TOYO ENGINEERING

GLOBAL NETWORK

Toyo Engineering Corporation

● **Head Office / Engineering Center**
Makuhari Technical Center,
1-1 Nakase, Mihama-ku, Chiba-shi,
Chiba 261-8601, Japan
Tel: 81-43-274-1000

● **Tokyo Office**
HIBIYA FORT TOWER, 16th Floor
1-1, Nishi Shimbashi 1-chome
Minato-ku, Tokyo 105-0003, Japan
Tel: 81-3-3508-0111

OFFICES

● **Jakarta**
Wisma IKPT, 2nd Fl., JL. MT. Haryono Kav.
4-5, Jakarta 12830, Indonesia
Tel: 62-21-835-4170
Fax: 62-21-835-4149

● **Moscow**
Room No.207, Entrance7,
World Trade Center, Krasnopresnenskaya
Nab.,12, Moscow 123610, Russia
Tel: 7-495-258-2064/1504

GROUP COMPANIES

● **TEC Project Services Corporation**
Makuhari Technical Center, 1-1 Nakase,
Mihama-ku, Chiba-shi, Chiba 261-8602, Japan
Tel: 81-43-272-5508

● **Toyo Engineering Korea Limited**
【Seoul】
Toyo B/D.11,Teheran-ro 37-gil, (Yeoksam-dong),
Gangnam-gu,Seoul,06142,Korea
Tel: 82-2-2189-1620
Fax: 82-2-2189-1890

● **Toyo Engineering Corporation (China)**
【Shanghai】
7F, New Bund Oriental Plaza I, No. 512 Haiyang
West Road, Pudong New District,Shanghai
200124, China
Tel: 86-21-6187-1270
Fax: 86-21-5888-8864/8874

● **Offshore Frontier Solutions Pte. Ltd.**
【Singapore】
9 North Buona Vista Drive, #21-01 The Metropolis
Tower 1, Singapore 138588
Tel: 65-6496-4000
Fax: 65-6496-4191

● **PT. Inti Karya Persada Tehnik（IKPT）**
【Jakarta】
JL. MT. Haryono Kav. 4-5, Jakarta 12830, Indonesia
Tel: 62-21-829-2177
Fax: 62-21-828-1444/62-21-835-3091

● **Toyo Engineering & Construction Sdn. Bhd.**
【Kuala Lumpur】
Suite 25.4, 25th Fl., Menara Haw Par,
Jalan Sultan Ismail, 50250 Kuala Lumpur, Malaysia
Tel: 60-3-2731-1100
Fax: 60-3-2731-1110

● **Toyo Engineering India Private Limited**
【Mumbai】
"Toyo Technology Center", 71, Kanjur Village Road,
Kanjurmarg (East), Mumbai-400 042, India
Tel: 91-22-2573-5000
Fax: 91-22-2573-5842

● **Toyo Engineering Europe, S.r.l**
【Milan】
10 Via Alzata, i-24030 Villa d'Adda, Bergamo, Italy
Tel: 39-035-4390520

● **Toyo U.S.A., Inc.**
【Houston】
15415 Katy Freeway, Suite 101, Houston,
Texas 77094
Tel: 1-281-579-8900
Fax: 1-281-599-9337

● **TS Participações e Investimentos S.A.**
【Sao Paulo】
Edifício Birmann 12, Rua Alexandre Dumas, n°
1.711, 1° andar, 04717-911,
Chácara Santo Antônio, São Paulo-SP, Brazil
Tel: 55-11-5525-4834
Fax: 55-11-5525-4841

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TOYO COMMUNICATIONS

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Geothermal energy is a hot topic now

Special feature

Geothermal Carbon Neutral Park

Proprietary technology g-Methanol™

Geothermal energy is a hot topic now.

Interview with a geothermal energy expert

As there is global demand for a shift to renewable energy to help achieve decarbonization, geothermal power is drawing attention.
Did you know that TOYO will participate in a geothermal energy development project in Indonesia, which is ranked second in the world in terms of the amount of geothermal resources? TOYO's participation will contribute to the decarbonization of Indonesia and to TOYO's commitment to transforming the development of geothermal energy.

Mr. Yoichi. Komatsu.

Next Generation Energy Project Development Department, Toyo Engineering Corporation

What is geothermal energy?

