

Application Guidelines Appendix

Chapter 6: Target Technology Areas

This chapter provides an overview of each technology area, outlines the background of the research and development (R&D) proposals being solicited, and describes the anticipated categories of technical components as well as the key bottlenecks expected to be addressed. Please note that these bottlenecks are illustrative rather than exhaustive; we welcome a broad range of innovative proposals beyond those explicitly mentioned.

We also encourage proposals that seek to promote collaboration and integration with other fields, provided that one of the three technical areas constitutes the primary focus. In such cases, applicants should select the most relevant of the three technical fields when submitting their application.

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6.1 “Resource Circulation” Area



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I . Overview of the Technology Area

In this technology area, we carry out R&D for technologies, materials, and chemical processes that enable efficient recycling of resources with low environmental impact and contribute significantly to reducing greenhouse gas emissions. The recovery and recycling of carbon and other resources is taking on increased importance worldwide as means to achieve carbon neutrality. For example, the recovery and recycling of greenhouse gases from industrial exhaust, which is a large-scale source of greenhouse gas emissions, is expected to contribute significantly to carbon neutrality. Consequently, there is a need for research into technologies for energy-saving and highly efficient separation and recovery of greenhouse gases, including carbon dioxide, and for the establishment of new processes for synthesizing high-performance and highly functional chemicals and fuels from greenhouse gases directly or from biomass that has absorbed and immobilized greenhouse gases. In addition, the production and distribution of storage batteries, fuel cells, and solar cells are expected to increase in the future in order to reduce greenhouse gas emissions. However, the supply of metal resources as raw materials and the countries that produce them are limited, making it important to recycle existing resources in order to ensure a stable supply of raw materials.

Thus, this technical field invites proposals for the development of technologies, materials, and chemical processes that facilitate the recycling of both organic and inorganic resources and contribute substantially to the reduction of greenhouse gas emissions. In addition, we encourage proposals that seek to enhance the efficiency and advancement of R&D through the application of AI and machine learning, grounded in transformative and high-impact concepts.

In the selection of R&D proposals, emphasis will be placed on the premise that the proposed technology can contribute to the reduction of greenhouse gas emissions with low environmental impact throughout the entire process of using the proposed technology from the perspective of energy flow and material flow.

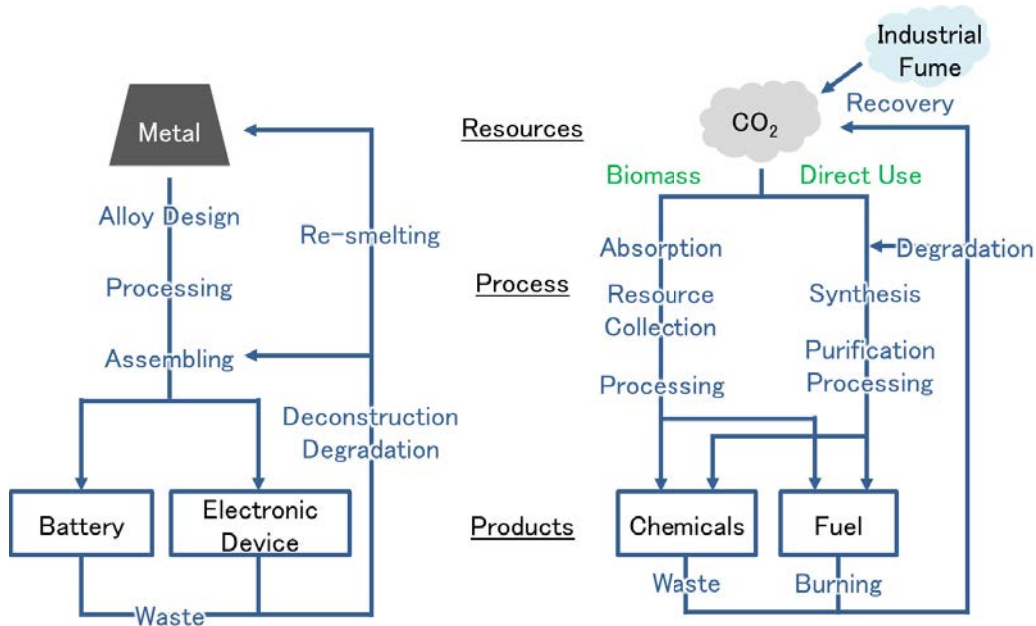


Figure 1: Target Technologies in “Resource Circulation” area

II. Technological elements for which proposals are sought

For FY 2026, we invite R&D proposals in the following categories within the “Resource Circulation” area:

