Green and
Sustainable
Chemistry

Introduction to GSC

Special Edition Revised Edition

Introduction to SDGs

Sustainable Development Goals

GSC plays a driving role in SDGs

Let's change the world towards a sustainable future!

Objective of the textbook series

Sustainable Development Goals (SDGs) are drawing international attention. SDGs are universal goals adopted by the United Nations, which see the harmonization of the three elements of economy, society and the environment as essential in order to achieve sustainable development (in other words to maintain the environment in which we live in). This school of thought is also common to Green and Sustainable Chemistry (GSC), which targets a balance between environmental conservation and economic development towards the sustainable growth of society.

The Japan Association for Chemical Innovation (JACI) textbook series has thus far introduced practical cases of what we can do in order to become leaders of a sustainable society. Serving as a special edition, this textbook aims to provide a commentary on SDGs from the perspective of GSC, and encourage readers to think and act.

What is GSC?

Acronym for Green and Sustainable Chemistry

Definition of GSC

Chemical sciences and technologies which are benign to both human health and the environment, and support the development of a sustainable society

Guidelines of GSC activities

- The chemistry community has been addressing future-oriented research and education, and development towards environmentally-benign systems, processes and products for the sustainable development of society.
- Specifically, in response to the Rio Declaration at the Earth Summit in 1992, the chemistry community has been working in a unified manner linking academia, industry and government to start up Green and Sustainable Chemistry and engage in its activities, in order to advance the pursuance of coexistence with the global environment, the satisfaction of society's needs, and economic rationality. These goals should be pursued with consideration for the environment, safety and health across the life cycles of chemical products, their design, selection of raw materials, processing, use, recycling and final disposal.
- Long-term global issues, in areas such as resources and energy, global warming, water and food, and demographics have increasingly become major and complicated concerns in the present century. Therefore, expectations are growing for innovations, based on the chemical sciences, as driving forces to solve such issues and to achieve the sustainable development of society with enhanced quality of life and well-being.
- The chemistry community will live up to these expectations by strongly advancing Green and Sustainable Chemistry through global partnership and collaboration and by bridging the boundaries that separate industries, academia, governments, consumers and nations.

Examples of GSC

- The general classification is expressed in terms of a combination of the intended social contribution and the means to achieve this goal. With regard to the objectives, the efforts to achieve them have extended in stages from social challenges to difficult long-term challenges, beginning with manufacturing or utilization, and common/basic categories have also been established -

Minimization of resource consumption and maximization of the efficiency of reaction processes for production with reduced environmental impact

1. Chemical technologies and products that lead to reduction in by-product formation and avoid the use of hazardous substances
2. Separation, purification and recycling technologies that reduce the generation and emission of greenhouse gases like CO_2 or toxic/hazardous substances, thus lowering environmental impact
3. Chemical technologies and products that reduce the generation and emission to the environment of greenhouse gases like CO_2 or toxic/hazardous substances
4. Catalysts and reaction processes that realize the saving of energy and resource and improvement in product yields

Risk reduction of chemical substances beneficial to safe and secure living environment

5. Chemical technologies, products and systems that reduce waste generation
6. Chemical technologies, products and systems that inhibit the generation and emission of hazardous substances and pollutants

Challenges to solve energy, resource, food and water issues

7. Chemical technologies, products and systems to utilize low-grade heat sources, non-conventional resources, and other similar alternatives
8. Chemical technologies, products and systems whereby un-utilized energy and resources can be converted into available energy, transported and stored
9. Chemical technologies, products and systems which decrease the dependence on exhaustible resources such as fossil fuels and scarce minerals and promote the shift to renewable energy and resources, including their storage
10. Chemical technologies, products and systems that contribute to the Three R's: Reduce, Reuse and Recycle
11. Chemical technologies, products and systems that promote the efficiency of production and supply of food, and utilization of water resources

Pioneering challenges to long-term issues aiming to realize a safe, secure and sustainable society with enhanced quality of life

