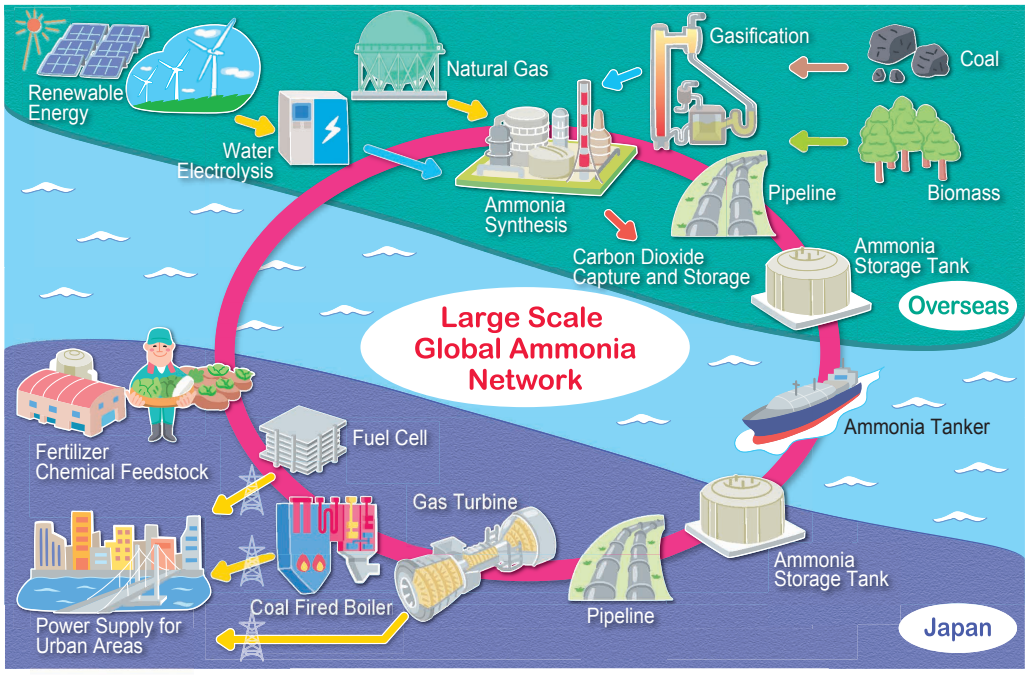
Stop the Global Warming by Hydrogen Energy Utilization Technology

Besides high efficiency hydrogen production technology, ammonia, one of hydrogen carriers, will change a supply chain with the aid of ammonia combustion technology

Hydrogen energy, now attracting attention in the world.
In addition to hydrogen, IHI has focused on ammonia which is a hydrogen carrier easier to transport and store than hydrogen, and accelerated a study on hydrogen energy utilization technologies such as co-combustion technology enabling the stable combustion of ammonia, and high efficiency hydrogen production technology from renewable energy. IHI's technologies make it possible to take another step closer to energy decarbonization.



Carbon-free energy supply chain targeted by IHI

Needs for energy decarbonization

The strong demand for CO_2 reduction has been increasing in the world, such as the setting of a below-two-degrees Celsius target (to keep below a mean global temperature rise of 2°C as compared with the pre-industrial levels) in the Paris agreement adopted at COP21 in December 2015. Under the two-degree scenario, it is thought to accelerate moves to suppress the use of fossil fuel toward 2050 worldwide, such as to decrease the use of fossil fuel even in non-OECD countries and to increase the use of renewable energy. IHI has contributed to reducing CO_2 from the use of fossil fuel through high efficiency coal fired boiler technology, CO_2 Capture and Storage (CCS) technology, and other such technologies. However, technology for further advancing the energy decarbonization is necessary for the future.

Ammonia as hydrogen carrier

Hydrogen energy is currently attracting attention not only in Japan but also abroad as an energy source contributable to

CO_2 reduction. Since although hydrogen does not generate CO_2 when used, it is known as secondary energy, technology for producing hydrogen from other energy sources, transporting and storing the produced hydrogen, and utilizing it at demanders, i.e., the entire supply chain should be established. Hydrogen is known to require high transportation and storage costs. For this reason, a method for converting to other hydrogen-containing substance (called carriers) is attracting attention. Among the carriers, IHI is focusing particularly on ammonia as a hydrogen carrier. This is because ammonia is characterized by the following points.

