

Innovation to Create New Market

May 28, 2026

Innovation & R&D

1. Development of Technique for Two-qubit Operations Using 4x4 Silicon Qubit Array

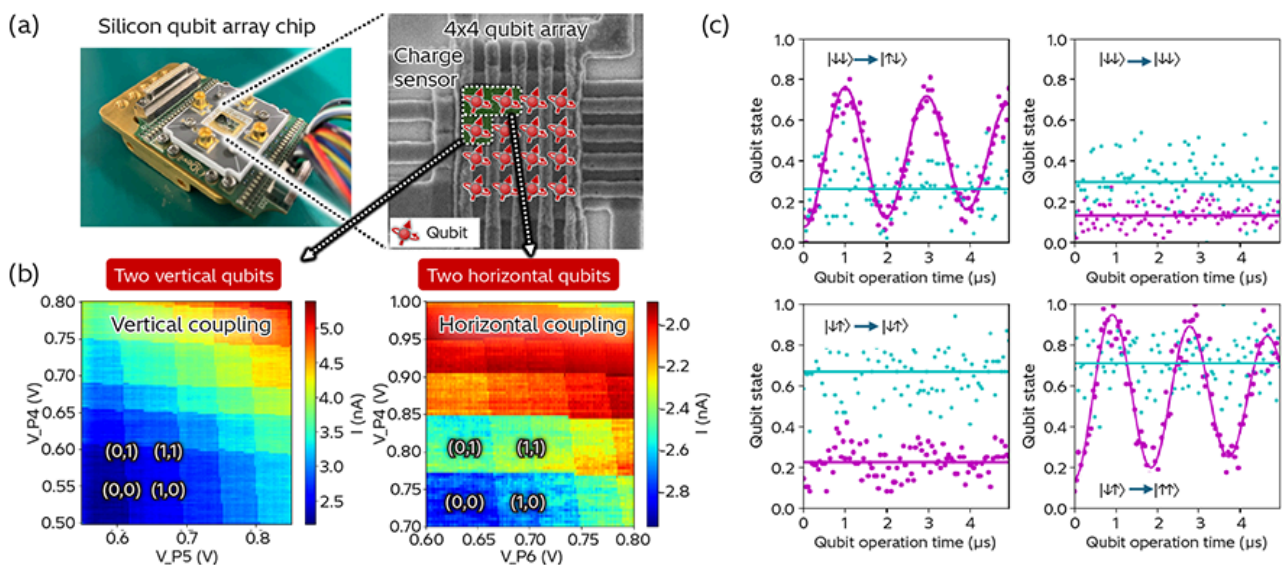
It is expected that systems with a million qubits or more will be needed for practical quantum computers. In addition to techniques for the efficient control of qubits, this will also require large-scale integration of qubit circuits and the implementation of error-correction codes^{*1}. Hitachi has already developed a technique for achieving single-qubit lifetimes that are two orders of magnitude longer than in the past, an essential requirement for error-correction codes. In addition to operations on individual qubits, however, practical quantum calculations require two-qubit operations analogous to the logic gates used in classical computers.

Now, with a view to achieving large-scale integration, Hitachi has developed a technique for two-qubit operations that uses a two-dimensional qubit array. This has included experimentally demonstrating two-qubit operations on the vertical and horizontal qubit pairs respectively in this 4x4 array of qubits. They are now accelerating the pace of research targeted at implementing error correction to help achieve the early practical realization of quantum computers.

This research was supported by the Moonshot Research and Development Program of the Japan Science and Technology Agency (JST) (Grant No. JPMJMS2065). Also, the prototype qubit array was fabricated at the Interuniversity Microelectronics Centre (Imec)^{*2}.

*1. A technique for correcting errors that occur during quantum computation. This involves redundancy, whereby a single logical qubit is implemented using multiple actual qubits, with the additional qubits used to detect and identify errors.

*2. A research institute based in Belgium that hosts world-leading semiconductor research and development infrastructure.



[1] Prototype Qubit Array Chip (a), Charge Stability Diagrams for Vertical and Horizontal Two-qubit Coupling (b), and Two-qubit Operation on Horizontal Qubit Pair (c)

