

Research and Development/Intellectual Property

Message from the Director in Charge of Research and Development/Intellectual Property

We are committed to developing innovative next-generation batteries from a long-term perspective, guided by our Vision 2035 roadmap for research and development. The development of all-solid-state batteries has successfully passed the intermediate stage gate in NEDO's Green Innovation Fund Project: Next-Generation Storage Battery Development Project, and its continuation has been officially decided. We are currently conducting performance evaluations on small cells while also initiating the introduction of new equipment to develop larger-capacity cell prototypes. In the area of sulfur cathode batteries, we are persistently continuing to develop underlying technologies in order to overcome the remaining challenges and realize our goal of creating ultra-lightweight batteries. For silicon-based anode batteries, we are developing reliable solutions to prevent performance degradation that accompanies charging and discharging. Furthermore, without being limited to batteries, we have begun developing technologies that contribute to reducing carbon dioxide emissions through research and development that applies our expertise in electrochemistry.

On the other hand, we recognize that achieving Vision 2035 requires not only technological advances but also an increase in corporate value that comes by strengthening intellectual capital. While continuing to strengthen our existing business domains, we will also leverage technologies developed through research and development to explore new fields—not only by securing intellectual property rights but also by adapting them to meet the needs of other companies, thereby building assets in the process. We aim to contribute to our business in a tangible way by ensuring that we build up a network of patents in key technological areas that we are working on in research and development, and by actively utilizing those intellectual property rights.

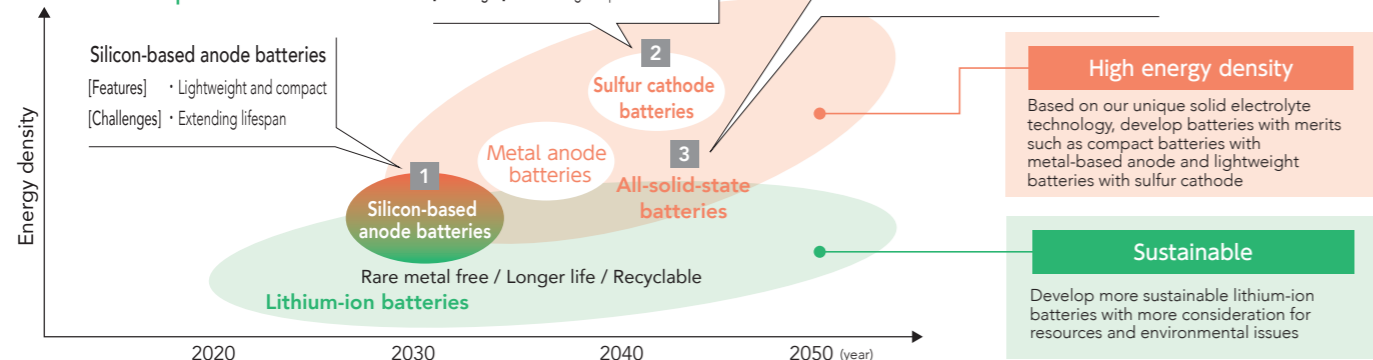


Koichi Nishiyama

Director;
In charge of research and development, intellectual property, and lithium-ion battery development;
Head of the R&D Center,
GS Yuasa International Ltd.

Research and Development

Roadmap for research and development



Main initiatives and achievements in next-generation battery development

1 Silicon-based anode batteries

Developed technologies that combine high energy density and long life performance, and demonstrated an energy density of 400 Wh/kg, which exceeds that of conventional lithium-ion batteries.



2 Sulfur cathode batteries

In NEDO's Advanced Aircraft System Commercialization Project, we successfully demonstrated a mass energy density of 500 Wh/kg (more than twice that of current lithium-ion batteries).



3 All-solid-state batteries

- Improved sulfide solid electrolytes, a key material for practical application
- Developed nitrogen-containing sulfide solid electrolytes with high ion conductivity and excellent water resistance
- Conducting joint research with Osaka Metropolitan University on NEDO's "Green Innovation Fund Project/Next-generation Storage Battery and Motor Development" (Selected topic title: "Advanced Solid State Battery Development")

Surrounding environment

- EV growth is sluggish and the trend indicating slowing down is remarkable, with HEVs and PHEVs regaining attention
- Large-scale ESS cells are becoming more prevalent, particularly among Chinese and South Korean manufacturers
- Increasingly rapid progress toward the practical application of all-solid-state batteries
- Advancement of semi-solid batteries, new types of batteries (NIB), etc.

