

# **Business strategy briefing**

## **Efforts to implement TOYO's synthetic fuel, g-Methanol, in society**

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**Toyo Engineering Corporation**

**Kenichi Tominaga**

**Executive Officer Acting General Manager of Engineering & Technology Division**

**General Manager of Next Generation Technology Development Division**



## Today's content

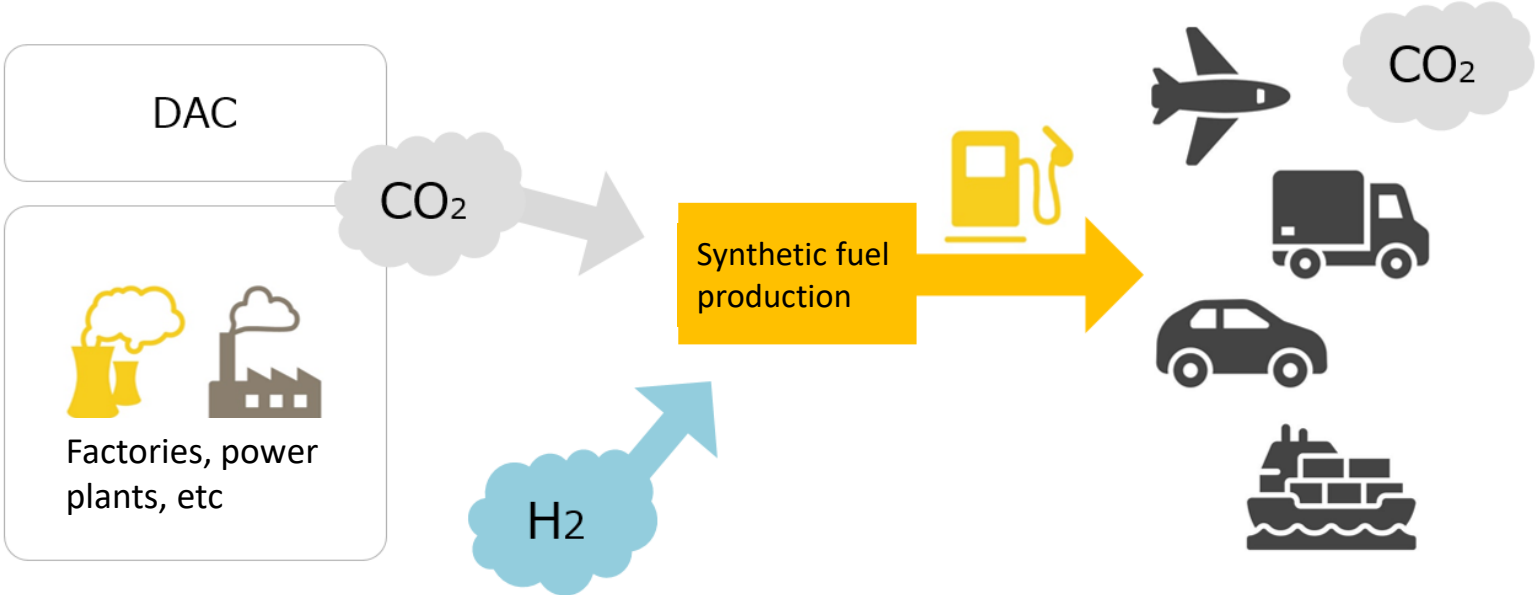
1. Synthetic fuel technology
2. Methanol production
3. Introduction of initiatives
4. Lastly



# 1. Synthetic fuel technology

## What is synthetic fuel?

Synthetic fuels are fuels made by synthesizing CO<sub>2</sub> (carbon dioxide) and H<sub>2</sub> (hydrogen). It is believed that this fuel can be considered decarbonized because it contributes to carbon recycling, which uses CO<sub>2</sub> as a resource.