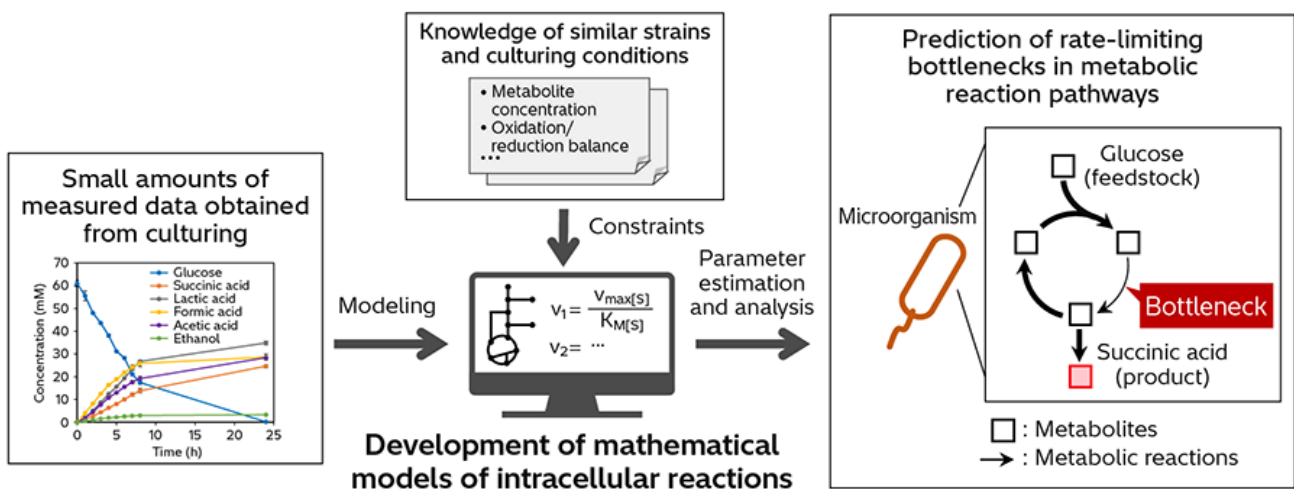
2. Cellular Metabolism Modeling for Practical Biomanufacturing

The goal of achieving a sustainable society calls for a transition to low-carbon and resource-recycling industries. Biomanufacturing, such as the use of microorganisms to produce chemical products from renewable feedstocks, has attracted attention as an effective option with a role to play in resource diversification and the decarbonization of the chemical industry. Essential to achieving this will be the use of synthetic biology for conferring function through the design of genes and metabolic pathways inside cells. Unfortunately, given the complex interactions between the vast array of intracellular metabolic reactions that take place inside a microorganism, designing for the efficient production of a target compound is no easy task. Existing practices rely on trial and error and involve a large amount of experimentation.

In partnership with the University of Osaka, Hitachi has proposed a technique for building mathematical models that can predict bottleneck reactions that influence how easily a substance can be produced, even when sufficient measurement data cannot be obtained*. This technique uses a kinetic model of metabolism that incorporates formulas to express the intracellular movement of substances, also utilizing quantitative data and empirical knowledge of culturing conditions and similar strains as constraints to improve the efficiency of formula parameter estimation and analysis. This enables the building of models with high accuracy even in the early stages of development and predicts which reaction steps will help to improve productivity.

When applied to succinic acid production in Escherichia coli (E. coli), it was demonstrated that use of the technique to boost rate-limiting steps succeeded in improving the production rate. In the future, Hitachi plans to further develop the technique and extend its application into other areas with the goal of expanding its industrial use to facilitate the practical realization of biomanufacturing.

* T. Takeya, et al., "Identification of the rate-limiting step in succinate-producing Escherichia coli strain by constructing kinetic models of metabolism using small amount of measured data," Proceedings of the 77th Annual Meeting of The Society for Biotechnology, Japan, p. 53 (2025.9) in Japanese.



[2] Development of Metabolic Kinetics Model from Small Quantities of Measurement Data

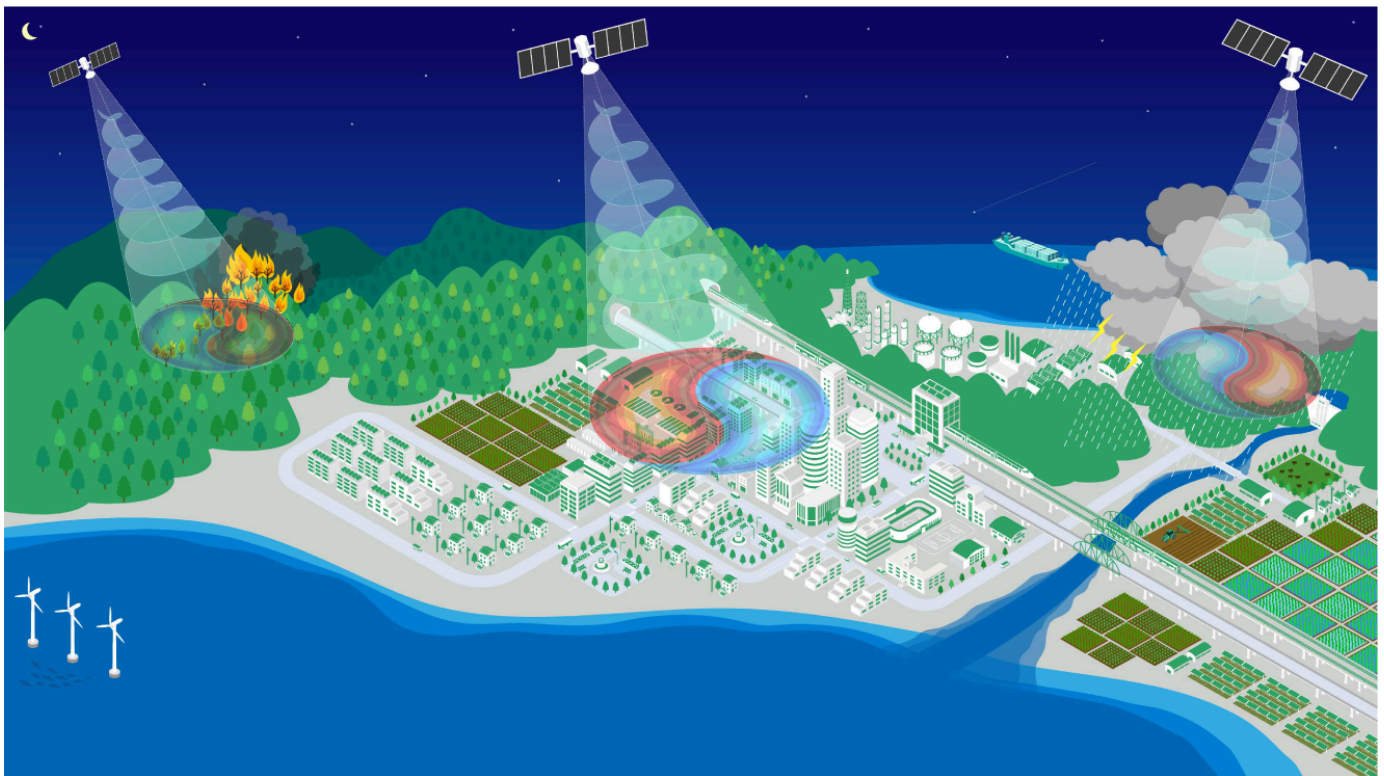
3. Advanced Remote Sensing Using Structured Radio Wave Technology

