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TOYO ENGINEERING

Creating a New Future for TOYO with DXoT

Corporate Strategy toward TOYO's Sustainable Growth and Future Vision

Digital Transformation (DX) promotes business innovation and drastically enhances productivity by leveraging digital technology. In July 2019, TOYO launched a dedicated DXoT (Digital Transformation of TOYO) Planning & Promotion Center, which is working to transform corporate management and business operations through DXoT. In this issue of TOYO TIMES, we asked Chief Digital Officer (CDO) Yoshio Kawauchi about TOYO's overall DXoT strategy and its impact on business operations.

Basic Attitude for Promoting DXoT: Seeing Both the Big Picture and the Details

■ Please explain the role of CDO and the DXoT strategy.

At TOYO, the CDO is responsible for formulating medium- to long-term digital strategies for the group, as well as overseeing all initiatives related to improving value-added services and reforming business practices through the use of digital technologies. Since taking up the position in April 2020, I have worked on DXoT.

There are three things I keep in mind: promoting DxoT with the full participation of the staff, improving the effectiveness of DxoT, and "seeing both the big picture and the details." The CDO formulates medium- to long-term digital strategies in line with TOYO's overall management policies. But focusing too much on company-wide plans may result in strategies that don't take into account the reality in the workplaces. On the other hand, we must avoid conforming to the status quo in our daily business as our DXoT is aiming to create new experiences. It is essential to accurately keep track of the actual individual business situations and the degree of diffusion in the workplace, and then to continuously develop policies that incorporate the perspectives of the above. I have expressed my thoughts as "seeing both the big picture and the details."

TOYO established the DXoT Planning & Promotion Center in July 2019. Noriaki Seo, who has a wealth of project and leadership experience, was appointed General Manager. Under his strong leadership, the DXoT Planning & Promotion Center is tackling company-wide business innovation in collaboration with TOYO's board members, who are leading 20 different DXoT tasks.

DXoT Initiatives Born from a Sense of Crisis Tackling Structural Innovation with the Power of Digital Technology

What was the background for accelerating DX initiatives in 2018? What was their goal?

The background was a sense of crisis. This has two meanings. One is the threat of the impact of AWP[*1] methodology on EPC[*2] project execution, and the other is society's changing needs, such as engagement in ESG and SDGs.

As for the impact of AWP methodology, in the latter half of the 2010s, attention in the world of engineering began swiftly moving toward a process called AWP. It allows for EPC execution productivity to be increased through the centralized management and visualization of information across the project based on a path of construction which is all about the sequence of steps for execution. Besides, clients began to demand that contractors digitalize project execution to increase communication efficiency, freshness of information and data-driven reporting. In this new situation, a company doesn't stand a chance as a contractor if they are unable to leverage digital technology in EPC project execution.

The other meaning of "a sense of crisis" is related to how TOYO should respond to the changing needs of society. In recent years, there has been firm demand for industry to engage with ESG and the SDGs, and the structure and content of business have changed significantly. In the same way that the automobile industry is shifting from fossil fuel-powered internal combustion engines to electric engines, for example, TOYO needs to shed its old ways. This is true not only in process technologies and execution methods in areas where the Company is highly proficient, such as fertilizer and ethylene plants, but also in integrating new technologies to reduce greenhouse gas emissions, such as CCUS.[*3] In order to achieve sustainable growth now and in the future, it is imperative for engineering companies to reform business fundamentally in response to the rapidly changing market environments and conditions in society. We are aware that DXoT is a significantly important strategy and methodology to make that a reality.

*1. AWP: Advanced Work Packaging
*2. EPC: Engineering, Procurement, and Construction
*3. CCUS: Carbon dioxide Capture, Utilization, and Storage

Establishing CC Driven Engineering

Many Japanese companies are accelerating their efforts for DX. What makes TOYO unique?

The most notable feature of DXoT is its comprehensive use of cutting-edge digital technologies and its focus on comprehensive innovation in all management and business structures. Looking at the kind of DX that has been featured in newspapers and magazines, I get the impression that in many cases companies are pursuing only partial integration with systems such as remote working, paperless daily operations, and automating the detection of irregularities in plant operations.

By comparison, DXoT applies to all areas of the business, including not only our main operations of engineering, procurement and construction, but also areas such as sales, accounting, project management, and information management. In particular, I am confident that TOYO's core EPC business can be transformed and strengthened in all areas supported by corporate transformation. This is our unique feature, and it means that DXoT is looking ahead to being a corporate transformation after DX.

What are the essential points and strategic goals of DXoT?

The DXoT strategy has three pillars. The first is achieving Commissioning-Construction (CC) driven engineering. EPC projects are executed in the chronological order of engineering, procurement, construction and commissioning. This order, however, results in low productivity in the construction stage. Therefore, it is essential that EPC execution be planned while using backcasting to develop the path of construction in order to maximize productivity in commissioning and construction. "CC Driven Engineering" is what TOYO calls this new operational process in which we identify the requirements for engineering and procurement on the two Cs. We will apply AWP through EPCC execution in FY2021.

