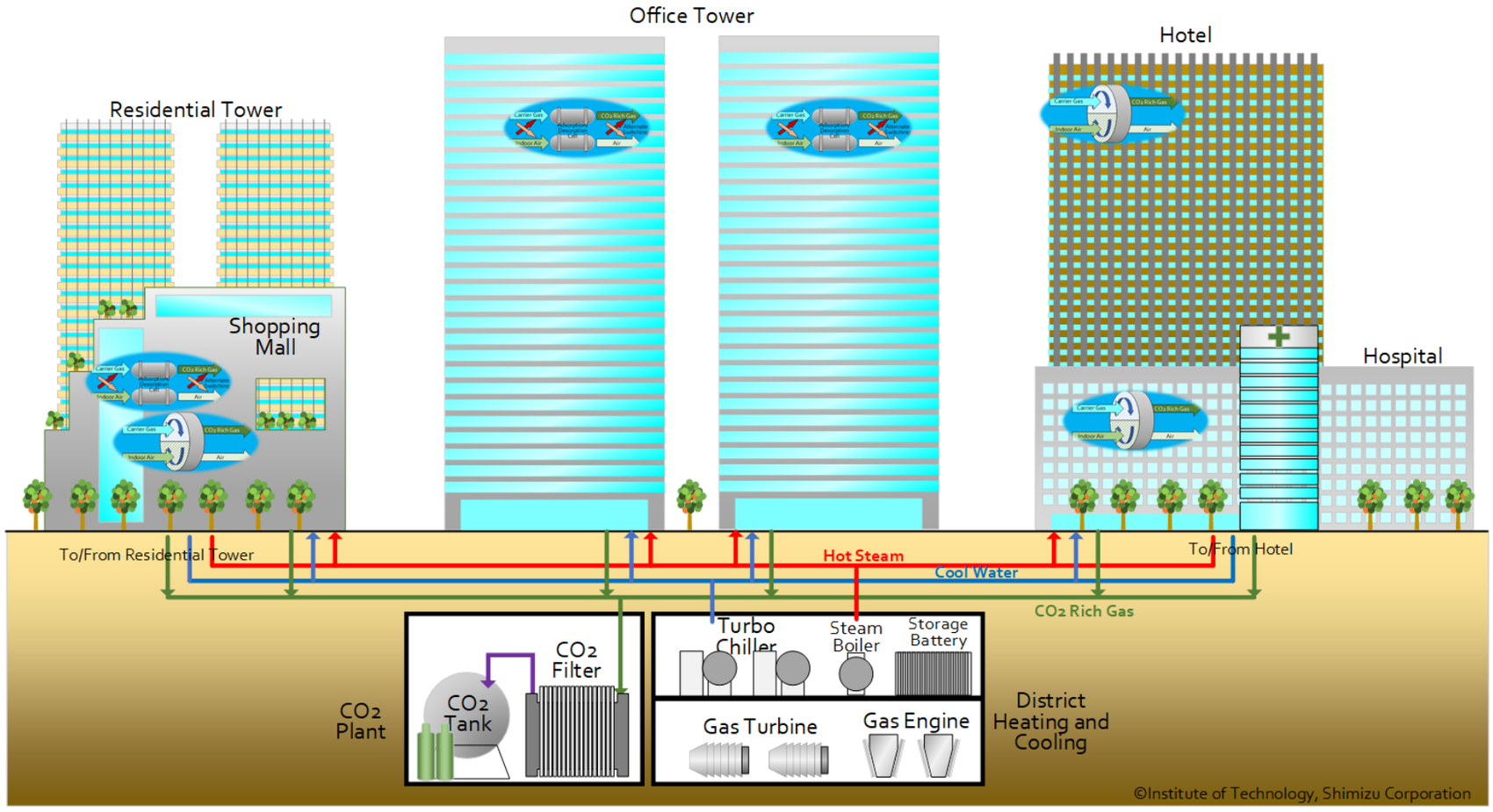
Implementing organizations : The University of Tokyo, Osaka University, Institute of Physical and Chemical Research (RIKEN), Ube Industries, Ltd., Shimizu Corporation, Chiyoda Corporation, Furukawa Electric Co., Ltd.

