Eco-friendly Products of Fujitsu Group

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The Fujitsu Group takes environmental awareness seriously, and as part of tackling environmental issues in society such as climate change, energy conservation and sustainable use of natural resources, it provides eco-friendly products and services globally, catering for needs at various levels from infrastructure to business and personal uses. This paper features five award-winning products that represent the Fujitsu Group's excellent eco-friendly products, namely UNIX Server SPARC M10 (UNIX server), FUJITSU Datacenter Product Modular Data Center (container datacenter), FACT-V X200 (ATM), FPSS Commercial Type I (universal power storage system), and Nocria X-series (air-conditioning). The UNIX server was awarded the Environment Minister's commendation in the Technology Development and Commercialization Category of the Minister of the Environment's 2013 Commendation for Global Warming Prevention Activity. Modular Data Center won a Board Members' Recommendation at Green IT Award 2013 Japan. Other products received various awards for environmental contribution through the Fujitsu Group's awards program. This article presents these products focusing on the new technologies that have been developed and deployed in them. It also outlines their energy efficiency and other environmentally conscious design aspects.

1. Introduction

Already, information and communications technology (ICT) equipment including servers is becoming enhanced in terms of its performance and degree of integration, and there is an increase in weight per server rack; furthermore, efficient installation of ICT equipment has recently become difficult. As a result, there is demand for the development of data centers that are highly efficient and require less initial investment. With industrial equipment such as automated teller machines (ATMs), there are increasing needs for a reduction of standby power consumption, etc. In addition, since the Great East Japan Earthquake, there has been growing demand for safe and long-life power storage systems capable of more stably supplying power. With home air conditioners, manufacturers are urgently required to achieve both an energy-saving effect and comfort as energy conservation regulations are legislated in Europe and other parts of the world.

In light of these situations, this paper describes new technologies used in environmentally conscious products.

2. UNIX server

Of data center operation costs, the cost relating to power consumption of air-conditioning equipment accounts for a large portion. In order to reduce the power consumption of air-conditioning equipment, major challenges that must be tackled are reducing the power consumption of hardware including servers and improving space efficiency. We have developed UNIX Server SPARC M10, which makes it easier to solve these challenges.

2.1 Features of SPARC M10

SPARC M10 is a next-generation server that meets the requirements for high-speed, real-time processing to address the needs of the big data era, scalability allowing flexible operation in line with business growth (up to 64 CPUs/1024 cores) and an excellent reliability and power/space conservation that are comparable to those of mainframes while ensuring conformity to

environment-related standards (**Figure 1**).

2.2 Technologies contributing to environmental load reduction

SPARC M10 helps to reduce environmental load thanks to its power-/resource-saving design.

1) Environmental load reduction of server itself

Of the power consumed in a server, the amount consumed by the processor accounts for a large portion. SPARC M10 is equipped with up to four CPUs per model to realize higher integration, higher performance and improved energy efficiency. The high-performance processor SPARC64 X developed by Fujitsu adopts the 28 nm semiconductor process technology and has 16 cores per processor. In addition, it uses the latest process technologies to aggregate the peripheral LSIs within the chip, which has achieved reduced power consumption and higher integration by cutting back on the number of components, for size reduction.

However, reducing size by using the latest technologies to achieve greater integration and aggregation of the peripheral LSIs causes heat to concentrate in the processor. For stable operation of a server device, the processor must be efficiently cooled to maintain the temperature at or below a certain level, which, with the air-cooling technologies used for common servers, requires larger heat sinks and the addition of cooling fans. However, reducing the size of servers and increasing their density are essential to reducing environmental load, and so achieving technological innovation from the conventional air cooling has been necessary. High-efficiency cooling technologies include liquid cooling technology, which is used in some supercomputers. However, liquid cooling requires equipment that supplies cooling water to the data center and the server also needs to be periodically stopped for equipment maintenance, which makes it unsuitable for servers in the business field. To deal with this problem, we have further evolved the liquid cooling technology and newly developed "hybrid cooling technology-Liquid Loop Cooling," which combines the advantages of the conventional water cooling and air cooling: The former is high efficiency and the latter eliminates the need for dedicated equipment in the data center and eliminates the need for maintenance (**Figure 2**).

The Liquid Loop Cooling Unit is composed of cooling plates that draw heat from the processor, a radiator for dissipating heat to the atmosphere and cooling unit (piping) connected with pumps for circulating the coolant. We have optimized the respective parts and integrated them into a compact unit, and thereby reduced the server size and fan energy, which was not possible with the conventional air cooling. In addition, the unit has built-in pumps and a radiator to eliminate the need for equipment to circulate cold water, which was separately required by the conventional liquid cooling. Furthermore, many technologies have been integrated in the unit to ensure its stable, long-term operation including the employment of long-life pumps newly developed and prevention of coolant deterioration by means of an additive, resulting in making the unit maintenance-free.