The second pillar is executing proactive corporate management. That means providing the right information at the right time in a form that allows easy decision making. In order for management to analyze and make

The Pillars of TOYO's DXoT Strategy

■ Three Pillars	■ Value	
❶ Achieving CC Driven Engineering	Society	● Reducing energy consumption through technological innovation and increased productivity ● Improving corporate value throughout the entire supply chain and enabling diverse work styles free from physical restrictions ● Ensuring safe, reliable plant operation through enhancing product and service quality
❷ Executing Proactive Corporate Management	Clients	● Maximizing return on investment ● Minimizing project execution risks ● Improving quality of information sharing (transparency and timeliness)
❸ Generating Sustainable Growth through Data Leverage	TOYO	● Achieving overwhelming competitiveness in value engineering and shortening project delivery lead time ● Enhancing timeliness of risk assessment and increasing speed in making decisions ● Increasing employee market value through strengthening human capital development

Six Times Productivity

decisions concerning the health of the company, they need to be able to accurately ascertain the progress of each individual project. However, detailed project performance is currently reported quarterly for each project, which certainly cannot be called timely. Therefore, we are increasing the frequency of project performance reports to a monthly basis, and will further shorten the period to a weekly or daily basis. This will make data-driven corporate management and taking preemptive measures possible. Further, we will visualize information in real time for important investments, the development of human resources, sales and proposals, and consolidated management. This way we can pursue the optimal allocation of management resources and enhance the decision-making process. This is what we call "Proactive Corporate Management."

The third pillar is generating sustainable growth through data leverage, allowing us to predict future events and produce more successful projects. Over its 60 years of corporate activities, TOYO has accumulated a vast amount of data and know-how related to management and business. However, this data is not in a form that can be immediately utilized. What defines an engineering company's project management is its risk management. How can we see and analyze the risks in the early stages of a project and maintain that risk consciousness all the way until the final handover? This "reading of the future" is what we are trying to achieve with data leverage, and that leads to the achievement of CC Driven Engineering and Proactive Corporate Management.

By taking an integrated approach to these three pillars of our strategy to change our current processes, TOYO is striving to create a new business structure which can flexibly adapt to change and strengthen our competitiveness.

The Quantitative Effect of DXoT: Significant Workload Reduction for Supervisors and Workers

Since starting on DXoT around three years ago, what kind of results have you seen?

In terms of qualitative results, we have seen a drastic increase in internal awareness concerning DXoT. For TOYO, DX is a company-wide initiative that combines a top-down approach from the DXoT Planning & Promotion Center and a bottom-up approach centered around DXoT promoters in each workplace. At Toyo-Japan, 30% of the employees are proactively participating in and contributing to DXoT. They are putting in great efforts to innovate with the existing business and corporate culture. CDOs have been appointed at each group company, and collaborative DX task activities have been developed with Toyo-Japan. We have also been announcing DXoT achievements to all employees several times a month, and the same has been shared with our global group companies. I believe that our greatest success has been deeply instilling a strong awareness into the entire group that we must strive for company growth through DX. On the other hand, as an example of quantitative results, DXoT has positively impacted productivity in engineering works such as information creation and information exchange in some engineering activities. This can reduce related engineering man-hours by approximately 70% and speed up engineering works by approximately three months. For another example, in site material management, DXoT can reduce workloads by approximately 20% through RFID[*4] digital solutions.

*4. RFID: Radio Frequency Identification System

Commitment to DX Will Be the Decisive Factor in the Industry

What is your vision for DX during the pandemic and in a post-COVID-19 world?

There are two things I find noteworthy related to DX under the COVID-19 pandemic. The first is that the level of effort put into digitalization will swiftly widen the gap between different companies and nations. Countries like Singapore and Taiwan used digital technologies to monitor people's movements and keep track of mask inventories in real time. However, Japan's systems are still mostly analogue, and there were occasions when, for example, corrections needed to be made to the number of infections that had been announced. The difference between countries in this point is striking. The time has come when the deciding factor in organizational strength is the ability to respond to digitalization.

The other point is the great potential for digital technology. TOYO holds Model Review Meetings with clients for each project, in which we discuss the content of engineering using a 3-D model of the plant. These important meetings cover a wide range of items, including obvious factors such as safety, maintainability, and operability in addition to other detailed specifications. For this reason, they can take as long as two months to complete for large projects. Before COVID-19, everyone believed these meetings had to be face to face, but after trying it, we became confident that meetings including participants from Japan, Russia, and India, for example, could also be held remotely. It is important for us to break down stereotypical ideas and move forward with trust in the possibilities of digital technology. We are challenging ourselves to make TOYO a company that can respond to rapid external changes with great speed.

Fiscal 2021 will be an even more important year for DXoT. What is TOYO's basic policy?