Our response

- Support development for existing businesses and BEVs, while accelerating the development of new battery chemicals and structures
- Promote the development of underlying technologies that will serve as the basis for new businesses other than batteries
- Strengthen advanced development and competitive analysis for next-generation industrial batteries
- Enhance the optimal allocation and training of engineers, while promoting measures to secure human resources

Changes in research and development system

On April 1, 2025, the LIB Technical Center was integrated into the R&D Center in order to streamline development operations and strengthen capabilities for developing next-generation batteries. Until now, research and development had been conducted in two departments: the R&D Center and the LIB Technical Center. In anticipation of the ever increasing importance of storage batteries in solving social issues, we will integrate the LIB Technical Center into the R&D Center to accelerate existing research and development, while also establishing a system to efficiently advance mid-to-long term research and development topics with continuity.

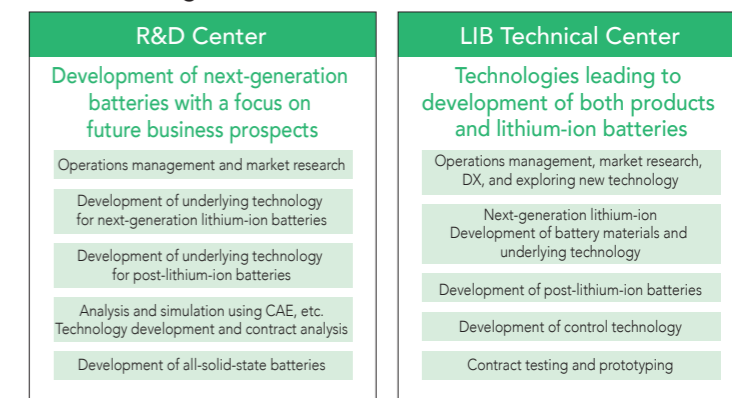
In addition, we will establish a new department specializing in carbon-neutral technology development and promote the development of separation and recovery technologies that contribute to CO2 reduction, as well as recycling technologies for lithium-ion batteries, which are essential for reusing resources and protecting the environment. We will apply this research and development to create new business that lead to the creation of new corporate value.

By integrating departments, we will strengthen our cost management system through redeployment of human resources and streamline non-R&D operations using IT technology by consolidating knowledge, thereby strengthening the overall management system for research and development operations.

See here for details

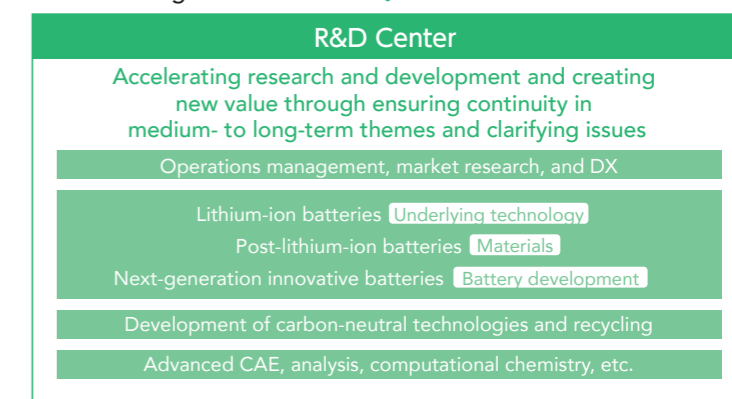
▶ <https://newsroom.gs-yuasa.com/news-release/319> (in Japanese)

Before changes



Integration

After changes



Research and development in segments

FY2024 R&D topics

Automotive batteries (Japan)	<ul style="list-style-type: none"> Promoted the development of auxiliary batteries for HEVs and BEVs In the EN battery series for the replacement market, we sold batteries with reduced burden of refill maintenance and improved durability 	<ul style="list-style-type: none"> Launched production line for new cell modules for HEVs Started mass production of LEV65, a new battery for PHEVs with an energy density 40% higher than conventional batteries Promoted the development of auxiliary batteries for BEVs that offer superior low-temperature output properties and improved service life characteristics using 12 V lithium-ion batteries Passed NEDO's interim review stage gate for the development of all-solid-state batteries in 2024
Automotive batteries (Overseas)	<ul style="list-style-type: none"> Developed VRLA (AGM)* batteries with the Turkish site Developed auxiliary batteries suitable for Chinese-made BEVs in Southeast Asian countries, with a focus on Thailand Released batteries with reduced burden of refill maintenance and improved durability, both of which are achieved through technology development with EN batteries for replacement In India, developed control valve lead-acid batteries for hybrid vehicles in addition to those for vehicles with start-stop systems (ISS vehicles) 	<ul style="list-style-type: none"> Succeeded in demonstrating a cell with a mass energy density of 500 Wh/kg in the research and development of lightweight lithium-sulfur batteries in the advanced aircraft system commercialization project Promoted the development of new membrane products in the membrane field
Industrial batteries and power supplies	<ul style="list-style-type: none"> With a focus on miniaturization and high efficiency, we developed circuit technology for power converters with 99% conversion efficiency as well as control technology through joint research with electric power companies Promoted the development of products suitable for market needs of products for forklifts at the sites in Thailand and Turkey Completed the development of the PCS-integrated energy storage system "Lineback Mega Grid" and shipping has begun 	