Shimizu Corporation Business description / Role in this PJ

☐Business domain / strength

- ➢ We are one of the leading construction company in Japan
- ➢ We can implement rapidly DAC system in buildings and cities that have huge areas.



DAC concept in smart city with district heating and cooling (DHC)

☐Role in this PJ

- ➢ DAC Technology Development
- ➢ We send CO_2 concentrated about 10 times (target 4000 ppm) mainly by the physical adsorption method to the electrochemical process.
- ➢ DAC mechanism construction / equipment design / manufacturing as building equipment, leading to social implementation involving architecture and city planning.

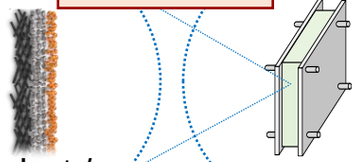
Project organization and goals

Larger electrode area
Stacking of electrodes

System development

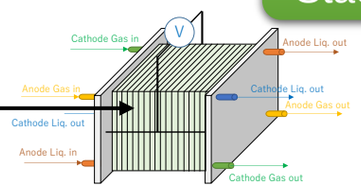
CO_2 electrolysis reactor

Osaka Univ.
Electrode



Catalyst / Electrode

CO_2 electrolysis reactor



Scale up/ stacking

Furukawa Electric Co., Ltd.
Cu-based substrates

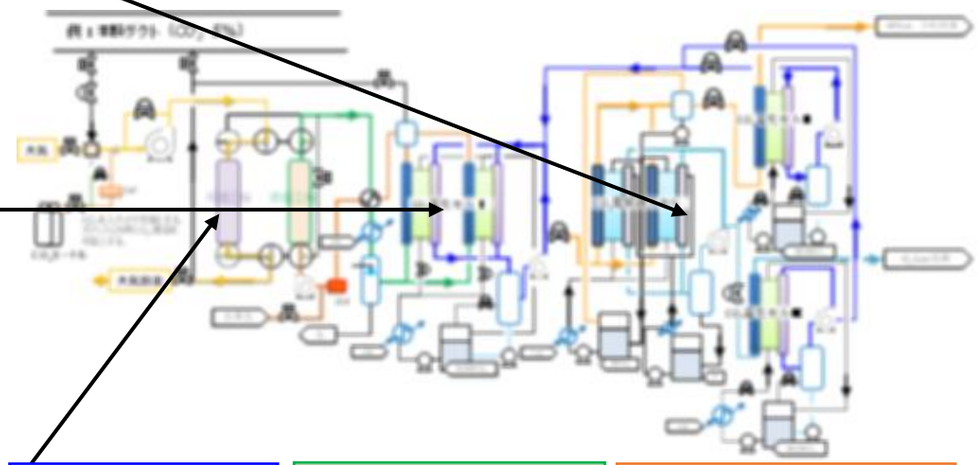
Ube Industries, Ltd.
Acid-tolerant catalysts

RIKEN
Reactor

The Univ. of Tokyo Chiyoda Corp.
Process integration

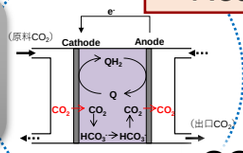
The Univ. of Tokyo・Chiyoda Corp.
Process integration / system control / characterization

