CSR Activity Report (CSR Guideline Activity Reports)

Contributing Solutions to Social Issues through Business Activities

Leverage innovation to provide solutions to various social issues such as climate change, resource and energy use, water resource and natural environment conservation, improvement of medical care, and promotion of public health, thereby contributing to sustainable development for society.

Basic Approach

Global environmental issues continue to become increasingly severe, marked by global warming, water scarcity, marine pollution, resource depletion, and loss of biodiversity. The world population is approximately eight billion, a number that is expected to surpass 10 billion by 2050. Meanwhile, developed countries as well as many emerging countries are expected to face rapid population aging, as average lifespans increase and birthrates decline.
In the world of the 21st century, the most critical shared challenges are to resolve global-scale environmental issues and to provide healthcare that helps people lead healthy, independent lives, which involves delivering high-quality medical care that reduces the burden on both patients and medical staff.

Toray Group has been implementing the Green Innovation Business Expansion Project (Green Innovation Project) since 2011 and the Life Innovation Business Expansion Project (Life Innovation Project) since 2014, and the progress of these projects has been monitored by the Sustainability Committee and other committees. To strengthen the initiatives, in 2018 and 2020 respectively, the Group established and announced the Toray Group Sustainability Vision followed by the Long-Term Corporate Vision, TORAY VISION 2030 to clearly outline the world as envisioned by the Toray Group in 2050. The Group also set KPIs to be achieved by 2030 as long-term milestone targets. Under the Medium-Term Management Program, Project AP-G 2025, announced in March 2023, Toray integrated the Green Innovation and Life Innovation businesses, creating a Sustainability Innovation (SI) Business[1] to better meet diversifying sustainability needs. The Group is now promoting initiatives aimed at expanding the SI Business together with the Digital Innovation (DI) Business[2], as part of an SI & DI Project.

Through the SI & DI Project, Toray Group aims to help achieve “a net-zero-emissions world, where greenhouse gas emissions are completely offset by absorption” (in other words, a net zero emissions, carbon-neutral world),” “a world where resources are sustainably managed,” “a world with a restored natural environment, with clean water and air for everyone,” and “a world where everyone enjoys good health and hygiene” as outlined in the Toray Group Sustainability Vision. The project seeks to do this by expanding Toray’s businesses in areas that contribute to these goals. Here are some specific examples of Toray initiatives under this vision. To accelerate efforts to combat climate change, the Group will expand aircraft and automobile applications for its advanced materials and help reduce CO_2 emissions by improving fuel efficiency through vehicle weight reduction. It will also work to help society transition to renewable energy by supplying materials for wind and hydrogen power applications. For the sustainable, circular use of resources, the Group will also promote initiatives for resource recycling and bio-technology. To help ensure safe water and air, it will proceed with initiatives in areas such as water treatment membranes and air filters. Finally, Toray will expand its products that support health, longevity, improved quality of medical care, and human safety, as well as help the elderly and home-care recipients to live more independent lives.

1 Sustainability Innovation (SI) business: Businesses or material lines that can help realize the Toray Group Sustainability Vision.
2 Digital Innovation (DI) business: Materials, equipment, technologies, and services, etc., based on advanced digital technology.

Structure

To promote activities designed to achieve the Toray Group Sustainability Vision, the Group established the Sustainability Committee headed by the president to serve as a group-wide committee. The committee is tasked with managing and promoting efforts to achieve the Toray Group Sustainability Vision. Toward this end, the committee draws up overall medium- and long-term roadmaps and action plans, deliberates on the yearly action plans for the two group-wide projects—the SI Business Expansion Project and the Climate Change Project—and oversees and manages implementation issues and the status of activities. The Sustainability Committee also collaborates with the CSR Committee, Risk Management Committee, Safety, Health and Environment Committee, and Technology Committee to address climate change-related issues for the entire Toray Group.
Through these projects, Toray Group is contributing to the reduction of greenhouse gas emissions to help achieve a carbon neutral world, as well as promoting the reduction of Toray Group greenhouse gas emissions to become carbon neutral itself. The Group is also accelerating its resource recycling efforts, including recycling and the conversion of key polymers to biomass-based polymers, by developing and promoting group-wide strategies for the implementation of sustainable, circular use of resources.
For more information on the Toray Group governance structure related to the issue of climate change, please refer to the Toray Group TCFD Report VER. 2.

CSR Roadmap 2022 Targets

CSR Roadmap goals

Help address social issues by developing innovative materials and new technologies, focusing on the fields of Green Innovation and Life Innovation

Main Initiatives and Key Performance Indicators

	KPI
(1) Increase revenue from Green Innovation products	7-❶
(2) Increase revenue from Life Innovation products	7-❷
(3) Expand contribution to CO_2 reduction in the value chain[3]	7-❸
(4) Expand water filtration throughput contribution by Toray's water treatment membranes[4]	7-❹
(5) Conduct a wide variety of product research and technology development to help build a low-carbon, circular economy	-
(6) Contribute to the utilization of biomass in and recycling of plastic products, the spread of renewable energy and hydrogen, and the reuse of water resources	-
(7) Contribute to countermeasures to public health risks, including infectious diseases, by developing and upgrading materials and products for protective clothing and personal protective equipment, as well as materials to protect environmental hygiene including of air and water	-

Key Performance Indicator (KPI)	Target			Fiscal 2022 Result
	Fiscal 2020	Fiscal 2021	Fiscal 2022	
7-❶ Revenue of Green Innovation products (IFRS)	1,000 billion yen (Fiscal 2022)			993.4 billion yen
7-❷ Revenue of Life Innovation products (IFRS)	300.0 billion yen (Fiscal 2022)			369.6 billion yen
7-❸ Contribution to CO_2 reduction in value chain	5.3 times compared to fiscal 2013 (Fiscal 2022)			9.5 times compared to fiscal 2013
7-❹ Contribution of Toray water treatment products	2.4 times compared to fiscal 2013 (Fiscal 2022)			2.5 times compared to fiscal 2013

Reporting scope : Toray Group

3 Toray calculates the value chain CO_2 emissions reduced throughout the entire product lifecycle in accordance with the chemical sector guidelines of the Japan Chemical Industry Association, and the International Council of Chemical Associations (ICCA).

4 Water treated annually with Toray water treatment membranes. It is calculated by multiplying the amount of fresh water that the Toray membranes can produce per day, including reverse osmosis (RO), ultrafiltration (UF) and membrane separation bioreactors (MBR), by the number of membrane elements sold.

Related Materiality for CSR

- Accelerating Climate Change Mitigation
- Promoting a Circular Economy
- Taking a Nature-Positive Approach
- Committed to Healthier Lives
- Developing in Collaboration with Stakeholders

* Click here for CSR Roadmap 2025 from the perspective of materiality (PDF:392.4KB). PDF
* Click here for a PDF summary of the main materiality-related initiatives, KPIs and progress achievements up to fiscal 2022 under the CSR Roadmap 2022 (PDF: 1.6MB). PDF

Looking to the Future

The consolidated revenue generated by the Green Innovation Project in fiscal 2022 was 993.4 billion yen, an increase of 161.2 billion yen from the previous year. Although sales of resin products were sluggish due to a slump in the automobile markets in Japan and China, sales of carbon fiber for aircraft and wind turbine blades, as well as water treatment membranes were strong.

The contribution to the reduction of CO_2 emissions and the expansion of water treatment from the use of Toray Group products throughout the value chain increased due to business expansion. The Group will continue to help address resource, energy, and global environmental issues through its businesses.

The consolidated revenue generated by the Life Innovation Project in fiscal 2022 was 369.6 billion yen, an increase of 61.2 billion yen from the previous year. This was due to increased sales of textiles for sports fabrics and automotive airbags, as well as carbon fiber for sporting-related applications. Toray Group will continue to leverage its strengths in advanced materials, while accelerating activities in the Pharmaceuticals & Medical Products Business.

Worldwide, a range of issues are becoming increasingly interconnected and serious. These include population growth and aging in many countries, as well as climate change, water shortages, and resource depletion.

This is inducing a transition to more sustainable modes of production and consumption. Initiatives will be implemented for moving to a circular economy where used products are recovered and regenerated to make new ones. This will enable a further transition from a mass production/mass consumption linear business scheme to business models such as PaaS (products as a service), sharing, product life extension, resource collection and recycling, and circulated supply chains.

In order to better respond to diversifying sustainability needs, in fiscal 2023 Toray Group integrated its Green Innovation and Life Innovation businesses to create the Sustainability Innovation (SI) business. Under the SI & DI Project, the Group is now enhancing its strength by expanding products that meet the aims of the Toray Group Sustainability Vision. These include aims to achieve “a net-zero-emissions world, where greenhouse gas emissions are completely offset by absorption,” (in other words, a net zero emissions, carbon-neutral world), “a world where resources are sustainably managed,” and “a world with a restored natural environment, with clean water and air for everyone,” and “a world where everyone enjoys good health and hygiene.”

Click here for the main initiatives and KPIs for CSR Guideline No. 7 “Contributing Solutions to Social Issues through Business Activities” during the CSR Roadmap 2025 period (fiscal 2023–2025).