Efficient cooling is realized with SPARC M10, where we have improved cooling air ventilation by eliminating the backplane and controlling the cooling

Figure 1
SPARC M10 lineup.

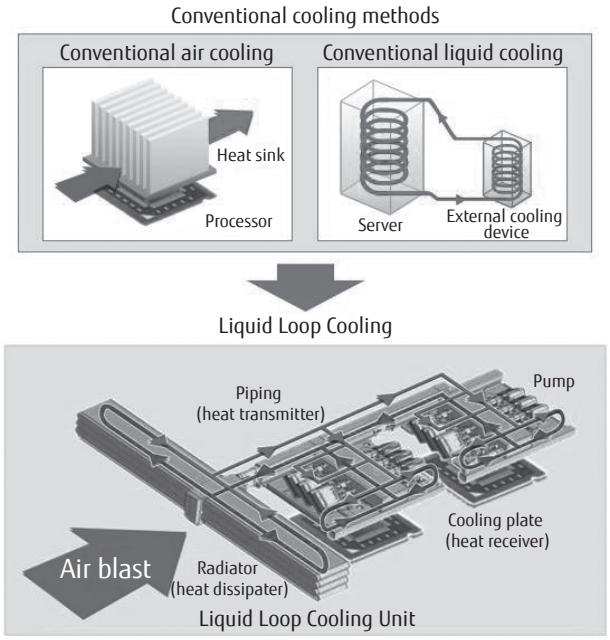

Figure 2
Hybrid cooling technology: Liquid Loop Cooling.

fan rotation speed according to the processor temperature, which has further reduced the fan energy.

One important technology that brings about a power-saving effect is power supply technology. Conversion loss is generated when the voltage required to drive semiconductors and various components used for ICT equipment is produced in a power supply unit, and how to minimize this loss is a major challenge in the development of a power supply unit. The power supply unit of SPARC M10-1 has achieved a conversion efficiency of 92% (with a load factor of 50%) and obtained the 80PLUS[note)] GOLD certification. The power supply units of SPARC M10-4 and SPARC M10-4S, which features a conversion efficiency of 94% (with a load factor of 50%), has earned the 80PLUS PLATINUM certification.

To reduce environmental load, it is important to use eco-friendly materials while also reducing power consumption. Fujitsu has developed the industry's first water-based paint that can be applied to plastic housings of ICT equipment, and it reduces the amounts of new oil used by 54% and volatile organic compounds by 80% as compared with the conventional solvent-based paints, contributing to resource conservation. With SPARC M10, this water-based paint is applied to the main unit's front panel, thereby helping to conserve the global environment.

2) Environmental load reduction during operation

SPARC M10 is provided with a mechanism that helps to reduce the environmental load of customers' operations when it is used, besides reducing the environmental load of the device itself.

If it is possible to visualize the operation status, running status, load factor, etc. of equipment, the results can be used to take measures for reducing power consumption. SPARC M10 is equipped with a system monitoring mechanism, XSCF (stands for eXtended System Control Facility), as a standard feature, which allows information, including the working conditions, power consumption, intake air temperature and exhaust air volume of the system during operation, to be acquired at any time. In addition, it monitors the intake air temperature and CPU temperature of the main unit and shows a message when any temperature error has been detected. This makes it possible to prevent system instability due to a temperature increase.

In operating a data center, it is sometimes necessary to pay attention to the electric energy used and if required restrict power consumption. With SPARC M10, the Power Capping feature can be used to set an upper limit to power consumption, thereby making it easier for users to control the server and reduce the power available to it at a given point in time.

The function of saving energy according to the running status is provided by the Power Saving feature, which reduces the power consumption of unused or low-utilization-rate hardware. For the power saving level, the user can select between Elastic mode for power conservation and Performance mode for performance that is given priority over power conservation. Energy usage according to the business volume can be achieved by setting the mode according to the user's operation. For example, Elastic mode can be selected when the volume of processing is small in a slack season and Performance mode in a busy season.

2.3 Energy-saving effect and environmental affinity

SPARC M10 has achieved a reduced power consumption and installation space as compared with

note) Energy saving program for electric devices promoted by the 80PLUS program (Ecos Plug Load Solutions).

Fujitsu's conventional model of an equivalent class (**Figure 3**).

SPARC M10 offers virtualization technologies called "hardware partitioning," "Oracle Solaris Zones" and "Oracle VM Server for SPARC" as standard features. A virtualization technology can be selected according to the business characteristics of the customer.

