

# Research and Development: Initiatives for Next-Generation Batteries

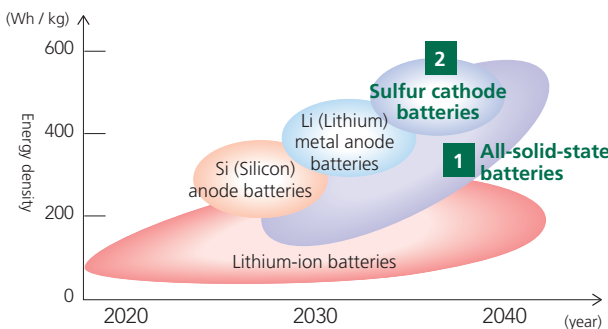
GS Yuasa has been among the first to promote research and development of lithium-ion batteries. We started mass production of prismatic lithium-ion batteries in the 1990s, and in 2008 became the first company in the world to supply lithium-ion batteries to mass-produced EVs. Since then, many automakers have adopted our automotive lithium-ion batteries. We aim to continue to contribute to the achievement of carbon neutrality through the development of next-generation battery technologies for a wide-range of applications including for electric vehicles.

## Current issues regarding lithium-ion batteries

Resource depletion	Lifespan	Energy density	Safety
Since rare metals such as cobalt and lithium are used as raw materials, there is a possibility that supply shortages will occur if electrification advances and demand rises sharply in the future.	Compared to lead-acid batteries, lithium-ion batteries have a longer life, but there is a need to further extend the lifespan of batteries.	Lithium-ion batteries are characterized by high energy density, but further improvement in energy density is necessary to extend the mileage of EVs.	Since the electrolytes used in current lithium-ion batteries are flammable, flame-retardant or non-combustible electrolytes are being sought.

## GS Yuasa's initiatives

### Road map for the development of next-generation batteries



### Research and development system

In order to achieve the early practical application of next-generation batteries such as all-solid-state batteries, we have established a specialized division at the R&D Center and are engaged in our own research and development.

Further, by becoming a member of the Consortium for Lithium-Ion Battery Technology and Evaluation Center (LIBTEC) and participating in projects commissioned by the New Energy and Industrial Technology Development Organization (NEDO), we are conducting basic research on all-solid-state batteries, which are expected to be next-generation batteries, in collaboration with Japanese automakers, parts manufacturers, and battery manufacturers.

#### 1 All-solid-state batteries

As part of our own research, we have improved the sulfide solid electrolyte, which is the key material for the commercialization of all-solid-state batteries, and have newly developed a nitrogen-containing sulfide solid electrolyte that combines high ionic conductivity with excellent water-resistance.

##### Point 1

Improved ionic conductivity enables high input / output and one can expect reduced charging time.

##### Point 2

Improved water-resistance can be expected to lead to improved safety during manufacturing and in case of failure.



It is necessary to reduce the interface resistance between the solid electrolyte and the active material to prevent capacity loss.

Please scan QR code for further details



#### 2 Sulfur cathode battery

In NEDO's Advanced Aircraft System Commercialization Project, we have achieved success in demonstration of 400Wh / kg-class lithium-sulfur battery.



##### Point 1

High energy density can be expected as sulfur has a high theoretical capacity.

##### Point 2

Sulfur is an abundant resource, and supply chain problems can be expected to be resolved.



Performance improvements in charge / discharge cycle lifetime among other things, are necessary.

Please scan QR code for further details



## In Focus

### Selected for Participation in NEDO Green Innovation Fund's Next-Generation Storage Battery Development Project —Accelerating development of all-solid-state battery utilizing proprietary high-performance solid electrolytes—

On April 19, 2022, our proposal for developing all-solid-state battery technologies was selected for the NEDO Green Innovation Fund's Next-Generation Storage Battery project. \* Funding from the Green Innovation Fund will help to accelerate the development and commercialization of all-solid-state batteries, which we have been working on.

#### Outline of the project

<b>Purpose</b>	Development of high-performance storage batteries such as all-solid-state batteries and battery materials
<b>Target</b>	The energy density that affects the cruising range, among other things, is more than twice the current (700-800Wh / L or more)

#### GS Yuasa's development targets for the project

- 1 Development of a solid electrolyte that combines high ionic conductivity with excellent water resistance
- 2 Development of high-capacity positive electrodes with low cobalt content
- 3 Development of negative electrodes with high capacity and long-life performance
- 4 Development of cell design and manufacturing processes that facilitate mass production

Please scan QR code for further details



NEDO news release



\* The Green Innovation Fund was established by NEDO (the New Energy and Industrial Technology Development Organization) to play a central role in Japan's efforts to achieve carbon neutrality. The aim of the fund is to provide long-term ongoing support for green innovation projects implemented by corporations, from the R&D and verification testing stages through to practical application, on the way to the achievement by Japan's public and private sectors of concrete and ambitious shared goals.