12. Chemical technologies, new products and new operational systems that contribute to the introduction of new social systems, for instance based on ICT, and aimed at solving social issues such as energy and resource consumption, food and water security, disaster prevention and infrastructure improvements, transportation and logistics, medical and health care, education and welfare, and other mega-trends of society
13. Chemical technologies, new products and new operational systems that contribute to the improvement of social and individual comfort whilst reducing and preferably inhibiting environmental impact

Systematization, dissemination, enlightenment and education of GSC including its metrics to be established

14. Systematization of GSC practices and concepts
15. Dissemination, enlightenment and education of GSC practices and concepts
16. Establishment and dissemination of GSC metrics

(Definition from JACI GSCN Council
https://www.jaci.or.jp/english/gscn/page_01.html)

What are the SDGs?

The SDGs are a common set of goals for international society

The Sustainable Development Goals (SDGs), also known as Global Goals, are a common set of goals that international society aims to achieve by 2030. These were agreed upon and adopted by 193 member states, including Japan, at the United Nations summit held in September 2015. The SDGs are also recorded in "Transforming our world: the 2030 Agenda for Sustainable Development," which was adopted at the simultaneously convened 70th session of the General Assembly of the United Nations. The SDGs aim to eliminate poverty, protect the Earth, and ensure the peace and well-being of global citizens.

United Nations Transforming our world: the 2030 Agenda for Sustainable Development
https://sdgs.un.org/2030agenda

Transforming the world

As indicated by the words "Transforming our world" in the title of the 2030 Agenda, the SDGs aim to transform the world for "People, Planet, Prosperity, and Peace" through "Partnerships" in international society. These "5Ps" are the foundations of the stance that must be taken in order to transform the world.

⟨The 5Ps of the 2030 Agenda⟩

People	We are determined to end poverty and hunger, in all their forms and dimensions, and to ensure that all human beings can fulfil their potential in dignity and equality and in a healthy environment.
Planet	We are determined to protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations.
Prosperity	We are determined to ensure that all human beings can enjoy prosperous and fulfilling lives and that economic, social and technological progress occurs in harmony with nature.
Peace	We are determined to foster peaceful, just and inclusive societies which are free from fear and violence. There can be no sustainable development without peace and no peace without sustainable development.
Partnership	We are determined to mobilize the means required to implement this Agenda through a revitalised Global Partnership for Sustainable Development, based on a spirit of strengthened global solidarity, focused in particular on the needs of the poorest and most vulnerable and with the participation of all countries, all stakeholders and all people.

In order to tackle the SDGs

The 17 goals

The 2030 Agenda cites a basic stance comprising the “5 Ps” to transform the world, and sets 17 specific goals to do this. These 17 SDGs are listed in the table on page 10. Additionally, 169 targets have been identified as issues requiring resolution. Among them, the seventh SDG, which can be significantly correlated with GSC, is described in the figure below. The goals cited in the SDGs are universal goals to be tackled throughout the entire world, in both developed and developing nations.

Fig.1 SDGs logo and 17 icons

Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all

- 7.1 By 2030, ensure universal access to affordable, reliable and modern energy services
- 7.2 By 2030, increase substantially the share of renewable energy in the global energy mix
- 7.3 By 2030, double the global rate of improvement in energy efficiency
- 7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology
- 7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support.

The 17 goals are interconnected

The 17 goals are interconnected, demonstrating the need for strategies to address climate change and environmental protection while promoting economic growth to solve poverty and meeting a wide range of societal needs such as education and health.

The correlations between the 17 goals can be depicted by the “wedding-cake model” proposed by the Stockholm Resilience Center. In this model, the 17 goals are classified into three interconnected tiers: “economy,” “society,” and “biosphere.” The foundation of this “cake” comprises four “biosphere” goals (goal number 13, 14, 15, and 6), which is followed by the “society” and “economy” tiers (from bottom to top). This illustrates the fact that economy is supported by society, and in turn society is supported by the biosphere or, in other words, the environment. According to the Resilience Centre, without environmental sustainability the sustainable development of society and economy cannot be realized.