In recent years, responding to increasingly severe natural disasters and improving the efficiency of maintenance for widely dispersed social infrastructure have become urgent priorities. To address these societal challenges, Hitachi is developing "structured radio

wave" technology, which leverages the physical degrees of freedom of radio waves, such as wavefront structure, polarization, and phase.

A key feature of this technology is its ability to simultaneously acquire multivariable data—including an object's shape, material, and dynamics—through the tight control and analysis of radio waves. For proof of concept, Hitachi utilized sound waves, which share common wave properties with radio waves, to demonstrate the effectiveness of a transmission and reception method based on the superposition of vortex wavefronts carrying orbital angular momentum (OAM). This achievement is expected to enable the acquisition of critical information, such as infrastructure displacement and vessel movements, even under cloud cover or at night, thereby contributing to rapid and precise decision-making in the field.

Moving forward, Hitachi will further accelerate demonstration testing to promote social implementation in a wide range of fields, including satellite remote sensing, contributing to the realization of a sustainable, safe, and secure society.

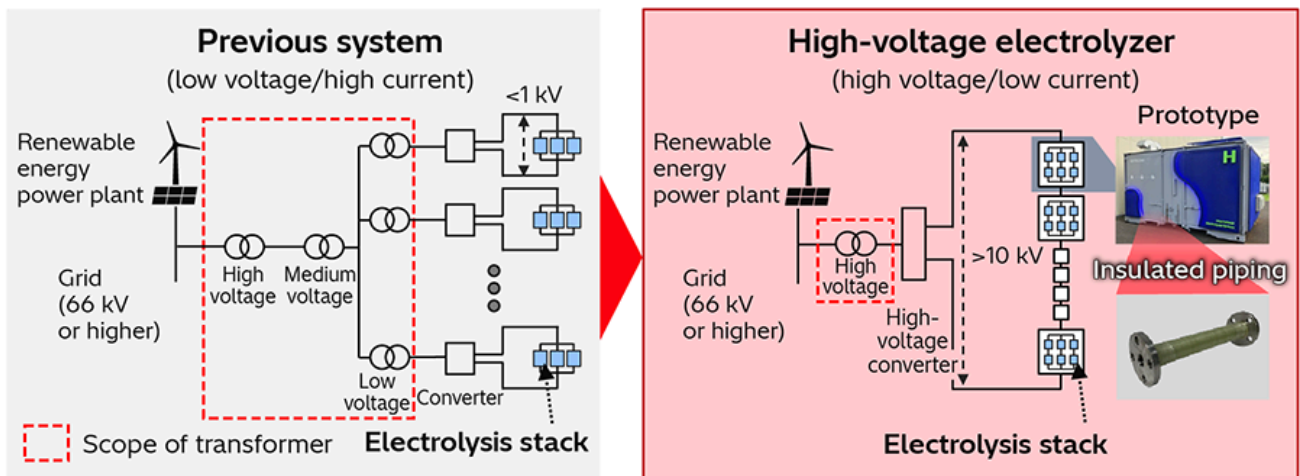


[3] Earth Observation Using Structured Radio Waves

4. Development of Medium- and High-voltage Electrolyzer for Better Use of Renewable Energy

Efforts toward decarbonization are accelerating worldwide to address the challenge of climate change and realize sustainable societies. Hydrogen has attracted growing attention as a next-generation green fuel for applications such as power generation, industrial processes, and transportation. In particular, expectations are high for the widespread adoption of green hydrogen produced using renewable energy.