- a. Resource recycling technologies that contribute to greenhouse gas reduction
- b. Highly efficient and energy-saving greenhouse gas separation, recovery, and utilization technologies
- c. Novel synthesis technologies for producing high-performance and highly functional materials from biomass with low environmental impact and high efficiency
- d. New ideas for resource recycling to achieve carbon neutrality

a. Resource recycling technologies that contribute to greenhouse gas reduction

Achieving carbon neutrality requires the energy-efficient use and recycling of limited resources, which is essential not only for reducing greenhouse gas emissions but also for addressing resource constraints and ensuring long-term sustainability. In particular, demand for a wide range of resources, including non-ferrous metals, has increased rapidly in recent years amid global efforts toward decarbonization. With the widespread adoption of energy-related products such as storage batteries, fuel cells, and solar cells, as well as products composed of heterogeneous and composite materials,

including automotive and industrial equipment components, the importance of advanced recycling technologies tailored to these materials has grown significantly. Further, widely used general-purpose polymer materials require advanced technologies for efficient decomposition and reuse.

This category invites R&D proposals focused on the development of recycling technologies for non-ferrous metals; chemical synthesis methods for degradable materials that enable the recycling of heterogeneous, composite, and polymer materials; the development of materials designed for facile decomposition; and innovative decomposition, dismantling, and reuse technologies that contribute to improved energy conservation and efficiency. Although we anticipate proposals addressing the following bottlenecks, we strongly encourage innovative approaches that extend beyond the examples provided below.

- Development of low-cost, environmentally sustainable recycling technologies for non-ferrous metals

We invite proposals for R&D of innovative, environmentally sustainable technologies that enable the cost-effective recycling of non-ferrous metals, including rare metals (such as rare earth elements and precious metals) that are subject to supply constraints and environmental regulations.

- Development of circular utilization technologies applicable to products made from heterogeneous and composite materials

We invite novel R&D proposals for synthesis methods and utilization processes of easily degradable materials that contribute to the circular utilization of products made from heterogeneous and composite materials such as storage batteries, fuel cells, solar cells, and vehicle bodies, as well as technologies for their decomposition, disassembly, and reuse

- Development of circular utilization technologies applicable to general-purpose polymer materials

We invite novel R&D proposals that efficiently decompose currently widely used polymer materials and contribute to the circular utilization of products made from these polymer materials.

- Development of recyclable polymeric materials that can be degraded and recycled in the environment

We invite proposals for novel and unprecedented R&D related to synthesis methods for recyclable polymeric materials that are highly versatile and that can significantly reduce greenhouse gas emissions through the reuse of raw materials.

b. Highly efficient and energy-efficient greenhouse gas separation, recovery, and utilization

technologies

The amount of greenhouse gas emissions generated by the use of fossil resources is enormous, and in order to reduce these emissions, efforts are being made to develop energy-saving technologies and shift to carbon dioxide-free renewable energy. Conversely, achieving carbon neutrality requires not only advances in energy conversion but also the effective separation and capture of greenhouse gases emitted from large-scale sources. Further, the recycling and utilization of captured greenhouse gases constitute an urgent and critical challenge. Although technologies for the separation and recovery of greenhouse gases are already being studied for practical application, there is still a need to develop technologies that outperform conventional methods for both separation and recovery in order to significantly improve performance and reduce costs for a wider range of applications. There is also a pressing need to establish novel synthetic processes for compounds with high industrial demand and to reposition greenhouse gases, particularly carbon dioxide, from being treated as “waste” to being utilized as valuable “resources.”

Therefore, this category invites R&D proposals aimed at developing innovative adsorption materials and separation membranes for greenhouse gases, as well as novel synthesis technologies for producing high-value-added compounds from carbon dioxide. Further, provided that the expected operating conditions and scope are clearly defined, proposed R&D projects will be highly evaluated if they demonstrate meaningful contributions to the reduction of greenhouse gas emissions across the entire process, including separation, recovery, and utilization. For example, we expect R&D proposals to solve the following bottlenecks, but we are looking for innovative proposals that are not limited to those listed below.

- Development of novel materials and processes capable of separating, capturing, and converting greenhouse gases with high efficiency and energy savings

We invite proposals for R&D of materials and processes for low-cost, high-efficiency separation, recovery, and conversion of methane, which has a high global warming potential, and carbon dioxide, which is emitted in large quantities from factories and other sources.