The temperature of the Earth's core is believed to be as high as 5,000 to 6,000℃. The Earth is continually heated from within.
The earth's internal heat is called geothermal.
Most notably, the geothermal energy stored in the layer close to the surface of the Earth, up to a depth of approx. 3km, is used as a resource for geothermal power generation activities and other purposes.

Where are geothermal resources located?

They are often found in volcanic regions.
Geothermal areas with especially high temperatures develop around volcanos. The source of the heat is the volcan magma chamber.
The United States leads the world in geothermal resources, followed by Indonesia and then Japan.

Why is geothermal power attracting attention as a source of renewable energy?

To generate electricity using geothermal power, geothermal fluid heated by magma is used to drive a turbine that generates electricity.
This is an environmentally friendly renewable method of generating electricity because fossil fuels are not used and dramatically less CO_2 is emitted than thermal power generation.
The stable generation of electricity is not affected by weather or other natural conditions, and geothermal fluid used in the generation of electricity can be reused to heat rooms and for other purposes. These advantages contribute to the growing interest in geothermal energy.

Geothermal power, which can generate electricity stably and be used for secondary purposes, is expected to become more widespread in the future!

Yes! The geothermal power market is growing rapidly, and we may safely say that its future growth potential is high.
In particular, Indonesian goal is to increase the installed capacity of its geothermal power plants to approx. 2.5 times the 2020 level by 2030,*1 and it is expected that they will develop new geothermal power plants in the future.
Japan has also set the target of increasing its capacity to 2.3 to 2.6 times the 2020 level by 2030.*2
Therefore, it can be said that expectations for geothermal energy as a renewable resource are increasing.

*1 NRE Development in Indonesia, June 16th, 2022
*2 Initiatives of the Ministry of Economy, Trade and Industry of Japan for expanding adoption of geothermal power generation by the Agency for Natural Resources and Energy

Has TOYO previously been involved in geothermal power development in Indonesia?

IKPT, our subsidiary in Indonesia, has track records in this area. It has worked on seven geothermal power plant construction projects.
In FY2024, it additionally received orders for three geothermal power plant construction projects.

IKPT is very active! How is TOYO involved in the development of geothermal power in Indonesia?

We have teamed up with the government of Indonesia and Indonesian geothermal power operators to realize the Geothermal Carbon Neutral Park plan, which is a combination of a geothermal power plant and various new technologies.

Recent initiatives

Sept. 2023: Memorandum of Understanding regarding joint study on the full scale geothermal utilization signed by PT Geo Dipa Energi and Toyo Engineering Corporation Letter of intent regarding joint research
Feb. 2024: Memorandum of Understanding regarding joint study on opportunities to developing full potential of geothermal energy signed by PT Medco Power Indonesia and Toyo Engineering Corporation Memorandum of Understanding toward
Aug. 2024: Letter of Intent regarding joint study to develop geothermal master plan for Indonesia signed

TOYO have built a cooperative relationship with Indonesia!

That's right.
At IIGCE, a conference in Indonesia that we participated in last year, we ran a booth jointly with IKPT under the theme, " Comprehensive Development and Optimization of Geothermal Fields." The participation of (then) Indonesian President Joko Widodo (Jokowi) contributed to the excitement of the event.
It was a good opportunity to showcase to visitors the combination of TOYO's technologies for the realization of the Geothermal Carbon Neutral Park, which will make full use of geothermal resources, and IKPT's extensive track record in the area of geothermal power plants, which is one of its strengths.

