Special Feature 2

Car Electronics Technology to Help Promote the Use of a Vehicle as a Power Source

Evacuation shelter without power
(2018 Hokkaido Eastern Iburi Earthquake)
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Car electrification is progressing in line with the enforcement of more stringent environmental regulations worldwide and higher environmental consciousness among customers, as evidenced by the widespread use of hybrid vehicles (HV), plug-in hybrid vehicles (PHV), electric vehicles (EV) and fuel cell vehicles (FCV). This Special Feature presents some of our power source devices that utilize the power source functionality of electrified vehicles to bring convenience, joy and a sense of security to customers.

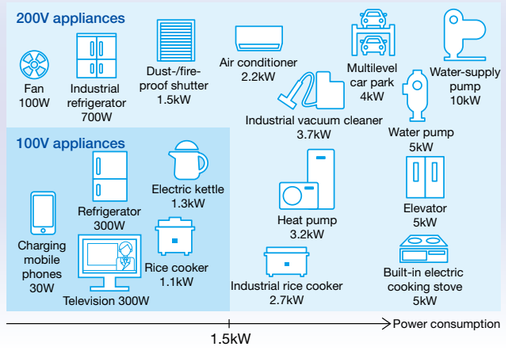
DC-AC Inverters Enabling Outdoor Use of Various Home Electric Appliances

A high-capacity battery is used to operate an electrified vehicle, and it has been attracting a great deal of public attention for its additional use as a power source.

In 1995, Toyota Industries rolled out an on-board DC-AC inverter that converts DC from the vehicle-mounted battery into 100V AC. This was the first DC-AC inverter in the world to be mounted at the time of vehicle assembly*1.

In 2001, we released another model for HVs and other electrified vehicles with a maximum output of 1.5kW, which allows the use of a broader range of home electric appliances from electric cooking tools to refrigerators and televisions.

*1: Survey by Toyota Industries Corporation



Jun Kumeno
General Manager, Business Planning Department, Electronics Division
(As of March 31, 2019)

The Car Electronics Business Satisfying Car Electrification Need at a Higher Level

The beginning of Toyota Industries' Electronics Business dates back to the 1960s when we started the development and production of inverters, controllers and other electronics products for the Lift Truck Business, in which the need for electrification was already rising. The power electronics and power semiconductor technologies, which we have augmented through the development of electric lift trucks, have been utilized in the subsequent development of automobile-use products.

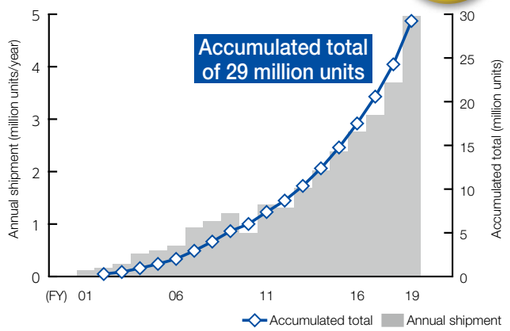
Vehicle-mounted products must offer the levels of quality and durability necessary to properly function over a wide range from low to high temperatures and under harsh usage conditions involving vibrations, rainwater and dust. We work to ensure the required performance by leveraging our strengths cultivated through the development of various key components for automobiles. We also utilize our know-how from the vehicle assembly business to create products optimally designed for mounting in vehicles.

Building on these strengths, we have developed DC-AC inverters with improved resistance against heat and vibrations and a better ability to shield electromagnetic noise. Since launching the first product, we have maintained the world's No. 1 market share*2.

*2: Survey by Toyota Industries Corporation

No. 1 global market share of 45%

■ Shipment Volume of DC-AC Inverters (60W to 1.5kW)



Note: On June 18, 2019, accumulated production exceeded 30 million units.

Besides DC-AC inverters, Toyota Industries develops and produces a range of electronics products. These include DC-DC converters that convert the high voltage of vehicle batteries into a lower voltage level to feed power to such devices as wipers and lights; rear inverters to provide a 4WD option for electrified vehicles; and on-board chargers and charging stands for PHVs and EVs. These products satisfy varying needs related to the electrified vehicles of automakers around the world, including Toyota Motor Corporation (TMC).

Expanding Applications of Power Source Technologies

DC-AC inverters, which had mainly been used in outdoor recreational activities, have drawn much public recognition as an emergency power source after the 2011 Great East Japan Earthquake. Back then, electrified vehicles were used as a power source to charge mobile phones and supply power for lighting and heating at evacuation shelters and homes.

Toyota Industries has since stepped up its development efforts so that our technologies and know-how can help people during a disaster and at various other occasions. At the same time, we have proactively engaged in discussion with universities, government agencies and other companies as an effort to promote the use of a vehicle as a power source in a variety of applications.

In the following sections, we provide three examples of product development initiatives utilizing our power source technologies.

Smartphones and other devices at a charging corner (2016 Kumamoto Earthquakes)
© The Yomiuri Shimbun

Drill at Toyota Industries for cooking and serving meals in a disaster

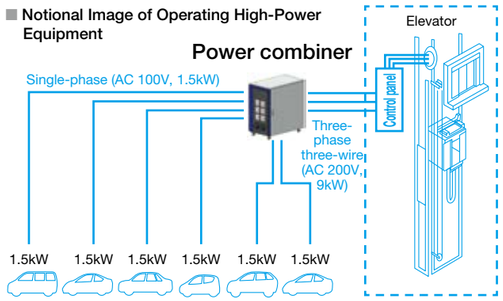
Initiative 1

Connecting Multiple DC-AC Inverters to Run High-Power Appliances during a Power Outage

To enable the operation of elevators, multilevel car park lifts, lighting fixtures of evacuation shelters, water-supply pumps and other high-power appliances and equipment when power is lost during a disaster, we developed a power combiner to connect six 1.5kW vehicle-use DC-AC inverters to provide a high wattage of 9kW.