- Synthesis technology for new high-value-added compounds using carbon dioxide as a raw material

We invite R&D proposals for new and groundbreaking technologies to convert carbon dioxide into chemical products that are in demand by industry, viewing carbon dioxide as a resource.

c. Novel synthesis technologies for producing high-performance and highly functional

materials from biomass with low environmental impact and high efficiency

The importance of utilizing biomass (woody and herbaceous materials) to absorb, fix, and recycle carbon dioxide is recognized worldwide, and research on the utilization of biomass has been conducted in a wide range of fields. Although Japan has abundant forest and marine resources, the country lags behind other countries in research on biomass utilization. In particular, there is a need to develop technologies that take into account Japan's unique weather, environmental, and geographical conditions. In this category, we seek to develop groundbreaking new chemical synthesis methods that efficiently convert inedible biomass into high-performance or highly functional chemical products and polymeric materials, as well as technologies that enable low-cost production of general-purpose chemical products and fuels such as organic acids and alcohols. For example, we expect R&D proposals to solve the following bottlenecks, but we are looking for innovative proposals not limited to these.

- Novel chemical synthesis technologies for creating high-functional materials and general-purpose chemical products from biomass raw materials

We invite R&D proposals for synthesis technologies that utilize polysaccharides, lignin, terpenes, and polyphenols to create high-performance or highly functional chemical products and polymer materials, as well as synthesis technologies for producing general-purpose chemicals such as organic acids, alcohols, and fuels, including SAF, with high efficiency.

The biological use of biomass is covered under the "Green Biotechnology" area. For details, refer to Chapter 6.2: "Green Biotechnology" Area of the Application Guidelines.

d. New ideas related to resource circulation to achieve carbon neutrality

We are also looking for R&D proposals that do not fall into the above categories but that are based on new ideas for circular use of organic and inorganic resources and that will make significant contributions to realizing carbon neutrality.

6.2 "Green Biotechnology" Area



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I . Overview of the Technology Area

The food, agriculture, forestry, and fisheries industries have been listed as priority areas in the "Green Growth Strategy" to contribute to realizing carbon neutrality, and attention is being paid to bio-manufacturing and the development of technologies that utilize biotechnology. In particular, the solidification and recycling of carbon dioxide in forests, timber, agricultural land, and oceans by plants and microorganisms has been attracting attention, and is expected to make a significant contribution to the reduction of greenhouse gas emissions. In this technology area, we aim to develop game-changing innovative technology seeds that contribute to reducing greenhouse gas emissions by making maximum use of the functions of microorganisms and plants.

While there have been many studies to elucidate and improve the functions of microorganisms and plants, recent years have also seen a growing interest in research targeting the symbiotic relationship between microbiota and plants, and even the symbiotic relationship with surrounding organisms. It has become clear that communication takes place through secretion and metabolism of minute amounts of signal transducers and other substances in complex biological systems in which diverse organisms interact with each other, and it is expected that the mechanisms of interaction in complex biological systems will be elucidated, controlled, and utilized to maximize biological functions.

In this technology area, we will conduct innovative and ambitious research into areas with many unknowns, such as the elucidation and utilization of mechanisms underlying biological diversity, the elucidation and utilization of the mechanisms of interactions in complex biological systems in the natural environment, and develop new technologies that contribute to realizing carbon neutrality through the use of biotechnology, mainly in academia. In R&D, we have high expectations for contributing to the reduction of greenhouse gas emissions and the fixation and utilization of carbon dioxide.

Furthermore, we seek R&D proposals that contribute to carbon neutrality through the integration and fusion of biotechnology with information science including AI and machine learning, which has been making remarkable progress.

We also welcome R&D proposals in interdisciplinary research that bridge biology with physics and chemistry.

