AS THE TURBINE TURNS...

#42 / MAY 2020 — THE DECARBONIZATION OF GAS TURBINE POWER

The gas turbine industry is facing the prospects of meeting proposed national and international targets for reducing carbon dioxide emissions and for the promotion of sustainable energy. The evolving role of gas turbines to decarbonize the world's energy conversion systems has been the theme of articles in the Global Gas Turbine News (GGTN) in the last three issues, in September 2019, December 2019, and March 2020.

At the request of the GGTN Editorial Board, I have been asked to briefly summarize some of the highlights of the five articles that dealt with this critical issue of decarbonization of gas turbine electrical power.

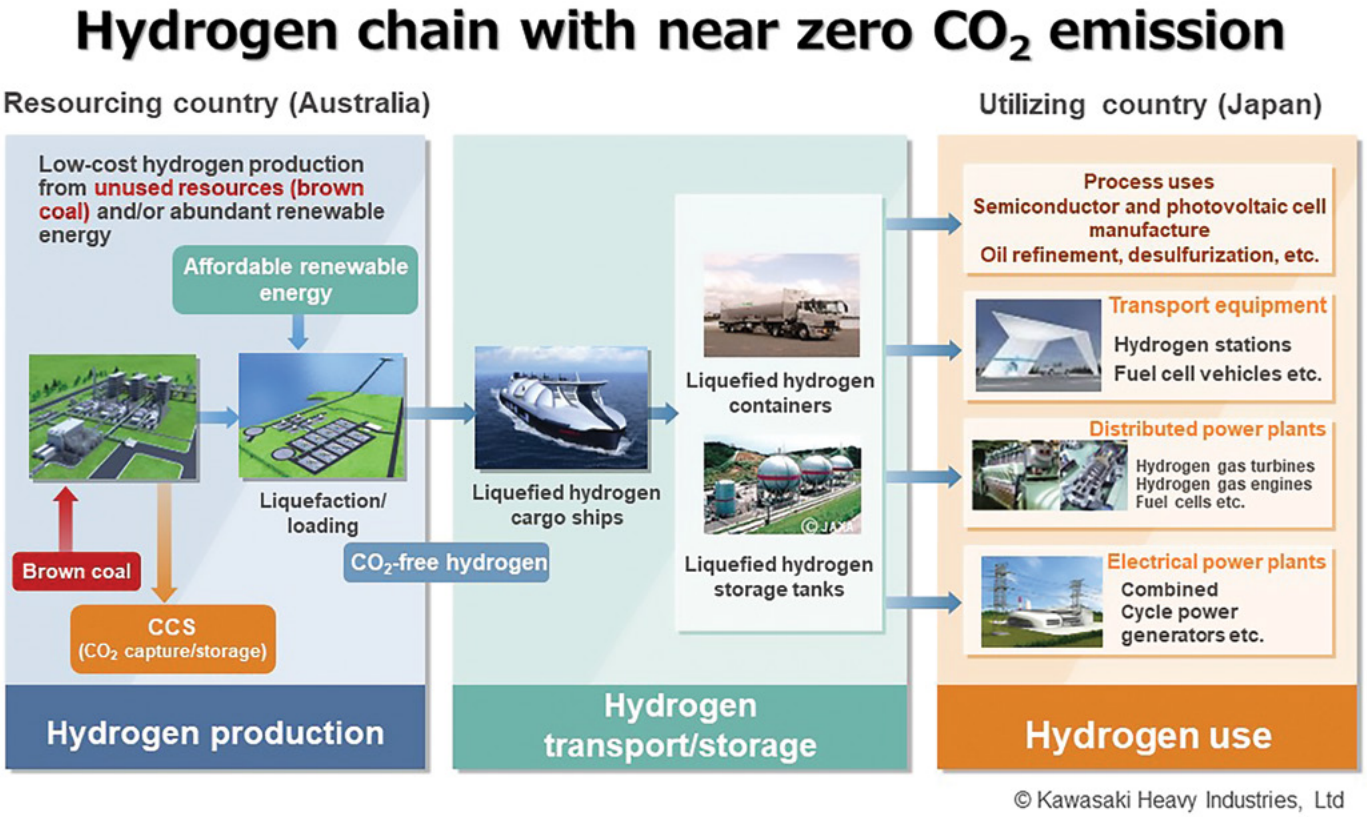
Decarbonization Highlights

In GGTN's September issue, Wegel and Baron [1] of EUTurbines considered that the bulk of future European electricity will be generated with variable wind and sun, requiring a growing need for system flexibility. That flexibility could be based on dispatchable decarbonized gas turbine power. Decarbonization would be achieved using gas turbine technology with renewable gases, focusing strongly on hydrogen, either stored or blended into natural gas as a fuel. Financial support will be needed for this conversion to renewable gases.