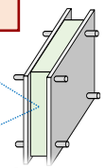
The Univ. of Tokyo
LCA analysis



CO_2 enrichment reactor

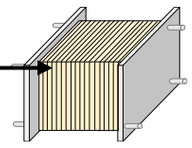
Osaka Univ.
Reactor





CO_2 enrichment reactor

Electrochemical reaction system



Scale up/ stacking

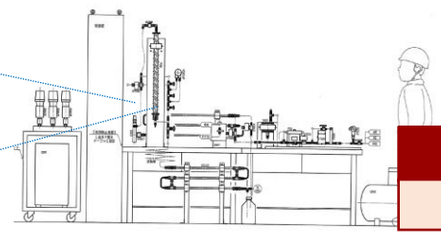
CO_2 Capture

CO_2 Enrichment

CO_2 Electrolysis

Physical CO_2 capture

Adsorption / desorption material



Adsorption / Desorption system

Shimizu Corp.
Prototyping

Shimizu Corp.
Process concept

Ube Industries, Ltd.
Provisional pilot field /
Social implementation scenario

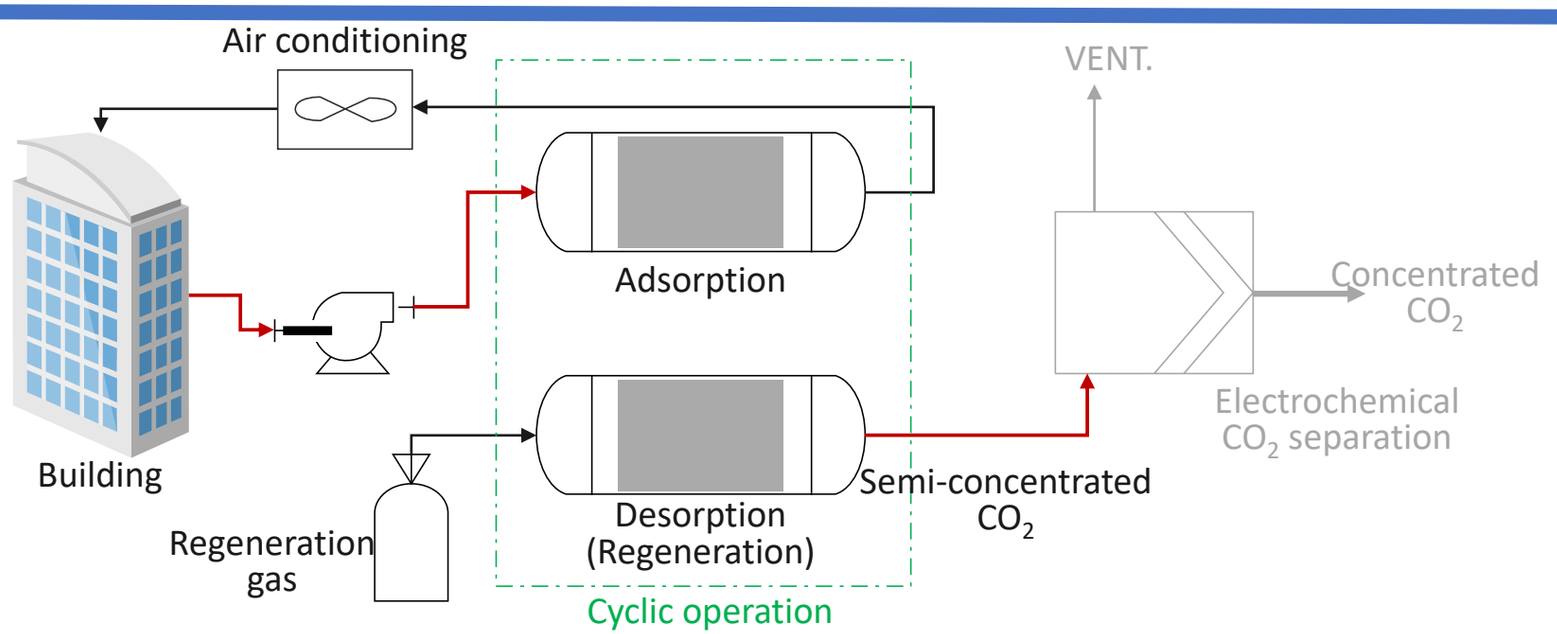
Goals

- Development of an integrated system that electrochemically converts CO_2 captured from an atmospheric air to valuable chemical substances
- Conducting a life cycle assessment on a pilot-scale plant to evaluate the effectiveness as a measure against global warming

