



Development-focus Businesses

In the Development-focus Businesses, we acknowledge a wide variety of social issues in countries around the world, identify issues to be solved from the lifecycle and value chain perspectives, and aim to create new businesses that are rooted in the local community while building new business models.

Currently, this activity centers around the building of an Ammonia Value Chain. We will steadily build up the Ammonia Value Chain and, at the same time, continue to search for and create further new businesses.

Significance of the IHI Group's Construction of an Ammonia Value Chain

The IHI Group aims to transform its business model from a model centered on selling equipment to one that provides value across the entire value chain. Currently, we are promoting the Ammonia Value Chain business as the center of this transformation. In order to contribute to our customers' efforts to reduce CO₂ emissions, we aim to create and expand business by providing clean ammonia fuel in combination with the IHI Group's technologies in utilizing ammonia (downstream) and receiving and storing ammonia (midstream), and by building a value chain that links upstream and downstream.

Ammonia does not emit CO₂ when burned. Focusing on this property, the IHI Group has been developing ammonia combustion technology for more than 10 years. As a result, we can provide equipment that utilizes world-leading technologies in ammonia combustion, such as boilers, gas turbines, and gas engines. Additionally, in ammonia-receiving and storage facilities, we are able to develop and provide facilities for ammonia by leveraging our experience in the LNG field, a field in which we boast top-class market share. By utilizing these advanced technical capabilities in the midstream and downstream of the Ammonia Value Chain, as well as by participating in ammonia production projects and supplying clean ammonia fuel to our customers, we can provide value throughout the value chain, connecting upstream and downstream. We are also developing methods to ensure the operation and safety management of equipment and facilities for the use of ammonia as a new fuel and building a platform to provide customers with measurements of the environmental value of the entire value chain. The IHI Group is able to enhance the value of ammonia as a new fuel and contribute to the realization of a decarbonized society, precisely because as a manufacturer, the IHI Group is committed to the entire value chain, including fuel supply.

Status of Constructing the Ammonia Value Chain

The Ammonia Value Chain business that the IHI Group is working on is making steady progress toward social implementation. In the upstream ammonia manufacturing projects, we are currently studying the manufacturing and marketing of green ammonia in India and Australia, and we believe that we are approaching the time of investment. In midstream ammonia storage and transportation, we have made progress with our domestic and overseas partners and are participating in a study of multiple ammonia-receiving terminals in Japan. In downstream ammonia utilization, we are making steady technological advancements and preparing for the social implementation of utilization equipment through various studies and tests. These include a demonstration test to convert fuel from coal to ammonia in a coal-fired thermal power generation plant, long-term durability testing conducted prior to demonstration for small-scale gas turbines combusted exclusively with ammonia, studies for the development and commercialization of large-scale gas turbines combusted exclusively with ammonia, and trials of ammonia engines for marine use.

Large quantities of ammonia are needed to use ammonia as fuel. Therefore, we must align the timing of upstream, midstream, and downstream social implementation. Even if ammonia utilization equipment becomes available, it cannot be operated without a supply of ammonia. Similarly, ammonia cannot be supplied without ammonia storage and transportation. By addressing the entire Ammonia Value Chain, the IHI Group will organically link upstream, midstream, and downstream in a timely manner to ensure social implementation.

Development-focus Businesses

We aim to contribute to the decarbonization of economies through the building and commercialization of an Ammonia Value Chain, and to create a business that will be paired with the Aero Engine and Rocket fields.

Kensuke Yamamoto

Executive Officer
Deputy General Manager of
Business Development Headquarters



Q What are the roles that should be played by the fuel Ammonia Value Chain businesses and the operating structure?

We aim to accelerate the building and commercialization of Ammonia Value Chain, and to create a business that will be paired with the Aero Engine and Rocket fields.

The Business Development Headquarters leads the entire process and is in charge of drafting the strategies to build the value chain. Projects that concern utilization are carried out with the Resources, Energy & Environment Business Area, and the development of new technologies is performed mainly by the Strategic Technologies Division and Corporate Research and Development Division. Each division is working together to organically link all activities to maximize results in the minimum amount of time.

Q What numerical targets do you have?

The Group targets approximately 900.0 billion yen in 2050 as revenue from the entire Ammonia Value Chain business. We hope to generate value in the entire value chain, leveraging our strengths, the ammonia utilization technologies in boilers, gas turbines, and engines, as well as the ammonia receiving/storage technologies, and also participating in ammonia production and supply business. By building a value chain from upstream to downstream, we aim to create new businesses and expand revenue. In terms of profitability, we currently anticipate a profit margin equal to the average of the IHI Group. However, we believe that further improvements in profitability can be expected depending on the status of future technological development, the development of Lifecycle businesses, and the speed of the proliferation of fuel ammonia.