Hitachi is developing a high-voltage electrolyzer system with a significantly reduced installation footprint. One of the main components of this system is insulated piping capable of safely transporting purified water, hydrogen, or oxygen even under high-voltage conditions. In this high-voltage-resistant piping, Hitachi adopts a proprietary composite material that enhances gas barrier performance and improves resistance to high voltage, heat, and corrosion. Its performance has been validated through trials using a prototype under actual operating conditions. By reducing the need for conventionally essential components such as transformers used to step down high-voltage grid power to lower voltages, it is anticipated that this technology will reduce the installation footprint of the new electrolyzer by up to 50%. In addition to the development and validation of large systems with megawatt-class or higher capacities, Hitachi aims to leverage the electric power control performance of high-voltage converters to progressively incorporate supply-demand functions. Through these efforts, Hitachi seeks to support both large-scale hydrogen supply and the further integration of renewable energy.



[4] Block Diagram of Newly Developed System and Photographs of Prototype and Insulated Piping

注：本記事は、2026年2月26日に掲載したものである。

5. Use of Digital Observatory for Innovation in Risk Management

With the world having been confronted with a variety of threats over recent years, including climate change and geopolitical risk, strengthening the resilience of social and economic activity is more essential than ever.

The Research & Development Group at Hitachi is developing a deep insight inferring technology that can identify the location of manufacturing sites anywhere with high accuracy by using generative artificial intelligence (AI) to analyze open data on companies. In joint research undertaken at the Digital Observatory established in partnership with the University of Tokyo, it is also working on a technique for analyzing news from around the world that relates to risks or regulation with the aim of preemptively identifying a wide variety of potential supply chain risks, not the least of which are changes in tariffs. On top of this, development is also progressing on an “opportunity seeking” technique that uses AI-driven domain analysis to go beyond merely assisting with avoiding the risks highlighted by the warning signs and instead also helps to uncover new business opportunities.

Future plans involve trialing these techniques at Hitachi and farther afield to build supply chains that can be resilient to change even in societies beset by uncertainty and to contribute to sustainable economic development.

Deep insights inference

Risk-related news

Identification of manufacturing sites

Power Plant Candidate Finder

Use this interface to find power plant investment opportunities.

Analysis Parameters

Select the IED model: 2014-2015

Enter the key word: 炭素

Define # Candidates: 20

Min Capacity (MW): 0

Max Capacity (MW): 200

Find Candidates

Stop Process

Candidate Data

Plant name	Country	Capacity (MW)	Year
1. Amurung power station	Indonesia	1,000	2015
2. Anshun power station	China	1,000	2015
3. Bangsha Bay power station	PT PLN (Persero) Bangladesh	2,070	205,1496
4. Bhangyang Power Station	PT PLN (Persero)	9,830	208,2737
5. Kandiun 2 power station	State Power Grid Corporation of China	4,051.9	122,0304
6. Madaya Steel Mill power station	PT Garuda Nusantara Steel	3,047.6	98,0304
7. Na Dong power station	State Power Grid Corporation of China	21,496.6	208,9708
8. Nanyang Industrial Park power station	PT Sarika Nusantara Indonesia	9,512.8	204,8305
9. Nanyang Industrial Park power station	PT Sarika Nusantara Indonesia	9,512.1	204,8305

Filters explanation

The filtering process involved the selection of candidates based on the combination of the selected filters and the characteristics of the candidates.

- Total Capacity (MW) Filter:** This filter is specified by the user. It focuses on smaller facilities characteristics compared to larger plants.
- Average Emission Factor Filter:** This filter was applied with the intention of raising the emission factor threshold. The reason behind this adjustment is to increase the number of candidate facilities, while still concentrating on those that are more polluting. By setting a minimum average emission factor, the process aims to identify plants that have higher emissions per unit of electricity generated, thus prioritizing them for potential interventions or improvements.