Consolidation and integration by virtualization raises expectations not only for improved efficiency of operation and management such as reduced maintenance work but also reduction of the installation space and power consumption by physically reducing the number of units of hardware assets (**Figure 4**).

In addition, the latest processor SPARC64 X allows flexible and large-scale server consolidation by combining SPARC M10, which features significantly improved performance, with the virtualization features. This may lead to further expansion of its beneficial effects including, for example, a reduction of the power required for air-conditioning equipment in an entire computer room.

In this way, we are striving to reduce the environmental load of SPARC M10 throughout a life cycle from design and development to use of an ICT product.

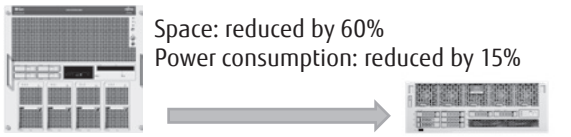

Figure 3
Comparison with conventional model (Fujitsu product of equivalent class).

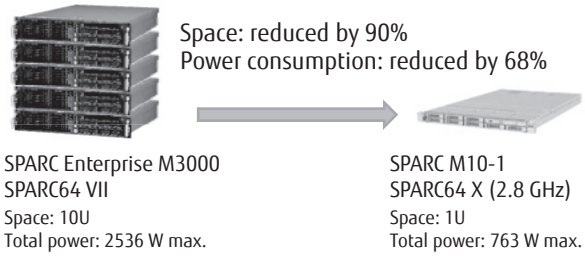

Figure 4
Example of server consolidation while maintaining equivalent performance.

3. Modular Data Center

Along with the increase in amount of power consumed by servers, due to the improvement of their computational capacity, and higher weight per server rack because of their higher mounting density, it is becoming difficult to efficiently house ICT equipment in existing buildings. This has given rise to demand for new buildings provided with high cooling capacity, load carrying performance and power supply capacity. However, the initial investment that is required when constructing a building is large, between a few billion to a few tens of billions of yen, and this has posed a challenge to users who desire to minimize the initial investment to develop their services in a phased manner. There is also another challenge arising from the international demand for environmental friendliness and the recent electric power situation: the need to reduce electric energy consumption required for site operation. FUJITSU Datacenter Product Modular Data Center, or a container datacenter, has been commercialized to meet these challenges (**Figure 5**).

3.1 Features

Modular Data Center is a container datacenter that packages the physical infrastructure required for data centers including air-conditioning equipment, power reception equipment and racks and software required for data center operation. It features the installability and compactness of a container datacenter, which is regarded as a structure under the Building Standards Act, and high energy-saving capability. The

Figure 5
Modular Data Center.

employment of indirect outside air cooling provides an operation environment that is friendly to ICT equipment while pursuing energy efficiency. In addition, further energy-saving and efficiency-improvement features are offered by having linked control of the internal ICT equipment and facilities.

3.2 Operation and management software

Software is used to realize the function of linking and integrating so as to manage and control the operations of the facilities and ICT equipment and thus reduce the operational burden placed on the administrator and support energy-saving operation of the data center.

The major operation and management features include:

- Management of configuration information and status of facility and ICT equipment
- Output of reports of measured data of power consumption, temperature, etc.
- Automatic control by policy setting

Of these, the following shows a specific example that describes automatic control by policy setting.

The servers in a rack or arbitrary multiple servers in a rack are defined as a unit called a group, to which an upper limit control (peak shaving) of the total power consumption is applied (**Figure 6**). If the user sets in advance as policies the power consumption upper limit, operation priorities of servers and trigger conditions for the energy-saving mode, any occurrence of a state that meets those conditions causes the servers to enter the energy-saving mode in the order of low operation priority to maintain the total power consumption at or below the upper limit. In the past, high-density mounting of ICT equipment required a predefined restriction on the quantity and types of the ICT equipment to be mounted so as to prevent the maximum power consumption of an entire rack from exceeding the power supply capacity. By using this software, they can be restricted by software according to the actual power consumption changes, which allows ICT equipment to be mounted in a higher density. The policies can be set for each server and server operation such as reducing power consumption only for less important servers is possible.

