Medium-Term Management Plan (FY2021-2025)
“Sustainable Technology and Business Development" Strategy
SAF, fuel ammonia, and business development approach

IR briefing materials

April 20, 2021
Toyo Engineering Corporation

TOYO ENGINEERING

Introduction: TOYO's Mid-Term Management Strategy

Achieve both Sustainable Technology and Business Development and Advanced EPC Operation, as well as the Sustainability of the Global Community and TOYO

Strategy “Sustainable Technology and Business Development”

Priority Areas: Environment and Energy

Co-creation with clients/partners from the concept

< BACKGROUND>

- Carbon neutral is the area to contribute
  - → Efforts against global warming
  - → Improving Quality of Life in Emerging Countries
  - → Their coexistence are directly linked to TOYO's Mission
- Proprietary solutions (CCUS, synthesis gas technology, etc.)
  - → Fuel ammonia
  - → Sustainable aviation fuels (SAF)
  - → Green methanol, etc.

New Knowledge and Business Opportunities returned to EPC →

SUSTAINABLE DEVELOPMENT GOALS

← Invest knowledge, experience and benefits gained through EPC

Strategy “Advanced EPC Operation”

Group operations

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DXoT (Digitalization without sanctuary)

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Ensuring Excellent Quality and Profitability

< BACKGROUND>

- TOYO's definitive advantages
  - → Group companies’ capabilities to accomplish EPC works since 1960s
  - → Abundant records in India, Russia/NIS※, Asia and Brazil whose demands are expected to grow
- EPC business continues to be the mainstay →Pursue ”Dramatic” productivity increase

※New Independent States (Russia and Emerging independent countries of the former Soviet Union other than the three Baltic countries)

Today's content

Introduction of the business concept of SAF and fuel ammonia and the business development approach

Carbon neutral business (Chapters 1 and 2)

Business domain

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Issues

- Market potential
- TOYO's vision of social implementation roadmap
- TOYO's solutions to major issues for social implementation

【Deep Insight】
TOYO's technical achievements and knowledge

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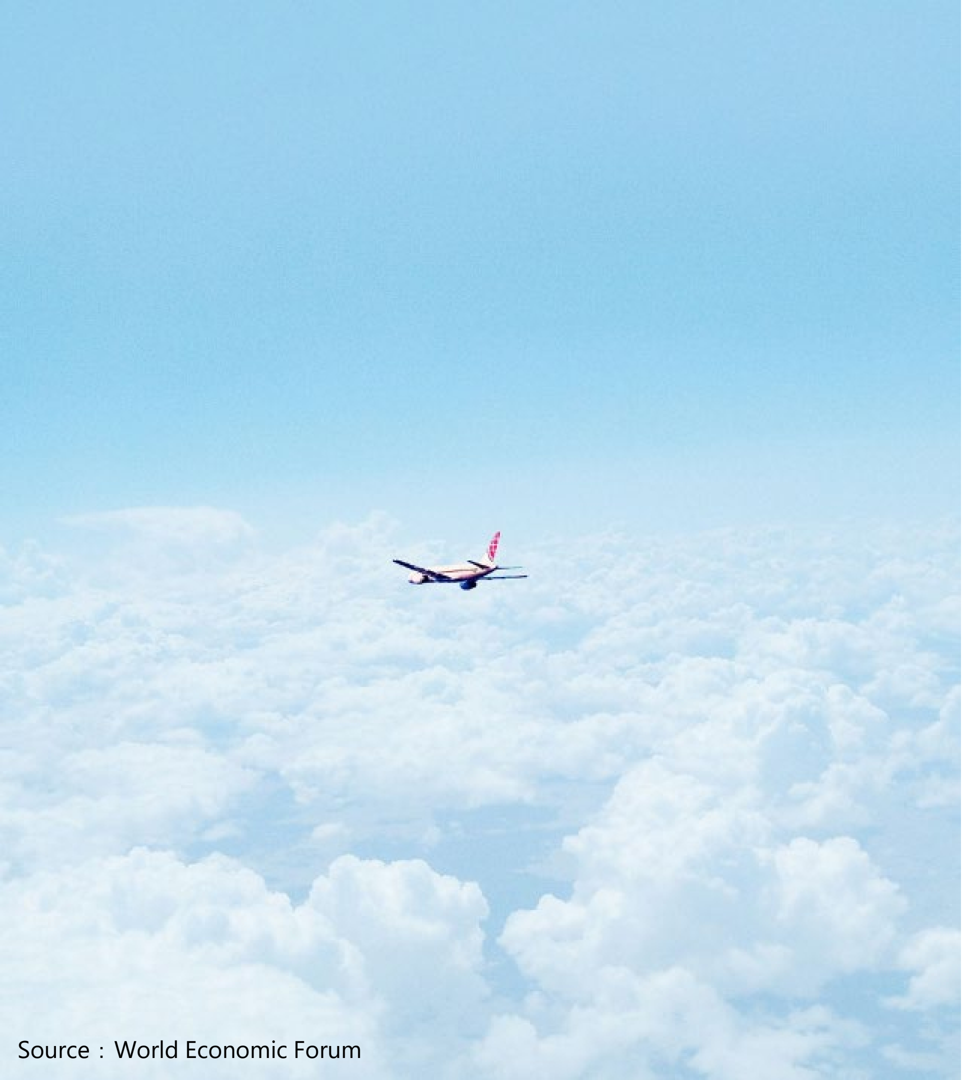
Business development approach

(Chapter 3)

