

September 2022

Renesas Electronics Corporation

Green Bond Report 2022

RENESAS
BIG IDEAS FOR EVERY SPACE



CONTENTS

- GREEN BOND OVERVIEW 2
- 1 ALLOCATION REPORTING 3
- 2 IMPACT REPORTING 4

GREEN BOND OVERVIEW

- On November 26, 2021, Renesas Electronics Corporation (“Renesas”) issued its first green bond
 - USD 500,000,000 1.543% Notes due November 26, 2024 (ISIN USJ4881VAA55 / US75972BAA98)
 - The Green Bond was issued under Renesas’ Green Bond Framework (“Framework”), which is available on its corporate website
 - The Framework is aligned with the International Capital Markets Association (ICMA) Green Bond Principles 2021, with a second-party opinion provided by Sustainalytics
- As of September 2022, 100% of the net proceeds of the Green Bond have been allocated to Eligible Green Projects defined in the Framework
 - In the Green Bond Report 2022, Renesas reports the environmental impacts of the projects funded with the Green Bond proceeds to the extent feasible
- Sustainalytics has provided verification on the Green Bond Report 2022

1 ALLOCATION REPORTING

USE OF PROCEEDS FOR ELIGIBLE GREEN PROJECTS

(as of September, 2022)

Eligible Green Projects	Amount (in millions) USD
Clean Transportation	317
Smart Electric Vehicles Solutions	34
Smart Autonomous Drive Solutions	283
Energy Efficiency	183
Smart Data Center Solutions	53
Smart Cellular Solutions	11
Smart Society Solutions	96
Renesas's Green Devices and Technology	23
Renewable Energy/	
Sustainable water and waste water management	0
Projects related to alleviating environmental impacts through our business activities	0
Total	500
Unallocated funds	0

Status as of September, 2022

Percentage of net proceeds of Green Bond allocated to Eligible Green Project	100%
Percentage of net proceeds of Green Bond allocated to Existing Eligible Green Project	100%

Green Funding	Amount (in millions) USD
USD 500,000,000 1.543% Notes due November 26, 2024	500

2 IMPACT REPORTING

At Renesas, we aspire to be the world's leading semiconductor company, developing sustainable products and solutions that benefit all humankind. Through provision of our products and solutions, we aim to achieve high energy efficiency and robust safety and security in various end applications, ultimately contributing to a greener society. The proceeds raised from the green bond will help us achieve this goal, by investing in research and development (R&D) activities aimed at providing positive environmental impacts.

At Renesas, we provide devices and solutions that contribute to making our customers' electronic equipment and systems energy efficient. Our products include devices that offer extremely low power consumption themselves and devices that contribute to enhancing the energy efficiency of customer systems through adoption of such devices.

In addition to making contributions through the development of sustainable products and solutions, Renesas also makes efforts to reduce negative impacts made through our own business activities.

1. Smart Electronic Vehicle Solutions

xEVs are becoming increasingly popular with more restrictions being placed on vehicle CO2 emissions, as a measure to deal with global warming and achieving a "sustainable society" that is environmentally friendly, safe and easy to live on. EVs and PHEVs can reduce GHG (Green House Gas) emission compared to traditional gasoline/diesel cars, and Renesas offers a wide range of solutions and evaluation kits to help accelerate xEV advancements with better power efficiency.

Renesas offers solutions and evaluation kits, more specifically semiconductors such as MCU, analog, and power semiconductors that is used to manufacture and run xEVs. Our xEV Inverter Reference Solutions, which converts DC power to AC power and maximizes PHEV/EV motor performance, offers superior power efficiency and 99% maximum inverter efficiency ⁽¹⁾.

On November 9, 2021, Renesas announced a new group of MCUs, the RH850/U2B MCUs, built for the rigorous workloads required by vehicle motion in terms of hybrid ICE and xEV traction inverter, as well as high-end zone control, connected gateway, and domain control applications ⁽²⁾. Renesas' internal data has shown that the MCUs used for controlling Battery Management Systems (BMS) such as the RH850, achieves 60-65% reduction in power consumption compared to competitor products. Another example of our energy-efficient solutions is the IGBT technology that reduces switching loss from AE3 to AE5 by 20% and conductive loss by 10%, reducing overall system level loss by 15% ⁽³⁾.