Shimizu's research item / Intermediate・Final goals

☐Research Item &Final goal

We will carry out DAC pilot demonstration
～ From basic examination To social implementation～

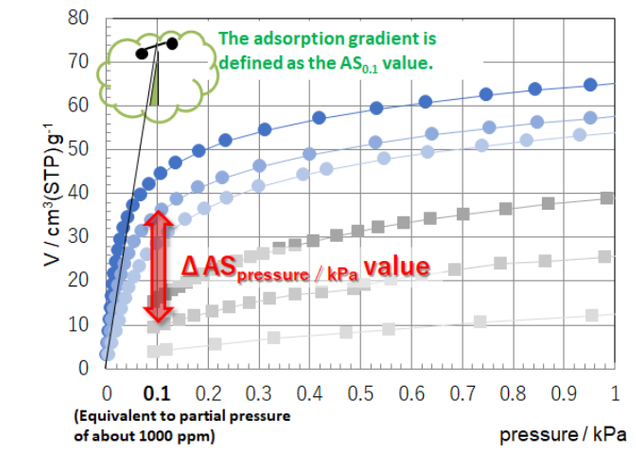


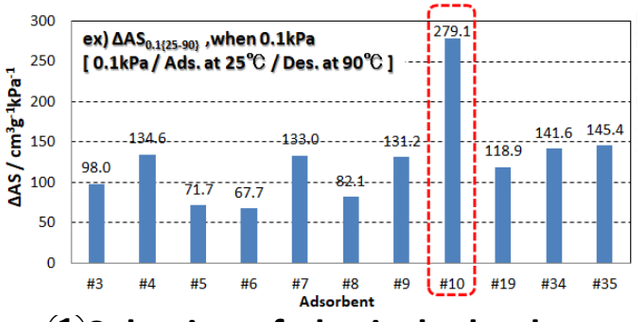
☐Intermediate Goals

～FY2022

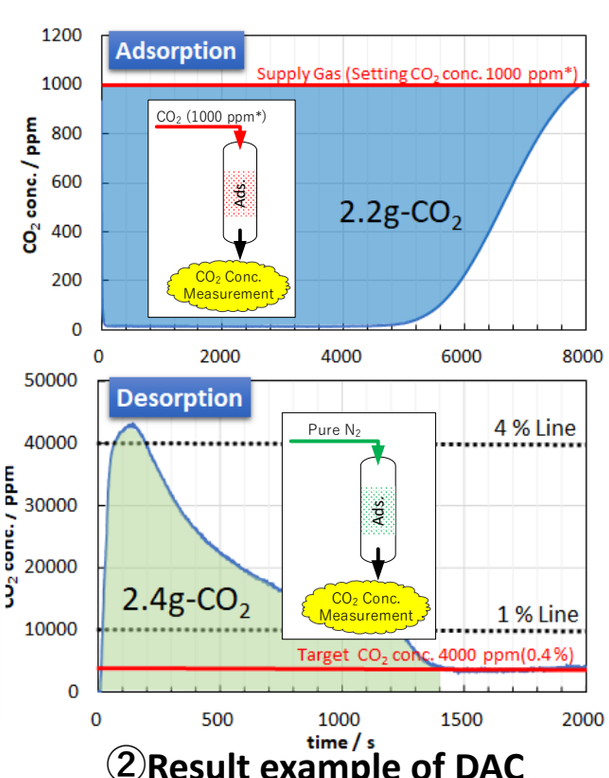
①Selection of physical adsorbent ⇒ Favorable

