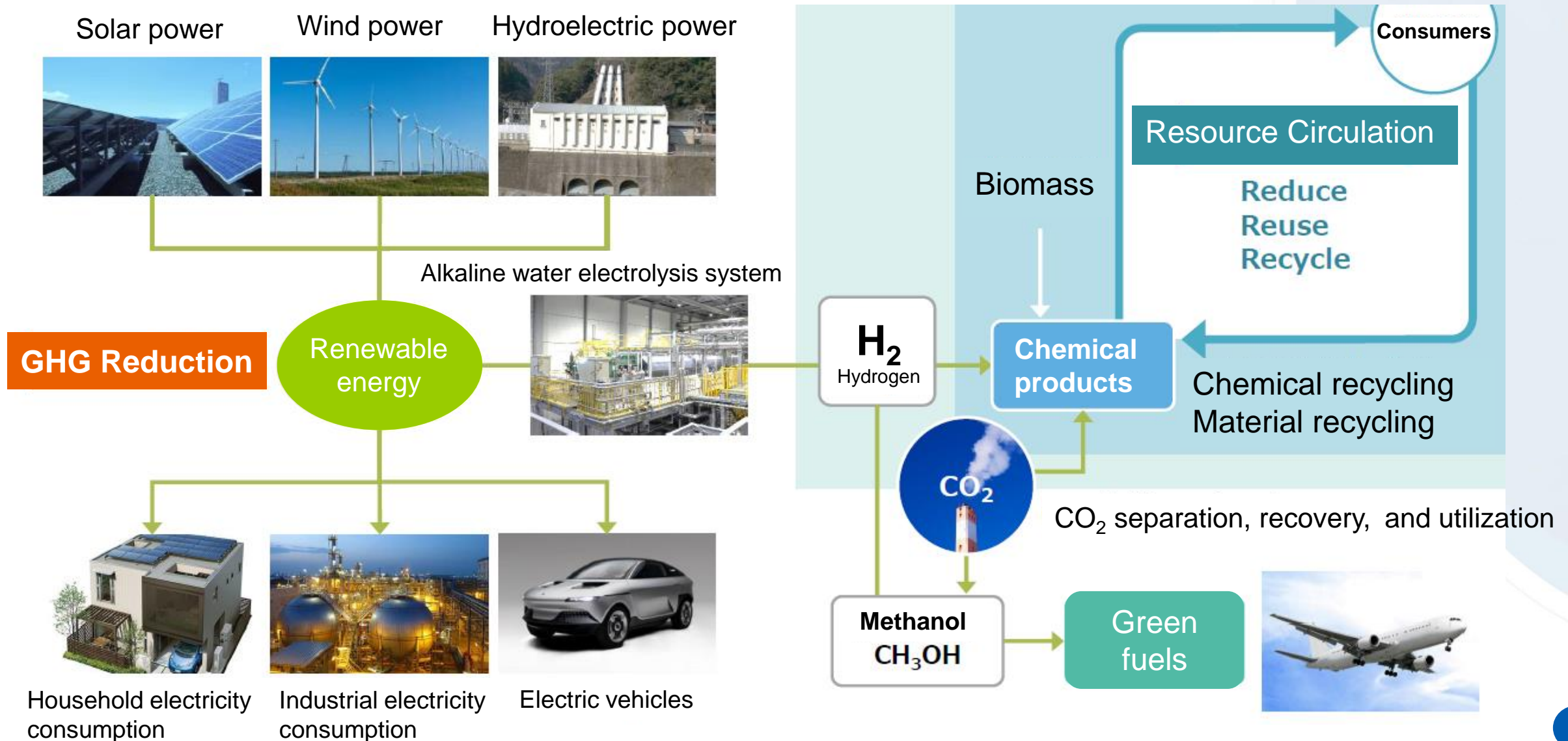




Asahi Kasei's R&D towards carbon neutrality

Asahi Kasei Corporation

Our vision for a carbon-neutral sustainable world



CO₂ chemistry

CO₂ utilization to produce specialty chemicals

- ✓ Asahi Kasei was **the first in the world to establish the polycarbonate production process from CO₂**. (technology licensing)
- ✓ Commercial operation of the first phase plant began in 2002. Currently, 10 plants are in operation.
- ✓ In 2018, Asahi Kasei's process had expanded to 16% of global production capacity. (approximately 800,000 tons)



The first phase plant
(commercial operation started in 2002)

Major applications of PC

- Enclosures for smartphones and home appliances
- Headlamp covers
- Shinkansen and aircraft windows
- DVDs and BDs



5,000,000 tons worldwide in 2018

Shinsuke Fukuoka was awarded the Medal with Purple Ribbon in 2008.