Detection of potential tariff risks

No. of news items about regulation

Tariffs news sorted by country

Tariff proclamation

Preparation of regulations such as IEEPA

Opportunity seeking

AI-driven domain analysis

Proposed measures

Explanation of reasons

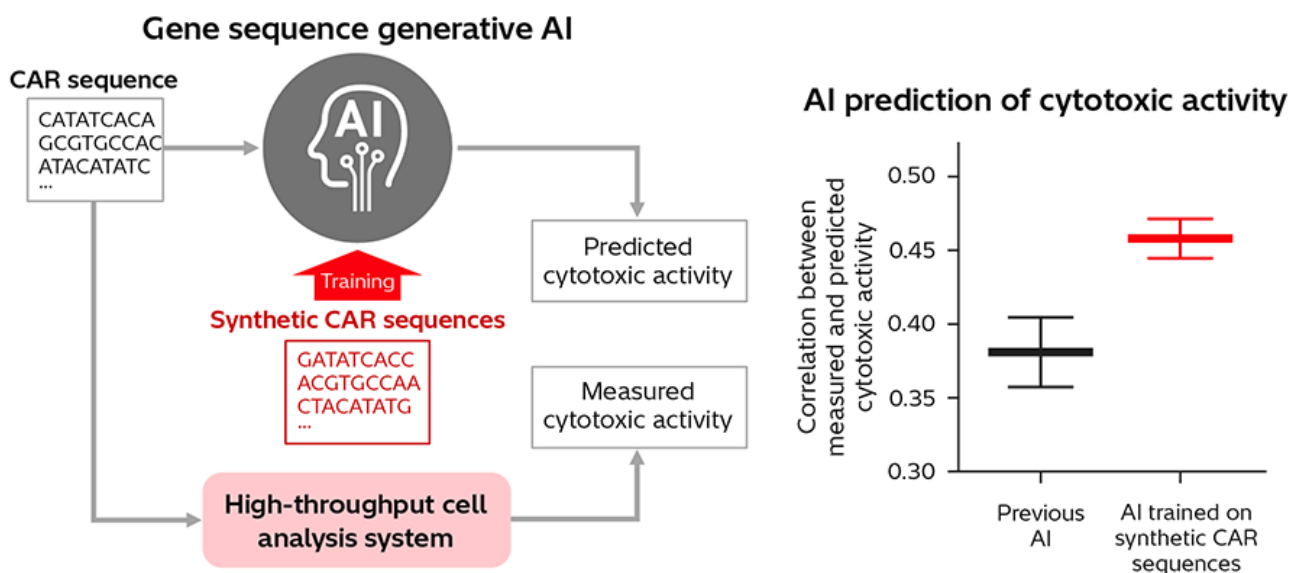
[5] Risk Prediction and Opportunity Identification for Global Markets

6. Evolution of Gene Sequence Generative AI on DesignCell Development Platform

The therapeutic use of chimeric antigen receptor (CAR) -T cells involves the introduction of CAR genes into immune cells. The benefits of this CAR-T cell therapy derive from using CAR-T cells to selectively attack the tumor and other cells involved in disease. While this offers the prospect of highly effective treatments, the high cost of treatment and the limited number of patients eligible for the therapy remain a problem.

To accelerate research into CAR-T cell therapy, Hitachi Kobe Laboratory has built a DesignCell development platform that combines gene sequence generative AI with a high-throughput cell analysis system. By training the AI on synthetic sequences similar to CAR, they have also achieved more accurate prediction of cytotoxic activity (how well CAR-T cells perform at attacking cancer cells in vitro). Details of this work have been posted on the bioRxiv preprint repository for the biological sciences*.

* [K. Yoshida, et al., "Enhancing CAR-T cell activity prediction via fine-tuning protein language models with generated CAR sequences," bioRxiv \(2025.4\),](#) [↗](#)



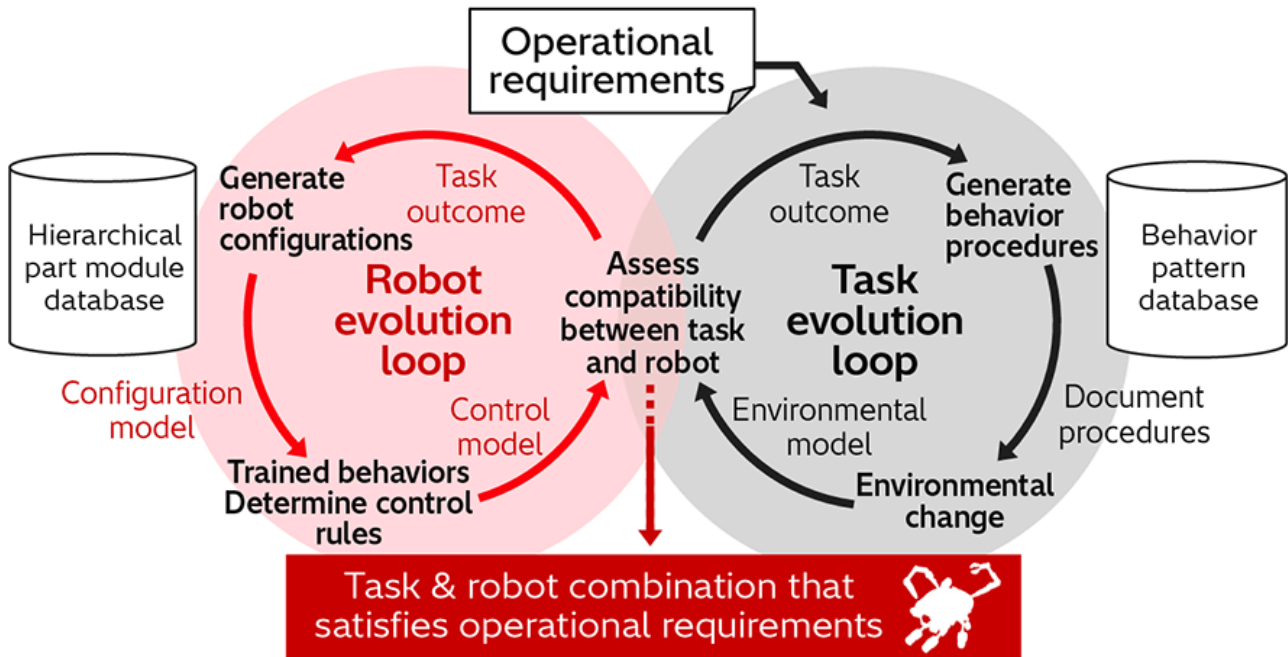
[6] Performance Improvement in Gene Sequence Generative AI

7. AI-invented Robotics Solution for Operational Innovation

Resolving a mix of different societal challenges simultaneously, such as increasing the supply of electricity, resources, and food while reducing the load on the environment, will require dramatic productivity improvements in conventional activities like infrastructure maintenance, construction, and agriculture and the extension of productive activity to unexploited locations such as deserts or space. To help achieve this, Hitachi is developing AI techniques for creating operational practices and robots capable of performing them that transcend human imagination.