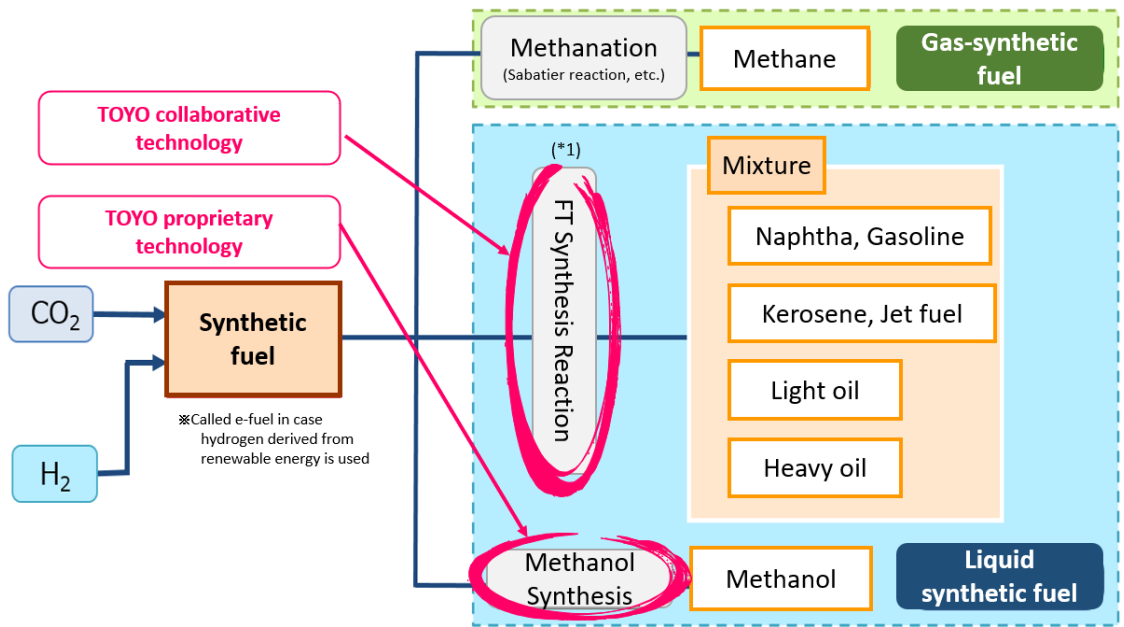


<Source: Agency for Natural Resources and Energy, [https://www.enecho.meti.go.jp/about/specal/johoteikyo/gosei\\_nenryo.html](https://www.enecho.meti.go.jp/about/specal/johoteikyo/gosei_nenryo.html)>

# 1. Synthetic fuel technology

TOYO is committed to FT synthesis and the social implementation of low-carbon footprint methanol technology.

Synthetic fuel is expected to be used for mobility (aircraft, large vessels, and large vehicles) that is difficult to convert to electricity and hydrogen, and to operate resilience and security (energy security and in the event of a disaster) because they can be stockpiled for a long time.



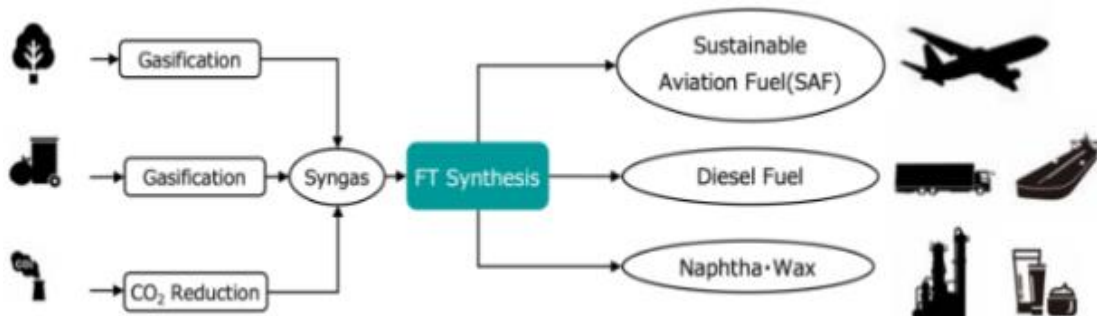
\*1: FT(Fischer-Tropsch) synthesis reaction. In the 1920s, it was developed as a technology to produce liquid fuels from synthetic gas in Germany.

# 1. Synthetic fuel technology

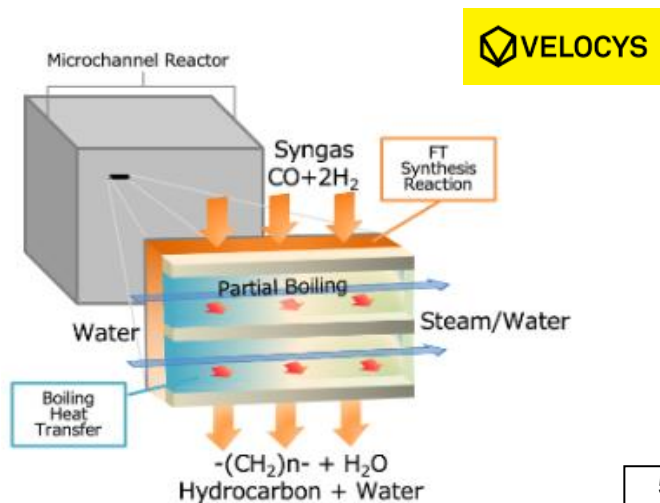
FT Synthesis: Together with VELOCYS, Inc., we are working on the social implementation of FT synthesis technology.

- A solution that combines FT synthesis technology using VELOCYS's microchannel technology and TOYO's core competence of engineering technology.
- FT Synthesis is a core technology for the production of synthetic fuels, including sustainable aviation fuels (SAF), from wood chips, municipal waste, and carbon dioxide emitted from industrial facilities.

