Research on HTGR and Nuclear Heat Applications to Attain a Low-Carbon Society

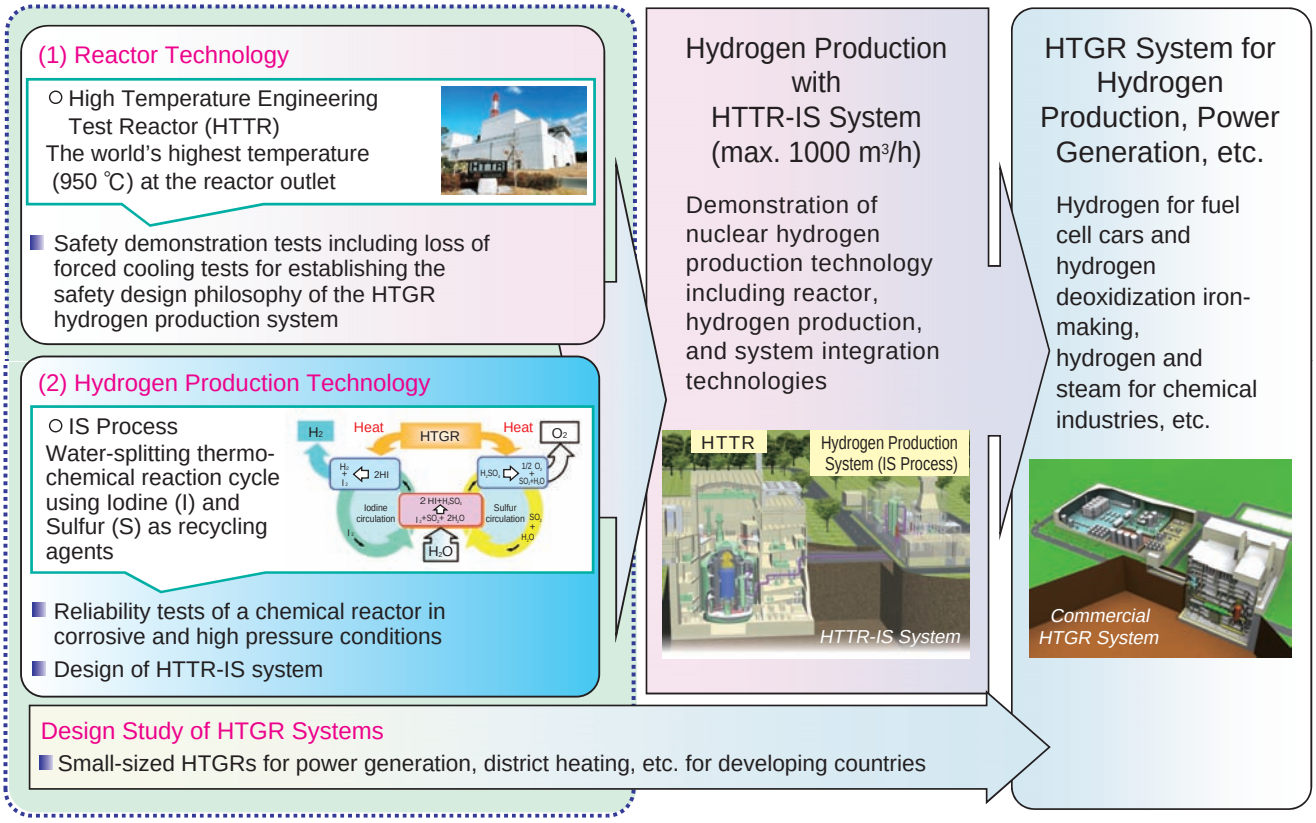

Fig.9-1 Plan of research on HTGR and nuclear heat applications
In order to diversify nuclear heat applications to non-electric fields such as transportation, iron-making, and chemical industries and attain a low-carbon society, we are carrying out research on HTGR, which can produce heat above 900 ℃, and nuclear heat applications.

The breakdown of Japan's energy consumption and CO_2 emissions in each field shows that utilization of heat in transportation and industry by combustion of fossil fuels accounts for around 70%. In order to achieve a greater than 50% reduction in overall carbon emissions to restrain global warming and attain a low-carbon society, diversification in the use of nuclear heat such as process heat and steam for chemical industries, district heating, desalination, and so on, as well as production of clean energy such as hydrogen, is indispensable. In particular, the demand of hydrogen for fuel cell cars and hydrogen deoxidization iron-making is expected to grow dramatically in the near future. Furthermore, in order to meet the growing demands for energy in developing countries while restraining global warming, deployment of nuclear power plants, especially those with small-sized reactors, is necessary because remote regions and cities in developing countries require a relatively small energy plant to produce affordable electricity and district heating, and to potentially generate new energy products to develop local economies. In particular, High Temperature Gas-cooled Reactors (HTGR), which feature superior inherent safety and economies despite their small size, can supply heat above 900 ℃ and meet the diverse energy demands described above. HTGRs can thus meet the energy production requirements for global greenhouse gas reduction.

We are carrying out HTGR research and development particularly with regard to reactor technology and heat utilization technology for the commercialization of an electricity and hydrogen cogeneration HTGR system (Fig.9-1). Japan's first high-temperature gas-cooled reactor, named the High-Temperature Engineering Test Reactor (HTTR), located at the Oarai Research and Development Center, is a graphite moderated and helium gas-cooled reactor with 30 MW thermal power and a maximum temperature of 950 ℃ at the reactor outlet. The first criticality of the HTTR was achieved in 1998, and 30 MW full power operation was attained in 2001 with a reactor outlet temperature of 850 ℃. Safety demonstration tests have been conducted since 2002. The first high temperature operation and first continuous operation at 950 ℃ for 50 days were successfully conducted in 2004 and 2010, respectively.

In terms of hydrogen production technology, a thermochemical hydrogen production cycle called the IS (Iodine-Sulphur) process has been developed step by step. In June 2004, continuous hydrogen production using a bench-scale test apparatus made of glass was successfully achieved, with a hydrogen production rate of about 30 ℓ /h for 1 week. Reliability tests of a chemical reactor in corrosive and high pressure conditions are now being conducted. The goal of the HTTR project is to demonstrate nuclear hydrogen production using the IS process connected with the HTTR by 2020, which will yield a hydrogen production rate up to 1000 m^3/h.

Design study of a small-sized HTGR system is also ongoing.