- Business model
- Specific examples



Source： World Economic Forum

Today's content

1 Sustainable Aviation Fuel (SAF) business

2 Fuel ammonia business

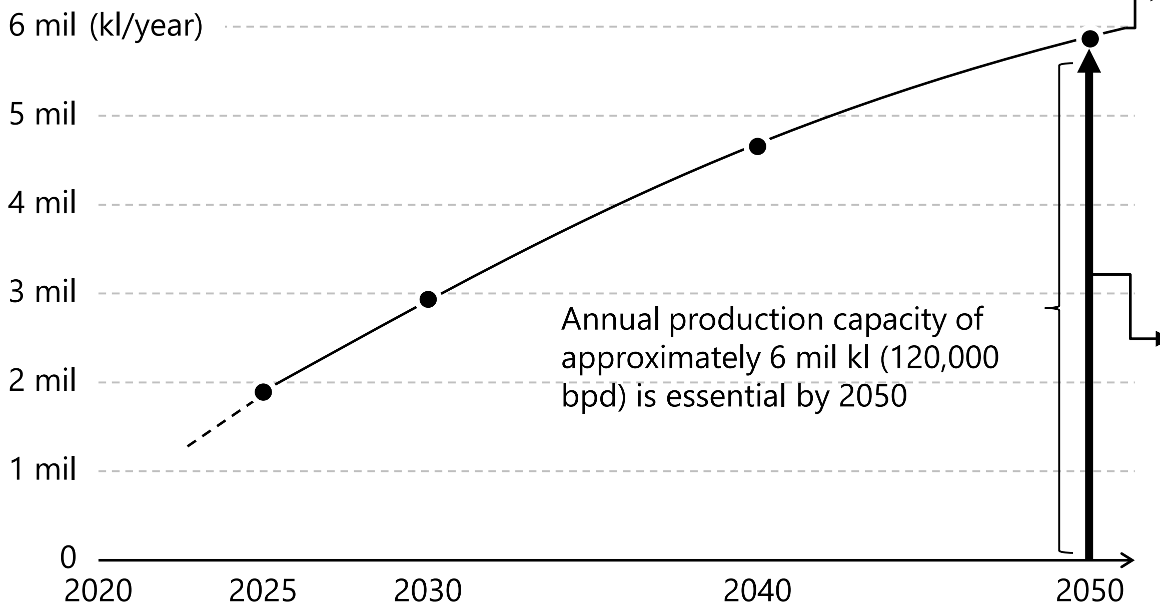
3 Business development approach

Market potential (Domestic)

The EPC market is expected to reach a cumulative total of 3.6 trillion yen and the fuel sales market is expected to exceed 600 billion yen by 2050 in Japan

SAF Demand Forecast by The Scheduled Airlines Association of Japan

It should be noted that the possibility of demand decline by COVID-19 is not counted



Estimated market size

<SAF Sales (Japan)>

600 billion yen per year in 2050

prerequisite

- CO_2 reduction targets: △50% in 2050
- SAF requirements: 6 million kl/year
- SAF price: 100 yen/liter

⇒ 100 yen × 6 million kl = 600 billion yen

<SAF production plant investment (Japan)>

Cumulative total of 3.6 trillion yen by 2050

prerequisite

- CO_2 reduction targets: △ 50% in 2050
- SAF requirements: 120,000bpd
- Capital expenditures: $300,000/bpd

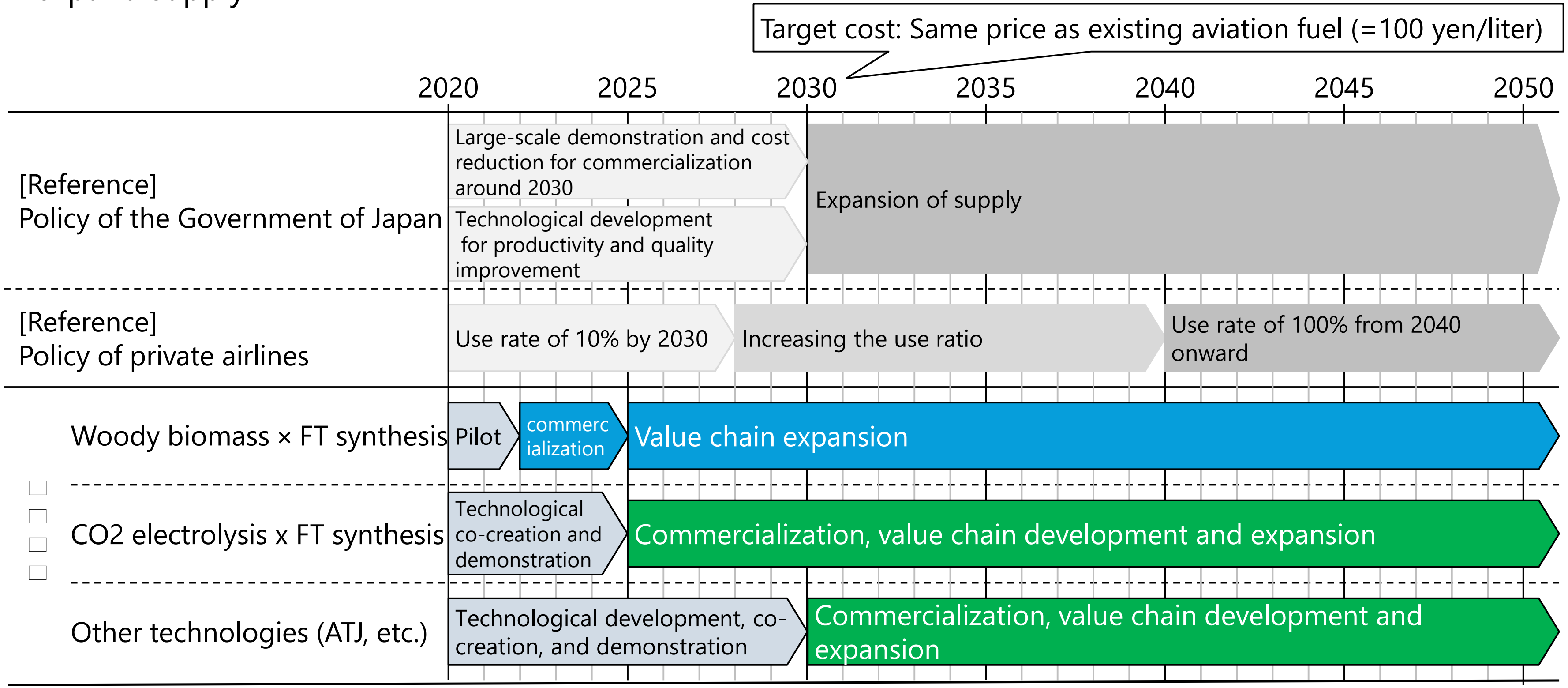
⇒ $300,000/bpd×120,000 bpd =3.6 trillion yen*1

Source: The Scheduled Airlines Association of Japan

*: US$1 = 100 yen

TOYO's social implementation roadmap

Co-creation of manufacturing processes using not only biomass but also CO_2 and other raw materials to expand supply



Source: Based on the Roadmap of METI and private airlines

TOYO's solutions to major issues for social implementation

Overcome three challenges: Reducing manufacturing costs, securing stable supplies of raw materials, and optimizing the purification process of FT crude