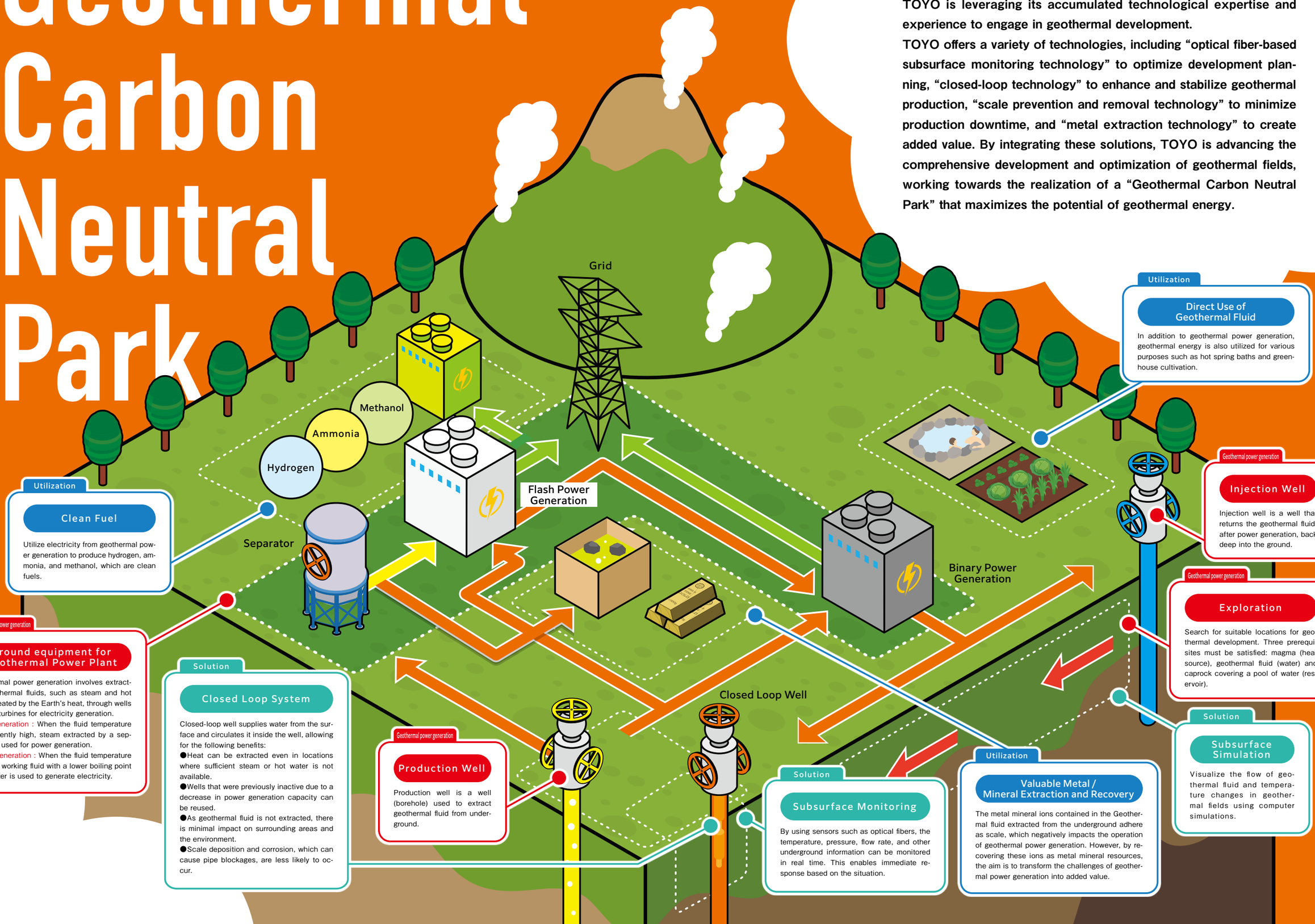
The Geothermal Carbon Neutral Park sounds exciting! Could you talk about it in more detail?

It is a plan for promoting the comprehensive optimization of geothermal fields by integrating innovative subsurface and surface technologies.
As a global engineering and project solutions partner, we are good at handling comprehensive development that combines different pieces of equipment and facility.
Let's take a look at the Geothermal Carbon Neutral Park Guide!

Geothermal Carbon Neutral Park

Geothermal energy is a hot topic now.

TOYO is leveraging its accumulated technological expertise and experience to engage in geothermal development.
TOYO offers a variety of technologies, including “optical fiber-based subsurface monitoring technology” to optimize development planning, “closed-loop technology” to enhance and stabilize geothermal production, “scale prevention and removal technology” to minimize production downtime, and “metal extraction technology” to create added value. By integrating these solutions, TOYO is advancing the comprehensive development and optimization of geothermal fields, working towards the realization of a “Geothermal Carbon Neutral Park” that maximizes the potential of geothermal energy.



Utilization

Direct Use of Geothermal Fluid

In addition to geothermal power generation, geothermal energy is also utilized for various purposes such as hot spring baths and greenhouse cultivation.

Geothermal power generation

Injection Well

Injection well is a well that returns the geothermal fluid, after power generation, back deep into the ground.