* Valve-regulated lead-acid batteries

Research and Development/Intellectual Property

Intellectual Property

The intellectual property division is working to achieve Vision 2035 based on a policy of ensuring the growth of existing businesses as well as new fields by using intellectual property rights and acquiring and capitalizing on intellectual property rights that other companies need from the perspectives of both Mono (products) and Koto (services) and is engaged in intellectual property activities. In FY2025, the final year of the Sixth Mid-Term Management Plan, we will conduct detailed analyses of key technologies that we have identified to date and newly emerging key technologies in order to acquire rights and build a patent network that prevents other companies from entering the market with these technologies. We are also making efforts to secure our rights by exercising our patent rights as necessary against third parties who infringe our rights.

Intellectual property strategy

<Main initiatives>

1 Disseminate intellectual property analysis information useful for business decisions in a timely manner

Until now, we have reported to management on the overall patent score of the Company and conducted macro analysis. From FY2024, we have taken a step further by analyzing the patents of our own and other companies on key development themes in collaboration with the development division, and are proceeding with the review and implementation of measures such as making an inventory of patents possessed, identifying risks in advance, selecting priority areas, and leveraging promising patents.

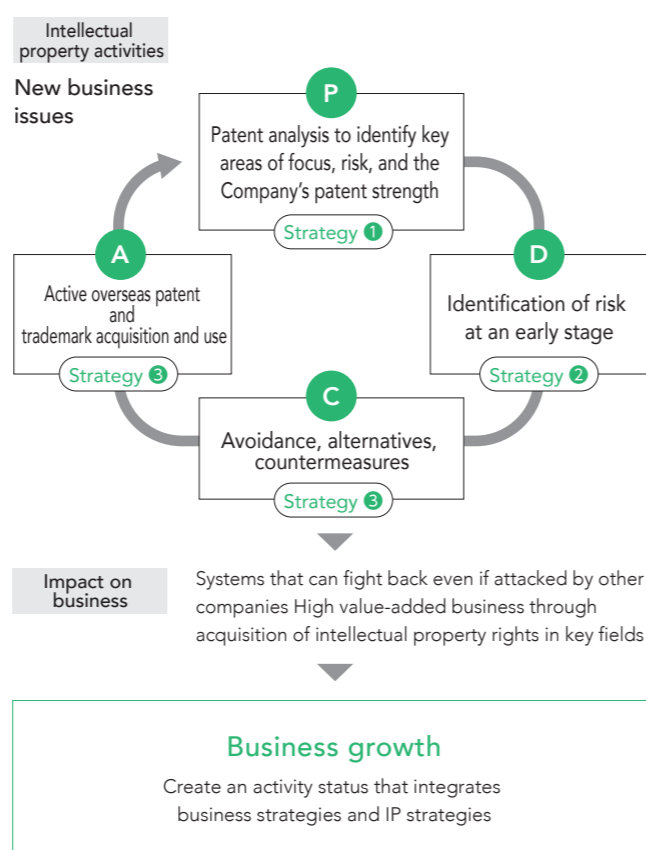
2 Building a patent network for key themes contributing to BEVs and lithium-ion battery businesses

Using the rights acquisition process reform methods we have refined over the years, we identify technologies that can significantly influence future business as key technologies and take special measures to protect them. Not like activities for normal patent applications, we will not only consider filing a defensive application of the company's own technology but also create patents that are difficult for other companies to avoid, thereby building a strong patent network.

3 Acquisition of patent rights in new business fields

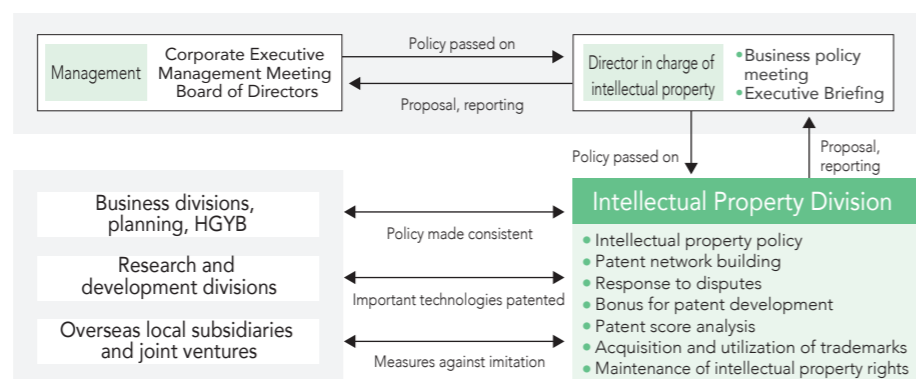
We have been engaged in measures to identify patents related to the provision of Koto at an early stage before providing solutions and services toward achieving Vision 2035. Patents related to Koto-zukuri (service creation) now account for 20% of our total patent applications, which will lead to the creation of patent assets that will be necessary for collaborating with other companies in the future.