	SAF Key Issues	TOYO's Solutions (Strengths)
1 Production cost reduction	The production cost of SAF is 2 to 4 times higher than existing aviation fuel	✔ Reduce costs by early realization of large-scale after successful demonstration with NEDO ✔ Further co-creation with Velocys, which has been demonstrated at commercial scale, and utilizing feedback from commercial plants
2 Biomass raw materials stable procurement	Various issues for stable procurement ● Sustainable use of forest resources ● Quality stabilization (moisture content, etc) ● Processing and distribution	✔ Create biomass value chain with customers and partners ✔ Create value chain considering the other raw materials such as municipal waste and CO_2
3 FT crude purification process optimization	Improved profitability by refining products (FT crude) from SAF plants into aviation fuel and petrochemicals	✔ Achieving the integration of SAF purification process through collaboration between our abundant experience in the petrochemical field and petrochemical companies

【Deep Insight】

TOYO's Knowledge of Synthesis Gas Technology

Production technology development /co-creation theme other than FT synthesis technology

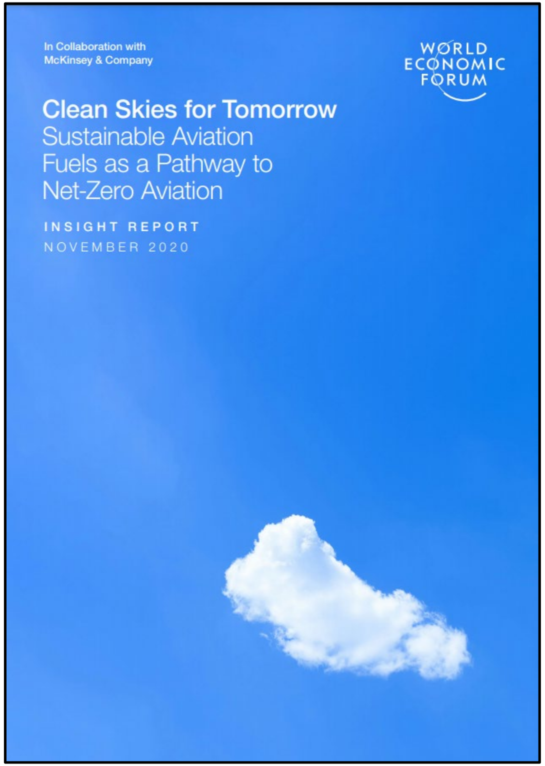
Aiming for early commercialization of FT synthesis at the core, co-creation of synthetic fuel technology for diversification of feedstocks will also be promoted

Production technology	Feedstocks	Technology overview	Companies
FT synthesis Fisher Tropsch process	● Biomass waste such as wood chips ● Municipal solid waste such as waste plastics	Production of aviation fuel by gasifying waste and liquefying them with catalysts	● Mitsubishi Power, JERA, **TOYO** ● Marubeni, etc
Synthetic fuel Power to Liquid	● CO_2 and H_2 in emission sources such as flue gas	Production of aviation fuel from carbon dioxide recovered from emission sources with carbon recycling technology	● Toshiba, Idemitsu, ANA, Japan CCS, **TOYO**
ATJ Alcohol to JET	● 1st-generation bioethanol (sugar cane, corn, etc.) ● 2nd-generation bioethanol (non-edible plants, wastepaper, biomass waste, etc)	Production of aviation fuel by reforming ethanol with catalysts	● Bits (Bio-venture), etc.
HEFA Hydroprocessed Esters & Fatty Acids	● Waste cooking oil ● Beef tallow ● Microalgae, etc	Production of aviation fuel by hydrocracking and reduction of waste cooking oil, etc. under high pressure	● IHI ● Euglena ● JGC, etc

Source: Energy Policy for 2030, Agency for Natural Resources and Energy (March 11, 2021)

Superiority of FT synthesis technology

WEF reported a superiority of gasification / FT synthesis with GHG reduction effects



Comparison of Life Cycle Assessment (LCA) of SAF production technology




	HEFA	Alcohol-to-jet[i]	Gasification/FT	Power-to-liquid
Opportunity description	Safe, proven, and scalable technology	—	Potential in the mid-term, however significant techno-economical uncertainty	Proof of concept 2025+, primarily where cheap high-volume electricity is available
Technology maturity	Mature	—	Commercial pilot	In development
Feedstock	Waste and residue lipids, purposely grown oil energy plants[ii] Transportable and with existing supply chains Potential to cover 5%-10% of total jet fuel demand	—	Agricultural and forestry residues, municipal solid waste[iv], purposely grown cellulosic energy crops[v] High availability of cheap feedstock, but fragmented collection	CO_2 and green electricity Unlimited potential via direct air capture Point source capture as bridging technology
% LCA GHG reduction vs. fossil jet	73%–84%[iii]	—	85%-94%[vi]	99%[vii]

i. Ethanol route; ii. Oilseed bearing trees on low-ILUC degraded land or as rotational oil cover crops; iii. Excluding all edible oil crops; iv. Mainly used for gas./FT; v. As rotational cover crops; vi. Excluding all edible sugars; vii. Up to 100% with a fully decarbonized supply chain

Source: CORSIA; RED II; De Jong et al. 2017; GLOBIUM 2015; ICCT 2017; ICCT 2019; E4tech 2020; Hayward et al. 2014; ENERGINET renewables catalogue; Van Dyk et al., 2019; NRL 2010; Umweltbundesamt 2016

Source： World Economic Forum Insight Report (November 2020)

Today's content

Market potential (1/2): Overall

Fuel ammonia is "the second LNG" that supports carbon neutral and energy security

As direct fuel

Various applications are expected as fuels that do not emit CO_2

- Co-firing/exclusive firing of thermal power generation
- Ship
- Industrial furnaces, etc

Significant contribution to carbon neutral in the electric power sector

- Flexible adjustment of supply-demand balance in line with the expansion of the renewable energy
- Inertial force to reduce the risk of blackout

As a hydrogen carrier

Superiority compared to liquid hydrogen and methylcyclohexane (MCH)

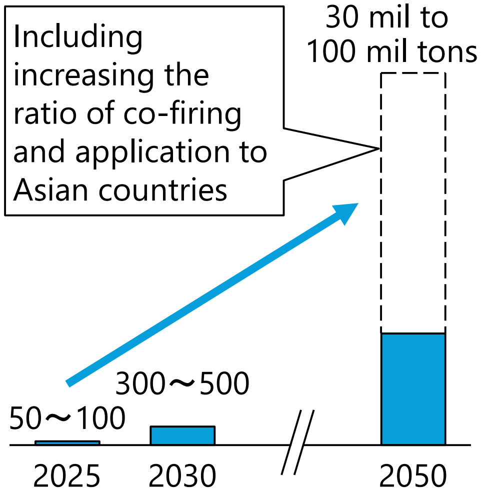
✔ The highest hydrogen density($121kg\text{-}H_2/m^3$)