②DAC basic experiment
⇒ Achieved target concentration





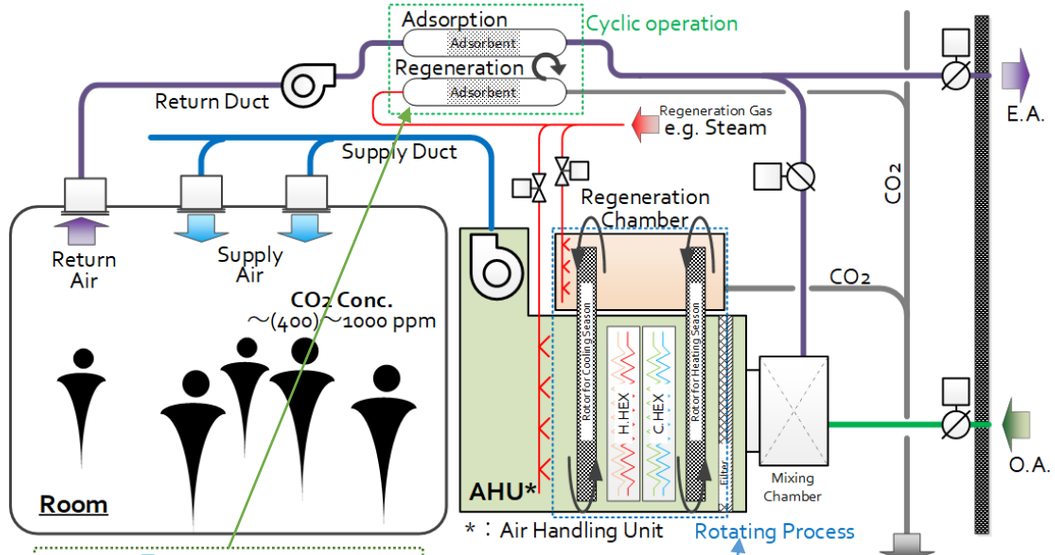
①Selection of physical adsorbent

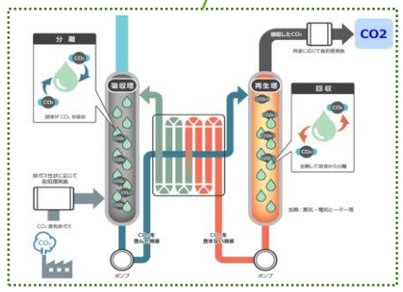


②Result example of DAC experiment(over 4000 ppm)

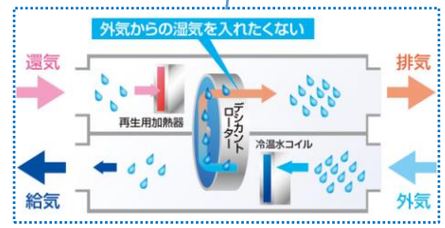
～FY2024 Manufacturing DAC Prototype

Collaboration with a major AHU manufacturer (expectation)





Absorbent Liq. Method (env.go.jp)