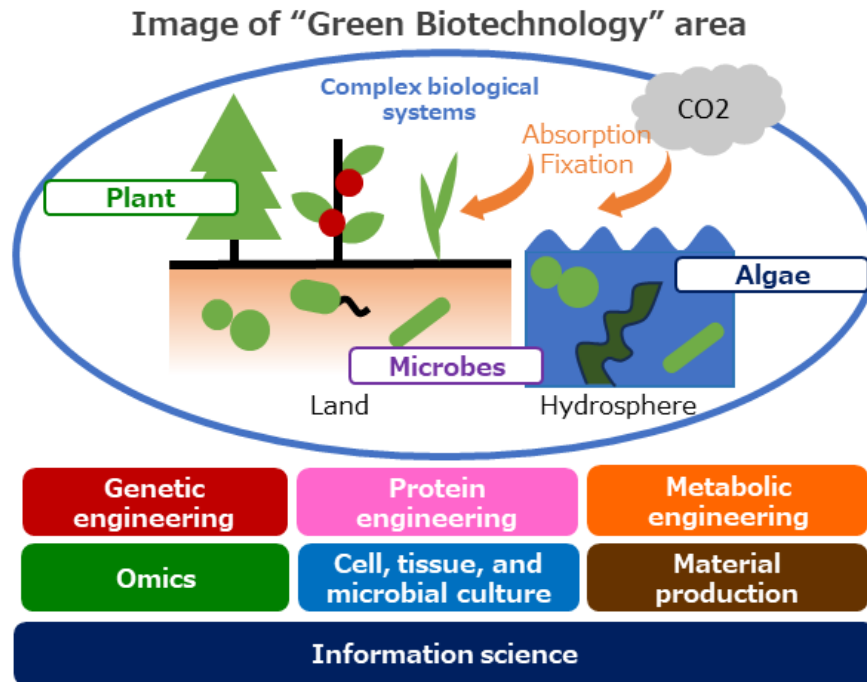


Figure 2: Target technologies in the "Green Biotechnology" area

II. Technological elements for which proposals are sought

For FY 2026, we invite R&D proposals in the following categories within the "Green Biotechnology" area:

- a. Technologies that contribute to carbon neutrality through the integration of biotechnology with information science including AI and machine learning
- b. Innovative technologies for analyzing, characterizing, designing, and controlling the structure and function of complex microbial systems and biomacromolecules
- c. Methods to control complex biological systems to maximize plant functions such as tolerance to environmental changes and enhancement of carbon dioxide fixation capacity
- d. Next-generation breeding technology for diverse plants to realize high-yield and low-environmental-impact biomass production
- e. Development and utilization of novel microorganisms and plants that can both reduce greenhouse gas emissions and produce food
- f. New ideas for using biotechnology to achieve carbon neutrality

In particular, for this fiscal year, we strongly encourage proactive submissions under Category a, which promotes the collaboration and integration of information science and biotechnology, and under Category f, which emphasizes innovative and high-impact concepts.

a. Technologies that contribute to carbon neutrality through the integration of biotechnology with information science including AI and machine learning

Information science including AI and machine learning, as exemplified by the 2024 Nobel Prize in Chemistry, is bringing innovative research methods to the field of biotechnology. For example, game-changing R&D is actively being conducted, such as analysis of large amounts of genetic information and identification of gene functions by using information science algorithms and computational resources, as well as integration and analysis of big data and understanding and control of complex networks within and between organisms by extensive use of information science.

Therefore, in this category, we invite proposals for game-changing technologies that contribute to carbon neutrality by bridging with information science, targeting categories b to e in the Green Biotechnology area.

If including biology researchers responsible for experimental verification in the R&D team at the time of application presents a challenge, we welcome proposals composed solely of information science groups targeting categories b–e. Such proposals may focus on R&D in information sciences and technology that contribute to the precise analysis, prediction, and control of life phenomena and complex biological systems. In that case, following selection, the project should commence with the information science group leading the work, accompanied by a phased plan in which biological researchers responsible for experimental verification are added as Co-Principal Investigator during the small-phase period. The R&D proposal must explicitly specify the timing of their participation, their expected role, and the scope of R&D tasks they will undertake. After selection, the PO and AD will provide support for matching with suitable biological researchers. Please note that the upper limit for R&D expenses remains fixed, even if a Co-Principal Investigator is added during the research period; applicants should account for this constraint when planning their budget.

For example, we expect R&D proposals to solve the following bottlenecks, but we are looking for innovative proposals not limited to these.

- Technologies for designing, analyzing, and controlling proteins with enhanced functions (such as activity, substrate specificity, and heat resistance) that support carbon neutrality, for example by improving carbon dioxide fixation, through the application of information science
We invite proposals for the development of technologies that leverage information science to impart specific, targeted functions to proteins that contribute to carbon neutrality.
- Development and application of new models that predict phenotypes of plants, microorganisms, etc. from genetic and image information by using information science
We invite R&D proposals to develop models that can predict biological phenotypes from large amounts of data such as genetic and image information by using information science, and apply these as technologies that contribute to carbon neutrality.
- Prediction of changes in soil microbial community structure due to global warming, modeling of microbial community dynamics, and prediction and utilization of novel useful substances or molecules from metagenomic sequences by using data science
We invite R&D proposals that contribute to carbon neutrality by developing models of complex biological systems that adapt to changes due to global warming, utilizing information science and data science.
- High-throughput analysis technologies by using new sensing devices and research digital transformation (DX), and technologies for automation and parallelization of experiments by using AI
We invite R&D proposals for the development of high-throughput analysis technologies utilizing information science, as well as development of technologies for experiment automation and parallelization, and applications of these that contribute to carbon neutrality
- R&D aimed at identifying practical enzyme candidates that can support carbon fixation, biomass conversion, environmental purification, and related applications, by predicting enzyme activity, substrate specificity, stability, and other properties through information science, followed by experimental verification
We are seeking R&D proposals that ultimately contribute to carbon neutrality, in which the information science group leads the identification of promising enzymes and the biological sciences group conducts the experimental validation.
- Development of screening methods that use sequence information and existing experimental data to predict whether molecules will function effectively and to what degree, enabling the

selection of promising candidates with fewer experiments

We are seeking R&D proposals that ultimately contribute to carbon neutrality, where the information science group leads the prediction of useful molecules and oversees efficient experimental validation.