(1) Ammonia is advantageous in transportation and storage because it has large hydrogen content per unit volume, and is easily liquefiable (8.46 atm at 20°C).
(2) Ammonia has already been widely used for fertilizer, chemical raw material, de-NO_x process, etc., and therefore the production technology and infrastructure for ammonia have been established.
(3) Ammonia can be directly combusted without being converted to hydrogen.

Ammonia co-combustion technology

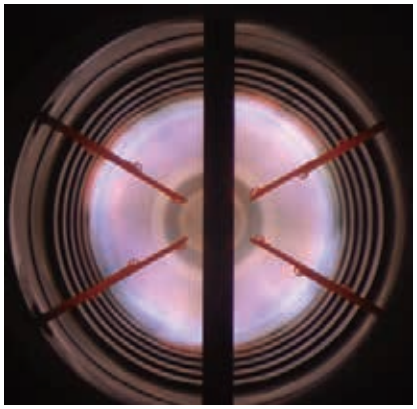
IHI is performing research and development on direct ammonia utilization technology in various types of power generation equipment such as gas turbines, fuel cells, and coal fired boilers with the support of the Cabinet Office Cross-ministerial Strategic Innovation Promotion Program (SIP).

Ammonia is directly combustible, but flame stability should be improved because burning velocity is as low as approximately 1/5 of that of methane gas. In addition, fuel-NO_x is formed from ammonia in a high temperature field without any measures to reduce NO_x, so low NO_x combustion technology is also required. IHI has performed an ammonia/city gas co-combustion test using an actual size model combustor for gas turbines. As a result, under conditions to co-combust ammonia by 20% of the gross heating value, stable combustion and NO_x production suppression could be simultaneously achieved. We are planning to introduce a 2 MW class gas turbine with ammonia supply system, and to demonstrate power generation by co-combusting ammonia and city gas. Further, we are also proceeding with the development of the ammonia co-combustion technology in a coal fired boiler with a large CO_2 reduction effect based on fuel substitution.

In addition we are examining not only the ammonia utilization technology but also the production technology, and accelerating the research and development in order to achieve social implementation earlier by establishing the entire supply chain.

Hydrogen production from renewable energy

In the short term, hydrogen and ammonia may be mass-producible from fossil fuel with the use of CCS. However, in the end, it is preferable to produce them from renewable energy. For example, in the case of hydrogen production from biomass, the Twin IHI Gasifier (TIGAR®) currently in a validation phase can be used. On the other hand, in the case of hydrogen production from photovoltaic or wind power generation, water electrolysis technology may be applicable. At present, although a cost for producing hydrogen by water electrolysis is relatively high, the need for it is increasing in terms of energy storage and effective use of surplus power.



Ammonia combustion state
(gas turbine combustor)

We are currently performing research and development on highly-efficient hydrogen production technology using power from photovoltaic power generation. In the research and development, hydrogen is highly efficiently produced by combining water electrolysis technologies having different responsivenesses to load variation and varying the loads of respective water electrolysis apparatuses in accordance with surplus power from the photovoltaic power generation. Simulation has just clarified the optimum combination, and from now, we are proceeding with a plan for validation. In addition, we are planning to proceed with the research of utilization technology such as conversion to ammonia, using produced hydrogen.

Future efforts

It is thought that hydrogen energy requires great cost such as costs for the building and improvement of infrastructures. However, among them, infrastructures for ammonia have already been set up, and therefore hydrogen energy technology is expected as technology which is socially implementable in an early stage.

We will try early technology establishment and social implementation toward energy decarbonization.

Inquiries:
Carbon Free Energy Project Department,
Research Laboratory,
Corporate Research & Development,
IHI Corporation
Phone: +81-45-759-2311
https://www.ihi.co.jp/en/