

# Example of National Research and Development Agencies' efforts on the nuclear innovation- Fusion and HTGR\*

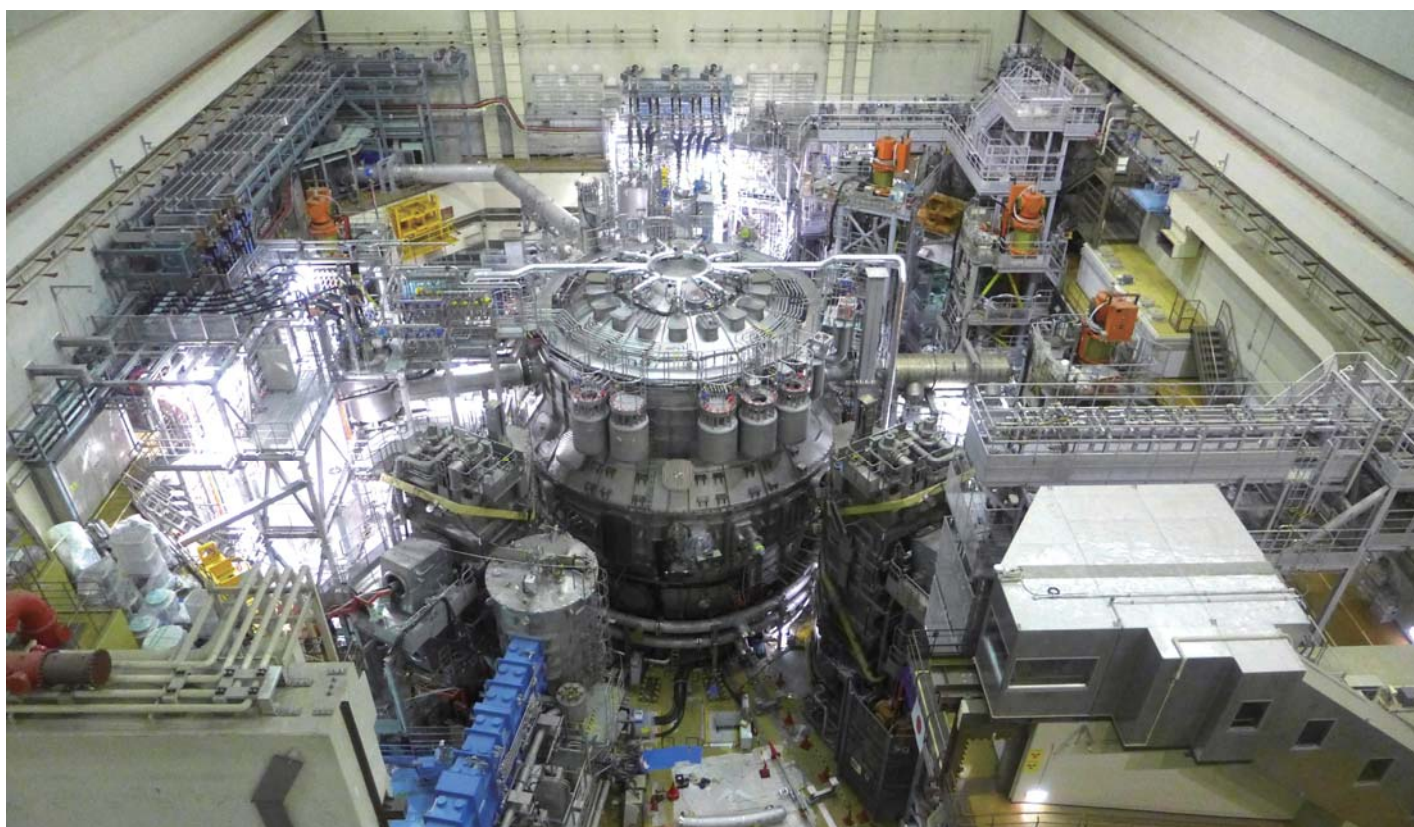
\*Nuclear energy (including fusion and HTGR) has been identified as one of 14 sectors expected to contribute to green growth in the Green Growth Strategy through Achieving Carbon Neutrality in 2050 revised in June 2021 by the Japanese Government.

## JT-60SA Core device in fusion research

Advanced superconducting Tokamak for stable confinement of high pressure plasma

**JT-60SA, the most powerful tokamak in the world starts operation.**

With a diameter of 12 m, JT-60SA is the largest and most powerful tokamak in the world until ITER itself starts operation. Through collaboration under the "Broader Approach Agreement," Europe and Japan completed JT-60SA construction in 2020 and are now continuing its integrated commissioning.



### What is fusion?

Nuclear fusion is a reaction in which light nuclei "fuse" together into a heavier nucleus, and enormous energy is generated at this time. It is this fusion energy that keeps the sun shining.

Fusion energy, which does not emit carbon dioxide in the process of power generation and for which abundant fuel can be extracted from seawater, is the ultimate energy source for humankind, being very safe and independent of weather conditions.