This technique starts by linking a variety of robot parts to the actions they are capable of performing. Based on this information, the AI generates a comprehensive list of candidate operations that can partially satisfy the specified task requirements and then couples these together randomly. Then, by combining the parts linked to each of the candidate operations, the technique is able to generate ideas for novel robots that defy human common sense. A trial run assigned the task of maintaining equipment installed on top of power poles demonstrated that the AI could come up with ideas such as a drone equipped with an arm that operates from a platform attached to the top of the power pole or an arm that climbs up and down power poles using a wheeled clamp mechanism.

In addition to improving the generality of the functions for AI invention, other plans include automating entire sequences of operation by using the technique in tandem with the Integrated World Infrastructure Model (IWIM). With early commercialization in mind, Hitachi is also identifying use cases and verifying the value that the technique delivers.

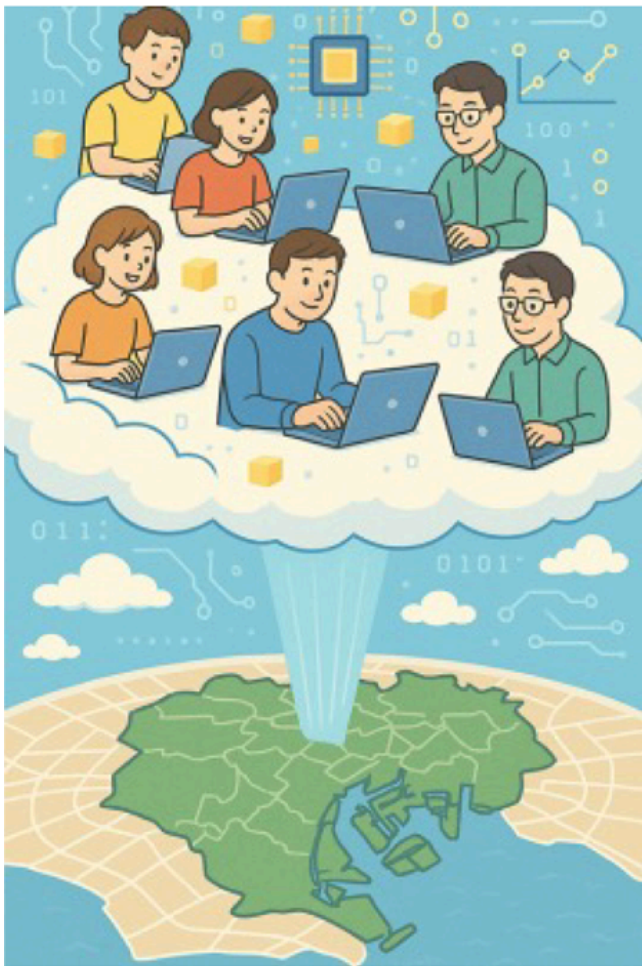


[7] Architecture for AI Invention of Operational Practices and Robots

8. Work by Hitachi-UTokyo Laboratory to Achieve Society 5.0

Hitachi-UTokyo Laboratory is engaged in an urban transformation project for achieving a smart society as envisaged by Society 5.0. At an industry-academia collaborative creation forum held in October 2025, it presented its Tokyo 24th Ward Concept for smart cities in a digitalized virtual space. Other topics covered in the presentation included its work on applying social psychology to well-being and the use of AI for the automatic generation of urban planning proposals based on district needs.

In its energy project, the laboratory conducted a web survey aimed at highlighting progress and challenges in the transition by Japanese municipal governments to decarbonization and sustainability, receiving a 67% response rate from local governments. The results indicated that, while municipalities are making some progress in their efforts to achieve decarbonization, they suffer from a severe lack of human and financial resources and are struggling to gain the support and buy-in of residents. The Hitachi-UTokyo Laboratory has produced a report on the need to establish governance practices to help overcome these challenges.



