Transition Roadmap for the Shunan Power Corporation Power Plant in Shunan City, Yamaguchi Prefecture (an Overview)

In its Guidance on Metrics, Targets and Transition Plans ("the Guidance"), the Task Force on Climate-related Financial Disclosures (TCFD) encourages organizations to disclose key information from their transition plans, including the following.

- Current greenhouse gas (GHG) emissions performance
- Impact of low-carbon transition on businesses, strategy, and financial planning
- Actions and activities to support transition, including GHG emission reduction targets and planned changes to businesses and strategy
    - Target year, scope of GHG emissions, scope of businesses
    - Assumptions, uncertainties, and methodology

The Guidance also lists the following as elements to be considered in a transition plan.

- Alignment with climate change actions and business strategies
- Alignment with quantitative indicators and targets (alignment with science-based decarbonization pathways)
- Assumptions underlying effective governance processes
- Actionable, specific initiatives
- Credible planning
- Periodical review and updates
- Annual reporting to stakeholders

In line with the above, we have formulated a transition roadmap for the Shunan Power Corporation power plant, consistent with the international goals adopted in the Paris Agreement, containing the following items.

Item	References
1. Project Overview and Governance	・ Materials on Shunan Power Corporation's power plant project
2. Current status of GHG emissions and challenges (materiality of environmental aspects)	・ Ministry of Economy, Trade and Industry, "Review Report on the Draft Environmental Impact Statement for the Tokuyama Factory East Plant No. 3 Power Generation Facility Project" (February 2009) (in Japanese only) ・ Ministry of the Environment, "Opinions of the Minister of the Environment on the Draft Environmental Impact Statement for the Tokuyama Factory East Plant No. 3 Power Generation Facility Project" (April 17, 2009)
3. Impact of low emissions transition in the electricity sector on the power generation business	・ IPCC Special Report "Global Warming of 1.5°C" ・ IEA, "Net Zero by 2050: a Roadmap for the Global Energy Sector" ・ Ministry of Economy, Trade and Industry, "Transition Roadmap for the Power Sector" (February 2022) (in Japanese only)
4. Short-, medium-, and long-term GHG emission reduction targets and indicators consistent with the Paris Agreement	・ Transition Pathway Initiative (TPI) "Sectoral Decarbonisation Pathways" ・ IPCC WG III contribution to the Sixth Assessment Report, Technical Summary

5. Business transformation roadmap for achieving zero emissions at East No 3. power plant	・ Ministry of Economy, Trade and Industry, "Transition Roadmap for the Power Sector" (February 2022) (in Japanese only) ・ Mitsubishi Heavy Industries, Engineering Communication Sheet (July 22, 2020)

Transition Roadmap for the Shunan Power Corporation Power Plant in Shunan City, Yamaguchi Prefecture (Details)

1. Project Overview and Governance

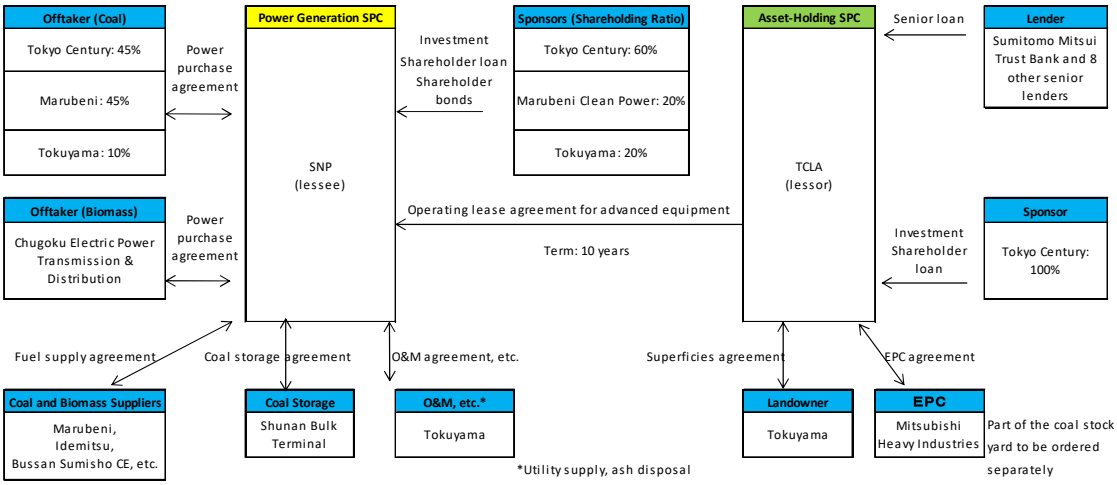
This project refers to the construction and operations of a new co-firing power plant that uses coal and woody biomass, with a generating-end output of 300,000 kW, at 7-46, 7-51, and 7-52 Harumi Town, Shunan City, Yamaguchi Prefecture, Japan ("the power generation project"). The project site is on the premises of the East Plant of the Tokuyama Factory owned by Tokuyama Corporation ("TK"), and the name of the power plant is Tokuyama Factory East Plant No. 3 Power Generation Facility ("East No. 3"). This power generation project is scheduled to start commercial operations in September 2022.