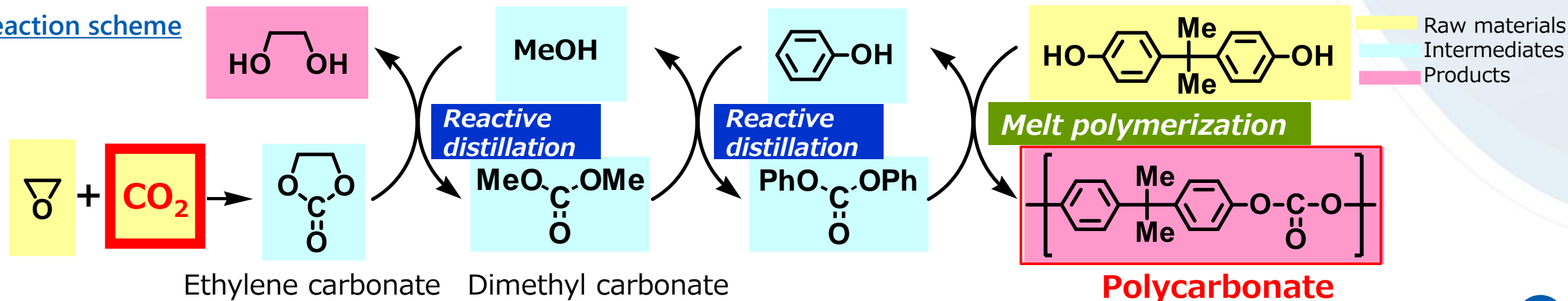


Characteristics and advantages of Asahi Kasei's process to produce polycarbonate from CO₂ as starting material

Key points that enabled practical application

- ✓ Application of Asahi Kasei's **catalytic and process technologies** that enabled high selectivity and lower energy consumption process.
- ✓ This process produces high-purity and high-quality PC from **CO₂ as starting material** instead of **using highly toxic phosgene** that need wastewater treatment.
⇒ Environment-friendly, energy saving and resource saving process.

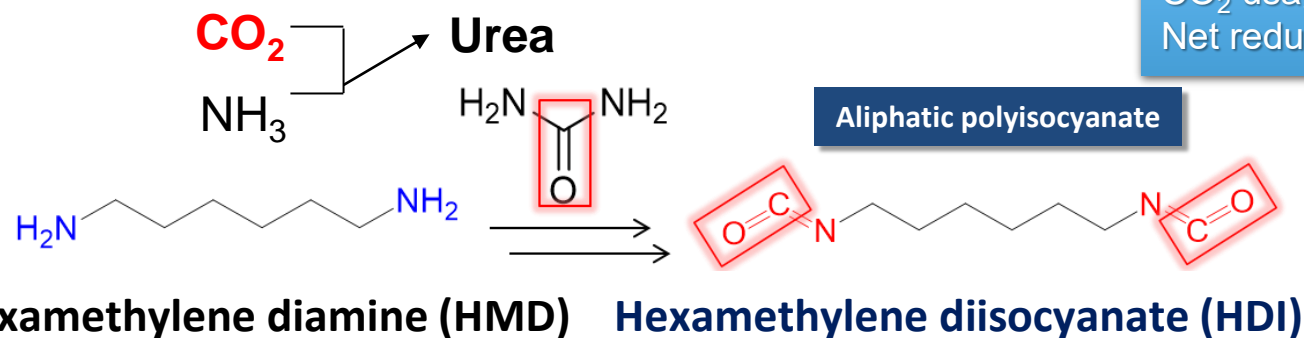
Reaction scheme



Isocyanates production from CO₂ as starting material (under development)

- ✓ Asahi Kasei is developing **the world's first sustainable process to produce raw materials of polyurethanes (isocyanates) using CO₂-derived urea.**
- ✓ This technology is also applied to polyfunctional isocyanates which have advantages such as transparency, low viscosity, superior appearance, and low temperature curing at 80°C. Low temp. curing is expected to help the **reduction of CO₂ in automotive coating.**

Hexamethylene diisocyanate (HDI)



Amount of CO₂ reduction in LCA

CO₂ usage: 0.73 t-CO₂/t-HDI

Net reduction (emissions – usage)

