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Chemical Industry's VISION on Global Warming Countermeasures

Japan Chemical Industry Association (JCIA)

I. Introduction

As global discussions on global warming countermeasures have progressed, strong calls are emerging for specific actions to be taken to reduce greenhouse gases (GHG).

Although the medium-term target has already developed for the GHG emission reductions promised by each country under the Paris Agreement to be promoted by further strengthening of conventional countermeasures, it has been called upon to re-establish the balance between the environment and the economy on a global scale so that it is truly sustainable over the long term. In order to realize this, it will need not an extension of existing conventional countermeasures, but new and transformational innovations.

"Chemistry" creates revolutionary and useful materials, which are produced by various substances. The chemical industry can make the latent potential of "chemistry" industrialized and also can play a core role for innovations as a solution provider of global warming issues.

Accordingly, Japan Chemical Industry Association (JCIA) had organized the Working Group for Review of Long-Term Strategy on Global Warming (here in after referred to as the "WG") under the Technical Affairs Committee with the participation of experts from its member companies, related organizations and academia. The purpose of this WG is to provide chemical industry's vision and solutions on global warming countermeasures in 2050 and beyond, and to propose the long-term strategy for the chemical industry to build a sustainable society. JCIA expects that this vision will be taken into account at the formulation of the long-term strategy in Japan under the Paris Agreement.

[Reference: Current policy trends in response]

With the entry into force of the Paris Agreement, the movement to address global warming countermeasures is becoming full-fledged. In Japan, "the Plan for Global Warming Countermeasures" (Cabinet decision in May, 2016) was decided and the plan defines a path to achieve a mid-term target of 26.0% greenhouse gas emission reduction by FY 2030 compared to FY 2013, clarifying policies and measures to be implemented. The long-term goal has aimed to reduce greenhouse gas emissions by 80% by the year 2050. This 80% reduction will not be achieved through the extension of existing measure so far, but will be enabled by each industry's development of transformational technologies and by enhancement of collaboration with other industries to engage in projects that transcend industry lines and deploy Japan's technologies and innovative power on a global scale.

* *If the emissions are reduced by 80% from the total of 1.41 billion tons (of which 360 million tons are emissions from industry) compared to the base year of FY2013, this means that only 250 to 280 million tons will be allowed to be emitted.*

Toward formulating "the long-term low greenhouse gas emission development strategies for 2050", Japan is required to submit the long-term strategies to the UN Secretariat by 2020. Under the leadership of the Ministry of Economy, Trade and Industry (METI), "Long-term Global Climate Change Policy Platform" has been set up and compiled a report. Based on the discussion results of "the Task Force for the Expansion of Inward Investment" and "the Task Force for Overseas Expansion Strategies", both of which were established under the platform. And long-term strategy formulation is being promoted through collaboration between industry, government, and universities. In addition, Under the Ministry of the Environment, "Long-term Low-carbon Vision" was developed, based on the discussions results of its Subcommittee under "the Global Environment Subcommittee" of "the Central Environment Council".

JCIA has worked on voluntary initiatives named "The Commitment to a Low-Carbon Society" formulated by the Japan Business Federation (Keidanren). The goals of the voluntary Action Plan are (a) Emission reductions from domestic business operations in Japan by 1.5 million tons-CO_2 compared to BAU in 2020 and by 2 million tons-CO_2 compared to BAU in 2030, (b) strengthening co-operation with other interested groups (achieving reductions in other divisions through low-carbon products, services, etc.), and (c) o promoting contribution at the international level.

**BAU (business-as-usual scenario): CO_2 emissions calculated under the assumption that the energy efficiency of economic activity in the year in question remained at the 2005 level*

II. The vision of the chemical industry

1. State of mid-21st century society

The chemical products currently used in society are generally made out of carbon from fossil feedstocks. They are vital to support many industries and livelihoods by using widely not only in consumer goods but also in various manufacturing processes. Although they will continue to be used in large quantities in the future, the source of carbon will be diversified towards a carbon circular economy. However, the use of fossil fuels as energy sources is considered to be drastically reduced.

As Japan's efforts to reduce GHG emissions have progressed, a social system based on hydrogen and electric energies will be established and renewable energy will become the mainstream as a secondary energy source.

2. Chemical industry as a solutions provider

In order to establish a carbon-circular society with greatly reducing GHG emissions, the chemical industry not only proposes and disseminates chemistry-based product designs and usage scenarios to GHG reductions, but also proposes and supplies the materials and products that can make the circular economy possible. As a result, the chemical industry will be recognized as a global solution provider.

To play the chemical industry's role as a solutions provider and to be supported by society, the following technologies and business model are required.

[1] Establishment of carbon-circulation
[2] Process and energy innovation
[3] Selection of environmentally focused business model and establishment of social infrastructure to allow the business model

[1] Establishment of carbon circulation

As the study on carbon circulation has progressed, raw materials to produce various chemical products will become increasingly diversified. At the same time, a social system for promoting carbon circulation need to be developed.