b. Innovative technologies for analyzing, characterizing, designing, and controlling the structure and function of complex microbial systems and biomacromolecules

Microorganisms play a central role in the planet's carbon and nitrogen cycles, and regulating their functions in the environment is considered critical for reducing greenhouse gas emissions. In natural ecosystems, microorganisms not only form diverse microbiotas but also exist within complex biological systems alongside other organisms. Studies have shown that microorganisms and plants interact within these systems through various signaling factors; however, many aspects remain poorly understood, including the variability of these interactions under diverse climatic and geographical conditions. Although progress has been made in metagenomic analysis of microbiota, systematic analysis and characterization of the structure and function of complex microbial systems in the environment remains difficult because there are many difficult-to-culture bacteria in the environment, and conventional techniques are insufficient to analyze these bacteria.

Therefore, this category calls for innovative high-throughput analytical techniques for information on complex microbial systems and biomacromolecules in order to elucidate the structure and function of complex microbial systems and biomacromolecules (such as enzyme proteins), about which there are many black boxes, and to obtain new knowledge that will contribute to the maintenance of global material cycles. For example, we expect R&D proposals that solve the following bottlenecks, but we invite innovative proposals not limited to these.

- Microbiota design and control technologies for reducing greenhouse gas emissions by controlling biofilm activity in the aquatic environment

We invite proposals for R&D that will elucidate the structure and function of complex microbial systems in the aquatic environment.

- Analysis of interactions among microorganisms in dynamically changing microbiota in diverse environments, elucidation of their mechanisms of action, and control technologies

We invite proposals for R&D that will elucidate and control the unknown interactions that occur with dynamic changes in the microbiota of diverse environments.

- Technologies for exploring genetic resources for new microorganisms and microbiota that contribute to low-carbon development, and applications for these technologies

We invite proposals for the exploration and application of the vast untapped biological resources of the unknown biosphere.

c. Methods to control complex biological systems to maximize plant functions such as tolerance to environmental changes and enhancement of carbon dioxide fixation capacity

Plants are thought to exhibit adaptability to diverse environments through symbiotic relationships with various organisms. In the field of plant-microbiota interactions, for example, efforts are underway to identify microorganisms that contribute to plant growth and to study interactive factors (signal transducers). However, there is also a need to identify receptors and factors possessed by plants themselves and analyze their dynamic changes in order to establish more efficient and effective interactions.

In addition, there is potential for the effects of complex biological systems on plants to be utilized in developing plants that are tolerant to various environments, resistant to pests and diseases, and can maintain production and growth in a variety of environments. However, it remains difficult to elucidate the mechanisms of interactions in complex biological systems involving diverse elements.

Therefore, in this category, we seek to analyze plant genes that contribute to interactions with complex biological systems, elucidate interaction factors produced by plants, and develop novel plant gene improvement, breeding, and cultivation methods based on these mechanisms of action in order to cultivate plants that exhibit excellent growth potential, carbon dioxide fixation capacity, and tolerance to environmental changes by utilizing the action of complex biological systems. For example, we expect R&D proposals to solve the following bottlenecks but are looking for innovative proposals not limited to those listed below.

- Analysis of plant genes affected by symbiotic microbiota and plants, and development of new plants using these genes

We invite proposals on new R&D based on the identification of receptors and factors possessed by plants themselves, and the analysis of their dynamic changes.

- New plant cultivation technologies that enable the design and control of complex biological systems to enhance photosynthetic capacity, accelerate growth, improve tolerance to environmental changes, and enhance disease and pest resistance

We seek proposals for R&D involving genetic improvement and breeding methods based on

analysis and elucidation of interactive factors and contributing plant genes.

- Elucidation of material cycles in complex biological systems through the monitoring of environmental and photosynthetic activities and the technology for their function control

We invite R&D proposals aimed at elucidating material cycles via photosynthesis in complex biological systems and applying function control by utilizing optical sensor technologies, simulation systems of the environment and yield, etc..

d. Next-generation breeding technology for diverse plants to realize high-yield and low-environmental-impact biomass production

The fixation of carbon dioxide by plant photosynthesis has potential to contribute to achieving carbon neutrality through negative emissions. To this end, it is particularly important to expand growing areas, improve productivity, and accelerate associated utilization cycles in order to increase plant biomass production, which can greatly help to reduce greenhouse gas emissions. For example, herbaceous biomass has the potential to power technologies for enabling more efficient crop breeding that will result in food production with a low environmental impact. For woody biomass, efforts must be made to expand the use of wood through the production of elite trees (elite trees are selected from the next generation of trees obtained through artificial crossbreeding among elite trees that have good growth, material quality, and other traits) and to secure and enhance medium- to long-term forest absorption of greenhouse gases through appropriate forest management. Achieving this will require the efficient development of elite trees through accelerated forest tree breeding and other measures, as well as expanded production of their seedlings.