20% reduction compared to conventional phosgene process



Applications of polyurethanes

- Foam, cushion
- Heat insulation
- Elastomer
- Paints, adhesives
- Fibers

Isocyanates

9,520,000 tons in 2018

Aliphatic	HDI	240,000 tons
	IPDI	50,000 tons
	MDI	7,050,000 tons
	TDI	2,180,000 tons

Polyfunctional isocyanates

Polyfunctional isocyanates

R-(NCO)_n
under development

- Transparency
- Ultra-low viscosity
- Non volatility
- Low temp. curing
- Superior appearance

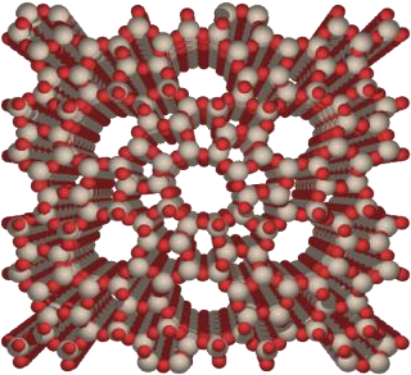
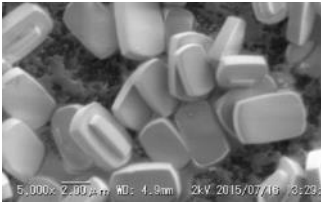
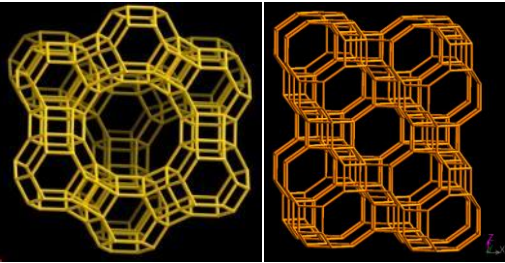
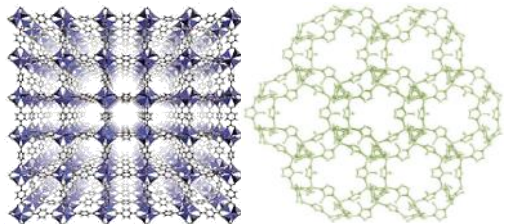
✓ Application in the automotive coating process

- low baking temperature
- reduction of step of coating process


- ✓ lower energy consumption
- ✓ CO₂ reduction

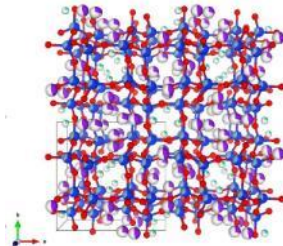
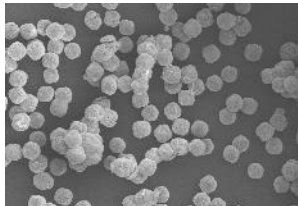
CO₂ separation and recovery

Application of zeolite technology to environment and energy

Zeolite technologies	
Core technology MFI (ZSM-5)  	Deepening of synthetic technology MWF, FAU CHA(SAPO-34, SSZ-13), hybrid, core-shell 
<ul style="list-style-type: none">• Synthesis• Production without templates• Crystalline shape and particle size control• Modification• Cation exchange• Shape forming with spray-drying process	Zeolite-like porous materials Acquisition and application of MOF technologies 