CSR Activity Report (CSR Guideline Activity Reports) - Contributing Solutions to Social Issues through Business Activities

Green Innovation Business Expansion Project

CSR Roadmap 2022
Main Initiatives (1)(3)(4)(5)(6)

Revenue of Green Innovation products（IFRS）

■Reporting scope
Toray Group

■Target
1,000 billion yen（Fiscal 2022）

Fiscal 2022 Result

993.4

billion yen

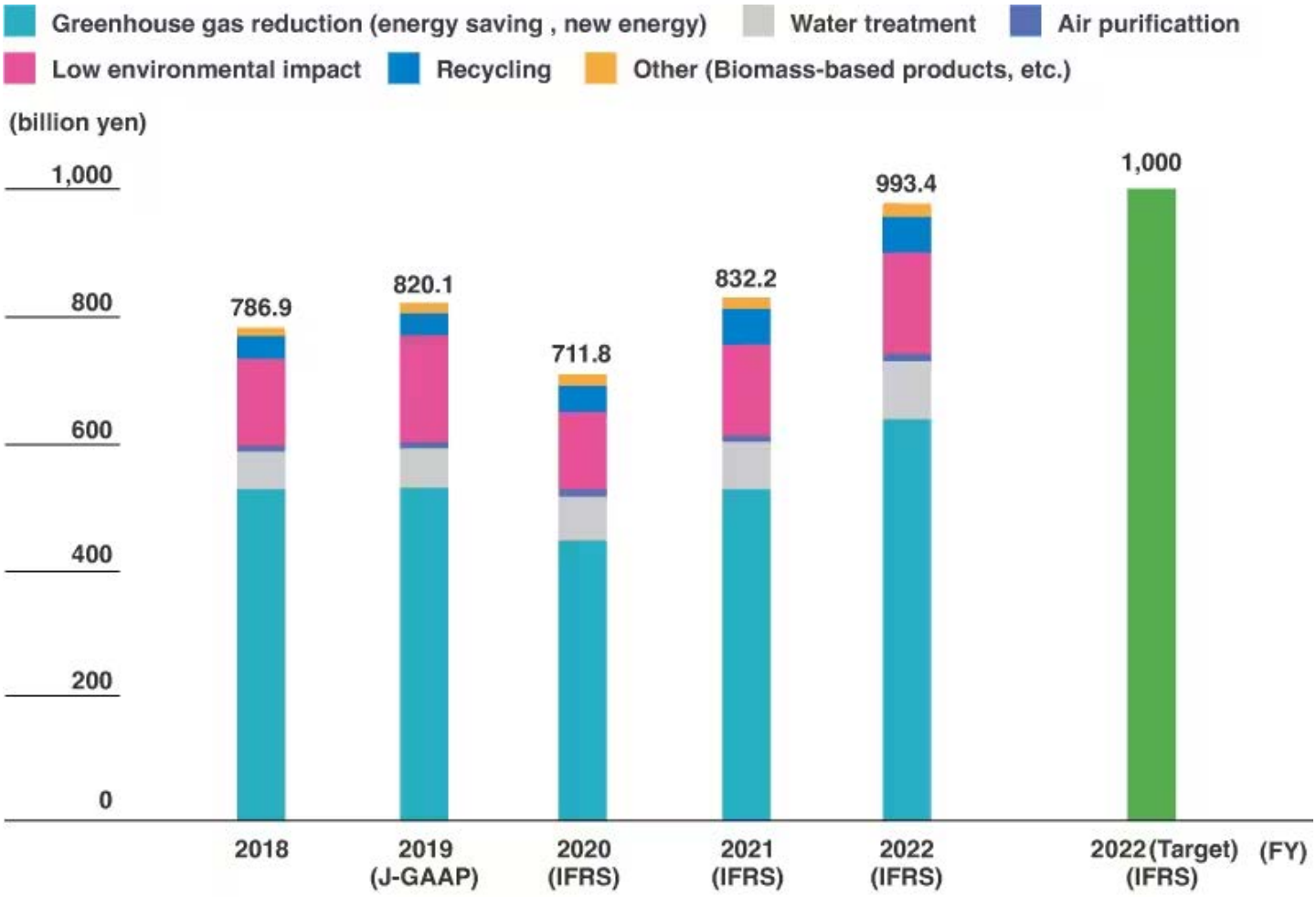
Toray Group embraces the thinking that all business strategies must prioritize responsibility for the global environment in an effort to help build a more sustainable world with a small carbon footprint. The Group is endeavoring to realize this vision by addressing global environmental, resource, and energy issues through the continued implementation of the Green Innovation Business Expansion Project. Under the Medium-Term Management Program, Project AP-G 2022, which began in fiscal 2020, the Group promoted the expansion of environment-related businesses and a challenging target of 1 trillion yen in consolidated revenue by fiscal 2022 based on International Financial Reporting Standards (IFRS). Despite the further challenges created by the COVID-19 pandemic, the Group achieved 993.4 billion yen, which is slightly below the target. Green Innovation businesses have steadily grown since the start in 2011, reaching 40% of the Group's consolidated revenue by the end of fiscal 2022[1]. Under the Medium-Term Management Program, Project AP-G 2025, which began in fiscal 2023, the Group has combined its Green and Life Innovation businesses to create the Sustainability Innovation (SI) business, which it aims to further expand.

In fiscal 2022, Toray Group products helped to reduce CO_2 emissions[2] in the value chain by 365.72 million tons (9.5 times higher than in fiscal 2013) and added 67.00 million tons of water filtration[3] (2.5 times higher than in fiscal 2013).

Contribution to CO_2 reduction[2] in value chain in fiscal 2022	**365.72 million tons-CO_2** (9.5 times compared to fiscal 2013)
Contribution of Toray water treatment products[3] in fiscal 2022	**67.00 million tons** (2.5 times compared to fiscal 2013)

1 Some Green Innovation results are also included in the Life Innovation results.
2 Toray calculates the value chain CO_2 emissions reduced throughout the entire product lifecycle in accordance with the chemical sector guidelines of the Japan Chemical Industry Association, and the International Council of Chemical Associations (ICCA).
3 Water treated annually with Toray water treatment membranes. It is calculated by multiplying the amount of fresh water that the Toray membranes can produce per day, including reverse osmosis (RO), ultrafiltration (UF) and membrane separation bioreactors (MBR), by the number of membrane elements sold.

Net Sales (Revenue) from Green Innovation Businesses (Toray Group)



Note: FY 2020-22 performance and FY 2022 target are revenue based on International Financial Reporting Standards (IFRS).

Click here for the main initiatives for CSR Guideline 7, “Contributing Solutions to Social Issues through Business Activities” in CSR Roadmap 2022.

CSR Activity Report (CSR Guideline Activity Reports) - Contributing Solutions to Social Issues through Business Activities

Promoting Life Cycle Management and Initiatives to Reduce GHG Emissions Across Toray Group and its Supply Chain

CSR Roadmap 2022
Main Initiatives (1)(3)(5)(6)

In addressing global environmental issues, it is vital to consider the entire life cycle of products and services in order to reduce environmental impact while also delivering improved economic and social value. In this respect, Toray Group has been promoting life cycle management for some time, while working to reduce greenhouse gas (GHG) emissions throughout the supply chain.

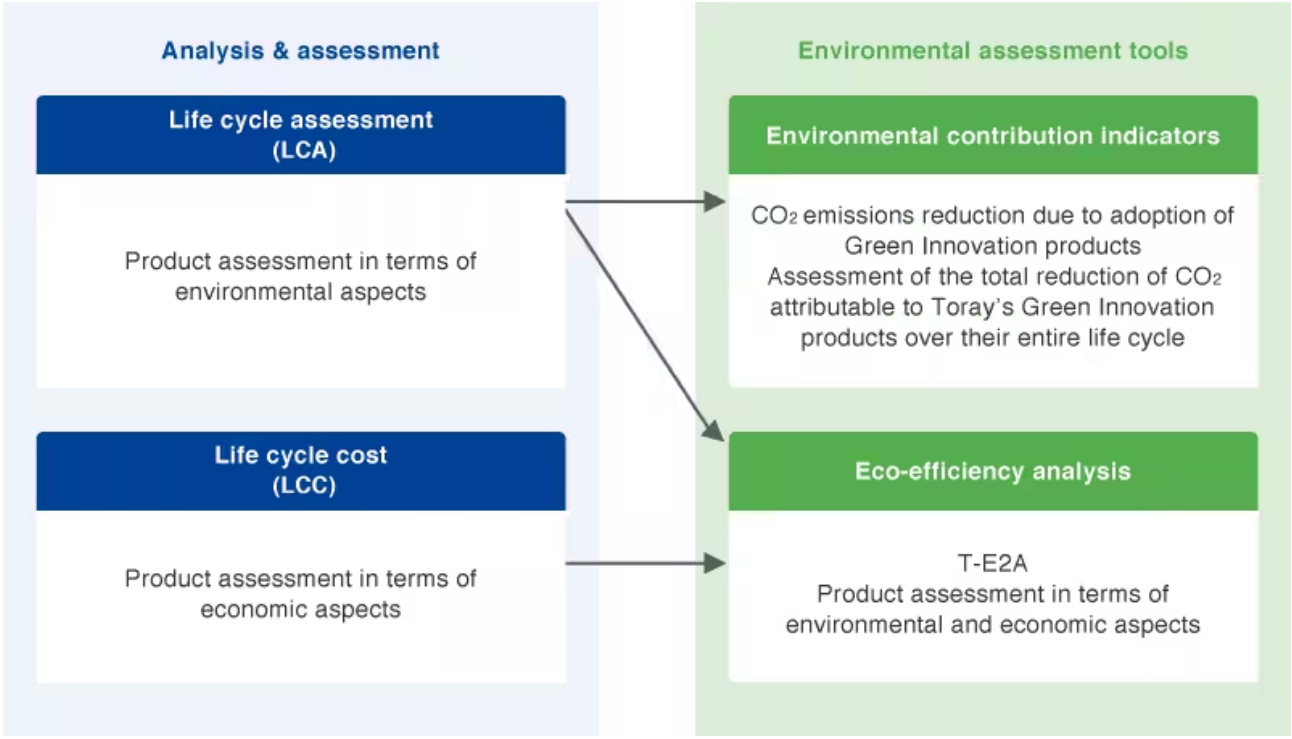
Life cycle management is the basis for Green Innovation products, and the Group has adopted life cycle assessment[1] and the Toray Eco-Efficiency Analysis (T-E2A)[2] tool.

In an effort to reduce GHG emissions and become carbon neutral, the Group will strive to become carbon neutral in its own business activities, while helping to realize a carbon neutral society by reducing GHG emissions throughout the supply chain.

1 Life cycle assessment is a method for quantitatively assessing the resources that have gone into a product and the impact the product will have on the environment and ecosystems over its life cycle.

2 T-E2A is an environmental analysis tool developed by Toray Industries, Inc. It produces a map of multiple products plotted along the axes of environmental impact and economic performance, enabling users to select the most environmentally friendly and economical products.

Toray Industries' Life Cycle Management Approach



Click here for the main initiatives for CSR Guideline 7, “Contributing Solutions to Social Issues through Business Activities” in CSR Roadmap 2022.