TOYO formulated an ICT[*5] medium-term strategy in fiscal 2020. This plan will serve as a five-year guide for ICT investment and the process of system development, also covering DXoT activities. Its numerical target is a productivity increase of six times in 2025 compared to fiscal 2019. This does not mean reducing the number of employees from six people to one for a given job, but rather it means a six-fold increase in gross profit generated per person through DX-based operational reforms.

As part of this, in 2021, TOYO plans to focus on establishing AWP, the core of CC Driven Engineering, and expand the scope of its application. Additionally, TOYO will systematize the data and knowledge accumulated by

each group company as part of our efforts to complete a knowledge management system that ensures uniform product quality and prevents the recurrence of quality issues and cost increases.

In my view, DXoT has the potential to create an impact in the range of tens of billions of yen across the entire group in five years. In addition, shortening project delivery lead time will allow clients to start operations earlier, leading to improved profits, so I hope that we can make the successes of DXoT evident as early as possible.

*5. ICT: Information and Communication Technology

Contributing to Creating Sustainable Societies As Our Clients' Best Partner

In closing, could you share your predictions on how DX will change TOYO and the engineering industry over the long term, such as in ten or twenty years?

I think the most important keyword to keep in mind for that future time range is "digital twins." Here, "twin" refers to recreating an exact digital version of real-word circumstances in the virtual world. I believe that within a few years, the engineering industry will be able to use cutting-edge digital technology to create digital twins of plants and projects. Ultimately, it will be possible to use digital twin simulations to forecast the impact of engineering design alterations or project actions before applying them in the real world.

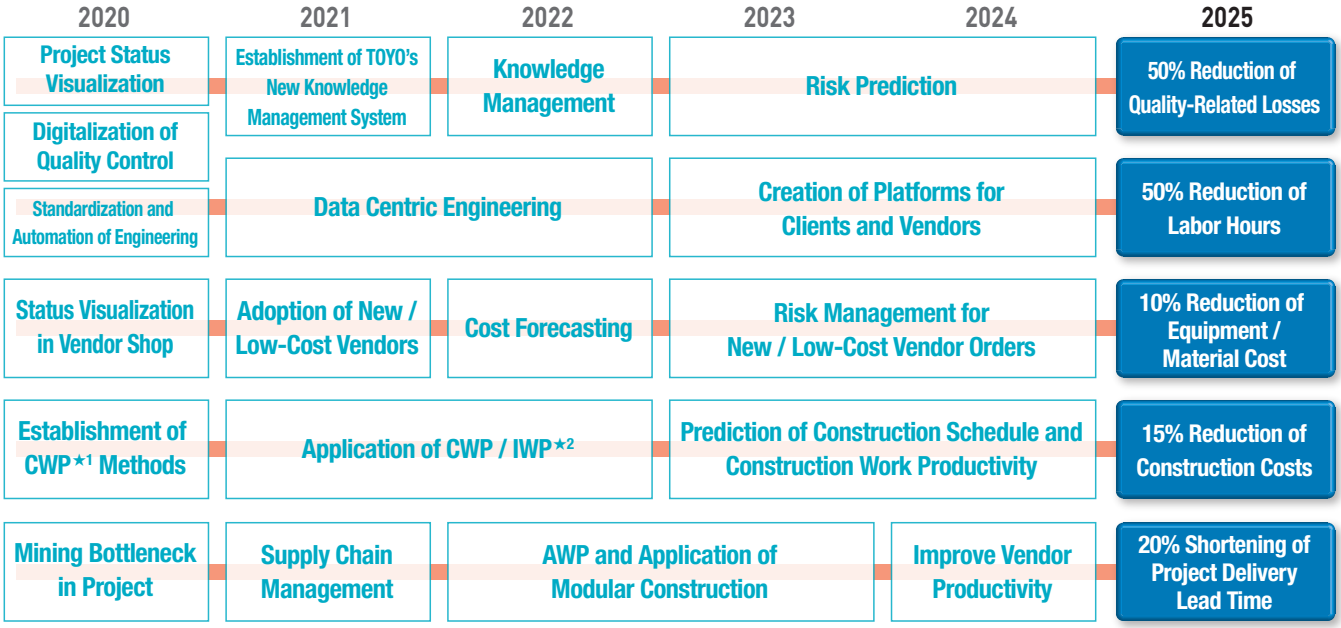
Digital twins will also make the creation of new business models possible. For example, in the field of public transportation, we are seeing MaaS[*6] enter the practical demonstration stage. MaaS uses digital technology to seamlessly share information and enable searching for means of transportation, usage, and payments via smartphones. Automobile companies that manufacture and sell cars are also considering using MaaS. Thinking along the lines of that analogy, TOYO's conventional business is to build plants and deliver them to clients, but in the future, utilizing digital twins that seamlessly connect EPC and O&M information may enable us to provide clients with a platform for "Production as a Service."