Fig. 2 Wedding-cake model depicting the concept of SDGs. Correlations between the 17 SDGs (depicted by their interconnection) can enable the formulation of strategies to resolve specific global issues.

Stockholm Resilience Centre
https://www.stockholmresilience.org/research/research-news/2016-06-14-how-food-connects-all-the-sdgs.html

Harmonizing the three elements

The three tiers (“economy,” “society,” and “biosphere”) into which the 17 goals are classified in the wedding-cake model correspond to the three core elements of the SDGs (i.e., economy, society, and the environment). The 2030 Agenda states that in order to achieve sustainable development harmonization between the three elements of economy, society and environment is essential. However, as can be seen from the wedding cake model, environmental sustainability is the premise of all sustainability.

"Social inclusion" means to support all people from loneliness, isolation, exclusion and friction, and to support each other as members of society so that they can lead to healthy and cultured lives. In other words, being a society in which nobody is left behind, in which all people are included and can participate is important in order to transform the world, and absolutely essential for sustainability.

Three elements of SDGs

It is vital that these three elements are harmonized.

Why are the SDGs necessary?

The preamble to the 2030 Agenda cites “eradicating poverty” as the most important issue, and pledges that “no one will be left behind.” In other words, the SDGs target every country from the developed nations to the developing nations. Why are the SDGs necessary throughout the entire world? Here we will explain about the background to the advent of the SDGs.

International initiatives against poverty

The Millennium Development Goals (MDGs), formulated in 2001 to overcome poverty in developing countries within a 15-year period (up to 2015), were the forerunners of the SDGs. The MDGs comprise eight goals and 21 targets (including measures against extreme poverty and hunger, the prevention of deadly illnesses, and the establishment of universal primary education) that require the support of the international community. Although the MDGs promoted development in many fields, several issues remained unresolved. For example, the insufficient implementation of initiatives to alleviate poverty in South Africa increased the disparity between the rich and the poor further. It is still vital to continue with initiatives to eradicate poverty.

Maintaining a viable environment (environmental sustainability)

While the MDGs achieved a certain degree of results, over their course the problems surrounding the global environment such as global warming worsened, and these problems had to be addressed. Therefore, by adding the sustainability initiatives that the United Nations has been advocating for many years, the SDGs were created as new goals for the next 15 years of the MDGs. The origins of “sustainability,” which indicates the maintenance of the environment in which we live, can be traced back to the concept of sustainable development proposed by the 1987 Brundtland Commission (a global commission on environment and development established by the United Nations in 1984). The concept that the Earth’s resources are finite, and notion of “meeting the needs of current generations without compromising the needs of future generations” became a vital signpost for subsequent global environmental conservation. Later, it became recognized that the widening gap between the wealthy and the poor and the problem of poverty could threaten the survival of human society, and this was clearly demonstrated at the United Nations Millennium Summit in 2000.

Making an appeal to the world

Earth’s resources are finite. Therefore, resolving global environmental issues is essential for sustainable development. Thus, the SDGs, which were formulated on the basis of the MDGs, are characterized by the addition of new areas such as climate change, economic inequality, innovation, sustainable consumption, and peace and justice, in addition to the poverty elimination set forth in the MDGs. The SDGs are also n urgent appeal to guide all nations along the path of sustainable development. In 2015, along with the adoption of the SDGs, the Paris Agreement was adopted at the 21st Conference of Parties (COP21) of the United Nations Framework Convention on Climate Change (UNFCCC). The Paris Agreement is a set of international rules that serve as a countermeasure against global warming (from 2020 onwards). By tackling climate change in accordance with the Paris Agreement the world will play an important role in the achievement of the SDGs.