Q What are the strengths and strategies that support the building of a fuel Ammonia Value Chain?

The IHI Group's strength lies in its ammonia utilization technologies that lead to decarbonization in the fields of electricity, industry, and marine vessels. And this is also the source of our competitiveness. In the early days of building the Ammonia Value Chain, it is very important to create the demand for fuel ammonia. The IHI Group is in a unique position in which we can not only attract off-takers leveraging ammonia utilization technology, but also build value chains quickly by investing in upstream green ammonia production projects and supplying ammonia to off-takers. First we will build small value chains to achieve results, continue to improve, and create and expand markets both in Japan and overseas to contribute to the realization of a decarbonized society.

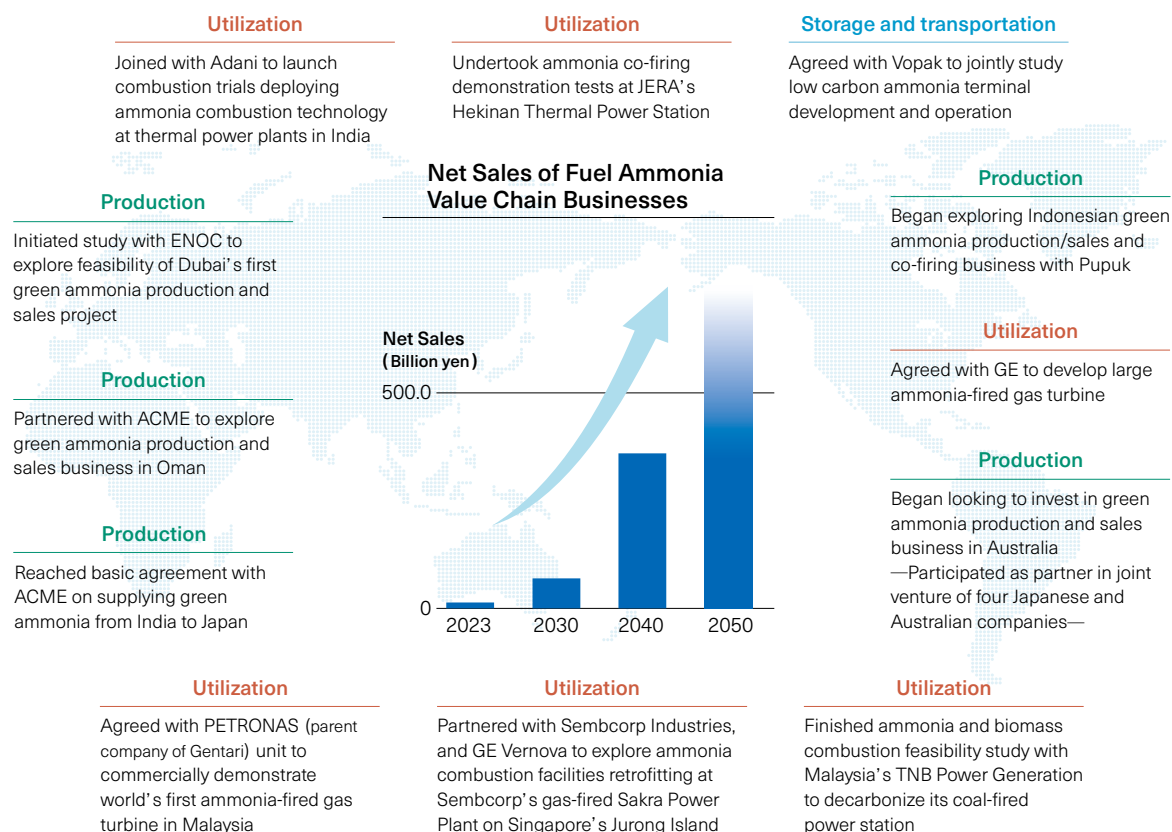
Additionally, safety is extremely important in building and expanding Ammonia Value Chain. The IHI Group is able to provide a seamless safety management throughout the entire value chain, which is also our strength. We are collaborating with

partners who have a proven record and experience in handling ammonia, and by further improving safety, we will create an environment where customers can use ammonia with safety and security.

Q Please tell us about the collaborations with your partners to build an Ammonia Value Chain?