Geothermal power generation

Exploration

Search for suitable locations for geothermal development. Three prerequisites must be satisfied: magma (heat source), geothermal fluid (water) and caprock covering a pool of water (reservoir).

Solution

Subsurface Simulation

Visualize the flow of geothermal fluid and temperature changes in geothermal fields using computer simulations.

Utilization

Valuable Metal / Mineral Extraction and Recovery

The metal mineral ions contained in the Geothermal fluid extracted from the underground adhere as scale, which negatively impacts the operation of geothermal power generation. However, by recovering these ions as metal mineral resources, the aim is to transform the challenges of geothermal power generation into added value.

Solution

Subsurface Monitoring

By using sensors such as optical fibers, the temperature, pressure, flow rate, and other underground information can be monitored in real time. This enables immediate response based on the situation.

Geothermal power generation

Production Well

Production well is a well (borehole) used to extract geothermal fluid from underground.

Solution

Closed Loop System

Closed-loop well supplies water from the surface and circulates it inside the well, allowing for the following benefits:
●Heat can be extracted even in locations where sufficient steam or hot water is not available.
●Wells that were previously inactive due to a decrease in power generation capacity can be reused.
●As geothermal fluid is not extracted, there is minimal impact on surrounding areas and the environment.
●Scale deposition and corrosion, which can cause pipe blockages, are less likely to occur.

Geothermal power generation

Ground equipment for Geothermal Power Plant

Geothermal power generation involves extracting geothermal fluids, such as steam and hot water, heated by the Earth's heat, through wells to drive turbines for electricity generation.
Flash generation : When the fluid temperature is sufficiently high, steam extracted by a separator is used for power generation.
Binary generation : When the fluid temperature is low, a working fluid with a lower boiling point than water is used to generate electricity.

Utilization

Clean Fuel

Utilize electricity from geothermal power generation to produce hydrogen, ammonia, and methanol, which are clean fuels.

The Potential of g-Methanol™

**Methanol is useful for various purposes in our lives.
It is used as a raw material for chemical products, such as plastics, synthetic fibers and adhesives, and as a fuel for ships and automobiles.
In the future, it will be a raw material for sustainable aviation fuel (SAF).
TOYO has developed a method called g-Methanol™ to produce an eco-friendly methanol and is working hard to build a sustainable society.**

Q Why is the g-Methanol™ technology attracting attention?

Previously, fuels were made from natural gas or coals in many cases. Recently, however, a method of synthesizing a fuel from hydrogen and CO_2 using renewable energy to protect the environment and sustainably supply of energy has been attracting attention.

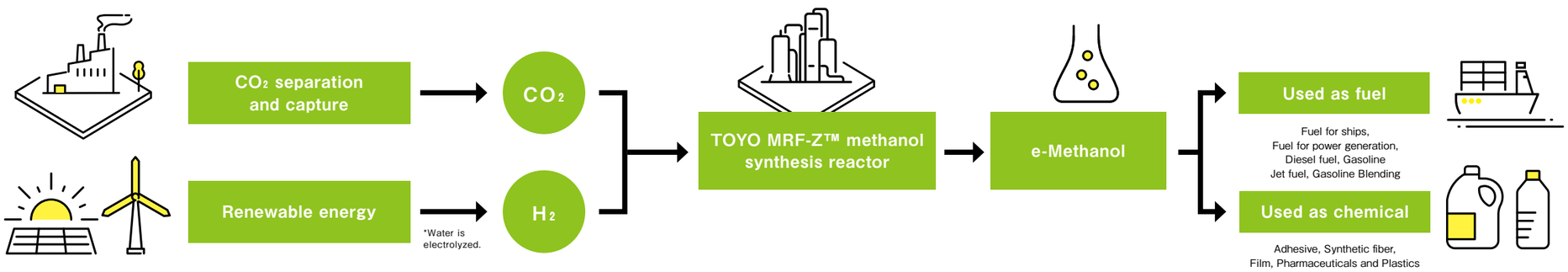
A

Q What is great about TOYO's technology?

TOYO has developed the proprietary MRF-Z™ Reactor for synthesizing hydrogen and CO_2.
This reactor reduces costs by decreasing the amount of catalyst used to accelerate synthesizing hydrogen and CO_2.
MRF-Z™ Reactor also makes it possible to improve energy efficiency and simplify maintenance work. They conserve energy by recovering thermal energy.