East No. 3 was originally planned as a private power plant at TK's Tokuyama Factory. Stable, inexpensive electricity is indispensable for manufacturing polycrystalline silicon, one of the main products of the factory, and the purpose of the project was to meet the need for an expansion in the private power plant to increase production at the site, which was under consideration at the time, as well as to address the anticipated future need to replace the outdated private power plant. Plans for construction were prepared and an environmental assessment was conducted in 2009. Due to the subsequent change in circumstances surrounding TK, however, the company began approaching its main business partners and other parties in December 2014 with the intention of jointly operating a business with a third party. Eventually, Marubeni Corporation ("MC") expressed interest and approached Tokyo Century Corporation ("TC") about a possible joint venture. In April 2015, MC and TC presented TK with a joint proposal for the power generation project as a collaborative venture among the three companies, and after repeated discussions, the three officially decided to enter into the power generation project in September 2017. An agreement had also been reached in March 2017 to adopt coal-biomass co-firing instead of coal-based mono-firing.

TCLA Limited Liability Company ("TCLA"), an asset-holding, special purpose company (SPC), and Shunan Power Corporation ("SNP"), a power generation SPC, were established as part of the power generation project. Under the plan, TCLA will construct the power plant, and once operations start, SNP will operate it under an operating lease agreement, with SNP taking over operations related to an environmental assessment from TK. TCLA was established by TC, and SNP was established by TC with a 60% equity share, TK with a 20% equity share, and Marubeni Clean Power Corporation ("MCP") with a 20% equity share. TCLA will obtain project financing for the power generation project by seeking loans from financial institutions. TCLA will be responsible for decision making as the client in the construction work for East No. 3, which will be handled by Mitsubishi Heavy Industries, Ltd. ("MHI"). In addition, SNP will conclude an operation and maintenance (O&M) contract for East No. 3 with TK.

TC, as the main sponsor of TCLA and SNP, has indicated its intention to decarbonize the power generation project by increasing the biomass co-firing ratio and switching to zero-emission power generation in the future. As a joint venture of the three companies (TC, TK, and MCP), the transition roadmap for East No. 3 is premised on coordination among the three companies.

Project Scheme



2. Current Status of GHG Emissions and Challenges (Materiality of Environmental Aspects)

On April 17, 2009, the Ministry of the Environment submitted the opinions of the Minister of the Environment on the draft environmental impact statement for the power generation project to the Minister of Economy, Trade and Industry, including a request for further reductions in carbon dioxide and air pollutants emitted from operations of the facility. The Minister of the Environment opinions called for reducing the carbon dioxide emissions intensity of the entire power generation facility by selecting a type of coal with low carbon dioxide emissions intensity and by co-firing biomass and other fuels as much as possible to reduce greenhouse gas emissions from overall project activities.

The power generation project plans to use white pellet (WP) at a co-firing ratio of 20 cal% at the start of operations, and the CO_2 emissions intensity is estimated at 592 g-CO_2/kWh*[1], excluding CO_2 emissions from WP from the calculation. Annual CO_2 emissions are estimated to be 300,000 kW output × 7,543 h/year (operating ratio) × 592 g-CO_2/kWh (CO_2 intensity)/1,000,000 ≈ 1,339,637 t-CO_2/year. The average CO_2 emissions intensity of ultra-supercritical (USC) coal-fired power generation in Japan is estimated to be 820 g-CO_2/kWh, but with the CO_2 intensity of the entire power sector estimated to be 470 g-CO_2/kWh in fiscal 2019, further CO_2 reductions will be required.