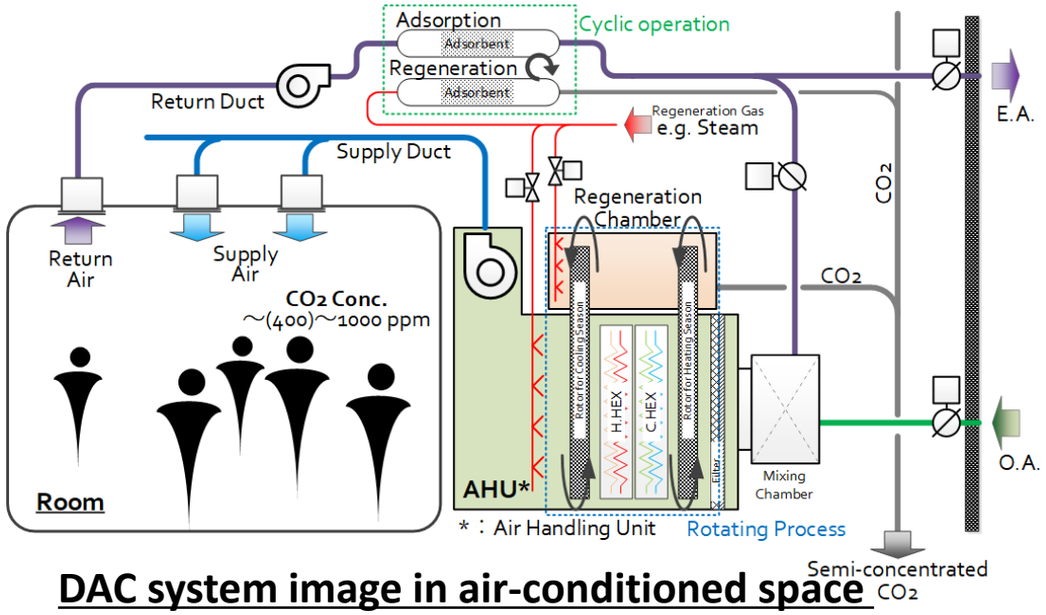


Desiccant rotor (SINKO INDUSTRIES LTD.)

Similar existing technologies

Targets

☐FY'24 Completion of DAC prototype



DAC system image in air-conditioned space

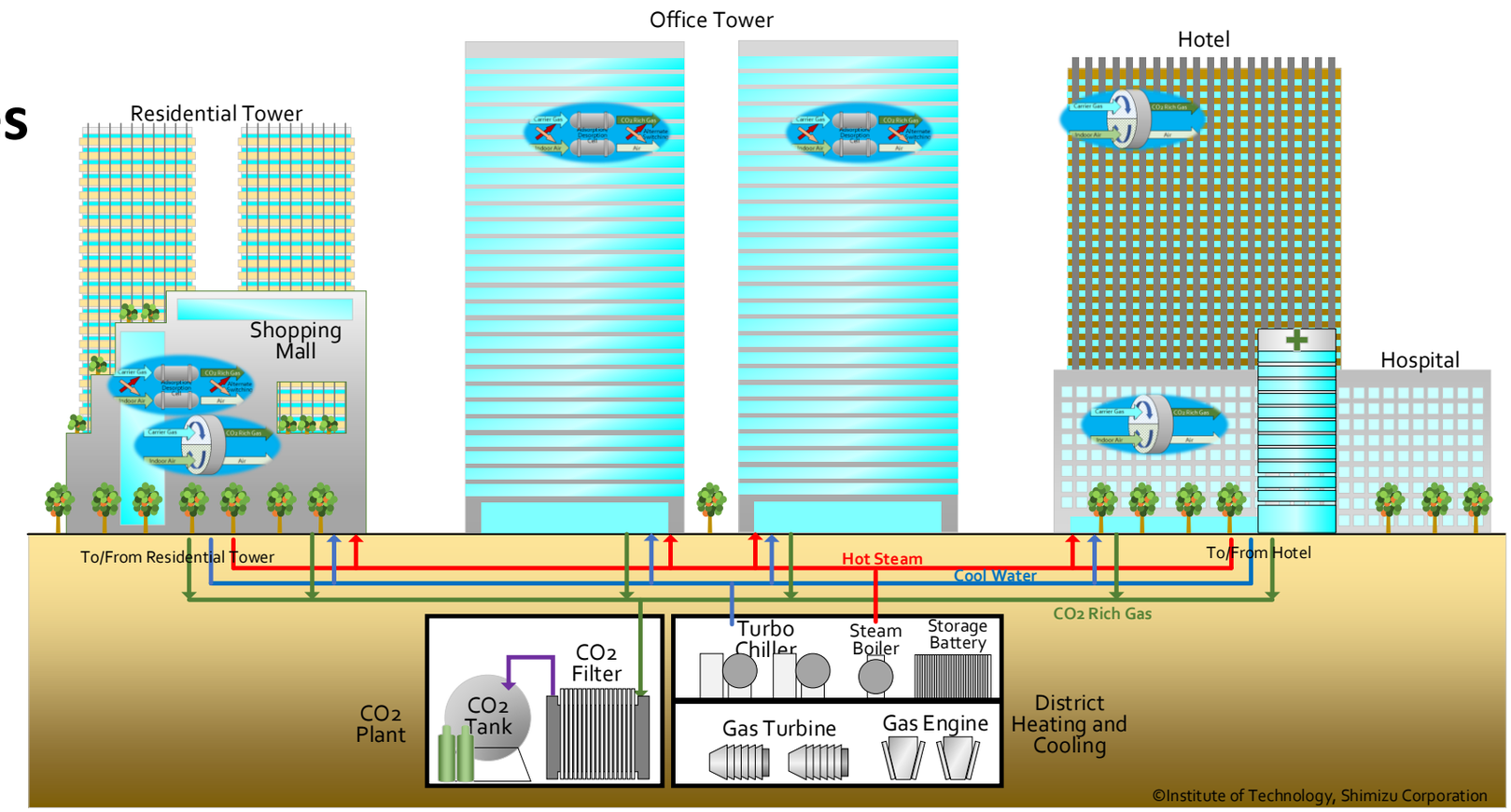
Further experiments to finalize specifications
Collaboration with AHU manufacturers

