Nippon Steel Corporation's Environmental Management —Environmental Initiatives—

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1. Introduction

At the meeting of prime ministerial and presidential representatives (summit meeting) of the United Nations in 2015, sustainable development goals (SDGs) consisting of 17 goals with 169 related targets were set forth as international objectives for 2030. Many of the 17 goals are relevant to the environment, and countries are requested to aim for a low carbon society (energy saving), a circular economy (waste reduction, resource saving and recycling) and a nature symbiotic society (conservation of biodiversity) as the steps to realize a sustainable society.

In 2006, the United Nations proposed the principles for responsible investment (PRI), and accordingly, investing in businesses that are actively engaged in the environment, society and governance (ESG investment) was emphasized. In Japan as well, ESG investment has expanded rapidly as the Government Pension Investment Fund (GPIF), the largest institutional investor in Japan, signed on to the PRI in 2015. Thus we saw the emergence of business enterprises that are selected by institutional investors. It can be said that environment conservation efforts have changed from a mere corporate social responsibility (CSR) to one that affects the competitiveness of enterprises. As a business entity, every company is required to exert efforts in the field of environment conservation in order to increase its corporate value and continue to grow in the long term.

2. Environmental Management of Nippon Steel

Nippon Steel Group's management philosophy is to continue being a business group that values trustworthiness and reliability. On this basis and with its environmental management as a core, the company has set forth the basic environmental policy (see **Fig. 1**), according to which it is committed to contributing to the construction of an environment-conservation oriented society of low environmental impacts. In actual practice, the company is actively working on various environmental issues from the regional to global scale. These include maintenance and improvement of the local living environment, reduction of waste discharge and promotion of its recycling, taking measures against global warming and conservation and improvement of biological diversity.

In addition, Nippon Steel contributes to achieving the SDGs by taking measures principally in the following five priority areas (see **Fig. 2**): (1) strengthening its environmental management system together with all group companies; (2) advancing countermeasures against global warming; (3) contributing to creating a circular economy; (4) proceeding with environmental risk management; and (5) promoting public relations activities related to the environment. The present paper describes the principal efforts and activities of the company in these priority areas except (1) above.



Under the principle of "Environmental Management," Nippon Steel is committed to contributing to the creation of an environment-conservation oriented society with lower environmental impact. For this purpose, the company will conduct business activities based on the viewpoint of environmental preservation in local communities, which includes the maintenance and improvement of good living environments and the promotion of reduction and recycling of waste. The company will also address challenges on a global scale including response to issues of global warming as well as the maintenance and improvement of biological diversity.

- Reducing environmental impacts at every stage of operations (Eco Process)
- 2 Offering of environment-oriented products (Eco Products)
- 3 Proposing environmental preservation solutions from a global perspective (Eco Solution)
- 4 Development of innovative technologies
- 5 Development of a rich environment
- 6 Promotion of environmental relations activities



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3. Advancing Countermeasures against Climate Change

The United Nations Framework Convention on Climate Change was established in 1992 with the ultimate goal of stabilizing the concentrations of greenhouse gases in the atmosphere, and the countries agreed to take measures against global warming worldwide. Based on this agreement, the conference of the parties (COP) to the Convention has been held annually since 1995. In the Paris Agreement adopted in 2015, ultimately, the aim of making efforts to restrain the rise of the average temperature from that at the time of the industrial revolution to less than 2°C, preferably 1.5°C, was accepted internationally. Later in 2018, a special report of the Intergovernmental Panel on Climate Change (IPCC) stated that, to hold down the temperature rise to below 1.5°C rather than below 2°C, carbon dioxide emission needed to be lowered to virtually zero by 2050. While countries announced ambitious targets to cut greenhouse gas emission one after another, Japan also declared in October 2020 that it would aim for carbon neutrality by 2050.

As for Japan's steel industry, the Japan Iron and Steel Federation (JISF) published in November 2018 a "JISF Long-term vision for climate change mitigation, challenge towards Zero-carbon STEEL." In addition, the JISF set forth the "basic policy of the Japan steel industry on 2050 carbon neutrality aimed by the Japanese government" in February 2021, stating that the industry would take on the challenge of attaining zero-carbon steel in a proactive manner. Since the hurdles are very high in the path to zero-carbon steel, and no straight-line approach is conceivable, the industry has selected a multi-track approach in which all applicable means such as COURSE50, hydrogen reduction ironmaking and carbon dioxide capture, utilization and storage (CCUS) are combined.