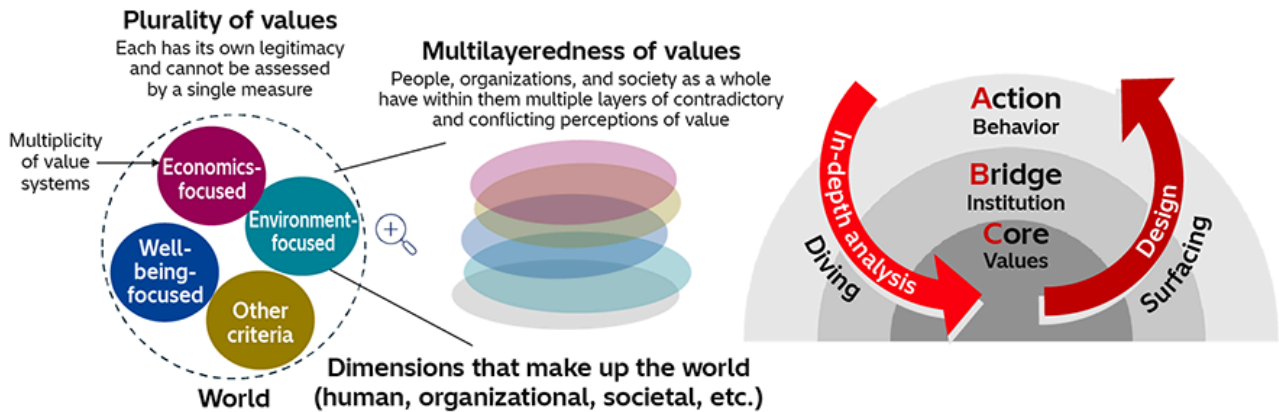
[8] Tokyo 24th Ward Concept (left) and Report on Transition in Japanese Municipal Governments (right)

9. Use of Philosophy in Social Development and Multilayered Society of Values

While the idea that science, technology, and economic growth foster well-being is widely accepted, in these times of conflict and other ongoing societal problems there is a need, now more than ever, to re-evaluate what we mean by value. This is true not only at the national level, but also in regard to the use of AI, robotics, and other innovative technologies to introduce new services to communities, with differences in opinion emerging about matters such as safety concerns and the technology's environmental and psychological impacts.

The Kyoto Institute of Philosophy has proposed the idea of a future “multilayered society of values” and is taking public action to bring it about. There is no unique answer regarding the directions that value takes and it can be said that for people and society to have different orientations is important in its own right. To achieve this, the Kyoto Institute of Philosophy offers a philosophical model and conceptual framework.

In its pursuit of innovation, Hitachi references and utilizes this philosophical model and conceptual framework in cases where the design and deployment of innovative technologies and services could pose value-related issues. It is confident that this initiative will help bring about a cooperative and harmonized society in which people coexist without conflict.



[9] New Perceptions of Value Based on its Multi-dimensional and Multi-layered Characteristics

Note: This image is a modified version of one prepared by the Kyoto Institute of Philosophy.

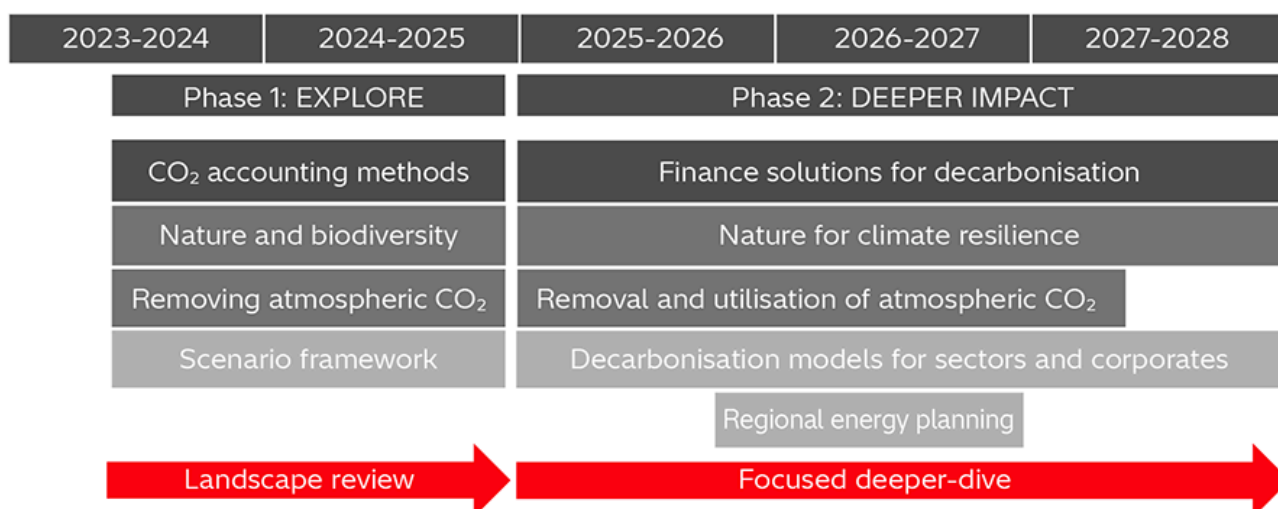
10. Research and Development for Solving Global Environmental and Societal Challenges

The Hitachi 'Centre for Decarbonization and Natural Climate Solutions,' a collaboration with Imperial College London, undertakes exploratory research in critical long-term global challenges.