<Production process for renewable fuels through FT synthesis>



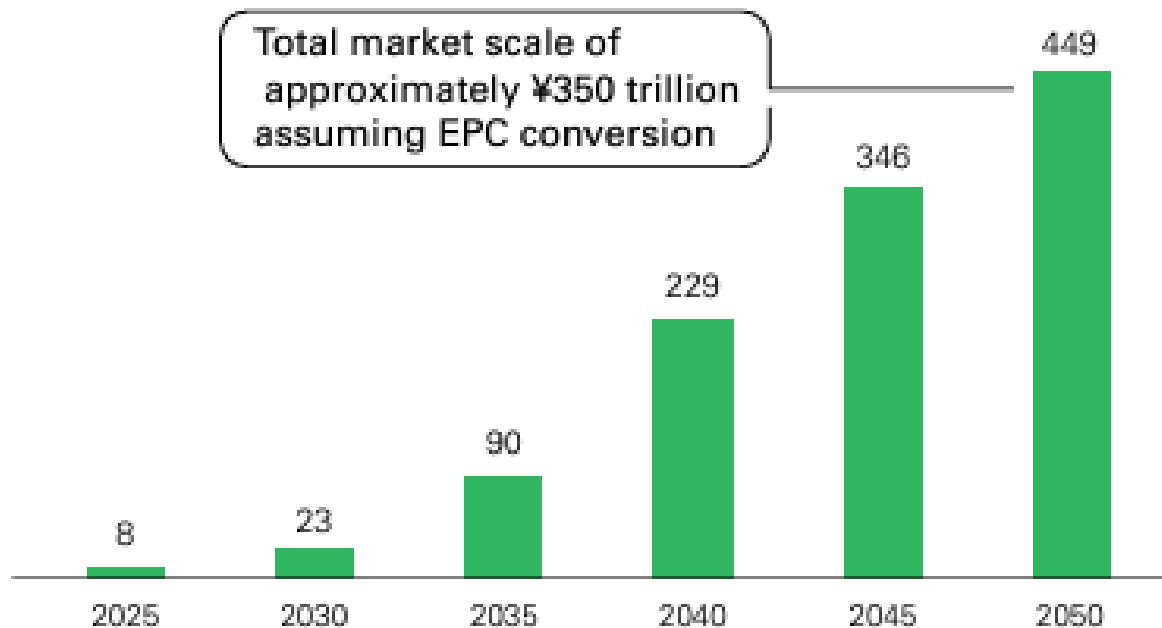
<Microchannel FT Synthesis Technology>



# 1. Synthetic fuel technology

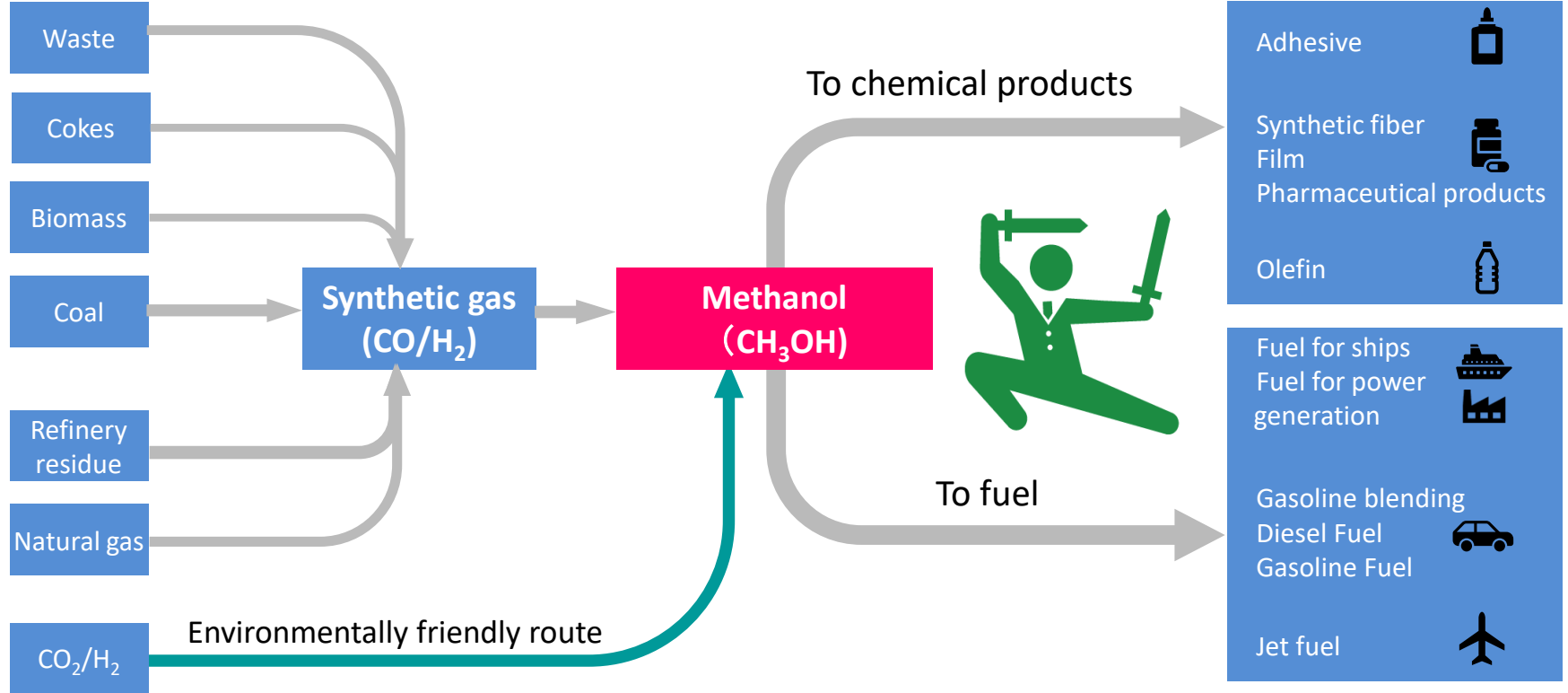
SAF demand is expected to increase sharply toward 2050.