With respect to the climate change problem, which is regarded as an important issue affecting the survival or otherwise of humankind, domestic and international trends have changed rapidly since the adoption of the Paris Agreement, and individual companies were requested to announce what actions they would be taking specifically to curb global warming. Nippon Steel is also attracting attention as one of the leading CO₂ emitting companies in Japan, and it is necessary for the company to accelerate efforts for decarbonization. While the company has worked on countermeasures against climate change through the three eco-activities and development of innovative technologies as given in Fig. 1, it set out in March 2021 the

"Nippon Steel Carbon Neutral Vision 2050-A Challenge of Zero-Carbon Steel" as a new medium- to long-term objective of its own. In addition, the company takes part in "Challenge Zero," an initiative of the Japan Federation of Economic Organizations (known as the Keidanren) to introduce technologies that are being developed to create a carbon-free society. Nippon Steel's activities under the scheme are presented below.

3.1 Nippon Steel Carbon Neutral Vision 2050-A Challenge of **Zero-Carbon Steel**

In consideration of Japan's Carbon Neutral 2050 policy, innovation for the decarbonization of the steel industry is indispensable. To remain in the leading position in the world steel industry in the efforts toward a carbon-free society, Nippon Steel has set forth a new action plan of its own against climate change, "Nippon Steel Carbon Neutral Vision 2050-A Challenge of Zero-Carbon Steel," which will study and carry out measures to attain it as the most important management task, and aggressively take on the challenge of developing ultra-innovative technologies to realize zero-carbon steel (see Figs. 3 and 4).

As stated, Nippon Steel is committed to achieving carbon neutrality through a multi-track approach; one track is challenging ultrainnovative technologies to achieve zero-carbon steel such as highgrade steel production using large electric arc furnaces and hydrogen reduction ironmaking (reduction by blowing hydrogen into blast furnace which is developed in Super-COURSE50 and direct reduction with 100% hydrogen), and another is offsetting discharged carbon dioxide by measures such as CCUS. As hydrogen reduction ironmaking, in particular, is a technology that does not exist anywhere in the world at present, there are calls for innovations to overcome extremely high hurdles, and R&D resources have to be invested in the long term and on a large scale to make it a reality. In parallel to these innovations in the steel industry, it is also essential to improve social infrastructures, activities of which include the economical and stable supply of carbon-free hydrogen in large amounts and carbon-free electricity, and availability of economically rational CCUS technology. Various difficulties and discussions are expected, but it is imperative to take on challenges boldly and aggressively. 3.2 "Challenge Zero"

Nippon Steel has been strongly aware of the necessity to take action proactively toward a carbon-free society, as well as the importance of its role as a main player in the innovation field, and as

> Carbon Offset

2050

Vision

Carbon dioxide Capture, Utilization, and Storag



Multi-aspect approach, including CCUS* and other carbon offset measure

Fig. 3 Zero-Carbon Steel: Nippon Steel's CO, emissions reduction scenario



Fig. 4 Nippon Steel's roadmap of CO, emissions reduction measures





such, has carried out a wide variety of R&D activities. Supporting "Challenge Zero" of the Keidanren in June 2020, the company has announced 10 specific initiatives as part of the challenge (see **Fig. 5**).

The goal of the challenge, the problems to be overcome to solve it, the strengths and specific actions of Nippon Steel, quantitative benefits when the challenge is solved, etc. are described therein in relation to each of the targeted innovations. For more details, readers are invited to refer to the Keidanren website (https://www.challenge-zero.jp/jp/member/92).

4. Contribution to Building a Circular Economy

A circular economy is a society in which the consumption of natural resources is minimized and the burden on the environment is reduced to the minimum by (1) suppressing the discharge of waste, (2) cyclical use of resources and (3) ensuring appropriate waste disposal. Japan is breaking away from an economic society based on mass production, mass consumption and mass disposal, and aiming at forming a circular economy by promoting the efficient use and recycling of resources from production to distribution, consumption and disposal. The government's Fundamental Plan for Establishing a Sound Material-Cycle Society stipulates the basic policies for measures related to the formation of a circular economy and those that the Government should take comprehensively and systematically. The target figures for the productivity of resources used for attaining economic indices, their recycling rates and final disposal amounts are set forth in it as indicators, showing the overall picture of a circular economy, and the results are tracked every year.

On the other hand, as has been frequently reported by the press in recent years, marine pollution caused by waste plastics has become a global problem. Appropriate responses to the global constraints of resources and waste and the marine pollution with plastics are required also in the SDGs, and with the common understanding that global efforts are urgently needed, discussions have been accelerated under international frameworks. As a consequence, at the G20 Summit Meeting in Osaka, Japan, in 2019, the Osaka Blue Ocean Vision proposing to stop further marine pollution with waste plastics by 2050 was shared by the member countries. Reflecting these movements, the circular economy with plastics recycling is becoming an important issue of the environment, society and governance (ESG), in addition to climate change.