On June 2, 2022, Renesas introduced an AUTOSAR-compliant complex device driver (CDD) software module for designers of automotive battery management systems (BMS) in electric vehicles (EVs)⁽⁴⁾. The new software pairs with Renesas' industry-leading ISL78714 Li-Ion battery management IC optimize performance of next-generation systems to maximize range, save electric power consumption, and extend battery life.

(1) <https://www.renesas.com/jp/en/application/winning-combinations-automotive/xev-inverter-reference-solution>

(2) <https://www.renesas.com/jp/en/about/press-room/renesas-expands-lineup-28nm-cross-domain-automotive-control-microcontrollers>

(3) <https://www.renesas.com/jp/en/blogs/worlds-best-performance-igbt-product-responds-energy-saving-and-high-performance-xev-electric>

(4) <https://www.renesas.com/jp/en/about/press-room/renesas-introduces-complex-device-driver-software-ease-development-battery-management-systems>

2. Smart Autonomous Drive Solutions

Autonomous driving or “AD”, and Advanced driver assistance system “ADAS”, is the future of vehicle transportation, and is predicted to dynamically change the automobile market. In addition to enhancement of safety, AD and ADAS also contributes to reduction of energy consumption and CO2 emission as a tool for promoting eco-driving, by assisting the driver in moving the car more efficiently, optimizing the use of engine and battery power ⁽¹⁾⁽²⁾.

Renesas' processor line acts as a platform for safe cognitive computing, contributing to sensing and decision-making, as well as body control and infotainment towards level 3 and 4 autonomous driving. In addition to such processors and sensors, Renesas offers a variety of energy efficient solutions such as the radar MMIC, which reduces power consumption by 67% compared to current SiGe processes, and by 40% compared to larger scale RFCMOS processes according to in-house research.

On February 17, 2021, Renesas announced the development of processor technologies for automotive SoCs used in autonomous driving and ADAS that aims to optimize both performance and power efficiency. The newly developed technology used in the new SoC, the high-performance CNN hardware accelerator, achieves best-in-class power efficiency of 13.8 TOPS/W ⁽³⁾. Later on March 30, 2021, Renesas also announced a new power and functional safety solution for systems based on the R-Car V3H SoC for ADAS automotive front cameras and driver monitor cameras ⁽⁴⁾. These R-Car solutions improve CNN performance efficiency by 20% compared to previous models, in addition to our PMIC solutions which reduces power loss by up to 33% compared to competitive PMICs under comparable operating conditions.

On March 3, 2022, Renesas announced the expansion of its collaboration with Honda in the field of advanced driver-assistance systems (ADAS)⁽⁵⁾. Honda adopted Renesas' R-Car automotive system on a chip (SoC) and RH850 automotive MCU for its Honda SENSING Elite system featured in the Legend, which went on sale in March 2021. Honda SENSING Elite incorporates advanced technology that qualifies for Level 3 automated driving (conditional automated driving in limited areas). Now Honda has again selected R-Car and RH850 for use in the Honda SENSING 360 omnidirectional safety and driver assistance system, which builds on the knowledge and expertise gained through research and development work on the earlier technology. The first automobile model equipped with Honda SENSING 360 is scheduled for release in China in 2022, with adoption in a broader range of models to follow.

On January 28, 2022, Renesas announced that its "development of technology to reduce power consumption of LSI for autonomous driving by model-based design method" won the Outstanding Business Operator Award at the 2021 NEDO Energy Conservation Technology Development Award sponsored by the New Energy and Industrial Technology Development Organization (NEDO)⁽⁶⁾.

NEDO conducts the Strategic Energy Conservation Technology Innovation Program, in which technology development themes that contribute to energy conservation are publicly invited and a portion of the development costs are subsidized. This award recognizes research and development projects conducted between FY 2012 and FY 2022 that have resulted in innovative technological development that contributes to energy conservation.

The newly awarded model-based design technique to reduce the power consumption of on-vehicle LSIs has realized low power consumption by optimizing the specifications of dedicated circuits by utilizing the model-based design technique so that image recognition required for autonomous driving systems can be processed in a hybrid structure consisting of a General Purpose Processor (CPU) + Dedicated Circuit (Accelerator IP) and more processing can be performed in dedicated circuits with low power consumption. As autonomous driving systems and ADAS (advanced driver assistance systems) become more

widespread, dramatic performance improvements are required for image recognition processing, while reducing power consumption of the LSI that performs the processing is an urgent issue. To address these challenges, Renesas implemented an image recognition algorithm on a hardware model and quickly repeated evaluations to achieve an optimal hardware design, thereby optimizing dedicated circuits that simultaneously improve performance and reduce power consumption.