Predicted demand for SAF up through 2025 to achieve net-zero emissions (Unit: billions of liters)



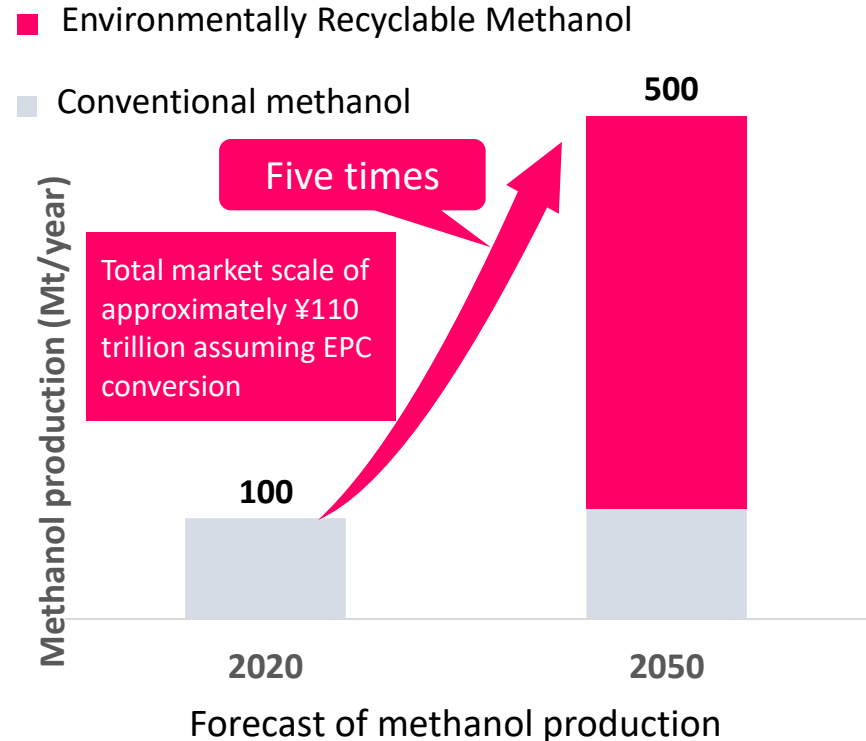
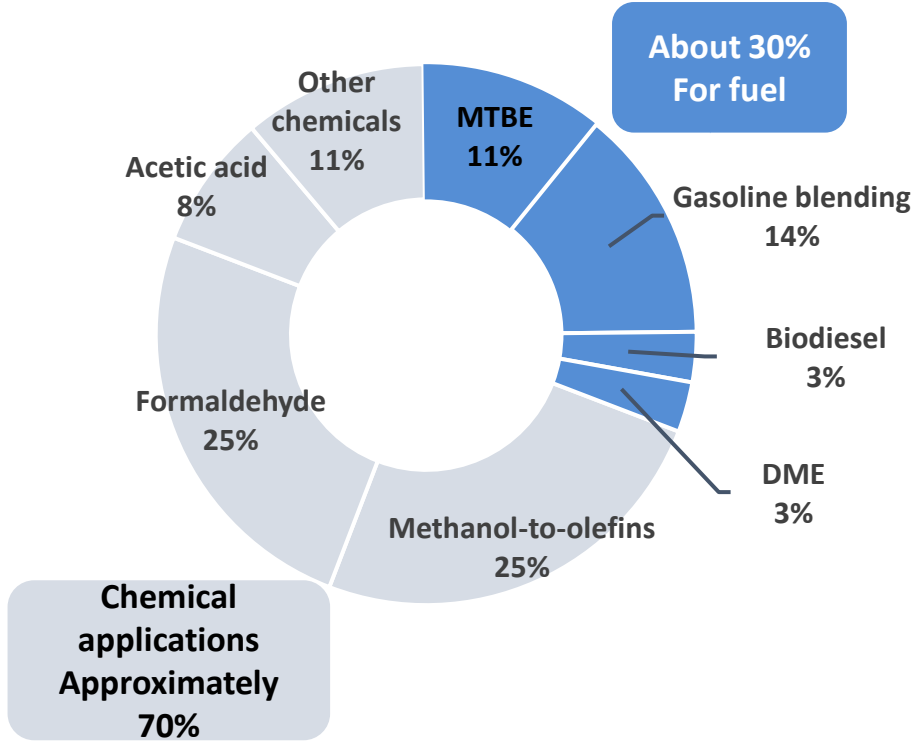
# 2. Methanol production

Methanol is an important option for a circular economy with its dual uses of synthetic fuel and chemical products.



# 2. Methanol production

Demand: Expected to grow five times by 2050 due to increased demand for clean fuels.