To use ammonia as fuel and promote its widespread use, it is important to have the viewpoint of energy security (safety, economy, stable supply, and environmental friendliness). It is difficult to realize these points by the IHI Group alone, and it is essential to strengthen collaborations with governments and partners. Currently, we are partnering with Yara,*1 which has knowledge of ammonia transportation, and Vopak,*2 which has expertise in receiving and storing ammonia. Through collaborations with these two companies, we plan to build a large-scale ammonia receiving terminal which excels in safety and economic efficiency in Japan. We are also currently involved in exploring ammonia receiving terminals in five locations in Japan in order to develop an ammonia supply structure to off-takers.

Progress Fuel with Ammonia Value Chain Businesses



We have also begun collaborations with multiple partners in the ammonia production and supply business. We plan to produce 400,000 tons of green ammonia derived from solar power generation per year from 2028 with India's ACME Group,*3 a leading renewable energy company, and to import the green ammonia to Japan. In Australia, we participate in a development project to produce green ammonia with Energy Estate, CS Energy, and Idemitsu Australia, and are exploring to produce and sell 500,000 tons of green ammonia per year. We plan to utilize the green ammonia to build an Ammonia Value Chain in Japan by 2030, and these are projects that can be quickly commercialized. A large demand in fuel ammonia can be expected in 2030 and onward; thus, we will also consider developing projects in areas such as the Middle East, Africa, and North and South America.

*1 Yara Clean Ammonia Norge AS, a group company of Norway's Yara International ASA, the world's largest nitrogen-based fertilizer manufacturer.

*2 Royal Vopak, a Dutch tank terminal operator, which has world's leading capacity of storing oil, chemicals, and others.

*3 India's major renewable energy operator, which works on the production of green ammonia and hydrogen using renewable energy.

Q Please tell us about the development of the supply infrastructure necessary to utilize ammonia as a fuel for power generation.

Improvement of facility safety assurance and development of supply infrastructure are necessary. For example, in April 2024, JERA began the world's first large-scale demonstration test to convert the fuel from coal into ammonia at a large-scale commercial coal-fired thermal plant of Hekinan Thermal Power Station in Hekinan City, Aichi Prefecture. This is a demonstration test to convert 20% of the coal used as fuel into ammonia at JERA's Unit 4 power plant with an output of 1 million kW, and our ammonia combustion technology is adopted in this experiment. In this demonstration test, we will verify stable combustion of ammonia and the reduction of nitrogen oxide emissions, and plan to increase the fuel conversion rate from coal into ammonia to over 50% by around 2028. JERA has experience and knowledge of using ammonia for denitrification, but this is the first time it uses ammonia on a large scale as fuel. Therefore, the plan is to construct a large-scale receiving and storage facility for commercialization in the future.

Approximately 500,000 tons of ammonia will be required every year if 20% of the fuel is converted to ammonia at the Unit 4 power plant. At present, approximately 1.1 million tons of ammonia is consumed in Japan, and if commercial operations

begin with a 20% fuel conversion, this alone will account for half of domestic consumption. To improve the fuel conversion rate in the future, the development of supply infrastructure, such as ammonia storage and transportation, will be essential.

Q What are the achievements in fiscal 2023 and what are the challenges?

In 2023, we were able to make progress in studying each area from upstream to downstream in the value chain, and have collaborated with various companies to build the value chain. In the upstream ammonia production and supply business, we have reached an agreement on the collaboration with India's ACME regarding the production and sales of green ammonia, and studies are underway. In the fields of storage and transportation, we have begun examining the ways to build an ammonia supply structure with highly experienced partners such as Yara and Vopak. In the downstream ammonia utilization field, we have begun exploring the commercial use of small-scale ammonia-fired gas turbines with Malaysia's Gentari, and adoption of large-scale ammonia-fired gas turbine among the three companies, IHI, Singapore's SEMBCORP, and the U.S. GE. It was a year in which we made significant progress in our activities to build a value chain.

Meanwhile, we have also identified issues including the need to reinforce our human capital for the ammonia production and supply business and to strengthen our development system for large gas turbines. We will promptly address these issues.

Q How do you position 2024 for the IHI Group?

2024 will be a very important year for building the Ammonia Value Chain. The world's first ammonia substitution demonstration test (representing 20% of heat value) at JERA's Hekinan Thermal Power Station is attracting a lot of attention among the power generation companies around the world. We expect that the market will take off immediately as a result of the demonstration test. In addition, a long-term durability test of a small-scale gas turbine combusted exclusively with ammonia (IM270) began in Aioi Works in June. In August, a tugboat powered by ammonia reciprocating engine for ships use by IHI Power Systems was completed and will be used for demonstration voyages while engaged in towing operations. By demonstrating that ammonia can be used safely and stably as a fuel in the fields of electricity, industry, and shipping, we hope to improve the reliability of fuel ammonia and stimulate demand.