Therefore, in this category, we call for the development of next-generation fundamental technologies that will increase the efficiency and speed of the breeding of diverse plants, including trees. For example, we expect R&D proposals to solve the following bottlenecks but are looking for innovative proposals not limited to those listed below.

- Plant genome information analysis, protein analysis, gene selection, and genome editing technologies based on new opportunities for increasing biomass production with high yield and low environmental impact

We invite R&D proposals for efficient crop breeding for increased biomass production, efficient development of elite trees, etc.

- Technologies for elucidating photosynthetic mechanisms and technologies for enhancing carbon dioxide fixation capacity by functional control, as well as technologies for controlling allocation

or storage of fixed carbon, or technologies that achieve both

We invite R&D proposals that explore not only enhancement of carbon fixation capacity by elucidating photosynthetic mechanisms, but also extend to biomass allocation, soil storage, etc. of fixed carbon.

- Technologies related to the development of novel biomass with high carbon dioxide fixation capacity (microalgae, large algae, trees, etc.)

We seek proposals for R&D in areas such as novel biomass development in a wide range of biospheres that include coastal and underwater biospheres, as well as terrestrial biospheres.

- Technologies aimed at reducing greenhouse gases other than carbon dioxide (methane, nitrous oxide, etc.) from plants

We invite proposals for R&D of technologies that contribute to reducing greenhouse gases that have a greater impact than carbon dioxide.

e. Development and utilization of novel microorganisms and plants that can both reduce greenhouse gas emissions and produce food

Microorganisms and plants are expected to play a major role in addressing the pressing protein and energy crises that are strongly expected to be solved in the future, and many efforts have been made to develop food production technologies that utilize the functions of microorganisms and plants. To help realize carbon neutrality, it is considered important to simultaneously improve the efficiency of food production and more effectively reduce greenhouse gas emissions. For example, to reduce greenhouse gas emissions in agriculture, there is potential for technologies that improve soil and increase fertilization efficiency by using microbial resources, that reduce energy input in livestock production, or that produce alternative proteins and fatty acids by way of precision fermentation.

In this category, we invite proposals for technologies that make maximum use of the functions of microorganisms and plants to enable energy- and resource-saving food production, as well as for the development of novel microorganisms and plants that contribute to food production. For example, we expect R&D proposals to solve the following bottlenecks, but we are looking for innovative proposals not limited to these.

- Technologies for crop development and the utilization of microorganisms to enable the production of food and feed with low energy input

We invite proposals for R&D related to the development of technologies for things such as soil improvement and fertilizer application efficiency utilizing soil microorganisms.

f. New Ideas for Using Biotechnology to Achieve Carbon Neutrality

We invite R&D proposals based on new ideas for contributing to achieving carbon neutrality that do not fall into the above categories. In particular, we expect proposals for basic research and technological development based on new ideas not limited to the above categories.

The development of synthesis technologies for chemical products made from biomass will be covered in the "Resource Circulation" area. For details, please refer to "6.1. 'Resource Circulation' Area" of the Application Guidelines.

6.3 "Semiconductor" Area



Program Officer

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I . Overview of the Technology Area

The power consumption of our information and communication infrastructure is increasing exponentially as we develop into a full-fledged advanced information society driven by technologies such as 5G/6G, IoT, automated driving, and robotics, as well as DX. Achieving carbon neutrality will require dramatic advancements in the power saving capabilities of semiconductor devices and circuit hardware, which are the foundation of information and communication infrastructure. Also crucial will be advancements in power transmission technologies, namely those involving energy conservation and large, complex, and highly reliable power grids running on renewable energy or hydrogen, as well as storage batteries.

In this technology area, we aim to radically reduce the power consumption of semiconductors for information and communication infrastructure. Specifically, we aim to develop semiconductor device and process technologies that enable ultra-low power logic memory, innovative transmission hardware technologies that reduce power consumption per communication bit by several orders of magnitude, and materials and implementation methods that enable highly efficient thermal management. We will also develop highly efficient and reliable power conversion and control circuits, inverter/converter stabilization technologies, etc., for energy conservation and higher reliability in large, complex power grids.