Source: by Toyo from IRENA Renewable Methanol Report Fig. 5

Source: Compiled by Toyo from IRENA Renewable Methanol Report Fig. 47

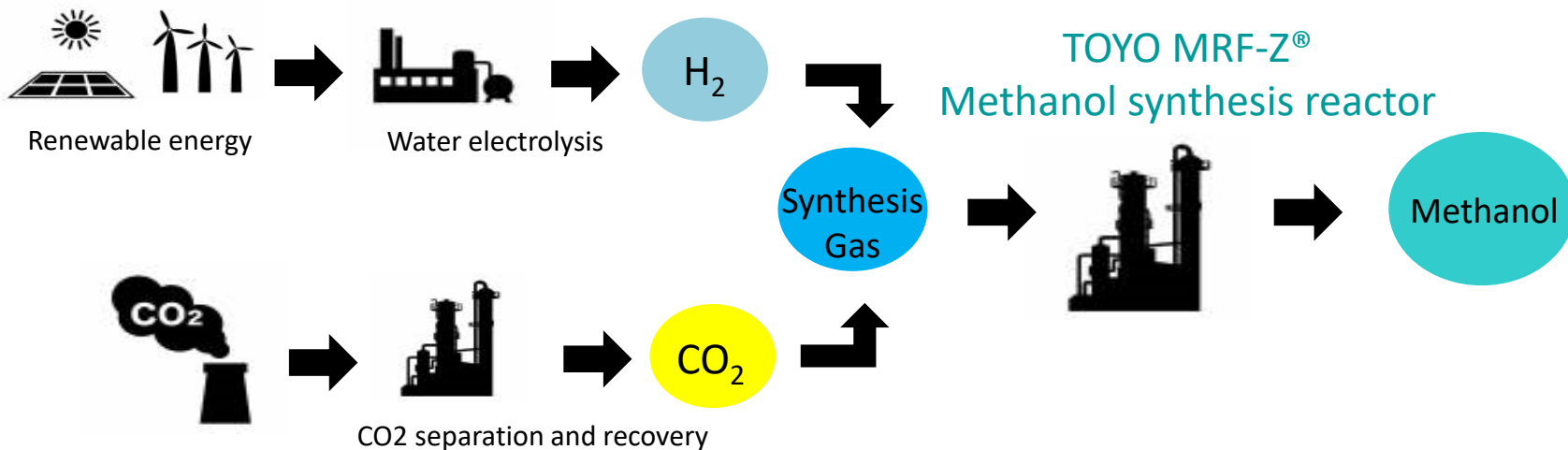


## 2. Methanol production

New Production Route: **g-Methanol®** is a process for producing clean, low-carbon footprint methanol.

### Strengths & Characteristics

- Adoption of MRF-Z reactor with unique structure using TOYO's proprietary technology.
- Variable absorption optimum design method for variable amount of renewable energy.
- Advanced plant control technology system adapted to varying amounts of renewable energy



# 2. Methanol production

## History of conventional methanol production

The MRF-Z<sup>®</sup> reactor, TOYO's methanol synthesis reaction technology, has been adapted to the large-scale development of conventional \*1 methanol plants.



Pilot plant,  
Japan  
(1985)

50 t/d



Trinidad and  
Tobacco  
(1990)

300 t/d



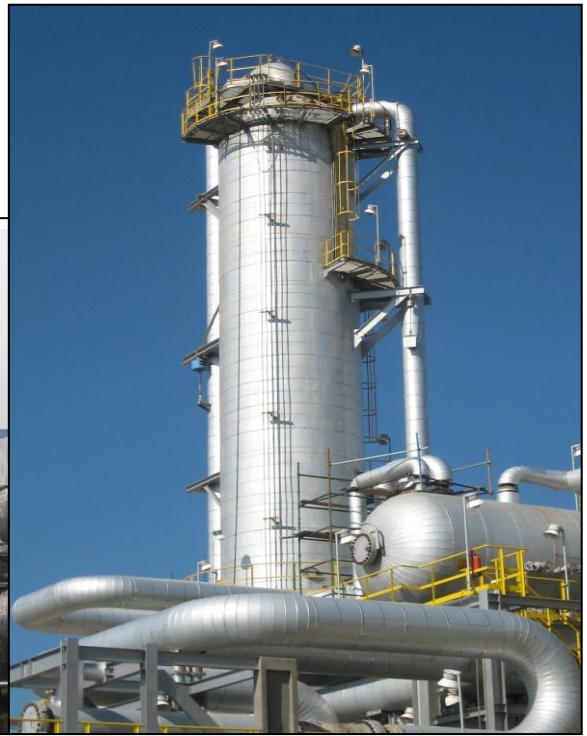
Sinopec  
Sichuan, China  
(1998)

420 t/d



Luthianhua Group  
Chengdu, China  
(2006)