Another thing to keep in mind is the idea of "distributed autonomous cooperative systems." Here, we can find an example in the field of power generation. Traditionally, a small number of large plants generate huge amounts of electricity. But now, power producers are investigating systems for virtual power plants, through which a large number of small plants provide electricity based on advanced IoT and AI prediction models for supply and demand. Shifting from large, concentrated, centralized systems to systems of multiple small, distributed, autonomous cooperative units will allow us to accelerate initiatives related to renewable energy usage, the creation of carbon-free societies, and improvement of resilience.

However, no matter how much the market environment may change and how much digital technology may evolve, TOYO's role and the value it offers to society will not change. Engineering companies have a responsibility to combine technology and knowledge to engage in solving infrastructure issues for society. TOYO has defined its mission as "Engineering for Sustainable Growth of the Global Community," and the Company's fundamental reason for existence is contributing to global sustainability as the best partner for its clients. This is something that will not change in ten years, or even in one hundred years. Rather, we will digitize all of the intellectual capital gained from the Company's accomplishments, experience, knowledge, technology, and even setbacks, and make full use of it in all areas. This is how TOYO can best contribute to economic prosperity and human experience in a sustainable world.

*6. MaaS: Mobility as a Service

Roadmap to "Increasing Productivity by Six Times"

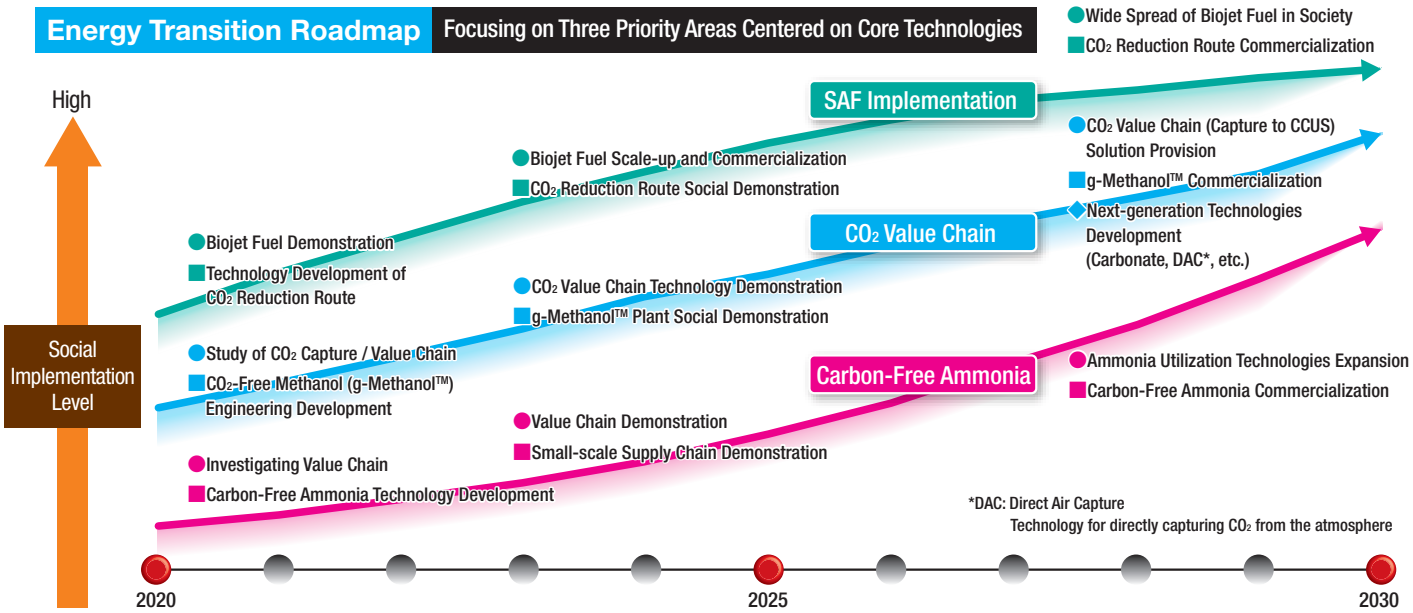


★1. CWP: Construction Work Package
★2. IWP: Installation Work Package

Striving Toward Energy Transition

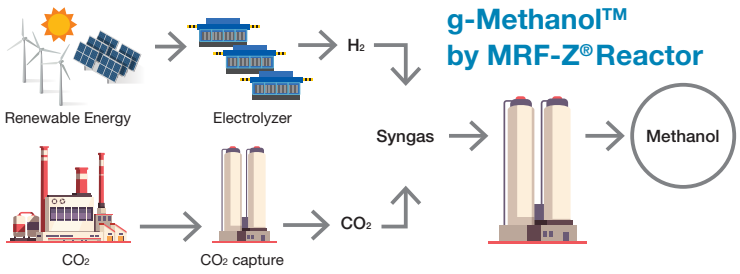
TOYO is carrying out multifaceted research, implementation, and development of energy transition initiatives toward the establishment of a carbon neutral society. TOYO has set three priority exploration areas in energy transition: 1) the development of sustainable aviation fuels (SAF*1), 2) CO_2 value chains, and 3) carbon-free ammonia value chains. Roadmaps have been formulated for each of these areas, and TOYO is making efforts to achieve these goals by not only leveraging the Company's strengths, but through co-creation partnerships. And in addition to the technologies introduced here, TOYO will work to sequentially add green hydrogen production, CO_2 capture technology, plant electrification, waste plastic recycling technology, and more to the development roadmap program.