A

The g-Methanol™ for synthesizing methanol in an eco-friendly way is a proprietary technology of TOYO.



A clean fuel produced using CO_2

INFORMATION

Participation in a trade show

We ran a booth at CCUS WORLD, a CO_2 separation, recovery, use, and storage technology trade show held at Makuhari Messe in October, 2024. We introduced g-Methanol™ and MRF-Z™ at our booth.
We used a model of MRF-Z™ and AR technology in our exhibits and showed a computer animated video that explained our technologies.

Project in India

TOYO will study the feasibility of a project for building a value chain that includes the processes for producing eco-friendly, resource-circulating methanol, importing it into Japan, and supplying it to customers. It will be produced using green hydrogen*1 and biogenic CO_2*2 that the National Thermal Power Corporation (NTPC), the state-run electric power company of India, plans to produce in South India and the g-Methanol™ method of synthesizing methanol developed by TOYO.
This project has been subsidized as part of the Global South Future-Oriented Co-Creation Project in the FY2023 supplementary budget by the Ministry of Economy, Trade, and Industry.
The period of the study will be around one year, and ENEOS Corporation is one of the companies that will potentially purchase the eco-friendly, resource-circulating methanol to be produced in the project. We aim to establish a value chain that encompasses the process up to the supply of methanol to customers as a marine fuel and its sales as a raw material for chemical products.

*1 Hydrogen made using renewable energy, etc. with no CO_2 emissions in the production process.
*2 Biomass-derived carbon dioxide

Other relevant technologies

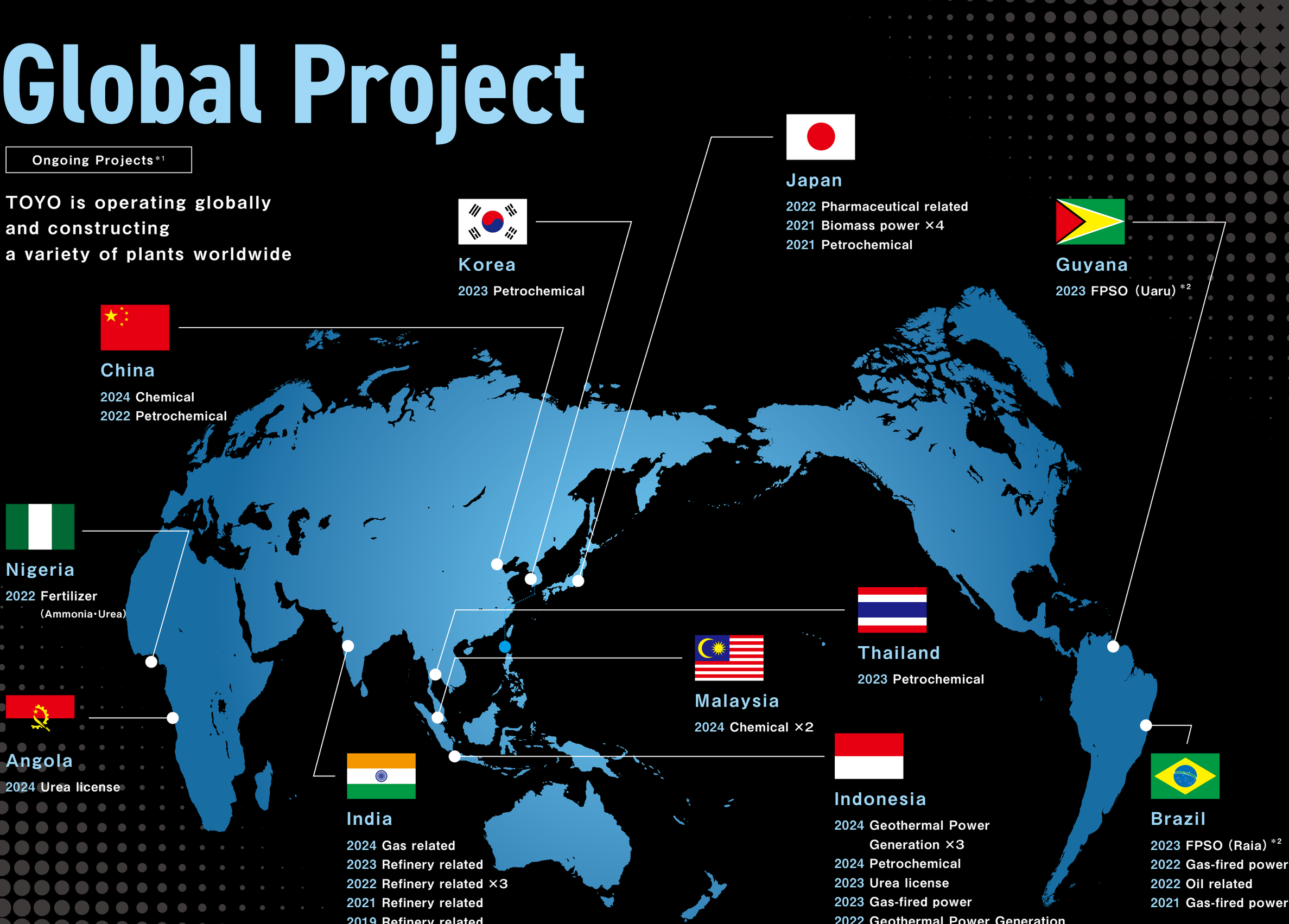
TOYO has also developed a tool for the efficient and effective design of plants using renewable energy and is developing a tool for the efficient and effective operation of these plants.
MethaMaster™ is a tool for efficiently planning plant equipment that enables users to quickly implement studies and analyses to evaluate the feasibility of a project or plan (feasibility study).
We are also developing MethaDynamics™ plant operation support tool that enables users to stably operate plants even using renewable energy, whose availability tends to fluctuate due to natural conditions and other factors.