(1) <https://css.umich.edu/factsheets/autonomous-vehicles-factsheet>

(2) <https://www.asiaeec-col.eccj.or.jp/specialreport202006/>

(3) <https://www.renesas.com/jp/en/about/press-room/renesas-develops-automotive-soc-functional-safety-technologies-cnn-accelerator-cores-and-asil-d>

(4) <https://www.renesas.com/jp/en/about/press-room/renesas-introduces-complete-power-and-functional-safety-solution-r-car-v3h-adas-camera-systems>

(5) <https://www.renesas.com/jp/en/about/press-room/renesas-automotive-semiconductors-selected-honda-adas>

(6) <https://www.renesas.com/jp/en/node/1571901> (Japanese only)

3. Smart Data Center Solution

As data centers increase in size and amount, it becomes increasingly important for these data centers to be run as efficiently as possible, due to the enormous global data center electricity demand. Renesas leads the industry with its high-quality memory interface chips and timing devices used for data centers, enabling the transition from DDR4 to DDR5, the new generation of data centers that not only increases bandwidth, but also improves bandwidth power efficiency by 16% ⁽¹⁾.

On November 4, 2021, Renesas introduced the industry's first industrial temperature DDR4 and DDR5 registered clock drivers (RCDs). This device delivers 2x channel speed improvement, low latency and excellent power management, enabling DDR5 industrial temp dual inline memory modules (DIMMs) and memory-down applications, while providing wide temperature range reliability for existing DDR4 applications ⁽²⁾.

On May 31, 2022, Renesas unveiled the industry's first I3C intelligent switch devices targeting next generation server motherboards and other infrastructure equipment. The new chips vastly enhance scalability and reliability while reducing the complexity of high-performance system designs. They offer advantages of high performance, improved reliability, very low power, and low electromagnetic interference (EMI)⁽³⁾.

(1) <https://www.renesas.com/us/en/about/press-room/renesas-introduces-ddr5-data-buffer-high-performance-server-and-cloud-service-applications>

(2) <https://www.renesas.com/jp/en/about/press-room/renesas-introduces-industry-s-first-industrial-temperature-grade-ddr5-and-ddr4-registered-clock>

(3) <https://www.renesas.com/jp/en/about/press-room/renesas-unveils-industry-s-first-i3c-intelligent-switch-family-next-generation-server-storage-and>

4. Smart Cellular Solutions

5G is the next generation wireless network technology, which compared to the previous 4G network, offers faster connections and allows for more devices to be connected at a time. It could hold positive implications on climate change, due to its ability to support companies and industries in implementing the most efficient

and flexible allocation of resources, through computation and AI analysis. Furthermore, it optimizes data transmission efficiency that reduces the amount of CO2 emission per data transferred. Renesas offers a complete portfolio of industry-leading products for 4G and 5G infrastructure.

On November 10, 2021, Renesas announced expansion of the 5G beamformer IC family with two new dual-polarization mmWave devices optimized for 2x2 antenna architecture for 5G and broadband wireless applications with best-in-class performance at n257, n258, and 261 bands. The highly integrated F5288 and F5268 transmitter/receiver (8T8R) chipsets sit on a small 5.1mm x 5.1mm BGA package and feature the industry's highest Tx output power capability in silicon – delivering more than 15.5dBm linear output power per channel ⁽¹⁾. The F5288 has 33% lower power consumption and leads to 8.4Kt of reduced/avoided GHG per year, compared to similar products by industry competitors.

(1) <https://www.renesas.com/jp/en/about/press-room/renesas-expands-5g-mmwave-beamformer-portfolio-industry-leading-transmitter-output-power-capability>

5. Smart Society Solutions

The solutions that Renesas provides through its semiconductors and sensor solutions not only increases energy efficiency of each product, but can also enhance performance of end applications and systems as whole, contributing to reduction in CO2 emission and energy consumption, as well as improvement in the well-being of people. Our MCU/MPU/SoC solutions, sensors, analog and power semiconductors is used in a variety of applications from industrial sectors, renewable energy to home appliances and IoT devices.

One example of these applications is renewable energy. Renesas' 8th generation IGBTs, which utilizes our low-power design expertise, allows for more than 30% reduction in power loss and increases energy efficiency of all systems.