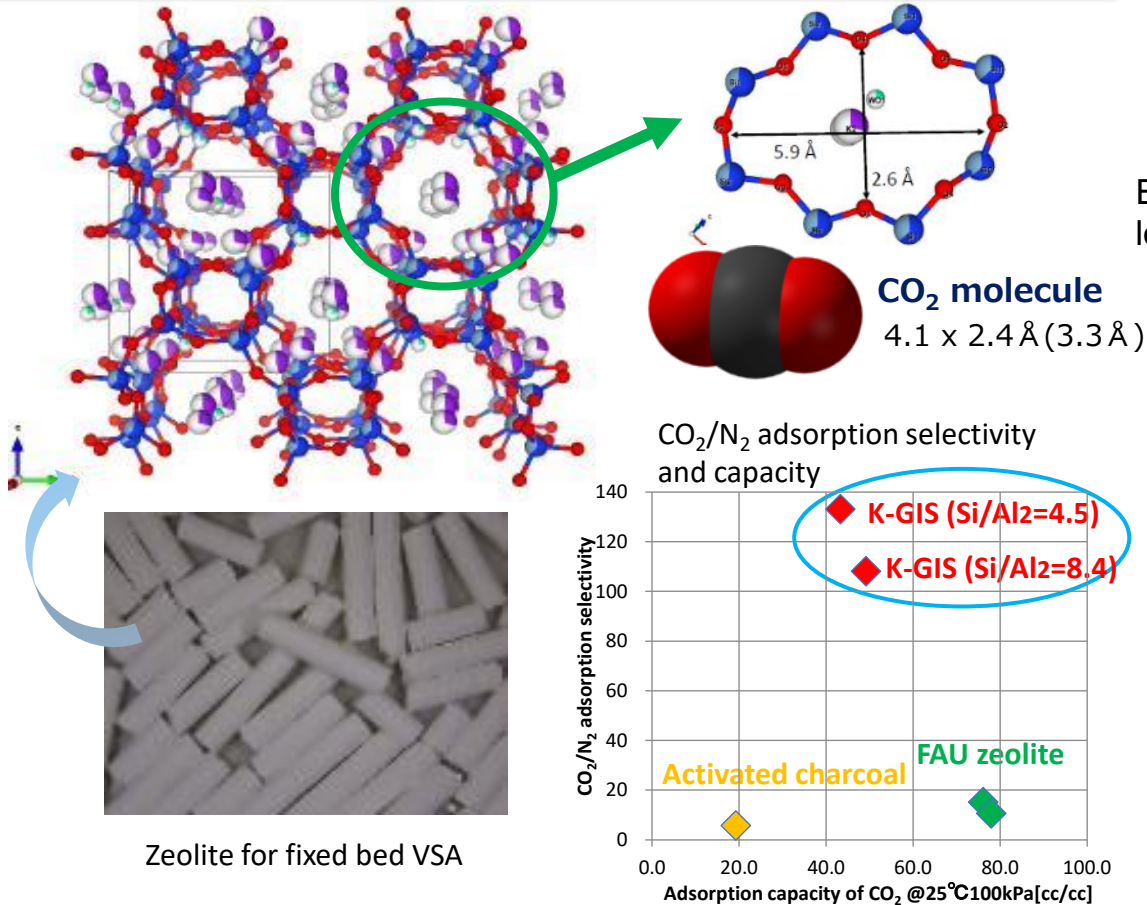
Petrochemicals	
Commercialization CH process (cyclohexanol) Alpha process (BTX) Omega process (propylene)	
Verification New process (BTX, propylene)	

Environment and energy	
<ul style="list-style-type: none">● CO₂ separation and recovery system (under development)	
	
<ul style="list-style-type: none">● Conversion of bioethanol to basic chemicals	

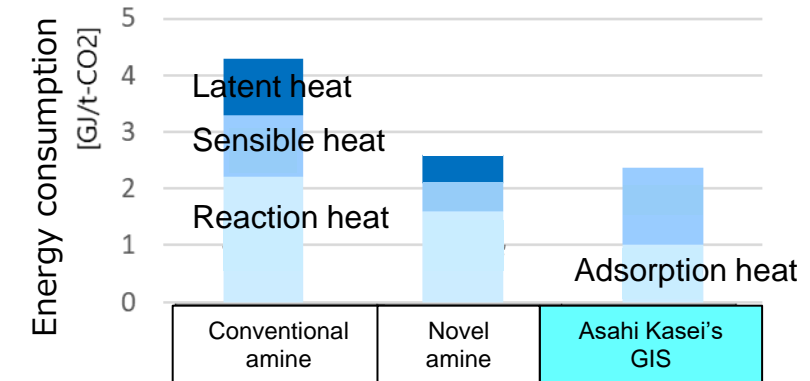
CO₂ separation and recovery system using zeolite

K-GIS type zeolite to adsorb CO₂ from mixed gases such as CO₂/N₂ and CO₂/CH₄ was developed requiring about half the energy consumption of existing amine-based processes for CO₂ adsorption and desorption. CO₂ separation and recovery system is under development to achieve high purity CO₂ purification and CO₂ removal at lower cost.

K-GIS type zeolite



Energy consumptions

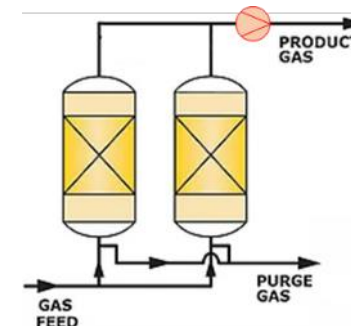


Energy consumption is lower than that of conventional amine-based processes, and lower cost and energy savings can be expected.