Image of the Group's intellectual property activities



Intellectual property systems

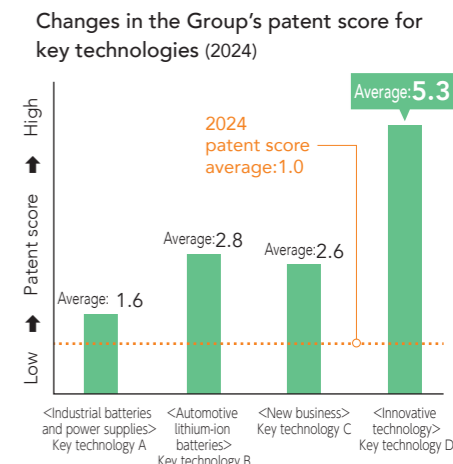
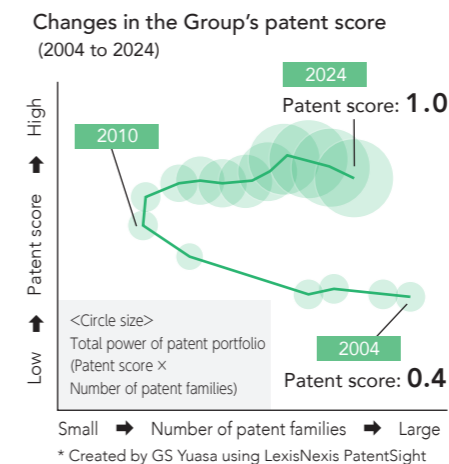
The intellectual property division is positioned as an administrative department at headquarters. The department is responsible for application and management of patents and trademarks of the entire GS Yuasa Group, plans various measures related to intellectual properties to increase added value of business, and is pushing hard to realize them in cooperation with relevant divisions.



GS Yuasa's strengths in intellectual property activities

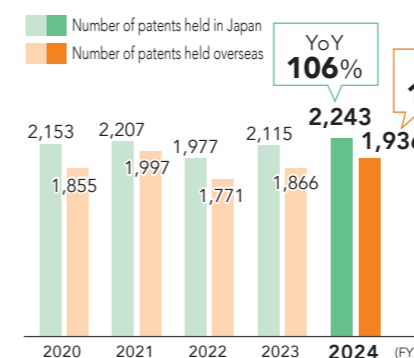
1 Patent score

The patent score represents the results of intellectual property creation activities to date, and has grown significantly compared to that at the time of the corporate merger in 2004. In addition, the patent score for key technologies has remained higher than that for other technologies.



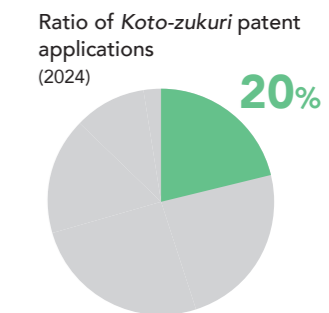
2 Number of patents held

The number of patents has been increasing year by year, but at the same time, due to abandonment of unnecessary patents through inventory, it has resulted in a slight increase in the total number.



3 Ratio of Koto-zukuri patent applications

Patents related to Koto-zukuri are mainly coming from the Industrial Batteries and Power Supplies Business Unit, which is working to create new businesses. Inventions are also coming from the Automotive Batteries Business Unit and affiliated companies. In FY2024, the ratio of in-house applications for patents related to Koto-zukuri reached 20%.



Communication with management

At the beginning of each fiscal year, we hold a business policy meeting to discuss activity policies with management as well as Executive Briefings twice a year to report on these policies, new issues, and the status of disputes. In addition, we participate in Corporate Executive Management Meetings, etc. as necessary.

Themes at an Executive Briefing (partial list)

- Report on patent scores, patent analysis of competitors
- Trademark infringement countermeasures in China, ASEAN, and Hong Kong
- Countermeasures against non-practicing entities (NPEs) in the U.S.

TOPICS

Examples of initiatives in intellectual property

- Cancellation of unfair trade names -

In Hong Kong, we filed a lawsuit demanding a change of trade name against a company that was using a name that sounded like one of our affiliates (Nippon Yuasa Group (China) Co., Ltd.), and we successfully had the trade name canceled.