CSR Activity Report (CSR Guideline Activity Reports) - Contributing Solutions to Social Issues through Business Activities

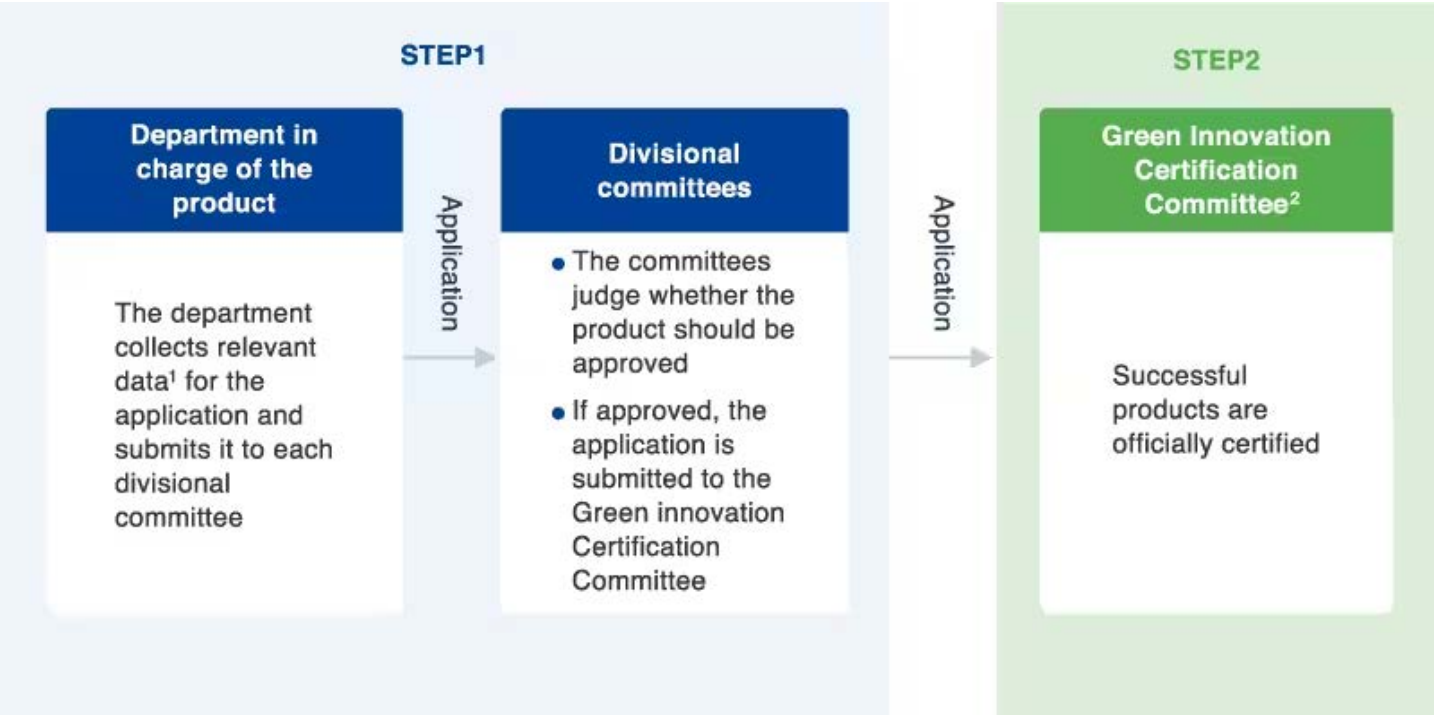
Approach to Green Innovation Products

CSR Roadmap 2022
Main Initiatives (1)(3)(4)(5)(6)

The following diagram outlines Toray Group's process and procedures up until fiscal 2022 for certifying Green Innovation products. Products were subjected to a two-stage screening process conducted by the divisional committees and by the group-wide Green Innovation Certification Committee. Those able to demonstrate objective evidence of providing an effective solution for global environmental issues were certified as Green Innovation products.

As of fiscal 2023, Green Innovation and Life Innovation products have been combined and renamed Sustainability Innovation (SI) products. These are screened by the Sustainability Innovation Certifying Committee (tentative name), which maintains the same certifying system as was used for Green Innovation products.

Green Innovation Product Certification Process



1 This includes LCA data, T-E2A data, and estimates of CO_2 emissions reduction attributable to the product.

2 Comprised of members of Toray Industries' Global Environment Business Strategic Planning Department, Corporate Marketing Planning Department, and Technology Center Planning Department, as well as experts when necessary.

Green Innovation-Related Products and R&D Announced in Fiscal 2022

CSR Roadmap 2022
Main Initiatives (1)(3)(4)(5)(6)

Toray to Domestically Sell Chemical Recycled Fiber Products Derived from Fishing Nets Expansion of Recovery and Recycling Systems in Japan

Discarded fishing nets

Toray Industries plans to begin selling nylon 6 chemically recycled fiber (N6CR) yarns, textiles, and other products in Japan. These offerings apply Toray's depolymerization and repolymerization technology[3] to recycled plastics and other materials that Refineverse Group, Inc., makes from recovered fishing nets.

This year, the Company set up a new production system at its Nagoya Plant that identifies virgin raw materials from fossil sources. This setup comprises a raw materials input facility for recycled fishing net-derived resin and recycled lactam storage tanks. This setup will recycle nylon 6 fiber products, accelerate efforts to develop an advanced fiber to fiber recycling business, and contributing to a circular economy.

Toray's new N6CR facility will enable it to overcome technical challenges and reinforce its range of high-performance, high-value-added nylon fibers for apparel. The company looks particularly to expand sales of thin, eco-friendly fabrics for sports and outdoor wear, innerwear, and legwear.

Common applications for industrial nylon fiber are automotive parts, ropes, fishing nets, carpets, and other general industrial materials. Toray's endeavor will help cut environmental impacts across an array of industrial fields and drive uptakes of sustainable resources.

Toray Industries will expand its advanced fiber to fiber recycling business by collaborating with customers in initiatives to sell products incorporating its N6CR materials.

3 Depolymerization and repolymerization is a process involving the initial breakdown of a polymer into its individual monomer units and removal of any impurities, followed by polymerization of the new monomers to create a new polymer.

Toray Invents 100% Bio-Based Adipic Acid from Sugars Derived from Inedible Biomass, Scaling Up for Application to Eco-Friendly Nylon 66

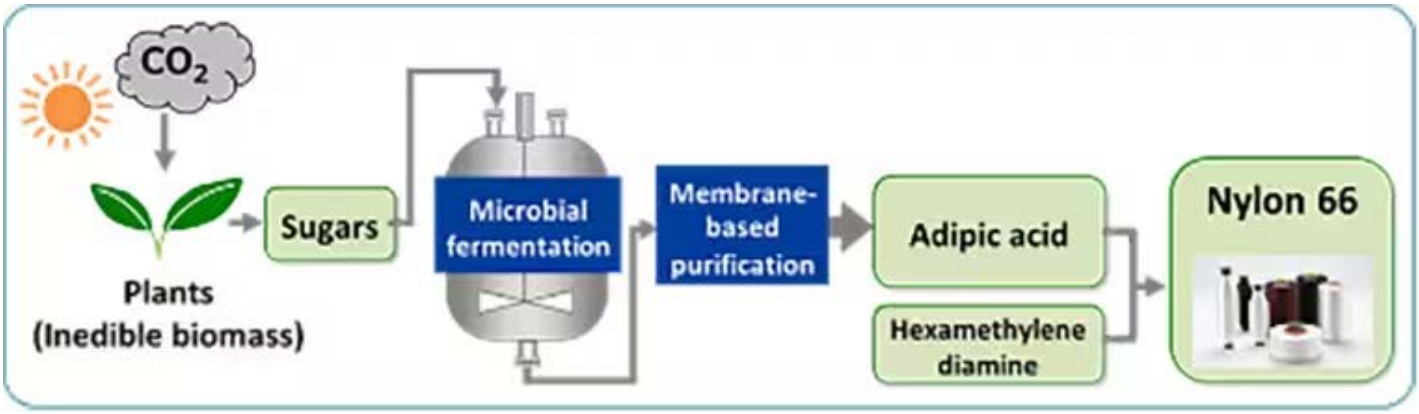
Toray Industries has developed the world's first 100% bio-based adipic acid, a raw material for nylon 66 (polyamide 66), from sugars derived from inedible biomass. This achievement came from using a proprietary synthesis technique combining the company's microbial fermentation technology and chemical purification technology that harnesses the power of separation membranes.

The Company has started to scale up this process. It will conduct polymerization trials, develop production technology, and conduct market research to commercialize nylon 66 applications by around 2030.

Nylon 66 has been used for many years in fibers, resins, and other applications due to its exceptionally durable, strong, and rigid properties. However, there has been increasing pressure to develop eco-friendly nylon 66. One challenge is that conventional chemical synthesis for producing adipic acid, the raw material of nylon 66, generates a greenhouse gas called dinitrogen monoxide.

Toray Industries was the first in the world to discover microorganisms that produce an adipic acid intermediate from sugars. The company reconfigured metabolic pathways within microorganisms to enhance production efficiency by applying genetic engineering technology, which artificially recombines genes to streamline synthesis in microorganisms. It also employed bioinformatics technologies to design optimal microbial fermentation pathways for synthesis. Quantity of the intermediate synthesized by microorganisms has increased more than 1,000-fold since the initial discovery, and the efficiency of synthesis has improved dramatically.
The Company is using reverse osmosis separation membranes to concentrate the intermediate in the purification process. This approach is more energy efficient than other methods that do not use these membranes.
This bio-adipic acid production technique is free of dinitrogen monoxide emissions, unlike the manufacturing processes for petroleum-derived adipic acid, and is expected to help combat global warming.

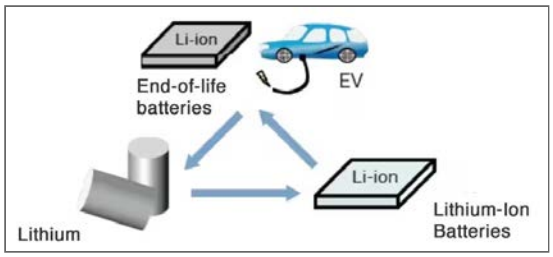
Overview of process, from inedible biomass-derived sugars to nylon 66



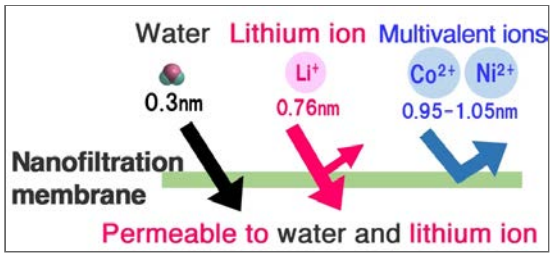
Toray's achievement is partly based on funding from the New Energy and Industrial Technology Development Organization (NEDO), Japan's national research and development agency.

Toray Creates Membrane Separators to Recover Lithium from End-of-Life Lithium-Ion Batteries.
A new highly lithium-selective nanofiltration membrane vastly improves acid resistance.

Toray Industries has created a new nanofiltration membrane to recover lithium from end-of-life (EOL) automotive lithium-ion batteries (LIBs) which are expected to be generated in large quantities in the future and are currently largely disposed of. The Company is already starting to evaluate recovery using actual leachate from EOL LIBs and will accelerate research and technological development to commercialize its approach.
Demand for lithium resources should surge with electric vehicle uptake. The challenge with the mainstream evaporation pond process[4] for lithium production is that the number of high-output locations is limited. The alternative to this is the ore process[5] which has issues with its lengthy production process and high-temperature heat treatment, generating high carbon dioxide emissions and increased costs which could drive lithium-ion battery prices even higher.