Even after 2050, fossil resources as feedstocks has continued to use with the advancement of noble use of oil (especially those with low utilization rate of heavy fraction etc.), the improvements on the chemical reactions and the progress in efforts to achieve zero carbon dioxide emissions by recycling of chemical byproducts and waste chemical products as raw materials.

[2] Process and energy innovation

Efficient production of chemicals at the petroleum refining and petrochemical process has been improved (direct extraction of light fractions from heavy oil, membrane separation of various fractions, and selective recovery of target fractions).

Energy-saving technology in the process of manufacturing mass production products has been applied to the new construction of facilities in developing countries and the international contribution with Japanese technology has been recognized.

Also, remarkable energy savings will be achieved in the production processes for high-value-added chemicals along with great improvements in the safety of chemical processes as well as reductions of waste generated when changing conventional reaction process.

Various kinds of materials produced in industrial complexes and plants will create and offer new products of high value with economy through the creation and utilization of a wide variety of value chains. This leads to reduction of energy consumption and minimization of emissions and logistics costs.

Moreover, plants located in the same complex will establish a flexible and efficient energy exchange system among industrial complexes and other companies, so that utilization of waste heat dramatically has been promoted and as the result the energy consumption has been reduced.

[3] Selection of environmentally focused business model and establishment of social infrastructure to allow the business model

Chemical industry supplies materials that enable "important and key functions" in the products which are necessary for consumer’s daily life, as well as for economic activity. And another "important and key functions" is the reduction of GHG especially at the stage of product use. Chemical industry proposes the design and use scenario of the products to reduce GHG emission at the stage of usage of the product, which is brought by cooperation along the chemical industry’s value chain. As a result, the development of consumer products leading to the reduction of GHG emissions will progress dramatically. While chemical industry emits a certain amount emission of GHGs at the production stages, chemical industry will provide the potential value of

the products to its downstream manufacturers, which lead to the GHGs reduction at the use stage of the products. Various contributions toward the energy efficiency and climate change countermeasures can be made by actually incorporating important materials corresponding to the proposal.

(i) Through the use of products, to achieve reductions of GHGs emission that greatly exceed the amount of GHG emitted at the stage of materials production

(ii) By supplying materials, produced through the most efficient processes that reduce GHG emissions, to recognize the products, as environmentally responsible products from the perspective of the overall reduction of GHG throughout their life cycle

Through the cooperation along chemical value chain toward the zero GHG emissions society, the business model to integrate environmental consideration into product design, development and production will become widespread in the society. In addition, the development of materials and products by considering recycle, the advancement of standardization in recyclable design, and the flexibility to change conditions at the manufacturing process will percolate throughout society.

The utilization of AI (artificial intelligence) will evolve (or advance) toward the establishment of technologies and business model mentioned above. In addition to accelerating development of innovative catalysts and highly safe and functional chemical products, research bringing social transformation, for example, the synthesis of amino acids and proteins from air and silicon from ordinary rocks as raw materials, will continue to germinate the innovations that will lead to the next society. Significant innovation will continue to be created by tackling innovation themes that enable huge scale (order-of-magnitude) improvements, not merely by the extension of existing measure's improvements or refinements (2-fold or 3-fold).

III. Toward realization of the JCIA's vision

In order to realize "the chemical industry's vision on Global warming Countermeasures", it is necessary to have the strategic direction toward the below focused areas and to make efforts to preferentially achieve them.

1. Carbon circulation of raw materials

It is necessary to promote a diversification of feedstocks that leads to carbon circulation and minimize GHG emissions in the life cycle of chemical products. As the countermeasures, based on a long-term perspective, chemical industry will promote carbon dioxide capture and utilization (CCU), use of biomass feedstock, and utilization of natural gas as fuel and/or feedstock, and use of methane hydrate resources. At the same time, chemical industry will work on the development of technologies necessary for reuse of waste (waste plastic etc.) as a carbon source. Also, chemical industry will thoroughly promote highly sophisticated use of fossil feedstocks. Regarding the use of biomass as raw materials, chemical industry will promote technological development for two cases, one is to use biomass as it is, such as cellulose nanofibers and lignin, etc., and the other is to use it as raw material for basic chemicals.

With regard to bioplastics (plastics produced from biological resources), it is expected technology development, not only with cost reduction, but also with adding non-conventional value, such as coloring and controlling sterilizing properties owing to the biological origin of the materials, which have never been before to improve its performance in order to establish its business model.

Along with above these technological developments, it is also necessary to establish the system to effectively collect the carbon source for chemical processes by promote the utilization of AI when biomass and waste as the carbon source were collected and transported.

2. Processes for minimizing energy use, and structural shift

It is necessary to promote technological innovation to achieve energy savings on an extraordinary scale in the manufacturing process. Firstly it is to develop membrane separation processes as the alternative distillation processes, which consume a lot of energy in the manufacturing process. With regard to high-value-added functional chemicals, it will promote to develop flow reactors (micro reactors) and bio generations as new and highly energy saving ways to produce, instead of the conventional batch production method of manufacturing, which spend huge energy for many product types in small quantities. It will also aim to realize epoch-making methods that carry out a reaction in a transportation process equipped with a new reaction system.