For more details!
TOYO's efforts toward decarbonization

Global Project

Ongoing Projects*1

TOYO is operating globally and constructing a variety of plants worldwide



China

2024 Chemical
2022 Petrochemical

Korea

2023 Petrochemical

Japan

2022 Pharmaceutical related
2021 Biomass power ×4
2021 Petrochemical

Guyana

2023 FPSO（Uaru）*2

Nigeria

2022 Fertilizer
（Ammonia・Urea）

Angola

2024 Urea license

India

2024 Gas related
2023 Refinery related
2022 Refinery related ×3
2021 Refinery related
2019 Refinery related

Malaysia

2024 Chemical ×2

Thailand

2023 Petrochemical

Indonesia

2024 Geothermal Power Generation ×3
2024 Petrochemical
2023 Urea license
2023 Gas-fired power
2022 Geothermal Power Generation

Brazil

2023 FPSO (Raia) *2
2022 Gas-fired power
2022 Oil related
2021 Gas-fired power

*1 As of the end of February 2025 *2 Equity method affiliate Offshore Frontier Solutions Pte. Ltd. project (investment ratio 35%)

Order received

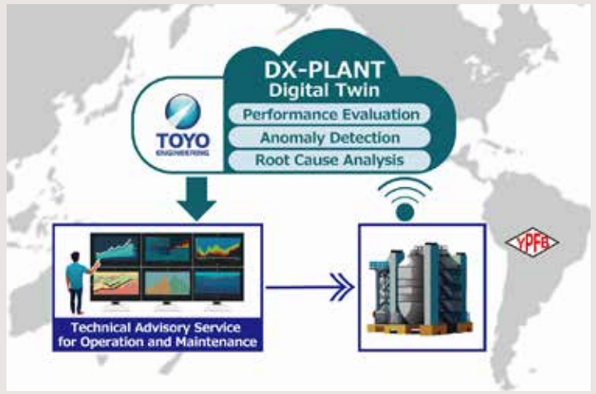
PT Inti Karya Persada Tehnik, a subsidiary of TOYO, Awarded EPC Contract for Super Absorbent Polymer (SAP) Production Plant in Indonesia

Scope	Engineering, procurement, and construction (EPC)
Scheduled Completion	2027

IKPT has been awarded an order from PT. NIPPON SHOKUBAI INDONESIA (NSI), a subsidiary of Nippon Shokubai Co., Ltd. in Indonesia, for a project to expand the superabsorbent polymer (SAP) manufacturing plant in Cilegon, Indonesia. IKPT has undertaken the engineering, procurement, and construction work, with completion scheduled for 2027. TOYO has accumulated experience in SAP manufacturing plant construction projects in Asia, Europe, and the United States, starting with a project in China in 2003. In Indonesia, TOYO has been awarded plant construction projects for NSI in 2011 and 2018. These achievements and the good relationship between the two companies led to the current order. Leveraging the knowledge gained from its EPC business, IKPT aims to contribute to the growth of the Southeast Asian market.