### What will JT-60SA contribute to?

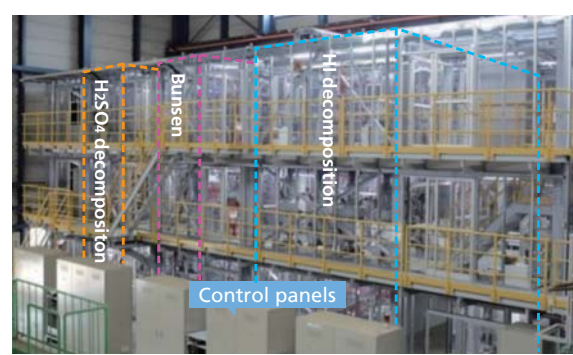
In order to continue fusion stably, it is necessary to heat the hydrogen fuel into a plasma state at temperatures exceeding 100 million degrees and to control it by the force of a magnetic field. JT-60SA will develop the control technology to maintain stable plasma with high temperature and density using control equipment that enhances plasma stability. JT-60SA is contributing to world-leading advanced research and human resource development, supporting ITER and the development of high-performance plasma for power generation.

**Broader Approach (BA) activities** include the JT-60SA project, research into durable materials for future devices, and preliminary work on the future Demonstration (DEMO) reactor. BA activities complement the ITER Project and aim to accelerate the realization of fusion energy.

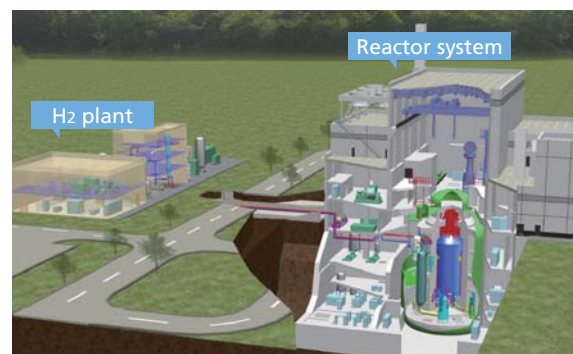
**ITER Project** is an ambitious energy project of unprecedented scale and involves more than 30 countries collaborating under the ITER Agreement. The goal of the ITER Project is to demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes.

## HTTR and H<sub>2</sub> facility Towards carbon neutrality

Test reactor of High Temperature Gas-cooled Reactor (HTGR) and carbon-free hydrogen production facility



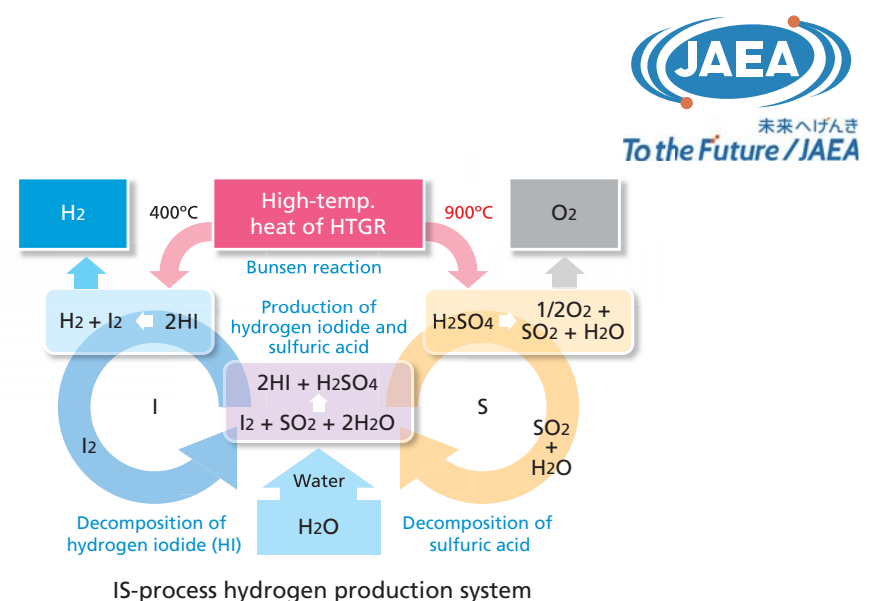
IS-process hydrogen production test facility



Future HTTR-hydrogen test plan



HTTR resumed operation



**R&D on HTGR-hydrogen system** includes operation of the HTTR to obtain various data for commercial HTGR, technology development for hydrogen production, commercial HTGR design and heat utilization test to be connected to the HTTR targeting demonstration for safe & reliable HTGR heat application technologies. The HTTR-hydrogen test is under planning.

### HTTR

High Temperature Engineering Test Reactor (HTTR) with 30MW is a prismatic block type HTGR in JAEA. The first criticality was achieved in 1998 and many operation tests have been carried out since then. The HTTR had provided 950°C, world's highest temperature heat outside the reactor in a high temperature test operation. After the great earthquake in 2011, the HTTR was not operated for safety review by the Nuclear Regulation Authority in conformity with new regulatory requirements. After the completion of safety review, JAEA restarted the HTTR without significant reinforcement on July 30, 2021.

### Hydrogen production test facility

JAEA has been developing thermochemical water splitting hydrogen production technology, Iodine Sulfur-process (IS-process). IS-process consists of three chemical reactions. To promote these chemical reactions, high temperature heat of 400°C and 900°C will be supplied from HTGR. HTGR-IS system is an ultimate carbon-free hydrogen production system. In January 2019, 150h continuous hydrogen production with rate of 30L/h was achieved by an electric heating test facility.

### What is expectation for HTGR-hydrogen system?

As the momentum toward the carbon neutrality by 2050 has built up globally and a significant role of nuclear energy, especially HTGR, has been increasingly recognized. HTGR-hydrogen system is considered one of the promising technologies toward carbon neutrality.