In fiscal 2020, we will begin feasibility tests jointly with relevant local governments to promote early commercialization of the power combiner as an emergency power source for local government offices, hospitals, welfare facilities, condominiums and large commercial facilities.

■ Notional Image of Operating High-Power Equipment



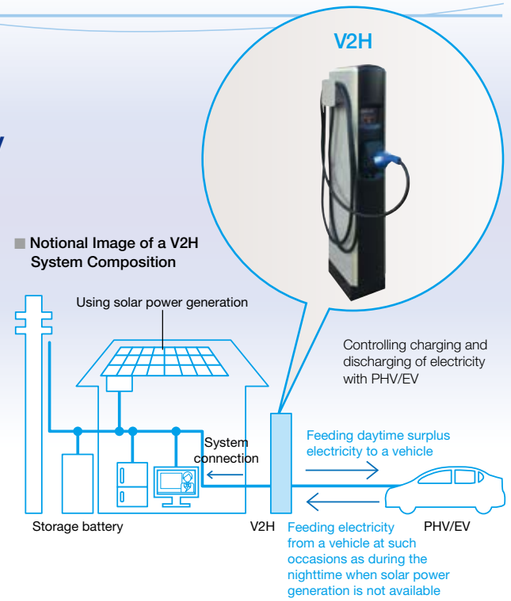
Initiative 2

Utilizing Charging Stand Technology to Achieve Mutual Vehicle-Home Power Supply

Toyota Industries develops and sells charging stands for PHVs and EVs. By applying the technology used in these products to bridge an external power source and a vehicle, we have developed a vehicle-to-home (V2H) system*3 to achieve a two-way power supply. The system accumulates a surplus of electricity generated by home solar panels or lower-priced nighttime electricity in a vehicle and feeds it back to a household when necessary. It can optimize household power consumption or serve as an emergency power source in a disaster. We are also developing a solution that can be linked to a home solar power generation system, and in anticipation of future partnerships with power companies, a software program to optimize the supply and demand balance of electricity.

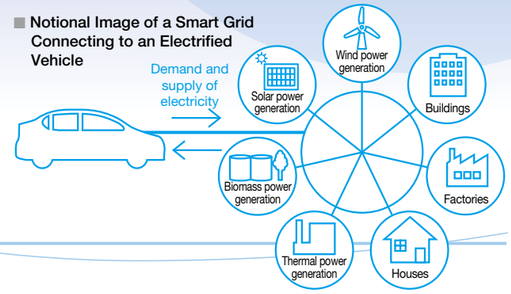
Building on the development of the V2H system, we intend to expand our business field from solely feeding power to vehicles to optimizing the charging and discharging of power between vehicles and various facilities and equipment, and in turn contribute to the creation of a smart grid*4 society.

■ Notional Image of a V2H System Composition



*3: General term used to refer to systems and equipment designed for using in home electricity accumulated in PHV/EV batteries
*4: Power grid that can control and optimize the flow of electricity both from the demand and supply sides

■ Notional Image of a Smart Grid Connecting to an Electrified Vehicle



Initiative 3

Converting High Power Output of a Fuel Cell (FC) Bus to Lower Power Output for Use as a Power Source for Evacuation Shelters or at Outdoor Events

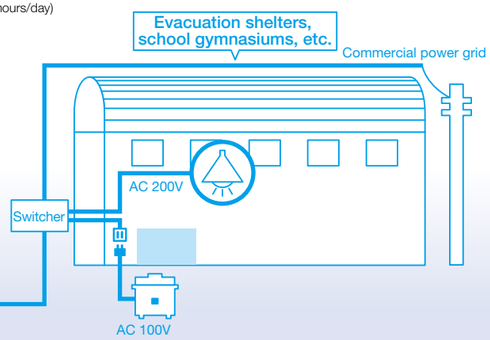
We have developed and released a vehicle-to-load (V2L) system*5 that uses the power generation function of an FC bus to supply electricity externally. This system can feed power simultaneously through six 100V 1.5kW outlets, equivalent to about four to five days' worth of power usage*6, which allows its use as a power source at outdoor events or for evacuation shelters.

Our V2L system is compatible with the SORA FC bus, which was released by TMC in March 2018 and has been already adopted by the Bureau of Transportation of the Tokyo Metropolitan Government and other private-sector bus operators.

Toward the year 2020, we anticipate more than 100 additional SORA FC buses will be on the road, including those required for the 2020 Tokyo Olympic and Paralympic Games, and will be utilized in various situations.

*5: Systems and equipment designed to use the power accumulation and generation capabilities of HVs, PHVs, EVs and FCVs to feed power to electric appliances
*6: Calculated by using a power use estimate of about 50 kWh/day (using lighting for six hours/day)

TMC's SORA FC bus



The initiatives described in this Special Feature are only a few examples of our products for use during disasters and other situations, which are based on our power source technologies. Going forward, we will continue to explore new applications for our existing products as well as develop new products in order to respond to ever-changing customer needs.