Order received

Introduction of DX-PLANT™ Operational Support Service to Bolivia's National Oil and Gas Company



TOYO has signed a Technical Advisory contract with Bolivia's state-owned company Yacimientos Petrolíferos Fiscales Bolivianos (YPFB) for the operation of a urea plant in Bulo Bulo, Cochabamba Department, utilizing DX-PLANT™. DX-PLANT™ is a cloud-based plant operation support service that leverages TOYO's urea process license, incorporating specialized knowledge through applications and remote monitoring systems to enhance the operation of YPFB's urea plant. By utilizing its engineering expertise in petrochemical plants such as urea and ethylene, TOYO aims to continue contributing to revenue improvement across the entire plant lifecycle as a total solution provider.

Order received

TOYO Awarded Ethanol to Ethylene Project in Thailand

Scope	Lump sum contract for Front-End Engineering Design (FEED)
Scheduled Completion	2025

TOYO has been awarded an order for the Front-End Engineering Design (FEED) of ethanol-derived bioethylene production facilities from Braskem Siam Company Limited, a joint venture between Brazil's Braskem S.A. and Thailand's SCG Chemicals. This FEED is a crucial step towards the project's Final Investment Decision (FID).

The final product, I'm green™ bio-polyethylene, is manufactured from renewable raw materials such as ethanol derived from sugarcane, significantly reducing the carbon footprint by capturing CO_2. Bioethylene is used in the production of sustainable plastic products, including food packaging and household items.

This order recognizes TOYO's extensive plant construction experience in Thailand and contributes to the development of the Southeast Asian market and the realization of a carbon-neutral society.

Order received

Toyo-China awarded Polyacetal Plant Project in China

Toyo-China has received an order from DP Engineering Plastics (Nantong) Co., Ltd. (DPE), a Chinese subsidiary of Polyplastics Co., Ltd., for the construction of a polyacetal resin (POM resin) plant in Nantong, China (CP-3 Project). Toyo-China will be responsible for the design, procurement, and construction work, with completion scheduled for 2026.

Toyo-China was awarded the CP-2 project by DPE in February 2022, and following its success, has now received the order for the CP-3 project. Once operational, this plant will become the world's largest engineering plastics production facility for DPE.

Moving forward, Toyo-China will continue to support investments in China in the fields of petrochemicals, high-performance chemicals, and fine chemicals, contributing to sustainability.

Scope	Engineering, procurement, and construction (EPC)
Scheduled Completion	2026

Order received

Toyo- India awarded EPC contract for Topside Facilities at Dahej LNG Terminal's Third Berth (Jetty)

Scope	Engineering, procurement, and construction (EPC)
Scheduled Completion	2027

Toyo-India has received an order from Petronet LNG Limited (PLL) for the construction of topside facilities for the third jetty at the LNG receiving terminal in Dahej, Gujarat. Toyo-India will be responsible for the design, procurement, and construction work, with completion scheduled for 2027.

This is the fifth order from PLL, demonstrating a strong relationship between the companies. Toyo-India aims to enhance its project execution capabilities for LNG-related facilities and contribute to the economic development of the growing Indian market.

Completion

Toyo-China completed Polyacetal Plant Project in China

Toyo-China received an order from Polyplastics Co., Ltd.'s Chinese subsidiary in 2022 to construct a polyacetal (POM) plant in Nantong City, China, as called CP-2 project. The plant was completed on June 28, 2024. This plant plays a crucial role in meeting the high demand for POM in the Chinese and Asian markets. TOYO will continue to contribute to the success of investment projects in China by overseas customers in the fields of petrochemicals, specialty chemicals, and fine chemicals, realizing its mission of "contributing to the sustainability of the earth and society through engineering."

Completion

Completion of Gas Separation Plant in Brazil

TSE participated in the inauguration of the UPGN Gas Separation Project at the Boaventura Energy Complex in Itaboraí, Rio de Janeiro, on September 13, 2024. This event, attended by over 2,000 people including Brazilian President Luiz Inácio Lula da Silva and other dignitaries, marks a significant milestone for Brazil's energy sector. The complex, with the largest natural gas processing capacity in the country, can process up to 21 million m³/day of natural gas, ensuring low-environmental-impact energy supply, job creation, and industrial development. The second unit was completed on November 14 of the same year, marking the completion of the entire complex.