Lithium recovery from end-of-life lithium-ion batteries



Lithium separation using nanofiltration membranes

Nanofiltration membranes can selectively separate dissolved multivalent ions and organic matter. Prime uses of these membranes are to filter ground and river water hardness and agricultural chemicals. They also desalinate and purify in food and biotechnology applications. One downside of conventional nanofiltration membranes is their vulnerability to highly acidic solutions, limiting their application to neutral solutions. Another is insufficient selectivity for multivalent ions, hampering separation efficiency. Prevailing membranes thus cannot be used to recover valuable metals from potent acid EOL LIB leachates.

Toray Industries created a new cross-linked polymer membrane with high acid resistance and a precision pore structure smaller than 1 nanometer. This success is the result of using organic synthesis, polymer chemistry, and nanotechnology after analyzing membrane degradation by acids and optimal membrane pore structures for selective separation. The acid-resistance of this membrane is around five-fold higher than conventional offerings, with the selectivity being 50% greater.

Toray's technology will streamline the recovery of valuable metals and make it possible to recover high-purity lithium in high yields. Carbon dioxide emissions from recovering 1kg of lithium compound using Toray's nanofiltration membrane process are nearly two-thirds lower than from the ore process.

Going forward, the Company will collaborate with automakers, battery and battery material manufacturers, recyclers, and other partners to establish a lithium recycling process. Toray Industries stands to help realize a carbon-neutral economy by eliminating the shortages of lithium that will become a significant concern amid the penetration of electric vehicles.

4 Evaporation pond process: Lithium compounds are produced by pumping brine from a salt lake, concentrating it under the sun for six to twelve months, and refining it.

5 The ore process: Lithium compounds are produced by dressing, roasting, leaching, and refining ore after mining.

Click here for the main initiatives for CSR Guideline 7, "Contributing Solutions to Social Issues through Business Activities" in CSR Roadmap 2022.

CSR Activity Report (CSR Guideline Activity Reports) - Contributing Solutions to Social Issues through Business Activities

Realizing a Circular Economy

CSR Roadmap 2022
Main Initiatives (1)(3)(5)(6)

As a manufacturer of a wide range of materials, Toray Group has been promoting various recycling initiatives to ensure that the earth's resources are efficiently utilized.
In the Toray Group Sustainability Vision, the Group outlines “a world where resources are sustainably managed,” as one of the perspectives of the world as envisioned in 2050. Conventional societies face a variety of problems, including the depletion of resources, marine pollution caused by large amounts of waste, and CO_2 emissions. In order to solve these problems and realize a sustainable, circular economy that makes effective use of resources, the Group facilitates recycling of plastic products, switching to biomass for raw material, adopting renewable energy and hydrogen, and reusing water, across its various technologies.
In its Medium-Term Management Program, Project AP-G 2022, Toray Group identified helping to build a circular economy as a key issue. An initiative example in this area is material recycling[1], which enables the reuse of products such as fibers/textiles, resins, and films. In addition, chemical recycling,[2] which converts products that are difficult to mechanically recycle back into basic chemicals such as monomers and gases, is already implemented for nylon fiber/textile products.
Toray Group is also working to develop materials that use bio-based instead of fossil resources, and membrane-integrated bioprocess technology, which efficiently produces these raw materials. Moreover, the Group is promoting carbon recycling, the use of CO_2 as a resource with our gas separation membranes. Toray technology is also used in the materials for the wind turbine blades and hydrogen production equipment that utilize renewable energy sources to generate electricity and hydrogen used in manufacturing processes, as well as in the water treatment membranes for the reuse of wastewater.
Under the Medium-Term Management Program, Project AP-G 2025, launched in fiscal 2023, Toray Group has set out helping to build a circular economy as an important objective. Accordingly, the Group aims to improve the value of its products and businesses by promoting further R&D. Additionally, Toray has identified the risks and opportunities associated with the transition to a circular economy as follows.

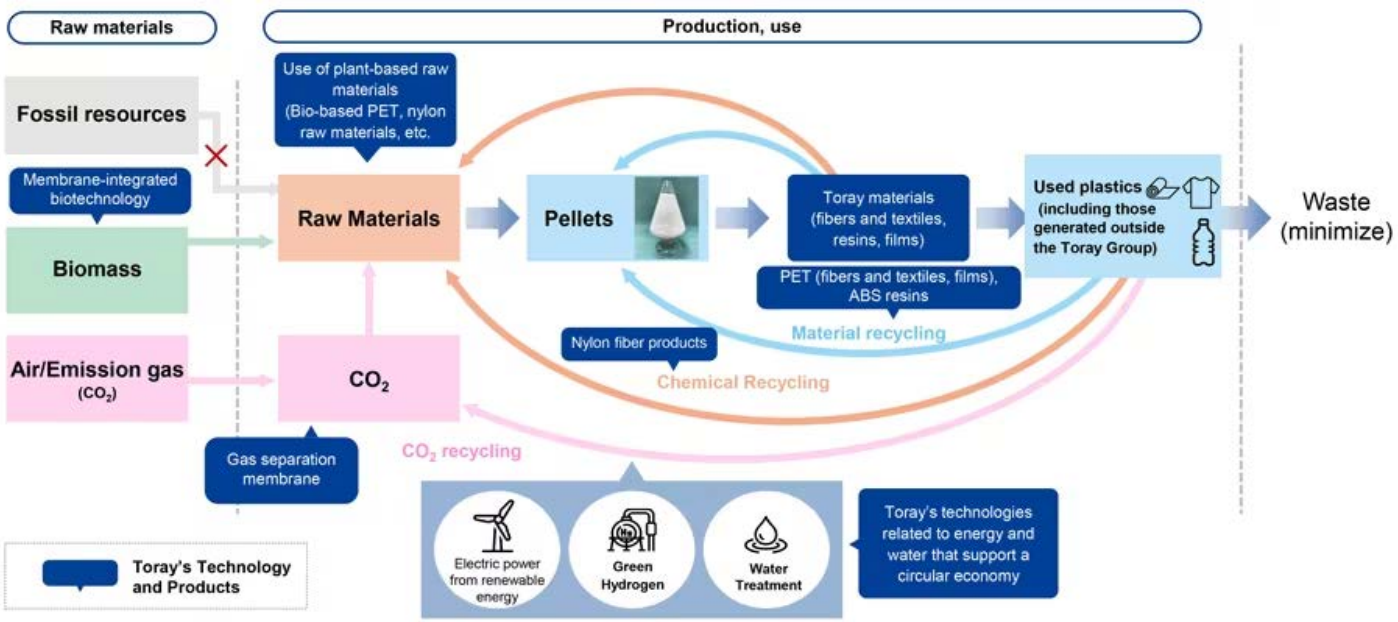
Risks

- Increased cost of waste processing
- Contraction of the materials market due to a shift away from mass production and consumption
- Lost opportunities due to any delay in adapting to the circular economy

Opportunities

- Growth of biomaterials business
- Growth of recycled materials business
- Growth of businesses that help reduce waste (waste reduction, and product durability)

In order to reduce the risks and maximize the opportunities, the Group intends to promote its biomaterials business and recycling as outlined below. In promoting these, Toray is also helping to create systems that can lay the foundation of a circular economy. These efforts include not only Toray Group's own activities, but also collaboration with recyclers (e.g. PET bottle recycling with Kyoei Industry Co., Ltd., and discarded fishing net recycling with Refineverse Group, Inc.), and collaboration with customers (e.g. fishing net-to-net recycling with Nitto Seimo Co., Ltd. and Maruha Nichiro Corporation).



1 Material recycling is a recycling process that uses heat to convert discarded plastic bottles and remnants produced during manufacturing processes into yarn, staple fiber, and other materials.

2 Chemical recycling is a recycling process that breaks down through depolymerization used products and remnants produced during manufacturing processes into monomers that are manufactured back into chips and then recycled into yarn, staple fiber and other materials.

Toray Group's target percentage of raw materials sourced from biomass and other recycled is 20% to be achieved by fiscal 2030 for core polymers (polyester and nylon). The actual rate in fiscal 2021 was only a few percent, and to achieve the 2030 target the Group will continue to promote recycling and the switch to biomass for raw materials.

Related Information

For more information on Toray Group waste reduction, chemical management, energy conservation, and climate change measures, please visit the website below.

› Safety, Accident Prevention, and Environmental Preservation

Recycling Activity Principles Established in March 2004

1. We shall design, produce, and sell products that reduce our impact on the environment.
2. We shall purchase and use materials and products which will help reduce our impact on the environment.
3. We shall disclose information related to recycling programs and recycled goods.
4. We shall voluntarily cooperate with customers to recycle or otherwise appropriately dispose of our products.

Biomaterials Business

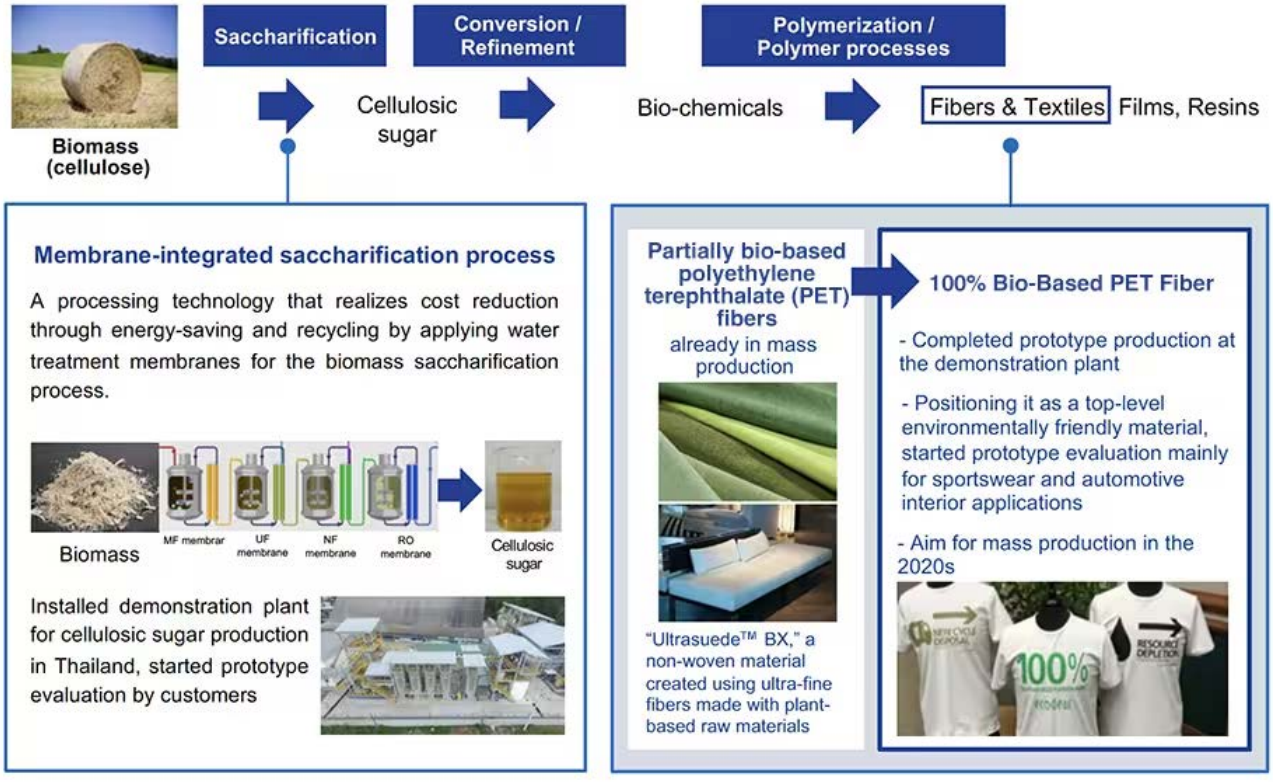
CSR Roadmap 2022
Main Initiatives (1)(3)(5)(6)