1,350 t/d



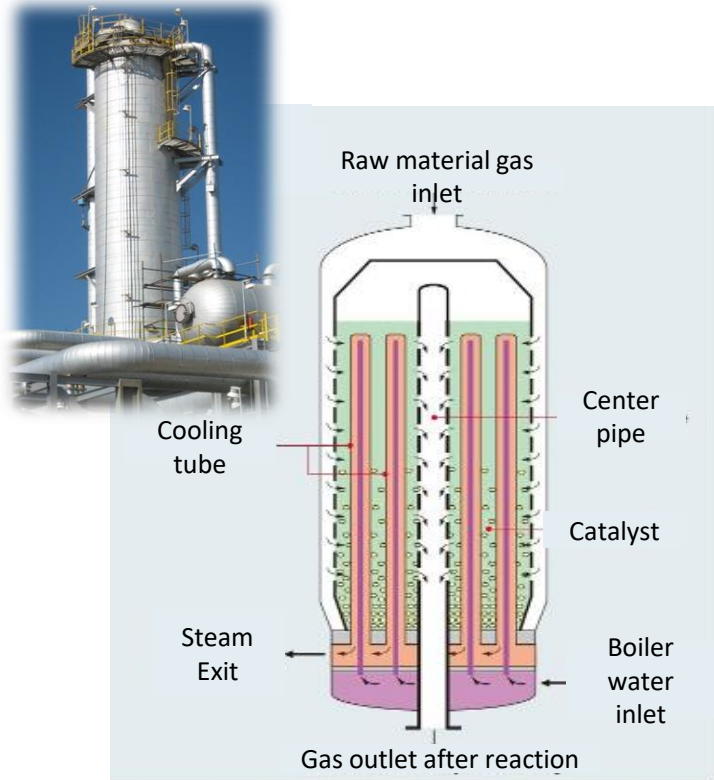
Oman methanol  
(2007)

3,000 t/d

\*1: Current methanol production method using fossil resources such as natural gas as raw materials

## 2. Methanol production

MRF-Z<sup>®</sup> methanol reactor, Toyo's proprietary technology will lead a social implementation of clean methanol.



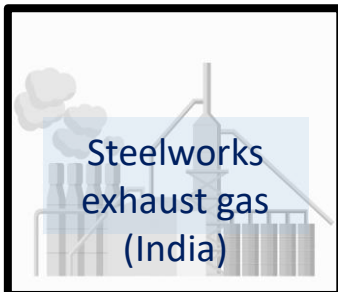
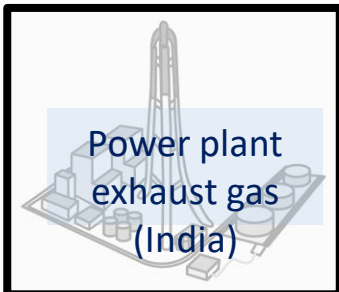
### Strengths and Characteristics

With its proprietary structure for catalytic filling on the shell side,

1. Continuous reaction heat removal provides maximum catalyst performance and compact design.
2. Shortening the fixed repair period through easy catalyst replacement.
3. Reducing pressure loss enables low operating power.
4. Strong structures are realized by the design of cooling tubes that are not affected by thermal stretching.

## 2. Methanol production

We are working on social implementation of low-carbon footprint methanol production from various sources of CO<sub>2</sub> emissions.