The environmental load of air pollutants must also be reduced by practicing stringent maintenance and management of flue gas denitrification equipment, desulfurization equipment, and electrostatic

*1: Mitsubishi Heavy Industries, Engineering Communication Sheet (July 22, 2020)

precipitators, and by taking additional appropriate measures as necessary to reduce the emission concentration of soot, nitrogen oxides, sulfur oxides, and other substances. Once operations start, emissions of trace substances such as heavy metals contained in coal must be promptly measured to confirm the validity of projections, and appropriate monitoring must also be conducted if the properties of the fuel used by the plant differ significantly from those in initial plans. Another important consideration is to request that appropriate measures be taken to manage coal dust during operations of the Shunan Bulk Terminal.

3. Impact of Low Emissions Transition in the Electricity Sector on the Power Generation Business

Global Trends:

Net-Zero Emissions Must be Achieved by 2050 to Limit Global Temperature Rise to 1.5°C

The Paris Agreement, adopted in 2015, set a common global goal of constraining the rise in global temperatures at well below 2°C over pre-industrial levels and pursuing efforts to further limit the rise to 1.5°C of pre-industrial levels. Subsequently, "Global Warming of 1.5°C," a special report released in 2018 by the Intergovernmental Panel on Climate Change (IPCC), indicated that to limit the increase in temperature by the end of the century to 1.5°C above pre-industrial levels, global CO_2 emissions must be reduced by 45% from 2010 levels by 2030, and to net-zero by 2050*[2]. At the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP26), held in 2021, the international community adopted a decision document stating its commitment to further pursue the goal of limiting the rise in global average temperature to 1.5°C, as laid out in the Paris Agreement. This has given an additional boost to initiatives for achieving net-zero GHG emissions. The IPCC's latest Sixth Assessment Report (Working Group III Report) noted that in order to limit the temperature increase to 1.5°C, global CO_2 emissions must be reduced by 50% from 2019 levels by 2030*[3].

A broad range of international organizations, including the IPCC, have noted the need to expand and urgently decarbonize the power sector, which is the largest source of CO_2 emissions. According to the net-zero scenario of the International Energy Agency (IEA), the power generation sector in developed countries will be required to achieve net-zero GHG emissions by 2035, while net-zero will be required globally by 2040. The IEA has pointed out that inefficient coal-fired power plants must be phased out by 2030, and those without CO_2 capture and storage (CCS) equipment must be reduced by 70%*[3]. It also points out that the emissions intensity of the electricity sector needs to be rapidly reduced from the 2019 global average of 0.468 t-CO_2/MWh (468 g-CO_2/kWh) to 0.138 t-CO_2/MWh (138 g-CO_2/kWh) by 2030*[4]. In the IPCC's Sixth Assessment Report (Working Group III Report), the scenario for limiting the temperature increase to 1.5°C clearly states that the CO_2 emissions intensity of the electricity sector needs to be reduced by 75% by 2030 compared to levels in 2019 (equivalent to about 117 g-CO_2/kWh)*[5].

*2: IPCC Special Report Global Warming of 1.5 ºC
*3: IEA Net Zero by 2050: https://www.iea.org/reports/net-zero-by-2050
*4: Transition Pathways Initiative: Carbon Performance Assessment of Electricity Utilities: Note on Methodology, November 2021
https://transitionpathwayinitiative.org/publications/94.pdf?type=Publication
*5: IPCC WG III contribution to the Sixth Assessment Report, Technical Summary, p34

Domestic Trends:

Transition Roadmap for the Power Generation Sector for Achieving Carbon Neutrality by 2050x

In October 2020, the Japanese government declared its goal of reducing overall GHG emissions to net zero and thereby achieving carbon neutrality by 2050. This was followed by an announcement in April 2021, in which the Japanese government stated its GHG emission reduction target of 46% by fiscal 2030 compared to fiscal 2013 levels, while continuing strenuous efforts in its challenge to meet the ambitious goal of reducing emissions by 50%. These reduction targets have been submitted to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) as Japan's Nationally Determined Contribution (NDC) under the Paris Agreement.