Toray Group is promoting initiatives related to biomaterials under a unified brand, Ecodear™. It is developing these products using raw materials derived from biomass-based resources rather than fossil resources. For example, Toray Group mass produces partially bio-based polyethylene terephthalate (PET) fibers that are made from plant-based ethylene glycol, derived from molasses byproducts. These fibers are also used to make Ultrasuede™ PX and Ultrasuede™ BX synthetic suede texture fabrics. Toray Group is also proceeding with trial sales of 100% bio-based PET fiber, while developing membrane-integrated bioprocesses for the in-house production of biomass-based raw materials. The Group has recently developed and launched Ecodear™ N510, a nylon fiber made from 100% plant-based raw materials.

100% Bio-Based PET Fiber, Membrane-Integrated Bioprocesses

Toray Group is positioning its 100% bio-based PET material made from molasses-derived ethylene glycol and bio-para-xylene produced at its pilot plant, as one of its top environmentally conscious products. Toray Group seeks to launch mass production of these materials for sportswear and automotive interior applications as early in the 2020s as possible.

Toray Group is also developing a membrane-integrated bioprocess to enable bio-based raw materials to be manufactured with greater efficiency. This membrane-integrated bioprocess combines membrane separation technology and biotechnology to create new applications for water treatment membranes in processes such as saccharification, fermentation, and purification. The technology significantly improves the manufacturing of raw sugar from non-edible biomass and increases fermentation efficiency, thereby contributing to realizing biomaterials made from biomass-based raw materials. Toray Group is currently operating a technology demonstration project for a saccharification process that produces sugars from nonedible biomass. Toray Group will work to commercialize the technology, in order to build a supply chain that produces materials and chemicals from non-edible biomass.



Promoting Recycling

CSR Roadmap 2022
Main Initiatives (1)(3)(5)(6)

At Toray Group, Ecouse™ is the unified brand for recycling-related initiatives across a wide range of business segments including fibers & textiles, plastics, and films. These products include fibers made by recovering and recycling discarded PET bottles and scrap ends generated from manufacturing processes, recycled resin made from scrap ends generated during manufacturing and collected used products, as well as films made by recovering and recycling films that have been used in customer processes.
In the fiber/textile segment, Toray Group uses discarded plastic (PET) bottles as raw materials, along with filtering and cleaning technologies to remove foreign matter, making it possible to develop a wide variety of recycled products. In 2019, Toray Group introduced the &+™ (“And plus”) brand of recycled fibers that include Toray’s original traceability function. After rebranding in April 2023, the Group added recycled fiber products made using nylon recovered from discarded fishing nets to the &+™ brand. Through initiatives to encourage the recovery of recyclable items, the brand is promoting support for and participation in Toray's recycling efforts.
By utilizing waste fibers, resin, and film, the Group is promoting initiatives to create systems that recycle materials for various uses.

Fiber and Textile Recycling

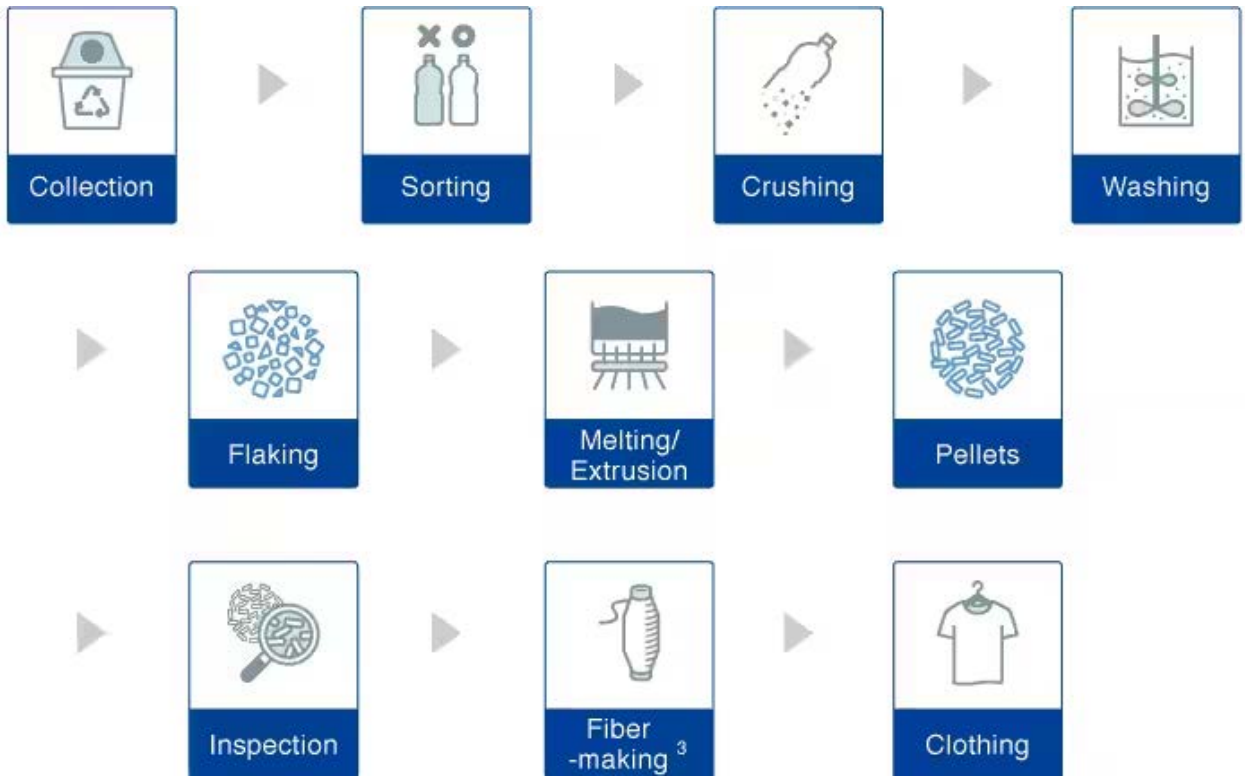
CSR Roadmap 2022
Main Initiatives (1)(3)(5)(6)

&+™ Fiber Brand Derived from Recycled Plastic Bottles

Previously, fibers derived from recycled plastic bottles were limited in variety due to contaminants mixed into raw materials, which made it difficult to produce special cross-sections and fine fibers. In response, Toray together with Kyoei Industry Co., Ltd. developed contaminant filtering technology and advanced plastic bottle cleaning techniques to stabilize the supply of high-quality raw materials. Combining these technologies with Toray’s fiber production technology, it is possible to achieve the same level of diversity in fabric applications as with fiber materials made directly from fossil resources. Moreover, Toray has commercialized its highly reliable polyester fiber under the &+™ brand by incorporating its proprietary traceability technology that can detect special additives premised in with plastic bottle-based raw materials. In January 2020, Toray Industries began full-scale sales of &+™ brand products. Going forward, the goal is to expand the scale of the brand by utilizing a diverse supply chain that includes textiles and sewn products, as well as fibers, and involves production sites around the world. The Group is also creating a unique recovery scheme for discarded fishing nets in collaboration with a recycling company and a fishing net manufacturer. The nylon in the recovered nets will be used for a newly released recycled nylon fiber material sold under the &+™ brand. Through the production and sale of high-value-added recycled nylon fiber based on Toray's chemical recycling technology, the Group aims to raise awareness of the need to help recover discarded fishing nets and is working to further promote the activity. The Group also intends to expand its recycled fiber material lineup to enable product planning that will further satisfy the needs of consumers.

> &+™ (product site)

PET Bottle Recycling Process to Make &+™ Products



3 &+™ fiber can be made into a wide variety of textiles. It is therefore used in a wide range of clothing including fashion garments and sportswear, by meeting diverse needs for functionality and texture.
Clean PET bottles that have been properly sorted are transformed using various recycling processes into high-quality &+™ PET fiber.

Promoting Recycling with UNIQLO

Together with UNIQLO, Toray is promoting new initiatives for sustainable products, with Toray supplying fibers made from recycled plastic bottles for UNIQLO's quick-drying wear DRY-EX brand polo shirts starting in 2020.
In addition, UNIQLO stores are collecting used down items from customers to recycle the feathers. Conventionally, the stuffing in duvets and other objects incorporating down is manually removed. Such processes are arduous with Ultra Light Down items because of their thin outer fabric and complex construction. By developing special extraction machinery, Toray has fully automated cutting, stirring and separating, and recovery, for 50-fold the process capacity of manual processes, thus greatly alleviating workloads. Toray and UNIQLO are jointly developing new recycling-based down products from recycled feathers.

