

Creating a Carbon-Neutral Future

— Striving to build a value chain —



Global warming-driven climate change is a huge social issue that **needs to** be tackled globally. As a measure against climate change, countries around the world are aiming to create a carbon-neutral society by setting greenhouse gas emissions reduction targets. However, in order to realize carbon neutrality, renovating power generation facilities and manufacturing equipment into those with less greenhouse gas emissions alone is not enough. Rather, it is essential to develop a system for realizing carbon neutrality is essential not only in manufacturing-related processes but also throughout the value chain — including storage, transportation, and utilization of materials/products.

The IHI Group will continue to provide solutions to help improve the global environment while considering nature and society more than ever before. We believe that this is a responsibility of the IHI Group, which has been contributing to society over the years through technology. This article introduces the IHI Group's initiatives for technological

development that takes place with various stakeholders to realize carbon neutrality throughout the value chain and the principles underlying them.

Establishing a technology to manufacture and store ammonia free of CO₂ emissions

The molecular formula for ammonia is NH₃. Since it does not emit carbon dioxide (CO₂) when burned, it is expected to be a next-generation fuel that contributes to tackling the climate change. The IHI Group is working to build the value chain for ammonia, a carbon-neutral fuel, from its production, transportation, and storage to utilization. To manufacture ammonia, we are developing low-cost, efficient manufacturing technologies for green ammonia production while dealing with fluctuations in output from renewable energy sources, a challenge for conventional power generation facilities. To store manufactured ammonia, we are building an ammonia

storage facility, that applies technologies that have been used to produce various kinds of storage facilities such as LNG tanks. Although it has been said that ammonia storage is already established as an existing technology, we still need to solve specific technical issues surrounding it, such as ammonia-induced stress corrosion cracking (SCC) of the tank's inner material. The IHI Group is developing a new method to test for SCC and a testing device to solve this technical issue. We have examined the design of ammonia tanks to increase their size and verified the design's technical feasibility. At the same time, we are also proceeding to obtain domestic approval for PC (prestressed concrete) membrane, which is considered to be the most promising solution for ammonia tanks. The aim is to quickly commercialize tanks for storing large volumes of ammonia in the future. We will also move forward to quickly establish channels to distribute stored ammonia.

Using ammonia to further reduction of CO₂ emissions

By utilizing stored ammonia as a fuel, we would like to develop a process that utilizes the fuel and reduces CO₂ emitted from power generation facilities. To that end, we have successfully demonstrated CO₂-free power generation with a small gas turbine fueled by ammonia alone and will continue the technological development to scale up the ammonia gas turbine to a commercial size. Furthermore, we plan to develop a technology that uses ammonia alone as a fuel for marine gas engines and other thermal power generation facilities.

Developing technologies that use CO₂ to manufacture clean and useful resources

The IHI Group is developing technologies to capture CO₂ emitted from factories and CO₂ in the atmosphere. We are working on methanation technology to manufacture synthesized methane (e-methane) by reacting the captured CO₂ with hydrogen (H₂). We expect that methanation technology will be one of the key technologies for carbon neutrality because methane (CH₄) is the main component of natural gas, and existing city gas infrastructure can be used to deliver it. We have already started sales of small methanation systems and received orders for methanation systems that reuse CO₂ emitted from experimental blast furnace facilities. These methanation systems are being

scaled up because they will need to process larger amounts of gas in the years to come. In addition, we are accelerating the technological development of lower olefins, which are raw materials for resins and plastics, made from CO₂ and H₂, as well as sustainable aviation fuel (SAF) in collaboration with research institutes.

New initiatives expected for energy decarbonization

In addition to the above, the IHI Group is carrying out initiatives such as utilizing biomass/battery energy storage systems and decarbonization of microgrids in off-grid communities.

While dealing with global social issues, we also aim to create a carbon-neutral society by providing solutions that cater to regional characteristics.

Integrating global knowledge and accelerating development with digital technology

We plan to help bring about carbon neutrality by developing new technologies and integrating them with those that we have accumulated (through our 170 years of history). Furthermore, we need to bring together knowledge in various fields to quickly introduce technologies that reduce CO₂ to the world. For that purpose, we will continue to collaborate with research institutes and companies around the world on many projects. To accelerate technological development further, we actively use digital technology such as AI to develop novel materials and digital twins that use numerical simulations.

Conclusion

The IHI Group aims to “create a world where nature and technology work in unity,” and will pledge to provide new value to resolve social issues. We will continue to work with a range of stakeholders and strive to realize carbon neutrality while taking advantage of our strengths in technological development and engineering to devise new technologies one after another that will benefit the planet.