To reduce the energy use ratio by fossil fuels' combustion, it will develop innovative technologies to exchange electric energy to thermal energy, such as resistance heating (Joule heat), microwave heating, induction heating, and heat pumps for industrial applications. Moreover, it will develop innovative processes without energy loss, such as inserting a heat-absorbing process or repeating heating and cooling after a process that emits heat. Furthermore, in order to increase energy efficiency, it will combine the processes of heat generation and heat absorption and will utilize waste heat. Then it will establish an energy management system by going beyond individual company within local petrochemical complex. As an effort by corporates' collaboration, it will build a mechanism for effective utilization of materials within an industrial complex.

Parallel to above these efforts, it will promote the utilization of AI in applications as establishing technologies such as minimizing the energy that has conventionally been required for regular repairs, predicting the lifespan of a production plant that transcend conventional concepts and in achieving feedforward control of processes that can accommodate various types of products, handle operation switching, and cope with disturbances.

3. Reduction of GHG emissions throughout product life cycle

It will commercialize high-insulation materials, highly lubricating materials, etc., as new materials bringing the entire value chain innovation. It will develop high-strength lightweight materials (such as CFRP, CFRTP) and will proactively propose them to downstream user industries and will establish the system of cooperation. It will finally contribute to the energy savings and minimizing emissions of GHGs throughout the product life cycle. Rather than adhere to the conventional business model of responding to user requests, it is expected for chemical industry to establish a new business model wherein chemical industry can make proposals to the final product manufacturers in anticipation of the

potential needs of the end user/customers. By using the business model, the chemical industry can propose product designs and use scenarios that will lead to overall reductions of GHG emission. Finally, chemical industry will play a leading role along the value chain and will establish its position as a solution provider to reduce GHG emission and achieve climate goals.

4. Expansion of the carbon-circular economy at the global level

Chemical Industry has been contributing to worldwide reduction of GHGs emission by the overseas deployment of its experience, technologies, products, and know-how cultivated by the establishment of a carbon-circular economy in Japan. Through bilateral dialogue and at the international organizations' meeting, chemical industry has sought opportunity to make its experience, technologies, products, and know-how widely known as indispensable to sustainable society and has sought the way for deployment of the Japanese technologies and business models in emerging countries

The following items should now begin to be tackled as actions based on the vision.

[1]The chemical industry should get all the collective effort by working together with other industries, the government, and academia/universities to formulate programs for developing innovative technologies.

[2]In order to contribute to significant GHG emission reductions overseas, the chemical industry will prepare for establishing the approach to propose the innovative technologies brought by the chemical industry to the international organizations for the internationally deployment of the technical strengths in the way of economic rationality.

[3]The chemical industry should establish a system of collaboration that transcends conventional industrial boundaries and propose a new social system in order to bring about social innovation throughout the entire value chain.

IV. Conclusions

It is obvious that the response to global warming awaits extremely high challenges on a global scale. Even in Japan, it is also obvious that the global warning countermeasures are toughest challenge level to overcome the issues. The solution cannot be accomplished by chemical industry alone. It requires the cooperation along the chemical industry's value chain. All stakeholders related to chemical industry will join together as never before to engage in activities of global warming countermeasures. Chemical industry surely make any effort to tackle the shared challenges of global warming and secure social recognition of the chemical industry's position as a solution provider that can solve problems related to global warming and can contribute to enable a sustainable society. JCIA earnestly expects its stakeholders to refer to the "vision" and to develop their own strategic plan to implement the concrete global warming countermeasures.

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Chemical Industry's VISION on Global Warming Countermeasures

✓ Develop an implementation plan of Japanese INDC based on the Paris Agreement and submission to the UN Secretariat (by 2020)
✓Creating innovation to solve global problems by manifesting the potential of "chemistry"

Ideal situation as a solution provider

① Establish the carbon circulation
•Use of various raw materials

② Increase energy efficiency by transforming the process
・ Improvement of efficiency and international expansion

③ Propose the new social system
Proposal of product design for realization of reduction of GHG considerably exceeding emission at the manufacturing stage

Toward realization of Ideal situation

① Carbon circulation of raw materials
• CCU, biomass, LNG, methane hydrate resources, bioplastics, and waste usage, etc

② Process and energy innovation
•Distillation ⇒ membrane separation
•Flow reactor, bio-production system
•Energy waste elimination process
• Energy ・ material management within the industrial complex

③ GHG reduction through product life cycle
• New materials leading to innovation of the entire value chain
• Propose products to supply chains predicting the potential needs of end consumers

④ Expansion overseas / Deployment in emerging countries on a business basis / Bilateral dialogue and utilization of international organizations

Formulate a technology development program by combine the total power of the chemical industry

Make proposals and systems for international expansion of products and technologies with economic rationality

Construct collaborative system / social system that causes social innovation throughout the value chain