Resin Recycling

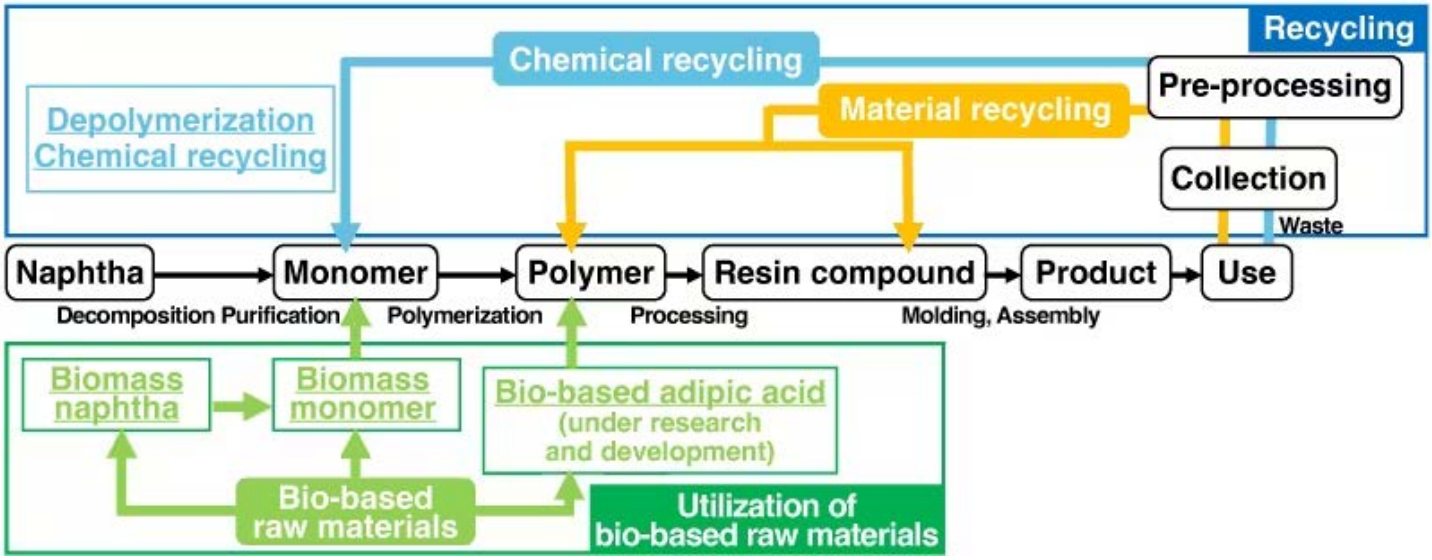
CSR Roadmap 2022
Main Initiatives (1)(3)(5)(6)

Toray Group is developing sustainable resin materials through recycling and the use of bio-based raw materials.
In the area of resin recycling, the Group is developing and distributing recycled resins based on a proprietary formulation design using material and chemical recycling (depolymerization chemical recycling), which breaks down polymers into monomer raw materials before re-polymerizing them.
Going forward, Toray will actively work to recycle resin using post-consumer material for recycling, thereby promoting sustainable resource utilization.
Furthermore, Ecouse™, a group-wide unified brand for recycled materials and products, will be expanded to include resins, and the development of the Ecouse™ series of environmentally friendly resin materials will be accelerated.

1. Recycled nylon 66 “Ecouse”AMILAN™: Toray has developed a recycled nylon 66 resin compound that is made by removing silicone from airbag fabric scrap cuttings, and then washing the remaining material. With Toray’s proprietary additive compounding technology, residual silicone resin is prevented from migrating to the surface of molded products, and mold adhesion is also significantly reduced. Accordingly, the flowability and mechanical properties of recycled nylon 66 “Ecouse”AMILAN™ are on par with injection molding grades derived from virgin raw materials.
2. Recycled PBT resin (polybutylene terephthalate) “Ecouse”TORAYCON™: Toray has launched a recycled PBT resin, “Ecouse”TORAYCON™, as a chemically recycled resin with physical properties comparable to virgin materials.
3. Recycled PPS (polyphenylene sulfide) resin “Ecouse”TORELINA™: Toray has developed a material recycling technology for glass fiber reinforced PPS resin.

In the area of bio-based raw material use, in 2023 Toray plans to launch biomass-based acrylonitrile butadiene styrene (ABS) resin made using the mass balance method (after ISCC Plus certification) by employing styrene monomer derived from biomass naphtha (biomass styrene monomer made using the mass balance method).

Resin Resource Recycling Initiatives

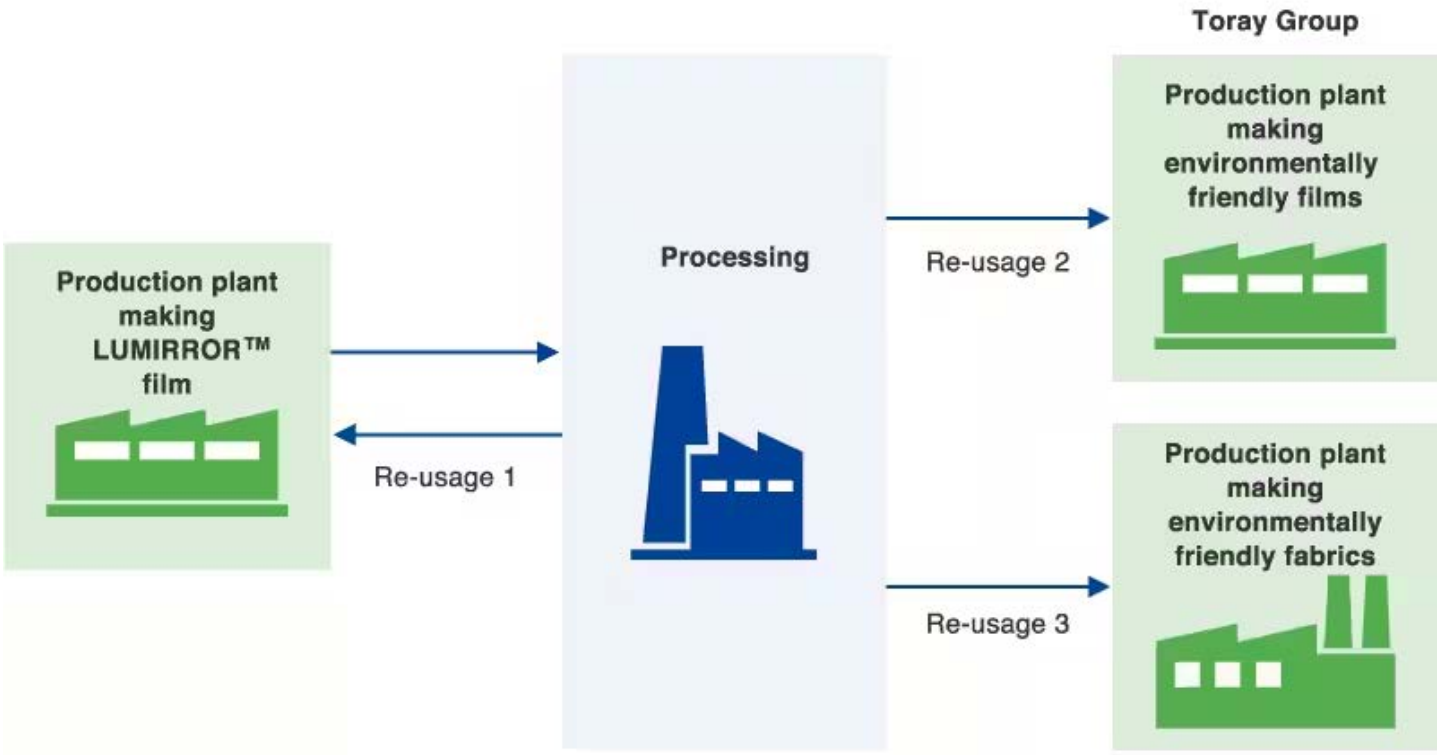


Film Recycling

CSR Roadmap 2022
Main Initiatives (1)(3)(5)(6)

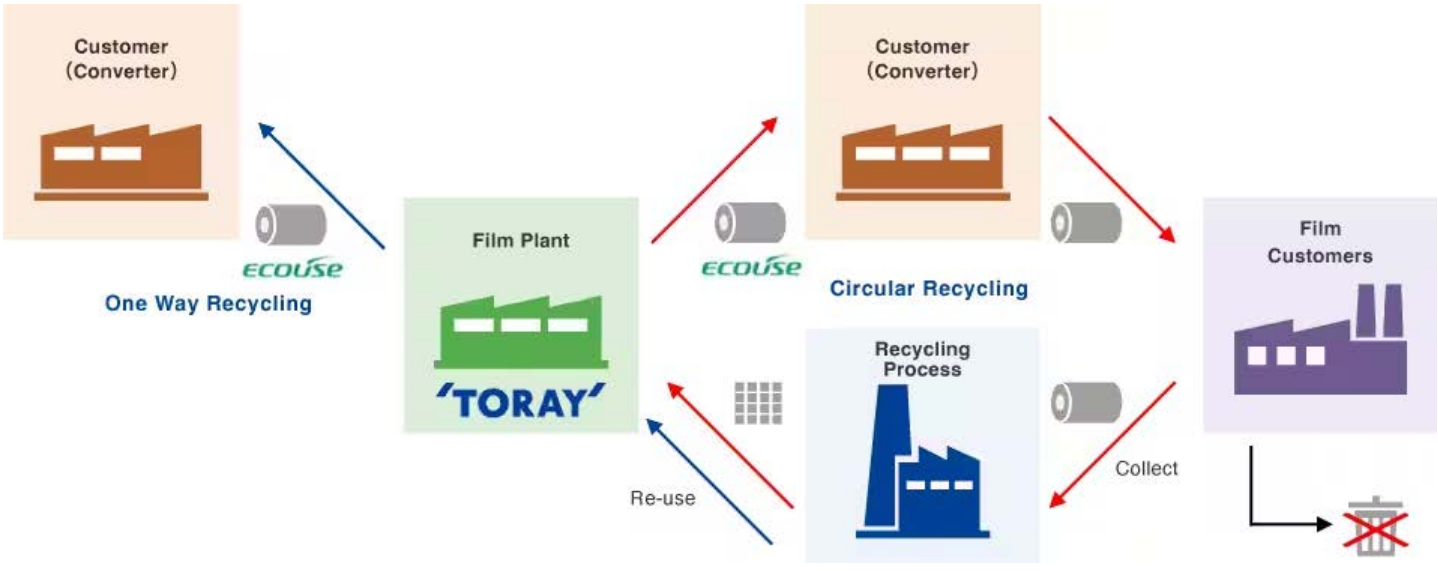
Toray Industries is promoting production activities that use resources carefully by using PET in such forms as waste from the PET film LUMIRROR™ manufacturing process to make eco-friendly textile and resin products and film. In addition, the Company operates a recycling system for collecting used PET film from customer manufacturing processes to be recycled and reused as raw material for film.

Processing and Re-using Recovered Raw Materials Generated from Manufacturing Processes



Reusing waste PET film from customer manufacturing processes

Toray Industries has established a recycling system to collect used films from electronic component applications and recover them for use in producing films, launching the Ecouse™ series, which is helping to create a world where resources are managed sustainably. The company combined mechanical recycling process technology, which removes coating materials and resins from film surfaces, with foreign matter removal techniques for each manufacturing process to enable reuse of the recovered materials in films without impairing mechanical characteristics or reliability. These PET films have reduced the amount of fossil-based resin used as a raw material and can therefore lower CO_2 emissions by up to 50% compared to conventional films. The Company will continue to make use of this system to help build a circular economy.