✔ Large-scale value chain can be built using existing infrastructure

However, caution should be exercised because of toxicity and corrosivity

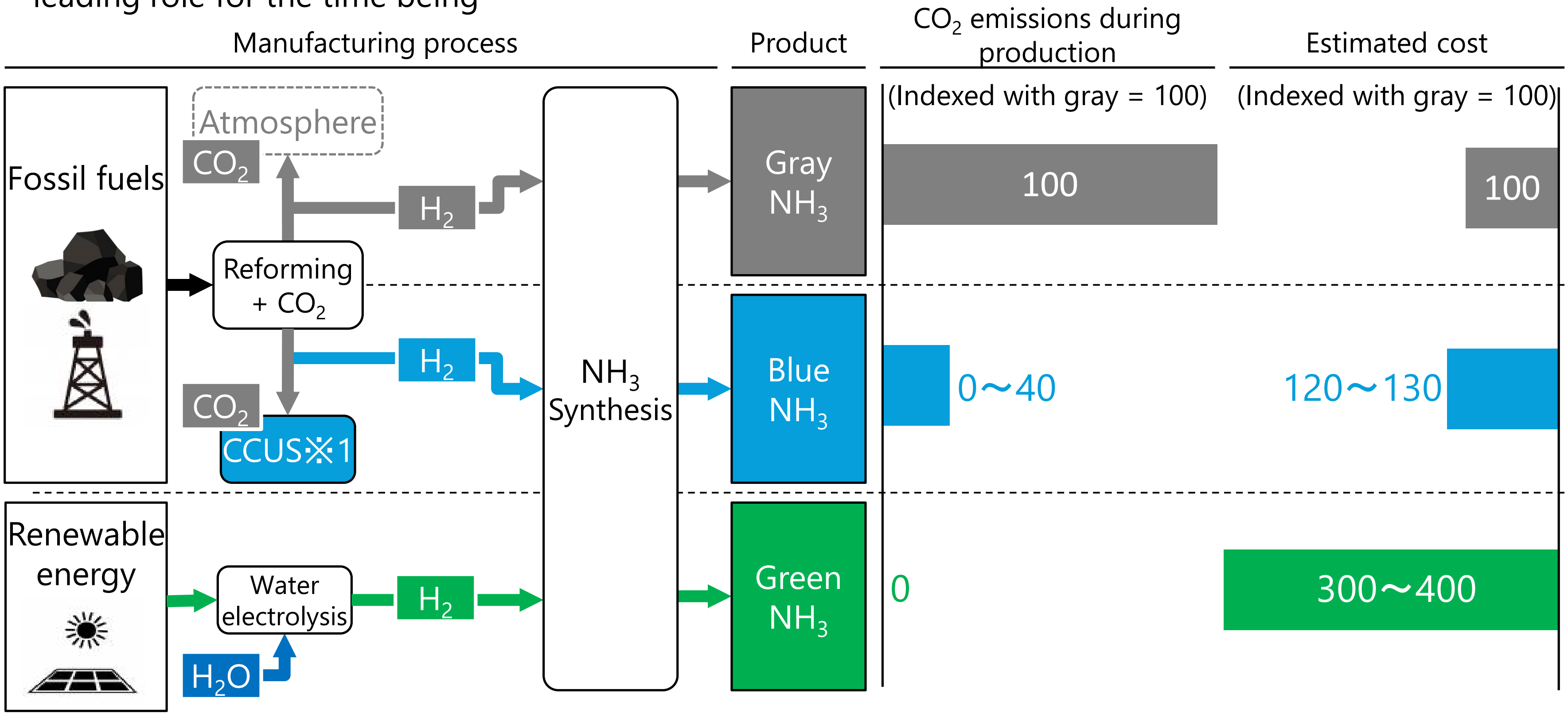
Estimated market size

30 to 100 million tons of demand in 2050 is expected for thermal power use



Market potential (2/2): by manufacturing method

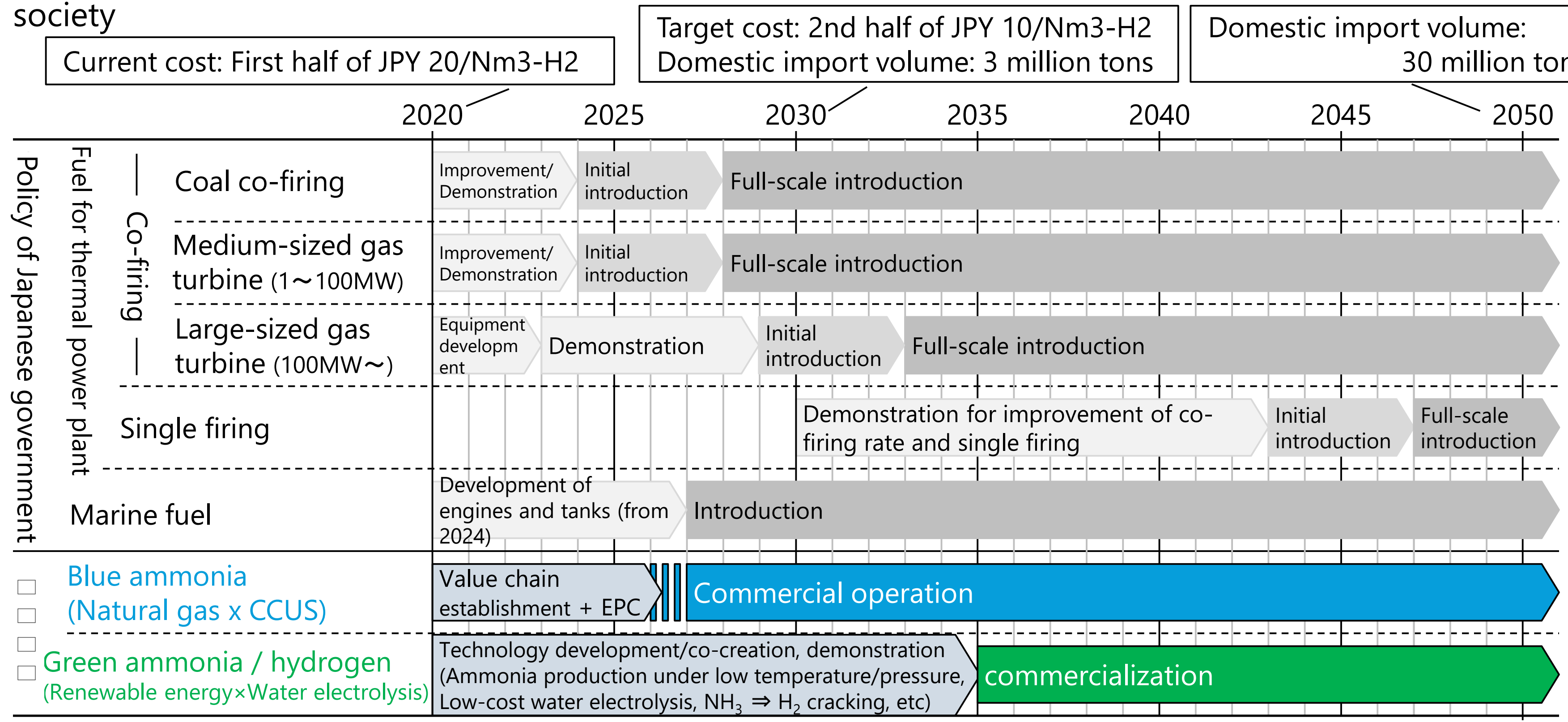
Achieving CO_2-free production is also essential. "Blue" ammonia, which is cost-competitive, will play a leading role for the time being