GGTN's December issue featured an article by Bothien and Ciani [2] of Ansaldo Energia in Switzerland. They present experimental results and data showing that an existing gas turbine combustion system can handle mixtures of natural gas and hydrogen over a wide range. They show how the full range of 0 – 100 percent hydrogen can be burned in a low-NO_x premix system without implementing any changes to standard hardware in their GT36 and GT26 gas turbines.

While [1] and [2] highlight European decarbonization activities involving hydrogen-fueled gas turbines, [3] and [4] deal with the extensive work going on in Japan on this topic.

Reporting on Mitsubishi Hitachi Power Systems (MHI) hydrogen-fired gas turbine development in GGTN's March issue, Nakumura [3] describes a new combustor that was developed to minimize the occurrence of flashback, that can typically be induced during hydrogen co-firing. MHI successfully passed a firing test using 30 percent hydrogen



mix in volume, resulting in a 10 percent reduction in CO_2 emissions. European and Japanese decarbonization efforts are being combined, with MHI converting a 440 MW natural gas fired combined cycle gas turbine plant in the Netherlands, to 100 percent hydrogen by 2025.

Also included in the GGTN March issue was an article by Nishimura [4] of Kawasaki Heavy Industries on Japan's hydrogen energy supply chain for decarbonization. Japan, the world's third largest economy, has few domestic sources of primary energy. In 2011-2014 the Hydrogen Society Plan was developed by the government, resulting in the world's first hydrogen energy supply chain pilot project between Australia and Japan.

Nishimura [4] points out that half of the world's total coal resources are in the form of brown coal (lignite). It's limited to on-site applications, since it can ignite spontaneously on contact with air. Victoria, Australia has extensive brown coal resources in its Latrobe Valley. Work has started on an A$500 million pilot project there to turn this brown coal into hydrogen for liquefaction, to be shipped from Port Hastings, Victoria, 9000 km, to the Port of Kobe, Japan, in Kawasaki LH2 tankers. The CO_2 resulting from the brown coal used to produce the hydrogen will be sequestered in deep underground offshore storage sites in the Bass Strait, separating Australia and Tasmania.

Kawasaki has developed a pure hydrogen dueled Dry Low NO_x combustor for their 1 MW electric power gas turbines. These will be used in a cogeneration plant on Kobe Port Island.

Finally, in GGTN's December issue, Allison [5] reports on the need for grid-scale energy storage technologies to cost-effectively store energy during periods of high renewable generation and discharge power when wind and solar renewables drop off. He points out that the success of machinery-based energy storage systems require the development of application-specific turbomachinery to meet transient response requirements with high round-trip efficiency at low cost.

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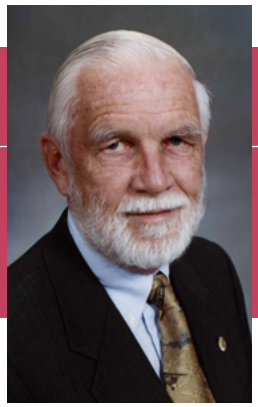

Summary

The five GGTN articles highlighted here present state-of-the-art information on the evolving role of gas turbines to decarbonize energy conversion systems. It is apparent that efforts in Europe and Japan to use hydrogen as a renewable, CO_2-free fuel for gas turbines are well advanced. (History shows that hydrogen was first used as the fuel for Hans von Ohain's very first jet engine in Germany in 1937 [6].) Gas turbines should play a key role in decarbonization through their use in grid storage technologies. One expert in this area has recently written me that new gas turbine heat storage concepts are multiplying like rabbits, and we should see all sorts of combinations being proposed in the next five years. Stay tuned! ◆

REFERENCES

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