Carbon Fiber Recycling

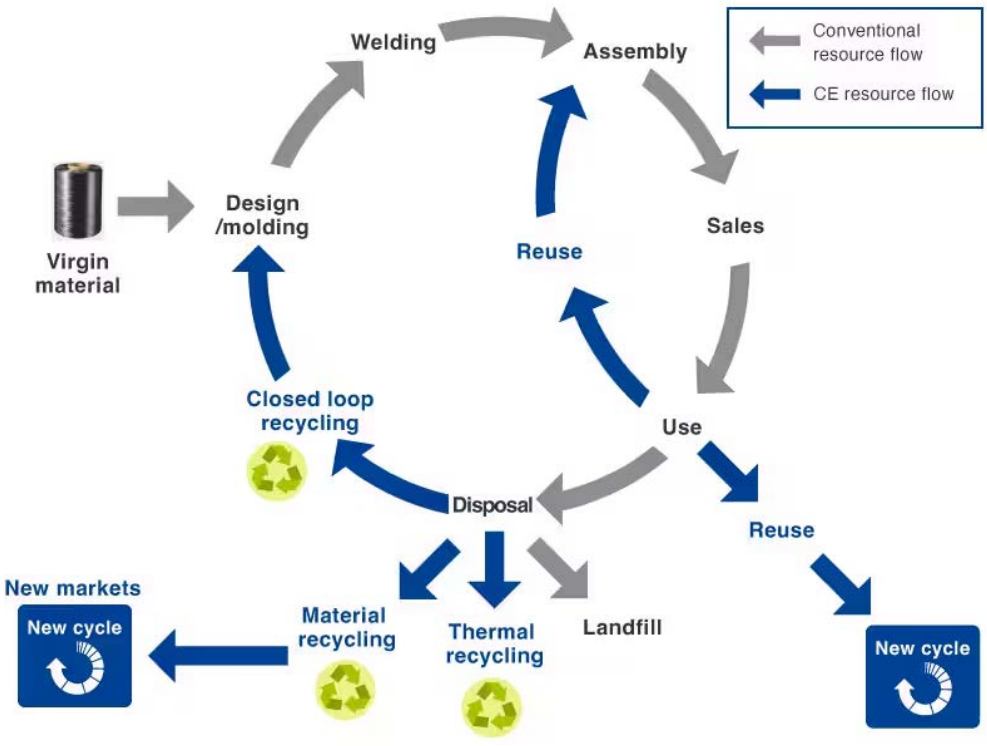
CSR Roadmap 2022
Main Initiatives (1)(3)(5)(6)

Due to its excellent mechanical properties, carbon fiber allows products to be lighter and last longer. Therefore, it is a material that significantly curbs CO_2 emissions over the entire lifecycle of the products, including their operation, contributing to solutions for global environmental issues. In particular, the use of carbon fiber in environmental products such as large wind turbines, aircraft, and hydrogen tanks significantly reduces CO_2 emissions during their operation. As demand grows, market expectations for the development of carbon fiber recycling technologies are also on the rise.

The successful development of recycled carbon fiber and associated applications requires collaboration with a wide range of customers to explore various possibilities for use in specific parts and materials. Toray Industries collaborated with Toyota Tsusho Corporation in a program of the New Energy and Industrial Technology Development Organization (NEDO) for the development of a highly efficient recycled carbon fiber manufacturing technology that uses an innovative and energy-efficient thermal decomposition method[4], and completed the project in 2017. This new technology uses combustible gas from matrix resin as the energy source for the thermal decomposition process, which is the process that consumes the most energy in this type of carbon fiber recycling. As a result, the companies have significantly reduced the amount of energy consumed in the recycling process. As a result, the companies have significantly reduced energy consumption and CO_2 emissions in the recycling process to less than one-tenth of the energy consumption and CO_2 emissions of virgin carbon fiber production. With an eye towards future commercialization, Toray Industries constructed and began to operate a pilot plant to test energy-efficient recycled carbon fiber manufacturing technologies. In addition, Toray Group will work with its customers to promote the development of new applications for recycled carbon fiber.

Through these efforts, the Group aims to establish a circular flow of carbon fiber that will help drive a circular economy. (See chart below.)

Establishing a Circular Economy (CE) That Uses Recycled Carbon Fiber



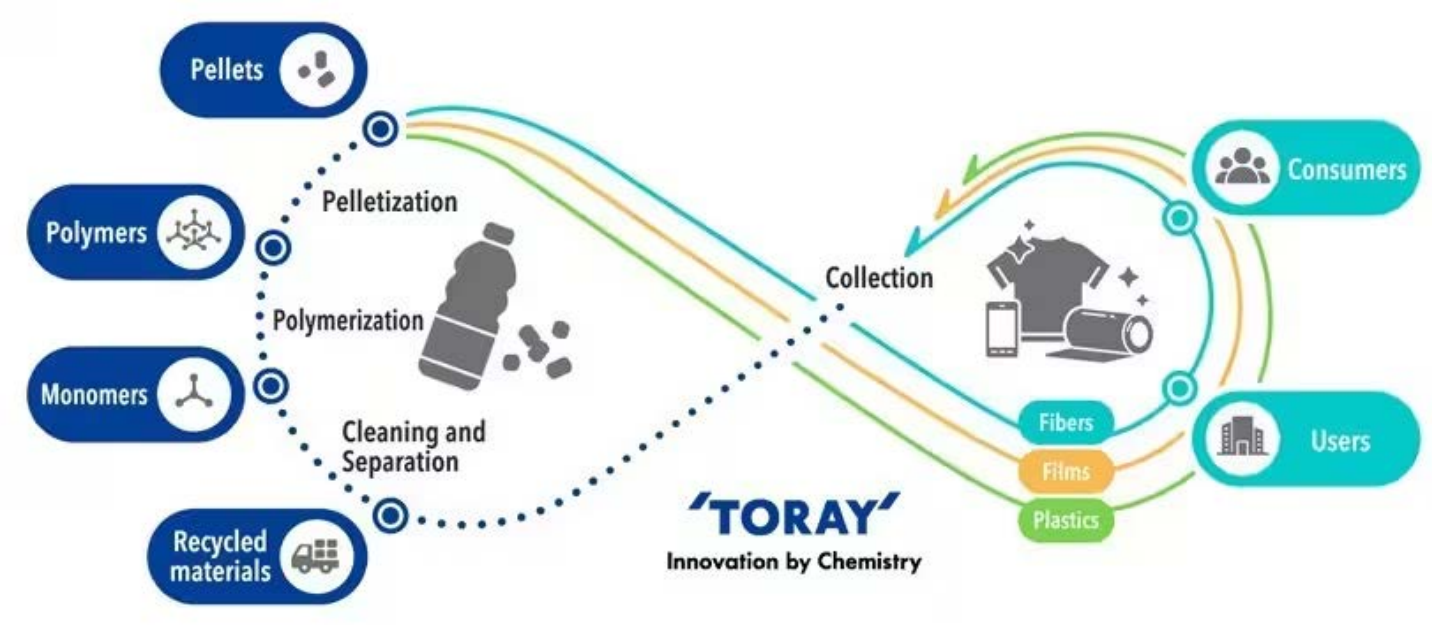
4 Thermal decomposition method: A recycling method in which carbon fiber is recovered by heating carbon fiber composite materials and thermally decomposing the matrix resins.

Blockchain-based Traceability

CSR Roadmap 2022
Main Initiatives (1)(3)(5)(6)

Since recycled materials basically have the same physical properties as virgin materials derived from fossil resources, traceability is important for assuring customers that the material has actually been recycled. Therefore, Toray is using blockchain technology to create a traceability system based on manufacturing and transport data from the supply chains of Toray Group products. The technology prevents input data from being tampered with.

Blockchain-based Traceability System



Click here for the main initiatives for CSR Guideline 7, “Contributing Solutions to Social Issues through Business Activities” in CSR Roadmap 2022.

CSR Activity Report (CSR Guideline Activity Reports) - Contributing Solutions to Social Issues through Business Activities

Life Innovation Business Expansion Project

CSR Roadmap 2022
Main Initiatives (2)

Revenue of Life Innovation products (IFRS)

■Reporting scope
Toray Group

■Target
300.0 billion yen（Fiscal 2022）

Fiscal 2022 Result

369.6

billion yen

In the field of health and medical care, the world has entered a period of historic change. The threats posed by the COVID-19 pandemic and the impact of climate change on healthcare have been added to the existing challenges of declining birthrates and aging populations in developed countries, climbing social security costs, and global healthcare disparities.

Toray Group's life science business helps to support health and medical care, especially through polymer material research, which Toray Group has pursued since its establishment.

The Life Innovation Business Expansion Project started in fiscal 2014 with the launch of the Medium-Term Management Program, Project AP-G 2016. Life Innovation is a group-wide project aimed at improving health by making the most of Toray Group's advanced materials, core and elemental technologies, and business platforms. The project focuses on businesses that can improve the quality of medical care, reduce the burden on medical staff, and support people's health maintenance and longevity.

Furthermore, under the Medium-Term Management Program, Project AP-G 2022, which was initiated in fiscal 2020, Toray Group has been adding businesses related to personal safety products, including ones that help protect people from infectious diseases, extreme weather (heat waves, etc.), disasters, and accidents, while strengthening these businesses.