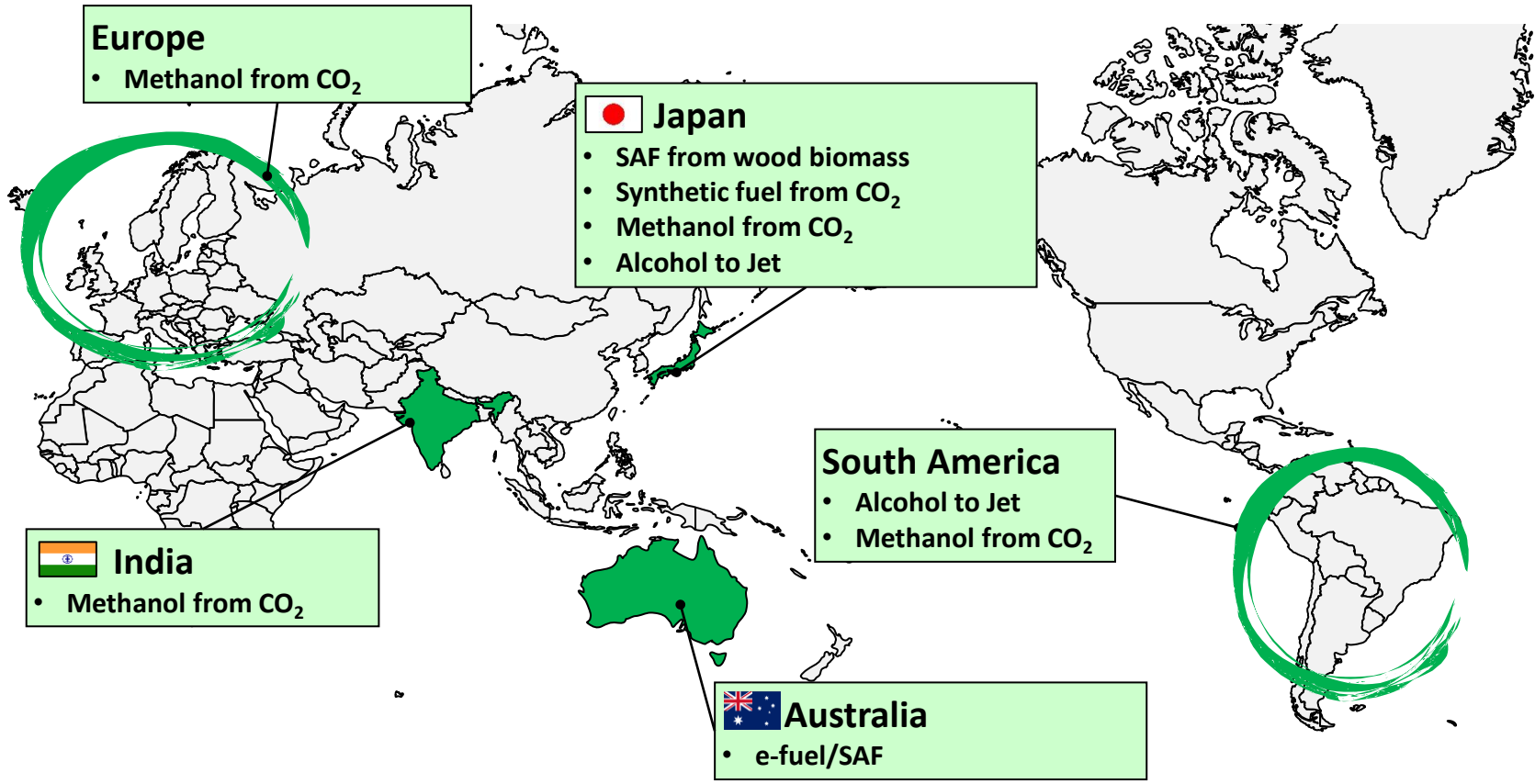


**g-Methanol<sup>®</sup>** Low-Carbon Footprint Methanol



### 3. Introduction of initiatives

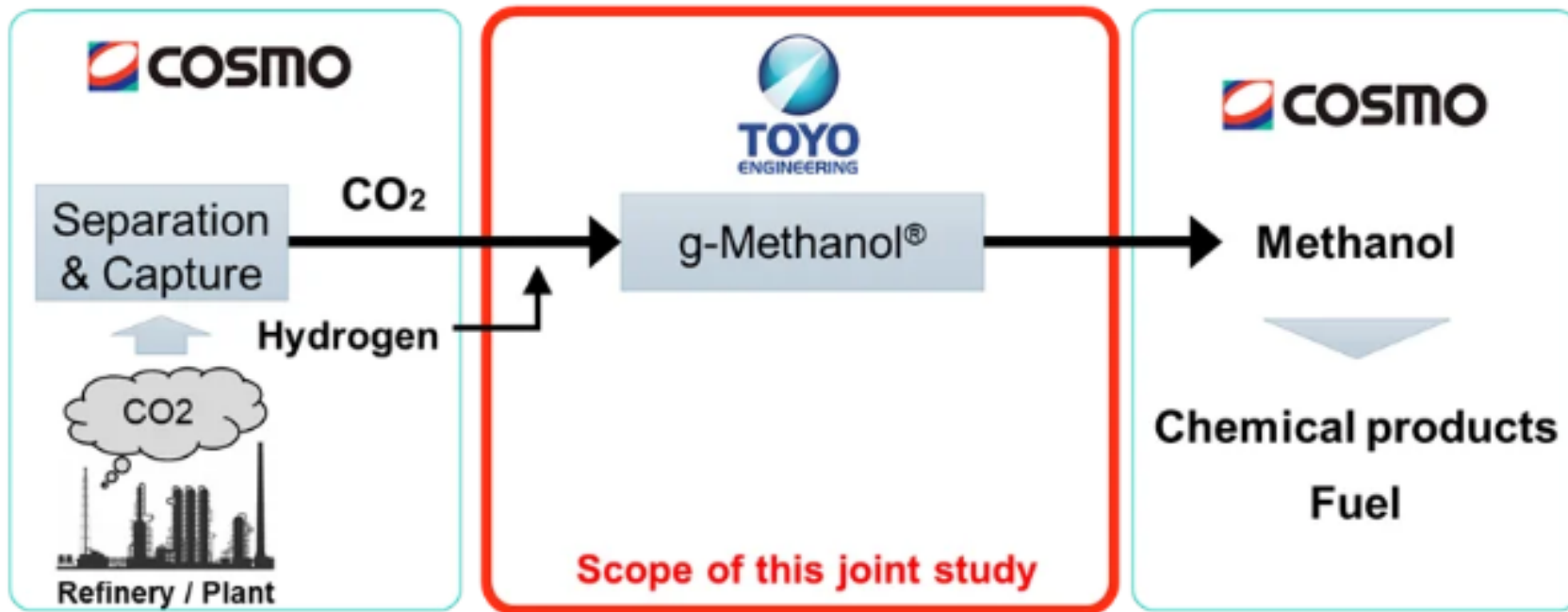
We are working on SAF, synthetic fuels, and g-Methanol® projects around the world.



### 3. Introduction of initiatives

We began a joint study on the production of methanol from CO<sub>2</sub> generated at refineries and other facilities.