Column 1

The Paris Agreement: Toward zero greenhouse-gas emissions

To ensure that the global average rising temperature is lower than 2˚C more than pre-industrial levels, the Paris Agreement aims to almost eliminate greenhouse-gas emissions during the second half of this century. In line with the United Nations Framework Convention on Climate Change, which was adopted in 1992, the Conference of Parties (COP) has been held every year since 1995, and continuous debate has taken place towards reductions in greenhouse gas emissions. The Kyoto Protocol adopted at COP3 in 1997 is a framework stipulating targets for the reduction of greenhouse gas emissions by the year 2020. The Kyoto Protocol placed a commitment to reduce greenhouse gas emissions only on the developed nations, whereas the Paris Agreement involves the participation of all nations.

The three elements of GSC and the SDGs

International trends

Both the SDGs and GSC are intrinsically connected to the history of “sustainable development.” It was in the 1970s that the human environment first started to become discussed. The Stockholm Declaration (Declaration of the United Nations Conference on the Human Environment) was adopted by the United Nations Conference on the Human Environment, and the international debate on environmental problems commenced. The 1987 Brundtland Commission advocated sustainable development and defined the concept (refer to page 5). At the 1992 United Nations Conference on Environment and Development (also known as “the Earth Summit”), the Rio declaration on Environment and Development was adopted. Sustainable development became an important keyword in the Rio Declaration, and started all sorts of initiatives to achieve harmony with the global environment across the world. Subsequently, targets to achieve sustainable development were stipulated by the United Nations, and the 2030 Agenda for Sustainable Development (including the SDGs) was adopted in 2015.

History of GSC

In response to the Rio Declaration initiatives towards sustainable development were launched, centering mainly on those involved in chemicals. “Green chemistry (GC)” has been advocated in the United States since 1994. This was based on the idea of manufacturing in ways that do not produce waste rather than processing waste after it has been generated. In 1994 the Sustech Program aimed at sustainable development was established in the EU, and in 1998 the Organization for Economic Cooperation and Development (OECD) started to advocate sustainable chemistry. The basic idea behind these are to design, produce and use efficient, effective, safe and environmentally friendly chemical products and processes.

Around this time, Japan too began to take green chemistry initiatives towards sustainable development, and in 1998 these became known as “green and sustainable chemistry” (GSC), combining reductions in environmental burdens with a sustainable society. In the year 2015 the Statement 2015 was adopted at the 7th International GSC Conference, and GSC initiatives were bolstered.

GSC pursues "chemistry that is friendly to people and the environment and supports the development of a sustainable society." GSC is pursuing the development of chemical technologies that simultaneously achieve the three elements of "coexistence with the global environment," "satisfaction with social needs," and "economic rationality," which are what chemistry can do for the sustainable development of society. Three elements of GSC are contained within the three elements of the SDGs, and the thinking behind them contains many common points. In other words, GSC's activities contribute to the SDGs.