※1：CCUS：Carbon Capture, Utilization and Storage

TOYO's social implementation roadmap

Take steps to efficiently invest management resources looking ahead to a future green ammonia / hydrogen society



Source: Based on the roadmap of METI and the Green Ammonia Consortium

TOYO's solutions to major issues for social implementation

Solutions utilizing TOYO's strengths for the social implementation of blue ammonia

Major issues of blue ammonia		TOYO's Solutions (Strengths)
1 Cost reduction for production and transportation	Power generation price (/kWh) in case of 20% co-firing with coal-fired is about 1.2 times higher than that of coal single firing	✔ Optimum design backed by an abundant EPC experience of ammonia plants (market share of 11% in the world) ✔ Alliance with Licensor (KBR) for more than 50 years = plant enlargement by combining technologies
2 CO_2 utilization by CCUS	It is possible to reduce power generation price by monetizing CO_2 ● CO_2-EOR※ ● Carbon credits, etc	✔ Realization of CO_2 utilization based on the experience and knowledge of CO_2-EOR since the 1980s ✔ Partnership with Baker Hughes to improve the profitability of sub-surface and surface integration
3 Securing and diversifying stable suppliers	It is necessary to diversify procurement and secure stability from geopolitics viewpoint in case ammonia becomes main fuel for thermal power generation in the future	✔ Abundant project experience in Russia -> Feasibility study of value chain establishment with Irkutsk Oil, JOGMEC, and ITOCHU ✔ Many inquiries from Asia, the Middle East, North America, and South America

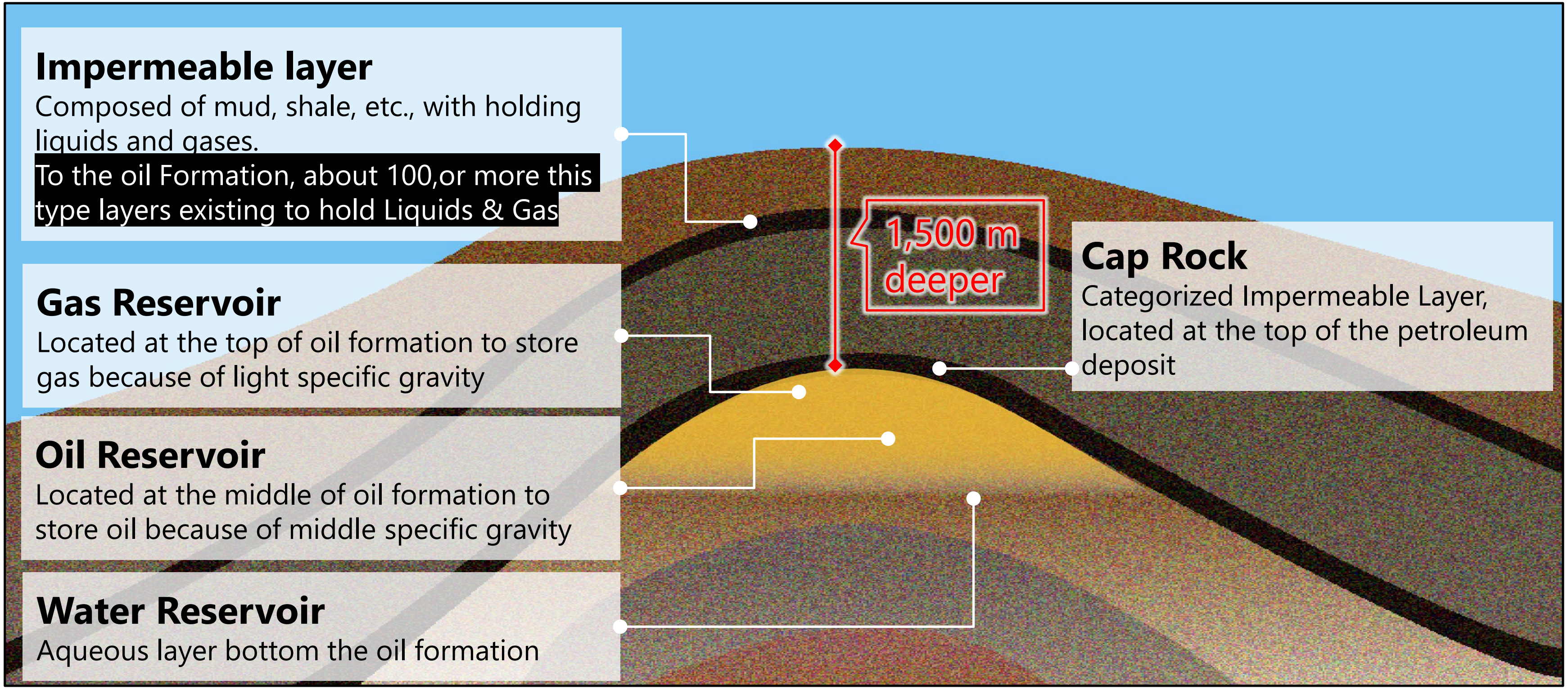
※CO_2-EOR (Enhanced Oil Recovery) is an enhanced oil recovery technology using CO_2 injection

【Deep Insight】

TOYO's knowledge of CO2-EOR which is the key to the social implementation of blue ammonia