Regarding the scope of the FY 2026 call for proposals, please ensure that you review “II. Technological elements for which proposals are sought”

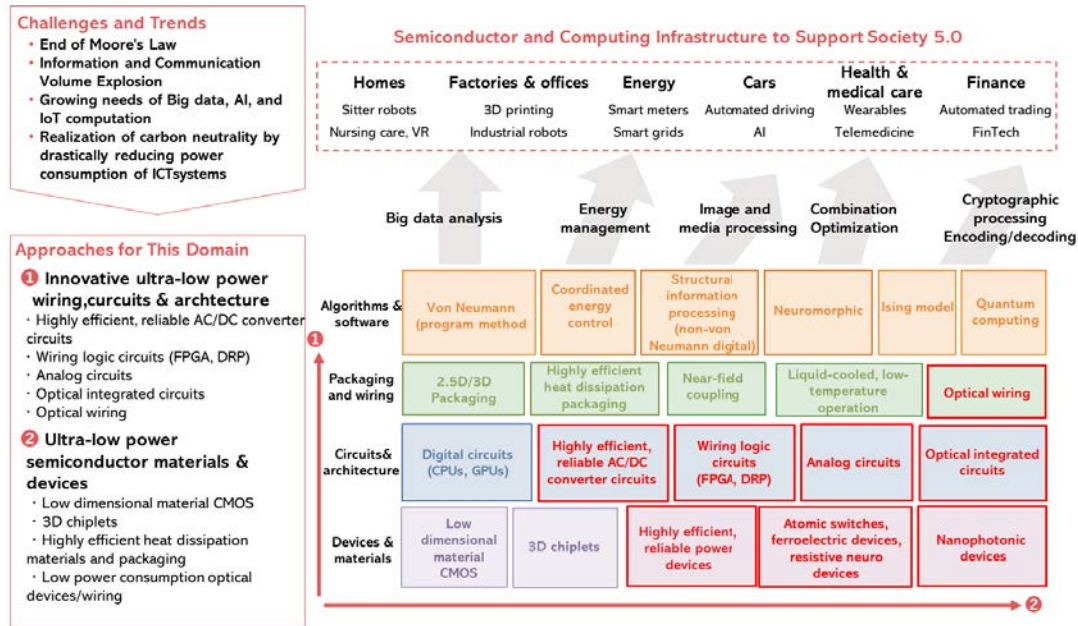


Figure 3: Target technologies in the “Semiconductors” area (red text indicates examples of technologies for which proposals will be solicited in FY 2026) (Modified from the JST-CRDS Strategic Proposal (CRDS-FY2017-SP-02))

II. Technological elements for which proposals are sought

For FY 2026, we invite R&D proposals in the following categories within the “Semiconductor” area:

- Innovative memory technologies that enable ultra-low-power operation
- Innovative transmission hardware technology that radically reduces power consumption per communication bit
- Power conversion devices, circuits, and control technologies to achieve high efficiency and reliability in large and complex power grids

a. Innovative memory technologies that enable ultra-low-power operation

Information-processing semiconductors based on existing silicon materials are approaching the physical limits of miniaturization and the end of Moore’s Law. At the same time, the rapid expansion of AI has driven a surge in memory demand, creating a major bottleneck in the large-scale data transfers between processors, memory, and storage. In particular, conventional main memory DRAM is volatile and requires refresh cycles, resulting in frequent data transfers to and from storage and contributing substantially to overall energy consumption. Innovations in memory technologies are therefore essential to overcoming these challenges.

This category invites R&D proposals focused on innovative memory technologies aimed at substantially reducing power consumption and enhancing overall system performance.

- Innovative memory technology

We invite R&D proposals related to the development of innovative memory based on novel concepts, as well as proposals that advance the scaling, acceleration, operating voltage reduction, and reliability improvement of non-volatile memories (such as FeRAM, MRAM, and similar technologies).

b. Innovative transmission hardware technologies that radically reduce power consumption per communication bit

The development of society into an advanced digital society (Society 5.0) will see the handling of vast amounts of data beyond conventional expectations, and global information volume is expected to reach more than 30 times that of 2018 by 2030 and 4,000 times by 2050. If development continues at the current pace, annual global power consumption for information alone is expected to reach 42 PWh in 2030 and 5,000 PWh in 2050, far exceeding the current consumption of around 24 PWh. In order to meet the ever-increasing demand for communications and realize a low-carbon society, there is an urgent need to develop innovative hardware technologies that reduce power consumption per communication bit by several orders of magnitude. It is particularly important to reduce communication energy usage by data centers where large amounts of data are processed. To achieve this, in addition to reducing the power consumption of high-speed router equipment, conventional electrical interconnects must be replaced with high-efficiency optical interconnects, and the repeated OEO conversions in the network must be removed and transformed into an optical switch network.