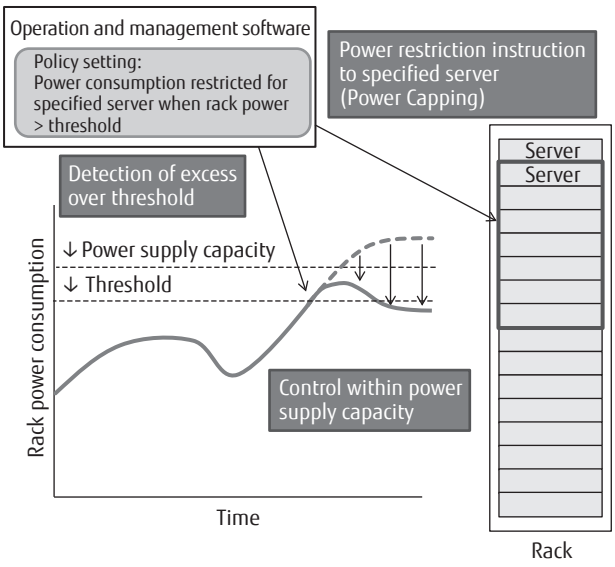

Figure 6
Example of control: Power Capping.

A practical example of installation of 1U/2-way servers is shown in **Figure 7**. Provision of upper limit control of the total power consumption has successfully improved the rate of occupancy by servers by over 40%.

If the server system constructed in a container is virtualized, it is also possible to stop low-utilization physical servers only during specified hours such as nighttime, when the number of uses decreases.

Conversely, if the upper limit is set to a lower value than usual for daytime hours, when the power supply and demand balance becomes tight, power usage can be easily equalized (peak shifting).

Traditionally, at ordinary data centers, it was common to operate ICT equipment in a range sufficiently lower than the maximum capacity (cooling and power supply capacity) of the facilities to be on the safe side for fear of the worst. This led to a failure to make the most of the original capacity of the facilities because the servers had to be more sparsely laid out than otherwise and lower-capacity servers had to be employed. By taking advantage of the peak shaving and peak shifting features as described above, facilities can be used near the limits of their capacity and, even in the event of a failure (such as equipment failure and tight power situation), continuity of services can be ensured without stopping ICT equipment.

3.3 High-efficiency air-conditioning system

For Modular Data Center, we have adopted a hybrid air conditioner combining indirect outside air cooling and an air compressor as shown in **Figure 8**.

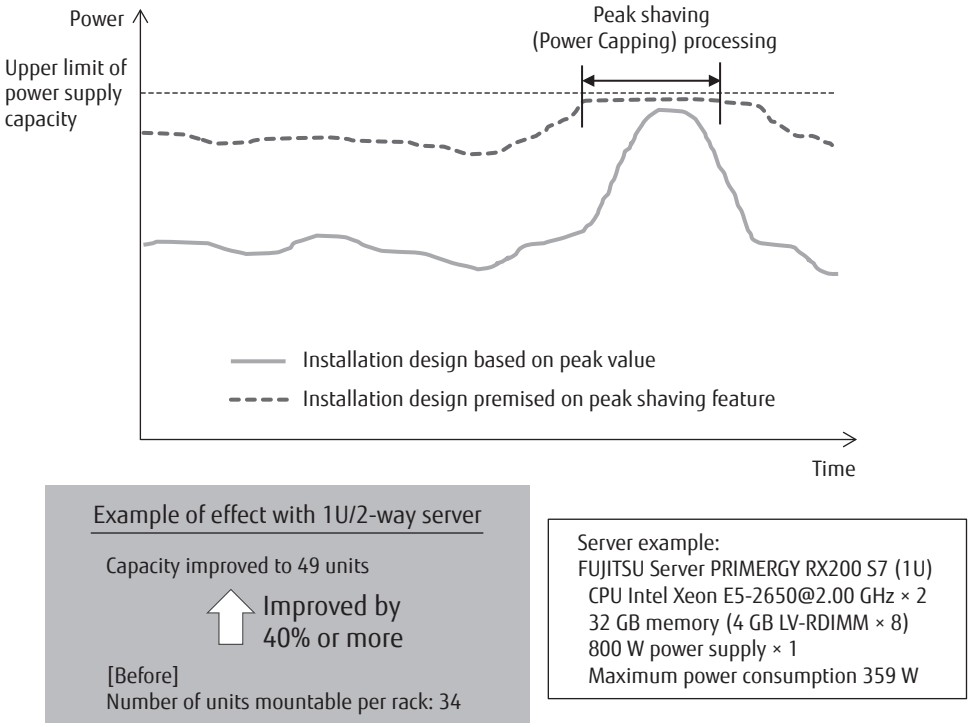

Figure 7
Improvement of rate of occupancy by power control.