Nippon Steel has actively made efforts to efficiently utilize limited natural resources and energy at every stage of its steel manufac-

turing processes, achieve zero emissions through recirculatory inhouse use of by-products at different processes, and recycle waste arising from the community and other industries. Regarding its contribution to the forming of a circular economy as an important ESG issue, the company has set forth two goals: (1) zero emissions from its steelworks and (2) recycling of waste discharged from the community, and the progress toward the goals is tracked against pre-defined key performance indicators (KPIs). These activities are presented in more detail in this section.

4.1 Zero emissions from steelworks

By-products such as slag from blast furnaces and steelmaking furnaces, dust, sludge and used refractory bricks arise from the iron and steel manufacturing processes, but most of them are recycled inside and outside the company to reduce the final disposal amount, and as a result, a high recycling ratio of 99% has been maintained. Decrease in the final disposal amount was set out as a KPI, and it was followed up against a target figure of 273000 t (all the units herein are metric) in fiscal year 2020 (from April to March next year, hereinafter FY in short), a 70% reduction from that in FY 2000 (see **Figs. 6** and **7**).

The amount of slag is especially large among the by-products, but roughly 70% of blast furnace slag is used for blast furnace cement, and steelmaking slag is used for various purposes such as the materials for road base and other civil engineering work, soil improvement, marine environment improvement, fertilizers, etc., and virtually all of it is recycled effectively. Blast furnace cement also contributes to decreasing the CO₂ emissions from cement production plants by reducing the consumption of limestone and fuel. In addition, VivaryTM Units, products consisting of a mixture of steelmaking slag and humic substance derived from waste wood, supply the iron necessary for the growth of seaweed, and contribute to the



Past figures are retrospectively revised by adding the amount generated by Nippon Steel Nisshin, which was absorbed in April 2020.

Fig. 6 Nippon Steel's final disposal amounts

By-product	Amount generated (wet weight – million tons)	Recycling application	Recycling rate
Blast furnace slag	12.78	Blast furnace cement, fine aggregate, road base, etc.	100%
Steelmaking slag	5.65	Road base, civil engineering materials, fertilizer, etc.	99%
Dust	3.13	Raw materials for use in-house and also zinc refining	100%
Sludge	0.43	Raw materials for in-house use	88%
Coal ash	0.52	Cement raw materials, construction materials	100%
Waste furnace materials	0.35	Reuse, etc.	68%
Others	2.07	In-house use, others	100%
Total	24.93	Total recycling rate	99%

1 Fine dust collected with a dust collector

2 Semi-solid slurry recovered from industrial wastewater or sewage treatment

Fig. 7 By-products and recycling (FY2019)

vivification of desertified sea beds; the effect of which is expected to serve also as blue carbon $(CO_2 absorbed and fixed by the marine ecosystem)$, and are attracting attention as a measure against climate change. Furthermore, the slag from iron and steelmaking processes contains nutrients that support the growth of plants, and is widely used as fertilizer, contributing to the improvement of agricultural productivity. Technical development for wider use of such by-products is important for building a circular economy.

4.2 Recycling of waste generated from community (waste plastic recycling)

Nippon Steel recycles the plastic containers and packaging that are collected from households by a chemical recycling method using coke ovens. The recycling ratio is 100%: 40% of it is recovered as hydrocarbon oil, 40% as coke oven gas, and 20% as coke.

Systems for collecting and recycling waste plastics have been established around seven areas of five steelworks of the company. The number of municipalities and municipality unions that take part in the recycling of plastic containers and packaging is 1108 across the country, and Nippon Steel is recycling them from 342 municipalities and unions (as of FY 2019). The total amount recycled by the company is roughly 200000 t per year, accounting for nearly 30% of the amount of waste plastics collected nationwide. The recycling efficiency of the process using coke ovens is very high, the processing capacity is large, and thanks to these advantages, it contributes to the circular economy in the regions covered by the system. The cumulative processing amount from FY 2000 to 2019 is approximately 3.28 million tons, which is equivalent to a decrease in CO₂ emission of 10.5 million tons. Recently, chemical fibers and food trays have been additionally included in the target of this processing system, and recycled into plastic products, etc.