DAC device image
(SINKO INDUSTRIES LTD.)

☐FY'27

Establishing design guidelines for architectural and urban implementation

- ➢ **Architecture planning**
- ➢ **City planning**
- ➢ **PJ total LCA including ethylene production**
- ➢ • • •



DAC concept in smart city with district heating and cooling (DHC)

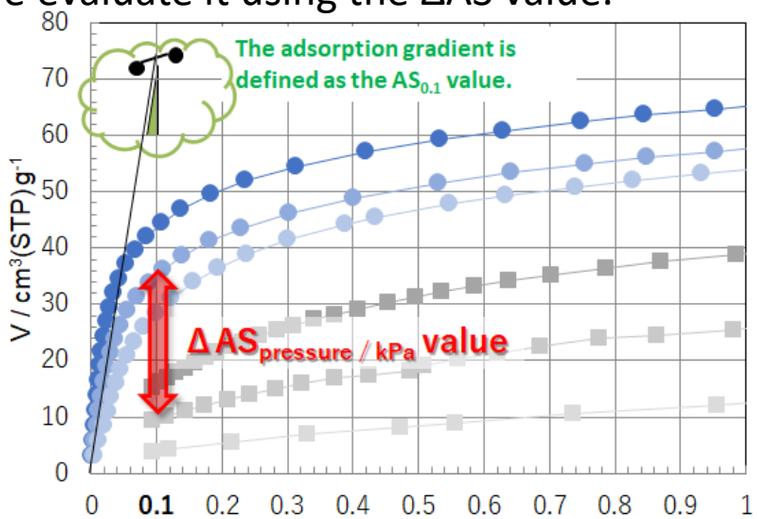
Achievements

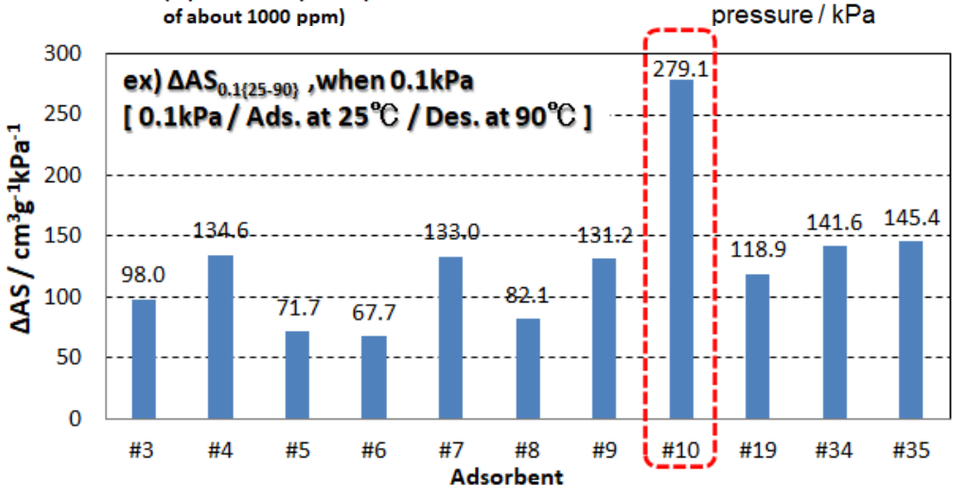
①Selection of physical adsorbent

1) Sieving the adsorbents by the adsorption isotherm
⇒ From 45 adsorbents to 11 adsorbents