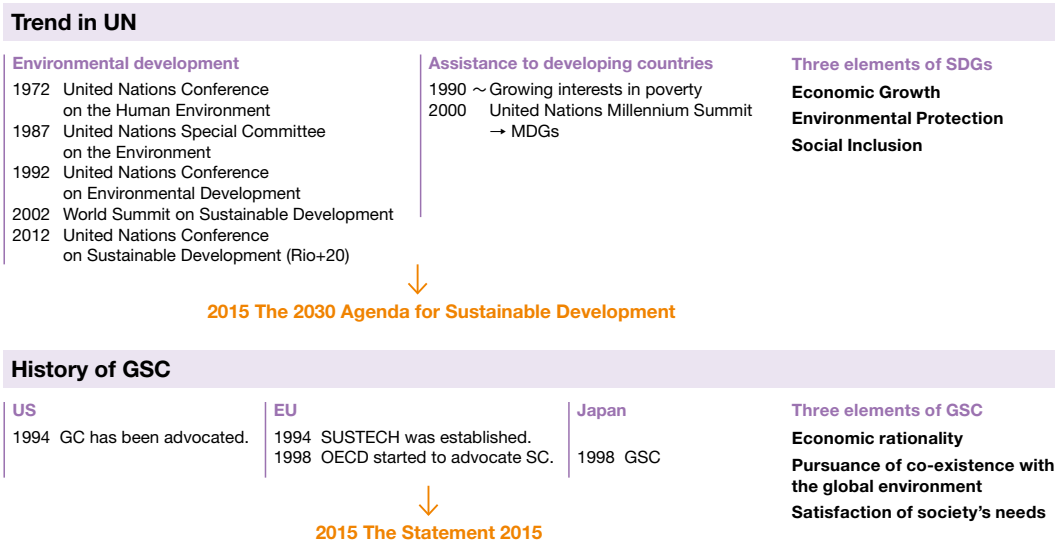

Fig.3 Trends in the UN, the history of GSC, and a comparison of the three elements of GSC
GSC activities contribute toward the achievement of the SDGs.

GSC is a driving force for the SDGs

The Statement 2015 express the pursuit of initiatives in GSC with worldwide cooperation. The GSC principles in Statement 2015 and the SDGs are very similar. The parts of Statement 2015 that correspond to the SDGs are marked in yellow. They have been compiled in Tab. 1.
(for more details please refer to: https://www.jaci.or.jp/about/page_11_02.html)

The initiatives in chemistry toward achieving the SDGs are wide-ranging, and it can be seen how CSC plays a driving role among them.

The Statement 2015

We, the participants of the 7th International GSC Conference Tokyo (GSC-7) and 4th JACI/GSC Symposium make the following declaration to promote "Green and Sustainable Chemistry (GSC) " as a key initiative in the ongoing efforts to achieve global sustainable development.

The global chemistry community has been addressing future-oriented research, innovation, education, and development towards environmentally-benign systems, processes, and products for the sustainable development of society.

In response to the Rio Declaration at the Earth Summit in 1992 and subsequent global Declarations, the global chemistry community has been working on challenges in a unified manner linking academia, industry, and government with a common focus to advance the adoption and uptake of Green and Sustainable Chemistry. The outcomes include the pursuance of coexistence with the global environment, the satisfaction of society' s needs, and economic rationality. These goals should be pursued with consideration for improved quality, performance, and job creation as well as health, safety, the environment across the life cycles of chemical products, their design, selection of raw materials, processing, use, recycling, and final disposal towards a Circular Economy.

Long-term global issues, in areas such as food and water security of supply, energy generation and consumption, resource efficiency, emerging markets, and technological advances and responsible industrial practices have increasingly become major and complicated societal concerns requiring serious attention and innovative solutions within a tight timeline. Therefore, expectations are growing for innovations, based on the chemical sciences and technologies, as driving forces to solve such issues and to achieve the sustainable development of society with enhanced quality of life and well-being.

These significant global issues will best be addressed through promotion of the interdisciplinary understanding of Green and Sustainable Chemistry throughout the discussion of " Toward New Developments in GSC. "

The global chemistry community will advance Green and Sustainable Chemistry through global partnership and collaboration and by bridging the boundaries that traditionally separate disciplines, academia, industries, consumers, governments, and nations.

Table.1 Comparison of Statement 2015 and the SDGs (the implementation of GSC promotes the SDGs)

The Statement 2015 (July 2015)	**SDGs** (September 2015)
Development for sustainable development	• Promote sustainable industrialization and foster innovation
GSC moving forward with academia, industry, and government joining together	• Encourage and promote effective public, public-private and civil society partnerships
Simultaneous realization of coexistence with the global environment, society's needs, and economic rationality	• Commit achieving sustainable development in its three dimensions - economic, social and environmental - (Paragraph 2 of Introduction of Declaration)
Consideration of health, environment and safety across the life cycles of products	• Reduce the adverse environmental impact by air quality and municipal and other waste management • Achieve the management of chemicals and all wastes throughout their life cycle
Security of food and water	• Ensure sustainable food production systems • Achieve universal and equitable access to safe and affordable drinking water
Generation and consumption of energy	• Ensure access to affordable, reliable, sustainable and modern energy
Expectations for innovation	• Enhance scientific research, and upgrade the technological capabilities of industrial sectors
By bridging the boundaries that traditionally separate disciplines, academia, industries, consumers, governments, and nations	• Encourage and promote effective public, public-private and civil society partnerships • Enhance North-South, South-South and triangular regional and international cooperation