Although material recycling is prioritized in the current bidding system for the recycling of containers and packaging plastics, the Basic Act for Establishing a Sound Material-Cycle Society regards material recycling and chemical recycling as being equivalent to each other, and either is considered to be an adequate recycling method. From the viewpoints of environmental loads and economy and considering the fact that roughly 50% of the waste not recycled at material recycling plants is sent to other waste treatment facilities and burnt for heat recovery, the chemical recycling method, by which virtually all the waste plastics are recycled with little residue, is the most environmentally friendly recycling method. Nippon Steel will propose to the Government to revise the bidding system, increase the collection of waste plastics and establish a legal system that covers not only plastic containers and packaging, but all general waste plastics. In this respect, it is important for the company to expand the capacity of the process.

5. Environmental Risk Management

Many environment-related laws have been enacted for pollution control; such include the Air Pollution Control Act, the Water Pollution Prevention Act, the Soil Contamination Countermeasures Act and the Act on Confirmation, etc. of Release Amounts of Specific Chemical Substances into the Environment and Promotion of Improvements to the Management. Thereof in addition to complying with these laws and regulations, Nippon Steel meticulously takes measures against environmental risks that differ from steelworks to steelworks, and aiming to continuously improve its environmental conservation activities in different regions of the country, it takes measures against environmental risks related to air, water, soil, etc., controls the discharge of chemical substances and properly treats in-

dustrial waste. The company's risk management related to air and water is described in this section.

5.1 Atmospheric risk management

Various measures are being taken to reduce the emission of sulfur oxides (SOx) and nitrogen oxides (NOx). Nippon Steel has concluded agreements with local governments that include stricter regulations than the total emission regulation standards under the Air Pollution Control Act, and to lower the emission level further to below those of such agreements, has implemented effective measures such as the use of low-sulfur fuels and introduction of equipment to decrease SOx and NOx emissions, burners that generate less NOx and exhaust gas treatment facilities. As an example, Fig. 8 shows a dry type exhaust gas desulfurization and denitrification facility using activated coke. In addition, in order to reduce soot and dust emitted from plants and raw material yards, equipment measures are taken based on atmospheric risk analysis employing scientific simulations, and at the same time, abnormal emissions to the local environment are checked by permanent monitoring and regular patrols. The company will further pursue the digital transformation of environmental management by applying technologies such as artificial intelligence and the Internet of things.

5.2 Water risk management

In its business activities, Nippon Steel has continuously endeavored to reduce environmental loads by decreasing water consumption and improving the efficiency of its use. The company annually uses approximately 6.5 billion cubic meters of water at all its steelworks and manufacturing bases in Japan, and roughly 90% of it is treated and circulated various times so that important natural water resources are not squandered and the amount of wastewater finally discharged is as small as possible. To this end, efforts are continuously exerted on a daily basis to maintain and improve the functions of water treatment equipment and carefully inspect and control the quality of discharged water. As an example of such facilities, Fig. 9 shows an activated sludge treatment facility for wastewater. The efforts of treatment and cyclic use of water also contribute to reducing the risk of water shortages. In addition, in view of the importance of preventing water pollution, systems of automatic drainage monitoring devices, drainage shut off gates and emergency water tanks are provided so that abnormal drainage is not discharged outside the steelworks in the unlikely event of operation problems. Operation procedures are set out for the treatment facilities, training is conducted periodically and the procedures are reviewed for improvement. Furthermore, to prevent abnormal water leakage from revetments and quays, procedures are defined, they are inspected regularly and repairing measures are taken when necessary.

6. Public Relations Activities Related to the Environment

Nippon Steel's public relations activities concerning the environment include active exchange of environmental information with various stakeholders, information disclosure in an appropriate and timely manner to continue to be trusted in society, as well as measures to conserve biodiversity and promote natural symbiosis. Its initiatives to preserve biodiversity and environment-related external awards are presented in this section.

6.1 Biodiversity conservation initiatives

At the 10th Conference of the Parties to the Convention on Biological Diversity (COP10 of the CBD) held in Nagoya, Aichi, Japan, in 2010, the Aichi Targets were adopted, requesting the parties to take effective and urgent actions to realize a world of natural symbi-



Fig. 8 Active coke dry type desulfurization equipment The dry desulfurization and denitrification methods, using active coke, enable SOx and NOx in emission gas to be eliminated.



Fig. 9 Activated sludge treatment equipment Organic matter is decomposed and eliminated by bacteria.

osis by 2050, and to this end, implement measures to prevent the loss of biological diversity by 2020. In the final year of the Targets, interest in the Post-Aichi Targets to be agreed upon at the COP15 of the CBD increased internationally. In view of this, the Ministry of the Environment organized the Japan Committee for United Nations Decade on Biodiversity (UNDB-J), naming the Chairman of the Keidanren as its head. In the midst of these movements, the Keidanren, focusing on the mainstreaming of biodiversity (incorporating conservation and sustainable utilization of biodiversity in social economic activities), took initiatives such as the Keidanren Biodiversity Declaration and launching of private partnerships for biodiversity. In October 2018, based on the adoption of the Paris Agreement and the SDGs, the Action Guidelines for the Keidanren Biodiversity Declaration were revised after nine years of activities, and efforts are being made to further promote the activities and expand the support base.