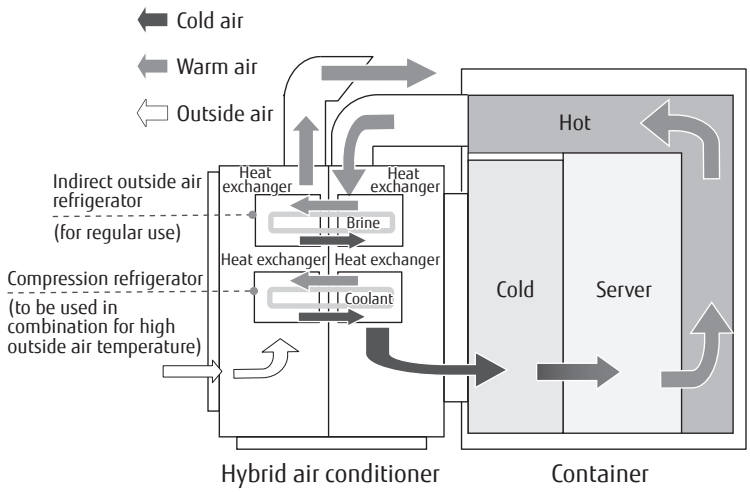

Figure 8
Hybrid air conditioner.

In regular operation, only the outside air temperature is used to cool inside the container. The air compressor is used for forced cooling only when the outside air temperature is high as in summer in the daytime. The system automatically switches between these cooling modes. Power supply is the only infrastructure required and cold water or city water is not necessary. This air-conditioning system does not draw outside air directly into the server room in the container, which means that the impact of dust, etc. on servers is minimized, and so they can be installed anywhere.

3.4 Energy-saving effect and environmental affinity

When installed in Japan, Modular Data Center shows a capability of 1.1 plus in power usage effectiveness (PUE), an indicator of data center operation efficiency. PUE is a ratio of the power consumption of ICT equipment to that of an entire data center and a value closer to 1 means a better power usage efficiency for ICT equipment. It was reported that the average PUE of data centers in Japan was approximately 1.74 in FY2010.[1)] Modular Data Center is capable of reducing power consumption by about 40% from these conventional data centers. In addition, Fujitsu offers a disposal service that recycles this product and ICT equipment after use to contribute to resource conservation and prevention of environmental disruption.

Modular Data Center as described above was awarded a Board Members' Recommendation at the Green IT Awards 2013.[2)] The reason for the award is that it achieves a 40% reduction of power consumption from conventional data centers by combining an air conditioner that selects the optimum cooling mode according to the outside air temperature and software that controls power consumption of ICT equipment according to the system operation status. We think that winning this prize is proof that society highly rates the developed technologies that have been commercialized by Fujitsu. We intend to continue implementing new technologies related to ICT equipment and facilities, thereby providing data center solutions that allow further energy-saving operation and cost reduction.

4. Automated teller machine (ATM)

Financial institutions have been pushing ahead with introduction of ATMs for automating teller operations. In the 1990s, in particular, improvement of processing performance was the keyword, and was characterized by the catchphrase "payment transaction complete in 10 seconds." Subsequently, financial institutions' view that ATMs are terminals to complement teller operations by processing simple transactions has changed to seeing them as service points capable of more complicated transaction operations and ATMs have evolved into terminals indispensable to such institutions.

4.1 Approach to energy conservation of ATMs

FACT-A, which was released in 1994, is an ATM product that realized high-speed processing. It was also equipped with a revolutionary internal interface that featured environmental friendliness by providing a function of cutting the power to unnecessary units at a given time according to the operations handled by the ATM and higher-speed startup of units. The FACT-V series released in 1999 inherited this interface.

For FACT-V X200 (**Figure 9**), we assumed that its effect would be maximized with industrial equipment by realizing energy conservation and worked on ensuring fundamental energy conservation.

4.2 Energy-saving technology of internal components

The focus of our attention was energy conservation "during standby when waiting for users," which accounts for most of the ATM's operating time. What we worked on first was to improve the efficiency of the device's power supply unit. Recent power supply units are designed to be very efficient and engineers usually attempt to improve efficiency under a condition of maximum load. An ATM has a big built-in mechanical unit, which consumes a large amount of power during transactions. However, these transactions only last for

Figure 9
FACT-V X200.

a few seconds. Most of the ATM operating time is occupied by waiting for users, when power consumption is small. For FACT-V X200, we have adopted a new power supply unit that can improve the efficiency in low load conditions.

Meanwhile, the bill recycling unit is what consumes the most power during transactions. We have also striven to reduce power consumption during operation by reducing the load of the mechanism that generates a driving force for pushing out the bills and by revising the motors.

Furthermore, we have provided the cooling fan of the device with a control that varies the number of revolutions according to the internal temperature of the device. Power consumption has successfully been reduced by decreasing the number of revolutions when the temperature is low. By taking these approaches, we have achieved a standby power consumption of 194 W and maximum power consumption of 650 W, a power consumption reduction of as much as 40% from conventional models.