interview

Let's think about what each of us can do from our own positions

Dr. Itaru Yasui
Present Professor Emeritus,
The University of Tokyo

Understanding the aims of the SDGs

"SDGs" have in recent years become a frequently heard phrase. Related material has become noticeable, and the number of companies involving themselves in SDGs is increasing. However, it appears that there are very few people who actually have a correct grasp of the original aim of the SDGs. The goals stated in the 2030 Agenda are often referred to as "objectives" in Japan, but their original meaning is not a set of objectives to be achieved. Here their significance lies in everybody showing a stance of approaching the goals. For example, Goal 1 is to "end poverty in all its forms everywhere," but this will surely be far from easy. The 17 goals were created from the perspective of "climate justice" (refer to the column below), meaning that this is their ultimate destination. The 169 targets are immediate objectives.

Transforming the world

The aim of the SDGs is to transform the world. Let us start by being thoroughly aware of the original aim, and thinking about what we ourselves or as an organization can do. The goals and targets are merely indicators, and it is not necessary to pursue them exactly according to the Agenda. What is important is that everybody aims for the goals and thinks about what they can do from their own position.

In order to do so, it is important for us to have discussions with people of all sorts of positions (which corresponds to Partnership, one of the 5Ps). It is sufficient that all of us think about what we can do in anticipation of the goals, do the things we, as individuals or organizations, can do, and change the current situation even a little. The repetition of such action will link in with the transforming of the world. Please try to read the English language text of the 2030 Agenda for Sustainable Development.

Column 2

Climate Justice: What is causing climate change?

The impact of climate change deriving from global warming is becoming apparent in many parts of the world. One of the most serious is the impact of rising sea levels. There are fears that if the sea level rises low-lying land will be flooded by sea water and become submerged, reducing the surface area of certain countries. Many people will lose their homes and forced to move. It is predicted that environmental degradation such as climate change and desertification will lead to the advent of "environmental refugees."

This sort of climate change due to global warming and depletion of energy resources is caused by the mass consumption of oil, coal and other fossil fuels mainly by people living in developed nations. While it has been the developed nations that have reaped the greater benefits, it is the poor people of developing nations that have not used fossil fuels much so far who will bear the brunt of climate change's serious impacts. Despite the fact that life in developing nations is bound to nature-based activities such as agriculture and fisheries, these nations do not have the sufficient funds or technology to adapt to climate change. In South Africa, for example, there are no safeguards if crops fail, and the impact of climate change is further exacerbating the disparity between rich and poor in Africa.

"Climate justice" is a concept in which the developed nations take responsibility for their massive consumption of fossil fuels and an attempt is made to redress unfairness by taking initiatives for the sake of the sustainability of all people's lives and a healthy ecosystem.

The climate change problem is regarded as an international human rights issue, and this awareness of climate justice is behind the SDGs and the Paris Agreement.

Questions

For deeper understanding

(1) In the textbook series “Introduction to the GSC,” the JACI highlights some exceptional technologies and products based on the principles of GSC. Let’s try to discuss practical examples of GSC from the perspective of SDGs. In particular, pay special attention to how the technologies shown below help to achieve coexistence with the global environment, satisfy society’s needs and assure economic rationality. In addition, let’s try to think about which of the cases fit in with which of the 17 goals.
The text can be read from the following URL.
https://www.jaci.or.jp/english/gscn/page_05.html

No.1 **Received the Minister of Economy, Trade and Industry Award of the 12th GSC Awards (2012)**
New laundry proposal for pioneering a sustainable society
Kao Corporation

Kao Corporation views laundry detergents from a Life Cycle Assessment (LCA) perspective in order to realize a sustainable society. Kao has made products compact and developed laundry detergents that dispense with just one rinse cycle instead of the conventional two cycles.
Kao proposes "eco together," a new laundry style that reduces environmental impacts together with consumers through just one rinse cycle.
https://www.jaci.or.jp/english/gscn/GSCgs/e01/gsc_e01.php