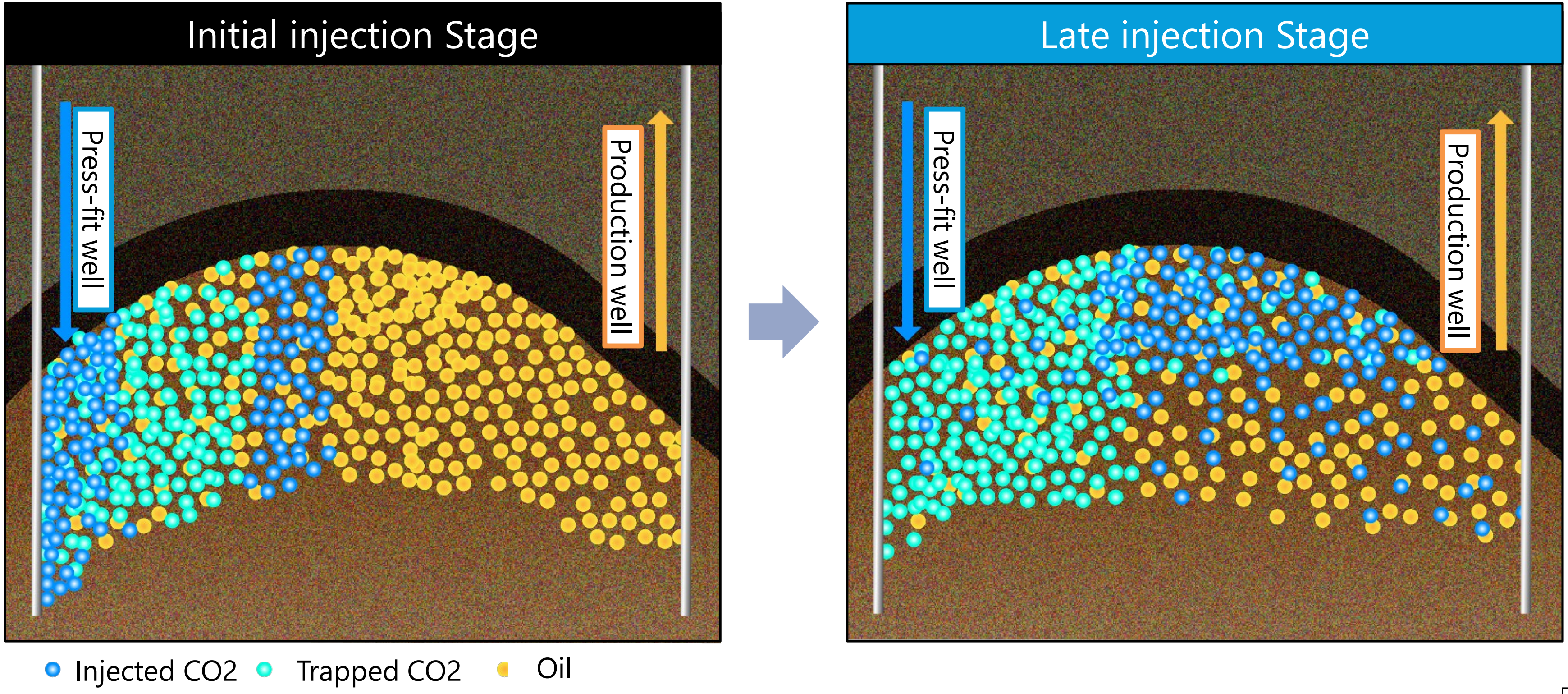
CO2-EOR (1/2): Typical oil field structure

Formation structure to enhance crude oil and gas recovery by injection CO2 generated from ammonia production into oil reservoir



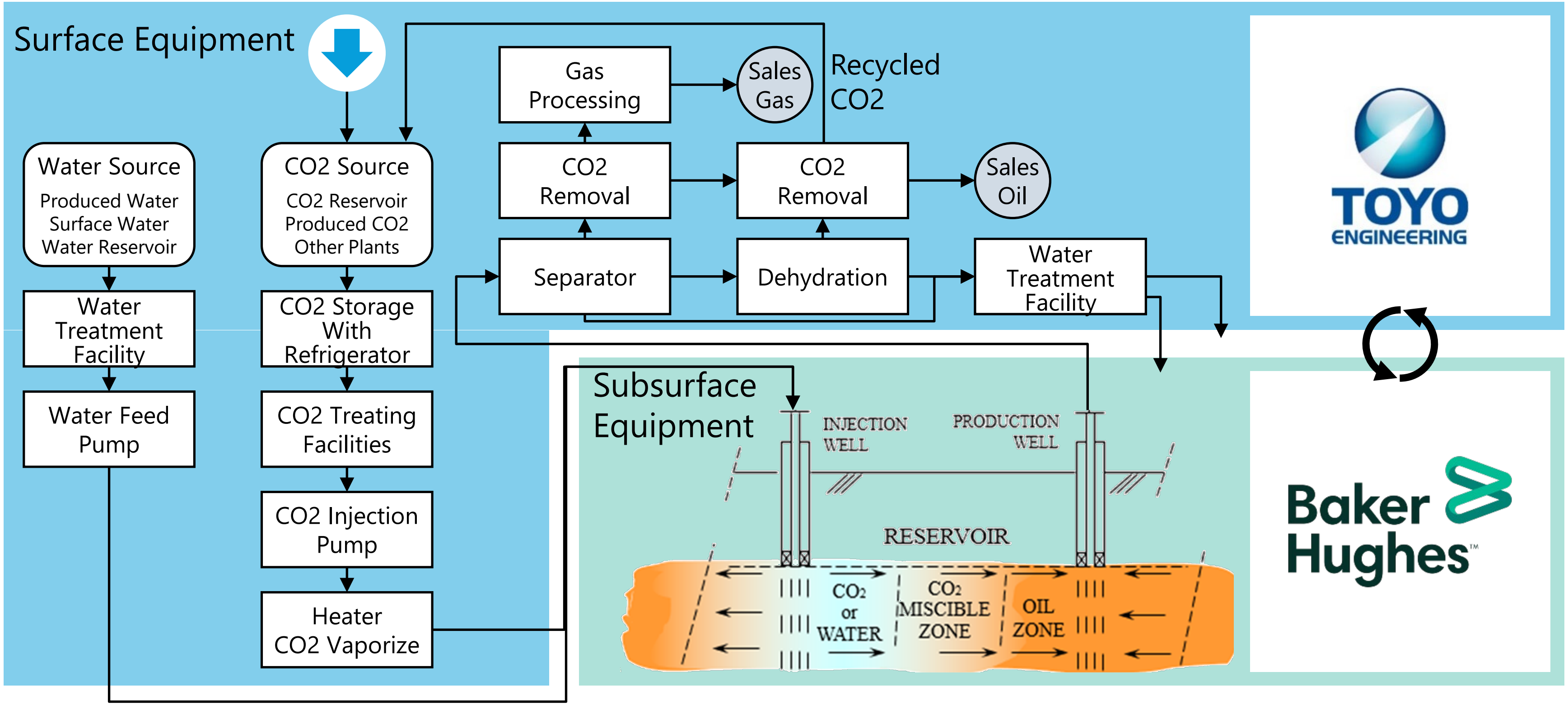
CO_2-EOR (2/2): CO_2 injection image

Injected CO_2 under high pressure replaces residual crude oil in the pore, to push free oil to production well. Some of high pressure CO_2 stays in the pore under CO_2 Mineralization Action.