The centre completed its first phase of research in 2024 and provided initial insights into reaching net zero CO₂ emissions and beyond. These insights were published and presented publicly in May 2025 at an event attended by UK Government and Industry. The results indicated a range of viable pathways to net zero, and that nature plays an important role in storing atmospheric CO₂ and in protecting society against climate impacts, such as flooding. It also showed that a range of different technologies will be required to remove CO₂ from the atmosphere.

The next phase of the research, using insights from phase one, applies a deeper industry focus so that insights can be utilized by Hitachi for identifying opportunities in

technology development, engaging with policy-makers and raising the profile of Hitachi as a global leader in sustainability.



[10] ICL's Research Plan for Reducing Greenhouse Gas Emissions and Minimizing the Impacts of Climate Change on Nature and Society

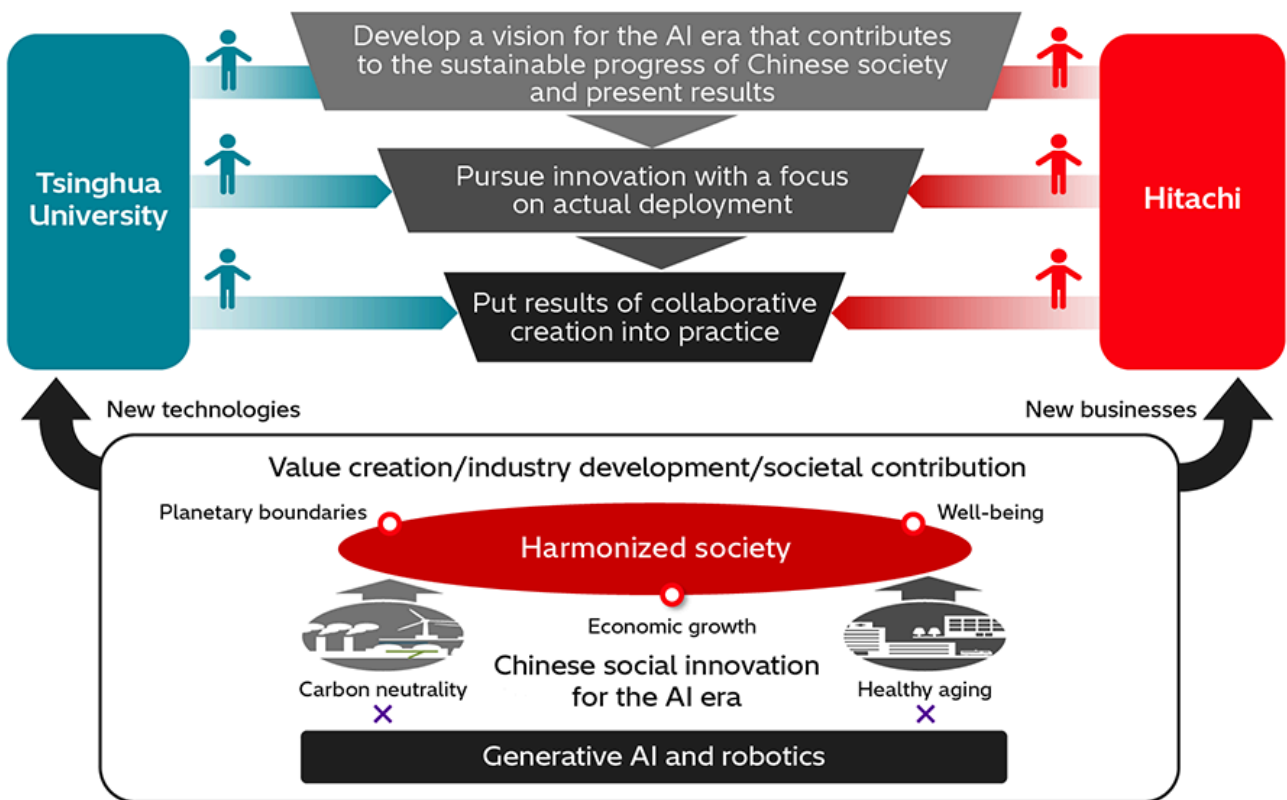
11. Collaborative Creation with Tsinghua University on Chinese Social Innovation for the AI Era

The Future-oriented Collaborative Innovation Scheme between Tsinghua University and Hitachi is a collaborative creation project with academia that has been running since 2019. Its goal is to produce innovations to address the challenges facing future Chinese society.

In 2025, the scheme commenced its third and latest round of activities for contributing to the sustainable progress of Chinese society (for 2025 to 2027) with the goal of generating Chinese social innovation for the AI era and implementing its innovations in practice. Work will focus on carbon neutrality and healthy aging, two key issues to be addressed in achieving a harmonized society that balances planetary boundaries, well-being, and economic growth. It will involve creating a future vision through the use of generative AI and robotics to come up with innovations, the development of advanced technology, and work on assessing its value and putting it to practical use.

In the future, Hitachi will work with partners such as regional government agencies and researchers from Tsinghua University who are at the forefront of their fields to resolve

challenges that are specific to China and will present these research findings to the Chinese public and global community.



[11] Overall Concept behind Chinese Social Innovation for the AI Era