No.2 **Received the Minister of Economy, Trade and Industry Award of the 2nd GSC Awards (2002)**
Novel Non-phosgene Polycarbonate Production Process Using By-product CO_2 as Starting Material
Asahi Kasei Corporation

Asahi Kasei Corporation has successfully produced a polycarbonate resin by using the by-product carbon dioxide, which has been emitted into the atmosphere until now, as a starting material. This production process does not use toxic materials such as phosgene as a starting material, which suppresses generation of wastewater and waste products. This is a breakthrough process with excellent environmental, social, and economic benefits.
https://www.jaci.or.jp/english/gscn/GSCgs/e02/gsc_e02.php

No.3 **Received the Minister of Economy, Trade and Industry Award of the 13th GSC Awards (2013)**
Development of Carbon Fiber Composite Materials for Lightweight Commercial Airplanes
Toray Industries, Inc.

Toray Industries, Inc. have developed carbon fiber-reinforced plastic (CFRP), a composite material that enables the fabrication of lightweight airplane structures. Reducing the weight of an airplane permits the carriage of more passengers and cargo and extends the flight distance. A lightweight airplane conserves energy, causes low CO_2 emissions, and minimizes the emission of greenhouse gases that cause global warming.
https://www.jaci.or.jp/english/gscn/GSCgs/e03/gsc_e03.php

No.4 **Received the Minister of Economy, Trade and Industry Award of the 14th GSC Awards (2014)**
Development and Commercialization of High Performance Transparent Plastics Derived From Plant-Based Raw Material
Mitsubishi Chemical Corporation

Mitsubishi Chemical Corporation succeeded in the development and commercialization of transparent engineering plastics whose main raw material is isosorbide derived from renewable resources. Not only was the environmental impact reduced by using a unique process utilizing renewable resources, but the performance of the product, such as excellent impact resistance and weathering resistance, was radically improved as well.
https://www.jaci.or.jp/english/gscn/GSCgs/e04/gsc_e04.php

(2) Discuss steps to promote the SDGs.

References

1) United Nations Information Centre https://www.unic.or.jp/
2) United Nations : Sustainable Development Goals https://www.un.org/sustainabledevelopment/sustainable-development-goals/
3) Ministry of Foreign Affairs JAPAN SDGs Action Platform https://www.mofa.go.jp/mofaj/gaiko/oda/sdgs/index.html

Appendix

Sustainable Development Goals (The 2030 Agenda)

Goal 1	End poverty in all its forms everywhere
Goal 2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Goal 3	Ensure healthy lives and promote well-being for all at all ages
Goal 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5	Achieve gender equality and empower all women and girls
Goal 6	Ensure availability and sustainable management of water and sanitation for all
Goal 7	Ensure access to affordable, reliable, sustainable and modern energy for all
Goal 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Goal 10	Reduce inequality within and among countries
Goal 11	Make cities and human settlements inclusive, safe, resilient and sustainable
Goal 12	Ensure sustainable consumption and production patterns
Goal 13	Take urgent action to combat climate change and its impacts*
Goal 14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Goal 15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Goal 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Goal 17	Strengthen the means of implementation and revitalize the global partnership for sustainable development.

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July 8, 2015
Kyohei Takahashi
on behalf of Organizing Committee
Milton Hearn AM, David Constable,
Sir Martyn Poliakoff, Masahiko Matsukata
on behalf of International Advisory Board
of 7th International GSC Conference Tokyo (GSC-7),
Japan July 5-8, 2015

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GSC : Green and Sustainable Chemistry

Chemical sciences and technologies
which are benign to both human health and the environment,
and support the development of a sustainable society.

Introduction to GSC

Learning from social practice cases that received the GSC Awards

Global issues, in areas such as resources and energy, global warming, water and food have increasingly become major and complicated concerns. Innovations for achieving both environmental conservation and economic development are needed in order to resolve these issues and realize the sustainable development of society, and expectations for GSC continue to rise. In this textbook series, technologies and products that have received the GSC Awards given to great achievements contributing to the progress of GSC are explained, so that everyone can understand “what is GSC?” and take responsibility for realizing a sustainable society.