Product Definitions and Guidelines

Improving the quality of medical care and reducing burden on medical staff

- Products used in medical treatment, products used in medical testing and diagnosis, supplies/products used in medical institutions

Supporting a society where people everywhere can live long, healthy lives

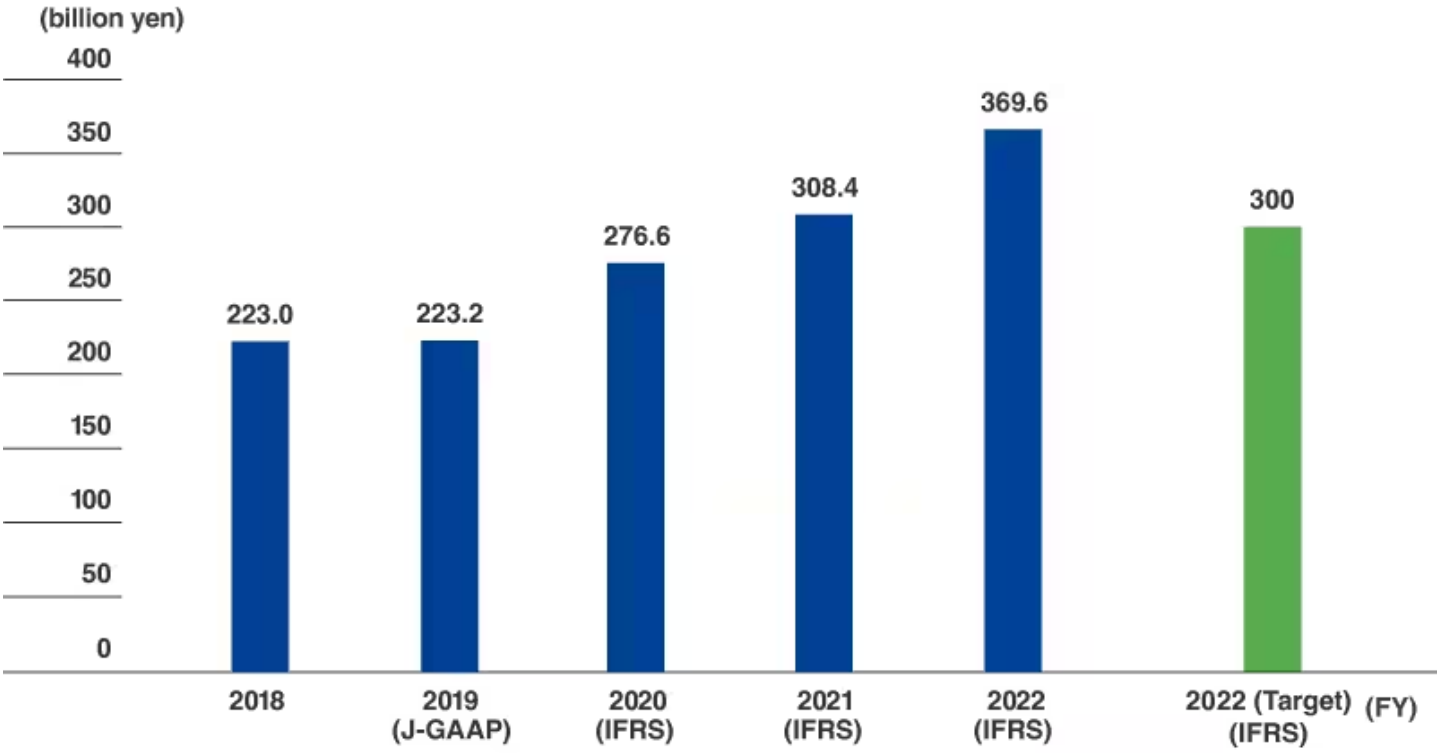
- Maintaining wellness, health, and independent living, improving activities of daily living (ADLs) for the elderly and home-care recipients, reducing the burden on care givers (nursing staff and families), and addressing public health issues

Supporting personal safety

- Leveraging materials to protect people from disasters, extreme weather (heat waves, etc.), accidents, and infectious diseases

With the addition of personal safety products to the Life Innovation business area in fiscal 2020, net sales (“revenue” from fiscal 2020) for these businesses have steadily increased from 142.2 billion yen in fiscal 2014 to 369.6 billion yen in fiscal 2022, surpassing the target of 300 billion yen for that year. The level has reached 15% of Toray Group's consolidated revenue.

Net Sales (Revenue) of Life Innovation Businesses (Toray Group)



Note: FY2020-22 performance and FY2022 target are revenue based on International Financial Reporting Standards (IFRS).

Under the Medium-Term Management Program, Project AP-G 2025, launched in fiscal 2023, the Life Innovation business has been combined with the Green Innovation business to create the Sustainability Innovation (SI) business, with the aim of further business expansion.

Toray Launches LIVMOA™ 4500AS Disposable Personal Protective Clothing Conforming with Japanese Standard for Chemical Spray Resistance

Toray Industries, Inc. has developed LIVMOA™ 4500AS disposable personal protective clothing. The new offering conforms with the JIS T 8115 Type 4 standard for the chemical spray resistance of chemical protective clothing. It also offers excellent dust protection and breathability and outstanding water resistance from the addition of seam tape.

Toray developed the fabric for this product in 2021. It employs a highly durable SMS (spunbond + dense, water-resistant meltblown + spunbond) nonwoven, antistatic fabric. This fabric protects against dust and can withstand a water pressure of 1,000mm H_2O (where the water pressure resistance at seams is less than 1,000 mm H_2O[1]), which is hard to achieve with regular SMS fabric. Toray believes that LIVMOA™ 4500AS is the world's first clothing to be Type 4-compliant while delivering an air permeability of around 7 cc/cm² per second[2]. This new product can provide protection in a variety of tasks in which water resistance is vital. They include controlling dioxin levels at waste incineration facilities and performing major regular factory repairs. They also encompass work at chemical plants, maintenance, working in dirty areas, or removing asbestos.

LIVMOA™ 4500AS

Since debuting the LIVMOA™ series in 2017, Toray has broadened the lineup to cater to diverse applications, including dust protection, infection control, and clean rooms. It will keep developing offerings that combine comfort and functionality for various needs.

1 Seams are resistant to under 1,000mm H_20 water pressure.
2 Based on Toray research

Toray Develops Antiviral Particles[3] that Deactivate Viruses Almost Immediately

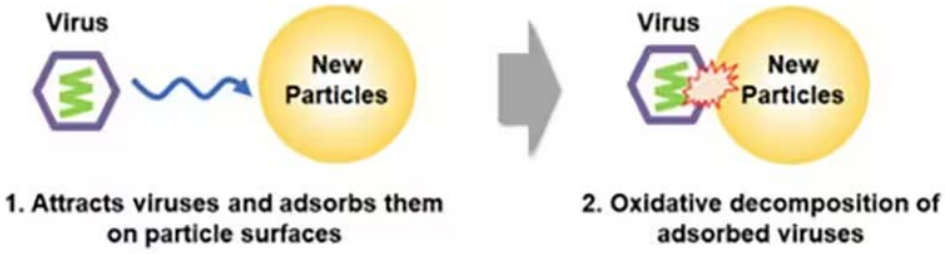
Conventional disinfection with antiseptic solutions and other chemicals is effective and fast-acting on viral infections. The downside, however, is short volatilization, necessitating regular disinfections. While non-volatile metal-based antivirals offer generally lasting protection, the issue is that many of them take at least an hour to deactivate 99.9% of viruses.

Toray responded to that situation by developing antiviral particles that deactivate 99.9% or more of SARS-CoV-2 virus (the cause of COVID-19) strains in just 15 seconds and 99.99% or more of the strains within 5 minutes. The company achieved this by adding virus adsorption and oxidative degradation capabilities to cerium oxide particles through proprietary synthesis and surface treatment techniques. Toray drew on functional particle design, synthesis, and surface control technologies that it has developed over the years. The new particles deactivate viruses around 100 times faster than conventional metal-based antiviral agents. They are thus among the world’s quickest deactivation delivery vehicles.

Another benefit is that the particles do not volatilize and are lasting protection. That is because they do not use the virus deactivation principle of slow releases with drugs, metal ions, or other active ingredients. The particles also offer excellent safety and resist discoloration and corrosion.

Prospective media for the particles include building materials, paints, and packaging materials. They could thus be deployed in diverse products, including in public spaces in which numerous people might gather, necessitating measures to safeguard from virus infection. Other targets could be public transportation facilities, restaurants, medical and eldercare facilities, interior walls and railings at schools, and regular appliances and food packaging. Antiviral particles could coat or be kneaded into diverse items. These could include non-woven fabrics for Toray's masks and medical gowns, air filters, car seats, and other products that could benefit from these particles to prevent droplet and contact infections. Toray will gradually roll out test samples of the particles to customers.

Viral inactivation principles for Toray's particle



3 The creation of these particles stemmed partly from a joint research effort with Professor Satoshi Taharaguchi of the School of Veterinary Medicine at Azabu University under the New Energy and Industrial Technology Development Organization's Feasibility Study Program on Materials and Biotechnology.

Toray HotBalloon™ Ablation Catheter Qualifies for Insurance to Treat Persistent Atrial Fibrillation


SATAKE・HotBalloon™ ablation catheter

Toray has secured insurance coverage for the SATAKE・HotBalloon™ ablation catheter currently sold by Toray Medical Co., Ltd. to treat drug refractory recurrent symptomatic persistent atrial fibrillation in Japan. The company is authorized domestically to manufacture and sell this product.

Atrial fibrillation is an irregular and often very rapid heart rhythm from abnormal electrical signal in the atria. There are four main types of such fibrillation; paroxysmal (terminates within 7 days), persistent (sustained beyond 7 days), long-standing persistent (sustained for at least 12 months) and permanent atrial fibrillation.

Around 70,000 ablations for atrial fibrillation are performed in Japan each year. An estimated 20% of those procedures are for the persistent type.

Toray secured marketing approval in 2015 for the SATAKE・HotBalloon™ ablation catheter to treat drug refractory recurrent symptomatic paroxysmal atrial fibrillation. There has been a growing need in recent years to also use this product for persistent atrial fibrillation.

The company accordingly obtained marketing approval in October 2021 to add HotBalloon™ to indications for treating drug refractory recurrent symptomatic persistent atrial fibrillation, with insurance coverage beginning in May 2022. Toray expects this additional indication can be a new treatment option for persistent atrial fibrillation patients.

Toray Files Manufacturing and Marketing Approval for In Vitro Diagnostic Test of Changing Apolipoprotein A2 Isoform Concentrations in Blood of Pancreatic Cancer Patients

On June 27, 2022, Toray filed a manufacturing and marketing approval with the Ministry of Health, Labour and Welfare for an in vitro diagnostic test to measure apolipoprotein A2 (APOA2) isoform concentrations in blood. APOA2 is a major component of high-density lipoprotein (HDL), and comprises a 77-amino acid chain. There is a carboxyl (C)-terminal amino acid sequence of alanine (A), threonine (T), and glutamine (Q). The APOA2-ATQ full-length protein and APOA2-AT C-terminal degraded isoform coexist in blood.

Professor Kazufumi Honda of the Graduate School of Medicine of Nippon Medical School discovered that the quantitative ratios of APOA2-AT and APOA2-ATQ change in the blood of pancreatic cancer patients (see four references below). He previously led the Department of Biomarkers for Early Detection of Cancer at the National Cancer Center Japan.

Toray has furthered on his research in developing a reagent to measure APOA2 isoform as an in vitro diagnostic test. The company is collaborating with the Nippon Medical School, leveraging research findings from the National Cancer Center and Japan Agency for Medical Research and Development.

This reagent measures both APOA2-AT and APOA2-ATQ levels in the blood of individuals with suspected pancreatic cancer. The reagent uses a proprietary Toray antibody in a sandwich enzyme-linked immunosorbent assay.

Click here for the main initiatives for CSR Guideline 7, “Contributing Solutions to Social Issues through Business Activities” in CSR Roadmap 2022.