



The Net Zero-Carbon Steel Perspective

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I am pleased to introduce this very timely publication on the environment.

In the steel sector, environmental technologies have mainly focused on environmental pollution, recycling, and reuse. However, currently the most important challenge of R&D in the steel sector is to realize net zero-carbon steel which requires the transformation of steel production processes. I am CEO of The Japan Steel-related Environmental Technology Fund, which has been allocating research funds to universities and research institutes engaged in the development of environmental technologies, placing more emphasis on supporting innovation to tackle climate change.

At the Conference of Parties to the United Nations Framework Convention on Climate Change in 2015 (COP21), in which I participated, the Paris Agreement was adopted. Its goal is to hold the increase in the global average temperature to well below 2°C in 2050, preferably to 1.5°C. The majority of scientists now demand the realization of carbon neutrality by 2050 due to frequent extreme weather around the globe. The EU's announcement of carbon neutrality by 2050 in December 2019, and the inauguration of President Biden who also committed to carbon neutrality by 2050, accelerated the trend of announcement of carbon neutrality by 2050 in many countries.

On October 26, 2020, the former Japanese Prime Minister Yoshihide Suga announced in his general-policy speech immediately after his inauguration that the Japanese government would aim at carbon neutrality by 2050. His announcement was sudden and surprising, but Nippon Steel Corporation had anticipated such declaration in advance. Nippon Steel decided to aim for carbon neutrality in 2050 as one of the most important mid- and long-term business strategies six months before his announcement and started considering how such goal could be achieved. Nippon Steel announced its mid- and long-term business plan on March 5, 2021 that was one of the most ambitious business plans among steel mills in the world. Nippon Steel would reduce greenhouse gas emissions by 30% by 2030 compared to the level in 2013 and aim to achieve carbon neutrality by 2050.

The steel industry releases 15% of the greenhouse gases in Japan and thereby it must realize carbon neutrality to allow Japan to be carbon neutral. Steel production unavoidably emits greenhouse gases (CO₂) in the reduction process of iron ore. Therefore, to achieve carbon neutrality in the steel industry, a large-scale reform is required to change the steelmaking processes themselves. To that end, there are three methods. The first is using Hydrogen and CCUS (Carbon Capture, Use and Storage) technologies. In this process, hydrogen is blown into blast furnaces to reduce CO₂ emissions and, in addition, the released CO₂ is separated and captured and is transformed into materials used for chemical products and construction. In CCS, sepa-

rated and captured CO₂ is stored underground. The second method is using large and efficient electric furnaces with carbon free power sources to produce high-quality steel. The third method is realizing ultimate complete hydrogen reduction steelmaking in which no CO₂ is released. It is necessary to combine these three methods comprehensively. Furthermore, to realize carbon neutrality in the steel industry, it needs to challenge difficult research and development that nobody has undertaken before. Examples of such challenges include technologies to blow high-temperature hydrogen into the reaction chamber, and setting conditions that enable continuous reaction, because hydrogen reduction is an endothermic reaction. Nippon Steel's mid- and long-term business plan released on March 5 includes those three specific research and development challenges. The preconditions to overcome these challenges are also very important, and those are cost-competitive carbon-free power supply, availability of CCUS, and the supply of a large volume of carbon-free hydrogen at a very low price.

On December 25, 2020, the Japanese government established the "Green Growth Strategy for Achieving Carbon Neutrality in 2050." The strategy points out that "The industrial sector will require reform of the existing manufacturing process to hydrogen reduction steelmaking." It also states, "Since the global market size of zero carbon-emission green steel (total of hydrogen reduction steelmaking, blast furnace + CCUS and so on) is anticipated to be up to 500 million tons per year (ca. 40 trillion yen per year) in 2050, the government will support establishment of the world's first hydrogen reduction steelmaking technology to acquire this market. The established top runner technology will be successively designated as the decarbonization standards required for the steel industry. Through these efforts, the realization of 'net zero-carbon steel' will contribute to decarbonization of the Japanese manufacturing industry including automobiles." In addition, the Japanese government is creating an unprecedented 2-trillion-yen fund to support such technical development in order to continuously support companies that will work hard on ambitious innovation for ten years.

China's state-owned China Baowu Steel Group—the world's largest steel producer—has already started researching and developing net zero-carbon steel with the full support of the Chinese government. If Japan allows others to go ahead in this sector and to surpass Japan regarding the international competitiveness, it would be very difficult for Nippon Steel, the Japanese steel industry, and also Japan's manufacturing industry using high-quality steel products to maintain their competitive edge. On the other hand, if Japan takes the lead in net zero-carbon steel in the world, we could win the international competition and obtain new business opportunities.

From these respects, net zero-carbon steel is a task that should be realized under the full support of the Japanese government as a national strategy. It has been estimated that Nippon Steel alone needs at least 500 billion yen for research and development. Even if this research and development were successful, an additional four to five trillion yen is required for investment in production facilities. As a result, the steel production cost will increase by two times or more even if all the preconditions are satisfied.

Therefore, to realize net zero-carbon steel, cooperation in research and development is essentially required with other steelmakers, other industries, universities, and research institutions that develop technologies related to CCUS and hydrogen. In addition, regarding the high production cost, customers and Japanese people's understanding is indispensable. I sincerely ask for your support and cooperation.

In conclusion, the next 30 years will be a revolutionary period in which the modern steel production method using carbon will change dramatically. I believe we are very fortunate to be facing this revolutionary era. Let's endeavor to ensure that Japan continuously leads the world in steel making innovation.