4.3 Super eco mode

As mentioned earlier, most of the ATM operating time consists of waiting for users. FACT-V X200 has the super eco mode, in which power consumption is reduced by cutting the power to the mechanical unit in the device when a certain period of time has passed without any transaction. This mode allows the power consumption of the device to be reduced to 65 W.

In order to encourage the owners of this device to use this mode, the time for recovery from the super eco mode must be short so that users will not be kept waiting. With FACT-V X200, the startup processes of the control CPU in the mechanical unit have been simplified and unnecessary mechanical reset operations reduced so as to minimize the startup time. Recovery to normal mode can be achieved within 9 seconds, when all transactions offered by the ATM become available.

4.4 Adoption of eco-friendly materials and recycling

For FACT-V X200, we have worked on making a product while paying special attention to its environmental performance by taking approaches such as use of recycled and plant-based plastics.

Chrome-free steel plates have been used for housings and powder coating used as a means of providing a finish, thereby making it possible to reduce the use of volatile organic compounds (VOCs) and recover and reuse paints.

From the perspective of the device's design, the customer console's cover component can be divided up for removal. This portion is subject to modification after product shipment in order to meet the demands of installation of optional parts, etc. and this design makes it possible to reduce the number of parts to be disposed of when a modification is implemented.

The FACT-V series has used various eco-friendly parts and materials up to now. FACT-V X200, which employs power-saving and other new technologies, has been certified as a Fujitsu Super Green Product.

We are committed to enhancing the convenience of customers who use ATMs and people who operate them and furthering the development of products that are even more environmentally friendly.

5. Universal power storage system

With the power supply situation that changed in the wake of the Great East Japan Earthquake, we have entered the age of "producing, storing and wisely using electricity" respectively in homes, offices and factories. As a result, there have been growing demands for storage batteries for disaster prevention applications and the market for stationary storage battery systems is expected to grow significantly. In addition, along with the construction of smart grids and dissemination of renewable energy, storage batteries started to become popular as social infrastructure that permits optimum use of stable electric power around 2010.

In order to stay in step with the changes in the business environment as described above, FDK Corporation (FDK) has added power storage systems, which were born out of the synergy of the electronic and battery component technologies it owned, to a new business domain as a pillar of new development. The company has developed a universal power storage system FPSS (standing for FDK Power Storage System) Commercial Type I (**Figure 10**) that makes use of a nickel-metal hydride battery, which features safety and long life. This power storage system is provided between the grid power and equipment used and connected to the outlet of the power storage battery main unit, and it automatically supplies power when a power

Figure 10
FPSS Commercial Type I.

outage occurs. It can also be used to shift power usage peaks in ordinary operation, which contributes to the reduction of CO_2 and power rates.

5.1 Development policy

As a development policy, we assumed the following scenes of use with the priority given to the user's benefits and aimed to create a storage battery system available as an "emergency power supply" in the unlikely event of a power outage and for power peak shaving in ordinary operation. We focused on user convenience in the product design, in areas including cleanliness, quietness, portability and a height allowing the device to be stored under a desk so that it could be installed according to the customer's needs in an office environment. The system has two storage capacity specifications: 2.5 kWh and 1.6 kWh.

1) In ordinary operation
- Stores power from commercial power or photovoltaic (PV) power generation to ensure power supply as an auxiliary of outdoor generators.
- Reduces daytime power costs by making use of power from PV power generation and storage of nighttime power and ensures minimum required power for living during scheduled power outage periods including indoor lighting, mobile phones, PCs, TVs and refrigerators.

2) In emergency
- Switches the power supply automatically to ensure energy necessary for continuation of minimum required operations.
- Ensures expanded power supply to uninterruptible power supplies (UPSs) for existing equipment that supplies power to the UPSs of critical systems to delay the stopping of the components.

5.2 Market trends

The size of the market for domestic stationary power storage systems was 23 MWh in terms of the equivalent power storage capacity in FY2011. The market, which grew by 158% in FY2012 from the previous year, is estimated to continue growing at a high rate of over 120% annually to reach 885 MWh in FY2020 (about 40 times larger than FY2011) (**Figure 11**).[3),4)] Based on the development policy, we have set the target market of this product at the segment for "storage batteries and emergency power supplies" of 3 kWh or smaller, which are intended to serve as stopgaps until stable operation of UPSs and generators is achieved.