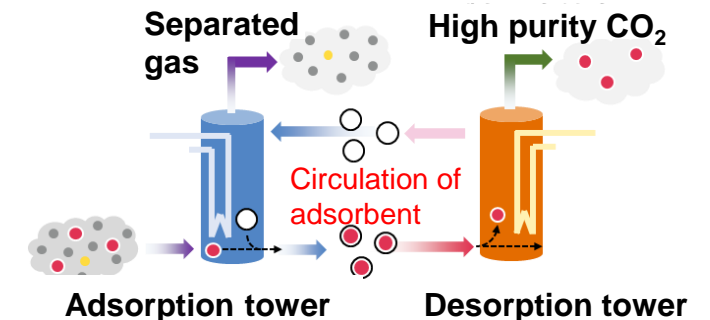
Development of CO₂ separation and recovery system

- Fixed bed VSA (<100,000 t/y): Liquid CO₂, hydrogen production, biomethane purification
- Fluidized bed TSA (≥100,000 t/y): Exhaust gasses from cement/thermal power generation, natural gas purification
- Targets: Commercialization in 2025 and in 2030, respectively.

VSA (vacuum swing adsorption)



TSA (thermal swing adsorption)



Digital platform for plastic resource circulation

Development of a blockchain-based digital platform for traceability of recycled plastics

(Press release in Japan on May 25, 2021)

Significance

- Recycled products have higher value in the world where resource recycling has been achieved.
- Behavior change of the customer is one of the key factors to achieve the resource-recycling society.

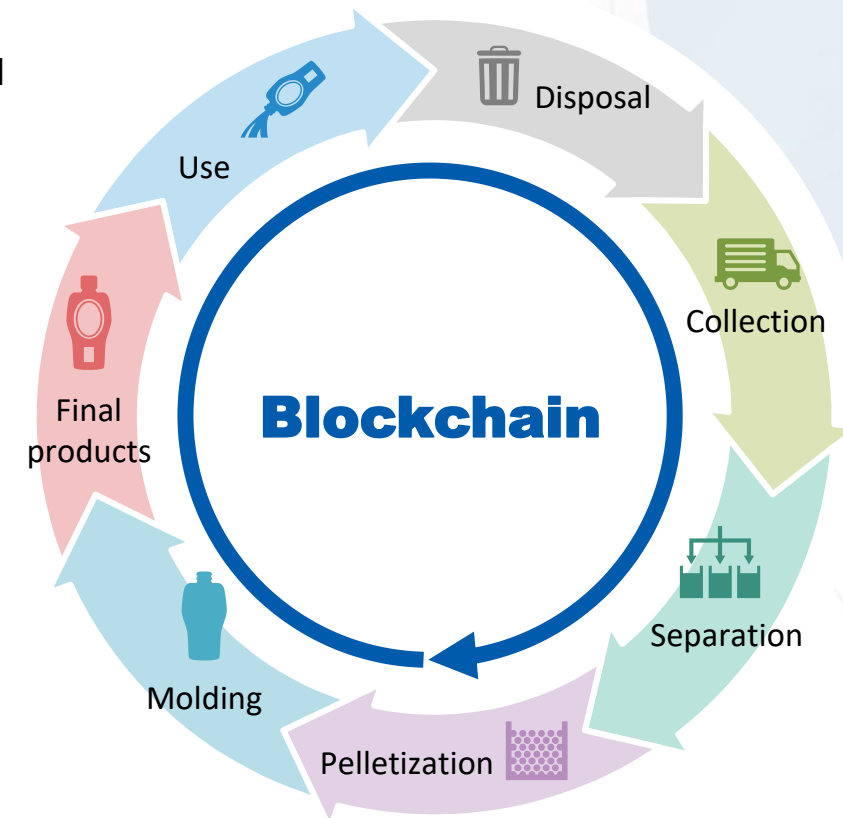
Technology

Blockchain

- Proving that the product is of recycled origin, which is difficult to prove by scientific analysis, through blockchain management.

Feature

**Recycling certification,
recycling chain transparency,
consumer behavior change**





Creating for Tomorrow

THE COMMITMENT OF THE ASAHI KASEI GROUP:

To do all that we can in every era to help the people of the world make the most of life and attain fulfillment in living.

Since our founding, we have always been deeply committed to contributing to the development of society, boldly anticipating the emergence of new needs.

This is what we mean by “Creating for Tomorrow.”