Given Japan's medium- to long-term targets for decarbonization, the reduction of CO_2 emissions from the energy conversion sector*[6], which accounts for about 40% of emissions in Japan, is urgent. In October 2021, the Cabinet of Japan approved a revised Plan for Global Warming Countermeasures based on the Law Concerning the Promotion of the Measures to Cope with Global Warming, which set the reduction rate of GHG emissions from the energy conversion sector at 47%, compared to fiscal 2013, in order to achieve the 46% reduction target by 2030. In addition, the Sixth Strategic Energy Plan, approved by the Cabinet of Japan in October 2021, laid out a future path for energy policy based on a long-term view toward achieving carbon neutrality by 2050 and policy responses for 2030 based on the outlook. The plan also revised the energy supply and demand outlook for 2030 and calls for maximizing the introduction of renewable energy, phasing out inefficient coal-fired thermal power generation, as well as reducing the ratio of thermal power generation as much as possible. Furthermore, it clearly states that the share of thermal power in the electricity mix should be reduced from around 76% in fiscal 2019, to around 41% (LNG-fired: 20%, coal-fired: 19%, oil-fired: 2%) by fiscal 2030.

Realizing these projections is expected to result in a 45% reduction in energy-derived CO_2 (including industrial, business, household, and transportation sectors) from fiscal 2013 levels. Assuming that emissions from the energy conversion sector will be reduced by 47% by 2030, and based on an average CO_2 intensity of 552 g-CO_2/kWh*[7] for electricity in Japan as of fiscal 2013, emissions intensity will fall to 292.6 g-CO_2/kWh by 2030. Meanwhile, if we apply the CO_2 intensity of 470 g-CO_2/kWh for the electricity sector as of fiscal 2019, which is the standard base year adopted by the international community for achieving net-zero emissions, a 50% reduction would mean 235

g-CO_2/kWh. However, if we align ourselves with the global standard and apply the CO_2 emissions intensity of 138 g-CO_2/kWh for the global power generation sector in 2030, which is consistent with achieving the 1.5°C target as estimated by the above-mentioned international institutions such as the IPCC and IEA, the power sector in Japan will be expected to set CO_2 reduction targets that are even more ambitious than current targets as set by the Japanese Government.

*6: The sector that converts primary energy, such as coal and oil, into secondary energy, such as electricity

*7: Federation of Electric Power Companies of Japan: https://www.fepc.or.jp/english/environment/global_warming/index.html

(Reference) Comparison of CO_2 Emissions Intensity and Decarbonization Scenario for the Power Sector (g-CO_2/kWh)

Scenario	2019	2030	2040	2050
IEA Net Zero (Global)	468	138	0	
Sixth Strategic Energy Plan (Japan)	470	293	—	0

Positioning and Sustainability of Biomass Power Generation

In the Transition Roadmap for the Power Sector, released by the Agency for Natural Resources and Energy in December 2021, promotion of biomass power generation constitutes an important part of initiatives for zero-emission thermal power generation, which also includes hydrogen, ammonia, CCUS utilization, and other means.

On the other hand, fuel costs account for the majority of biomass power generation costs. Therefore, the Sixth Strategic Energy Plan notes that the challenge of expanding the introduction of biomass power generation lies in reducing fuel costs while ensuring stable procurement and sustainability of limited biomass fuel. The key measures include establishing quality standards for woody biomass fuels to stimulate market transactions, reducing fuel costs, and ensuring the stability of the forestry business. In addition, to ensure the sustainability of biomass fuels, the FIT/FIP system requires using fuels that meet sustainability standards formulated by conducting specialized and technical discussions from the perspectives of the environment, society, labor, and governance, as well as compatibility with food supply and demand, and life cycle greenhouse gas emissions. The method of confirming the sustainability of biomass fuels involves clarifying the evaluation criteria for obtaining third-party certification and requires supply chain traceability from the point of origin to the power plant for main products, and from the point of origin of the fuel to the power plant for co-products.

4. Short-, Medium-, and Long-Term GHG Emission Reduction Targets and Indicators Consistent with the Paris Agreement

For the transition of the power generation project, it is important to set targets consistent with the goal of pursuing the Paris Agreement's best-effort target of limiting global temperature rise to less than 1.5°C above pre-industrial levels. Since the current emissions intensity of East No. 3 is higher than the CO_2 emission intensity of the entire power sector as of fiscal 2019, the first step is to lower the CO_2 emissions intensity as soon as possible after the start of commercial operations, with due consideration for economic feasibility and viability. If the biomass co-firing ratio is raised from the current 20 cal% to 29.3 cal%, which is the upper limit under the FIT system, the CO_2 emissions intensity of East No. 3 is expected to decrease by approximately 11% from 592 g-CO_2/kWh to 525 g-CO_2/kWh. In addition, further improvement in the co-firing ratio can be achieved by switching to using black pellet (BP) biomass, which is relatively higher in calorific value and combustibility and is suitable for mono-fuel combustion. Based on a rough estimate, the CO_2 emissions intensity at East No. 3 can be reduced by approximately 33% from levels at the start of commercial operations by increasing the biomass co-firing ratio to 50 cal% over the medium term.*[8]