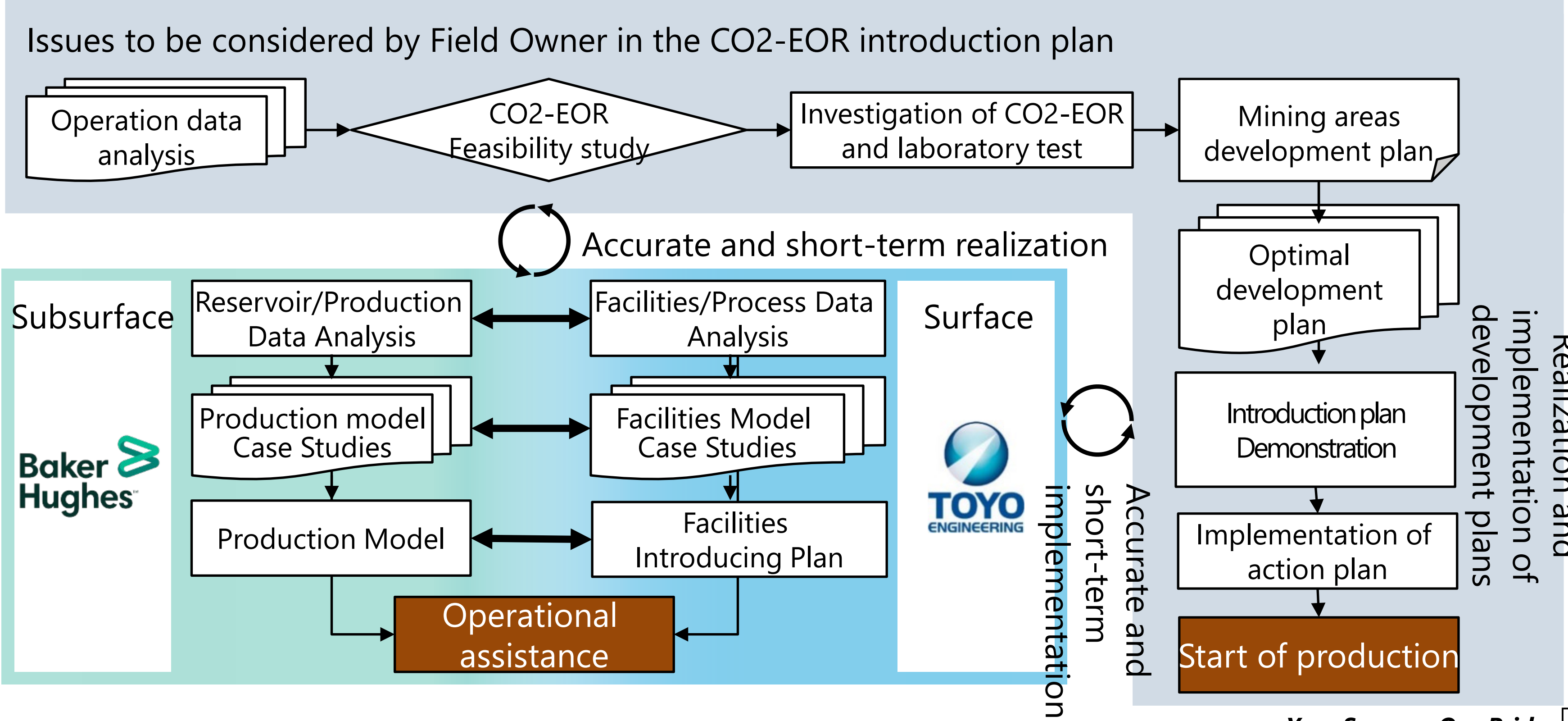
CO2-EOR Process (1/2): Subsurface and surface integration

One of the most effective Methods in EOR Application to Oil Field by integrated actions by surface facilities plan/design (TOYO) and subsurface injected formation plan (Baker Hughes)



CO2-EOR Process (2/2): Subsurface and surface integration

Effective Methods by integrated actions for surface plan/design (TOYO) and subsurface information plan (Baker Hughes)



TOYO's performance on IOR/EOR = 50 or more

EOR is applicable in all over the world, depending on the size of the oil and gas field

TOYO's performance on IOR/EOR

✓ = TOYO

Covering from the project concept development stages of oil and gas field to operation support after EPC

	Project Concept planning stage			Subsurface analysis planning			Planning and design of surface equipment			Operation	
	Initial Planning	Type Selection	Application Plan	Analysis	Drilling	Production Model	Planning	Design	Const-ruction	Planning	Super-visory
Turkey	Owner	With Owner	✓	Customer	✓	With Owner	✓	✓	✓	✓	✓
Europe	Owner	✓	✓	✓	Owner	✓	✓	✓	✓	✓	✓
Japan	Owner	Owner	Owner	Owner	Owner	Owner	✓	✓	✓	✓	Owner
Southeast Asia	✓	BH	With BH	BH	Owner	Owner	✓	✓	Owner	With BH	✓
Central America	✓	BH	With BH	BH	Owner	Owner	✓	✓	Owner	With BH	Owner
South America	✓	BH	With BH	BH	BH	—	✓	—	—	With BH	—
Russia	Owner	✓	✓	Other partners	Other partners	✓	✓	✓	—	✓	—