5.3 Product features

With the development policy and market trends as explained above taken into account, we have striven to ensure that product features bring the direction of improvement in line with environmental consciousness and to improve users' convenience. The product features include:

1) Adoption of nickel-metal hydride batteries featuring low environmental load and high safety
- The amounts of environmentally hazardous substances used are smaller than other battery systems (lead and sulfuric acid for lead-acid batteries and cadmium for nickel-cadmium batteries)
- Electrolytes are aqueous and inflammability is extremely low if ignited. The batteries are characterized by resistance to combustion and smoking in worst-case scenarios such as destruction of the product and acknowledged to be safe as compared with lithium-ion and other batteries.
- Nickel-metal hydride batteries have an established product collection and recycling model, which realizes a significant reduction of the amount of items to dispose of and allows them to be reused as a metal product material.
- The nickel-metal hydride batteries used have obtained a third-party safety certification (UL2054).
- The batteries feature very small capacity degradation even after long-term use and can operate in an environment of –10°C, which makes it possible

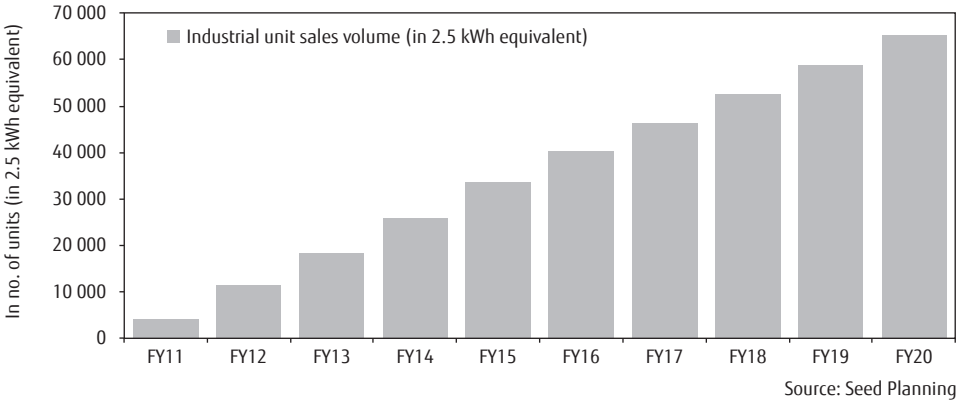

Figure 11
Industrial power storage system market forecast (domestic).

to install them in low-temperature areas and locations.

2) Realization of space efficiency and weight reduction as a system

- The high-density mounting of nickel-metal hydride batteries has realized one of the smallest volumes in the industry (111 L) as a product in the 2.5 kWh storage capacity class (based on survey by FDK).
- The weight of the housing has been trimmed to achieve a significant weight reduction from the initial model developed (to 79 kg from 95 kg).

3) Scalability

- Power can be stored from a power conditioner of a PV generation system, besides ordinary commercial power, to supply power to various electrical products.
- Management software can be used to enable state management and remote monitoring of up to 30 units by LAN lines.

4) Consideration given to user convenience

- The sophisticated design features a color scheme with cream that matches an office environment.
- The LCD operation panel is located obliquely in front to significantly improve the operability and visibility. The LCD brightness during a power outage has been increased to make it easier to see.
- A function is provided that issues a buzzer sound as well as an e-mail to notify of any component failure detected.
- A timer function is provided to charge with lower-rate nighttime power, which can be used as ordinary daytime power supply to realize reduced office running costs and reduced power consumption during usage peak hours (scheduled operation for peak shifting and peak shaving).
- Supplying power does not cause gas emissions, which allows use in an indoor environment.
- Four outlets (two each in front and rear) are provided to give a layout best suited for the application.
- The seismic isolation leveling foot mechanism, which has a proven track record with Fujitsu servers and other devices, is provided as standard equipment together with casters. This allows the device to be installed where and when required.
- FDK's proprietary life prediction technology is provided and batteries can be used until just before the end of their life. Customers can be notified one year before the end of the battery life by subscribing to a separate maintenance service.

5) Environmental friendliness and economic efficiency[5)]

- Use of peak shifting operation allows reduction of CO_2 (1.4 t/10 years/unit) and the power rate (69 000 yen/10 years/unit).
- Use of peak shaving operation allows equalization of the power used and reduction of the power base rate (100 800 yen/10 years/unit).

For development, the electronics and battery businesses, which FDK has owned, has been integrated and resources of the respective companies in the Fujitsu Group have been utilized for housing design, firmware development, management software development,

maintenance service, etc. It made it easier to have a full product rollout from the start and increased the product added value and led to development of products that have no competition.

The activities for the development of this product won the Fujitsu Group's Environmental Encouragement Award in 2013. At present, we are making arrangements to apply for its certification as a Fujitsu Super Green Product. Based on the development activities built up, FDK is committed to keep developing eco-friendly power storage system products by taking advantage of the safety and other features of nickel–hydrogen batteries.

6. Room air conditioner Nocria X-series

Fujitsu General Ltd. has made use of its proprietary technology for controlling two air currents to develop the Nocria X-series of room air conditioners, which realizes comfort of a natural wind while saving energy (**Figure 12**).