As a medium- to long-term target for 2030, in addition to a biomass co-firing ratio for BP of at least 50 cal%, if the ammonia co-firing ratio can be raised to at least 20 cal% and coal consumption is kept below 30% of calorific value to the extent possible, it is estimated that emissions at East No. 3 will be reduced by at least 50% compared to levels at the start of commercial operations (assuming that higher co-firing ratios for zero-emission ammonia is technically established through ongoing verification projects currently overseen by the Ministry of Economy, Trade and Industry and others). In order to meet the higher levels of CO_2 reduction required by international climate scenarios, achieving net-zero emissions by 2040 will be the long-term goal for East No. 3, assuming that high levels of biomass-ammonia co-firing will be verified and established from a technological standpoint. Where the introduction of biomass-ammonia co-firing technology significantly impairs business profitability, the use of highly reliable carbon credits and the introduction of bioenergy and CCS technology will also be considered for achieving the target.

CO_2 Emission Reduction Targets for Achieving Net-Zero Emissions at East No. 3

Period	Measures	Emission Factor Estimates	Reduction rate
At start of operations (September 2022)	Operate at WP co-firing ratio of 20 cal%	592 g-CO_2/kWh	—
Short term (2022 to 2023)	Increase WP co-firing ratio from 20 cal% to 23 cal% and introduce BP at co-firing ratio of around 6 cal% toward achieving biomass co-firing	525 g-CO_2/kWh	11%

	ratio of 29.3 cal%, the upper limit of FIT; prepare for verification, procurement, and operation for switch to BP		
Medium term (2025)	Increase BP co-firing ratio to 50 cal% (or WP-BP co-firing ratio of 50 cal%); prepare plans for ammonia procurement and verification	380-410 g-CO_2/ kWh	Maximum 33%
Medium to long term (2030)	Operate at BP co-firing ratio of 50 cal% (or WP-BP co-firing ratio of 50 cal%), operate at ammonia co-firing ratio of at least 20 cal% (fuel ratio to be adjusted based on performance advantage)	<292 g-CO_2/ kWh*	50% or higher
Long term (2040)	Operate at BP co-firing ratio of 50 cal% (or WP-BP co-firing ratio of 50 cal%), operate at ammonia co-firing ratio of 50 cal% (fuel ratio to be adjusted based on performance advantage)	0-CO_2/kWh*	100%

*Note: The emissions intensity of co-firing ammonia with BP at co-firing of over 50 cal% is estimated based on the assumption that each 1 cal% increase in the biomass-ammonia co-firing ratio is equivalent to a 1% reduction in emissions intensity. The above figures require verification by the plant manufacturer.

*8: Estimated value confirmed based on hearing conducted with MHI engineers. Since it will be difficult to achieve a biomass co-firing ratio of 50.0 cal% by operating the plant based on specifications for existing equipment, verification will be required based on specifications for boiler performance after modifications are made to the facility.

5. Business Transformation Roadmap for Achieving Zero Emissions at East No. 3 power plant

The target values of the transition roadmap for this power generation project indicate a pathway for realizing carbon neutrality in the power sector by 2040 in line with international scenarios and are based on the following premises.

- Given the possibility that operating East No. 3 with a biomass co-firing ratio of above 20 cal% may create constraints on individual equipment, no such constraints should in practice occur, and even if they are present, additional capital investment should not pose any technical or

business feasibility issues.

- Given that increasing the biomass co-firing ratio from around 30 cal% to 50 cal% may require modifications to current facility specifications for East No. 3, additional capital investment costs and fuel conversion to biomass should not significantly impair the profitability of the project.
- In the medium to long term, in addition to biomass co-firing, the technology for feeding ammonia into thermal power plants at a ratio of at least 20 cal% should be verified and established by 2030.
- Given the long-term goal of achieving zero emissions for this power generation project by 2040, stable procurement of biomass and ammonia (either blue or green) should be ensured, and the economics of biomass-ammonia co-firing should improve.
- CO_2 emissions from biomass fuel combustion are not included in the calculation.

Future Considerations for Business Transformation

The following considerations should be taken into account to achieve the above reduction targets.