#### Joint study conceptual diagram



### 3. Introduction of initiatives

## Methanol Demonstration Plant in India and Synthetic Fuel value chain study started in Australia.

### Examples of initiatives that take advantage of TOYO's strengths (g-Methanol® and FT synthesis)

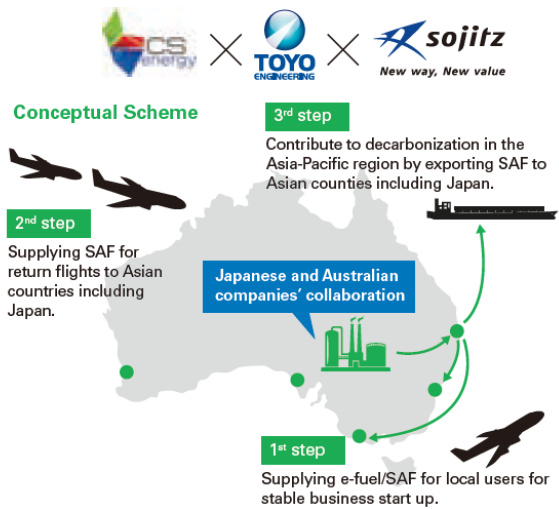
Regarding g-Methanol®, we receive inquiries from all over the world, and, in 2021, we received an order from the Indian state-owned company NTPC to license out our technology for a demo plant, and we delivered a reactor in February of 2023. In addition, in March of 2023, we concluded an MOU with CS Energy—a power company owned by the government of Queensland, Australia—and Sojitz Corporation, and we started considering building a value chain of e-fuel/SAF that uses renewable-energy hydrogen there.

#### Constructing a g-Methanol® demo plant

- Customer: National Thermal Power Corporation, India (NTPC)
- Construction site: Vindhyachal, Madhya Pradesh
- Production capacity: 10 tons per day



#### Building an e-fuel/SAF value chain in Queensland, Australia

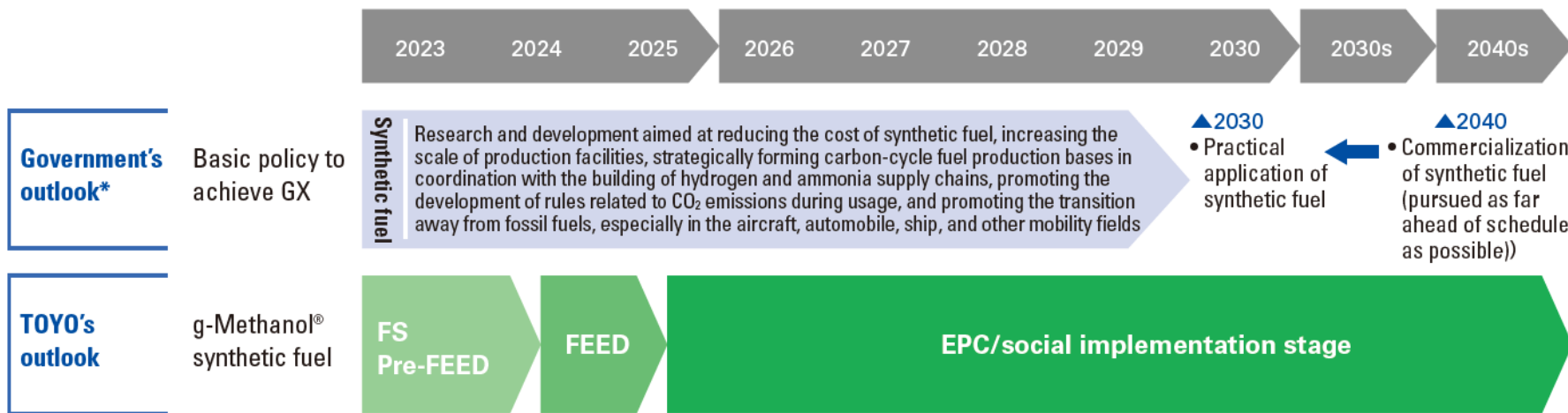


# 3. Introduction of initiatives

## Roadmap for development of synthetic fuel and g-Methanol®

### Roadmap to achieve social implementation

Synthetic fuel assumes both a reduction in the cost of hydrogen derived from renewable energy and the full-scale spread of such hydrogen. Methanol has already been practically applied as a ship fuel, and—given that there is a possibility of the market shifting to aviation-fuel raw material in the future—relatively early social implementation is expected. Although most of the current work is at the study stage, it is assumed that projects will be advanced towards social implementation based on a schedule that involves handling basic engineering and receiving EPC orders from 2024 to 2025.



\* Source: The Basic Policy for the Realization of GX: Reference document (February of 2023 Cabinet decision)



# 4. Lastly



## 1. Cooperation with the business owner side

In addition to the conventional energy and chemicals sector, we will work together with the manufacturing sector (steel and cement) business owners to study implementation and accelerate development through national policy projects.



## 2. Technical cooperation

Expand the range of value chain proposals in cooperation with companies that possess technologies to convert methanol to olefin (plastic feedstock), gasoline, and jet fuel.



## 3. Establishment of total optimization method

We will establish an optimized design method that takes into account renewable energy, electricity storage, and raw materials and product storage facilities. We will make swift and effective proposals to business owners for feasibility studies and a wide range of case studies.



# Toyo Engineering Corporation

URL <https://www.toyo-eng.com>

For further questions on this material, please contact:

Yoshifumi SHIRAISHI

General Manager

Corporate Communications Department

2-8-1 Akanehama, Narashino, Chiba, Japan 275-0024

TEL +81-47-454-1681

E-mail [ir@toyo-eng.com](mailto:ir@toyo-eng.com)

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