Another example of these applications, is factory automation. In the industrial sector, digitalization and smartification is now implemented, and demand towards end point computing for factory automation is increasing. Renesas' AI technology designed for factories, adds processing capabilities to MCU/MPUs and achieves the same processing power as high-end AI chips using only a few watts of electricity in the process. In addition, Renesas provides sensors and MCUs needed to control and operate these factory automations, such as our latest RZ/V MPU series announced on May 19, 2021, and can reduce power consumption by 80% compared to previous generations ⁽¹⁾.

Additional examples of these applications is IoT and home appliance. Thanks to IoT, home appliances and industrial machinery are attaining greater functionality from network connectivity and human machine interface (HMI) enhancements. This added functionality also leads to greater energy efficiency, which could be seen in technology like air conditioners with inverters included in them, which have 58% less power consumption compared to air conditioners without. The RL78, RX, and RA products from Renesas' MCU portfolio, announced on April 13, 2021, achieves 30% less electricity consumption compared to past products. ⁽²⁾.

On June 22, 2022, Renesas is changing the way designers build sensor-connected IoT applications with a range of new solutions targeted at faster design cycles, improved accuracy, and reduced system cost. In addition to the new HS4XXX family of relative humidity and temperature sensors, Renesas is introducing the ZSSC3281 sensor signal conditioning (SSC) IC for highly accurate amplification, digitization, and sensor-specific correction of sensor signals⁽³⁾. By combining these temperature and humidity sensors and sensor signal conditioners with MPUs and MCUs, Building Automation (BA) and Home Appliance (HA) air conditioning control can be achieved with high precision, fast measurement response time, and ultra-low power consumption, contributing to power savings for BA and HA.

- (1) <https://www.renesas.com/jp/en/about/press-room/renesas-launches-entry-level-rzv2l-mpus-best-class-power-efficiency-and-high-precision-ai>
- (2) <https://www.renesas.com/jp/en/about/press-room/renesas-strengthens-rl78-family-low-power-mcus-16-bit-general-purpose-rl78q23>
- (3) <https://www.renesas.com/jp/en/about/press-room/renesas-delivers-industry-s-most-complete-intelligent-sensor-solutions-iot-applications>

6. Renesas' Green Devices and Technology

For a long time Renesas has been a world-leading supplier of low-power MPUs and MCUs, and recently has expanded its power-efficient analog and power portfolio through the acquisitions of Intersil, IDT and Dialog. Achieving high energy efficiency in our products is a principal goal in each step of our research and development, as well as design processes.

Renesas has taken many initiatives internally, in order to develop green devices and technology. On June 16, 2022, Renesas announced that it has developed circuit technologies for an embedded spin-transfer torque magnetoresistive random-access memory (STT-MRAM, hereinafter MRAM) test chip with fast read and write operations fabricated using a 22-nm process⁽¹⁾. The test chip includes a 32-megabit (Mbit) embedded MRAM memory cell array and achieves 5.9-nanosecond (ns) random read access at a maximum junction temperature of 150°C, and a write throughput of 5.8-megabyte-per-second (MB/s). Faster rewriting time reduces system downtime during over-the-air (OTA), which is essential for endpoint devices, reduces code rewriting time at set manufacturers, and contributes to efficiency and energy savings by applying the latest applications through code rewriting.

On February 24, 2022, Renesas announced the development of two 2.4 GHz RF transceiver technologies that support the Bluetooth® Low Energy (LE) low-power, near-field communication standard⁽²⁾. The new technologies also achieve a smaller mounting area and better power efficiency. In addition to being compact, low cost, and power efficient, IoT devices must provide flexible support for Bluetooth LE regardless of their implementation format. Renesas has developed two new technologies to address these requirements: 1) a matching circuit technology that covers a wide impedance range and enables the IC to match a variety of antenna and board impedances without an external impedance-matching circuit; 2) a signal correction technology for locally generated reference signals that uses a small circuit to self correct inconsistencies in the circuit elements and variations in surrounding conditions without calibration. They offer best-in-class power efficiency, with power consumption of 3.6 mW and 4.1 mW during reception and transmission respectively. These advances enable the small size, low cost, and low power consumption of Bluetooth LE, which is widely applied in IoT devices.

- (1) <https://www.renesas.com/jp/en/about/press-room/renesas-develops-circuit-technologies-22-nm-embedded-stt-mram-faster-read-and-write-performance-mcus>
- (2) <https://www.renesas.com/jp/en/about/press-room/renesas-develops-bluetooth-low-energy-rf-transceiver-technologies-simplify-board-design-reduce>