2) Establishment of DAC potential evaluation method
The difference ΔAS value between the adsorption amount at the mounting adsorption temperature and the desorption temperature is defined as the evaluation value. Selection of adsorbent for DAC experiment by comparing ΔAS values

3) Improvement of adsorbent
If there is an improvement proposal from the manufacturer, etc., we evaluate it using the ΔAS value.



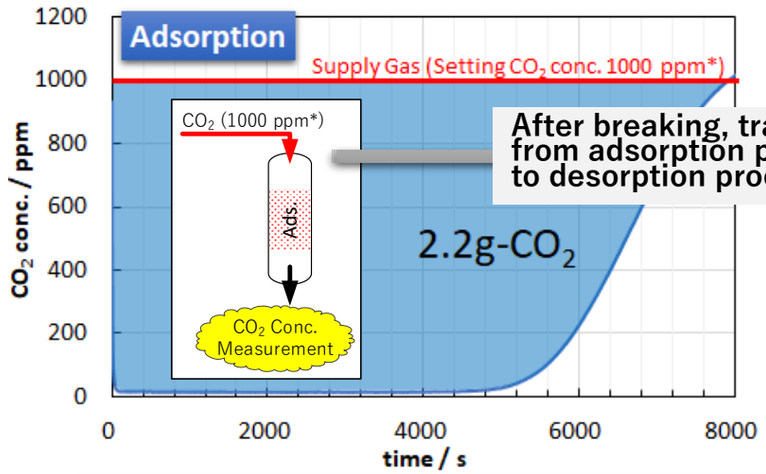


Example of adsorbent selection result using ΔAS value (original definition)

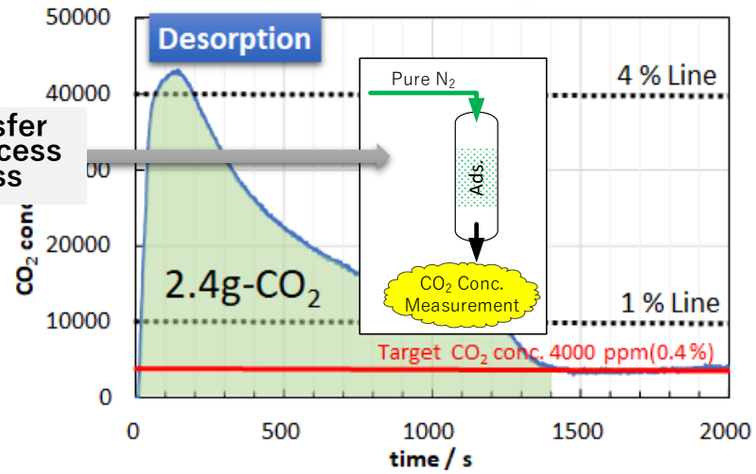
②DAC basic experiment


①Semi-dry DAC experimental system


②Steam desorption experimental system



After breaking, transfer from adsorption process to desorption process



＊1000 ppm : Indoor CO_2 concentration upper limit standard value based on Japanese regulation.
Ex.） CO_2 concentration range ： 400 ppm （No occupancy） ～ 1000 ppm （Full occupancy）

Examples of DAC experiment results using the same adsorbent

1) Target concentration 4000 ppm (0.4%) ⇒ Achieved

2) Reproducibility in moist air ⇒ Continuing issues

3) Steam desorption ⇒ Continuing issues

Started collaboration with AHU manufacturers (new partners) as DAC device manufacturer

MOONSHOT
RESEARCH & DEVELOPMENT PROGRAM