As a member of the Keidanren, Nippon Steel also declared to act according to the action guidelines for the Declaration, and set forth its policy for the future as shown in **Fig. 10**.

On Keidanren's website on the Biodiversity Declaration, the company presented the following as its specific efforts at biodiversity conservation: (1) fostering of hometown forests; (2) development of marine forests; and (3) participation in local projects for biodiversity conservation. These activities are closely linked to the company's integrated environment management, which includes the initiatives for construction of a circular economy and countermeasures against climate change. Nippon Steel is proud, therefore, of the fact that its management resources have contributed to the construction of a sustainable society in different aspects. It is committed to strengthening its activities toward building a nature symbiotic society and developing the technologies to evaluate the effects of (1) further activities for biodiversity conservation in cooperation with

Policy for the future

- Recognizing both that our business activities greatly rely on the nature's gifts, and that biodiversity is vital for realizing a sustainable society, we understand the relationships of our business activities with biodiversity and are pledged to respond to challenges rooted in diverse local features, in order to build a society in harmony with nature.
- As a member of the international community, we also recognize that initiatives aimed at building a society in harmony with nature are closely related to global issues of measures to deal with climate change and creation of a circular economy. We aim to realize a sustainable society through an integrated environmental corporate management which includes these initiatives in business activities.

Fig. 10 Initiatives on conservation of biodiversity

Table 1 Awards received recently from external organizations				
Award name	Sponsor	Detail		
Ichimura Prize in Industry against Global Warming for Distinguished Achievement	Ichimura Foundation for New Technology	Technology to restore sea forest by use of steel slag, which benefits diverse ecosystems (2019) Development HRX19 [™] high-strength stainless steel for high-pressure hydrogen environments to help accelerate the creation of a hydrogen-oriented society (2018)		
EcoPro Award "Sponsor's Award (Prize for Excellence)"	Sustainable Management Promotion Organization	Vivary TM Series (Vivary TM Units, Vivary TM Rock) (2019)		
Iwatani Naoji Memorial Award	The Iwatani Naoji Foundation	Development HRX19 [™] high-strength stainless steel for high-pressure hydrogen environments to help accelerate the creation of a hydrogen-oriented society (2018)		
New Energy Award (METI Minister's Award)	New Energy Foundation	Visionary approach to expand a biomass-to-coal co-firing ratio in pulverized-coal-fired thermal power generation (2016)		
Recycling Technology HONDA AWARD	Japan Environmental Management Association for Industry /Resources Recycling Promotion Center	Development of full utilization process of steel making slag (2020)		
Awards for Resources Recirculation Technologies and Systems		Establishment of a resource recycling system by alloy iron melting furnaces, enabling recycling of the entire chrome resources (Yawata Works) (2017)		
		Development and commercialization of technology for zero emissions in the integrated steel- works (Nagoya Works) (2015)		
Environment Award	Nikkan Kogyo Shimbun /National Institute for	Seeks to develop an ecosystem network the "Inochi-wo-Tsunagu (Life Sustaining) Project" (Nagoya Works) (2018)		

local societies and (2) expansion of marine forests to wider regions and their evolution into blue carbon.

Environmental Studies

6.2 Environment-related external awards

As a consequence of promoting the various environmental initiatives mentioned herein, Nippon Steel has received numerous awards from outside organizations (see **Table 1**). This resulted from actively working on environmental conservation and contributing to society for many decades. Various environment-related external awards have been newly instituted, such as the Ichimura Prize in Industry against Global Warming for Distinguished Achievement, which was established in 2018. As contribution to the achievement of the SDGs is required, the importance of receiving such environment-related external awards is increasing for enhancing the corporate value of Nippon Steel.

7. Conclusion

In order to realize a sustainable society, it is becoming increasingly important to regard environmental issues as new growth factors, rather than economic constraints, and to realize virtuous cycles of environment and economy wherein environment conservation and activated economy are integrated. In addition, as stated at the beginning, the time has come in which corporate enterprises are selected based on their environmental efforts, and their competitiveness is influenced by them. Environmental initiatives are attracting more and more attention, and it is imperative to bring together the wisdom of Nippon Steel to contribute to local communities and the global environment through the three eco-activities and development of ultra-innovative technologies.



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