Today's content

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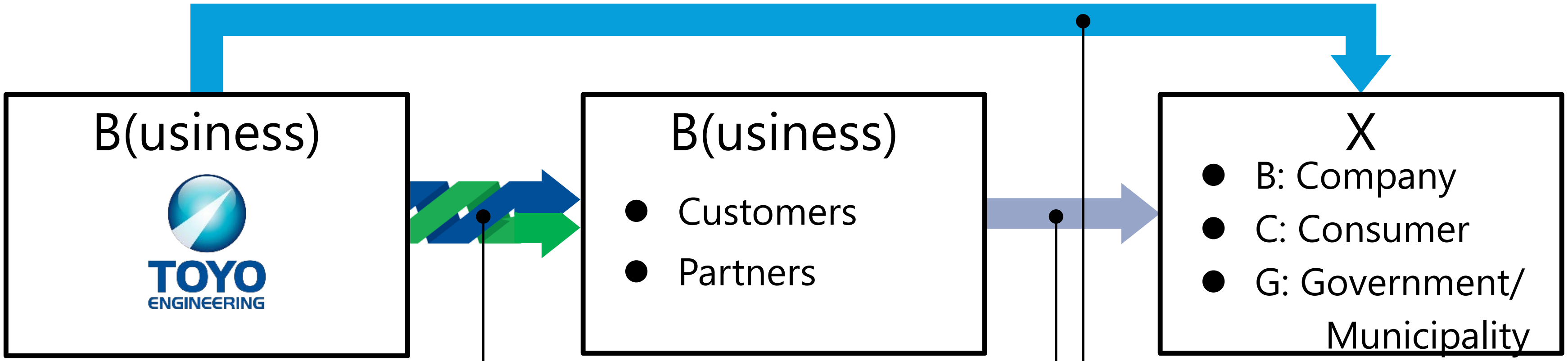
New business model (e.g., B2B2X model)

Expand business models beyond EPC through collaboration with customers and partners



Up to now: Expanding the Value Chain between TOYO and customers

R&D → FS → FEED → IPMT → EPC → O&M

← More Toward Upstream

Image of "Award = single-job" and competitiveness was the issue

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From now on: Co-creation of business structures, rules, regulations, etc involving "customer's customers" in addition to the reinforcement described on the left

-> The world is changing discontinuously

= The biggest business opportunity

Encourage the creation of business with customers and partners

Example of B2B2X Model: East Siberia fuel ammonia project

Feasibility study with Irkutsk Oil, JOGMEC, and ITOCHU to create a value chain

B(usiness)

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B(usiness)

JOGMEC

ITOCHU

X

- B: Company
- C: Consumer
- G: Government/ Municipality

Solutions utilizing TOYO's traditional strengths

- Feasibility study with technical verification
- Creation of Master Plan
- Completion of EPC

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Creating value chain by utilizing TOYO's technologies

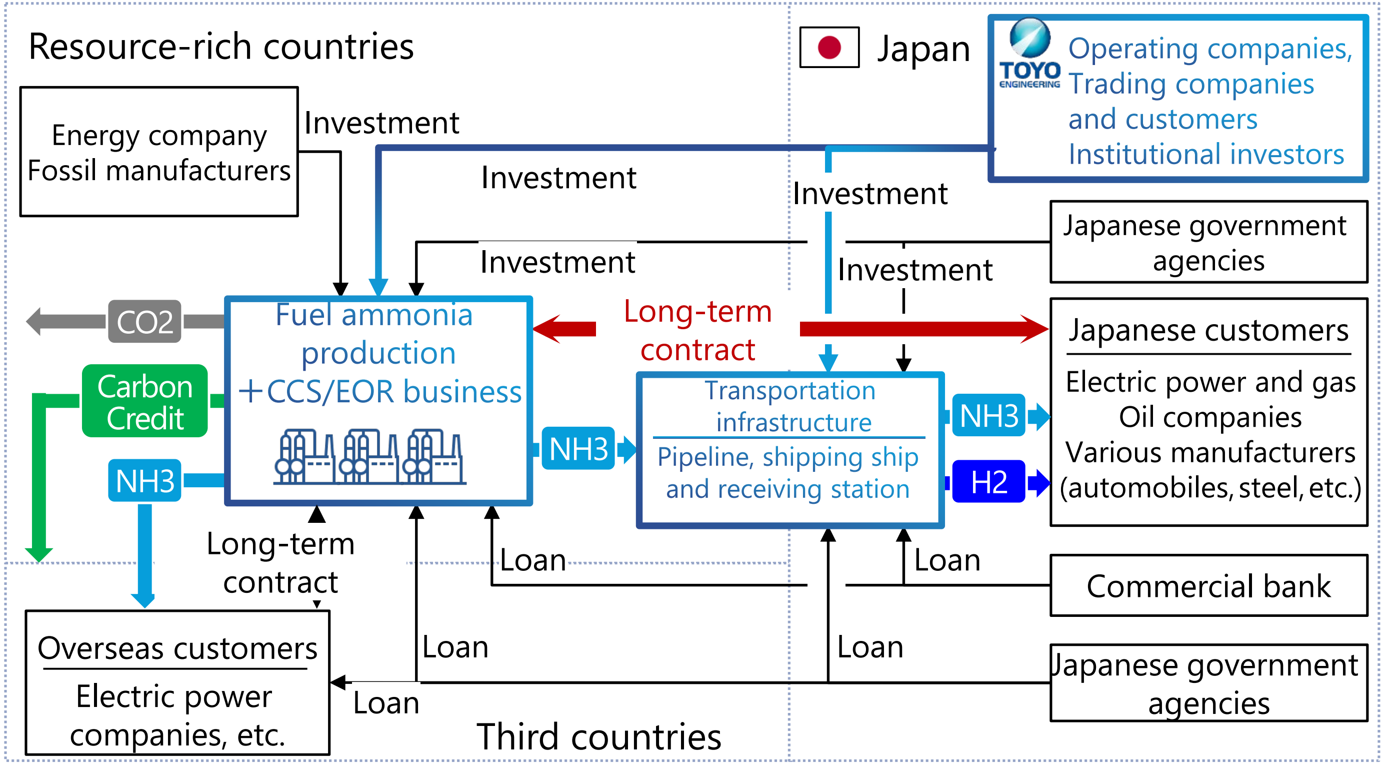
To Electric Power Company: Sales of Fuel Ammonia

To Others: Ammonia -> Conversion to Hydrogen -> Sales

To Consumer: Sales of generated power

Fuel Ammonia value chain concept and major issues

Co-creation from demand to value chain with partners by leveraging knowledge from resource development, EOR, and EPC



Major Issues

Creating demand

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Realization of economical import prices

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1. Cost reduction of ammonia production & transportation
2. To secure customers for CO2 credit
3. Making a long-term trading model
4. Improvement of carbon credit market
5. Preferential tax treatment
6. On a long-term, low-interest basis Financing


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