6.1 Air conditioner elements and roles

There are three elements that determine comfort offered by an air conditioner: "temperature," "humidity" and "air current." The biggest feature of this product is the special attention given to air current control.

Air current of an air conditioner has two main roles: "to regulate the temperature of a room by blasting out cool and warm air" and "to control the convection in a room."

6.2 DUAL BLASTERS

Conventional air conditioners had one air outlet at the center that combined the two roles. This series is equipped with side fans "DUAL BLASTERS" (**Figure 13**) on the left and right sides of the indoor unit. The air for cooling and heating is blasted out from the center and room-temperature air from the two sides, so as to give the two roles to the independent air currents respectively. This is a new concept that forms the basis of the development.

Specifically, for cooling, cool air directly blowing hard on the body is not liked in Japan but a breeze of 0.2 to 0.4 m/s is considered comfortable. With this condition, the sensible temperature can be decreased without the need to lower the temperature setting, which raises expectations for an energy-saving effect. However, it is difficult to circulate a breeze across a room with an air current from the center alone and there is only a limited area in the room in which sufficient flow velocity for that purpose can be obtained. To address this problem, besides the cool air blasted out horizontally from the center, this series blasts out room-temperature air taken in from the side of the side fans slightly obliquely downward (45 degrees as a standard) at a higher wind velocity than the cool air. In this way, a breeze is generated across a wider area in the room. The air is circulated as a natural wind without blowing a cool wind directly onto the body, which achieves a comfortably cool feeling, suggesting a breeze, with a moderate temperature setting and offers comfort to even those who do not like being cooled by air conditioning.

Conversely, for heating, warm air is blasted out downward from the center and the side air currents are directed slightly more upward than the warm air to keep the warm air from rising. This prevents ascent of the warm air and circulates a warm wind to every corner of the room, thereby realizing comfortable heating that "keeps the head cool and the feet warm."

Figure 12
Room air conditioner Nocria X-series.

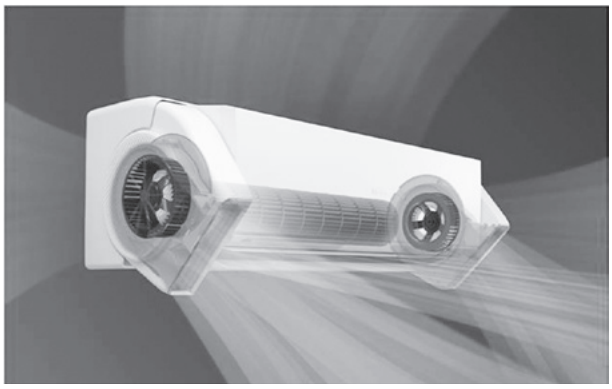

Figure 13
"DUAL BLASTERS" image.

Furthermore, measures have been taken including the adoption of a high-efficiency heat exchanger with the effectiveness improved by approximately 20% from the conventional model to achieve high energy efficiency and leading-class heating capacity at the same time. There are also various other power-saving features provided such as "Hitoride ni eco," which means "eco by itself," in which the temperature sensors integrated into the indoor unit and the remote controller automatically work to prevent excessive cooling and heating.

By developing this series, we intend to meet the need to obtain comfort while saving power by mild air-conditioning operation and reduce energy consumption (energy consumption CO_2 emissions during use).

7. Conclusion

This paper has presented representative examples of the Fujitsu Group's eco-friendly products. We will continue to offer eco-friendly products to meet the requests of customers and society.

Lastly, we would like to extend our sincere gratitude to the people at Fuji Electric Co., Ltd. for their tremendous cooperation rendered to us in product development that led to the winning of Board Members' Recommendation at the Green IT Awards 2013, which was awarded jointly to Fuji Electric, Fujitsu Laboratories and Fujitsu.

References

1) Japan Data Center Council: Revised Power Saving Manual for Data Centers (Ver. 1.3). June 21, 2012.
2) Fujitsu: Fujitsu Modular Data Center Wins Special Judges' Prize at the Green IT Awards 2013. September 18, 2013.
http://www.fujitsu.com/global/about/resources/news/press-releases/2013/0918-01.html
3) Seed Planning, Inc.: Stationary Power Storage Battery/System Market Trends Research: Strategy of Various Companies for Disseminating Storage Batteries in View of Smart Communities. January 27, 2012 (in Japanese).
4) Seed Planning, Inc.: Stationary Power Storage Battery/System Market Trends Research Results. February 9, 2012 (in Japanese).
http://www.seedplanning.co.jp/press/2012/2012020901.html
5) Tokyo Electric Power Company Inc.: Electricity Rate System for All-Electric Houses. As of June 30, 2013.

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