Special Edition

“Introduction to SDGs” Sustainable Development Goals GSC plays a driving role in SDGs

Let's change the world towards a sustainable future!

The SDGs are global goals adopted by the United Nations, and it is essential to harmonize the three elements of economy, society, and the environment in order to achieve sustainable development. This way of thinking is shared with the GSC, which aims to achieve both environmental conservation and economic development for the sustainable development of society. As a special issue, this text aims to explain the SDGs from the perspective of the GSC and encourage everyone to think about and put them into practice.

No.1

New laundry proposal for pioneering a sustainable society

Kao Corporation

The "new laundry proposal for pioneering a sustainable society" of Kao Corporation, which received the Minister of Economy, Trade and Industry Award of the 12th GSC Awards (2012), is characterized by the introduction of Life Cycle Assessment (LCA) into the development of laundry detergents, and the proposal to reduce laundry-related environmental impacts together with consumers by using just one rinse cycle in laundry. How was this innovation generated that simultaneously satisfies environmental friendliness, social contribution and economic rationality?

No.2

Novel Non-phosgene Polycarbonate Production Process Using By-product CO_2 as Starting Material

Asahi Kasei Corporation

The great success of this technology is that unlike the conventional polycarbonate production process, it does not use toxic phosgene as a starting material. At the same time, the technology was revolutionary because it achieved saving of both resources and energy. More than 10 years have passed, and the technology has been widely commercialized all over the world. This worldwide use was highly regarded, and the process became the first technology by a Japanese company to receive the Heroes of Chemistry Award from the American Chemical Society in 2014. What kind of technology is involved in this world-renowned polycarbonate production process?

No.3

Development of Carbon Fiber Composite Materials for Lightweight Commercial Airplanes

Toray Industries, Inc.

TORAY's carbon fiber reinforced plastic developed through over 40 years of research and development has features of high toughness (material tenacity) in combination with light weight and flexibility. The high toughness carbon fiber reinforced plastic (high toughness CFRP) realizes weight reduction of airplanes which is effective in improving fuel consumption, and makes a substantial contribution to reducing environmental impact.

No.4

Development and Commercialization of High Performance Transparent Plastics Derived from Plant-Based Raw Material

Mitsubishi Chemical Corporation

"DURABIOTM", the transparent engineering plastic made from renewable resources developed by the company, not only contributes to the reduction of environmental impact, but also realizes performance exceeding that of conventional engineering plastics in terms of optical characteristics, weathering resistance, etc.

No.5

Development of High-Performance Reverse Osmosis Membrane Contribution to the solution of global water issues

Toray Industries, Inc.

This reverse osmosis membrane can be used in not only seawater but also river water, sewage wastewater, and various other water treatment systems, providing high quality water while saving energy.

No.6

Development of Low Environmental Load Battery for Idling-Stop System Vehicle with High Charge Acceptance and High Durability

Hitachi Chemical Co., Ltd.
(Currently Energywith Co., Ltd.)
Hitachi, Ltd.

Idling-stop systems heavily burden on the battery, causing existing batteries to rapidly degrade, with short battery lifetimes. This technology resolves this problem and contributes to the reduction in CO_2 emissions.

No.7

Development of Water-based Inkjet Ink for Food Package

Kao Corporation

Kao Corporation developed a “water-based inkjet ink” for printing on the plastic films used for packaging daily commodities and food.
The ink maintains a high image quality and has lower volatile organic compound emissions, thereby reducing its environmental impact.

No.8

Development and Commercialization of a New Manufacturing Process for Propylene Oxide Utilizing Cumene Recycling

Sumitomo Chemical Co., Ltd.

Sumitomo Chemical Co., Ltd. developed a new manufacturing process for propylene oxide, which is used as a raw material for polyurethane and other materials.
The new process enables high yields of propylene oxide while reducing its environmental impact.

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