*1. SAF: Sustainable Aviation Fuel (Aviation fuel produced from a sustainable source with low CO_2 emissions in the process from raw feed production/collection to combustion)

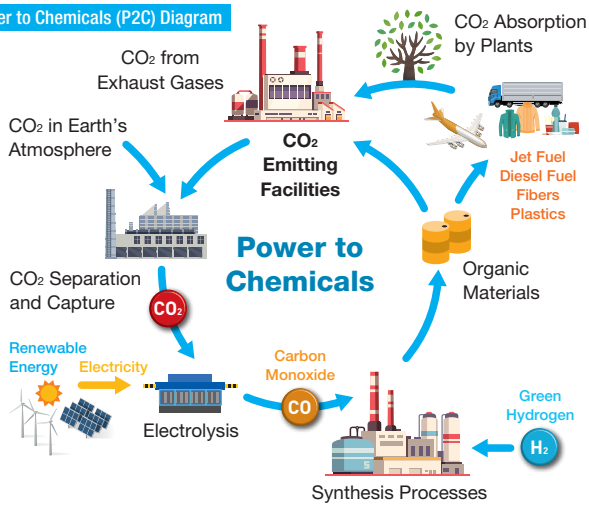


CO_2 Value Chains

CO_2 Recycling Chain: g-Methanol™ (Direct Methanol Synthesis from CO_2)



Power to Chemicals (P2C) Diagram

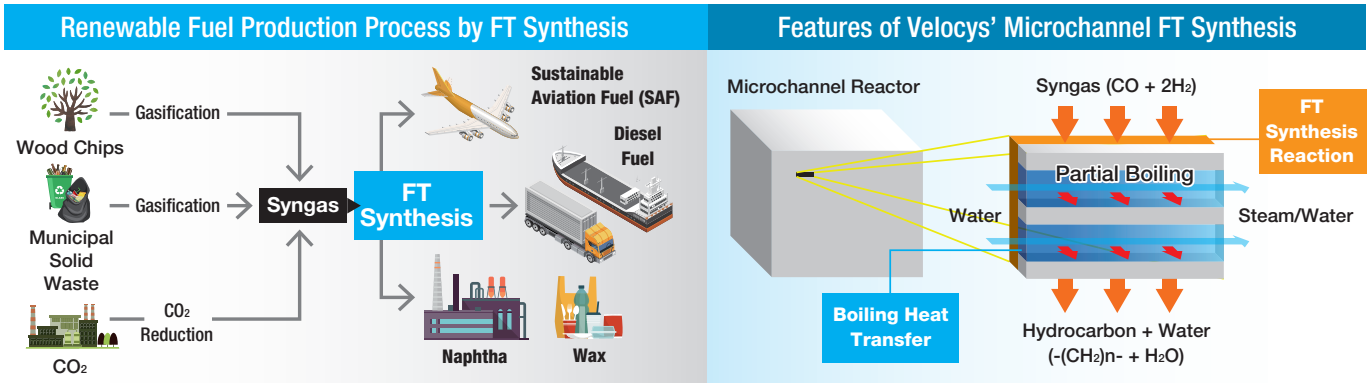


In the carbon recycling field—a domain which is targeting the creation of a recycling-based society—TOYO is focusing on CO_2 capture, utilization and storage, as well as all areas of the resource recycling chain.

TOYO has a wealth of experience in constructing plants that manufacture products with synthetic gas as feedstock, such as ammonia, methanol, dimethyl ether, and hydrogen. For methanol plants, TOYO will be applying its proprietary radial flow MRF-Z® methanol synthesis reactor technology. TOYO is working on conducting a practical demonstration of g-Methanol™, a process which creates synthetic gas from exhaust gas and atmospheric CO_2, rather than from associated petroleum gas or natural gas.

Additionally, TOYO has begun examining e-fuels, which synthesize fuel directly from CO_2, beginning with the development of jet fuel production facilities that combine Toshiba Corporation's CO_2 electrolysis technologies with FT reactions.

SAF Implementation



TOYO is working to establish SAF manufacturing technologies that reduce CO_2 emissions from jet fuel. In 2020, as part of the "Development of Production Technologies for Biojet Fuels" project being conducted by the New Energy and Industrial Technology Development Organization (NEDO), TOYO was commissioned to produce bio-jet fuel at a validation plant using the microchannel FT synthesis*2 technologies of Velocys Inc., U.S.A. Microchannel FT synthesis technology is compact in size and highly efficient, so it is well suited to small- and medium-sized bio-jet fuel manufacturing plants.