In this category, we invite R&D proposals for solving bottlenecks in information processing and communication paths using various technologies, including power-saving chip-to-chip and chiplet-to-chiplet communication, next-generation optical transceiver technologies for board-to-board (rack-to-rack) communication, high-speed optical switch technologies for optical networking, and power-saving high-speed router equipment. For example, we expect R&D proposals to solve the following bottlenecks, but we are looking for innovative proposals not limited to these.

- Ultra-low power, high-density, broadband interconnect technologies for chip-to-chip and chiplet-to-chiplet interconnection

We invite R&D proposals for new transmission methods, packaging technologies, optical wiring technologies, etc. that will enable a drastic reduction of communication energy on package substrates and boards.

- Next-generation optical transceiver technologies for high-capacity and power-saving data transmission among boards and racks

We seek proposals for next-generation optical transceiver technologies such as Co-Packaged Optics (CPO) and Near-Package Optics (NPO), which enable significant reductions in the power consumption of chip I/O SerDes and optical transceiver optoelectronic interfaces, and technologies to boost density and capacity, along with innovative active optical devices such as semiconductor lasers that can operate with low voltages, new ultra-high speed optical modulators, and ultra-low capacitance light receiving elements.

- Innovative optical switch device technologies that enable significant power savings by reducing OEO conversion

Aiming to reduce OEO conversion in optical communication networks and data center networks and transform them into all-optical networks, we invite R&D proposals for optical switch technologies that can be applied to optical circuit switches (OCS), optical burst switches (OBO), and optical packet switches (OPS), and for means to give them multiple ports and greater speeds while miniaturizing them.

- Innovative memory and FPGA technologies for power saving in high-speed router equipment

We invite R&D proposals for the development of non-volatile memory and circuit networks that will enable lower power usage by FPGA circuits that control the information processing of route-switching routers installed in many communication pathways.

c. Power conversion devices, circuits, and control technologies to achieve high efficiency and reliability in large and complex power grids

Achieving carbon neutrality will require not only meeting ambitious power-saving goals for information infrastructure but also reducing electrical energy consumption throughout the entire supply chain, in all its size and complexity, from "production," "transportation," "distribution," and "collection" to the "supply" and "use" of electrical energy. This in turn will require backbone power grids to have greater efficiency and advanced control and operation methods for the numerous interface devices and circuits that exist in their complex power systems, which run on renewables, hydrogen, and storage batteries. In addition, connecting various distributed energy sources to consumer systems and operating them in coordination from the power grid to equipment in homes and buildings will require the installation of numerous inverters and converters, as well as frequent power conversion to and from the grid, making the advanced control and operation technologies of grid-connected equipment,

and the ability to control EMC, among the bottlenecks being faced. In addition, for future high-voltage power conversion, it is important to conduct basic research on the next generation of semiconductor devices that will greatly surpass the performance of conventional devices in terms of such things as drive voltage and current. For example, we expect R&D proposals to solve the following bottlenecks, but we are looking for innovative proposals not limited to these.

- Semiconductor materials (such as AlN, Ga₂O₃, diamond) and device technologies that significantly surpass conventional performance in drive voltage and current, which are essential for enabling future ultra-high-voltage power conversion

We seek R&D proposals aimed at establishing these technologies, including process development and performance evaluation, to achieve optimal device characteristics.

- Fundamental high-efficiency technologies for the power capacities of voltage and AC-DC converter circuits, which exist in a wide range of applications, from the grid to distributed power systems

The use of DC and AC power supplies of various voltages in a variety of devices requires a large number of voltage and AC-DC converter circuits. We invite R&D proposals for technologies to radically downsize and increase the efficiency of voltage and AC-DC converter circuits, including higher performance passive devices that work with power devices in these circuits, as well as circuit configurations and control schemes. In addition, we seek R&D proposals for gate driver technologies to enable the high-precision and safe operation of power conversion circuits (inverters/converters), suppress the breakdown and degradation of power semiconductors, and enhance system reliability.

- Inverter and converter circuit technologies that can cope with instability and noise in the grid

We invite proposals for R&D on inverter and converter technologies that can cope with frequency and voltage fluctuations that occur in power grids where DC-driven renewable energy sources (solar power, wind power, storage batteries) have become the main power source, and that can also reduce noise in power conversion systems.

- Intelligent smart inverter technologies that enable the coordinated operation of devices in homes and buildings from the power grid with high reliability and low power consumption

We invite R&D proposals for intelligent smart inverter technologies that have the ability to autonomously regulate power grids connected to various power sources to stabilize the power systems, improve power quality, and achieve coordinated power savings for the entire power network.