- Given that the upper limit of the WP co-firing ratio may be around 23 cal%, as opposed to the planned increase in the WP co-firing ratio from 20 cal% to 29.3 cal%, adjustments to equipment and verification should be implemented to enable procuring BP for the remaining biomass volume and feeding it directly into the coal mill.
- Needs and costs of equipment modification/retrofitting to accommodate BP input and other issues (to be confirmed with the manufacturer)
  - Cargo handling, yard, port facilities, conveyors, coal and biomass mills, boilers, dust collectors, handling covers, cooling systems for controlling dust explosion, and other equipment
  - Modifications to equipment required for increasing the biomass co-firing ratio from 29.3 cal% to at least 50 cal% based on BP input
- Confirm volume and costs of procuring BP, as well as quality and traceability (LCA of GHG emissions, including sourcing origin and supply chain) (to be confirmed with fuel suppliers)
  - Identification of BP suppliers and origin
  - BP quality assurance (including environmental and forest certifications and third-party certification for legality and sustainability)
  - BP procurement costs
- Equipment modifications for accommodating ammonia and related issues (to be confirmed with the manufacturer and fuel suppliers)
  - Technical feasibility
  - Facility remodeling and renovation, infrastructure development
  - Financing

- Outlook on ammonia procurement volume, environmental performance, and costs (assuming a survey is conducted by fuel providers and external agencies)
  - LCA of GHG emissions from the ammonia manufacturing process of suppliers (use of renewable energy sources, natural gas, and other sources)
- Analysis of economic rationality of biomass-ammonia co-firing (assuming research by external agencies)
- Relationship to peripheral businesses and operations
  - Positioning within TK's factory
  - Positioning within industrial complexes in the Shunan area
  - Progress in the carbon neutral port project at Tokuyama-Kudamatsu Port, and potential for collaboration
  - Possibility of participation in METI's verification project on ammonia co-firing at East No. 3

Investment Plan for the Transition Roadmap

Phase and Content	**Equipment to Be Considered for Investment**	**Implementation Period**
Phase 1 Maximize co-firing ratio using WP at the current facility (assuming 22–23 cal%)	—	FY2022
Phase 2 Introduce BP to increase the co-firing ratio to 29.3 cal% (upper limit of biomass co-firing ratio under FIT)	● Equipment* required for additionally procuring BP and directly feeding it into the coal mill to achieve the 29.3 cal% biomass co-firing ratio based on the results of Phase 1 (including modification and verification of cargo handling, yard, port facilities, conveyors, coal and biomass mills, boilers, dust collectors, handling covers, and cooling systems for controlling dust explosion) *Actual equipment requirements and costs must be confirmed with the manufacturer and relevant stakeholders.	FY2023–FY2024
Phase 3 Aim to raise biomass co-firing ratio to 50 cal% or higher by increasing the	● Equipment required for additionally procuring BP and directly feeding it into the coal mill to achieve the 50 cal% biomass co-firing ratio based on the results of Phase 2 (including	FY2024–FY2025

BP co-firing ratio	modification and verification of cargo handling, yard, port facilities, conveyors, coal and biomass mills, boilers, dust collectors, handling covers, and cooling systems for controlling dust explosion) *Actual equipment requirements and costs must be confirmed with the manufacturer and relevant stakeholders.	
Phase 4 Aim for ammonia co-firing ratio of 20 cal% in addition to biomass co-firing ratio of 50 cal% or higher (coal: 30 cal% or less)	● Begin analysis and research on technical feasibility studies and business profitability to achieve ammonia co-firing ratio of 20 cal% in addition to biomass co-firing ratio of at least 50 cal%, consult with plant manufacturers, fuel suppliers, and related stakeholders regarding necessary facility modifications, infrastructure development, and funding, and implement modification plans and verification tests to determine whether commercial operation of ammonia co-firing is possible.* *Content regarding the technical feasibility of high-level ammonia co-firing will be revised as needed and based on progress of government verification projects and other developments.	FY2026–FY2030
Phase 5 In addition to achieving biomass co-firing ratio of 50 cal%, aim to operate at ammonia co-firing ratio of 50 cal% (coal: 0-cal%)	● Equipment including high-level ammonia co-firing and mono-fuel combustion burners for realizing biomass-ammonia co-firing at ratios of 50 cal% each, or mono-fuel firing of either biomass or ammonia based on the results of verification in Phase 4; equipment for fuel procurement, transportation, supply and storage, and equipment required for achieving zero emissions at East No. 3	To FY2040