This project is being carried out in partnership with Mitsubishi Power, Ltd., JERA Co., Inc., and the Japan Aerospace Exploration Agency, which is a national research and development agency. In the future, TOYO will diversify raw materials (such as woody biomass and municipal waste) for gasification process technologies, and combine that with reduction technologies to use CO_2 as feedstock. Further, TOYO will strive to develop economically efficient plants and to provide solutions for the social implementation of SAF facilities.

NEDO Biojet Fuel Production Technology Development Project (2020)

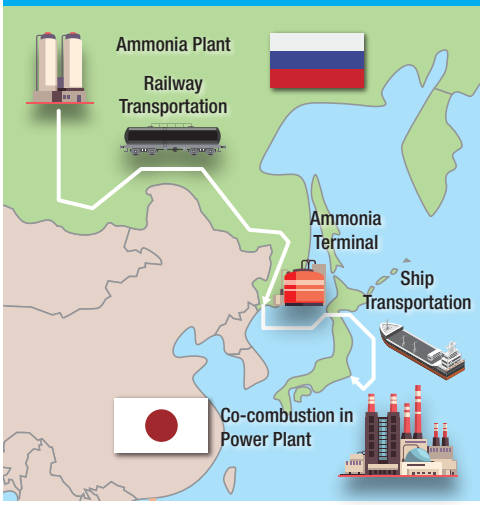
*2. FT (Fischer-Tropsch) synthesis: Technology for synthesizing liquid hydrocarbons from syngas (mixed gas of carbon monoxide and hydrogen) using a catalyst

Carbon-Free Ammonia

TOYO has carried out fertilizer plant construction projects throughout the world that combine the ammonia process of KBR, Inc., U.S.A., and TOYO's proprietary ACES21® urea synthesis technology. TOYO's history with fertilizer plants includes the construction of more than 80 ammonia plants. Now, ammonia is attracting attention as a carbon-free energy source, and the Green Growth Strategy announced by the Japanese Ministry of Economy, Trade and Industry is aiming for the establishment of an international supply chain for ammonia as a fuel.

In response to this, TOYO has been working on the development of technologies for carbon-free ammonia production facilities, which occupy the furthest upstream part of the supply chain. Specifically, TOYO is working on the practical demonstration of a blue ammonia production facility, which combines CO_2 capture and storage, CO_2 capture and utilization, and enhanced oil recovery. This project is being promoted in partnership with ITOCHU Corporation and carried out as an outsourced survey by the Japan Oil, Gas and Metals National Corporation (JOGMEC). As the first step, the companies conducted a feasibility study on the production and transportation value chain for ammonia produced from hydrogen as feedstock by Irkutsk Oil Company, LLC, Russia. The overall design structure of a value chain that combines production such as the above with CO_2 value chains is a social issue with which engineering companies should be engaged. Also, from a long-term perspective, TOYO will continue working to develop production technologies for green ammonia derived from renewable energy sources.

Ammonia Value Chain Conceptual Diagram for Eastern Siberia and Japan



Groundbreaking Ceremonies for Two Biomass Power Plant Projects

Groundbreaking ceremony at the Omaezakikou Biomass Power Plant

In March 2021, TOYO held groundbreaking ceremonies for two new biomass-fired power plant projects in Japan. TOYO was awarded these construction projects in late 2019, and construction work will begin in full scale following the traditional ceremonial prayer for safety. The first project is a 50 MW plant in Gamagori, Aichi Prefecture, for Gamagori Biomass Power Generation Godo Kaisha, a joint venture company comprised of Chubu Electric Power Co., Inc., Marubeni Clean Power Corporation and SB Energy Corp. The second is a 75 MW-class plant in a region straddling the cities of Omaezaki and Makinohara in Shizuoka Prefecture. This project is planned by Omaezakikou Biomass Energy G.K., which is comprised of RENOVA, Inc., Chubu Electric Power, Suzuyo Shoji Co., Ltd., and Mitsubishi Electric Credit Corp. TOYO will carry out this project under a joint venture with Nippon Steel Engineering Co., Ltd.

Both projects are full turnkey contracts, covering engineering, procurement, construction and commissioning. Work is scheduled to be completed in the summer of 2023.

Awarded Seventh Biomass Power Plant Project in Japan

TOYO was awarded a construction project for a 75 MW biomass power plant planned by Ichihara Yawatafuto Biomass Power GK in Ichihara City, Chiba Prefecture. Completion of construction is scheduled for 2023.

This is TOYO's seventh biomass power plant project, following a 75 MW-class biomass power generation plant in Shizuoka Prefecture and a 50 MW-class plant in Aichi Prefecture, both awarded in 2019. TOYO's first biomass power plant project awarded in 2018, located in Ibaraki Prefecture's Kamisu City, is now at the final stage.

TOYO is continuing to expand its portfolio of assisting with biomass and other forms of renewable energy utilization, which is expected to contribute to the creation of a low-carbon society.