Provided by Petrobras

Completion

Completion of Ichihara Biomass Project

TOYO's Ichihara Biomass Power Plant in Ichihara City, Chiba Prefecture, with a generation capacity of 75MW, held its completion ceremony on November 8, 2024, and began commercial operation on September 21, 2024. This project contributes to sustainable energy supply by using wood pellets, a renewable energy source, as fuel.

To overcome the constraints of the narrow construction site, three large storage tanks were installed to ensure a stable fuel supply. The project faced challenges from the COVID-19 pandemic from the outset, necessitating remote communication with internal and external parties. Significant efforts were made to address site constraints, layout design, civil engineering adjustments, material management, heavy machinery placement, and coordination among partner companies, overcoming many difficulties within a limited construction period.

We are grateful for the efforts of all involved in overcoming troubles and responding to urgent requests. We look forward to your continued support and cooperation.

Completion

Completion of Nigata Biomass Project

TOYO's biomass power plant project for Niigata East Port Biomass Power Plant(with a generation capacity of 50MW) in Niigata Prefecture was handed over to the client and commenced commercial operation on December 23, 2024.
This project, which started construction in April 2022, is TOYO's eighth project. While following the precedents set by previous projects and incorporating feedback, this project also had to adapt to the changing times, including the COVID-19 pandemic, climate change (extreme heat near the construction site), and work style reforms at the site. Despite various challenges, we successfully completed the project by working together with all involved parties.

Completion

Completion of Omaezaki Ko Biomass Project

The biomass power plant (with a generation capacity of 75MW) jointly constructed by TOYO and NIPPON STEEL ENGINEERING CO., LTD. in Omaezaki City, Shizuoka Prefecture, was handed over to the client, Omaezakikou Biomass Energy G.K., and began commercial operation on January 29, 2025. This power plant, which uses wood pellets and palm kernel shells (PKS) as fuel, is located at Omaezakikou, the southernmost point of Shizuoka Prefecture and the entrance to Suruga Bay. The expected annual power transmission is equivalent to the annual power consumption of approximately 170,000 households, contributing to the realization of a sustainable society through this power plant.
The project faced numerous challenges, including the impact of the COVID-19 pandemic, but was completed thanks to the guidance and cooperation of all involved parties. We extend our deepest gratitude.

Initiative

TOYO, PIHC and ITOCHU Signed A Joint Development Agreement of The Green Ammonia Initiative from Aceh (Project "GAIA")

TOYO, in collaboration with Pupuk Indonesia Holding Company (PIHC) and ITOCHU Corporation, is advancing a project to install water electrolysis equipment at an existing ammonia plant to supply green hydrogen derived from renewable energy and produce green ammonia. This project was announced at the 2nd Ministerial Meeting of the Asia Zero Emission Community (AZEC) held in Jakarta on August 21, 2024. By utilizing the existing plant designed and constructed by TOYO and procuring it as marine fuel through ITOCHU Corporation, the aim is to build a sustainable value chain. In the future, there are plans to expand this system to other plants under PIHC. The project has commenced the Front-End Engineering Design (FEED) from August 2024, with the establishment of a joint venture company by the three companies within the fiscal year 2024, aiming for a final investment decision (FID) in the first half of 2025 and production start around 2027. This initiative has also been selected as a target project for the Ministry of Economy, Trade and Industry's "Global South Future-Oriented Co-Creation Subsidy." Through this effort, the goal is to contribute to the realization of a sustainable society.

Initiative

Day 1 of a new way of working begins at TOYO's new office, which will be the growth engine for a new era

We have completed the relocation of our headquarters from Narashino City to Makuhari new city in Chiba City, and started operations in the new office from December 2024. This relocation aims to maximize the potential of our diverse talents, organically connect teams, and serve as the growth engine for TOYO's new era. In the new office, we have defined seven unique activities based on Activity-Based Working (ABW) to organize TOYO's work style. These activities are outlined in the work style guidelines decided by our employees, aiming to enhance individual creativity and productivity while promoting organizational communication. Moving forward, we will continue to evolve our office and work styles with all employees, pursuing sustainable growth for TOYO.