3-D model of Ichihara Biomass Power Plant

Awarded Refinery Project in India

Toyo-India was awarded a full turn-key contract for engineering, procurement, construction, and commissioning services on a diesel hydrotreating unit and a hydrogen production unit as part of a construction project for a large integrated refining and petrochemical complex planned by HPCL Rajasthan Refinery Ltd. (HRRL) in Barmer, Rajasthan, India. HRRL is a joint venture company that is 74% owned by Hindustan Petroleum Corporation Limited, a major Indian state oil company, and 26% owned by the Government of Rajasthan. Toyo-India is to oversee the units that will make up the complex.

India is experiencing considerable economic expansion, and many investments are currently planned based on the government's efforts to promote the policy of local production for petroleum products and petrochemicals.

TOYO has steadily accumulated a record of achievements in India since constructing a fertilizer plant in the 1960s, and also developed experience and knowledge through working on refinery projects in the 1990s. Based on these strengths, TOYO is now contributing to strengthening energy security in India.

Power Generation Starts at Three Large-scale Photovoltaic Power Plants in Japan


Iwaki Mega Solar Power Plant (Fukushima Prefecture)


Yumesaki Mega Solar Power Plant (Hyogo Prefecture)

Three of TOYO's large-scale photovoltaic (mega solar) power plant projects have started selling electricity. In December 2019, the plant in Katsuura City, Chiba Prefecture (power generating capacity of 32 MW DC) launched commercial operations, followed in April 2020 by the Iwaki City, Fukushima Prefecture plant (42 MW), and the Himeji City, Hyogo Prefecture plant (72 MW) in December 2020.

The three projects suffered damage from large typhoons and heavy rains in 2019. Also, they were impacted in 2020 by the COVID-19 pandemic—an issue that could not have been predicted when the projects started. TOYO placed utmost priority on measures to prevent infection, and continued construction in collaboration with each client.


Katsuura Ueno Mega Solar Power Plant (Chiba Prefecture)

Since its first award of a mega solar power plant in Okayama Prefecture in 2014, TOYO has undertaken 10 such projects for a total power generating capacity exceeding 700 MW, including a project currently under construction in Niigata Prefecture. TOYO will continue contributing to the creation of sustainable societies through projects related to renewable energy.

Completed New Naphtha Cracking Heaters Project

TOYO has completed a project to expand the existing naphtha cracking furnaces at the Chiba plant of Maruzen Petrochemical Co., Ltd. Ever since Maruzen Petrochemical awarded TOYO the project for the ethylene unit of its Chiba plant No. 3 in 1967, a great deal of projects have been implemented for the client.

This was the second naphtha cracking furnace expansion project following the previous one conducted about 10 years ago. Toyo-Japan carried out the engineering and procurement work, while TOYO's Japanese group company TEC Project Services Corporation (TPS) mainly undertook the construction work. The project began in summer 2018, and was completed on schedule in summer 2020 in twenty-five months and without any accidents or disasters.

TOYO will continue to meet client needs and execute high-quality projects while placing the highest priority on safety.


Completed naphtha cracking furnace and project team members

Completed Petrochemical Plant in Indonesia

Toyo-Japan and TOYO's Indonesian group company PT. Inti Karya Persada Tehnik (IKPT) completed a petrochemical project and handed it over to Indonesia's largest integrated publicly listed petrochemical company, PT Chandra Asri Petrochemical Tbk (CAP). The project consisted of the construction of a butene-1 unit, a Methyl Tertiary Butyl Ether (MTBE) production unit, and an enclosed ground flare system inside the client's petrochemical complex located in Cilegon, on the western tip of Java, Indonesia.

The project was jointly awarded to Toyo-Japan and IKPT in April 2018 and engineering, onshore procurement and construction work were carried out by IKPT, while Toyo-Japan undertook the engineering work and overseas procurement. Butene-1 is already being used as the feedstock at other plants of CAP, while MTBE is being supplied domestically as an additive for gasoline. The butene-1 and MTBE units built by Chandra Asri are geared toward helping the Government of Indonesia reduce imports and boost the domestic economy. In addition, the enclosed ground flare system will play an important role in reducing the impact on the community and environment by reducing noise and light that otherwise may emanate from the operations.

Work was adversely affected by the spread of COVID-19 during the final stage of construction, but the project was completed on schedule, and the client started operations in the latter half of 2020 as planned.

Panorama of the butene-1/MTBE plant

The enclosed ground flare system

Awarded Project for New Medium Molecule Pharmaceutical Ingredient Plant

Predictive rendering of finished manufacturing plant for medium molecule pharmaceutical ingredients

TOYO's Japanese group company TEC Project Services Corporation (TPS) was awarded a project to construct a new manufacturing plant for medium molecule pharmaceutical ingredients (nucleic acid and peptide pharmaceuticals). The project is being planned by Ajinomoto Co., Inc., at their Tokai Facility. TPS will be involved from the initial planning stage of this project, and will carry out engineering, procurement, construction and commissioning services on a full turn-key basis.

The project involves the construction of Japan's largest manufacturing plant for nucleic acid and peptide pharmaceuticals ingredients, which are currently attracting attention as next-generation drugs.

TPS positions pharmaceuticals among its core businesses and is working to expand in this field. The company is also advancing initiatives related to next-generation pharmaceuticals, including nucleic acid, peptide, and biopharmaceuticals, for which growth is expected.

Strengthening O&M through Investment in JIW

In April 2020, TOYO joined the shareholders of Japan Infra Waymark (JIW), along with other major domestic infrastructure and energy companies. Established as a subsidiary of Nippon Telegraph and Telephone West Corporation, JIW uses drones and AI to provide efficient infrastructure inspection services based on accumulated knowledge and experience with infrastructure inspections and maintenance at NTT's group.

In infrastructure inspections as well as the plant safety field, from the perspective of aging equipment, shortages of inspectors and others, advanced inspection work, manpower saving and automation of work will be required. Therefore, the use of digital technologies such as drones and AI at plants is expected to increase going forward.

In addition to EPC work, TOYO is aiming to expand its business to support plant owners in operation and maintenance (O&M). TOYO is planning to provide solutions tailored to customer needs and make inspection and maintenance work more efficient by utilizing tools such as drones and robots.

By participating in this investment, TOYO is promoting collaborations with JIW and the other investors and developing O&M business-related services. Based on a cooperative relationship with JIW, TOYO is striving for the joint development of advanced services, such as equipment inspections conducted by using image recognition and other AI technologies.

Concluded Business Alliance Agreement in Pharmaceuticals and Fine Chemicals Field

TPS has concluded a business alliance agreement with Taisei Corporation in the pharmaceuticals and fine chemicals field.

This alliance will allow both companies to leverage and complement their strengths in technology, know-how, and human resources in advanced pharmaceuticals and fine chemicals—a market in which future growth is expected.

TPS will take advantage of the synergy produced by this alliance to precisely determine wide-ranging client needs, and make possible value-added, high-quality proposals and project execution.

Supporting Technology Development for Rare-earth Mud Recovery Systems

Rare-earth elements are indispensable in areas where demand has been rapidly increasing in recent years, such as digital technologies, renewable energy, battery materials for hybrid and electric vehicles, and magnetic materials. These are important to the creation of a low-carbon society and the achievement of the sustainable development goals (SDGs). Also, developing the deposits found at a depth of 6,000 meters on the seafloor in Japan's exclusive economic zone is important to the resource security of Japan.

Under the Cross-ministerial Strategic Innovation Promotion Program, a team led by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) is developing a world's first technology for the unprecedented deep-sea development of oil and gas, such as recovering rare-earth mud from a depth of 6,000 meters. There are challenges not only in the sub-sea level depth, but also in the characteristics of rare-earth mud itself.

The rare-earth mud on the seafloor is highly viscous and does not flow smoothly through pipes. Turning it into slurry of a lower viscosity and pumping it to the surface requires the optimization of subsea production systems equipped with agitating blades, pumps, valves, monitoring sensors, electricity, and control modules.

TOYO has built extensive experience with resource development and subsea technologies through years of working on technological development. Appling this strength to the new recovery system, TOYO has already implemented conceptual design and basic engineering. An ocean demonstration test applying this system is being planned for fiscal 2022.

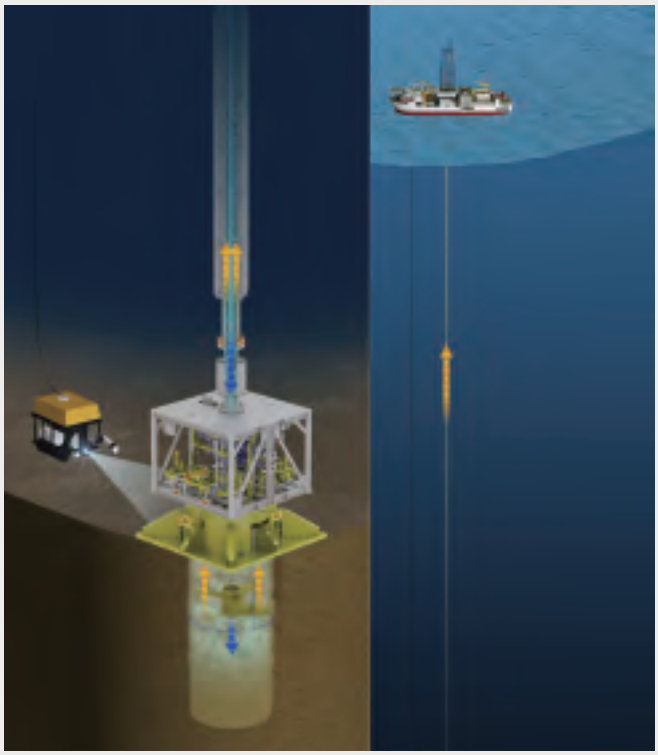


Illustration of a subsea production system

TOYO ENGINEERING

GLOBAL NETWORK

Toyo Engineering Corporation

HEAD OFFICE / ENGINEERING CENTER
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